THE USE OF EXPLORATORY SCENARIOS IN DESIGNING POST-MINING

APPALACHIA

by

ASHLEY LYNN STINSON

(Under the Direction of Bruce K. Ferguson)

ABSTRACT

The Appalachian Plateau covers over 100,000 square miles in the eastern United States. For over a century, these mountains have been exploited through underground mining, leaving a host of rural towns plagued by rapidly declining populations, lack of economic fitness, and environmental devastation. This thesis examines how design interventions could be applied in Appalachian post-mining towns to preserve rural livelihood, stimulate reinvestment, and improve environmental conditions. Case study methodology is applied to Vintondale, Pennsylvania, relying on scholarly literature and the author's observations during a site visit to generate exploratory landscape scenarios. The results suggest that there may be ways to address the community, economy, and ecology in Vintondale; however, it was determined that individual town characteristics led to certain design opportunities and/or restrictions.

INDEX WORDS: Landscape architecture, Rural planning, Vintondale, Pennsylvania, Blacklick Creek watershed, AMD&ART, Appalachia, Underground mining, Exploratory landscape scenarios, Environmental remediation, Social reinvestment

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DEDICATION

For Joann Musgrove. She never saw this work completed, but her unwavering love, faith, and pride continue to guide and encourage me.

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CHAPTER ONE: WE DON'T KNOW HOW TO CLOSE DOWN A MINE

The Appalachian Plateau is a large geographic landform in the eastern United States that covers over 100,000 square miles and touches ten states – western New York, in the north, to northern Alabama, in the south (Ferguson 1985). Called a plateau, because it was once an upland area that gently sloped away from the central crests of the Appalachian Mountains, this region has with age, folded and given way to mountain ridges and narrow creek bottoms that alternate in an undulating pattern (Erikson 1976). Over a century ago it was discovered that coal seams were readily accessible in the hollows of these mountains, and it is through coal mining that man has influenced the natural systems within the Appalachian Plateau. The surface of the land is streaked with black and grey, and water bodies run reddish-orange from the mines that open up into the hollows of these mountains (Erikson 1976).

The countless mining operations, both past and present, have also shaped the cultural legacies of the region. Mining settlements formed around the mouths of mine portals and roads connected one settlement town to another. This system of mines created an almost unbroken line of settlement with heavier pockets focused around mine openings. Almost everyone living in these settlements depended on the mining of coal in one way or another, either directly through labor, or indirectly through support services, disability, or retirement

(Erikson 1976, Weber 2008). Even though they are no longer actively mined, the natural and cultural legacies remnant from the underground operations in the early 20th century are still visible throughout the mountains.

Coal was mined for over a century before any environmental regulations were put in place; because of this, mining activities have caused extensive disturbance to land, forests, and waterways, triggering catastrophic damage such as acid mine drainage (AMD), mine subsidence, mountain-top removal, and stream infill, all of which have significant ecosystem impacts (Squillace 1990; Reece 2006; Wei, Wei et al. 2011). The government did not intervene in mining activities until 1910 with the creation of the United States Bureau of Mines (BOM). As described in its mission, the primary concern in establishing the BOM was not the health and safety of the workers or the environment, but the protection of the mining technology, the efficiency of the process, and the economic prosperity of the industry (Office of Surface Mining 2012).

The first major environmental regulation was enacted over a century after mining began in the U. S.; in 1977 the U.S. Surface Mining Control and Reclamation Act (SMCRA) required the reclamation of abandoned mine lands (AML) to a condition that could equally (or better) support the uses of a site prior to mining (Wei, Wei et al. 2011). The act covers the surface effects of underground coal mining as well as coal preparation, processing facilities, and bony piles (Squillace 1990). Even so, only mines permitted after 1977 are regulated. Additional regulations came in 1977, with the establishment of the

Office of Surface Mining (OSM), which houses the Abandoned Mine Lands program; this program works to eliminate or reduce the dangers to public health, safety, and the environment resulting from the estimated 500,000 abandoned mines in the United States (Office of Surface Mining 2012). Since 1977, the AML program has awarded over $4.06 billion to partners in 24 states, which has been used to reclaim approximately 240,000 acres of high-priority coal-related problems and almost 315,000 acres containing bony refuse (Office of Surface Mining 2012).

The timeliness of this thesis has been reinforced by current events on the political front. Government officials have recently proposed that OSM and the Bureau of Land Management (BLM) should be merged to streamline departments under the Department of the Interior. This merger could signal a step backward for environmental regulations and public protection. The Bureau of Land Management oversees coal mining leases on approximately 700 million acres of federally owned estates and focuses primarily on the western United States; OSM is 20 times smaller than BLM and is in charge of enforcing rules and regulations passed by states and protecting people and the environment from mining activities. Because of these differences in scope, the goals of the two organizations could be at odds. Lawmakers and citizens alike are concerned that this merger would weaken or destroy the reclamation act, which is the only one that protects coalfield citizens, such as those in Vintondale, Pennsylvania (McIntyre 2012; Office of Surface Mining 2012).

The merger could make it more difficult to navigate the complexity of politics, stakeholders, regulations, lack of funding, lack of interest, and the expansive time frame for mining operations, and also could threaten the AML program. The $4 billion awarded over the years by this program has been directed at protecting and restoring public health, safety, property, and the adjacent degraded land and water resources; however, there is no program or precedent that rebuilds a lost economy or community—an equally devastating result of mine closure. A 1972 study investigated the status of known coal mining camps operating in southeastern Kansas in the early 20th century; the study established that 77 out of the 111 known settlements were non-existent at the time of the study, and only one of them had developed into a city with a vibrant economy (Powell 1972). The same issue has been identified throughout historic coal mining regions, especially within the valleys of the Appalachian Mountains (Erikson 1976).

So what has happened to the remaining 30% of mining settlements that hung about in the form of hamlets, villages, and small town? A similar pattern emerges in these areas: a large proportion of residents (as high as 70%) are unemployed following the closing of the mine, and support service businesses such as markets, banks, and restaurants have closed. Young adults leave the villages for education and employment, and families that are able to find employment elsewhere do so, which exacerbates the economic problem. The remaining families turn to government support to help with monthly housing, food, and utility bills (Powell 1972; Erikson 1976; Miller 1993).

These towns not only lose their sole source of economy, but also the community that has formed. There is a deep commitment to community in mining settlements because of the hardships that the residents have endured, but when the mine closes and support businesses are forced to shut down, families that have known each other for generations are torn apart. It has been noted that following the closure of a mine, residents become withdrawn and individualistic, regarding the event as a betrayal to their community (Erikson 1976).

Research question

How can planning and design interventions be applied in rural Appalachian post-mining towns, with the hopes that doing so will preserve rural livelihood, stimulate reinvestment, and improve environmental conditions? In response to the primary research questions above, it is the goal of this thesis to investigate the ability of landscape architecture to preserve rural livelihoods and encourage reinvestment within these settlements by considering all three factors in play – economy, society, and ecology. For this purpose, reinvestment refers not only to the investment of financial capital but also social capital (investment in community endeavors and relationships), allowing the question to address social welfare alongside fiscal welfare.

The question is investigated through an applied case study in Vintondale, a small post-mining town in central Pennsylvania (see Figure 1.1). Vintondale operated as an underground coal-mining settlement from 1907 to 1968 and has been experiencing a continual population decline since World War II; it fits the profile described in the previous section in terms of both the environmental and economic problems. In addition, Vintondale has been studied in depth by the U.S. Bureau of Mines and was also the site of AMD & ART's pilot project from 1994-2005 (detailed in Chapter Two), which provided exceptional data for the development of exploratory landscape scenarios (Ferguson 1992; Weber 2008).

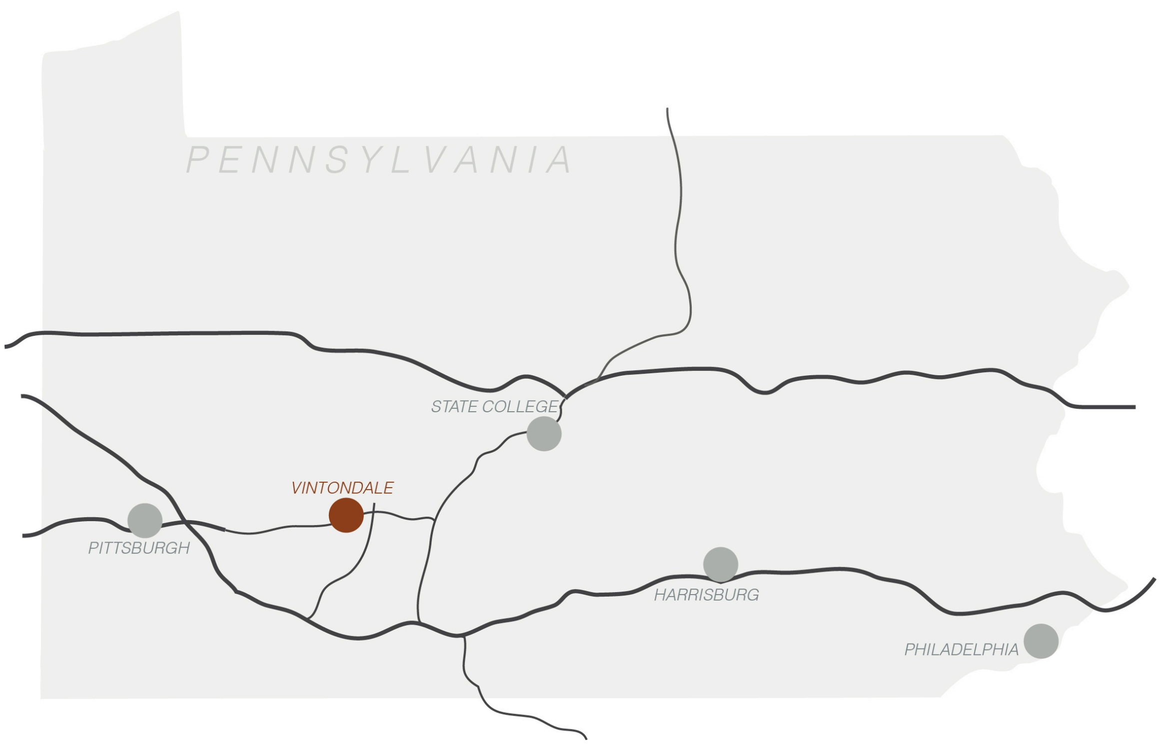

Figure 1.1: Vintondale's location within the state of Pennsylvania
The above diagram shows the location of Vintondale in relation to other major cities within Pennsylvania, in addition to major road connections.

Thesis structure and research methodology

The overall progression of this thesis is as follows: After this introduction, Chapter Two reviews the evolution of Vintondale from its earliest days to the present. This historical narrative provides insight into the community and economic structure of the town and details the relationship between the industrial past and the environmentally damaged present, presenting an overview of AMD remediation technologies in the process. Chapter Two ends with an exploration into the role that AMD & ART has played in the human community and natural environment of Vintondale. Chapter Three develops a series of exploratory landscape scenarios; these scenarios draw upon the environmental and social history of the settlement, as well as incorporate successful initiatives that have been undertaken in other rural post-mining towns to envision future land use for Vintondale, Pennsylvania. Chapter Four evaluates the proposed scenarios and presents three possibilities for the future of the town. Chapter Five concludes with a thesis summary and discussion of broader applications that could be developed from the work presented here.

The research process for this thesis involved a review of scholarly literature pertaining to rural Appalachian mining settlements, with an emphasis placed on studies specific to Vintondale, Pennsylvania. A significant amount of information was drawn from rural sociology as well as reclamation science and applied to Vintondale through case study methodology developed by John T. Lyle. Scholarly research was supported through conversations with individuals and this author's own visit to Vintondale and the AMD & ART site, which provided additional source material and first-hand inspiration for the scenarios detailed in Chapters Three and Four.

Relevance

We don't know how to close down a mine. This statement was presented to the author when this thesis was still in the discussion phase, and it continued resonate with her until it had to be put into writing. What makes this proclamation especially profound is that the "we" is a general term, not one that specifically calls out a certain group of people. It communicates that coal has been mined in the United States for over 150 years and there is still no way to close a mine without subjecting the community and environment to a slow and agonizing demise.

An abundance of research exists on mine reclamation technologies, but most is focused solely on treating water quality, which is only a fraction of the problem (Skousen, Rose et al. 1998; Kalin 2004; Johnson and Hallberg 2005; Wei, Wei et al. 2011). Ecological/environmental engineers, hydrologists, hydrogeologists, or others in science professions are often responsible for the design and installation of passive treatment systems. A paper presented on passive mine reclamation technologies at a conference in 2009 stated "…the overall goals…are the restoration of disturbed ecosystems and development of new sustainable ecosystems having both human and ecological value. Passive treatment of abandoned mine drainage therefore fulfills both the ecosystem restoration and development goals…" (Nairn, Beisel et al. 2009); the same paper presented the image seen in Figure 1.1 as an ecologically engineered design for a passive water treatment system. This design is representative of standard AMD passive treatment systems. Not only does a series of toxic pools surrounded by a turf monoculture not restore the disturbed ecosystem to its previous use, but it also does not create a new sustainable ecosystem with human and ecological value.

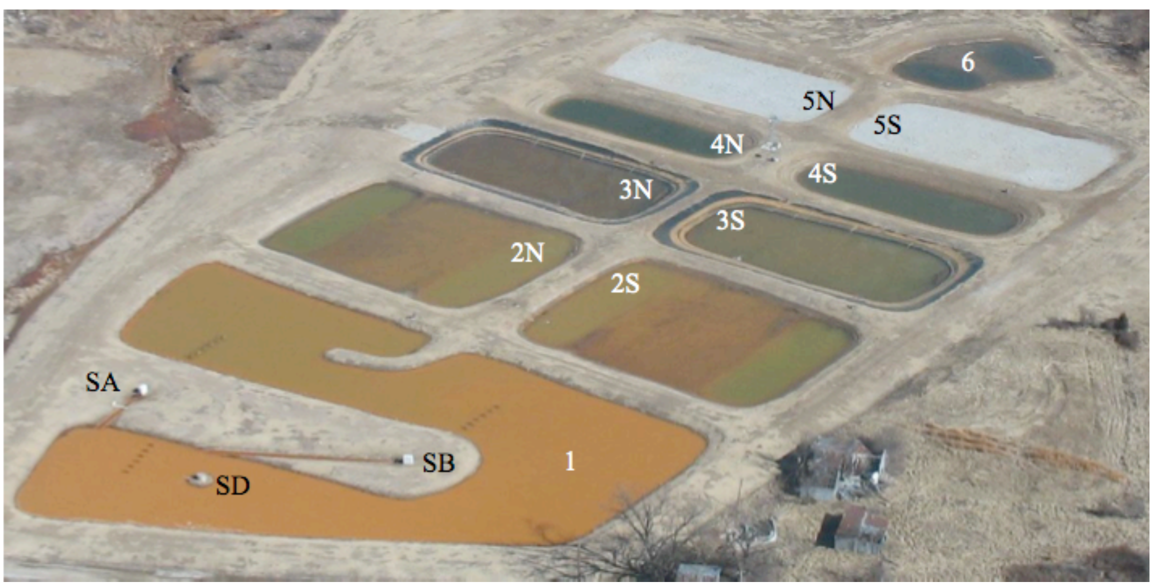

Figure 1.2: Aerial view of a designed passive AMD treatment system (Nairn, Beisel et al. 2009)

The purpose of this thesis is not to re-design passive AMD treatment systems, but rather address the larger challenges of restoring community and economy to a fractured town. The above was presented as evidence that most restoration scientists do not seem concerned with the welfare of a community.

Closing down a mine involves much more than mitigating ecological damage, which makes it aptly suited for landscape architecture, a profession that is trained to consider not only ecological goals, but also societal, and economic concerns. If the 5,200 remaining high-priority coal-related abandoned mine sites in the U.S. are treated through the same techniques, there will be healed land, but a neglected population (Office of Surface Mining 2012). This paper argues that these neglected populations can be assisted through the application of specific landscape scenarios.

The conceptual framework presented in the body of this document has broader relevance for the discipline of landscape architecture. While the central purpose of this thesis is to explore multiple ideas for how one small post-mining settlement might approach the revitalization of its community, economy, and ecology, the evaluation of this study may help to resolve best practices for rural post-mining communities. The synthesis of the information goes well beyond Vintondale, Pennsylvania to encompass a host of rural mining towns scattered throughout the Appalachian Mountains.

CHAPTER TWO: THE LIFE AND LEGACY OF KING COAL IN VINTONDALE

The town of Vintondale, Pennsylvania has lived and died by the exploitation of the coal seams that run through its mountains. The physiography of the Blacklick Creek valley region is representative of the Appalachian plateau with alternating rounded mountain ridges and synclinal valleys; the landforms are interspersed with tributary streams, the one for which the valley is named running to the north of Vintondale (Ferguson 1985). Vintondale was easily mined because the underlying geology was lifted in a gently rolling anticlinal ridge, and the north and south branches of Blacklick Creek eroded the overlying soil to form a longitudinal gorge, which made the coal seam accessible (Ferguson 1992). The accessibility of the coal seam dictated the placement of six mine portals into the mountain, and, as can be seen through much of Appalachia, the village is clustered around the mouths of these portals (Ferguson 1985; Weber 2008). In addition, Vintondale is similar to other rural post-mining towns built in the early 20th century in that it has a rapidly declining population; this decline is due both to the fact that there is no coal left in the local mines to support an economy, and that the town is not conducive to modern lifestyles because it lacks connectivity to major commercial centers (Ferguson 1985). This chapter examines the past and present state of the community, economy, and environment and shows how the presence of coal has impacted all facets of life in this small town (Figure 2.1).

