FTN Associates Ltd.
water resources / environmental consultants

ECOLOGICAL ASSESSMENT OF LAKE ATALANTA ROGERS, BENTON COUNTY, ARKANSAS

February 7, 2014

ECOLOGICAL ASSESSMENT OF LAKE ATALANTA
ROGERS, BENTON COUNTY, ARKANSAS

Prepared for

City of Rogers
301 West Chestnut Street
Rogers, AR 72756

Prepared by

FTN Associates, Ltd.
124 West Sunbridge, Suite 3
Fayetteville, AR 72703

FTN Project No. R04485-0010-001

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1.0 INTRODUCTION

The City of Rogers (the Client) contracted with FTN Associates, Ltd. (FTN) of Fayetteville, Arkansas, to provide an ecological assessment, delineate Section 404 features, provide a karst survey, and provide recommendations for Best Management Practices (BMPs) all for the proposed improvements to Lake Atalanta Park. This document addresses the ecological assessment, karst survey, and proposed BMPs. The Section 404 delineation will not be included within this report but will be provided as a stand-alone document suitable for US Army Corps of Engineers (Corps) submittal. The approximately 240-acre project area is generally located around and includes Lake Atalanta in Rogers, Arkansas; Figures 1.1 and 1.2 illustrate the extent of the irregularly shaped project area. Figure 1.3 provides an overview of the proposed Lake Atalanta improvements. Figure 1.4 depicts surface geology and known springs in the vicinity. The project area is mapped on US Geologic Survey (USGS) topographic quadrangle Rogers, ARK (7.5-minute series). Legal description of the project area is parts of Sections 5, 7, 8, 17, and 18, Township 19 North, Range 29 West.

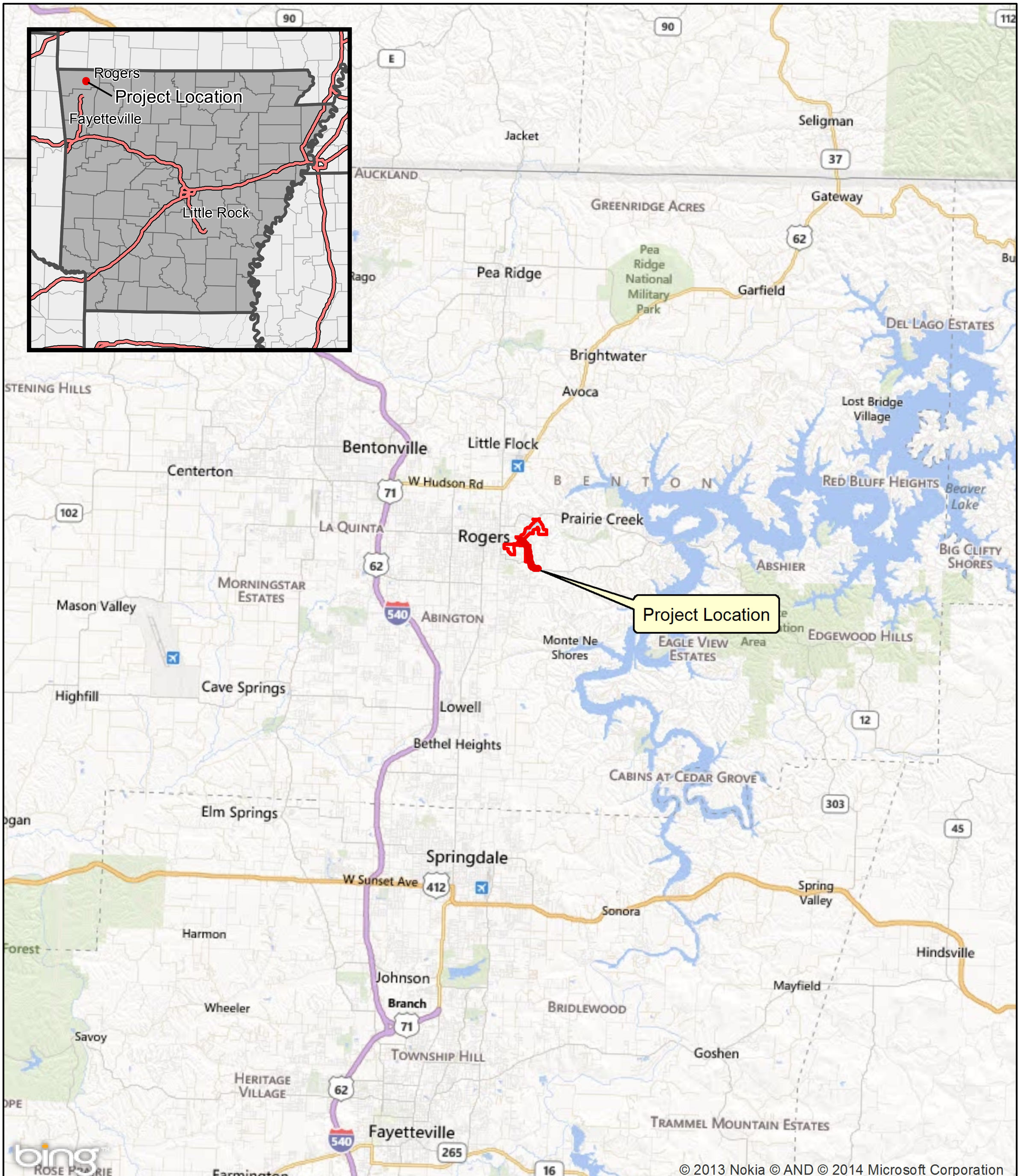

Figure 1.1 Vicinity map
Lake Atalanta Park
City of Rogers, Arkansas

Basemap Source
(c) 2010 Microsoft Corporation
and its data suppliers

0 2 4 Miles

By: KLF
Date: Jan. 21, 2014
Project No.: 04485-0010-001

FTN Associates Ltd.

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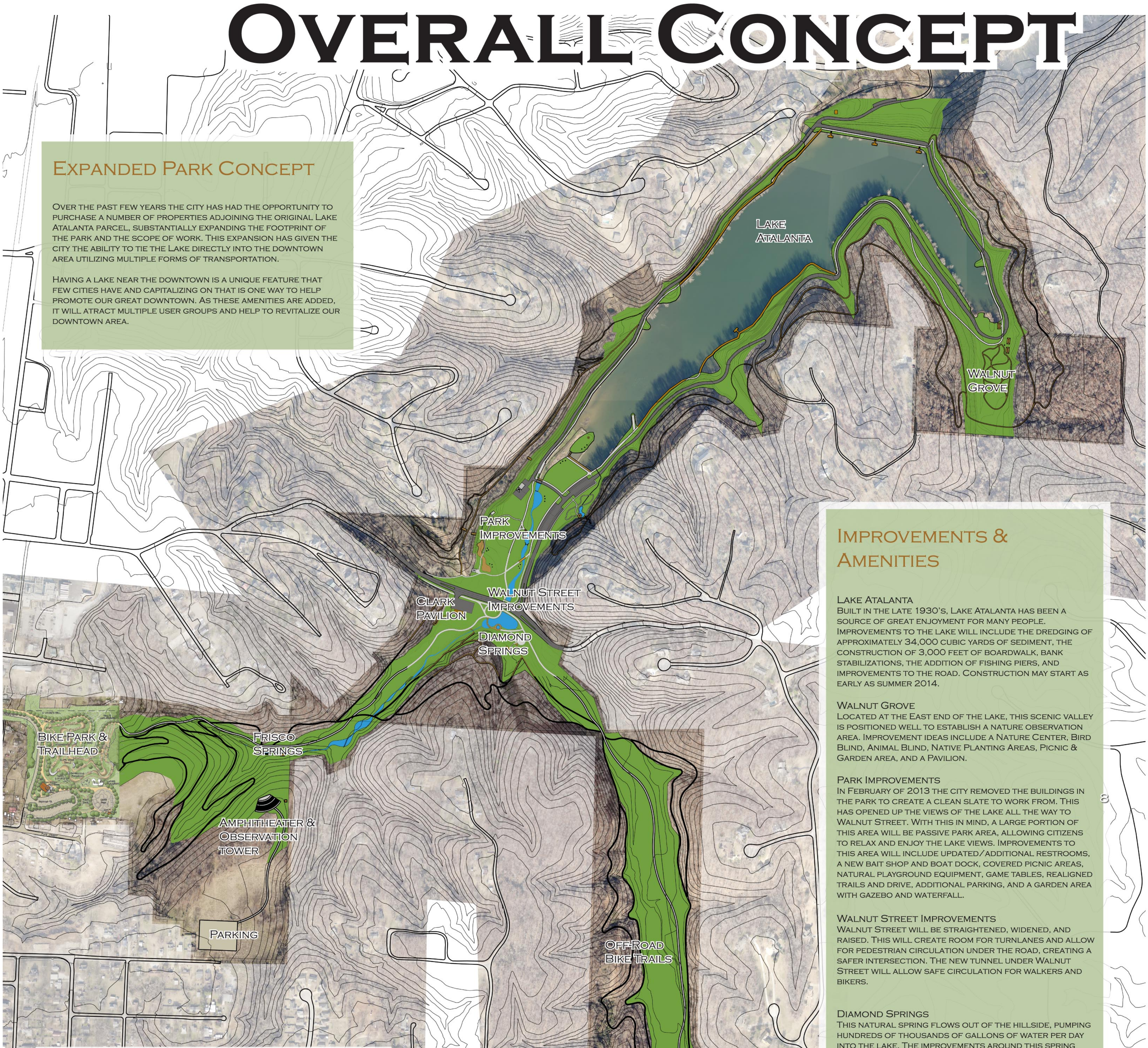
Lake Atalanta Improvements

Overall Concept

Expanded Park Concept

Over the past few years the city has had the opportunity to purchase a number of properties adjoining the original Lake Atalanta parcel, substantially expanding the footprint of the park and the scope of work. This expansion has given the city the ability to tie the Lake directly into the downtown area utilizing multiple forms of transportation.

Having a lake near the downtown is a unique feature that few cities have and capitalizing on that is one way to help promote our great downtown. As these amenities are added, it will attract multiple user groups and help to revitalize our downtown area.



Improvements & Amenities

Lake Atalanta
Built in the late 1930's, Lake Atalanta has been a source of great enjoyment for many people. Improvements to the lake will include the dredging of approximately 34,000 cubic yards of sediment, the construction of 3,000 feet of boardwalk, bank stabilizations, the addition of fishing piers, and improvements to the road. Construction may start as early as summer 2014.

Walnut Grove
Located at the East end of the lake, this scenic valley is positioned well to establish a nature observation area. Improvement ideas include a Nature Center, Bird Blind, Animal Blind, Native Planting Areas, Picnic & Garden area, and a Pavilion.

Park Improvements
In February of 2013 the city removed the buildings in the park to create a clean slate to work from. This has opened up the views of the lake all the way to Walnut Street. With this in mind, a large portion of this area will be passive park area, allowing citizens to relax and enjoy the lake views. Improvements to this area will include updated/additional restrooms, a new bait shop and boat dock, covered picnic areas, natural playground equipment, game tables, realigned trails and drive, additional parking, and a garden area with gazebo and waterfall.

Walnut Street Improvements
Walnut Street will be straightened, widened, and raised. This will create room for turnlanes and allow for pedestrian circulation under the road, creating a safer intersection. The new tunnel under Walnut Street will allow safe circulation for walkers and bikers.

Diamond Springs
This natural spring flows out of the hillside, pumping hundreds of thousands of gallons of water per day into the lake. The improvements around this spring will make it a feature attraction for citizens to enjoy. The Scout Hutch near-by could also be improved to house a number of amenities.

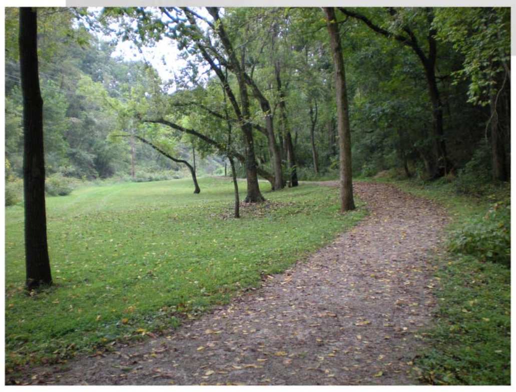
Clark Pavilion
Upgrades will be made to the existing Clark Pavilion along with additional parking.

Bike Park and Trailhead
A park trailhead will be added to serve the downtown area along with a concrete trail leading down to the lake. The Bike Park will consist of Slope Style Trails, Skills Course, and Pump Track.

Frisco Springs
Historically being one of Rogers most valuable and cherished resources, Frisco Springs will once again become a destination feature. The improvements made to this area will showcase its importance through the history of Rogers.

Amphitheater and Observation Tower
Located near the top of a hill overlooking the valley leading to Lake Atalanta, these features will capture the seriene beauty of this area.

Off-Road Biking/Hiking Trails
Around 12 miles of off-road trails will be incorporated into the hillsides. These low impact trails will allow citizens to enjoy areas typically not utilized in the surrounding woods.



Rogers Arkansas — Where Possible Lives

Figure 1.2 Lake Atalanta Improvements Overall Concept

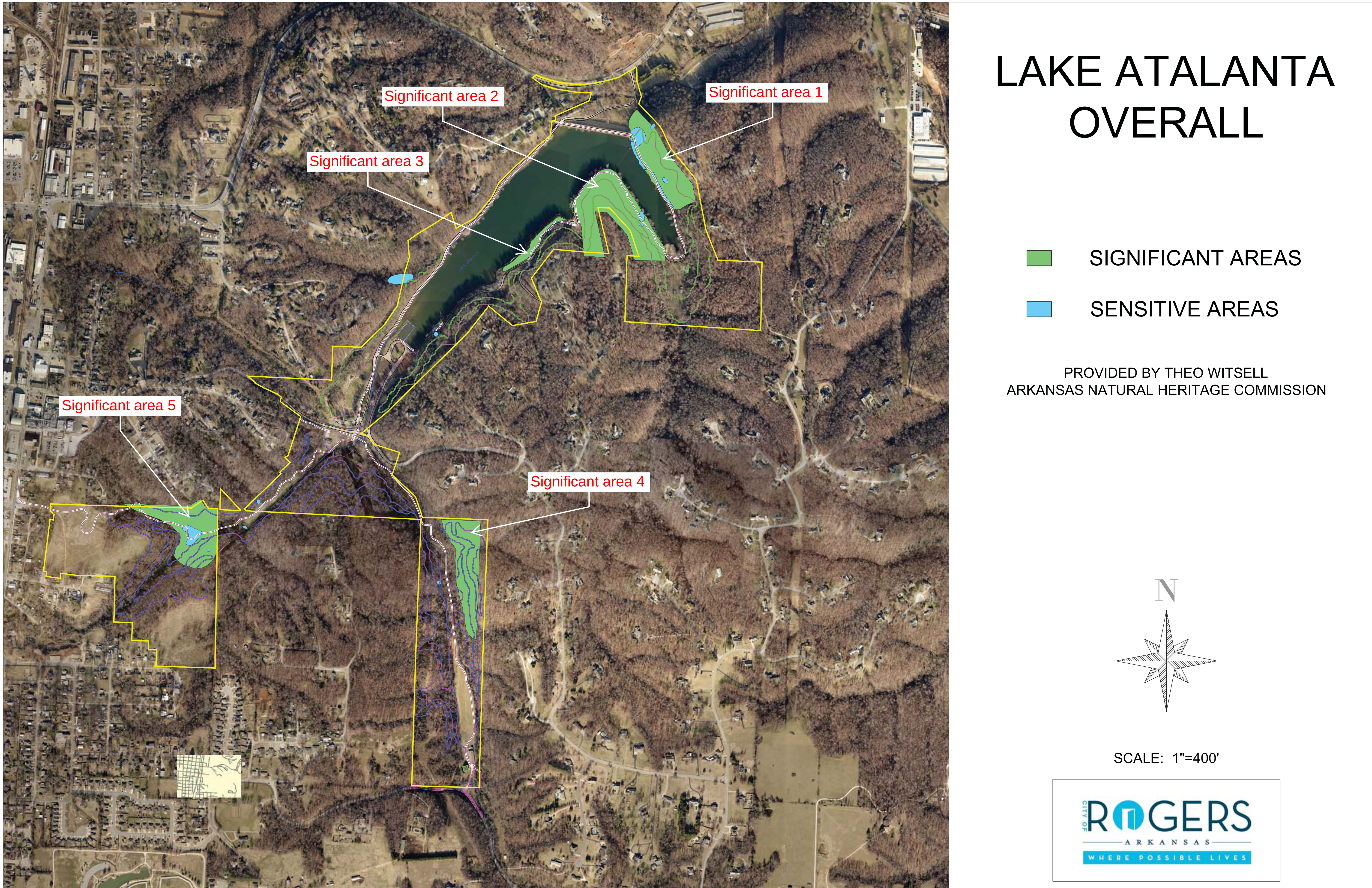


Figure 1.3 Map showing proposed park extent and sensitive areas

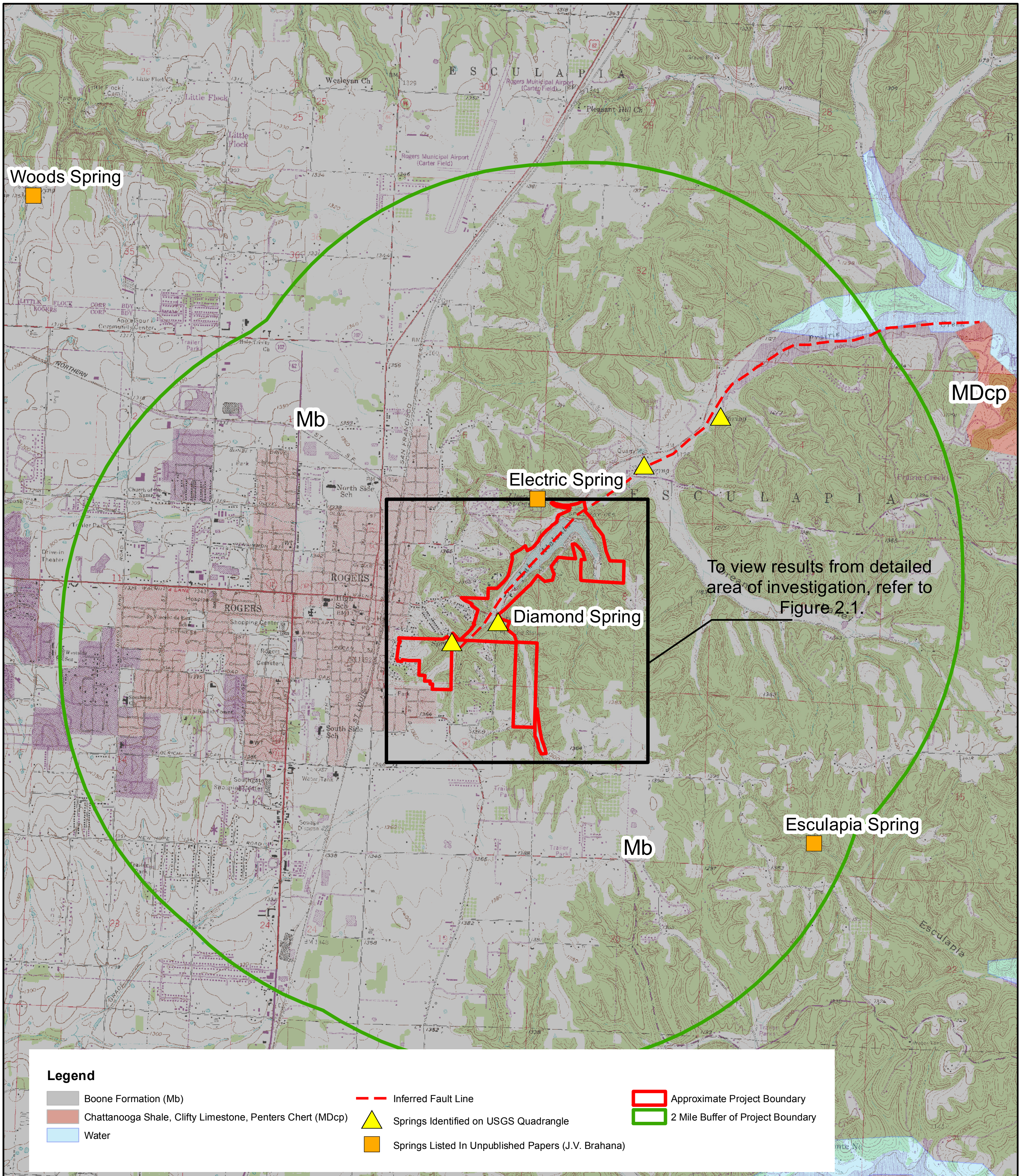


Figure 1.4 Geologic map with known springs
Lake Atalanta Park
City of Rogers, Arkansas

ftn Associates Ltd.