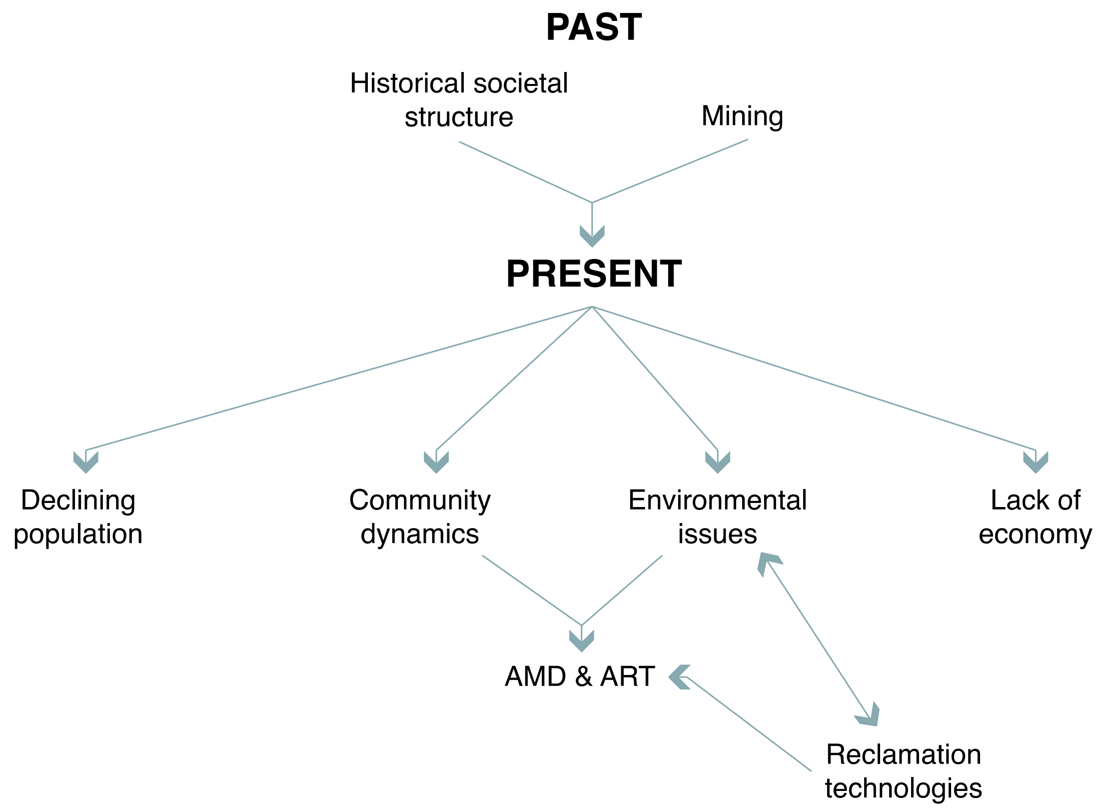

Figure 2.1: Relationships of the information presented in Chapter Two

Interest in Vintondale began in 1845 with the construction of Eliza Furnace for iron ore processing; however, a combination of low quality iron ore and the failure of the Pennsylvania Railroad to develop in the region led to the closure of the furnace two years later. The valley lay dormant for almost 50 years until Judge Augustine Vinton Barker began to purchase land and coal rights in the area; within three years he had the support of influential investors, which quickly led to the construction and operation of the Pennsylvania Railroad extension along Blacklick Creek (Weber 2008). Between the influx of money, political support, and inexpensive transportation, a productive coal field developed in the basin, operated by Vinton Colliery Company.

The first coal was shipped out of Vintondale in 1894, and within a decade, the operation expanded to include a battery of coke ovens, a tipple, washery, power house, machine shop, and ammonia plant. Production continued undisturbed for forty years until 1945 when the washery burned; after that event, the mine changed hands three times before coal production ceased in the No. 6 mine at Vintondale in 1968.

Life in the coal camps

An influx of settlers accompanied the opening of coal camps in Vintondale, which included skilled laborers from Europe as well as unskilled laborers from the surrounding region. (Erikson 1976; Weber 2008). By the 1920s, Vintondale had over 25 languages being spoken within its borders because of the various ethnic populations who came there for employment (Weber 2008). Those who entered into the settlement were cut off from the only way of life that they had ever known, inhabiting instead a patriarchy led by the coal operator. The organization of mining settlements at the time allowed the coal operator to not only be an employer, but also a landlord, mayor, chief of police, banker, and school superintendant (Erikson 1976). This patriarchy strengthened in 1907 when Vintondale incorporated and company officials took over the borough council; town merchants circulated petitions in 1913 and 1915 to open council positions to non-company men to no avail (Weber 2008). Between the language barriers and distinct anti-union policies, it was easy for Vinton Colliery Company to remain in control (Erikson 1976; Weber 2008).

The small borough of Vintondale reached its peak in the 1920s with over 30 business, a hospital, a primary school, and a four-year high school operating in the area (Weber 2008). It was also during this time that Vintondale received national attention. A strike in 1922 brought out the aggressive side of the coal operator; entrances to town were militantly guarded and heavily armed coal and iron police patrolled the streets on horseback. Arthur Garfield Hayes of the Civil Liberties Union was sent to investigate and as he walked down the sidewalk, he was arrested for trespassing on company ground. In 1924, workers again initiated a walkout over a wage cut. In both instances, the company evicted the men responsible and resumed control over its operations and the town (Weber 2008). The decade following these events was characterized by a gradual slide into passivity and dependency on the company.

Beginning in the 1930s, a number of events occurred that offered a new way of life for rural settlers. Emigration from Vintondale began as a trickle when young men left to join organizations like the Civilian Conservation Corps; during World War II an even larger number joined the armed forces and, taking advantage of veteran's benefits, settled elsewhere. The flow outward was not an equal opportunity for everyone, however, as the best-educated and most skilled laborers were recruited persistently, the older citizens and unskilled laborers remained. Automation, introduced in 1957 when the mine changed hands for the first time, served to reduce the number of working men by half; what was once a trickling pattern of emigration was now a violent outflow. Pressure from inside the camps, combined with the pull of opportunities from outside, contributed to what may be the largest proportional out-migration of persons in the history of the country (see Figure 2.2) (Erikson 1976).

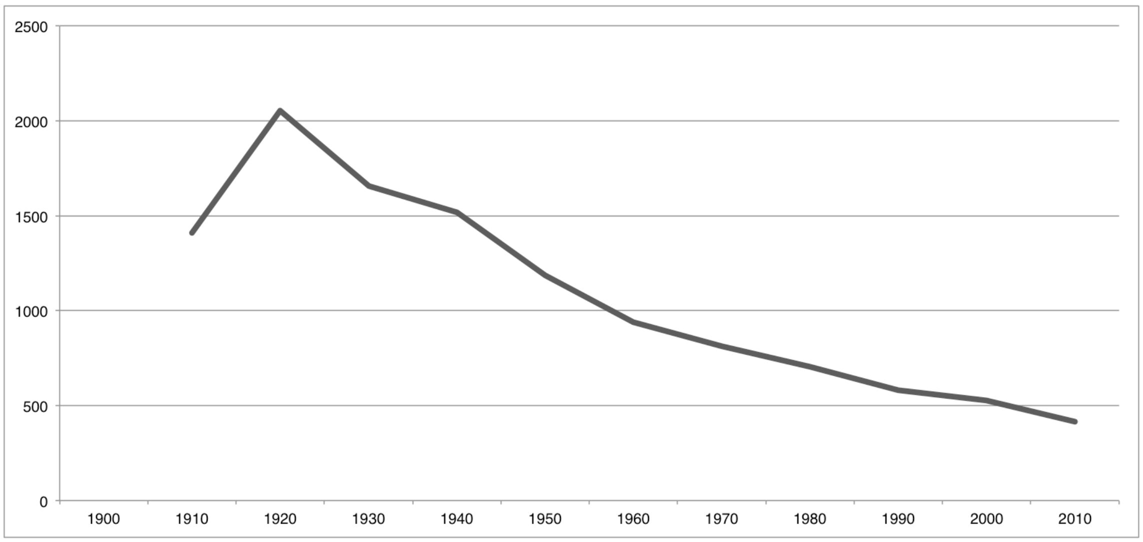

Figure 2.2: Vintondale, PA population 1907-present
Data from the U.S. Census Bureau decennial census (U.S. Census Bureau 2012)

All of these factors have contributed to Vintondale's current social structure. The families that remained in Vintondale were ones that could not afford to leave; their population was high in disability and unemployment, and low in literacy and industrial skills. When welfare was introduced to the mountains during the Great Depression, nearly 75% of people in Vintondale were recipients; today, 25% of residents receive governmental aid in the form of food stamps (Weber 2008; U.S. Census Bureau 2010 b). Of the 414 citizens residing in the borough nearly a quarter of them are over 65 and/or living below the poverty level, and over 40% have not worked in the past year (as of 2010) (U.S. Census Bureau 2010 b; U.S. Census Bureau 2010 c). Additionally, mortality and emigration continue to decrease the number of residents in Vintondale (U.S. Census Bureau 2010 c). As the number of citizens in the borough continues to decrease, businesses that once were profitable have since failed; there is no longer a grocery store or school in Vintondale.

Environmental concerns

Abandoned mine lands (AML) are the most notable of the environmental legacies resulting from historic mining activities, and include intensive damage to the land, forests, and surrounding waterways. Acid mine drainage (AMD) is the most prevalent. The ubiquitous presence of AMD has led the U. S. Environmental Protection Agency to name it the primary water quality problem in the Appalachian region (Wei, Wei et al. 2011). The chemical process that results in AMD is not of concern to this thesis and is therefore described summarily: when iron pyrite and other sulphidic minerals that are found in coal deposits are exposed to oxygen and water, an accelerated oxidation process takes place, sulfuric acid being the byproduct. The sulfuric acid is transported into Blacklick Creek through groundwater or overland flows, and once the water velocity slows or an alkaline substance is added, the acid is precipitated out onto the streambed and aquatic organisms, resulting in what is known as “yellow boy” (Ferguson 1992; Johnson and Hallberg 2005; Wei, Wei et al. 2011).

The Blacklick Creek watershed, which encompasses 420 square miles, has over 200 square miles of undermined crust (see Figure 2.3) and 90 acid pollution sources, which culminate in over 300,000 lb/day of total acid production emptying into tributaries and larger surface water bodies (Ferguson 1992). In addition to the underground AMD sources, castoff refuse piles (bony piles) that result from coal mining operations contribute to stream acidity via overland flow. Because coal was mined by hand during this era and the separation methods were imperfect, the coal concentration in a bony pile can be as high as 30% (Ferguson 1992). Because of the concentrated nature of the iron and pyrite, the AMD that flows from bony piles can also be more aggressive than that which discharges from the mine itself (Johnson and Hallberg 2005).

Figure 2.3: Extent of underground mines around Vintondale
The underground mines are shown in red to convey the extent of deep mines surrounding Vintondale (depicted with a white border) (Ferguson 1992)

Figure 2.4 details the types and locations of AMD sources in Vintondale, which are essential to note because many of the exploratory landscape scenarios presented in Chapter Three propose AMD remediation as a design intervention. Within the half-mile area of Vintondale, there are four underground AMD discharge points that enter into South Branch Blacklick Creek; three bore holes in North Branch Blacklick Creek that were designed to relieve the water pressure in mine No. 6 (Figure 2.5); and a large, highly acidic bony pile, which is being undercut by South Branch Blacklick Creek (Figure 2.6) (Ferguson 1992; Weber 2008).

Figure 2.4: Type and location of AMD sources in Vintondale (Ferguson 1992)


Figure 2.5: Bore holes in North Branch Blacklick Creek (photograph by author, May 2011)


Figure 2.6: AMD from the bony pile along South Branch Blacklick Creek (photograph by author, May 2011)

Both land and water reclamation objectives for the Blacklick Creek watershed were determined in a previous study conducted by the U.S. Bureau of Mines (Ferguson 1992). Within the Vintondale boundary, there are no high priority land reclamation sites; however, the bony pile that lies along South Branch Blacklick Creek was listed by BOM as one of the highest water reclamation priorities in the watershed, and the stream net acid load in both South and North Branch Blacklick Creek exceeds 100,000 lb/day. With this information in mind, all of the exploratory landscape scenarios described in the next section propose water reclamation strategies that would treat the sources of AMD within the North and South Branch Blacklick Creek.

Water reclamation strategies

With the exception of bony pile treatments, water reclamation strategies are often only “migration control” measures, referring to the movement of sulfuric acid within the water body. For descriptive purposes, they have been grouped into active and passive remediation strategies. Active AMD treatment refers to the continuous application of alkaline materials (such as limestone) to neutralize AMD and precipitate suspended metals and metalloids out of solution, causing yellow boy to occur in a controlled environment. Passive treatment systems depend on the use of natural and/or constructed wetland ecosystems to treat AMD and require relatively few continuing inputs in comparison to active treatment systems (Johnson and Hallberg 2005). In general, active AMD treatments are used at active or continuously mined sites whereas passive treatments are applied at closed and abandoned mines (Trumm 2007). As all of the mines at Vintondale are closed, only passive treatment options are considered and described below. Bony pile treatments that are proposed are considered preventative measures instead of control measures because they remove the source of pyrite and prevent further AMD from occurring at the site (Johnson and Hallberg 2005). They are described in the latter part of this section.

Passive AMD Treatments include horizontal flow systems such as constructed wetlands and anoxic limestone drains (ALD), as well as vertical flow systems such as successive alkalinity producing systems (SAPS), limestone ponds, and open limestone channels (OLC) (Skousen, Rose et al. 1998). Constructed wetlands are either aerobic or anaerobic. Aerobic wetlands consist of wetland vegetation planted in shallow (less than a foot), relatively impermeable sediment, such as clay. The purpose of aerobic wetlands is to collect acidic water and provide aeration, which encourages the oxidation process and allows the metals to precipitate. Conversely, anaerobic wetlands are constructed of wetland vegetation planted in deep (more than a foot) permeable sediments such as soil, peat moss, mushroom compost, sawdust, or other organic mixtures, and underlain with limestone. The organic compounds and limestone together produce net alkalinity that is introduced into the net acid water in order to precipitate out dissolved metals (Skousen, Rose et al. 1998; Sheoran and Sheoran 2006). ALDs are limestone cells or trenches that add alkalinity in the form of dissolved limestone into low-oxygen (anoxic) water. ALDs function differently than many other passive treatment systems in that they do not precipitate heavy metals. Their sole function is to convert net acidic mine water to net alkaline water by adding alkalinity (Skousen, Rose et al. 1998).

Compared to the horizontal flow treatment systems previously described, vertical flow systems greatly increase the interaction of water with organic matter and limestone. Vertical flow systems are referred to by a variety of names, including APS and SAPS or vertical flow wetlands (Kepler and McClery 1994). SAPS can be adapted to suit the proposed site conditions, which is one of their benefits, but the typical SAPS contain a series of constructed wetlands. The water is first settled into collecting ponds and then filtered by hydraulic pressure through one or more anaerobic wetlands. Relying on pressure, again the water moves into a series of aerobic wetlands to encourage heavy metal precipitation. The treated water can then enter a nearby surface water body or can be used to construct wetlands for habitat (Kepler and McClery 1994; Skousen, Rose et al. 1998; Nairn and Mercer 2000).

Limestone ponds and OLCs are both passive vertical treatment systems that rely on the dissolution of limestone to add alkalinity to water and encourage precipitation of heavy metals. Limestone ponds are constructed at the upwelling of an AMD discharge point. A pond is formed above the seep and lined with limestone on the bottom. The water flows up through the limestone and ponds for one to two days to maximize alkaline inputs. OLCs are open channels or ditches lined with limestone that allow water to flow over the alkaline substance and keep moving instead of ponding. Often, OLCs are placed successively in a stream channel to encourage maximum alkaline mixing (Skousen, Rose et al. 1998; Johnson and Hallberg 2005).

Bony pile remediation strategies, also important to the exploratory landscape scenarios proposed in Chapter Three, include bioremediation, specifically mycoremediation, or removal. Mycoremediation relies on native fungal species to alter or detoxify heavy metals and petroleum by-products. Mycelial networks alter the chemical and molecular structure of the toxins, converting them to a harmless compound, which reduces or eliminates their effects on the environment (Jones 2009). By metabolizing iron, pyrite, aluminum, magnesium, and other heavy metals associated with AMD, these networks convert the chemicals into harmless compound, preventing them from oxidizing and contributing to the net acidity in the Blacklick Creek watershed. This can be done in situ or ex situ.

Removal of the bony pile is another option for preventatively treating AMD at Vintondale. There are two recommendations: the first, a treatment recommended by the U.S. Bureau of Mines, is called I-cubed; the second is removal and incineration, which is also referred to as co-gen. I-cubed is short for incineration-income-injection and it addresses not only the bony pile but also the adjacent deep mines (Ferguson 1985). The coal that remains in the bony pile is a low-grade fuel that can be removed from site and incinerated. The second step recovers costs by capturing the heat from the incinerator, making it available to be used locally or to be converted into electricity and transferred to the regional electric utility grid. The last step captures the fly ash (which is alkaline) that is generated during incineration, mixes it into a cement slurry, and pumps it into a deep mine to slow the rate of acid water transmission (Ferguson 1985). While this approach was once considered controversial, recent experimentation with backfilling mines using fly-ash has proven to be successful not only in treating AMD but also in solving the problem of storage for fly-ash generated during incineration (Pacchioli 1995; Gitari, Petrik et al. 2011; Vadapalli, Gitari et al. 2012). The co-gen approach utilizes the first two steps of the I-cubed method but does not include backfilling mines. In this scenario, the fly ash is stored off site and not utilized.

AMD & ART: Artfully transforming environmental liabilities into community assets?

AMD & ART is a non-profit organization, and the brainchild of T. Allan Comp, a historian and public arts advocate. In the 1990's, Comp came to Southwestern Pennsylvania promoting his cause and organization, and found like-minded individuals, as well as a pilot project site. The stated mission of AMD & ART is *artfully transforming environmental liabilities into community assets.* Behind both the name and mission lies the goal of the organization – to build a partnership between professionals in the sciences and humanities through a joint initiative for the environmental restoration of AMLs (Comp 2005). The goal of this process is to make places that were once hazardous into areas that communities embrace.

Talks of the Vintondale pilot site began in 1995 with the idea of treating the AMD seep from mine portal No. 6 through a series of passive remediation techniques on a public art scale. A site visit during the 27th through the 30th of September in 1996 sent planners back to the drawing board. Three bore holes had been drilled in North Branch Blacklick Creek to relieve the pressure in the No. 6 mine. The sulfur water had been seeping into the homes in the lower end of town and the state stepped in. Because the site location had already been chosen, a new source of AMD needed to be located quickly (AMD+ART 1996; Weber 2008). With the abundance of acid inputs into Blacklick Creek, it was not difficult to find a replacement, and the group decided to pipe AMD from the No. 3 mine to the treatment ponds (see figure 2.7) (AMD+ART 1997).

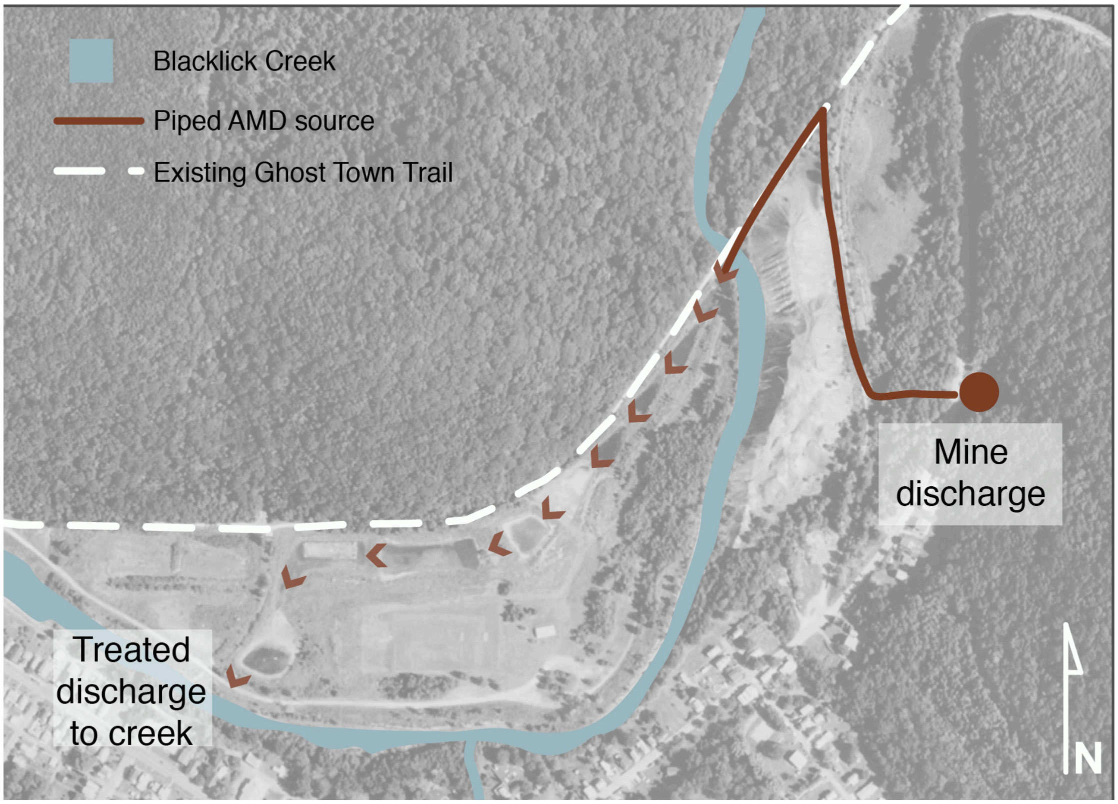

Figure 2.7: AMD source and water discharge location at AMD & ART Park (AMD+ART 1996)

From the beginning, the project in Vintondale was aimed at cultivating community involvement to forge a "renewed bond of common heritage and future commitment" (AMD+ART 1996). With a site chosen and momentum building, AMD & ART began to plan community meetings and other events to engage citizens. Following the first meeting, a newspaper reported, "if the number of people in attendance and the enthusiasm expressed is any indication of how successfully a proposed AMD remediation project will proceed, then the project should be a huge success" (AMD+ART 1997). The timeline below details community involvement in the Vintondale pilot project and tracks community participation over time (Figure 2.8).

Through the process of community meetings, charrettes, presentations, and revisions, the AMD & ART staff created a vision for a park meant to be installed along the banks of South Branch Blacklick Creek. It was a vision that, with the help of public and private funding, interns, volunteers, and Vintondale citizens, would transform a sparse field littered with coal refuse from an eyesore to an asset.

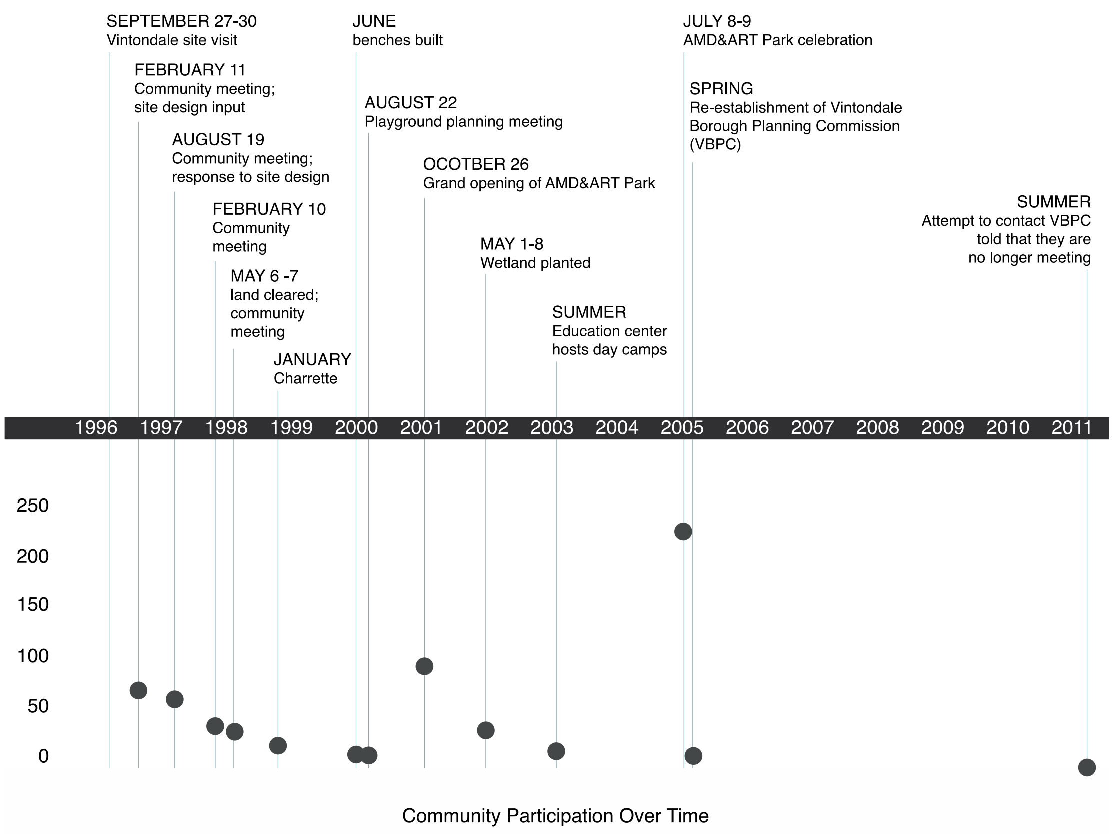

Figure 2.8: Timeline of community involvement in AMD & ART events
Aside from two outliers (the grand opening and the AMD & ART Park celebration), there is a general trend of loss of community participation as the project progresses. Data from AMD & ART newsletters 1996-2005.

The final plan rendering, illustrated by Landscape Architect Julie Bargmann, can be seen in Figure 2.9. A SAP system consisting of six ponds captures AMD from mine No. 3 in pond one and successively neutralizes and precipitates heavy metals. The ponds are bordered by a litmus garden, the plantings of which were chosen so that their fall foliage changed successively from red to orange, yellow, green, and blue along the treatment ponds—a design intended to mimic the neutralization of the toxic water. With the assistance of the Wildlife Habitat Council (WHC), wetlands were planned amongst the colliery foundations, which the community wanted to preserve. Walking trails, a pavilion, and recreational fields were programmed in the design to provide passive and active recreation for Vintondale residents. To fulfill the education component of AMD & ART, the entire site was designed to work as an outdoor classroom; additional space was donated in the nearby church for indoor classrooms (AMD+ART 2003).

Earlier plans that emerged from the community meetings included items such as a playground, BMX trails, volleyball courts, horseshoe pits, parking for the elderly and handicapped, and a foot bridge across South Branch Blacklick Creek, but these were removed before the final plans were created (AMD+ART 2000). Additionally, early plans of the AMD & ART pilot site did not include the preservation of the Vinton Coal and Coke foundations; only after they were discovered during excavation and citizens voiced their concern for preservation did they become a cornerstone for interpretation in the wetlands (AMD+ART 2005).

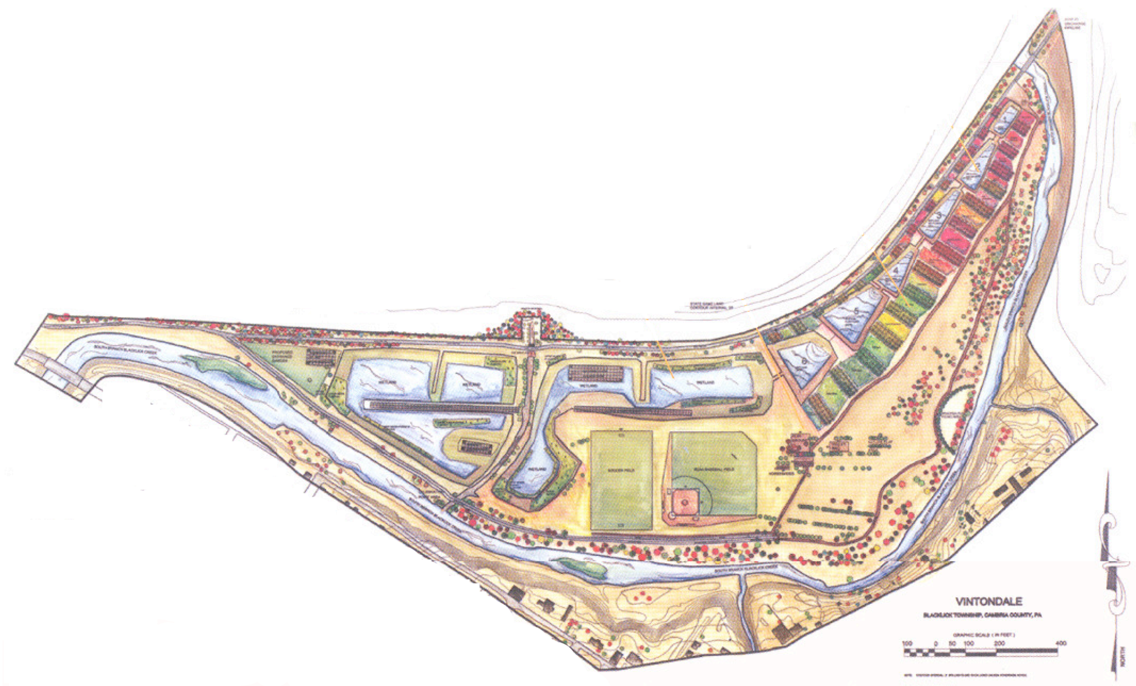

Figure 2.9: AMD & ART Park rendering by Julie Bargmann (www.amdandart.org)

AMD & ART Park in Vintondale was a pilot project, and as such, it encountered unforeseen complications. The wetlands, which were designed by the WHC, were constructed but were not ever certified. The process requires that a team of citizen volunteers ("wildlife team") complete the work and monitor the project for a year before applying (Wildlife Habitat Council 2012). According to the WHC, the point of contact at AMD & ART turned over frequently and a wildlife team never developed to oversee the monitoring and maintenance of the project (Rebecca Culler, *personal communication*). The lack of motivation may have been due in large part to the fact that plants failed to establish in the park. An intern with AMD & ART in the summer of 2001 related that the initial planting of vegetation was not installed properly and most of it subsequently died (Doug Pardue, *personal communication*).

In addition to the failure to establish wetland vegetation and the litmus garden, the SAPS was not functioning properly; acidic water was infiltrating into the ground instead of filtering through the wetlands to be treated (AMD+ART 2003). On August 13, 2003, the Office of Surface Mining approved enhancements to the AMD remediation system. The improvements included lining ponds 4 and 6 and lowering the spillways to enhance the treatment and flow of water. Manufactured soil was added around the ponds so that there was a better growth medium to support re-vegetation. The Pennsylvania Department of Environmental Protection (PADEP) conducted water quality testing three times after the enhancements were implemented and found that the pH improved, rising from 2.8-3.0 in pond 1 to 6.1-6.3 at the outflow of pond 6 (Department of Environmental Protection 2006). AMD & ART turned over the management of the park to the Vintondale Borough Planning Commission in 2005 and water quality testing was suspended by DEP following the last sampling in 2006. The residents were officially in charge of the park.

This thesis began to investigate if AMD & ART actually achieved their stated mission of *artfully transforming environmental liabilities into community assets* five years after outside organizations provided any support for the management and maintenance of the park. Because art, especially environmental art, is widely controversial as to what is considered successful, the artistic component of AMD & ART will be overlooked in this analysis. Disregarding the artistic component of the park, the statement can still be broken down into two parts to fully investigate the success of this endeavor: 1) was an environmental liability removed, and 2) is the AMD & ART park a community asset?

The answer to the first question is simply no. Data collected before the installation of the SAPS in Vintondale show that the average pH in South Branch Blacklick Creek above Bracken and Shuman run (the two creeks that enter at Vintondale) holds stable above 5.0; as the creek passes through the town of Vintondale, the pH drops to below 3.0. Because the SAPS is treating one of the four primary AMD discharges into South Branch Blacklick Creek, it is logical that there should be an increase in pH downstream of the treatment system. The pH upstream of the two creeks continues to read above 5.0 and downstream testing reveals pH ranging from 2.6-3.1 (L. Robert Kimball & Associates 2005; Department of Environmental Protection 2006). This begs the question: if water quality tests performed by DEP in 2006 showed that water leaving pond 6 had a pH above 6, why is this not registering when testing South Branch Blacklick Creek? A site visit on May 15, 2011 revealed that the pH is not changing because the treatment system is not emptying into South Branch Blacklick Creek as designed. Upon further inspection, it was made apparent that there was also no water flowing into the treatment system (see figures 2.10 and 2.11). The site visit was conducted in the spring, when there is typically a greater volume of flow. Using flow data from DEP monitoring as a guide, it can be assumed that there should be a flow of approximately 200 gallons per minute (GPM) from the white PVC pipe into pond 1 and an outflow over the slate of 150-200 GPM; yet neither was experiencing any flow at the time of the author's visit (Department of Environmental Protection 2006). Because there is no inflow or outflow of the SAPS at AMD & ART Park, it can be said safely that the treatment system is not working and therefore did not remove an environmental liability.

Figure 2.10: "Clean Slate" – discharge point of treated water into South Branch Blacklick Creek (photograph by author, May 2011)

Figure 2.11: PVC pipe that drains water from mine No. 3 into pond 1 at AMD & ART Park (photograph by author, May 2011)

In addition to installing a system that is not functioning seven years after establishment, AMD & ART ignored the bony pile that is being undercut by South Branch Blacklick Creek. Not only is the bony pile the largest contributor of acid in

Vintondale, but it is also highly combustible (Ferguson 1992). It was given highest priority by the Bureau of Mines in a publication released in 1992 and was overlooked subsequently by AMD & ART when they came to Vintondale five years later. When the failure of the SAPS is considered in conjunction with the oversight of the bony pile, it is obvious that, environmentally speaking, AMD & ART Park is not successful.