Basemap Source
USGS Quadrangle
Rogers, AR

0 2,000 4,000 Feet

N

By: KLF
Date: Jan. 13, 2014
Project No.: 04485-0010-001

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2.0 ENVIRONMENTAL SETTING

2.1 Physiographic Characteristics

The project area lies within a primarily forested “green space” surrounding the man-made Lake Atalanta and portions of its headwaters in Rogers, Benton County, Arkansas. The project area is located within the Dissected Springfield Plateau Ecoregion of the Boston Mountains and, typical of the area, it exhibits moderate to steep slopes, numerous drainages, and karst features. Elevation within this area varies from approximately 1,100 to 1,350 ft above sea level. Streams within the project area vary in size from small headwater drains to larger spring-fed perennial channels. In addition, there are reaches of several channels within the area that would be considered “losing streams”. This term applies to streams in which water flows become subterranean when the groundwater level is below the base of the channel. The tributary with the greatest surface drainage area within the project area is the unnamed tributary to Lake Atalanta, which flows from south to north throughout a large portion of the project area. The perennial stream that begins at Frisco Spring, flows to Lake Atalanta, then exits the lake is named Prairie Creek.

Areas outside the project area support a mix of urban and suburban environments, specifically residential and commercial. Downtown Rogers is located just west of the project area, however, residential development represents the dominant surrounding urban/suburban environment.

2.2 Climate

The climate within the project area is described as relatively warm summers and mild winters, although occasional arctic air masses affect the area in winter. The average annual precipitation is approximately 45 inches and the average growing season is slightly less than 200 days (SCS 1977). The average seasonal snowfall is 8 to 9 inches.

2.3 Geology

Lake Atalanta is located in the Springfield Plateau, a physiographic province of the Ozarks. The Springfield Plateau is characterized by gently dipping sedimentary rocks that were dissected by streams to form a rolling hill topography with gentle to moderate slopes. According to the geologic worksheet of the Rogers Quadrangle, Glick (1970) maps the uppermost stratigraphic unit at the property as the Boone Formation. This formation is a limestone interbedded with varying amounts of chert and clay and is the dominant rock unit found at land surfaces throughout most of the Springfield Plateau. In northern Arkansas, the Boone Formation has been fractured and dissolved to form an open network of springs, caves, enlarged fractures, bedding planes, conduits, sinkholes, and sinking streams (Lamonds 1972). As the Boone Formation weathers, the chert and clay form a loose layer (regolith) that mantles the landscape and has a tendency to mask surficial expressions of karst features (Brahana 1997). In this general setting, groundwater flow is typically rapid, flow directions are difficult to predict, interaction between surface and groundwater systems are typically extensive, and processes of contaminant attenuation that characterize many other groundwater systems, such as those in porous media, are typically absent (Brahana 2011).

2.4 Soils

The project area is mapped by the SCS (Soil Survey of Benton County, AR) as supporting Elsah soils, Nixa cherty silt loam, and Noark cherty silt loam. Elsah soils are found along flood plains of small streams; the remaining soils are moderately well drained soils of moderate to steep ridges and ridgetops. Soils in the area tend to be cherty and fairly well drained.

2.5 Biology

2.5.1 Vegetation

Vegetative communities within the project area included woodlands and glades, mesic hardwood forest, riparian forests, and early-mid successional disturbed communities. A mesic hardwood forest community would best describe the overall dominant community surrounding Lake Atalanta. The Arkansas Natural Heritage Commission (ANHC 2013; Appendix B) reports on an inventory of the communities within the project area and found a few sensitive areas, including areas supporting sensitive plant species. ANHC also identifies significant areas that may contain sensitive areas. These significant areas are depicted in green on the map provided by the City of Rogers and referenced herein as Figure 1.3. Although few of these areas will be impacted by project activities, at least two significant areas identified by ANHC will be impacted by proposed bike trails (the trails shown by purple lines in Figure 1.3 are the preliminary proposed routes). A description of community types and their dominant species is listed below.

Glades and woodlands, as identified by ANHC and observed by FTN, supported a canopy of post oak (*Quercus stellata*), chinquapin oak (*Q. muehlenbergii*), Shumard’s oak (*Q. shumardii*), and eastern red-cedar (*Juniperus virginiana*). In addition, acidic chert woodlands also supported a mix of black oak (*Quercus velutina*), white oak (*Q. alba*), post oak, blackjack oak (*Q. marilandica*), and mockernut hickory (*Carya tomentosa*). A riparian non-wetland forested community was observed along channels throughout the project area. Dominant species in this community type included: sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), hackberry (*Celtis occidentalis*), Shumard’s oak, slippery elm (*Ulmus rubra*), flowering dogwood (*Cornus florida*), box elder (*Acer negundo*), spicebush (*Lindera benzoin*), and Japanese honeysuckle (*Lonicera japonica*). Finally, disturbed areas supported a mix of non-native and native grasses, including tall fescue (*Festuca arundinacea*), Bermuda grass (*Cynodon dactylon*), broom-sedge (*Andropogon virginicus*), and additional herbaceous species.

Several exotic/invasive plant species were observed within the project area, in fact the Rapid Terrestrial Ecological Assessment provided by ANHC identified a total of 35 species. Specifically, FTN observed large numbers of the following invasive species: Japanese honeysuckle (*Lonicera japonica*), Chinese privet (*Ligustrum sinense*), bush honeysuckle (*Lonicera maackii*), wintercreeper (*Euonymus fortunei*), Japanese stilt (*Microstegium vimineum*), beefsteak plant (*Perilla frutescens*), and multiflora rose (*Rosa multiflora*). All of these species were common and fairly widespread throughout the proposed project area.

2.5.2 Wildlife

Field observations were performed during January 2014 to observe fauna within the project area and to determine species that could potentially occur. Comprehensive observations could not be made due to the season; additional observations may be required at a later date as project details are developed. The project area is bisected by several right-of-ways (ROWs) (especially roads) and, to a lesser extent, existing City trails and unplanned pedestrian trails that create a great deal of edge habitat and contribute to fragmentation. In addition, portions of the project area and contiguous areas surrounding the project area vary from large single home sites to residential subdivisions creating what would best be described as an urban "green space" community. The area has the potential to support several species of fauna (and several were observed, not to mention the park being a well-known birding area); however, the large number of birds observed is at least partially due to the presence of Lake Atalanta, which attracts waterfowl, shorebirds, and other species that might otherwise not be found within the area. Although the project area has the potential to support numerous avian species, it lacks the potential to support breeding populations of many disturbance-sensitive bird species (especially those neotropical migrants that prefer undisturbed forested habitat) because of the existing fragmented edge habitat that prevents successful nesting of many of those species. However, the project area still supports numerous species of birds and provides foraging opportunities for a wide range of resident birds and migrants. In addition, as mentioned above, Lake Atalanta provides feeding and loafing habitat for a wide range of waterfowl, shorebirds, and others. The project area also has the potential to support a number of reptiles and amphibians, most of which are common to the region. Several mammals, both large and small, are supported within the project area; the area is well known for its large number of white-tail deer (*Odocoileus virginianus*). Due to the weather conditions (very cold/icy) and season that field observations were conducted, several species of wildlife were not detected that may inhabit the project area; this is especially true for species such as reptiles and amphibians. Table 2.1 provides a list of species observed within the project area during field observations but is by no means an exhaustive list of species utilizing the project area.

Several species of both reptiles and amphibians could potentially occur within the project area; however, only red-eared slider was observed during field investigations due to the timing and season of field investigations. Reptiles and amphibians expected to occur at the site include those generalists that are common to the Ozark mountain region of Arkansas and Missouri. Although several species of birds were observed at the project area, the above list is by no means representative of the total number of species that frequent the area. Local birders list nearly 200

Table 2.1. List of fauna observed at Lake Atalanta during January 2014 field visits.

Common Name	Latin Name
Herpetofauna	
Red-eared slider	*Trachemys scripta*
Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
Bufflehead	*Bucephala albeola*
Gadwall	*Anas strepera*
Lesser Scaup	*Aythya affinis*
Great Blue Heron	*Ardea herodias*
Turkey Vulture	*Cathartes aura*
Black Vulture	*Coragyps atratus*
Bald Eagle	*Haliaeetus leucocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Downy Woodpecker	*Picoides pubescens*
Belted Kingfisher	*Megaceryle alcyon*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Carolina Chickadee	*Poecile carolinensis*
Tufted Titmouse	*Baeolophus bicolor*
White-breasted Nuthatch	*Sitta carolinensis*
Ruby-crowned Kinglet	*Regulus calendula*
Winter Wren	*Troglodytes hiemalis*
Carolina Wren	*Thryothorus ludovicianus*
Eastern Bluebird	*Sialia sialis*
American Robin	*Turdus migratorius*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
White-Throated Sparrow	*Zonotrichia albicollis*
Song Sparrow	*Melospiza melodia*
Dark-eyed Junco	*Junco hyemalis*
Mammals	
Gray squirrel	*Sciurus carolinensis*
Raccoon	*Procyon lotor*
Virginia opossum	*Didelphis virginiana*
Fox sp.	*NA*
Coyote	*Canis latrans*
White-tailed deer	*Odocoileus virginianus*

species that have been observed within the park. Several mammals were observed in the project area; although small mammals such as rodents and bats were not observed, several of those species most likely occur.

2.6 Aquatic Communities and Water Quality

2.6.1 Surface Water/Karst Features

Several surface water features were observed during the January 2014 field investigations within the project area, the largest being Lake Atalanta, impounded on a spring-fed perennial channel locally known as Prairie Creek, both below and above the lake to its major source, Frisco Spring. In addition, several smaller intermittent channels and ephemeral channels were observed within the project area (Figure 2.1). Because of the upland terrain, several upland headwater drainages were observed, although very few contain water for long enough periods to sustain aquatic communities (except for those that support spring-fed reaches). A total of 18 springs were observed within the project area, some of which are named (including Frisco Spring and Diamond Spring). Several other springs occur within the project area; more detailed information regarding these features is included in Section 2.9. In addition to these karst features, a number of seeps, gaining and losing stream reaches and dry valleys were observed within the area, however, no caves were observed.

2.6.2 Aquatic Communities

The Ozark Highlands ecoregion as listed by Arkansas Pollution Control and Ecological Commission (APCEC) is identified as an ecoregion that is known to support several natural and scenic waters, in addition to several ecologically sensitive waters (APCEC 2011). However, because the project area is located within an overall urban environment, streams within the area exhibit at least some impacts from urban runoff, channelization, and other features that may inhibit the channels from functioning to their potential. Sedimentation and runoff may affect water quality and prevent some intolerant fish and/or benthic macroinvertebrates from colonizing the stream or at least the affected reach of the stream (intolerant species refers to individuals that are either sensitive to pollutants or habitat impacts, such as channelization). In addition, restrictive barriers such as undersized culverts and other crossings may inhibit movement of certain fishes within stream channels. Overall, however, streams within the project area receive their headwater flow from an area that is at least partially forested and exhibits only a minor to moderate amount of development (mainly residential). There is a poultry plant located above the project area, and it is likely that stormwater runoff from the plant enters surface drainages within the Frisco Spring recharge zone.

Several of the channels within the project area would best be described as either ephemeral exhibiting an ordinary high water mark (OWHM) or intermittent “losing streams” and therefore support very little in the way of aquatic species because of the very limited duration of their flows. Some of the gaining/losing streams, however, support reaches of perennial flow and support a community consisting of the following species of fish: central stoneroller (*Campostoma anomalum*), darters (*Etheostoma* sp.), sunfish (*Lepomis* sp.), and potentially several additional species. Notably, rainbow trout (*Salmo gairdneri*), an introduced/non-native species, was observed in the section of Prairie Creek upstream of the lake. The occurrence of this species is most likely the result of individuals originally stocked in the lake that moved upstream into the spring-fed channel. In addition, benthic macroinvertebrates and semi-aquatic species such as amphibians utilize both perennial channels and intermittent channels within the project area. No attempt was made to quantify these communities; however, intermittent and small perennial channels in the region are known to support a diversity of benthic insect species including insects from the following orders: Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Coleoptera (beetles), and several others. It is likely the streams within this area are similar in community structure to surrounding areas, although they probably support a greater diversity of species than these streams in more urban portions of Rogers.

2.7 Wetlands

The project area was examined in October 2012, January 2013, and January 2014 for the presence of potential Section 404 wetlands according to requirements of the 1987 Corps Wetlands Delineation Manual. FTN did not identify any potential Section 404 wetlands within the project area that would qualify for Corps jurisdiction. Lake Atalanta, a man-made impoundment, would qualify for Corps jurisdiction; the lake, however is best described as an "open water" feature and supports little in the way of fringe wetlands outside its OHWM.

2.8 Threatened and Endangered Species

The US Fish and Wildlife Service (USFWS 2013) lists the following federally listed species for Benton County:

- Ozark cavefish (*Amblyopsis rosae*), threatened;
- Benton County Cave crayfish (*Cambarus aculabrum*), endangered;
- Gray bat (*Myotis grisescens*), endangered;
- Indiana bat (*Myotis sodalis*), endangered;
- Ozark big-eared bat (*Corynorhinus townsendii ingens*), endangered;
- Piping Plover (*Charadrius melodus*), threatened;
- Neosho mucket (*Lampsilis rafinesqueana*), endangered;
- Rabbitsfoot (*Quadrula cylindrica cylindrica*), threatened; and
- Arkansas darter (*Etheostoma cragini*), candidate species.

FTN conducted field investigations during January 2014 and concluded that three species of the above mentioned federally listed species could possibly occur within the project area. These include gray bat, Indiana bat, and piping plover. Gray bat is known to occur locally in Benton County, specifically, two caves in Benton County are known to support summer maternity colonies (Logan Cave and Cave Springs Cave). This species prefers to forage along/over bodies of water; therefore it could potentially utilize the project area for foraging. There were no caves observed within the project area that could support hibernating individuals or maternity colonies. Indiana bat is also historically known to utilize Cave Springs Cave, which is located several miles southwest of the project area. Indiana bat also makes use of large trees with sloughing (loose) bark as summer roost. Portions of the project area support large white oaks that could potentially, although unlikely, be utilized by Indiana bat during summer. Piping Plover is a small shorebird that prefers open sandy beaches and nests in the upper Great Plains and northern Atlantic coast. Piping Plovers occasionally occur in Arkansas during migration from their breeding grounds to the north en route to the Gulf Coast region. Overall, habitat is lacking within the project area for Piping Plover; however, it is possible that transient individuals could occur and possibly forage along portions of Lake Atalanta.

In addition to the federally listed mussels (which lack sufficient habitat to occur within the project area), three other federally listed aquatic species occur within portions of Benton County, i.e., Ozark cavefish, Benton County Cave crayfish, and Arkansas darter. Ozark cavefish and Benton County Cave crayfish are known from specific caves/karst features in Benton County and are not known to occur within the project area. Ozark cavefish have occasionally flushed out of springs similar to those within the project area because of the interconnectivity of the karst geology. Therefore, it is remotely possible they could occur within project area, but overall habitat for them appears to be lacking. In addition, Arkansas darter, a federal candidate species, has also been extensively surveyed in the Benton County area and is not known to occur within the project area (Wagner et al. 2006). Portions of Prairie Creek, upstream of the lake and continuing to the spring head of Frisco Spring, supported minor amounts of habitat that could be suitable for Arkansas darter (specifically a small perennial channel exhibiting aquatic vegetation). The portions of the channel suitable for this species were marginal at best and would be unlikely to occur within these reaches; moreover, this species is not known to occur within the White River drainage, which is the ultimate receiving water for the project.

In addition to the federally listed species, ANHC tracks a number of state listed and sensitive species. The rapid ecological assessment performed by ANHC recorded a few of the sensitive plant species (Appendix B). In addition, a few species of herpetofauna and birds that are tracked by ANHC could potentially occur within the project area, including, but not limited to: wood frog (*Rana sylvatica*), Oklahoma salamander (*Eurycea tynerensis*), ground snake (*Sonora semiannulata*), and Bewick's Wren (*Thrymanes bewickii*).

2.9 Karst Investigation

The objective of the karst survey was to identify and describe karst features on and within direct vicinity of the property that have the potential to be adversely impacted by future improvements and amenities planned for the park by the City of Rogers. In addition to the literature review and survey, a qualitative assessment of the level of concern regarding the potential for impacts to the karst hydrogeological system is provided.

The site visit was conducted on January 9 and 10, 2014 and entailed a field reconnaissance of the site and immediate area. Observed karst features were photographed, described in a field book, and located with a hand-held Garmin Etrex GPS unit. Publicly available documents from several agencies were reviewed: Arkansas Geological Survey (AGS), Arkansas Water Resources Center, U.S. Geological Survey (USGS), The Nature Conservancy (TNC), and manuscripts from the David W. Mullins Library at the University of Arkansas (U of A), Fayetteville.

A revised geologic map dated 2004 shows an inferred fault with a northeast orientation that follows the Prairie Creek drainage and bisects Lake Atalanta (Dowell 2004). Faults are important because these features tend to focus groundwater flow through ubiquitous fracture systems. In Northwest Arkansas, karst features, such as caves and springs, tend to develop around regional faults (Brahana 1997). Figure 1.4 provides a topographic map of the project and surrounding area with known spring locations shown. Springs identified on this map are from the USGS topographic quadrangle, Rogers (7.5-minute series) and as provided by Dr. Van Brahana, U of A Professor of Geology Emeritus. USGS National Water Information System was also referenced and had no additional data within the area of interest. This map shows that the area in the vicinity of the inferred fault (depicted by a dashed red line) contains a high concentration of springs, which is consistent with observations made throughout the Springfield Plateau (Brahana 1997 and Brahana 2011). The detailed field investigation revealed additional springs and other karst features typical of the karst landscape in the Boone Formation of the Ozark Plateau. Locations of these features are shown in Figure 2.1.