It is more difficult to quantify whether or not AMD & ART Park is an asset to the community of Vintondale. To do this, the park will be evaluated against the Vintondale residents' own vision for their future after the park was installed. A series of visioning activities was conducted with local citizens following the establishment of AMD & ART Park as part of a doctoral dissertation (Therig 2007). The residents' ideas were grouped into three categories for Vintondale's future: preservation of the historic small town character, development of the diverse housing and recreation opportunities, and coordination of active citizen participation (AMD+ART 2001). Interviews conducted with residents revealed surprise that the community got involved at all, and extreme doubt in the potential of the park to draw tourists, suggesting the community's inability to imagine a better future for themselves (Therig 2007).

If the success of the park is evaluated in terms of the community's vision for itself and its ability to bring this vision to fruition, then the park has failed here also. The establishment of AMD & ART Park has not increased tourism enough to warrant the establishment of any new businesses that would threaten the historic small town character, and there has been no housing diversity added to this area (U.S. Census Bureau 2010 a). The recreational opportunities that were originally programmed with the park are still available, but conversations with local residents relayed that the fields are rarely used. The coordination of active citizen participation is perhaps the largest failure. Not only has the Vintondale Borough Planning Committee dissolved within six years of its re-establishment, but no citizens group was ever formed to oversee the management or maintenance of the park. A group could not even stay coordinated long enough to ever apply for certification of the wetlands through WHC, which is only a one-year process. In an almost prophetic statement, T. A. Comp wrote upon completion of AMD & ART Park, "Neglect the park in this dynamic natural environment and nature will transform a pioneering public park with an AMD treatment system and wetlands into a dense and wild place – years later someone will be discovering old interpretive signs buried in the undergrowth" (AMD+ART 2005). The situation Comp describes is exactly what the author found upon a site visit in 2011.

CHAPTER THREE: INVESTIGATING OPTIONS: AN APPLICATION OF EXPLORATORY LANDSCAPE SCENARIOS

This chapter explains the methodology that was used in the development and application of exploratory landscape scenarios to a case study in Vintondale, Pennsylvania. Case studies have a long history in landscape architecture and it is well-established that the case study method promises to be effective in advancing the theory and knowledge base of the profession (Francis 2001). Within landscape architecture, case studies are historical, narrative/anecdotal, or a combination of the two. Design professions such as landscape architecture rarely (if ever) employ experimental or quasi-experimental case studies because the expense and scale of projects makes controlled empirical study difficult (Francis 2001). This thesis applies the case study methodology to Vintondale, Pennsylvania using an anecdotal approach of exploratory landscape scenarios based on the methodology taught by John T. Lyle at Cal Poly Pomona and subsequently described in his book *Design for Human Ecosystems* (Lyle 1999; Francis 2001). These scenarios draw upon the environmental and social history of rural Appalachian mining settlements in order to envision future land use, and answer the question posed in Chapter One of this thesis. In doing so, some of these elaborate on the vision that the residents of Vintondale proposed, others apply successful precedents in other deep mining towns, and the remainder are original ideas researched and developed through this thesis.

The exploratory landscape scenarios, as applied to Vintondale, Pennsylvania, provide a holistic perspective on the social, economic, and environmental problems that exist in rural Appalachian mining towns. The benefit to this methodology is that the scenarios can be based on a multitude of factors that are often neglected when a designer only proposes one “answer” to a design “problem.” Scenarios can consider different policy options, alternative development models, conflicting landscape interests held by different stakeholders, and/or the implications of present decisions or societal behaviors (Ramos 2010). Much like Lyle’s method, the process of developing the proposed scenarios involved collecting data, creating a detailed account of the site and its surrounding context, and then proposing general scenarios which help predict and guide future planning decisions rather than detail exact outcomes (Lyle 1999).

As a result of this method, the scenarios proposed in this chapter are intuitive rather than morphological (Ramos 2010). This methodology was chosen because intuitive design scenarios emphasize gaining insight into societal and ecological processes and their influences on one another, whereas morphological design scenarios rely on computer simulation, modeling, and quantified data. The intuitive approach plays upon the strengths of landscape architecture as a creative profession that works in both the humanities and sciences. The morphological approach, on the other hand, excludes the societal implications (Ramos 2010).

These scenarios do not explicitly follow the methodology put forth by Lyle, as his scenarios propose different development options that each contain multiple uses within them (Lyle 1999). In contrast, the following scenarios focus solely on one aspect of development and/or programming in order to drive scenarios further in a singular direction. The scenarios are then evaluated in the following chapter to determine which design interventions are the most beneficial and have the greatest significant outcome for environmental, community, and economic enhancement, as well as public protection. The exploratory landscape scenarios were developed as a result of site visits, unstructured interviews, a literature review, and GIS data. The data were grouped into themes and developed into the following seven landscape scenarios (Table 2.1):

Table 3.1: Summary of scenarios and design interventions of each

Scenario	Design Interventions
Non-consumptive outdoor recreation as a generator of environmental remediation and economic stimulation	Wetlands Wetland boardwalk Wildlife viewing platform Hiking trails Mountain bike trails Mycoremediation of the bony pile Dam Shuman Run Campground Support businesses • Bike rental

	• Watersport outfitter • Hotels and cabins • Restaurants • Grocery store • Gas station
Consumptive outdoor recreation as a generator of environmental remediation and economic stimulation	Wetlands Transitional grassland habitat I-cubed method for bony pile remediation Dam Shuman Run Support businesses • Hotels, cabins, campground, R.V. parking • Meat processing and packaging facility • Small sporting goods store • Hunting and fishing license sales • Restaurants • Grocery store • Gas station
Creation of an experimental field station to generate knowledge about AMD	Experimental field station Environmental monitoring of bony pile, and AMD from bore holes and mine portals Support businesses • Student housing or apartments • Bike rental • Watersport outfitter • Restaurants • Grocery store • Gas station
Downtown revitalization to stimulate economic growth and support community development	Main street infill Main street building re-use I-cubed method for bony pile

	remediation
Historic preservation as a means to generate tourism and increase opportunities for environmental education	Recreation or “ghosting” of the Vinton Coal and Coke buildings Mining history tour Rail car diner along Ghost Town Trail Passive AMD treatment of South Branch Blacklick Creek I-cubed method for bony pile remediation
Dam construction as a means to counteract AMD and neutralize water pH within the Blacklick Creek watershed	Relocation of residents Dam Blacklick Creek Diversion well at the base of the dam Co-gen method for bony pile remediation
Assisted natural regeneration and passive AMD treatment for ecological recovery	Relocation of residents Forest regeneration SAPS along North and South Branch Blacklick Creeks I-cubed for bony pile remediation

Non-consumptive outdoor recreation as a generator of environmental remediation and economic stimulation

Non-consumptive outdoor recreation, as defined in this thesis, is any outdoor recreational activity that does not result in removing a living organism from its environment (e.g. hunting, fishing, picking flowers). This exploratory landscape scenario was considered separately from the hunting-related recreation scenario (following this section) because the uses of the same resource are often incongruent. These two uses have been categorized as consumptive (private) and non-consumptive (collective), because those terms are descriptive of the ways that individuals interact with wildlife (Cocheba and

Langford 1978). Hunting, which results in killing an animal, is a consumptive process and benefits a private party; non-hunting uses, such as bird watching, do not preclude others from using the same creatures or natural resources simultaneously or for a different purpose in the future (Cocheba and Langford 1978). This scenario comprises both active and passive recreation, but excludes anything deemed as consumptive, such as fishing or hunting.

Design interventions in this scenario are intended to maximize the availability for non-consumptive outdoor recreation by providing recreational opportunities that take advantage of the natural site features (see Figure 3.1). Wetlands are developed along Blacklick Creek that provide passive treatment of AMD in upstream cells, and, as the water neutralizes, habitat for native and migratory waterfowl. A wetland boardwalk and wildlife viewing platform is recommended to provide opportunities for bird-watching. Additional habitat enhancements such as bird boxes, bat boxes, and plant species that are beneficial for native pollinators should be added. Hiking trails are programmed in the state game lands to the north of the site and mountain bike trails are added to the south to appeal to a wide array of users. This scenario recommends using mycoremediation technologies for the bony pile, which utilize higher order mycorrhizal fungi to break down petroleum and heavy metals and stabilize the bank, which will then be planted with native grasses and shrubs and serve as wildlife habitat and an overlook point. Scientific literature has shown that mycelial networks can alter the chemical and molecular structures of the toxins and render them harmless. This intervention, therefore, addresses the water reclamation objectives and removes the stream acid input (Jones 2009). Shuman run, the contributing stream that flows into Blacklick Creek, is dammed to create a small pond that can be used by recreationists for swimming and flat-water canoeing, as well as serve the proposed campground. To capitalize on Blacklick Creek and the already-established Ghost Town Trail, a bike rental and water-sport outfitter are recommended. All of these features are designed to attract tourists to Vintondale, therefore requiring added amenities for visitors such as hotels, cabins, restaurants, a grocery store, and a gas station.

Figure 3.1: Non-consumptive outdoor recreation scenario

People in pursuit of the non-consumptive form of outdoor recreation are spending increasingly more money and time engaging in outdoor activities such as hiking and birding (Aiken 2009; Chi-Ok and Hammitt 2010). From 2001 to 2006, the amount of money spent in the state of Pennsylvania on wildlife watching nearly doubled, and both in-state and out-of-state residents spend an equivalent amount of money within Pennsylvania in this pursuit (Aiken 2009). This scenario encourages the expansion of outdoor recreation opportunities and programs to capitalize on this trend. There is already a strong recreational driver in Indiana County, which borders Vintondale to the west, and this scenario allows for the opportunity to pull many of those tourists into Vintondale by offering outdoor recreation, such as wetlands and mountain bike trails, that is not available in nearby counties.

The amount of money spent on non-consumptive recreational pursuits is still relatively little compared to other economic drivers, so it is important to maximize the amount of money that the local economy can gain through appealing to non-consumptive recreational tourists. In his article on evaluating non-priced recreational resources, Peter Pearse argues that "indulging in a particular recreational opportunity are in part fixed…and in part variable, with respect to the number of days at the recreational site" (Pearse 1968; Gibbs 1974). By providing amenities such as lodging and food, tourists would be encouraged to extend their stay, and therefore spend more money in Vintondale to support the local economy.

Consumptive outdoor recreation as a generator of environmental remediation and economic stimulation

This scenario posits that habitat management, including hunting as a recreational objective, would increase ecotourism and stimulate the local economy. Research has largely categorized ecotourism with the following four principles: (1) the decision to participate in a recreation activity; (2) the decision of which site to visit; (3) the decision of how many trips to make to a given site; and (4) the decision of how long to stay (Loomis 1995). All of these principles are affected by the natural resource quality, which includes air quality, water quality, degree of naturalness, abundance of fish and wildlife, forest cover, etc. (Loomis 1995). This scenario, depicted in Figure 3.2, balances AMD treatment in the Blacklick Creek watershed with game lands management, increases in wildlife habitat biodiversity, and economic development infill opportunities. This balance would increase the natural resource quality and stimulate ecotourism in the Vintondale borough.

Wetlands developed along Blacklick Creek provide passive treatment of AMD in upstream cells. As the water neutralizes, it also creates habitat for native and migratory game fowl. Transitional grassland habitat is recommended to the north of the wetlands to encourage habitat and species biodiversity and to provide quail stocking and hunting. The bony pile is managed through the I-cubed method, which not only removes the stream acid input but also treats the AMD source at mine portal No. 6 through alkaline grout injection. Again, Shuman run is dammed to create a small pond for the purpose of stocking fish; Shuman run is only slightly degraded by AMD, and a limestone riffle placed upstream would raise the pH of the water to where it could support fish (L. Robert Kimball & Associates 2005). For maximum habitat benefits, a riparian buffer should be created to stabilize the banks and provide valuable nutrients to support colonization. Businesses, including restaurants, a gas station, grocery store, meat processing and packaging facility, a small sporting goods store, hunting and fishing license sales, and a variety of lodging options at multiple price points such as a campground, hotel, cabins, and an R.V. lot, are recommended in this scenario.

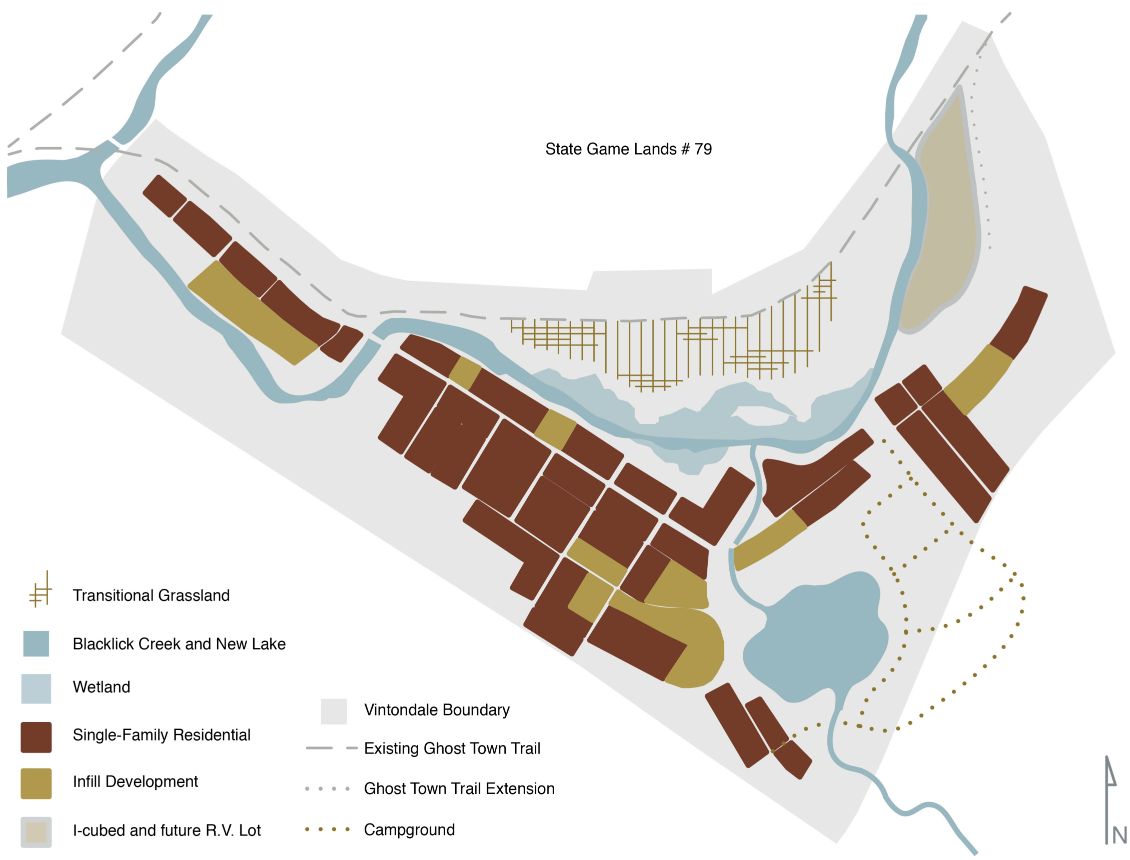

Figure 3.2: Consumptive outdoor recreation scenario

Hunting-related ecotourism generates a significant amount of money annually. In Pennsylvania, deer hunting alone results in over $245 million annually in retail and $122 million in wage earnings (Diefenbach, Palmer et al. 1997) and results in an equivalent amount of money being spent by in-state and out-of-state residents per day. Fishing, on the other hand, generates almost twice as much money from out-of-state residents as opposed to those in-state (Aiken 2009). The support businesses that are proposed take advantage of this revenue potential and will encourage money to be spent in Vintondale instead of tourists purchasing gear and licenses in other towns.

Consumption-based recreational activities are bolstered in Vintondale because it is bordered to the north by Pennsylvania State Game Lands. These lands are managed by the state to protect wildlife and habitat for current and future generations (Rosenbery 2009). *Management and Biology of White-Tailed Deer in Pennsylvania 2009-2018* recognizes that providing consumptive recreational opportunities is important for the management of deer herd size and the quality of the natural habitat (Rosenbery 2009). However, this scenario takes into account the seasonality of hunting one species and has recommended increasing habitat diversity to support a variety of wildlife. Wild turkeys have the same habitat requirements of white-tailed deer, but additional game species such as wood duck, black duck, common and hooded merganser, coots, and quail require wetlands and transitional grasslands, which are recommended (Pennsylvania Game Commission 2009).

Management and promotion of the game lands for recreational objectives is only one half of the equation for Vintondale. The other part of the strategy is to encourage landowners to enter into a fee hunting scheme, granting access to hunters on private land. Fee hunting gives landowners an incentive to use practices that maintain or enhance wildlife habitat and to actively coordinate with state wildlife management agencies (Jordan and Workman 1989). Both public and fee hunting opportunities, coupled with strategic infill development such as food, lodging, and processing facilities, could increase ecotourism opportunities within the borough.

Creation of an experimental field station to generate knowledge about AMD

As has previously been discussed in this thesis, there is still much to learn about the continuing effects of underground coal mining on society, the environment, and the economy. This scenario proposes that an experimental field station be built in Vintondale along Blacklick Creek to house a multi-disciplinary program which could include but is not limited to: environmental science, biology, geology, zoology, psychology, sociology, history, environmental engineering and/or environmental ethics.

This scenario focuses less on the rehabilitation of the local ecology and instead recommends that the entire site and its surroundings be used as an outdoor laboratory where student and faculty researchers could develop experiments, protocols, and standards for a better way to close a mine and either prevent or treat the negative effects of AMD. In addition to “hard” scientific investigation, a field station could also support the social sciences, studying the societal and economic challenges that post-mining towns face. As shown in Figure 3.3, an experimental field station would provide classroom and indoor laboratory space for students and faculty, allowing them the opportunity to experiment with and monitor environmental hazards such as the bony pile, AMD from mine portal No. 6, and the bore holes in North Branch Blacklick Creek. Student housing, such as a dorm or individual apartments, provide residences in this scenario, while a gas station, restaurants, and a grocery store make it convenient to live in Vintondale. A bike rental and water-sport outfitter provide outdoor recreational opportunities and increase the quality of life for students, faculty, and residents by allowing them to engage positively with nature.

The field station model has proven successful for other colleges and universities across the country, and scientists argue that field stations support research and education and are conducive to scientific breakthroughs (Michener 2009). Field stations offer legacies of data and accumulated knowledge along with motivated students and faculty. Couple this with areas such as Vintondale that present a unique local environment and a field station can foster unexpected scientific discovery (Michener 2009). The existing literature on field stations cover only those utilized for scientific purposes; however, a review of field programs of both major state universities and private liberal arts colleges revealed that many large universities create field stations primarily for scientific advancement (e.g.

biological or ecological field stations), whereas liberal arts schools focus on including both the arts and sciences in field station curricula. For example, the Northwoods Field Station operated by Hiram College in Michigan's upper peninsula offers courses in biology, field botany, natural history, astronomy, literature, and leadership.

Figure 3.3: Experimental field station and research scenario

There are four private colleges and universities within an hour's drive of Vintondale that could operate a field station. These include St. Francis University, Indiana University of Pennsylvania, Mount Aloysius College, and St. Vincent

College. Additionally, both Pennsylvania State University and the University of Pittsburgh have a strong presence in this part of Pennsylvania and already have extensive campus networks. Not only would a field station encourage visitation to and awareness of Vintondale by a younger demographic, but it also could further research about underground coal mining and mine closure, which would perhaps lead to significant changes in mining protocol, legislation, and closure proceedings.

Downtown revitalization to stimulate economic growth and support community development

This scenario focuses entirely on the development of a downtown core as an economic driver for the local economy. Between 1907 and 1930, there were approximately 30 businesses in Vintondale, including clothing stores, butcher shops, hotels, grocery stores, speakeasies and bars, a jewelry store, and a mechanic shop. Currently only five commercial buildings remain on Main Street, and none of them host any commercial activity (Weber 2008). Structures situated on Main Street are primarily residential homes, which means that this scenario would require a major redevelopment of the Main Street corridor, including rezoning. Because of the declining population, however, many of the residential homes sit vacant and mixed-use zoning could allow for residential homes to be interspersed with new businesses.

Figure 3.4 details the design and programming interventions proposed in this scenario. The primary recommendation is to create a vibrant Main Street through infill or building re-use, but additionally the I-cubed method is proposed to generate income from the bony pile and provide additional electrical generation through incineration, which could offset the added load placed on the power supply by infill businesses. The I-cubed method also eliminates the acid input source into South Branch Blacklick Creek and the grout injection backfills and treats the AMD in mine portal No. 6 (Ferguson 1985).

Figure 3.4: Downtown redevelopment scenario

Downtown redevelopment in small towns such as Vintondale often takes the form of a central business district (CBD), which requires the use of economic "tools" to enable legislation and other mechanisms for the creation of a social and economic center (Paradis 2000). There are a host of non-profit organizations that work with CBDs to educate local communities about the revitalization and management of their downtowns and neighborhood commercial districts, the most notable of which is the Main Street Program – a downtown revitalization program developed and administered by the National Trust for Historic Preservation (National Trust for Historic Preservation 2012). The problem with this method is that it often relies on a community already having a downtown commercial district, and critical mass of consumers and/or residents, which Vintondale lacks.

CBDs can transform small-town downtown districts into visitor-oriented attractions, while still serving the needs of the local citizens (Snepenger, Reiman et al. 1998; Paradis 2000). Infill in Vintondale would need to be considered extensively to ensure that the proposed businesses can survive, as survival depends on residents in neighboring towns frequent them. The problem with this scenario is that it only addresses economic development along Main Street as a means to pull tourists into Vintondale and create jobs for local citizens. With the aging population of the town, there would also need to be a resurgence of young people moving into the area. Additionally, given the lack of connectivity to larger areas, the location of Vintondale may not be conducive to major economic redevelopment. (Ferguson 1985). A downtown development program would need to be undertaken in conjunction with other scenarios presented in this thesis.

Historic preservation as a means to generate tourism and increase opportunities for environmental education

Historical interpretation offers the opportunity to translate to the public what the town of Vintondale would have been like during 1907 to 1945, its most significant period of development due to the active coal and iron production in the Blacklick Creek valley (Weber 2008). Considerable research has been compiled about Vintondale during this period, but aside from the interpretive signage at Eliza Furnace, not much is being done to promote the town's historic significance as a cultural landscape. This scenario, as shown in Figure 3.5, proposes that Vintondale capitalize on its mining history as a point of pride and nostalgia in a town that is virtually disappearing.

The most significant action proposed is a recreation or "ghosting" of the Vinton Coal and Coke washery and power house, which was the most noteworthy building related to the mining activities in Vintondale in 1907. In addition to the washery and power house, there was an extensive network of coke ovens, the foundations of which are still visible in the constructed wetlands. If the building was reconstructed, it could be used for a mining history museum similar to that found in Center City, PA and other mining towns throughout Appalachia. Ghosting the building footprint would be more economical than building a new structure, and it would still pay homage to the history of the site without disturbing the functioning wetlands. A mining history tour, which would highlight some of the buildings from the 1907-1945 era still standing on Main Street, is recommended for the town in this scenario. Additionally, a rail car along the Ghost Town Trail to the west of the town could be repurposed into a diner. Along with embracing the history of the town as a coal producer, it is important in this scenario to address the effects that coal mining has had on the town. Passive AMD treatments should be used in South Branch Blacklick Creek in conjunction with the I-cubed method, which will remove the bony pile and treat the AMD discharge from mine portal No. 6. All of the design interventions are proposed to reveal the cultural history of Vintondale and celebrate its past while working toward a better environmental future.

In this scenario, Vintondale's historic and cultural landscape must also be considered. Defined by the National Park Service, a cultural landscape is “a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values” (Birnbaum 1994). Within this definition, Vintondale could be considered a historic vernacular landscape, which is a landscape that is defined by the activities or occupancy of the people that lived there. The social and cultural attitudes of the people in a historic vernacular landscape are unique and the landscape reflects the physical, biological, and in the case of Vintondale in particular, the cultural character of their everyday lives

(Birnbaum 1994). Unfortunately, most of the visual history of Vintondale has been destroyed through fires and other natural disasters, leaving primarily photographs and written records of the town's history. The few remaining structures from the 1907-1945 time period are the foundation of the washery and coke ovens (see Figure 3.6) and several of the businesses along Main Street (Weber 2008). Eliza Furnace still stands where it was originally constructed (Weber 2008).

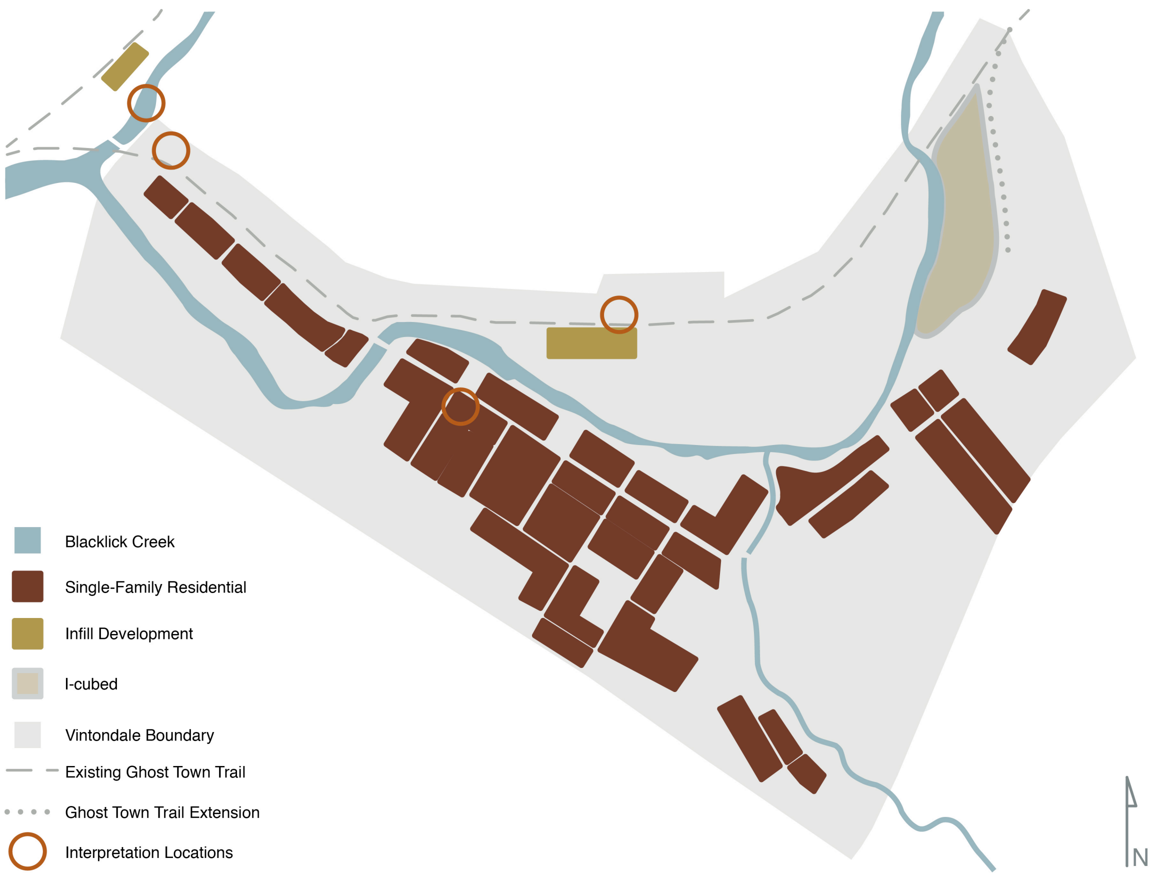

Figure 3.5: Historic preservation scenario


Figure 3.6: Visible remnants of the coke ovens (photograph by author)

The National Park Service provides four distinct treatment approaches to the historic preservation of cultural landscapes, which include preservation, rehabilitation, restoration, and reconstruction (Birnbaum 1994). This scenario does not posit which of these treatments would be “right” for Vintondale, as they are dependent upon several factors, including the physical condition, proposed use, and intended interpretation of the landscape. However, this scenario does propose that instead of recreating the town, residents interpret the past and present in an effort to tell the story of the borough. This recommended interpretation reflects the fact that, as this thesis has shown, the ramifications of coal mining persist today despite mine closings and the essential disappearance of mining towns.

There are several examples of Appalachian towns and regions addressing and celebrating their heritage as coal producers. In 1966, the state of West Virginia partnered with the National Park Service to establish an 11-county

National Coal Heritage Area, followed by a 98-mile long Coal Heritage Trail two years later (Klein 2004). On a smaller scale, the Kentucky Coal Mining Museum, a heritage center located in Benham, Kentucky, houses special exhibits on the company towns of Benham and Lynch. The museum coordinates tours with a nearby mine portal and details the everyday life of families living in this region (Alford 2009). Following the example of these precedents, recognizing the town's history as a point of pride can help to generate excitement about Vintondale and awareness of rural Appalachian towns as cultural landscapes.

Dam construction as a means to counteract AMD and neutralize water pH within the Blacklick Creek watershed

This scenario, depicted in Figure 3.7, was initially developed to return Vintondale to a power-generating town as a way to create an economy. After further study, it became clear that a hydropower dam could also create a hydraulic head that would counteract the hydraulic pressure of the acidic water in the underground mine, effectively stopping the flow of AMD into Vintondale (Ferguson 1978). The consequence of building a dam of this size is that two-thirds of the town of Vintondale, along with its historical features, would be under water. As with most dam creations, it would require the relocation of area residents. The scenario requires the removal and incineration of the bony pile before the dam is created so that the petroleum and heavy metals do not make the entire reservoir toxic. Additionally, a diversion well will be placed at the outflow of the dam to neutralize the acidity of the water.

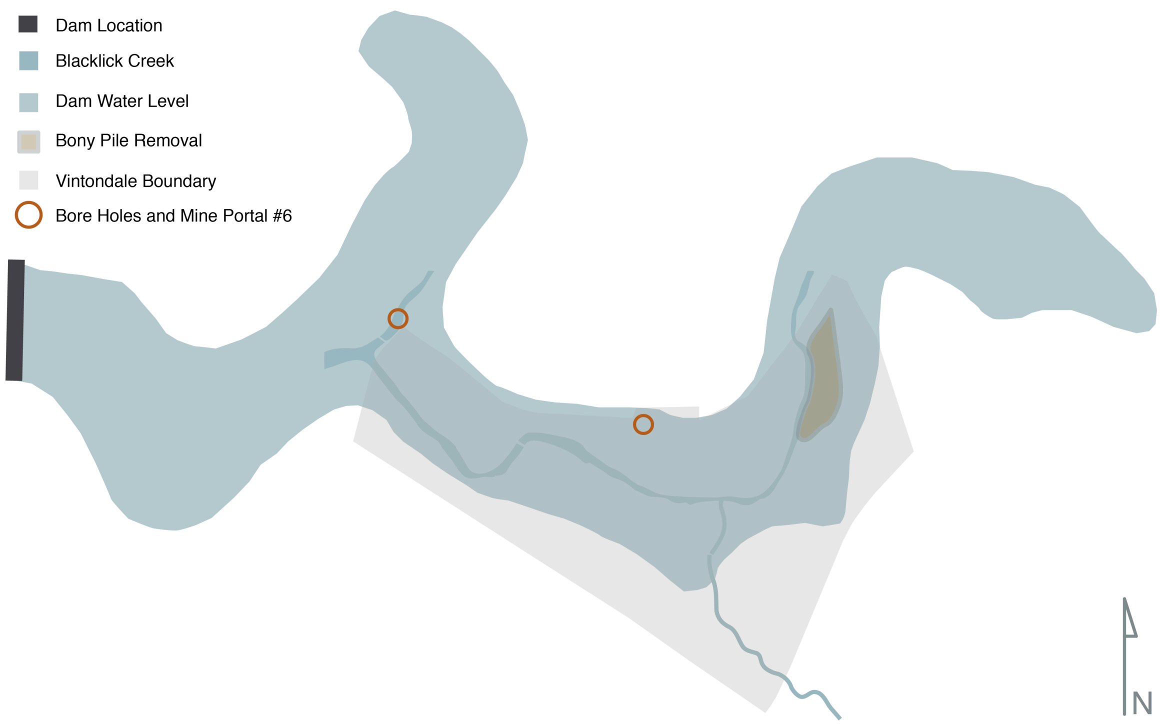

Figure 3.7: Dam construction scenario
Proposed configuration of the reservoir that would be created if a dam were constructed to counteract contributing AMD

The dynamics of underground mines need to be considered in this scenario. An underground mine functions as an aquifer, or storage for ground water. When it is thought of in this way, acid mine drainage can be explained using a simple physics principle called Bernoulli's Relationship, which describes that hydraulic head (h) is equal to elevation head (z) plus pressure head (p), or h=z+p. In an aquifer situation, the pressure head (p) is constant across the site because atmospheric pressure determines the top of the saturated zone of the soil. Z, or elevation, represents the energy available to drive water through the aquifer materials to a point of discharge, such as a mine portal or seeping well (Fetter 1988). Groundwater flows from higher to lower hydraulic head, which is why acid mine drainage flows from the pressurized underground aquifer to the surface. This scenario proposes that damming a lake of adequate size will create a hydraulic head sufficient to suppress the flow of groundwater to the surface.

Because the stream water flowing into the lake is already slightly acidic, removing the acid mine drainage will not solve all of the acidity problems in the body of water. Placing a diversion well at the base of the dam will neutralize the water as it flows out of the lake. The well is a device that consists of a sunken cylinder fed by a large pipe that conducts outflow from the dam. The cylinder is approximately half full of crushed limestone. The flowing water fluidizes the limestone into a fine powder, which serves two purposes – it reacts further with the acid, and is also carried into the stream to further neutralize the water (Arnold 1991). The pressure created by the lake and the construction of the diversion well will serve to stop acid mine drainage at the fork of the North and South branches of Blacklick Creek and neutralize any contributing acid sources.

This is a provocative scenario because there are positive and negative aspects for both environmental enhancement and community and economic enhancement. Dams are contentious issues because of their environmental safety liabilities (topping or failing), the forced relocation of residents, and their negative ecological effects (change in water temperature, bank erosion, disruption of aquatic habitat, etc.). Additionally, because water in an underground mine exists in a highly pressurized state, stopping the outflow in Vintondale may result in AMD discharge in other locations. The safety liabilities and relocation of residents are further negative consequences that need to be weighed carefully.