In 2001, the USGS performed a streamflow and water quality study of Prairie Creek. Prairie Creek originates at Frisco Spring, forms and flows through Lake Atalanta, and terminates at Beaver Lake. Water quality samples were collected from nine locations in and around Lake Atalanta Park. Elevated concentrations of dissolved ammonia, dissolved nitrate, and total phosphorous were observed at certain sampling locations. For dissolved ammonia, concentrations were above typical levels observed in streams of the western Springfield Plateau

(Moix et al. 2003). All other constituent concentrations were above levels observed in least-disturbed reference streams of the Ozarks but within the range observed for streams in the region (Joseph and Green 1994a; Joseph and Green 1994b). For dissolved ammonia and total phosphorous, the highest concentrations (14.3 mg/L and 0.23 mg/L, respectively) were observed 0.01 miles downstream from Frisco Spring, apparently downstream of a tributary that enters on the north side of the channel. Possible sources for the observed concentrations included sewage, organic, and animal metabolic wastes (Moix et al. 2003). These sources are possibly associated with storm water runoff from urban residential/industrial properties on the east side of Rogers and leaking septic systems in areas surrounding the park.

The 2001 USGS streamflow study identified three losing (two within the Project Area) and two gaining (one within the Project Area) reaches along Prairie Creek. The presence of losing and gaining reaches indicates interaction between the shallow groundwater aquifer and surface water flow of Prairie Creek (Moix et al. 2003). Additionally, the Karst Area Sensitivity Map for Northwest Arkansas (KASM) depicts the Lake Atalanta Park area as a having moderate to high risk for development activities to negatively impact groundwater. The KASM shows the relative sensitivity of the landscape to groundwater pollution and was developed using a modified US EPA DRASTIC model (TNC 2007). No other site-specific information was obtained from any of the other reviewed sources.

Results of the field investigation are presented in a feature location map (Figure 2.1) on which karst features are identified by a two-letter abbreviation followed by number. These features are summarized in Table 2.2 which serves as a key to the feature location map, shown with representative photographs (Appendix C), and briefly described herein. Due to the abundance of karst features present on the property and the time and budget constraints of the project, a comprehensive inventory of all karst features was not performed. Instead, a strategy was applied to investigate whether a karst landscape was prevalent throughout the property and in the region, and to catalogue significant karst features within the Project Area.

Outcrop of the Boone Formation was observed practically throughout the entire property. When present, outcrop thickness was variable ranging from a few feet to tens of feet. Outcrop was nearly continuous along the slopes in the southwest parcel, the west side of Lake Atalanta, and the east side of the southeast parcel. Elsewhere, outcrop was usually discontinuous, limited in occurrence and thickness, and highly weathered when present. The material overlying the Boone Formation was a cherty-clay regolith. Regolith thickness was variable and ranged from a thin veneer to exposures that exceeded 10 ft in thickness.

Karst features were observed throughout the entire property and included three large springs, more than 15 small springs and seeps, six losing and two regaining stream segments, a dry valley, and solution enhanced bedding planes and fractures. Karst features were abundant in the southwest parcel of the property, especially in draws surrounding the proposed Bike Park, and the southeast portion of the southeast parcel in the vicinity of the proposed Pleasant Ridge Trail. In these areas, the Boone Formation was characterized by low chert content and a high fracture density, which is ideal for dissolution of limestone. Around Lake Atalanta, exposures of the Boone Formation were characterized by a high chert content and low fracture density and karst features were not as abundant or as well developed. In the Walnut Grove area (Figure 1.2), the slopes were not as steep as the other areas and outcrop was not observed. A small springbox (LA-03) was observed behind an old residential home. Water was trickling from a man-made rock wall into the springbox. This area contained a dry stream bed, representing a dry valley. Similarly, no surface flow was observed in draws along the east side of Lake Atalanta. Lack of surface drainage other than during and following intense precipitation events is a characteristic feature of karst landscapes. Outcrop with well-developed solution enhanced bedding planes and a small spring that immediately sunk into the subsurface was observed in a draw north of Walnut Grove (LA-05).

The most significant karst features observed were three springs: Frisco (SW-10), Diamond (SW-16), and an unnamed spring (SE-08) emerging from a limestone outcrop with maturely developed karst features: open fissures, solution enhanced bedding planes, ubiquitous small-scale dissolution features known as karren (Photo 10 in Appendix C) and, on the northern end, a platform of bare limestone (limestone pavement). The 2001 USGS streamflow study reported that Frisco Spring had an instantaneous discharge of 0.44 ft^3/s and Diamond Spring had an instantaneous discharge of 2.41 ft^3/s during low-flow conditions. For the 2001 water year, Prairie Creek basin was considered to be drier than normal due to below-average rainfall

(Moix et al. 2003), which probably resulted in diminished baseflows for these springs. Spring SE-08 was not evaluated in the study. However, during our field observations, the discharge of Spring SE-08 appeared roughly similar to or somewhat less than the discharge of Frisco Spring. The baseflow discharges of these springs represent large producing spring systems for the Springfield Plateau. These types of springs usually contain a flow component characterized by an extensive network of relatively deep, interconnected, and focused flowpaths in the phreatic (saturated) zone that persist over a large area. In addition to a relatively large recharge zone, springs with high baseflow discharge values may contain a component of diffuse flow that helps sustain baseflow and allows for some natural attenuation of surface derived contaminants. The shallow flow (or local recharge) component cannot be inferred from average baseflow discharge data. Qualification of the shallow flow component that allows for rapid recharge to the springs is important in order to understand how land use and land cover on and in the direct vicinity of the park will affect groundwater quality and flows.

For comparison, Cave Springs Cave was reported to have a mean annual (includes low and high flow events) discharge of 3.1 ft^3/s (Brown et al. 1998) and a baseflow (low-flow) discharge of 0.66 ft^3/s (Brown and Graening 2001) with a recharge zone approximately 15 square miles in extent (Brown et al. 1998). The reported baseflow discharge values for Diamond and Frisco springs suggest recharge zones that extend far (possibly for miles) outside the park boundaries. Spring SE-08 is located near the southeast park boundary and most of the recharge zone for this spring is expected to be outside the park. However, the spring run formed by SE-08 flows onto the park property and ultimately sinks at location SE-01, indicating that negative impacts to Spring SE-08 could potentially impair groundwater in the park. Based on currently available information, it is not possible to determine whether these springs belong to separate spring basins or are part of an underflow/overflow spring system, which is a common type of spring system found throughout the Springfield Plateau.

The water quality of these springs will be impacted by surface uses and could be impacted by areas of potential pollutant sources not only within the park but throughout the entire recharge area. The 2001 USGS study (Moix et al. 2003) reported elevated dissolved nitrate values for Diamond (3.4 mg/L) and Frisco (3.2 mg/L) springs and an elevated total phosphorous value (0.22 mg/L) for Diamond Spring which demonstrates the susceptibility of these springs to land use activities. While the dissolved nitrate values were within the range commonly observed in the region, the total phosphorous value represented the high end of the range typically observed in the region, with a slightly higher concentration than 24 other springs sampled in Benton and Carroll counties (Joseph and Green 1994a and 1994b). It should be noted that some of these sampled springs were located in the Salem Plateau, a physiographic province of the Ozarks located north of the Springfield Plateau that has more maturely developed karst features. The USGS study documents that prior to 2001, minor impairments to the water quality of Frisco and Diamond Springs were already present. The study did not attempt to identify location of potential sources.

Table 2.2. Summary of selected karst features at Lake Atalanta Park.

Feature ID[1]	Feature Position[2]		Type of Feature	Selected Representative Photos in Appendix A	Description
	Latitude	Longitude			
SW-01	N36.33147	W94.11300	Spring	--	Spring run formed from multiple seeps. Seeps emerge from cherty regolith of the Boone Formation at the base of a headwall to a draw.
SW-02	N36.33062	W94.11192	Outcrop	--	Limestone outcrop of Boone Formation with solution enhanced bedding planes to include a small shaft and flute-like structure.
SW-03	N36.33030	W94.11181	Spring	--	Small spring emerges from regolith of the Boone Formation at base of stream channel.
SW-04	N36.32979	W94.11089	Seeps	Photo 1	Highly weathered limestone outcrop of Boone Formation with numerous seeps emerging along base of solution enhanced bedding plane.
SW-05	N36.32955	W94.11052	Spring	Photo 2	Limestone outcrop of Boone Formation with solution enhanced bedding planes and fracture. Spring emerges from base of fracture.
SW-06	N36.32946	W94.11003	Losing Stream	--	Stream formed by SW-01, SW-03, SW-04, and SW-05 sinks into subsurface.
SW-07	N36.32684	W94.11246	Spring	--	Spring emerges near headwall of draw. Spring orifice covered by debris (mainly logs) from cleared parcel to the south.
SW-08	N36.32699	W94.11228	Spring	--	Small spring emerges from cherty regolith of the Boone Formation.
SW-09	N36.32693	W94.11167	Spring	--	Small spring emerges from under tree root.
SW-10	N36.32931	W94.10883	Frisco Spring	--	Spring emerges from limestone outcrop of Boone Formation along a solution enhanced bedding plane at base of outcrop. Numerous karst features are present in outcrop to include a large solution conduit containing breakdown immediately north of spring box.
SW-11	N36.32693	W94.10959	Seeps	--	Multiple seeps occur along toe of slope forming a small spring run that sinks into subsurface after approximately 20 ft.
SW-12	N36.33053	W94.10661	Spring	--	Small spring that forms at toe of slope. Flow from spring is directed under existing trail through a pipe.
SW-13	N36.33094	W94.10629	Outcrop	Photo 3	Limestone outcrop of the Boone Formation with solution enhanced bedding planes near base of outcrop.

1. SW = Southwest parcel of property, SE = Southeast parcel of property, LA = Lake Atalanta and represents the parcel of property adjacent to lake.
2. Latitude and longitude provided in decimal degrees; Projection WGS 84.

Table 2.2. Summary of selected karst features at Lake Atalanta Park (continued).

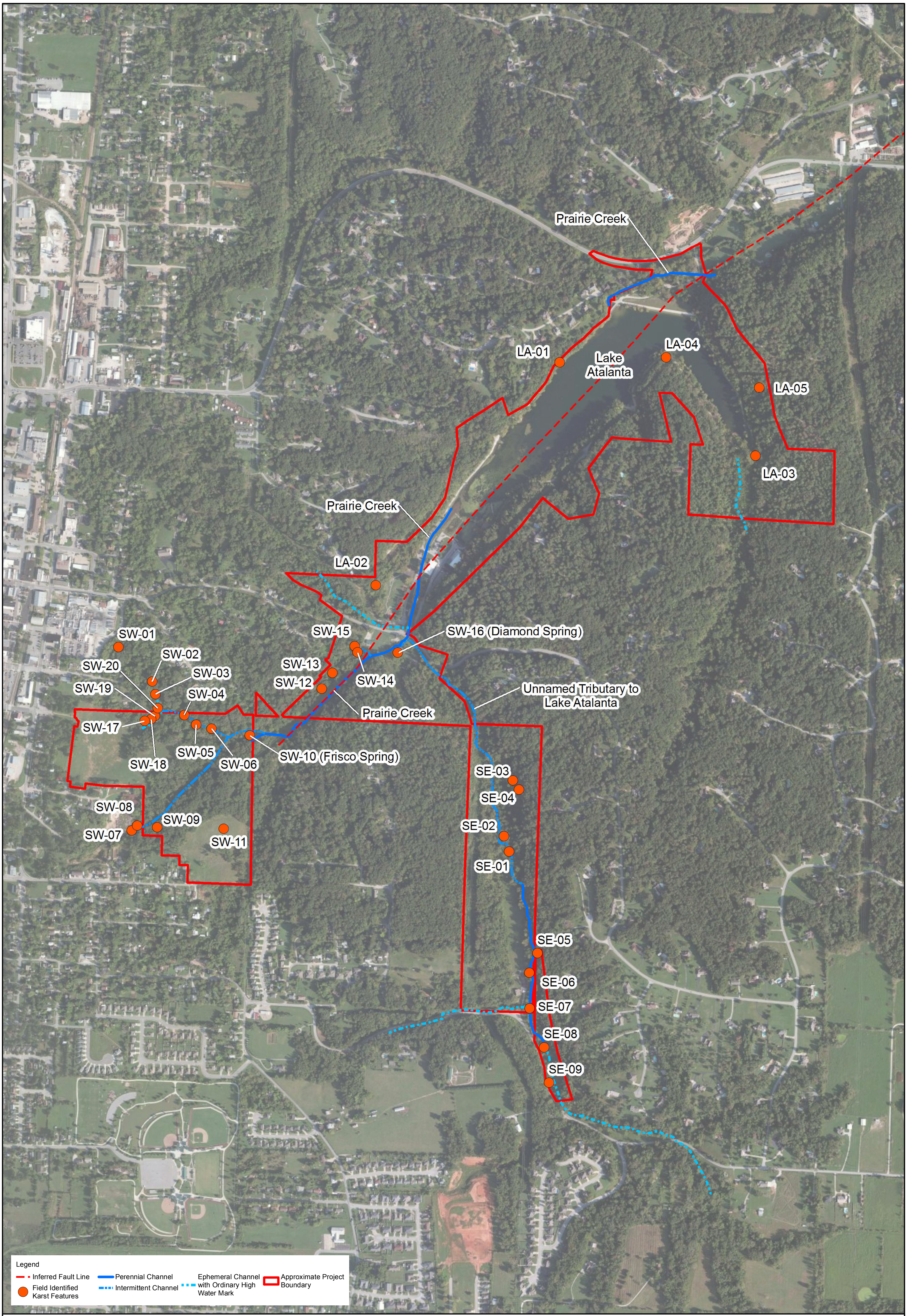
Feature ID[1]	Feature Position[2]		Type of Feature	Selected Representative Photos in Appendix A	Description
	Latitude	Longitude			
SW-14	N36.33147	W94.10551	Spring	--	Small spring that emerges at toe of slope from cherty regolith of the Boone Formation.
SW-15	N36.33162	W94.10561	Seep	--	Small seep.
SW-16	--	--	Diamond Spring	--	Access to spring was not possible due to locked fence.
SW-17	N36.32962	W94.11213	Spring	--	Small spring emerges from base of limestone outcrop of the Boone Formation.
SW-18	N36.32967	W94.11193	Spring	Photo 4	Small spring emerges from limestone outcrop of Boone Formation with well-developed solution features. Approximately 5 feet from spring orifice, stream channel transitions from limestone outcrop to cherty regolith and flow from Spring SW-18 and SW-17 sinks into subsurface.
SW-19	N36.32975	W94.11182	Regaining Stream	--	Stream regains flow.
SW-20	N36.32995	W94.11173	Outcrop	--	Limestone outcrop of Boone Formation with solution enhanced fracture forming an open fissure. Located on existing trail.
LA-01	N36.33892	W94.09938	Outcrop	--	Limestone outcrop of Boone Formation with solution enhanced bedding planes.
LA-02	N36.33318	W94.10499	Outcrop	Photo 5	Limestone outcrop of Boone Formation with solution enhanced bedding planes and fracture.
LA-03	N36.33666	W94.09319	Spring	--	Spring box at old homestead. Small seepage occurs from man-made rock wall.
LA-04	N36.33910	W94.09605	Outcrop	--	Small outcrop of limestone of Boone Formation along east side of lake with solution enhanced bedding planes.
LA-05	N36.33839	W94.09312	Outcrop	Photo 6	Limestone outcrop of Boone Formation with solution enhanced bedding planes. Small spring emerges from one of the bedding planes and flows a short distance before sinking into subsurface.
LA-06	N36.33868	W94.09312	Seeps	--	Multiple seeps emerge from base of limestone outcrop of Boone Formation. Outcrop is highly weathered.

1. SW = Southwest parcel of property, SE = Southeast parcel of property, LA = Lake Atalanta and represents the parcel of property adjacent to lake.
2. Latitude and longitude provided in decimal degrees; Projection WGS 84.

Table 2.2. Summary of selected karst features at Lake Atalanta Park (continued).

Feature ID[1]	Feature Position[2]		Type of Feature	Selected Representative Photos in Appendix A	Description
	Latitude	Longitude			
SE-01	N36.32651	W94.10064	Losing Stream	--	Spring flow from numerous upgradient seeps and springs sinks into subsurface. Stream bed remains dry until confluence with Prairie Creek.
SE-02	N36.32689	W94.10081	Outcrop	--	Solution feature in limestone outcrop of Boone Formation.
SE-03	N36.32831	W94.10057	Outcrop	Photo 7	Limestone outcrop of Boone Formation with solution enhanced bedding planes and fracture forming an open fissure.
SE-04	N36.32808	W94.10037	Outcrop	--	Limestone outcrop of Boone Formation with solution enhanced bedding planes and fractures.
SE-05	N36.32395	W94.09968	Seep	--	Seep emerging from cherty regolith of Boone Formation along stream bank.
SE-06	N36.32345	W94.09992	Springs/Seeps	--	Numerous (>10) springs and seeps emerge from cherty regolith of Boone Formation along stream bank.
SE-07	N36.32255	W94.09989	Spring	--	Spring emerges from cherty regolith near stream bank. Spring dishcarges from pipe.
SE-08	N36.32157	W94.09941	Spring	Photo 8	Large spring emerges from limestone outcrop of Boone Formation. Outcrop extends upgradient of spring and exhibits well-developed karst features to include solution enhanced bedding planes and fractures (open fissures).
SE-09	N36.32068	W94.09924	Outcrop	Photos 9 and 10	From Spring SE-08 to location SE-09, well-developed karst features exist in limestone outcrop of Boone Formation. Karst features include solution enhanced fractures forming open fissures, ubiquitous small-scale solution features known as karren and, at the northern end, a platform of bare limestone (limestone pavement).

1. SW = Southwest parcel of property, SE = Southeast parcel of property, LA = Lake Atalanta and represents the parcel of property adjacent to lake
2. Latitude and longitude provided in decimal degrees; Projection WGS 84.



ftn Associates Ltd.

Figure 3. Map showing streams and karst features
Lake Atalanta Park
City of Rogers, Arkansas

0 400 800
Feet

By: KLF
Date: Jan. 13, 2014
Project No.: 04485-0010-001

Path: S:\projects\04485-0010-001\gis\doc\map\Karst_Sample_Locations.mxd

3.0 POTENTIAL ENVIRONMENTAL IMPACTS

3.1 General Impact

3.1.1 Impacts to Terrestrial Communities/Fauna

The proposed project area consists of several hiking/bike trails throughout the park and other features to provide recreation opportunities to residents of Rogers and surrounding communities. These proposed features will also provide wildlife observation opportunities to residents and visitors. However, the proposed features are expected to create minor impacts to the project area, especially throughout the construction project. The proposed trail dimensions and other impacts vary based on type (please refer to Table 3.1), and some loss of habitat will occur as a result of the proposed trails. As mentioned in Section 2.0 above, few neotropical migrant birds that prefer interior forest likely utilize the area for breeding; overall the project area likely supports breeding birds that are more tolerant of disturbed habitats and edge effects. For example, there is anecdotal evidence that Wood Thrush (*Hylocichla mustelina*) nests within the park, however, it would seem doubtful that many pairs of Wood Thrush or, for that matter, any other interior forested species would be able to utilize the fragmented, suburban setting of the park for successful nesting. Predators such as house cats and native predators (raccoon, fox, etc.) utilizing the existing area would likely prevent those species from successfully nesting. It should be noted however, that an increase in habitat fragmentation, including the proposed trail system, would likely have at least some adverse impacts to existing breeding birds as a result of increased inter-specific competition, increased predator corridors, minor removal of nesting habitat (especially for ground and/or shrub nesters), and increase in human activity. Because many of the species utilizing the park for breeding are likely tolerant of habitat fragmentation (especially considering the site currently is surrounded by development), the overall adverse impacts to the bird community are probably minor.