However, there are also positive ecological effects that need to be considered with this proposal. The stream ecology of Blacklick Creek is already degraded to the point that it does not support aquatic habitat or a riparian buffer (L. Robert Kimball & Associates 2005). Combining removal of the bony pile with suppression of the AMD drainage from the mine and fluidization of limestone to increase alkalinity would change the water chemistry in such a way that the reservoir may be able to support aquatic life once again. A variety of technologies are available that can control the temperature, oxygen levels, and water quality at the outflow of a dam (Tennessee Valley Authority 2012). In addition to changes in water chemistry, studies have shown that identifying and minimizing the geomorphologic modifications that occur after dam construction is crucial to protecting the biological integrity of a river (Ligon, Dietrich et al. 1995).

Assisted natural regeneration and passive AMD treatment for ecological recovery

The final scenario, shown in Figure 3.8, critically investigates the societal and economic status of Vintondale and questions whether settlement in this area is still viable and sustainable. The economic sustainability of Vintondale is questionable—there is no tax base to support schools, medical services, or even a grocery store. With no services or jobs available in the town, there is no draw for immigration, leaving the town caught in a positive feedback loop of a declining and aging citizenry. On top of this, three-fourths of the houses in Vintondale were constructed before 1930 and require additional considerations, such as heating with propane, which must be delivered by a truck. The town struggles are compounded by the fact that power lines must be maintained, and that the county continuously needs to spend money on road maintenance and snow removal (U.S. Census Bureau 2010 a).

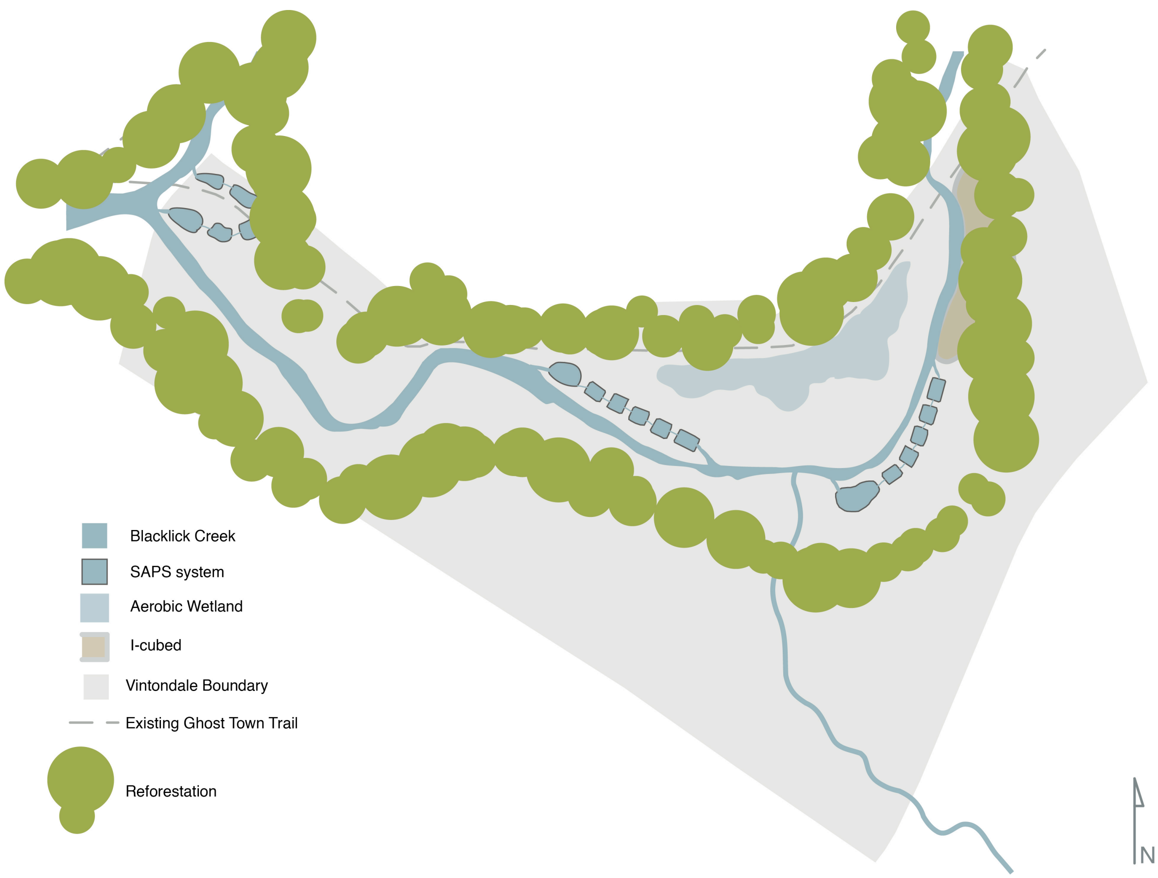

Figure 3.8: Assisted natural regeneration scenario

This scenario proposes that instead of trying to rebuild an economy in Vintondale, the residential housing should be removed and the location restored to its natural habitat. It is recommended that the bony pile be removed through I-cubed methods and that a series of SAPS be established along South Branch Blacklick Creek and North Branch Blacklick Creek to continue to passively neutralize the water in the streams. Creating aerobic wetlands at mine portal No. 6 will passively neutralize the water and allow infiltration. Assisted natural regeneration is recommended to restore healthy forests and riparian buffers, allowing for this land to become part of the state game lands.

If this technique were hypothetically applied on a large scale across Appalachia, the network of state protected forests would be immense, and the money saved by not having to maintain government services to these rural areas could be reallocated to natural resource protection. The scenario could also have extensive ramifications for landscape ecology, which focuses on the spatial relationships of ecosystems, flows of energy, nutrients, and species, and the ecological dynamics of landscapes over time (Turner, Gardner et al. 2001). The Eastern Wildway, which runs the length of the Appalachian spine, is a network of lands stretching from the Acadian forests of Canada to the Everglades of Florida. Restoring the ecological integrity of post-mining towns throughout the Appalachians could allow these areas to weave into this network and provide valuable connectivity for migratory species stopover habitat and wildlife that need large home territories (Turner, Gardner et al. 2001)

Conclusion

The scenarios presented above are not answers or solutions in and of themselves. The hypothetical investigation of such disparate themes is meant to suggest inspiring alternatives to the status quo. Chapter Four qualitatively evaluates the individual design interventions within the scenarios by applying a bi-polar matrix that uses ordinal ranking to determine which of these hold the most promise for environmental, community, and economic enhancement as well as public protection. The end of the chapter proposes three combined scenarios that provide the most provocative solutions to the ecological and societal problems that plague Vintondale.

CHAPTER FOUR: THREE FUTURES: EVALUATION AND SYNTHESIS OF EXPLORATORY LANDSCAPE SCENARIOS

Exploratory landscape scenarios pose many possible design alternatives that need to be evaluated. In practice, many of the scenarios would be intuitively ruled out due to cost or environmental disruption, but for the purposes of this thesis, an analytical approach is adopted that attempts to measure to what degree each scenario component satisfies the goal established at the beginning of the thesis – to use planning and design to preserve rural livelihoods and encourage reinvestment within rural Appalachian settlements in regards to economy, society, and ecology. This analytical approach, adopted by J.T. Lyle in his design scenario methodology, has proven useful in the development of a final proposal (Lyle 1999).

The evaluation matrix presented in Table 4.1 examines the exploratory landscape scenarios outlined in the previous chapter (the ‘y’ axis) and analyzes them within categories on the basis of their environmental, community, and ecological enhancement as well as public protection (along the ‘x’ axis). These categories are made up of individual elements that were adapted from multiple sources and utilized as a basis of ranking the design interventions within each scenario; the sources of origination include the U. S. Bureau of Mines report on the Blacklick Creek watershed, additional watershed reports, and the previously mentioned doctoral dissertation on community visioning (Ferguson 1992, Therig 2007, L. Robert Kimball & Associates 2005).

The design interventions within the scenarios were evaluated qualitatively as positive, neutral (having no effect) or negative. Psychological research has shown that listing and making a bi-polar comparison of features in alternative solutions is effective as a decision-making tool, and that it can be more effective to determine the strength of an argument at an ordinal (positive/negative) level rather than a cardinal (numerical valuation) level (D. Dubois, H. Fargier et al. 2008; J. F. Bonnefon, D. Dubois et al. in press). The extent of the research for this thesis did not provide enough information to quantitatively score the individual design interventions or create a system for ranking aside from positive or negative.

Over forty separate design interventions were proposed and evaluated in the matrix, each one only taking into consideration the effect on that particular category. For example, physical and noise intrusion under the environmental enhancement category judges the physical or audible presence of a design intervention within the landscape (i.e., does an intervention remove habitat and replace it with something better or worse? Will any noise created by this design intervention disrupt wildlife?). Within the community and economic enhancement category, noise intrusion and visual intrusion are considered on the basis of their impact to residents and visitors (i.e., does a design intervention make a once quiet residential area noisy late into the night? Will a building disrupt a view or be visually appealing?).

Within the environmental enhancement category, design interventions are rated based on their impact on habitat quality, size, and diversity, as well as any physical or noise intrusions that they would impose on the environment. Additionally, water and land reclamation objectives were considered (Ferguson 1992), as were flood control and surface runoff control (quality and quantity). For a design intervention to be judged positively, it had to create more of a benefit to the local ecology than the negative environmental impact of building or installing it. A negative rating was given when a design intervention poses an undesirable ecological outcome, such as creating additional surface runoff or decreasing habitat size, diversity, or overall quality. An intervention was deemed to have no significant impact if it would not affect the local ecology either positively or negatively (e.g., opening a restaurant in an already existing building).

Community and economic enhancements were considered together because many of the factors within this category have overlapping benefits. For example, tax revenue is an economic factor; however, if a scenario proposes an intervention that will increase tax revenue, it is an advantage for both the city and the community, as local tax dollars are often allocated in part for the salaries of civil servants, who in turn benefit the community. This category does not account at all for environmental factors, instead judging the interventions only in relation to their impact on humans or the economy. Factors under community and economic enhancement include the creation of housing options for people of different incomes, creation of commercial spaces, tax revenue, or private profit. Also included are the creation of visitor accommodations, recreational facilities, and/or educational facilities and the use of the proposed design interventions by adults or by youth. Interventions are also judged on the basis of creating or blocking river and wetland access or if they create or prohibit pedestrian, bicycle, and water sport use. Finally, the scenario components are evaluated for their noise or visual effects. A positive rating was given if the design intervention created or bolstered these factors; a negative rating was given to those interventions that prohibited or interfered with community and economic enhancement. If there was no significant effect on the community or economy, it was given a neutral rating.

The public protection category contains three known environmental hazards in Vintondale: flooding, stream water quality (including AMD from upstream and the AMD inputs within the Vintondale boundaries), and the presence of the bony pile (Ferguson 1992; L. Robert Kimball & Associates 2005; Weber 2008). Again, the design interventions are judged in relation to human well-being; A positive rating was given to an intervention that decreases or removes the environmental hazard, whereas one that adds to a hazard was scored negatively. Interventions that have no effect on environmental hazards were given neutral ratings.

Table 4.1: Matrix evaluation

The bi-polar evaluation matrix is used to assess design interventions within each scenario that hold the most promise for social and economic reinvestment and economic rehabilitation

	Environmental enhancement												Community and economic enhancement																			Public Protection					
	Habitat quality	Habitat size	Habitat diversity	Physical intrusion	Noise intrusion	Water reclamation objectives	Land reclamation objectives	Flood control	Surface run-off control	+	o	-	Multi-income housing	Commercial use	Tax revenue	Private profit	Visitor accommodations	Use by adults	Use by youth	Recreational facilities	Educational facilities	River access	Wetland access	Pedestrian use	Bicycle use	Water sport use	Noise intrusion	Visual intrusion	+	o	-	Flooding	Water quality	Bony pile	+	o	-
Non-consumptive outdoor recreation scenario																																					
Wetland	+	+	+	+	o	+	o	+	+	7	2	0	o	o	o	o	o	+	+	+	o	-	+	o	o	+	o	+	6	9	1	+	+	o	2	1	0
Wetland boardwalk	o	o	o	-	-	o	o	o	o	0	7	2	o	o	o	o	o	+	+	+	+	+	+	+	o	-	-	-	7	6	3	o	o	o	0	3	0
Wildlife viewing platform	o	o	o	-	-	o	o	o	o	0	7	2	o	o	o	o	o	+	+	+	+	o	o	+	o	o	-	-	5	9	2	o	o	o	0	3	0
Hiking trails through state game lands	o	o	o	-	-	o	o	o	o	0	7	2	o	o	o	o	o	+	+	o	o	o	o	+	o	o	-	o	3	12	1	o	o	o	0	3	0
Mountain bike trails	-	o	-	-	-	o	o	o	-	0	4	5	o	o	o	o	o	+	+	+	-	o	o	o	+	o	-	-	4	9	3	o	o	o	0	3	0
Mycoremediation and revegetation of bony pile	+	+	+	o	o	+	o	o	+	5	4	0	o	o	o	o	o	o	o	o	+	o	o	+	o	o	o	o	2	14	0	o	+	+	2	1	0
Dam stream to create lake (swimming and boating)	-	-	-	-	o	o	o	+	+	2	3	4	o	o	o	o	o	+	+	+	o	o	o	o	o	o	-	-	3	11	2	o	o	o	0	3	0
Campground, hotel, cabins	-	-	o	-	-	o	o	o	-	0	4	5	o	+	+	+	+	+	+	+	o	o	o	o	o	o	-	-	7	7	2	o	o	o	0	3	0
Restaurant (s)	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	o	+	+	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Grocery	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Gas station	-	o	o	o	o	o	o	o	-	0	7	2	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	-	5	9	2	o	-	o	0	2	1
Bike rental	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	+	+	o	o	o	o	+	o	o	o	8	8	0	o	o	o	0	3	0
Kayak outfitter and launch	-	o	o	-	-	o	o	o	o	0	6	3	o	+	+	+	+	+	+	+	o	+	+	o	o	+	-	-	10	3	2	o	o	o	0	3	0
Consumptive outdoor recreation scenario																																					
Wetland	+	+	+	+	o	+	o	+	+	7	2	0	o	o	o	o	o	+	+	+	o	-	+	o	o	+	o	+	6	9	1	+	+	o	2	1	0
Transitional grassland habitat	+	+	+	+	o	o	o	o	+	5	4	0	o	o	o	o	o	+	+	+	o	o	o	o	o	o	o	+	4	12	0	+	+	o	2	1	0
I-cubed	+	o	o	+	-	+	o	o	+	4	4	1	o	o	o	+	o	o	o	o	o	+	o	o	o	o	-	-	2	12	2	o	+	+	2	1	0
Dam stream to create lake (fishing)	-	-	-	-	o	o	o	+	+	2	3	4	o	o	o	o	o	+	+	+	o	o	o	o	o	+	o	+	5	11	0	o	o	o	0	3	0
Campground, hotel, cabins, and R.V. area	-	-	o	-	-	o	o	o	-	0	4	5	o	+	+	+	+	+	+	+	o	o	o	o	o	o	-	-	7	7	2	o	o	o	0	3	0
Restaurant (s)	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	o	+	+	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Grocery	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Processing and packaging facility	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	-	5	9	2	o	o	o	0	3	0
Gas station	-	o	o	o	o	o	o	o	-	0	7	2	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	-	5	9	2	o	-	o	0	2	1
Sporting store	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	+	o	o	o	o	o	o	o	o	o	6	10	0	o	o	o	0	3	0
Hunting and fishing license sales	+	o	+	+	+	o	o	o	o	4	5	0	o	o	+	+	+	+	+	+	+	o	o	o	o	o	o	o	7	9	0	o	o	o	0	3	0
Experimental field station scenario																																					
Experimental field station	o	o	o	-	o	o	o	o	o	0	8	1	+	+	+	+	o	+	+	o	+	o	o	o	o	o	o	o	7	9	0	o	o	o	0	3	0
Student housing and apartments	o	o	o	o	-	o	o	o	o	0	8	1	+	o	+	+	+	+	o	o	o	o	o	o	o	o	-	o	5	10	1	o	o	o	0	3	0
Gas station	-	o	o	o	o	o	o	o	-	0	7	2	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	-	5	9	2	o	-	o	0	2	1
Identified test locations	o	o	o	+	o	o	o	o	o	1	8	0	o	o	o	o	o	+	o	o	+	o	o	o	o	o	o	-	2	13	1	o	+	o	1	2	0
Bony pile experimentation	o	o	o	+	o	+	o	o	+	3	6	0	o	o	o	o	o	+	o	o	+	o	o	o	o	o	o	-	2	13	1	o	+	+	2	1	0
Active AMD treatment in Blacklick Creek	+	o	+	+	o	o	o	o	o	3	6	0	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	-	1	14	1	o	+	o	1	2	0
Passive AMD treatment in Blacklick Creek	+	o	+	+	o	o	o	o	o	3	6	0	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	-	1	14	1	o	+	o	1	2	0
Restaurant (s)	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	o	+	+	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Grocery	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	o	o	o	o	o	o	o	o	-	+	6	9	1	o	o	o	0	3	0
Bike rental	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	+	+	o	o	o	o	+	o	o	o	8	8	0	o	o	o	0	3	0
Kayak outfitter and launch	-	o	o	-	-	o	o	o	o	0	6	3	o	+	+	+	+	+	+	+	o	+	+	o	o	+	-	-	10	3	2	o	o	o	0	3	0
Downtown revitalization scenario																																					
Redeveloped downtown core	o	o	o	o	o	o	o	o	o	0	9	0	+	+	+	+	+	+	+	o	o	o	o	+	o	o	-	+	9	6	1	o	o	o	0	3	0
Retain AMD + ART park	+	o	o	o	o	+	o	+	o	3	6	0	o	o	o	o	o	+	+	+	+	o	+	+	+	o	o	+	8	8	0	o	+	o	1	2	0
Historic preservation scenario																																					
Railcar diner	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	+	o	o	o	o	o	o	o	o	+	7	9	0	o	o	o	0	3	0
Mining history tour	o	o	o	-	-	o	o	o	o	0	7	2	o	+	o	o	o	+	+	+	+	o	o	+	o	o	o	o	6	10	0	o	o	o	0	3	0
I-cubed	+	o	o	+	-	+	o	o	+	4	4	1	o	o	o	+	o	o	o	o	o	+	o	o	o	o	-	-	2	13	1	o	+	+	2	1	0
Passive AMD treatment in Blacklick Creek	+	o	+	+	o	o	o	o	o	3	6	0	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	-	1	14	1	o	+	o	1	2	0
Recreation of Vinton Coke and Colliery	o	-	-	-	o	o	o	o	o	0	6	3	o	+	+	+	+	+	+	+	+	o	o	o	o	o	o	+	9	7	0	o	o	o	0	3	0
"Ghosting" of Vinton Coke and Colliery	o	o	o	o	o	o	o	o	o	0	9	0	o	+	+	+	+	+	+	+	+	o	o	o	o	o	o	+	9	7	0	o	o	o	0	3	0
Preservation of existing historical buildings	o	o	o	o	o	o	o	o	o	0	9	0	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	+	2	14	0	o	o	o	0	3	0
Dam construction scenario																																					
Dam	+	+	+	-	o	+	o	+	o	5	3	1	o	o	o	+	o	o	o	+	o	o	o	-	-	+	o	-	3	10	3	o	+	o	1	2	0
Diversion well	+	o	o	-	o	+	o	o	o	2	6	1	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	-	1	14	1	o	+	o	1	2	0
Relocation of residents	o	o	o	-	o	o	o	o	o	0	8	1	-	-	-	-	o	o	o	o	o	o	-	o	o	o	o	o	0	11	5	+	o	o	1	2	0
Incineration of bony pile	+	o	o	+	-	+	o	o	+	4	4	1	o	o	o	+	o	o	o	o	o	+	o	o	o	o	-	-	2	12	2	o	+	+	2	1	0
Limestone riffle	+	o	o	+	o	o	o	o	o	2	7	0	o	o	o	o	o	o	o	o	+	o	o	o	o	o	o	+	2	14	0	o	+	o	1	2	0
Assisted nature scenario																																					
Large scale SAPS system	+	+	+	+	o	+	o	+	+	7	2	0	o	o	o	o	o	o	o	o	+	-	-	o	o	o	o	-	1	12	3	+	+	+	3	0	0
I-cubed	+	o	o	+	-	+	o	o	+	4	4	1	o	o	o	+	o	o	o	o	o	+	o	o	o	o	-	-	2	13	1	o	+	+	2	1	0
Flow-through fly ash cement	+	+	+	-	o	+	o	o	o	4	4	1	o	o	o	o	o	o	o	o	+	-	-	o	o	o	o	-	1	12	3	o	+	+	2	1	0
Reforestation	+	+	+	+	+	o	+	+	+	8	1	0	o	o	o	o	o	+	+	+	o	o	o	+	o	o	+	+	6	10	0	+	+	o	2	1	0
Removal of residential housing	o	+	o	+	+	o	o	o	o	3	6	0	-	-	-	-	o	o	o	o	o	o	-	o	o	o	o	o	0	11	5	+	o	o	1	2	0
Current scenario (no change)																																					
SAPS	o	o	o	+	o	+	o	o	o	2	7	0	o	o	o	o	o	o	o	o	+	o	+	o	o	o	o	+	3	13	0	o	+	0	1	2	0
Litmus garden	o	o	o	-	o	o	o	o	o	0	8	1	o	o	o	o	o	+	+	o	+	o	o	+	+	o	o	-	5	10	1	o	o	o	0	3	0
Blacklick Creek scouring of bony pile	-	-	-	-	o	-	o	o	-	0	3	6	o	o	o	o	o	-	-	-	o	-	o	o	o	-	o	-	0	10	6	o	-	-	0	1	2
Bore holes	-	-	-	-	o	-	o	o	o	0	4	5	o	o	o	o	o	o	o	o	o	-	o	o	o	-	o	-	0	13	3	o	-	o	0	2	1
Multi-use sports fields	-	-	-	-	-	o	o	o	-	0	3	6	o	o	o	o	o	+	+	+	o	o	o	+	o	o	-	+	5	10	1	-	o	o	0	2	1
Pavillions	o	o	o	-	-	o	o	o	o	0	7	2	o	o	o	o	o	+	+	+	+	o	o	+	o	o	-	+	6	9	1	o	o	o	0	3	0
Ghost Town Trail	o	o	o	+	o	o	o	o	o	1	8	0	o	o	o	o	+	+	+	+	+	o	o	+	+	o	o	+	8	8	0	o	o	o	0	3	0
Wetlands	+	+	+	+	o	+	o	+	+	7	2	0	o	o	o	o	o	+	+	+	o	-	+	o	o	+	o	+	6	9	1	+	+	o	2	1	0

The number of positive, neutral, and negative ratings was summed for each design intervention according to category to determine which were likely to have the greatest positive or negative impact for environmental enhancement, community and economic enhancement, and public protection. An eighth scenario, reflecting the current state of each feature in Vintondale, was evaluated using the same scoring process and was included in the matrix. Evaluating this scenario allowed for comparisons to be drawn between the environmental, social, and economic effects of the proposed scenarios to the effects already present in the borough.

Within the environmental enhancement category, the design interventions with the greatest anticipated positive effects and zero negative impacts are: wetland creation, mycoremediation and revegetation of the bony pile, creation of transitional grassland habitat, large-scale SAPS installation, and reforestation. The greatest positive outcomes for community and economic enhancement are: redevelopment of the downtown core, bike rental, kayak outfitter and launch, hunting and fishing license sales, the recreation or ghosting of Vinton Coal and Coke buildings, an experimental field station, retention of AMD & ART Park after restoring it to working order, and maintenance of and connectivity to the Ghost Town Trail. Table 4.2 contains only those design interventions considered when creating the scenarios presented in Figures 4.1, 4.2, and 4.3; the public protection category is not included because the design interventions with positive environmental enhancement also had a positive effect on public protection.

Table 4.2: Selection of design components
These design components are used in the final designs for Vintondale based on their potential positive impact on the environment, community, or economy. The components are no longer considered to be part of any specific design scenario.

Environmental enhancement	+	o	-	Community and economic enhancement	+	o	-
Wetland	7	2	0	Bike rental	8	8	0
Mycoremediation and revegetation of bony pile	5	4	0	Kayak outfitter and launch	10	3	2
Transitional grassland habitat	5	4	0	Hunting and fishing license sales	7	9	0
Large scale SAPS system	7	2	0	Experimental field station	7	9	0
Reforestation	8	1	0	Redeveloped downtown core	9	6	1
				Retain AMD + ART park	8	8	0
				Recreation of Vinton Coke and Coal	9	7	0
				"Ghosting" of Vinton Coke and Coal	9	7	0
				Ghost Town Trail	8	8	0

This thesis exists in the realm of the hypothetical because there is no specific client to guide the decision-making process. The hypothetical approach is beneficial in this case, as it allowed a thorough exploration of scenarios, which in turn framed the three designs put forth in this chapter. Together, these illustrate that there may be ways to stimulate the economy, reinvigorate the community, and/or rehabilitate the ecology in Vintondale, Pennsylvania. Individually, these designs show that without a client, there are vastly different possibilities when drawing from the same available programming options

The design proposed in Figure 4.1 focuses on the community and economic enhancement category and includes design interventions that maximize the community and economic benefit. The design proposes infill buildings along Main Street to help revitalize downtown, as these buildings could accommodate a kayak outfitter, bike rental shops, and hunting and fishing license sales. The recreation of Vinton Coal and Coke buildings can house a mining history museum, and the coke ovens are used to create a water treatment system to process and clean the water from "yellow boy creek" that drains through AMD & ART Park from mine portal No. 6. Additional parking is added for kayak launch and take out, and foot bridges that provide access to the Ghost Town Trail are proposed over South Branch Blacklick Creek. Environmental design interventions that were able to work with the community enhancement included the mycoremediation and revegetation of the bony pile, restoration of the AMD & ART SAPS to working order, planting a buffer of native vegetation surrounding the SAPS, and the inclusion of water treatment in the recreation of Vintondale coke oven housing.

This proposal emphasizes the design interventions that could increase tourism and promote small business ownership within the town. Vintondale boasts a beautiful setting to draw in passive and active recreationists, and increasing the water quality by remediating the bony pile could make it extremely attractive to those wishing to get away from more congested areas. Maximizing the attractions within the town (historic interpretation, open park space, active and passive recreation, lively downtown infill) would provide a variety of activities for different types of users. However, the plan proposed would be extremely expensive to implement, and in the long run, is not guaranteed to pay off, financially speaking. It has already been determined that Vintondale lacks easily connected through-roads, so the added infill and recreation would have to be enough of an attraction to draw users from larger surrounding areas, even though it may not be convenient.

Figure 4.2 proposes a radically different solution for Vintondale and includes the systematic removal of housing as the town continues to decline. This is followed by reforestation efforts that stabilize soil, control surface runoff, and provide habitat connectivity. The forest is proposed to become part of the State Game Lands and be maintained under the protection and guidance of the state of Pennsylvania. Because AMD inputs continue upstream, there are SAPS proposed that divert a portion of the South Branch Blacklick Creek flow through the treatment system. These are passive systems that will require very little maintenance but will need to be flushed periodically to remain in working order. The South Branch is widened as it passes through Vintondale to create wetlands, which helps to purify water and create additional habitat diversity. The wetlands are bordered by transitional native grassland habitat, and the bony pile is treated through mycoremediation and revegetation.

This plan demonstrates undeniably that human settlements contribute to the fracturing of ecosystems and degradation of the local ecology. The proposal maximizes design interventions that would restore the ecological value of the area. It would occur over a long time period, systematically removing houses as they were vacated, until all that remained of Vintondale is the SAPS, a reminder to those that stumble upon them while out for a hike, that this area was not always a thriving ecological system. However, a full-scale ecological restoration, as this plan proposes, is expensive, and would still require on-going maintenance by either the government or a third party. The reality that this proposal confronts is that the town is currently unsustainable. Unless major economic investment would occur, as is proposed in Figure 4.1, the town will continue towards its demise; this plan is not realistic in that it will happen any time soon, but it does offer an alternative to a ghost town with a fractured environment that will inevitably occur if nothing is done to either economically revitalize the town or guide it through the process of removal and ecological healing.

Figure 4.3 combines the community and economic enhancements with the environmental enhancements. This proposal plans for the experimental field station, where students and faculty can both act as stewards for the environmental enhancements and serve as community coordinators to assist with community projects and collaborative efforts. Downtown redevelopment, including infill businesses such as kayak outfitters, bike rentals, and hunting and fishing license sales, is also planned in this proposal. Parking is added for kayak launches and take-outs, as well as along the Ghost Town Trail for accessibility. The South Branch is widened to create wetland habitat, which is bordered by transitional native grasslands in an attempt to make a biologically diverse ecological system. It is also proposed that the surrounding forests enter into a management plan with the state to help create valuable wildlife habitat. Again, the bony pile is treated through mycoremediation and revegetation in this proposal.

This final proposal attempts to blend Figures 4.1 and 4.2 and maximize the economic, social, and ecological benefits that can be achieved in Vintondale. While it does combine many of the economic programs, such as downtown infill, active, and passive recreation, it also creates additional wildlife habitat, forest management, and bony pile remediation. However, by programming infill development along with environmental restoration, the two may occasionally be at odds. Infill development increases tourism, building foot prints, and the need for additional paved surfaces for parking; all of these elements contribute to the degradation of the environment. Conversely, placing wetlands in proximity to increased development may increase the chances of flooding, animal-vehicle collisions, or nuisance wildlife. Unlike the other two proposals, this one achieves the goal of preserving rural livelihood, stimulating reinvestment, and improving environmental conditions. It realistically develops the town into a destination by increasing the economic, social, and ecological value of the area.