There would likely be little or no effect on mammals and herpetofauna within the project area, although small numbers of amphibians and reptiles may be affected during construction of park features. Most of the proposed activities for the bike trails include hand-cutting of shrubs and understory, establishing trails (native materials), and other minor activities that would produce only minor impacts. In fact, hand removal of shrubs in some portions of the project area may result in removal of exotic species such as Chinese privet, which is a dominant shrub in portions of the project area. This activity may also be considered a Best Management Practice (BMP). FTN recommends construction of trails and additional features be performed at other times than the prime period of bird nesting activity (May through August). This would reduce impacts to breeding birds that utilize the project area. Again, because most of the vegetation removal is expected to be completed by hand, very minor impacts to most terrestrial faunal species would be expected. FTN also recommends additional hand removal of invasive species, where possible, to reduce competition with native vegetation within the project area.

Finally, at least some of the proposed bike and hiking trail alternatives would affect sensitive communities, identified as "significant areas" by ANHC in their 2013 rapid ecological assessment (Appendix B) and shown on Figure 1.3. This is especially true for significant areas 4 and 5, as identified in the ANHC report, because bike trails are proposed to be denser in these areas than the remainder of the significant areas. Significant area 4 is described by ANHC as supporting chert woodlands (dominated by white oak and black oak) and mesic hardwood forest. Because of the sparse groundcover and shrub layer within this area, the proposed 3-ft wide bike trails would have only very minor impacts to vegetation. Significant area 5 is described by ANHC as supporting similar communities (chert woodland and mesic hardwood forest), but also supported Ozark trillium (*Trillium ozarkanum*), a rare but non-federally listed plant species known from scattered localities in several states. Trails within this area are proposed to be much less dense than in significant area 4 and it is unlikely the 3-ft trails would directly impact Ozark trillium, but it is possible individual plants could be destroyed as a result of project impacts. FTN recommends a qualified biologist or botanist survey the proposed trail ROW in the spring (prior to trail construction) within the significant areas to allow appropriate realignment of proposed trail prior to construction.

3.2 Soils and Erosion Potential

Detailed descriptions of the soils in the project area are provided in Section 2.4. According to the SCS, the dominant soils across the project site present only a slight hazard of erosion.

Because of the steep terrain located in portions of the project area, construction of trails and other features warrants erosion control measures during project construction. These erosion control measures will help prevent potential offsite movement of sediment into any downslope drainages outside the project area. Additional recommendations regarding BMPs to be applied in these and other areas are discussed in Section 4, while additional BMP details are provided as Appendix D.

3.3 Hydrology and Water Quality

3.3.1 Impacts to Channels

Approximately 15 to 20 stream crossings within the project area will either be spanned by wooden bridges that cross the channel above the OHWM or will be intersected by low-water crossings. Channels that will be spanned would receive very minor impacts, as features within the channel would not be impacted and only very minor amounts of vegetation would be removed along portions of the riparian zone. Impacts to water quality at spanned crossings are expected to be minimal, as very little disturbance would be created within the channel, causing minimal sedimentation. It is recommended that low water crossings not be used unless required due to trail grade or turn radius requirements due to the potential impacts from sedimentation. FTN recommends that no low water crossings be placed in perennial streams or larger intermittent streams with the potential for high flow volumes during storm events.

In addition to the proposed trail crossing impacts, the culvert crossing beneath Walnut Street, several hundred feet above Lake Atalanta, is proposed to be replaced. The proposed upgrade will provide a four-barrel, 10-ft by 10-ft, reinforced concrete box culvert, increasing the opportunity for aquatic species to move upstream and downstream between the culvert. The culvert will extend approximately 110 ft in length, therefore, it is approximately 80 ft longer than the existing 30-ft long four-barrel, 11-ft by 6-ft reinforced concrete box culvert below Walnut Street that is partially in-filled with sediments. An additional two-barrel, 10-ft by 10-ft reinforced concrete box culvert, approximately 140 ft in length, is proposed to be installed upstream of and adjacent to the Walnut Street embankment, along the Unnamed Tributary to Lake Atalanta. The culvert is needed to allow both the Walnut Street realignment and to preserve the historic waterworks structures at Diamond Spring due to topographic constraints. These culverts will not impede aquatic species movement, but will remove colonization opportunities within these reaches for several species of benthic macroinvertebrates and some species of fish. A small pool (approximately 1/3 acre) will be placed between the Walnut Street culverts and the double-box culvert upstream of Walnut Street. This pool will have a natural bottom with rock walls, boulders, and native vegetation plantings along the edge. Additional details regarding the proposed pool and potential impacts of the pool to life in the stream and springs are provided in Section 4. The Lake Atalanta park improvements immediately downstream of Walnut Street will include channel modification, improvement or replacement of existing crossings, preservation of an existing historical weir, and additional native plantings. Overall, the impacts to habitat associated with these features are anticipated to be moderate. Some of these features, such as the stream improvements and benefits of increased mobility upstream and downstream, probably outweigh the minor loss of habitat.

A sedimentation basin is proposed upstream of Walnut Street and the subsequent upstream culvert along the intermittent Unnamed Tributary to Lake Atalanta, to allow aggregate transported from upstream during flood flows to settle out prior to reaching the lake. This reach of the channel represents an intermittent reach that rarely flows with surface water. Multiple weirs (two are proposed) would be used together with a widened cross-sectional area to reduce water velocities; however, a total open width of at least 12 inches within each weir would be along the design invert for the passage of low flows and provide for movement of aquatic species that typically inhabit the perennial reach of the channel further upstream. The perennial reach is located approximately one-half mile upstream and supports a channel averaging approximately 7 to 10 ft wide by 2 to 12 inches deep. Small fish were observed in the channel, including stonerollers and unidentified darters; neither of these would likely be impeded by the proposed weirs or trail bridges, although minor impacts would be expected to this community as result of the weir placement.

Channel improvements and restoration activities are proposed along portions of Pleasant Ridge Road, upstream of the perennial reach. These activities are intended to lower channel velocities, reduce bank erosion and channel incision, and restore channel bank vegetation along the east shoulder of Pleasant Ridge Road

In Lake Atalanta and at the Walnut Grove area near the north end of the park, proposed improvements include dredging of lake sediments, construction of a boardwalk and fishing piers along the shoreline, and footpaths and additional native plantings in the Walnut Grove area). The Prairie Creek parking area is also proposed to be modified and improved. There is a potential for minor impacts to surface water quality from these proposed improvements, mainly from significant storm events during construction.

The anticipated minor impacts described in this subsection may be minimized with the use of BMPs. Recommendations regarding BMPs to be applied are provided in Section 4, while additional BMP details are included as Appendix D.

3.4 Wetlands

No Corps regulated Section 404 wetlands (or other waters of the US) were identified within the entire project area, other than Lake Atalanta, which is a regulated water under Section 404. A portion of the Lake is planned to be dredged; however, we understand that activity along with proposed lake embankment stabilization and associated boardwalk construction is addressed in a separate permit application to the Corps, Little Rock District and those impacts will not be considered in this document.

3.5 Endangered Species

As indicated in Section 2.0, several species that occur in Benton County have been federally listed as species regulated by USFWS under the Endangered Species Act.

As identified earlier, there is at least some potential for the occurrence of three federally listed species: Piping Plover, gray bat, and Indiana bat. Proposed project activities would have little, if any, impact to Piping Plover, which unlikely occurs within the project area, but could potentially pass through during migration along the shores of Lake Atalanta. Gray bat is known to occur within Benton County; both Cave Springs Cave and Logan Cave (located well outside the project area) have been known to support summer maternity colonies. No caves or similar features were observed within the project area that appeared suitable for utilization by gray bat, however, this species could potentially forage within the project area, especially near Lake Atalanta. There are no proposed activities to the lake that would negatively affect gray bat, therefore, it would unlikely be impacted by project activities. Although unlikely, Indiana bat could potentially utilize larger trees with loose bark for summer roosts within the project area. We understand that no large trees (such as white oak) with sloughing bark are to be removed during project construction (such as clearing trails), therefore this bat species, if it occurs, would unlikely be impacted by project activities. Overall project activities are minor and adverse impacts, if any impacts, to federally listed species would be minor as well.

3.6 Karst Investigation

Based on the findings of Moix and others (2003) and the karst survey performed by FTN, Lake Atalanta Park represents an active portion of a larger karst landscape that contains a complex hydrologic system with appreciable surface-groundwater interaction. Despite the presence of some very large producing springs, the karst landscape is typical for the Springfield Plateau and is not unusual for the area or unique to the park. A previous study has shown that Frisco and Diamond springs do not represent pristine conditions with respect to nutrients. In fact, nutrient concentrations for these springs are within the range of (dissolved nitrate) or slightly exceeding (total phosphorus) values commonly observed throughout the region.

There is a potential for slight to moderate water quality impacts to the springs from the proposed project elements if the runoff from constructed impervious areas (proposed concrete trail, amphitheater and parking), increased sedimentation in runoff from unpaved trails, and disturbance during construction is unchecked by appropriate BMPs. As the springs and seeps are generally up-gradient of the proposed pool area, box culverts, and proposed lake improvements (park, pavilion upgrade, dredging / boardwalk and Walnut Grove area), impacts to spring and seep water quality from these features are not expected. Appropriate BMPs may be utilized to mitigate for these potential impacts and, if properly designed, constructed and maintained, impacts to surface water quality are expected to be slight.

4.0 SUMMARY AND CONCLUSIONS

In summary, the project area supports a diversity of Ozark highland features especially when considering the urban environment surrounding the area. Proposed project elements include renovations of existing areas and new features, including:

- Prairie Creek improvements and the Walnut Grove amenities, boardwalk construction for embankment stabilization, Lake Atalanta Park improvements at the south end of the lake, north of Walnut Street, and channel stabilization and restoration along Pleasant Ridge Road;
- Hiking and biking trails (paved and unpaved);
- Walnut Street Improvements including street realignment, box culvert replacement and addition, and forebay construction;
- A Bike Park and trailhead;
- An amphitheater, observation tower and parking area south of Frisco Spring; and
- Dredging of lake sediments / dredged fill placement.

These features are meant to provide access for the public to utilize the park and surrounding area and not cause adverse impacts to the fauna and flora within the area. Creation of these features will necessitate some impacts to the area; however, overall these impacts will be limited and minor if properly designed and constructed BMPs are utilized and maintained both during construction and post-construction. Detailed explanations of anticipated impacts are provided in the paragraphs below. Utilization of proper BMPs will be required and will provide protection of both aquatic and terrestrial species. Recommendations regarding BMPs are provided together with the detailed explanations of anticipated impacts.

The lake boardwalk and bank stabilization, Lake Atalanta Park improvements on Prairie Creek, Lake Atalanta road improvements, the downstream Prairie Creek parking improvements and Walnut Grove amenities, and streambank stabilization and restoration along Pleasant Ridge Road would all cause only minor, in some cases, beneficial impacts to flora and fauna within the project area. The proposed lake boardwalk and associated bank stabilization would cause some minor impacts to aquatic species during construction, but would otherwise create little or no adverse impacts. The proposed improvements to Prairie Creek within the existing park north of Walnut Street would provide beneficial impacts to aquatic species, especially fish, through the creation of varied habitats, such as pools/riffles/runs, the addition of boulders, and the addition of woody habitat (root wads). The improvements to the road surrounding the lake would likely have neglible impacts because a road is already established and no additional clearing would be associated with this activity. The proposed Pleasant Ridge Road area streambank restoration and stabilization would likely have minor impacts during construction but would provide beneficial impacts to aquatic species through the addition of improved habitat features. Collectively these proposed features would cause such minor impacts, especially when considering some potential benefits to wildlife, that overall they would have no effect on the surrounding environment.

The proposed bike trails and hiking trails, as discussed in earlier sections, would potentially impact ecological communities within the project area. These impacts would overall be considered minor, but could potentially impact a few sensitive plants, birds, and potentially other species such as herpetofauna and small mammals. Because of the density of the proposed trails, especially the mountain bike trails proposed in the area south of Frisco Spring, the potential exists for minor to moderate impacts in this particular area. Ozark trillium, a sensitive plant, occurs in this area; in addition, the mesic oak-hickory community also potentially supports several species of breeding birds, including a few species of neotropical migrants that could be impacted by additional habitat fragmentation created by the trail system. As suggested in earlier sections, FTN recommends conducting additional surveys for flora and fauna during the spring and/or early summer prior to additional trail construction activities in sensitive areas. This would allow for realignment of portions of the trail that may impact sensitive species. In addition, portions of this trail, especially just above the Frisco Spring head, are excessively steep and erosion could be an issue; therefore, another alternative may be to reduce the trail density in this area, or at least avoid the area near Frisco Spring.

Walnut Street realignment itself would have very minor impacts to the area, however, the proposed pool located just south of Walnut Street would create at least minor adverse impacts to aquatic species. The proposed pool would consist of an impoundment of Prairie Creek just upstream of Walnut Street, somewhat similar to the historic pool at Diamond Spring depicted in the photographs below (provide by the Rogers Historical Museum).

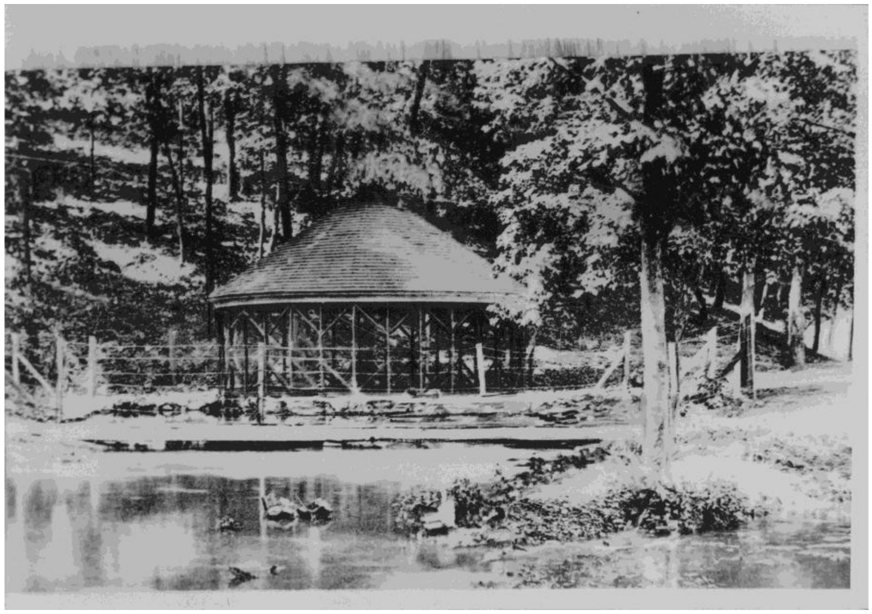


Figure 4.1. South view of Diamond Spring.

Figure 4.2. View from Diamond Spring to northeast.

The proposed pool would cover approximately 0.3 acres and range in depth from about 7 to 9 ft on the east, to a shallow shelf about 1 to 1 1/2 ft deep on the west where the Frisco Spring drainage enters, to maintain moving water on the west side. The pool bottom will be covered with natural materials including sand, gravel, cobbles and boulders that range in size up to 2 to 3 ft diameter. The pool would cause the loss of approximately 150 linear feet of Prairie Creek (a spring fed reach) that is likely utilized by small fish such as darters and minnows, in addition to benthic macroinvertebrates that prefer lotic (flowing) conditions. In addition, creation of the pool would slightly impact the small riparian zone along the right descending bank of Prairie Creek. To mitigate these impacts, FTN recommends planting the shallow portions of the pool with native aquatic (hydrophytic) vegetation and riparian vegetation, preferably mimicking those native species present within the project area. While the pool will remove some functions and values for certain species, it will create habitat for others, such as fish that prefer larger pools (sunfish, etc.), semi-aquatic species such as frogs, and possibly attract wading birds that may feed on sunfish, frogs, and others. The proposed culvert replacement at Walnut Street would cause the loss of some habitat for benthic macroinvertebrates and fish, but would also maintain an adequate connection to portions of Prairie Creek upstream of Walnut Street to allow for movement and colonization of aquatic species.

The proposed bike park and trail head will impact a large area, introducing impervious surface and numerous trails/parking. However, this area currently supports an urban/suburban disturbed community that primarily supports species tolerant of those environments. It is likely some native species, especially sparrows, small mammals (mice, etc.), and other disturbance tolerant species utilize this are to some extent, but overall impacts to this area would be considered minor when considering the current condition of the area. In summary, a large area will be impacted, but the existing functionality of the area is so low, that these impacts would be considered minor.

The proposed amphitheater is located within an upland oak-hickory forest. The associated parking area is proposed adjacent to the amphitheater within an early successional disturbed community. This proposed action would impact these communities and necessitate the removal of forested areas. This would create minor impacts to species utilizing this area; removing nesting opportunities, foraging areas, and cover for birds (in additional to minor impacts to other species). Overall, the community within this area supported a somewhat low diversity of plant species, especially within the early successional area. In summary, these activities would likely cause minor adverse impacts to species utilizing the area, but because the area is of relatively low quality in regards to diversity and functions/values, the overall impacts as result of these features would be negligible.

To mitigate potential water quality impacts from the proposed project to the observed springs, seeps, and other significant karst features observed on the property, the City should require that development plans and post-construction activities in the karst-sensitive areas of the park incorporate BMPs designed for karst terrain, such as the Community Growth BMPs for Conservation of the Elm Springs/Tontitown Recharge Zone (USFWS 2007), provided as Appendix D, or other similarly modified BMPs. If such BMPs are properly designed, applied, constructed, and maintained for project elements in karst-sensitive areas, impacts to water quality of the springs should be minimal. The Construction in Sensitive Areas BMP of Appendix D references maintaining a 300-ft buffer from karst features such as a cave, sinkhole, losing stream, and springs. This BMP is not applicable, as most of these karst features within the park area already have development such as trails, roads, or parking areas significantly closer than 300 ft and often as close as 0 to 30 ft. Based on our field reconnaissance and the proposed project features, the additional development consists of similar trails and parking improvements and, with the use of the other BMPs provided in Appendix D, additional impacts from development within the project area are expected to be minor.

If impacts to water quality are observed in the future, identifying the source of the impacts would likely require delineation of the recharge areas for the springs and determining the significance of the shallow flow component (if any) for the springs within Lake Atalanta Park. Qualification of the proportion between the shallow flow and deeper baseflow components would be very relevant to establishing to what extent BMPs within the park are indeed necessary to mitigate impacts to water quality of spring flows within the project area.

Even if BMPs are properly applied within the park boundaries, the potential for water quality impacts to the springs from the portion of the recharge zone outside the park area will still exist, especially given existing developed urban areas likely comprise a significant portion of the recharge zone. Because neither the size and extent of the recharge zone outside the park area, nor the proportion of shallow and deeper components of spring baseflow on Lake Atlanta Park are known, it is recommended that BMPs be used within the park to minimize potential impacts from the park developments.

Appropriate BMPs must also be employed for proper erosion prevention and sediment control to help mitigate the potential impacts to surface water quality during and after the construction of trails and paths, parking areas, and structures. In addition to the BMPs prepared by USFWS (2007), applicable BMPs are provided in Chapter 8 of the City of Rogers Drainage Manual (2012). For hiking and biking trails, stream or concentrated flow crossings should include features that span channels rather than obstruct their flow (i.e., span bridges rather than pipe culverts). If at-grade low-water crossings must be installed due to grade change or turn radius limitations, an armored crossing or a crossing that is lined and surfaced with native stones to stabilize the substrate and reduce sedimentation within the channel. Further upslope, concentrated drainage should be minimized by proper trail design and construction utilizing sustainable trail design recommendations provided in Trail Solutions (IMBA 2004), with special attention to limiting grades (10% maximum on longer slopes, 15% for short runs), positioning trail to avoid long downhill slopes that will channel water, and appropriate design and placement of drainage features using 'knicks' and 'Rolling Grade Dips'. During construction, BMPs in gently sloping areas or at the top of steeper slopes should consist of properly anchored straw or fiber wattles with end laps, placed downslope of trail. Double rows of wattles are recommended where more concentrated surface runoff is expected, while silt fence with wire backing should be generally employed in lower areas and steeper areas to prohibit entry of sediments into concentrated flows in swales, drainage channels, or dry valleys. If construction is planned along steep slopes such as for channel restoration and stabilization, or embankment stabilization along the lake, additional features such as erosion control matting will be required to help prevent erosion and control sediment.

Around the Bike Park and Trailhead, the Walnut Grove amenities, and impervious areas such as the Amphitheater & Parking Lot, and Prairie Creek and Clark Pavilion parking areas, typical BMPs such as wattles and silt fence may be used during construction. Post-construction BMPs that provide for filtration of stormwater to remove and reduce sediments and potential pollutants should be used to treat stormwater runoff before it leaves the site. These BMPs may include bioretention devices such as raingardens or other similar features in accordance with City of Rogers Drainage Manual Chapter 9, Section 4, or, where approved by the City, porous pavements with underdrains or other appropriate low impact stormwater practices. Where susceptible karst features are present, surface drainage should be redirected away from those features, either through filtration devices or into sheet flow areas or water quality swales, over vegetated surfaces to allow infiltration through surface soils for additional filtering.

Dredged fill is proposed to be placed east of the proposed Walnut Grove amenities area as part of this project. If so, habitat loss will occur in the area of placement. Appropriate measures must be taken to ensure the fill is contained to the proposed location and potential stormwater from upslope is diverted around the proposed fill area. These measures will include properly designed earthen berms, slope protection, erosion prevention measures and additional measures further downslope. If properly constructed and managed, the risk of significant impacts from this feature is considered to be low. However, as the overall available volume for fill placement in this area is small compared to the anticipated volume of dredged material, we recommend other options be considered.

Inspection and maintenance of BMPs, outlined in the Stormwater Pollution Prevention Plan (SWPPP), will be performed on a weekly basis during project construction as required by the National Pollutant Discharge Elimination System (NPDES) permit issued by ADEQ. Post-construction BMPs will be required to be maintained on a periodic basis to remove sediments and ensure proper function.

In summary, the proposed features are meant to provide access for the public to utilize the park and surrounding area. Creation of these features will necessitate some impacts to the natural environment; however, overall these impacts will be limited and minor if properly designed and constructed.

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APPENDIX A

ENVIRONMENTAL SETTING PHOTOGRAPHS

Photo 1. View of intermittent channel common to the project area.

Photo 2. Hardwood community that dominates project area.


Photo 3. Representative view of Lake Atalanta.

Photo 4. Prairie Creek downstream of Lake Atalanta.

Photo 5. Belted Kingfisher observed along southern portion of Lake Atalanta.

Photo 6. View of park near Walnut Street.

APPENDIX B

ANHC RAPID TERRESTRIAL ECOLOGICAL ASSESSMENT OF LAKE ATALANTA PARK

A Rapid Terrestrial Ecological Assessment of Lake Atalanta Park,

City of Rogers, Benton County, Arkansas

Prairie grasses including big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and side-oats grama (*Bouteloua curtipendula*) thrive in a southwest-facing limestone glade overlooking Lake Atalanta. This area, on a steep hillside east of the Lake Atalanta dam, contains some of the highest quality natural communities remaining in the park.

By Theo Witsell

Arkansas Natural Heritage Commission

November 30, 2013

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A Rapid Terrestrial Ecological Assessment of Lake Atalanta Park,

City of Rogers, Benton County, Arkansas

By Theo Witsell, Arkansas Natural Heritage Commission

Executive Summary

In September and October of 2013, staff of the Arkansas Natural Heritage Commission conducted an inventory of the plant species and terrestrial natural communities at Lake Atalanta Park. This inventory documented eight terrestrial natural communities and 539 plant species present in the park. Five sites were identified as Ecologically Significant Areas and populations of seven plant species of state conservation concern were found. This report maps and describes these Ecologically Significant Areas including management recommendations, provides specific details on the occurrences of rare plant species in the park, and provides general information on the park's natural communities. An annotated list of plant species documented from the park is also provided.

Background and History

Lake Atalanta Park is owned by the City of Rogers and includes properties surrounding Lake Atalanta. The city is planning various improvements and other development projects on these properties. Area educators and other interested citizens have been working to conduct an ecological inventory of park property to identify any significant ecological communities and/or areas of significant flora and fauna in the park. The Arkansas Natural Heritage Commission (ANHC) is a key resource in conducting surveys to identify such areas and provide technical assistance regarding their management needs.

In September of 2013 the City of Rogers contracted with the ANHC to conduct a rapid terrestrial ecological assessment of city-owned lands surrounding Lake Atalanta. This assessment focused on plant species and terrestrial habitats and did not include animal surveys or surveys of aquatic habitats such as springs and spring runs (aside from vegetation along them) or the lake itself. Three trips were made by ANHC staff in September and October 2013 to conduct field inventory for this assessment. Information gathered on these trips was combined with information ANHC staff gathered on a fourth trip made in 2011 as part of a field trip with the Arkansas Native Plant Society. Dates of these field trips were as follows:

20 October 2013 – Theo Witsell (ANHC Botanist)

16, 17, & 18 October 2013 – Theo Witsell (ANHC Botanist)

9, 10, & 11 September 2013 – Theo Witsell (ANHC Botanist)

15 May 2011 – Theo Witsell (ANHC Botanist) on a field trip of the Arkansas Native Plant Society led by Joan Reynolds

Data gathered during these site visits provided the basis for this ecological assessment. However, due to the timeline established for this inventory contract, regular inventory trips were not made throughout the growing season, so it should be understood that the inventory for this assessment cannot be considered comprehensive. Some plant species are visible and/or identifiable only in the spring or early summer and were thus likely undetected in the field work for this assessment. To some extent, information provided by local naturalists who regularly visit the park (especially those affiliated with the Arkansas Native Plant Society, Northwest Arkansas Master Naturalists, Northwest Arkansas Audubon Society, and the Northwest Arkansas Community College) helped to fill in these gaps and is incorporated into the assessment.

Site Description

General Description

Lake Atalanta Park (Figs. 1, 2, & 3) is located just east of downtown Rogers, Arkansas in a rugged section of the Dissected Springfield Plateau Ecoregion near its boundary with the Springfield Plateau Ecoregion, which lies a short distance to the west. The site lies south of Highway 12 and city-owned land lies both north and south of East Walnut Street. The terrain in and around the park is dissected, with moderate to steep slopes of various aspects along several headwater tributaries of Prairie Creek. Small stream valleys are narrow and situated between chert and limestone hills.

Lake Atalanta Park contains approximately 220 feet of topographic relief, with elevations ranging from roughly 1370 feet near East Cherry Street at the southwest corner of the property to roughly 1150 feet where Prairie Creek leaves the park below the Lake Atalanta dam. All slopes and aspects are present.

The geology of the property is comprised almost entirely of the Mississippian-aged Boone Formation, with small areas of Quaternary alluvium deposited along the larger streams. The Boone Formation consists of alternating beds of limestone (both coarse and fine-grained) and chert, creating calcareous and acidic soils respectively, each with their own characteristic plant communities. Numerous springs (both perennial and ephemeral) occur on the property.

Streams on the property are characteristic of small streams in the Springfield Plateau and move a substantial gravel bedload. The larger streams have formed noticeable terraces. Most streams on the property are intermittent though several that emerge from or are fed by large springs flow year-round into Lake Atalanta.

Karst Features

Because so much of the underlying geology is limestone, karst features are prominent in the park. As mentioned above, many of the streams are either dry or losing (flowing underground) by early summer, with some areas maintaining flow year round from the numerous springs on the property.

Ecological Significance

The flora of Lake Atalanta Park is diverse, with elements of both the (former) tallgrass prairies of the flat Springfield Plateau surface to the west and the rich forests of the White River Valley to the east. The property was found to support eight distinct plant communities or terrestrial habitats: 1) limestone glades and woodlands, 2) acidic chert woodlands, 3) mesic hardwood slope forests, 4) riparian forests, 5) spring runs, 6) lakeshores, 7) fields, and 8) disturbed areas. Each of these is described briefly below in the section on plant communities.

Native plant communities over most of the property are in a moderately to severely degraded condition. Several areas support mature forests dominated by large trees but the shrub and herbaceous (ground cover) layers are often dominated by non-native invasive species and contain few native species. Even the best glades and dry woodlands on the property are fire-suppressed and have substantial cedar and other woody plant encroachment, a departure from their natural condition.

Despite these facts however, Lake Atalanta Park is a botanically significant area. The site is remarkably diverse for its size and landscape context, with nearly 540 vascular plant species documented to date. Furthermore, seven of the plant species in the park are of state conservation concern, and two are considered to be of global concern, with conservation status ranks of G3 (globally vulnerable) or higher. The park supports elements of a more northern and eastern flora in its mesic ravines and elements of an endemic and more western flora in its glades and dry woodlands. No federally listed species (species listed as Threatened or Endangered under the U.S. Endangered Species Act) were found during the present study. See Appendix D for a complete list of plant species of conservation concern found in the park.

Plant Communities

The following are general descriptions of the plant communities present in the park. More detailed descriptions of communities found in ecologically significant areas appear in Appendix C.

1) Limestone Glades and Woodlands

Glades are naturally treeless openings in forested landscapes where bedrock is exposed or comes close to the surface of the ground. In their natural state, glades are characterized by treeless or very sparsely wooded openings dominated by a variety of drought-tolerant grasses, shrubs, and wildflowers. Glade soils are thin and while they may be wet in the winter and spring (due to bedrock limiting infiltration of water) they are exceedingly dry in the summer and early fall. Glades support a rich diversity of droughtadapted plants and animals including a number of rare species that are restricted to open glade habitat. Glades are classified based on the type of geology on which they occur. Limestone glades such as those found in Lake Atalanta Park (Figs. 8e, 8f, 9a, & 9b) have a high pH and support a number of plant species that are not found in glades formed on acidic rocks like sandstone, chert, or granite. Glades are widely recognized as habitats of conservation concern and there are many resources available regarding their ecology, restoration, and management.

In their natural condition, the open structure of glades is maintained in part by periodic fire. In the absence of fire, glades will generally become dense with woody vegetation. In the Ozarks, one of the most common invading trees is the native eastern red-cedar (*Juniperus virginiana*), which can completely fill in glade openings over time resulting in the elimination of characteristic glade flora and fauna. Glades generally transition into surrounding deeper-soiled open woodland communities, which have enough soil to support trees, though they are often spaced widely enough to allow sunlight to reach the ground and support a diverse community of plants on the ground. The canopy in these woodlands is often dominated by post oak (*Quercus stellata*), chinquapin oak (*Quercus muehlenbergii*), Shumard's oak (*Quercus shumardii*), and white ash (*Fraxinus americana*).

A more detailed description of the limestone glades in the park can be found in Appendix C.

2) Acidic Chert Woodlands

Acidic chert woodland (Fig. 4) is common in the park. These dry to dry-mesic woodlands occur on well-drained uplands with chert substrate. They are typically dominated by black oak (*Quercus velutina*), white oak (*Quercus alba*), and mockernut hickory (*Carya alba*) but often contain post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*) on drier sites. Common understory species include flowering dogwood (*Cornus florida*), Carolina buckthorn (*Frangula caroliniana*), sassafras (*Sassafras albidum*), farkleberry (*Vaccinium arboreum*), and winged elm (*Ulmus alata*). Ground cover is characteristic of acidic woodlands and often includes low-bush blueberry (*Vaccinium pallidum*), deerberry (*Vaccinium stamineum*), dittany (*Cunila origanoides*), hawkweed (*Hieracium gronovii*), Muhlenberg's sedge (*Carex muehlenbergii* var. *enervis*), and several species of rosette grasses (*Dichanthelium* spp.), goldenrods (*Solidago* spp.), asters (*Symphyotrichum* spp.), bush-clovers (*Lespedeza* spp.) and tick-trefoils (*Desmodium* spp.).

An unusual area of open chert grassland, or barrens, (Fig. 5) is found on a moderately steep northwest-facing slope on the east side of Lake Atalanta, between Lake Atalanta Road and the shore of the lake. This community may represent an extremely open phase of the surrounding chert woodland and supports an exceptionally diverse native flora containing several species that were not found elsewhere in the park.

Scattered plants of Ozark chinquapin (*Castanea pumila* var. *ozarkensis*) (Fig. 4e) occur in chert woodlands in the park. This species was once a common canopy tree in woodlands on acidic soils across the Ozarks but has been decimated by the Chestnut Blight, an introduced fungal pathogen that arrived in the local area about 1957. Infected trees are killed to the ground and though they may continue to resprout from the roots, they are generally reduced to shrub stature and rarely get large enough to produce fruit. Chinquapin wood is exceptionally rot resistant and trunks of large dead trees, often called "chinquapin skeletons" (Fig. 4f) dating to the late 1950s can still be found in the park.

A more detailed description of the chert woodlands in the park can be found in Appendix C.

3) Mesic Hardwood Slope Forests

This community (Figs. 8a & 8b) is associated primarily with north- and east-facing slopes in the park but may occur on all aspects in narrow valleys, especially on lower slopes. The canopy is typically dominated by white oak (*Quercus alba*) and northern red oak (*Quercus rubra*), and often includes shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), mockernut hickory (C*arya alba*), red maple (*Acer rubrum*), basswood (*Tilia americana*), black walnut (*Juglans nigra*), and other hardwood species. Common shrubs include spicebush (*Lindera benzoin*), pawpaw (*Asimina triloba*), bladdernut (*Staphylea trifolia*), hop-hornbeam (*Ostrya virginiana*), hazelnut (*Corylus americana*), American holly (*Ilex opaca*), and wild hydrangea (*Hydrangea arborescens*).

A rich herbaceous layer includes a variety of ferns, forbs, grasses, and sedges. Characteristic ferns and forbs include northern maidenhair fern (*Adiantum pedatum*), broad beech fern (*Phegopteris hexagonoptera*), Christmas fern (*Polystichum acrostichoides*), honewort (*Cryptotaenia canadensis*), aniseroot (*Osmorhiza longistylis*), black cohosh (*Actaea racemosa*), goat's-beard (*Aruncus dioicus*), clustered black snakeroot (*Sanicula odorata*), wakerobin (*Trillium sessile*), green trillium (*Trillium viridescens*), large-flower bellwort (*Uvularia grandiflora*), Jack-in-the-pulpit (*Arisaema triphyllum*), wild ginger (*Asarum canadense*), white snakeroot (*Ageratina altissima*), wreath goldenrod (*Solidago caesia*), blue wood aster (*Symphyotrichum drummondii*), wild geranium (*Geranium maculatum*), bloodroot (*Sanguinaria canadensis*), lopseed (*Phryma leptostachya*), wild blue phlox (*Phlox divaricata* subsp. *laphamii*), Jacob's-ladder (*Polemonium reptans*), sweet-scent bedstraw (*Galium triflorum*), blue violet (*Viola sororia*), Joe-pye-weed (*Eutrochium purpureum*), and Solomon's-seal (*Polygonatum biflorum*). Bearded shorthusk (*Brachyelytrum erectum*), hairy woodland brome (*Bromus pubescens*), bottlebrush-grass (*Elymus hystrix*), and Virginia wild rye (*Elymus virginicus*) are common grasses.

4) Riparian Forests

This habitat occurs along wooded streams in the park. Riparian forest along the upper reaches of the smallest streams may differ little from surrounding upland forest in terms of tree canopy, though the herbaceous layer and even the shrub layer may be strikingly different. In examples of this habitat on larger streams in the park, canopy cover varies but typical species include sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), slippery elm (*Ulmus rubra*), red maple (*Acer rubrum*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), bitternut hickory (*Carya cordiformis*), basswood (*Tilia americana*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), persimmon (*Diospyros virginiana*), and other hardwood species.

Common woody species in the understory include spicebush (*Lindera benzoin*), deciduous holly (*Ilex decidua*), Carolina buckthorn (*Frangula caroliniana*), ninebark (*Physocarpus opulifolius*), pawpaw (*Asimina triloba*), bladdernut (*Staphylea trifolia*), and hop-hornbeam (*Ostrya virginiana*). Shade-tolerant grasses and sedges are common in riparian forests and include river-oats (*Chasmanthium latifolium*), hairy wild rye (*Elymus villosus*), Virginia wild rye (*Elymus virginicus*), bottlebrush-grass (*Elymus hystrix*), stout wood-reed (*Cinna arundinacea*), bearded shorthusk (*Brachyelytrum erectum*), and many species of sedges (*Carex* spp.).

Common ferns and forbs include Christmas fern (*Polystichum acrostichoides*), broad beech fern (*Phegopteris hexagonoptera*), Virginia waterleaf (*Hydrophyllum virginianum*), yellow ironweed (*Verbesina alternifolia*), frostweed (*Verbesina virginica*), bear's-foot (Smallanthus uvedalius), cup-plant (Silphium perfoliatum), wild blue phlox (Phlox divaricata subsp. laphamii), blue violet (*Viola sororia*), downy yellow violet (*Viola pubescens*), beggar's-lice (*Hackelia virginiana*), tall bellflower (*Campanula americana*), carpenter's-square (*Scrophularia marilandica*), enchanter's-nightshade (*Circaea canadensis subsp. canadensis*), and giant yellow-hyssop (*Agastache nepetoides*). Vines include moonseed (*Menispermum canadense*), bristly greenbrier (Smilax hispida), and carrion-flower (*Smilax pulverulenta*).

5) Spring Runs

Spring runs (Figs. 6c, 6d, 6e, & 6f) are groundwater-fed streams that receive all or most of their water from springs. These streams may be small or large but they generally flow all year. The cool, constant flow of mineral-rich groundwater supports a number of species that rarely, if ever, occur on streams without groundwater influence. Spring runs at Lake Atalanta Park support a number of characteristic plants including spotted jewelweed (*Impatiens capensis*), dotted smartweed (*Persicaria punctata*), golden ragwort (*Packera aurea*), fowl manna grass (*Glyceria striata*), great blue lobelia (*Lobelia siphilitica*), water speedwell (*Veronica anagallis-aquatica*), bulrush (*Scirpus atrovirens*), rice cut grass (*Leersia oryzoides*), wire-stem muhly (*Muhlenbergia frondosa*), toothcup (*Rotala ramosior*), swamp agrimony (*Agrimonia parviflora*), deer-tongue rosette grass (*Dichanthelium clandestinum*), smooth wild petunia (*Ruellia strepens*), tall bellflower (*Campanula americana*), pink thoroughwort (*Fleischmannia incarnata*), and a number of sedges (*Carex* spp.). Larger spring runs are generally surrounded by typical riparian forest vegetation unless they have been cleared or otherwise disturbed.