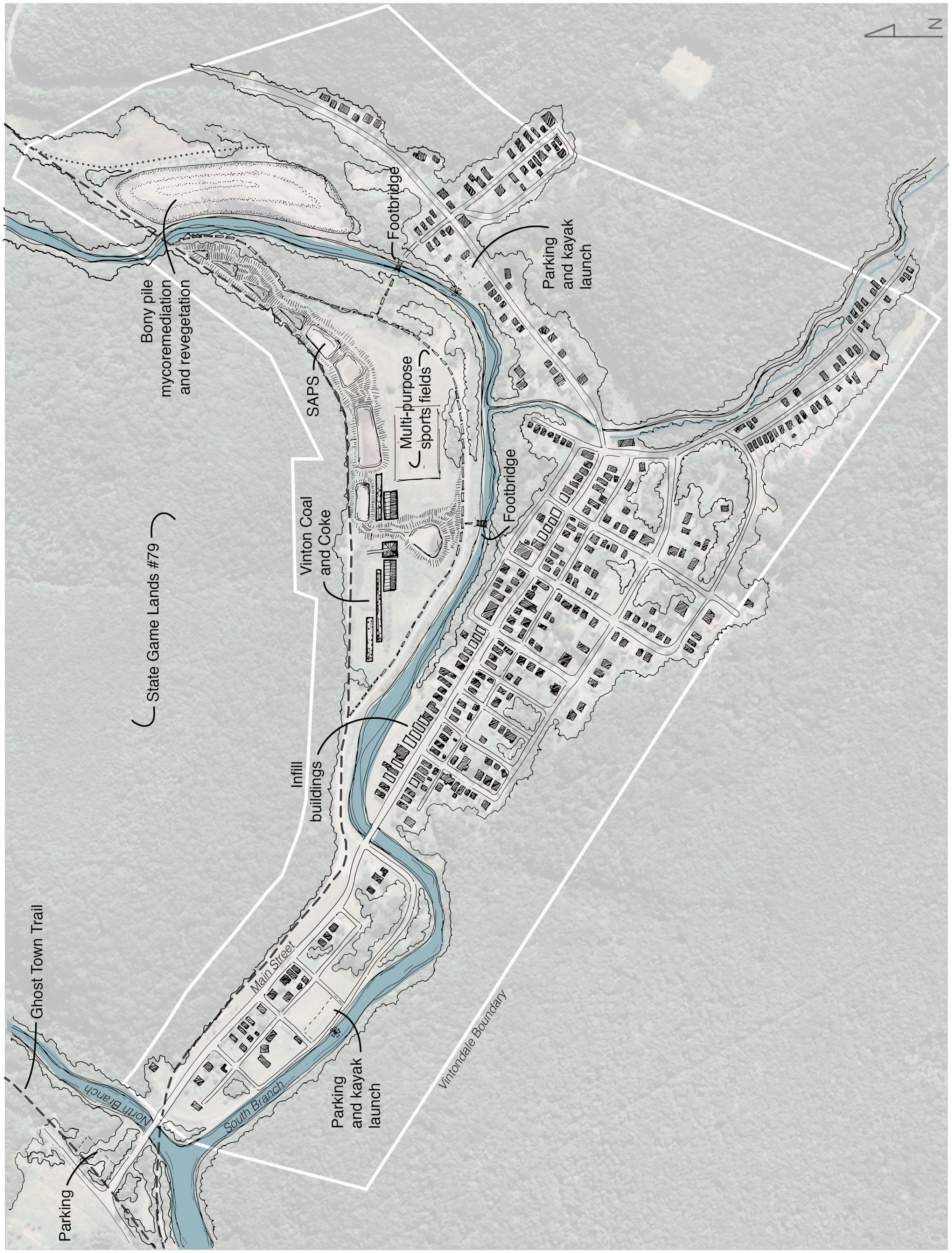

Figure 4.1: Community and economic development at Vintondale

Figure 4.2: Environmental rehabilitation at Vintondale

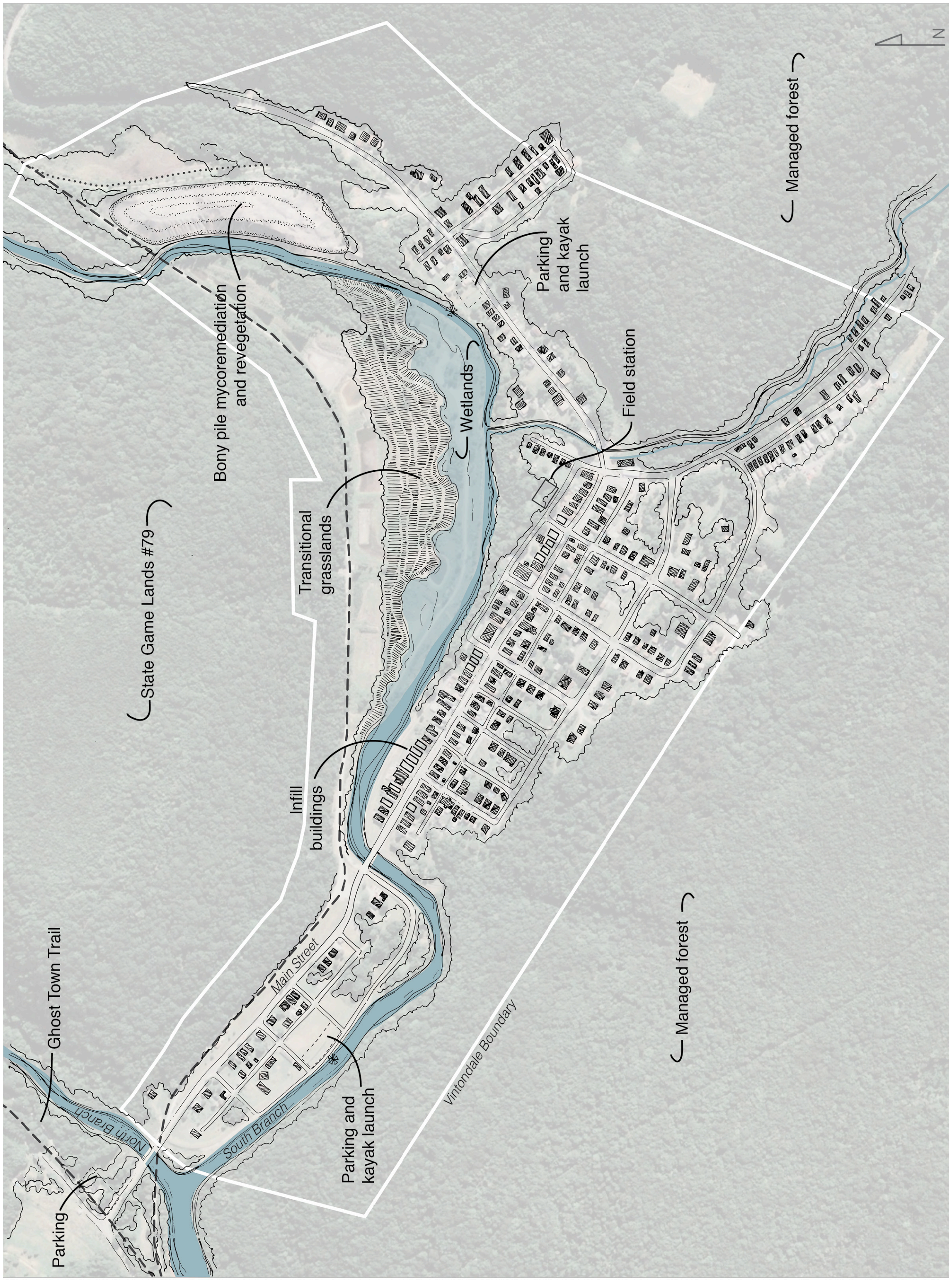

Figure 4.3: Reviving the community, economy, and ecology of Vintondale

CHAPTER FIVE: CONCLUSION: SPECIFIC TOWN CHARACTERISTICS AND THE NEED FOR A COOPERATIVE APPROACH

The question posed at the beginning of this thesis asked how planning and design interventions could be applied in rural Appalachian post-mining towns, with the hopes that doing so will preserve rural livelihood, stimulate reinvestment, and improve environmental conditions. Chapter Three proposed seven vastly different exploratory landscape scenarios to help elucidate the potential that rural Appalachian post-mining towns hold. Chapter Four utilized a bi-polar evaluation of the scenario components to determine which held the most promise in revitalizing the social, economic, and ecological dynamics in Vintondale; the chapter also provided three proposals for possible land use and planning designations. Together, these have illustrated that there may be ways to stimulate the economy, reinvigorate the community, and/or rehabilitate the ecology in Vintondale, Pennsylvania.

The lack of a determined client has made possible the examination of scenarios that would not be given credence in an office setting, such as the removal of the residents for the purpose of dam construction or environmental restoration through reforestation and wetlands. This approach also allowed for the exploration of other disparate options, as two scenarios valued the livelihood of rural Appalachia over the significant rehabilitation of the environment and encouraged downtown revitalization and historic interpretation, while another placed emphasis on using the entire town for science and humanities studies. Additionally, two scenarios proposed environmental restoration for the purpose of recreational exploitation and economic gain. The process of working through these vastly different scenarios has directly led to the conclusion that in order to make a considerable difference in rehabilitation and preservation efforts, contributors must prioritize issues; they can either place more emphasis on the environment over the community and economy, or focus on the economy and community more than the environment—but they cannot consider all three areas equally.

The bi-polar evaluation of the design interventions through the matrix, along with the three final designs that were presented, have made obvious the incompatibility of human and environmental needs in Vintondale, Pennsylvania. In the matrix shown in Chapter Four, there was not one design intervention that was equally positive for both the community and environment; the ranking showed that an environmentally beneficial solution was negative, or at least neutral, from a community standpoint, and vice-versa. The designs showed that to significantly remediate the environmental damage, humans would need to be removed from the area; inversely, to develop the town in a way that benefits the community and economic situation would require further exploitation of environmental resources in the form of fossil fuel and land consumption. To further develop this point, the last design, which attempts to reconcile the environmental, societal, and economic goals, falls short in being able to achieve significant benefit to any of them. While the inherent purpose of landscape architecture is to mediate the juncture between humans and the environment, in situations such as Vintondale, it may be possible that the two remain incompatible.

Overall, scholarly literature and the case study applied in this thesis support the feasibility of rural livelihood preservation and reinvestment on the one hand, as well as environmental reclamation on the other. What has been determined is that there is not a one-size-fits-all approach to post-mining towns like Vintondale when the aim is to the community, ecology, and economy together. It was established in Chapter One that the condition of Vintondale is similar to what is evident throughout much of rural post-mining Appalachia – a disengaged and declining population, lack of financial resources, and a devastated environment; however, there are features that make Vintondale, and each rural village like it, a unique design challenge. Challenges such as these require the creativity of a designer to help navigate ecological and societal issues to determine which strategies should be pursued within each community.

It is this author's belief that AMD & ART failed in Vintondale because the organization focused solely on the environmental challenges and assumed that solving them would lead to community and economic reinvestment from the citizens and outsiders. When the publicity faded away and it became clear to the residents that the park was not going to resolve the economic problems of the town, they became disinterested (Therig 2007). The failure of AMD & ART in Vintondale does not mean that rural citizens are not interested in the environment, nor does it mean that a creative approach to AMD treatment is unnecessary. What the failure of AMD & ART shows is that fixing one part of a problem will not fix the others; rather, citizens, leaders, designers, and non-governmental organizations need to work to determine a holistic approach that benefits the community, the economy, and the environment. It is only after this cooperative determination is made that a town can more forward toward overcoming its challenges.

REFERENCES

Aiken, R. (2009). Net Economic Values of Wildlife-Related Recreation in 2006. U.S.F. a. W. Service. Washington, D.C.

Alford, R. (2009). Kentucky Hopes for big haul from coal mine tourism. USA Today. Lynch, Kentucky.

AMD+ART (1996). AMD & ART. A. H. D. Corporation. Altoona, PA, **1:** 4.

AMD+ART (1997). AMD & ART. A. H. D. Corporation. Altoona, PA. **2:** 4.

AMD+ART (2000). AMD & ART, Inc. Johnstown, PA. **1:** 8.

AMD+ART (2001). AMD & ART, Inc. Johnstown, PA. **2:** 6.

AMD+ART (2003). AMD & ART, Inc. Johnstown, PA. **3:** 8.

AMD+ART (2003). AMD & ART, Inc. Johnstown, PA. **5:** 2.

AMD+ART (2005). AMD & ART, Inc. Johnstown, PA. **8:** 6.

AMD+ART (2005). AMD & ART, Inc. Johnstown, PA. **8:** 4.

Arnold, D. E. (1991). Diversion Wells - A Low Cost Approach to Treatment of Acid Mine Drainage. Twelfth Annual West Virginia Surface Mine Drainage Task Force Symposium. Morgantown, WV.

Birnbaum, C. A. (1994). Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes. N. P. Service. Washington, D.C.

Chi-Ok, O. and W. E. Hammitt (2010). "Determining Economic Benefits of Park Trails: Management Implications." Journal of Park & Recreation Administration **28**(2): 94-107.

Cocheba, D. J. and W. A. Langford (1978). "Wildlife Valuation: The Collective Good Aspect of Hunting." Land Economics **54**(4): 490.

Comp, T. A. (2005). "Founder's Statement: AMD & ART: A Challenge to Creativity in Reclamation." Retrieved 1/13/2012, 2012, from http://www.amdandart.org/founder.html.

D. Dubois, H. Fargier, et al. (2008). "On the qualitative comparison of decisions having positive and negative features." Journal of Artificial Intelligence Research **32**: 385-417.

Department of Environmental Protection (2006). System Inflow Outflow. Harrisburg, Pennsylvania, Department of Environmental Protection.

Diefenbach, D. R., W. L. Palmer, et al. (1997). "Attitudes of Pennsylvania Sportsmen towards Managing White-Tailed Deer to Protect the Ecological Integrity of Forests." Wildlife Society Bulletin **25**(2): 244-251.

Erikson, K. (1976). Everything In Its Path. New York, Simon & Schuster Paperbacks.

Ferguson, B. K. (1978). "Regional Analysis of Potential Water Power." Energy Sources **4**(2): 8.

Ferguson, B. K. (1985). "A Watershed Approach to Past Mistakes." Landscape Architecture Magazine: 44-49.

Ferguson, B. K. (1985). "Watershed Planning for Acid Mine Drainage Abatement." Water Resources Bulletin Vol. 21, No. 2, p 253-263, April, 1985. 13 Fig, 1 Tab, 10 Ref.

Ferguson, B. K., Maurice Deul, Murray Dougherty (1992). Criteria for abandoned mine reclamation: regional planning to develop project guidelines in the Blaclick Creek watershed, Pennsylvania. B. o. M. United States Department of the Interior. Pittsburgh**:** 16.

Fetter, C. W. (1988). Applied Hydrogeology, Merrill Publishing Co.

Francis, M. (2001). "A case study method for landscape architecture." Landscape journal **20**(1): 15-29.

Gibbs, K. C. (1974). "Evaluation of Outdoor Recreational Resources: A Note." Land Economics **50**(3): 309.

Gitari, W. M., L. F. Petrik, et al. (2011). "Interaction of acid mine drainage with Ordinary Portland Cement blended solid residues generated from active treatment of acid mine drainage with coal fly ash." Journal of Environmental Science and Health Part A **46**: 117-137.

J. F. Bonnefon, D. Dubois, et al. (in press). "Qualitative heuristics for balancing the pros and cons." Theory & Decision.

Johnson, D. B. and K. B. Hallberg (2005). "Acid mine drainage remediation options: a review." Science of the Total Environment **338**(1-2): 3-14.

Jones, G. K. (2009). Bioremediation of Contaminated Riparian Zones Using Mycorrhizal Fungi - An Exploration of the Feasibility of Restoration Through Mycoremediation, Evergreen State College. **Master of Environmental Studies:** 67.

Jordan, L. A. and J. P. Workman (1989). "Economics and Management of Fee Hunting for Deer and Elk in Utah." Wildlife Society Bulletin **17**(4): 482-487.

Kalin, M. (2004). "Passive mine water treatment: the correct approach?" Ecological Engineering **22**(4-5): 299-304.

Kepler, D. A. and E. C. McClery (1994). Successive Alkalinity-Producing Systems (SAPS) for the Treatment of Acid Mine Drainage.

Klein, J. M. (2004). "Coal country: West Virginia's down-at-the-heels towns hope to cash in on tourists who appreciate the proud history of a bygone time." Preservation: the magazine of the National Trust for Historic Preservation **56**(5): 50-52.

L. Robert Kimball & Associates (2005). Blacklick Creek Watershed Assessment/Restoration Plan. Blacklick Creek Watershed**:** 52.

Ligon, F. K., W. E. Dietrich, et al. (1995). "Downstream Ecological Effects of Dams: A geomorphic perspective." BioScience **45**(3): 183-192.

Loomis, J. B. (1995). "Four models for determining environmental quality effects on recreational demand and regional economics." Ecological Economics (Amsterdam) **12**(1): 55-65.

Lyle, J. T. (1999). Design for Human Ecosystems. New York, Island Press.

McIntyre, L. (2012). Merger Misgivings. Landscape Architecture Magazine. Washington, D.C., Ann Looper Pryor**:** 26-27.

Michener, W. K. B. K. L. M. A. R. R. H. W. W. M. D. M. (2009). "Biological Field Stations: Research Legacies and Sites for Serendipity." BioScience **59**(4): 300.

Miller, B. A. (1993). "Rural Distress and Survival: The School and the Importance of "Community"." Journal of Research in Rural Education **9**(2): 84-103.

Nairn, R. W., T. Beisel, et al. (2009). Challenges in design and construction of a large multi-cell passive treatment system for ferruginous lead-zinc mine waters. National Meeting of the American Society of Mining and Reclamation. Billings, MT, ASMR**:** 871-892.

Nairn, R. W. and M. N. Mercer (2000). "Alkalinity generation and metals retention in a successive alkalinity producing system." Mine Water and The Environment **19**(2): 124-133.

National Trust for Historic Preservation (2012). "Main Street Programs." Retrieved 1/16/11, 2012, from http://www.preservationnation.org/main-street/about-main-street/the-programs/.

Office of Surface Mining (2012). "Abandoned Mine Lands Portal." Retrieved 2/8, 2012, from www.abandonedmines.gov.

Office of Surface Mining (2012). "Bureau of Mines Publications and Journal Articles 1910-1996." Retrieved 2/20/2012, 2012.

Pacchioli, D. (1995). "Plugging Up Old Mines." Research/Penn State **16**(1): 3.

Paradis, T. W. (2000). "Conceptualizing Small Towns as Urban Places: The Process of Downtown Redevelopment in Galena, Illinois." Urban Geography **21**(1): 61-82.

Pearse, P. H. (1968). "A New Approach to the Evaluation of Non-Priced Recreational Resources." Land Economics **44**(1): 87.
Powell, W. E. (1972). "Former Mining Communities of the Cherokee-Crawford Coal Field of Southeastern Kansas." Kansas Historical Quartery **38**(2): 187-199.

Pennsylvania Game Commission (2011). Pennsylvania Guide to Migratory Game Bird Hunting Seasons and Bag Limits 2011-2012. Pennsylvania Game Commission. Harrisburg, PA.

Ramos, I. L. (2010). "'Exploratory landscape scenarios' in the formulation of 'landscape quality objectives'." Futures **42**(7): 682.

Reece, E. (2006). Lost Mountain A year in the vanishing wilderness: radical strip mining and the devastation of Appalachia. New York, Riverhead Books.

Rosenbery, D. C. S., Jeannine Tardiff FLeegle, Bret D. Wallingford (2009). "Management and Biology of White-Tailed Deer in Pennsylvania 2009-2018." 148.

Sheoran, A. S. and V. Sheoran (2006). "Heavy metal removal mechanism of acid mine drainage in wetlands: A critical review." Minerals Engineering **19**(2): 105-116.

Skousen, J., A. Rose, et al. (1998). Handbook of technologies for avoidance and remediation of acid mine drainage. Morgantown, WV, The National Mine Land Reclamation Center.

Snepenger, D. J., S. Reiman, et al. (1998). "Is downtown mainly for tourists?" Journal of Travel Research **36**(3): 5-12.

Squillace, M. (1990). The Strip Mining Handbook: A Coalfield Citizens' Guide to Using the Law to Fight Back Against the Ravages of Strip Mining and Underground Mining, Environmental Policy Institute.

Tennessee Valley Authority (2012). "Water Quality Improvements at Tributary Dams." from www.tva.gov/environment/water/rri_triblist.htm.

Therig, S. (2007). "A Practical Theory-Based Approach to Action-Research in Survivor Communities." Journal of Extension **45**(2).

Trumm, D. (2007). Selection of active treatment systems for acid mine drainage. Christchurch, NZ, CRL Energy Limited.

Turner, M. G., R. H. Gardner, et al. (2001). Landscape Ecology In Theory and Practice: Pattern and Process. New York, Springer Science + Business Media, Inc.

U.S. Census Bureau (2010 a). Physical Housing Characteristics for Occupied Housing Units. A. C. Survey. Washington, D.C., American Fact Finder.

U.S. Census Bureau (2010 b). Food Stamps/SNAP. A. C. Survey. Washington D.C., American Fact Finder.

U.S. Census Bureau (2010 c). Age Groups and Sex: 2010. Washington, D.C., American Fact Finder.

U.S. Census Bureau (2012). "Selected Historical Decennial Census Population and Housing Counts." Retrieved 11/02/2011, from http://www.census.gov/population/www/censusdata/hiscendata.html.

Vadapalli, V. R. K., M. W. Gitari, et al. (2012). "Integrated acid mine drainage management using fly ash." Journal of Environmental Science & Health, Part A: Toxic/Hazardous Substances & Environmental Engineering **47**(1): 60-69.

Weber, Denise Dusza (2008). Vintondale, Arcadia Publishing.

Wei, X., H. Wei, et al. (2011). "Post-reclamation water quality trend in a Mid-Appalachian watershed of abandoned mine lands." Science of the Total Environment **409**: 941-948.

Wildlife Habitat Council (2012). "Certification." Retrieved 2/20/2012, 2012, from www.wildlifehc.org/certification/.