6) Lakeshores

Shorelines (Figs. 6a & 6b) along the margin of Lake Atalanta provide habitat for a variety of wetland and woodland species. Common species include false nettle (*Boehmeria cylindrica),* beggar-ticks (*Bidens frondosa*), Japanese stilt grass (*Microstegium vimineum*), river-oats (*Chasmanthium latifolium*), small carp grass (*Arthraxon hispidus*), American bugleweed (*Lycopus americanus*), rusty flatsedge (*Cyperus odoratus*), yellow flatsedge (*Cyperus flavescens*), monkey-flower (*Mimulus alatus*), great blue lobelia (*Lobelia siphilitica*), red maple (*Acer rubrum*), white woodland aster (*Symphyotrichum lateriflorum*), fox sedge (*Carex vulpinoidea*), summer sedge (*Carex lurida*), Frank's sedge (*Carex frankii*), a sedge (*Carex annectens*), wax-leaf meadow-rue (*Thalictrum revolutum*), Catesby's virgin's-blower (*Clematis catesbyana*), Florida paspalum (*Paspalum floridanum*), wild potato vine (*Ipomoea pandurata*), brown-eyed Susan (*Rudbeckia triloba*), common scouring-rush (*Equisetum hyemale*), Missouri ironweed (*Vernonia missurica*), Virginia wild rye (*Elymus virginicus* var. *virginicus*), southeastern wild rye (*Elymus glabriflorus*), and hedge bindweed (*Calystegia sepium*).

7) Fields

Several fields (Fig. 12a) occur on park property, all of which are dominated by various species of mostly non-native grasses. These include long-established fields on stream terraces, such as those on the Fleming and Shelton tracts, and those recently created by the removal of upland forest, such as those off of East Cherry Street and East Oak Street near the southwest edge of the park. Common grass species in these fields include tall fescue (*Schedonorus arundinaceus*), Bermuda (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), purple-top tridens (*Tridens flavus* var. *flavus*), crabgrass (*Digitaria* spp.), and, where partially shaded, Japanese stilt grass (*Microstegium vimineum*). A number of weedy forbs also occur in these fields.

8) Disturbed Areas

A variety of disturbed habitats occur throughout the park, from informal parking areas around the lake to areas of exposed dirt and gravel where structures were recently demolished. Other examples of disturbed habitats in the park include mowed lawns, powerline rights-of-way periodically sprayed with herbicides, eroding stream banks, and roadsides. These habitats all provide habitat for weedy species, native and introduced, that benefit from various kinds of disturbance. Some types of disturbed areas that aren't intensively maintained, especially roadsides and powerline rights-of-way, often retain vegetation typical of the natural communities that they border.

Ecological Stresses

Five major ecological stresses on the park's terrestrial natural communities were identified during field work for this assessment. These are:

1) fire suppression
2) non-native invasive plant species
3) deer pressure
4) altered hydrology/stream erosion
5) human-caused disturbances

These stresses are often interrelated and have worked together to produce the current condition of the park's natural communities.

Fire Suppression

Whether ignited by lightning or by Native Americans, landscape scale fire is widely understood to have been a natural ecological process that played a major role in shaping nearly all upland habitats in the Ozark Plateau. Fires regularly burned across the Ozark landscape before European settlement and the structure and species composition of natural communities was shaped in large part by the frequency and intensity of these fires in a given spot. The main effects of fire on habitats in the region were 1) to periodically remove leaves and other dead plant material from the ground and 2) to maintain open conditions by arresting the growth of woody vegetation. The degree of habitat openness in the presettlement landscape varied with geographic location, landform, local climate, and other factors. Conditions ranged from open prairie and savanna on the flat surface of the Springfield Plateau west of Lake Atalanta (where fires were more frequent and intense) to lush closed canopy hardwood forests in the deep hollows draining to the White River from Lake Atalanta east (where fires were less frequent and intense). However, much of the upland landscape around Lake Atalanta was probably somewhere in between savanna and closed forest – a mosaic of semi-open woodlands where periodic fires allowed light to reach the ground and sustained diverse carpets of sun-loving grasses and wildflowers.

As fires were suppressed, these open habitats, along with the species that depended on them, declined across the region. Consequently, many species that were more common historically are rare today. Prescribed fire, or the intentional ignition and management of “controlled burns”, is widely used today (where appropriate) to manage for healthy and diverse woodlands, prairies, glades, and other plant communities.

Non-native Invasive Plant Species

Lake Atalanta Park is home to a wide variety of non-native invasive plants, a consequence of its location on the edge of an urban area and a long history of disturbance to its natural communities. Intense use of the park by humans, both presently and historically, coupled with a large deer population have likely contributed to the colonization and spread of certain invasive plant species. The spread of these species, combined with other factors, has displaced native species and altered the structure and species composition of natural communities in many areas of the park.

Appendix F presents a table of non-native invasive plant species in the park that are negatively impacting native habitats, or that have the potential to negatively impact native habitats in the future. This list includes information about the life form (forb, grass, woody vine, shrub, tree, etc.) of each species, as well and the habitat(s) they occupy in the park. Following this table is an annotated list with park-specific information on each species.

Deer Pressure

As is the case in many urban and suburban wooded areas, a large deer population has exerted substantial pressure on the plant communities at Lake Atalanta Park. Large deer herds can cause populations of many plant species to decline over time or even become extirpated locally as deer consume most or all the plants of a given species. Deer may also encourage certain unpalatable invasive species by avoiding them while eating the native species that formerly occupied the same habitat. Deer were regularly encountered during field work in the park and signs of high deer pressure were observed in many areas including browse lines on shrubs and a general lack of a native ground flora in many park woodlands.

Altered Hydrology/Stream Erosion

Many riparian habitats in Lake Atalanta Park show signs of altered hydrology caused by excessive and ongoing stream erosion. Several of the larger streams show evidence of recent and ongoing downcutting (Figs. 12e & 12f). Some of the smaller tributaries that feed these streams are actively head cutting in response to this lowering of the channel bottom in the larger streams. This downcutting can lower the water table in riparian habitats, reducing soil moisture and making habitat unsuitable for some species. In addition, all of this bank and channel erosion is moving large amounts of sediment into Lake Atalanta as well as altering the riparian habitats in the park.

Human-Caused Disturbances

Lake Atalanta Park has a long history of human alteration and most of the park's natural communities have been affected by these activities. Examples include fragmentation of park forests and woodlands by roads and utility rights-of-way, alteration of hydrology by development (both within and outside the park), logging and/or clearing forests, spraying of herbicides in utility rights-of-way that cross the park, impoundment of springs, and channelization of spring runs.

Acknowledgments

The following individuals provided valuable assistance by sharing their information, knowledge, and photographs of the flora of Lake Atalanta Park and/or by accompanying me in the field during site visits: Deb Bartholomew, Gordon Bradford, Craig Fraiser, Burnetta Hinterthuer, Tom McClure, Joe Neal, David Oakley, Joan Reynolds, and Ellen Turner. Special thanks to Joan Reynolds for access to her plant inventory records, her assistance in the field, and for lending a kayak to enable surveys of areas along and above the lakeshore.

APPENDIX A: AERIAL PHOTO AND TOPOGRAPHIC MAPS OF LAKE ATALANTA PARK

Location of Lake Atalanta Park

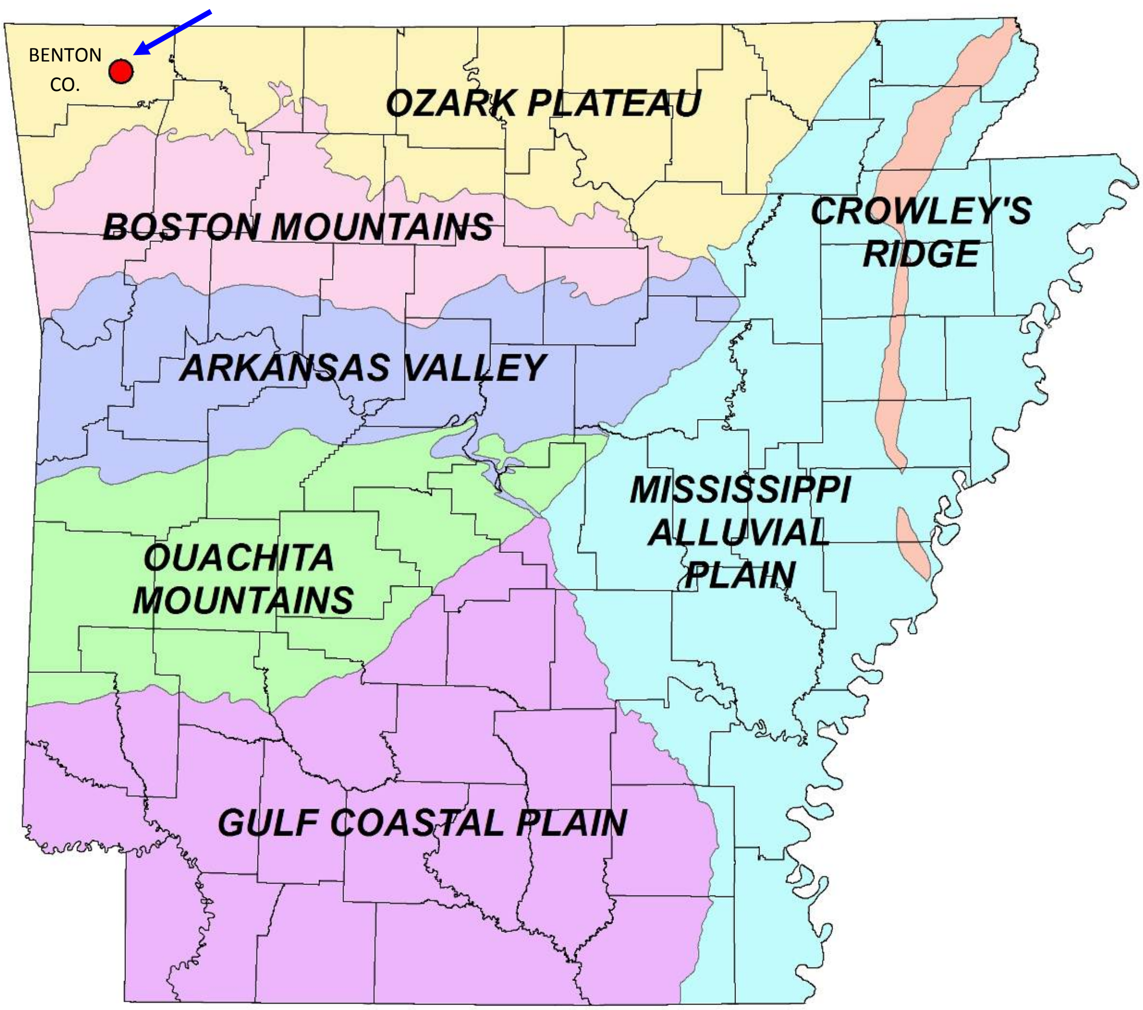

FIGURE 1. Location of Lake Atalanta Park, Benton County, Arkansas.

Lake Atalanta Park – Aerial Photo

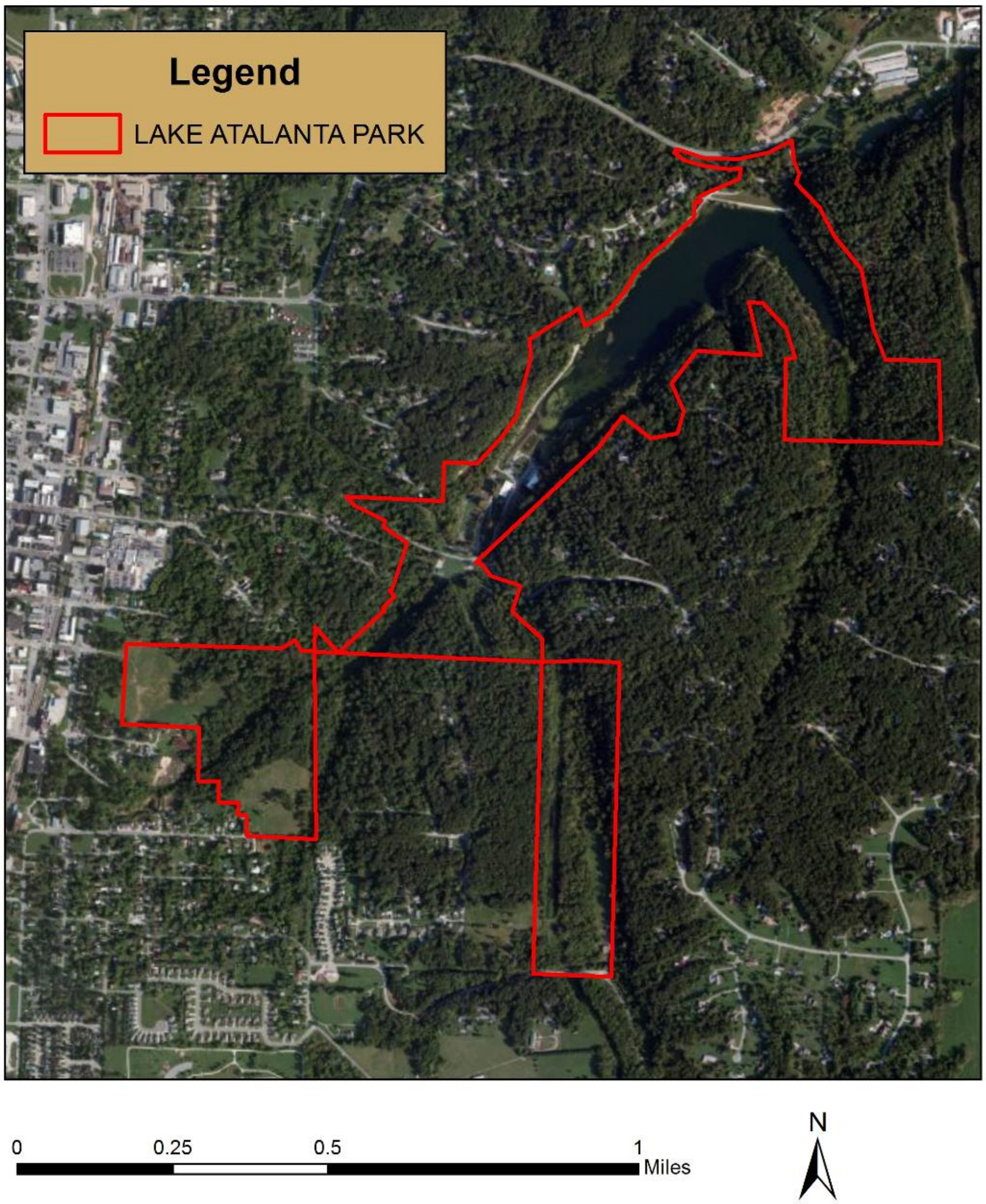

FIGURE 2. Map of Lake Atalanta Park on 2012 aerial photo. Map by Theo Witsell, Arkansas Natural Heritage Commission, 2013.

Lake Atalanta Park – Topo Map

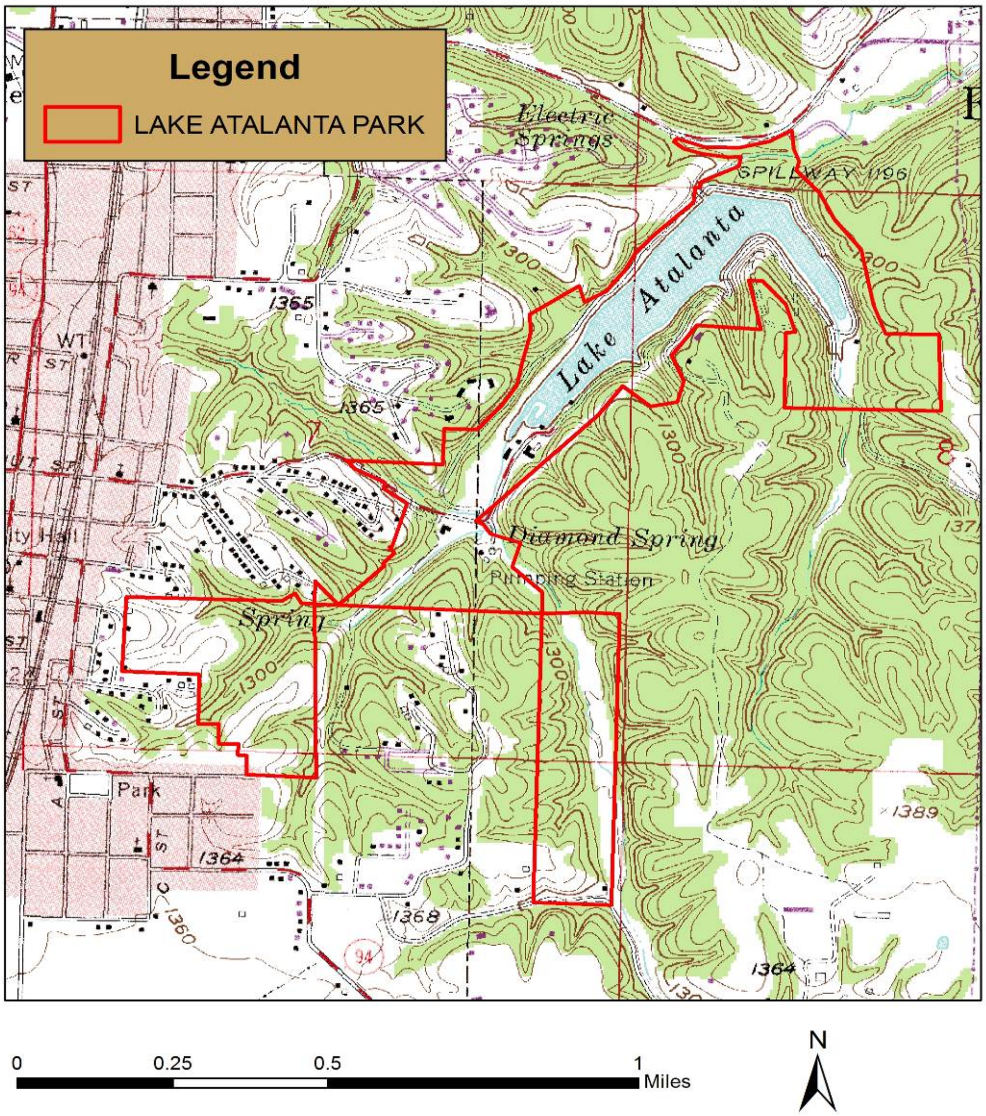

FIGURE 3. Map of Lake Atalanta Park on USGS topo map from Rogers 7.5' quadrangle. Map by Theo Witsell, Arkansas Natural Heritage Commission, 2013.

APPENDIX B: PHOTOGRAPHS OF SPECIES AND COMMUNITIES AT LAKE ATALANTA PARK

All photos taken by Theo Witsell in September and October 2013 unless otherwise noted.

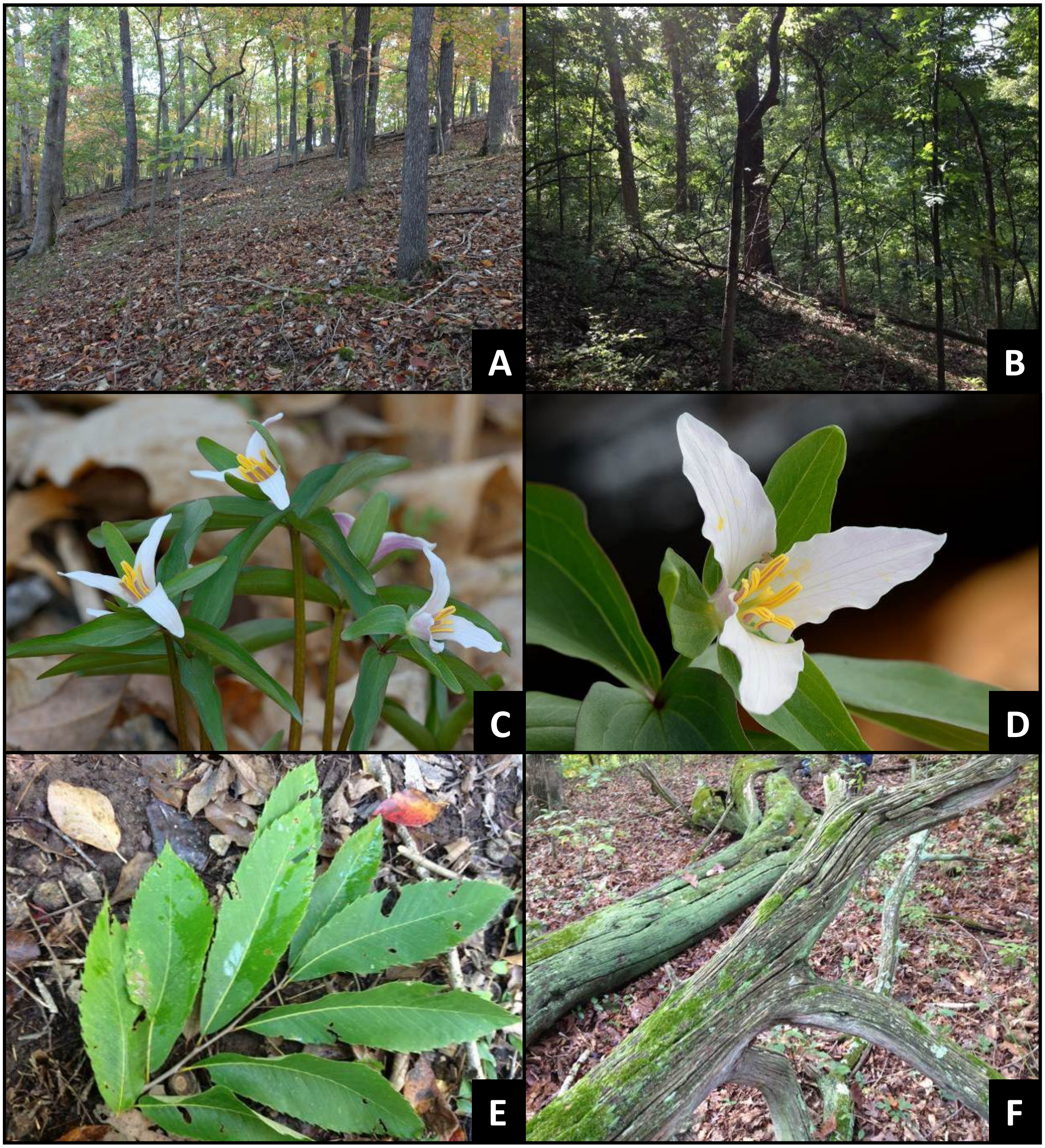

FIGURE 4. A. Acidic chert woodland dominated by black oak (*Quercus velutina*) and white oak (*Quercus alba*), upstream from Lake Atalanta. **B.** This acidic chert woodland south of Frisco Spring is home to a population of Ozark trillium (*Trillium ozarkanum*), a plant species of global conservation concern found only in portions of the Ozark Plateau and Ouachita Mountains. **C.** and **D.** Ozark trillium at Lake Atalanta Park. Photos by David Oakley. **E.** Leaves of Ozark chinquapin (*Castanea pumila* var. *ozarkensis*), an uncommon tree that has been decimated throughout its range by Chesnut Blight, an introduced fungal pathogen. Small trees were found at several sites in chert woodlands in the park. **F.** These "skeletons" of big Ozark chinquapin trees killed by the blight in the late 1950s still persist on the Fleming tract in the southern part of the park.

FIGURE 5. A. and **B.** These chert barrens on the east side of Lake Atalanta support a rich diversity of grassland and woodland plant species and are relatively free from invasive species. This community may represent an extremely open phase of the surrounding chert woodland. **C.** Prairie grasses including Indian grass (*Sorghastrum nutans*) and little bluestem (*Schizachyrium scoparium*) share this chert barrens with wildflowers such as rough blazing-star (*Liatris aspera*), rattlesnake master (*Eryngium yuccifolium*), beebalm (*Monarda fistulosa*), white-leaf mountain-mint (*Pycnanthemum albescens*), several species of asters (*Symphyotrichum* sp.) and goldenrods (*Solidago* sp.), and many species of native legumes.

FIGURE 6. A. and **B.** Lakeshore habitat along the margins of Lake Atalanta supports a number of wetland plant species not found elsewhere in the park. **C.** Frisco Spring is one of several large, perennial springs in the park that feed Lake Atalanta. **D.** Spring-fed creeks or spring runs like this one issuing from Frisco Spring flow year-round and provide habitat for species that need cool ground water. **E.** A more disturbed portion of this same spring run (under a powerline right-of-way upstream from the pavilion) is dominated by non-native invasive plants such as Japanese stilt grass (*Microstegium vimineum*) and air-potato or cinnamon vine (*Dioscorea polystacha*). **F.** A dense stand of reed canary grass (*Phalaris arundinacea*) along a spring run downstream from Frisco Spring. This species is a major invasive capable of displacing all other species in open wetlands.

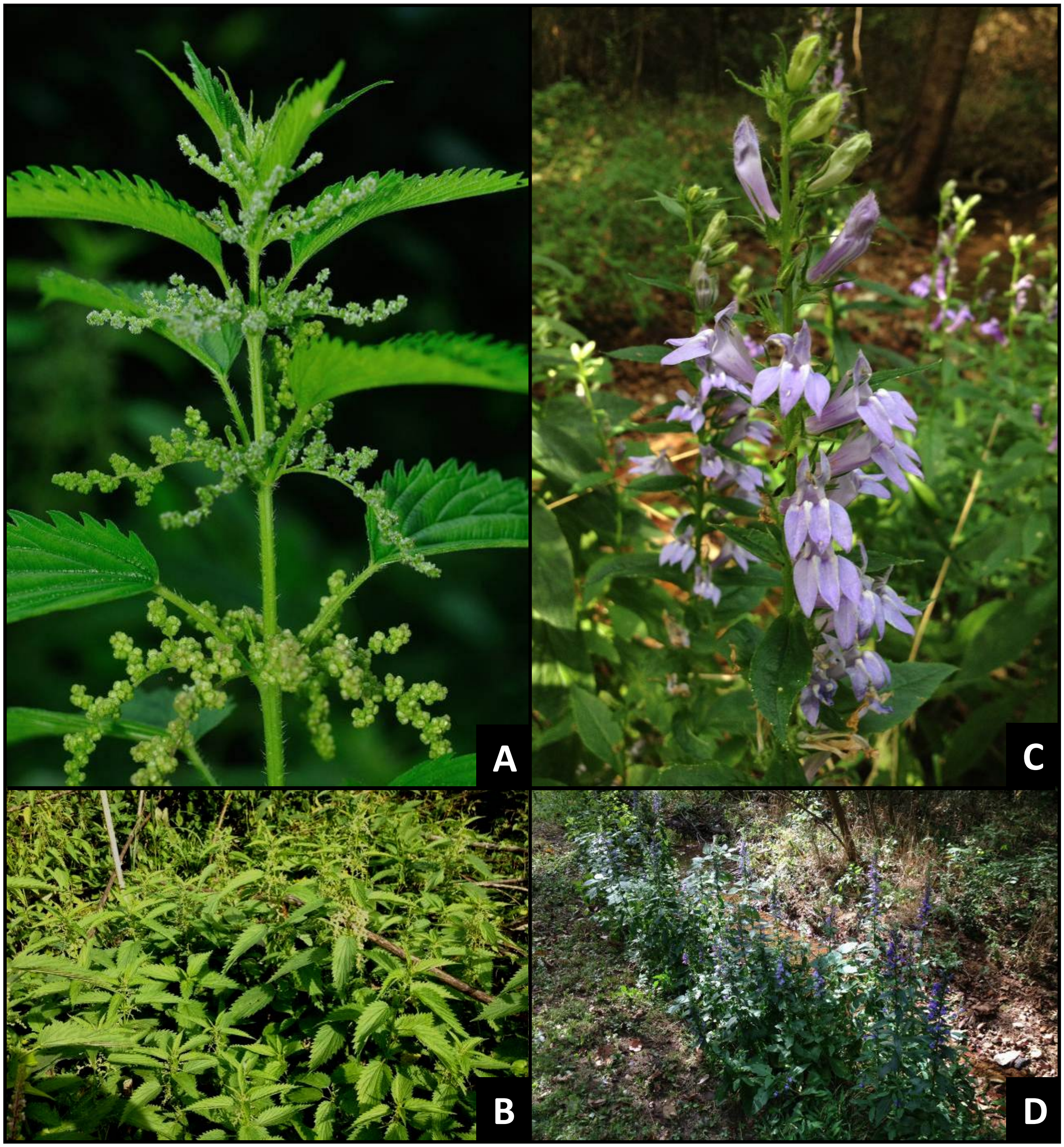

FIGURE 7. A. Slender nettle (*Urtica gracilis*), a species of state conservation concern known from just two sites in Arkansas, one of which is along a spring-fed creek issuing from Frisco Spring. Photo by David Oakley. **B.** A group of slender nettle plants downstream from Frisco Spring. **C.** Great blue lobelia (*Lobelia siphilitica*), a species characteristic of groundwater-fed wetlands and spring runs, downstream from Frisco Spring. **D.** A stand of great blue lobelia downstream from Frisco Spring.

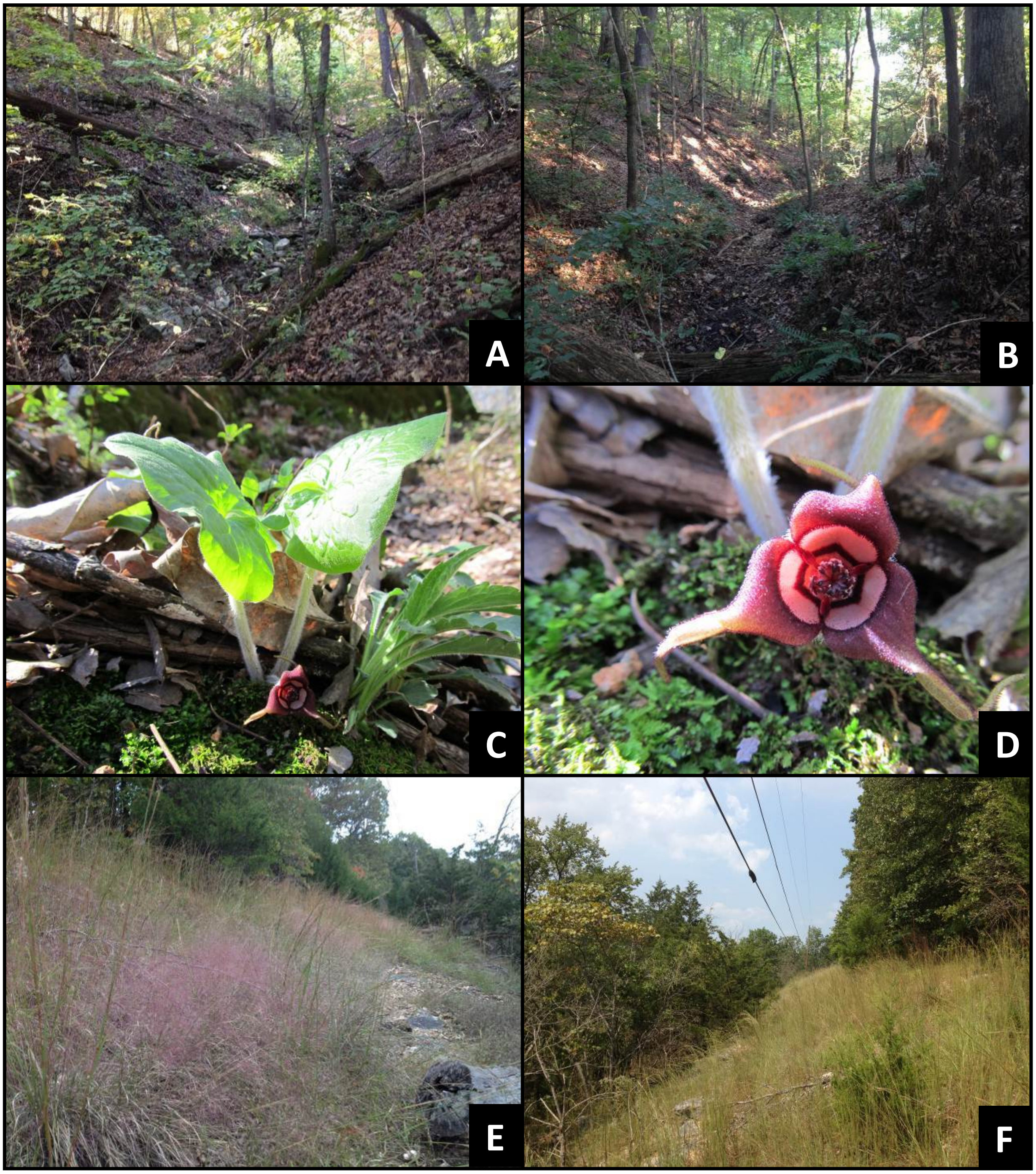

FIGURE 8. A. and **B.** Rich, mesic hardwood forests occur in protected ravines that feed Lake Atalanta and are home to a number of spring wildflower species. **C.** One of the most significant rare plants at Lake Atalanta Park is the taper-tip wild ginger (*Asarum canadense* var. *acuminatum*) which is typically found in states to the north and east of Arkansas. In Arkansas, it is only known from a few locations in Benton, Newton, and Stone counties, all in mesic harwood forests in protected ravines with limestone-derived soils. Photo by Joan Reynolds. **D.** Taper-tip wild ginger is differentiated from the more common wild ginger by its long petal tips, large plants, and leaves that are tapered to a pointed tip. Photo by Joan Reynolds. **E.** and **F.** Limestone glade habitat on a hillside east of the Lake Atalanta dam.

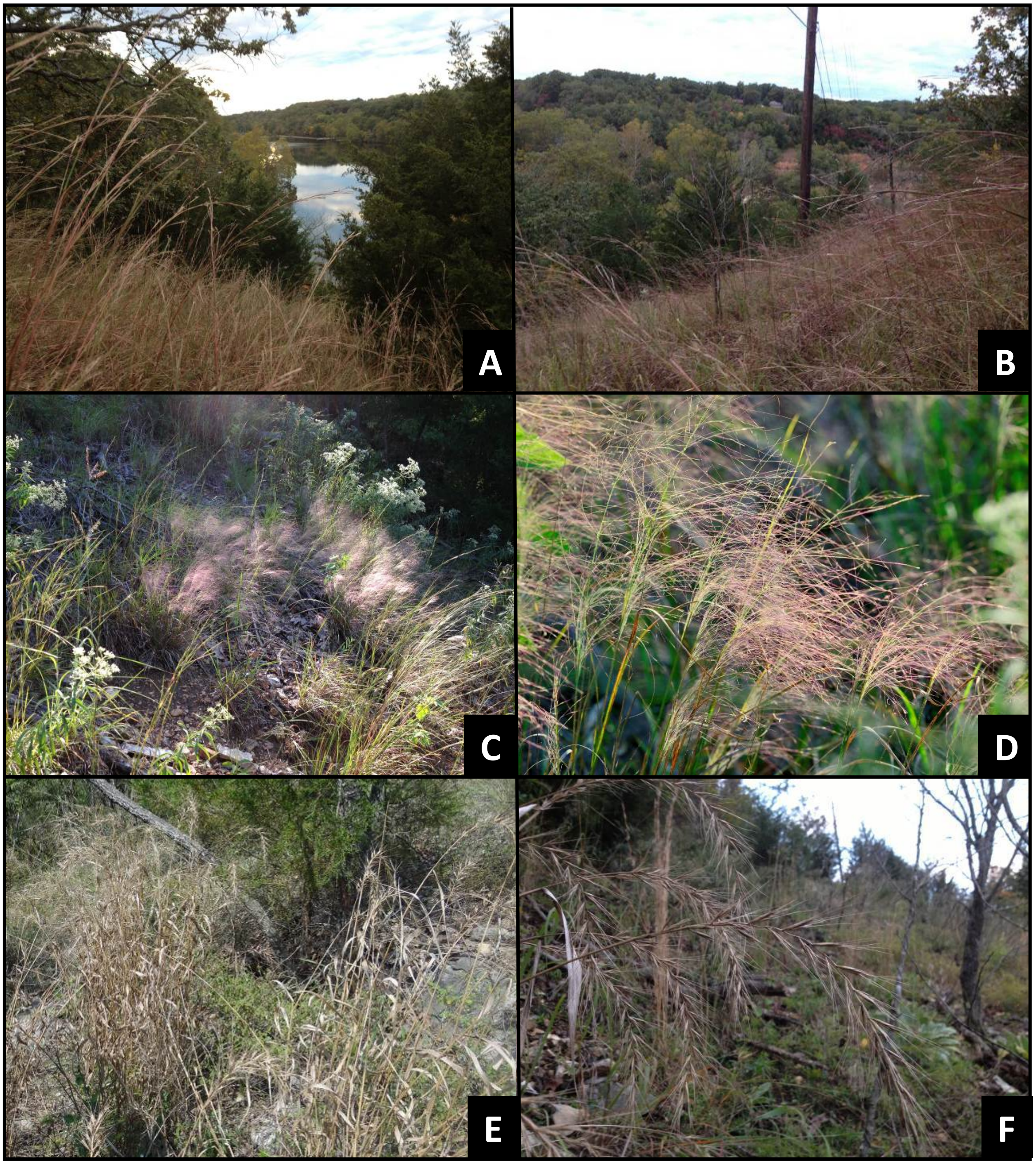

FIGURE 9. A. and **B.** Limestone glade on a hillside east of the Lake Atalanta dam. **C.** Hair-awn muhly grass (*Muhlenbergia capillaris*), also known as pink smoke grass, is an indicator of good quality glade and savanna habitat. Growing in limestone glades near the north end of Lake Atalanta. **D.** Detail of hair-awn muhly grass. Photo by David Oakley. **E.** Church's wild rye (*Elymus churchii*), a grass species described new-to-science in 2006 and known only from the mountains of Arkansas, Missouri, and Oklahoma. Growing in limestone glades and adjacent woodlands near the north end of Lake Atalanta. Photo by Joan Reynolds. **F.** Detail of Church's wild rye.

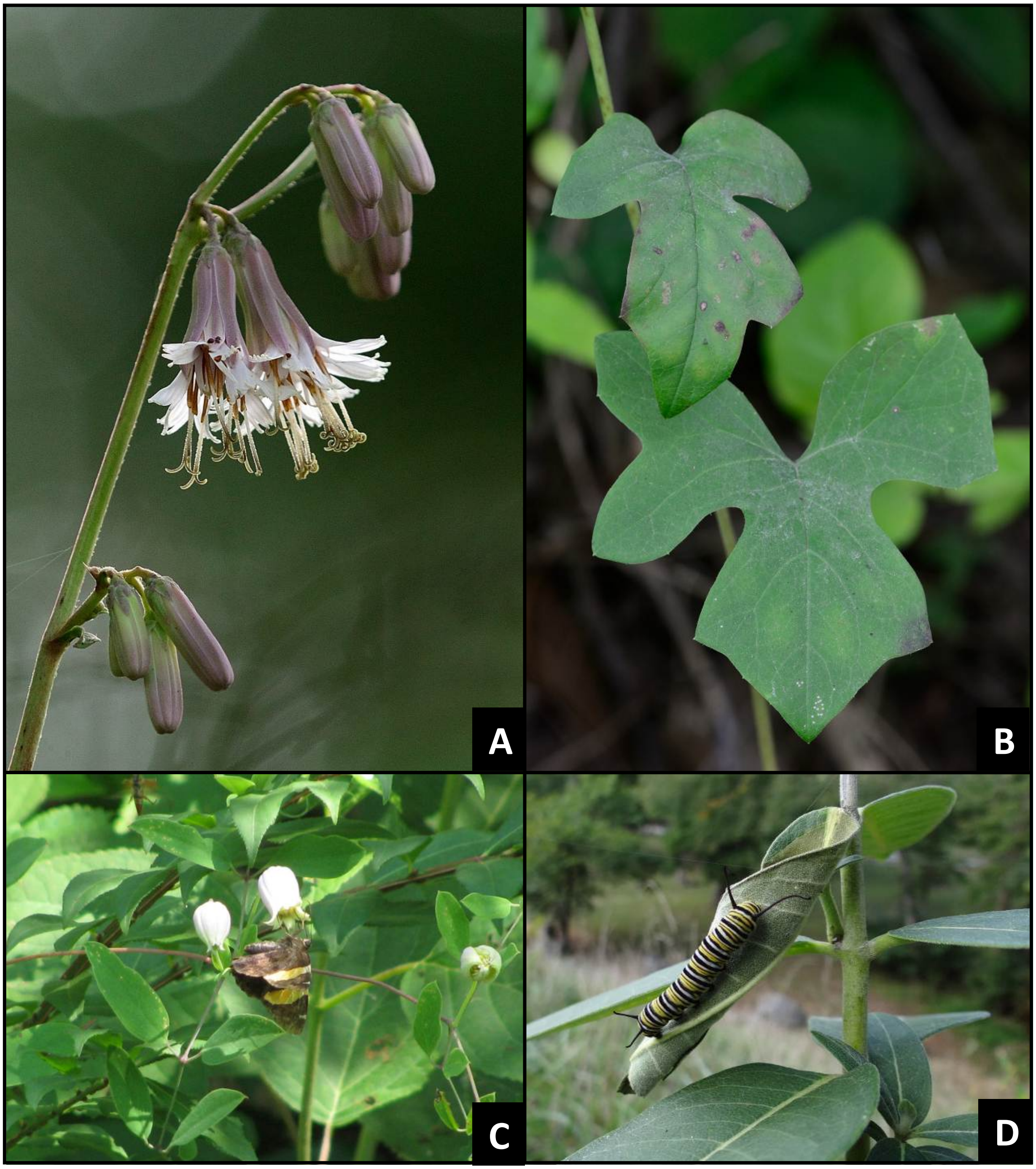

FIGURE 10. A. White rattlesnake-root (*Prenanthes alba*), a species of state conservation concern, growing on rocky limestone slopes above Lake Atalanta Road. Photo by David Oakley. **B.** Detail of white rattlesnake-root (*Prenanthes alba*) leaves, Lake Atalanta Park. Photo by David Oakley. **C.** Golden-banded Skipper (*Autochton cellus*) nectaring on pale leather-flower (*Clematis versicolor*) in glade above Lake Atalanta Road. Photo by Joan Reynolds. **D.** Caterpillar of the Monarch butterfly (*Danaus plexippus*) on its host plant purple milkweed (*Asclepias purpurascens*) east of the dam. Photo by Joan Reynolds.

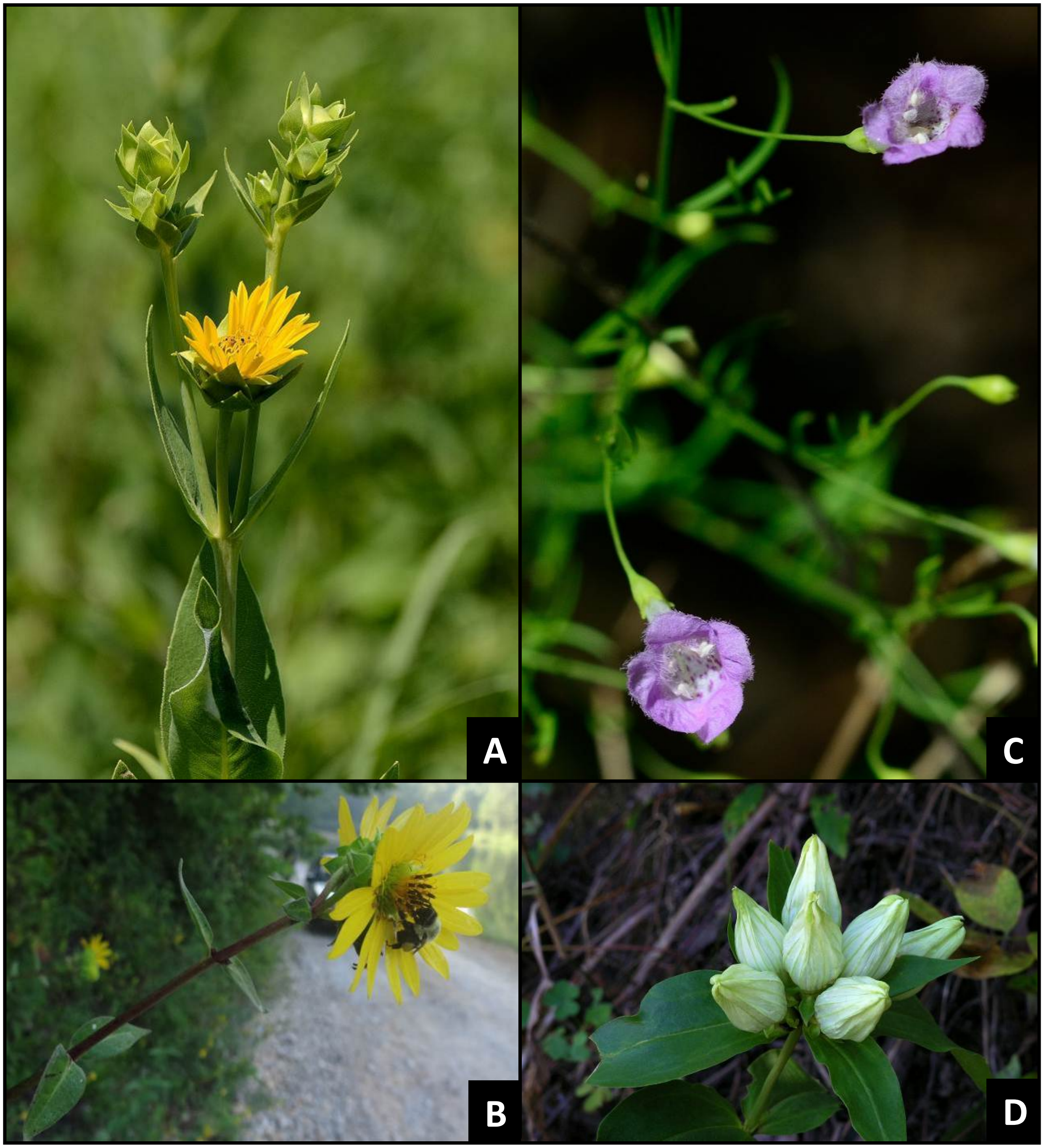

FIGURE 11. A. Smooth rosinweed (*Silphium integrifolium* var. *laeve*), a plant of state conservation concern found in Arkansas only at a few sites in Benton and Carroll counties. Photo by David Oakley. **B.** A bumblebee (*Bombus* sp.) pollinating smooth rosinweed along Lake Atalanta Road. Photo by Joan Reynolds. **C.** Gattinger's false foxglove (*Agalinis gattingeri*), a common species of dry open chert woodlands on upper slopes and ridges. Photo by David Oakley. **D.** Pale gentian (*Gentiana alba*), a species of state conservation concern, growing on a rocky limestone slope along Lake Atalanta Road. Photo by Craig Fraiser.

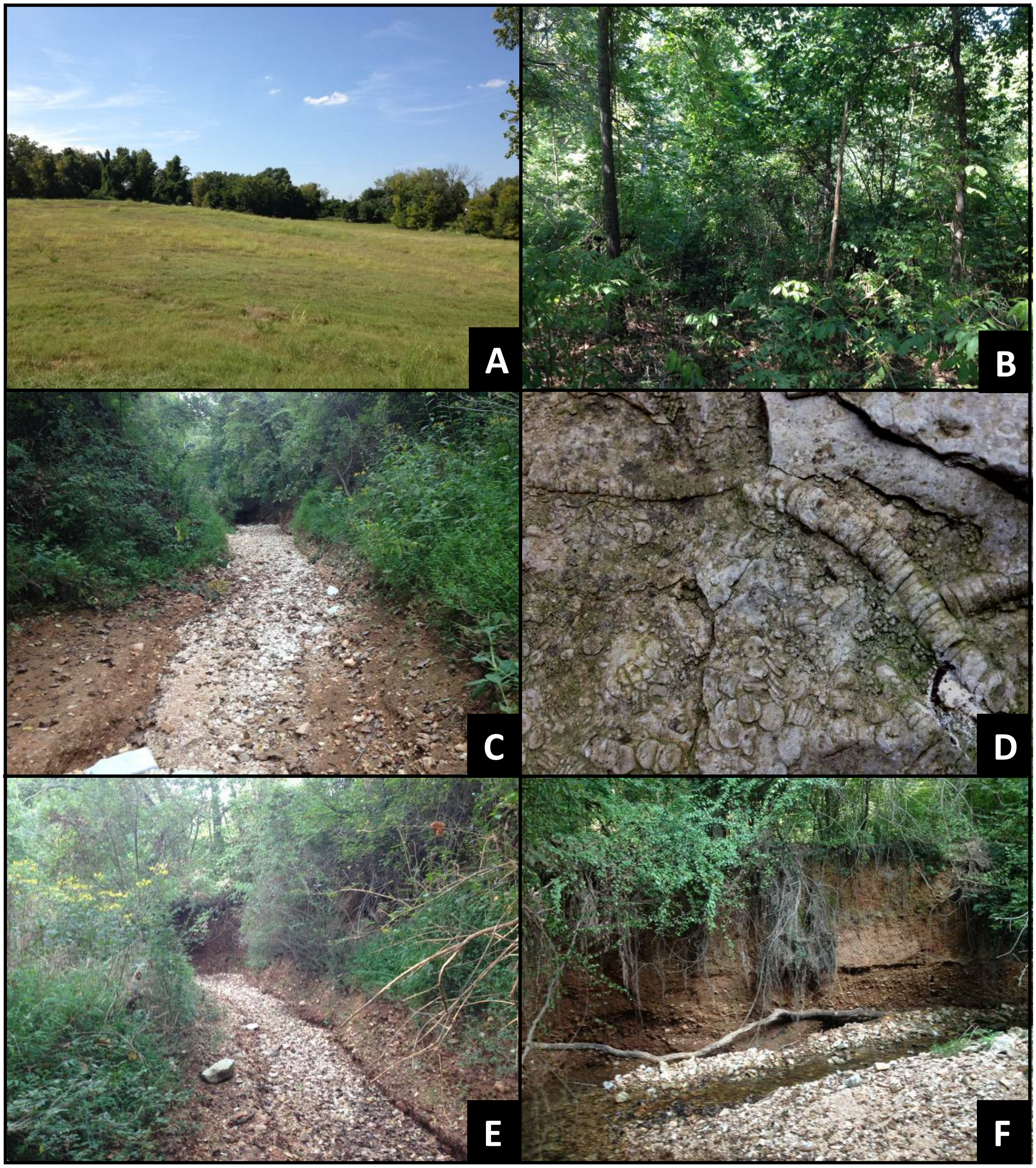

FIGURE 12. A. Upland field dominated by non-native grasses in the southwest part of the park. **B.** Degraded chert woodland with heavy encroachment by several non-native invasive shrubs and vines including burning-bush (*Euonymus alatus*), Chinese privet (*Ligustrum sinense*), Oriental bittersweet (*Celastrus orbiculatus*), and Japanese honeysuckle (*Lonicera japonica*). **C.** This losing stream south of Lake Atalanta is indicative of a karst landscape. **D.** Crinoid fossils in the Boone Limestone along a creek upstream from Lake Atalanta. **E.** Stream south of Lake Atalanta showing active downcutting. This small stream was incised more than eight feet deep in some places and smaller tributaries were actively head cutting in response. **F.** Same stream showing severe (and recent) bank erosion. Note exposed roots.

FIGURE 13. A. Powerline right-of-way dominated by two non-native invasive species: Japanese stilt grass (*Microstegium vimineum*) and beefsteak plant (*Perilla frutescens*). These and other invasive annual species have become dominant in rights-of-way where herbicide spraying has destroyed the native perennial herbaceous vegetation. **B.** Solid stand of beefsteak-plant in an herbicide-sprayed powerline right-of-way. **C.** Dense stand of kudzu (*Pueraria montana*) taking over a wooded upper slope south of the pavilion.

APPENDIX C: ECOLOGICALLY SIGNIFICANT AREAS AT LAKE ATALANTA PARK

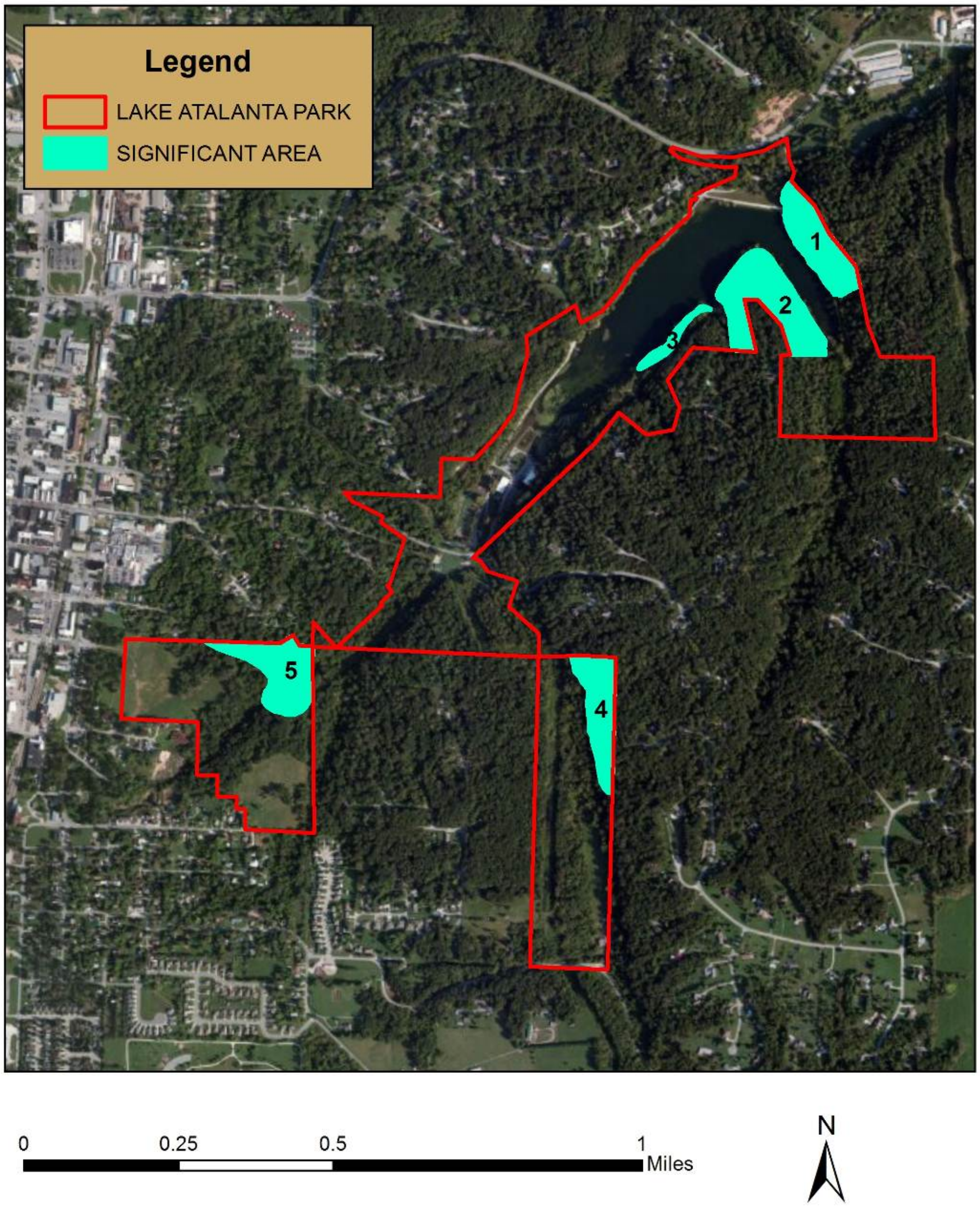

FIGURE 14. Map showing location of five Ecologically Significant Areas at Lake Atalanta Park. Map by Theo Witsell, Arkansas Natural Heritage Commission, 2013.

Ecologically Significant Areas

Five Ecologically Significant Areas were identified at Lake Atalanta Park during the rapid assessment. An Ecologically Significant Area is defined here as an area with relatively intact or high quality natural communities. These areas may include populations of species of conservation concern or may simply support relatively intact plant communities with high native species diversity and low levels of non-native invasive species. These may be thought of as those areas of the park that are the least altered in terms of their natural condition, most biologically diverse, and that would be the easiest to restore and maintain in good condition.

Identification of these five areas as Ecologically Significant Areas is not meant to indicate that other areas of the park are not ecologically significant or worthy of protection or management to enhance their natural values. In particular, there are other areas that support populations of plant species of conservation concern but that are not identified here as Ecologically Significant Areas due to their small size, altered condition, landscape context, or for other reasons.

This appendix contains descriptions and maps of each of these areas. Descriptions provide latitude and longitude coordinates of the centrum of each area followed by a justification of why they were deemed ecologically significant and a description of the plant community or communities present. Brief management recommendations are also provided for each area.

Two areas of Lake Atalanta Park support small areas of good quality limestone glade vegetation. Both occur on limestone and both are associated, at least partially, with powerline rights-of-way where the maintenance of open conditions has preserved open habitat for glade species. However, this is something of a mixed bag as the use of herbicides to maintain these open rights-of-way has been detrimental to some species and in some areas. Coordination with right-of-way managers is needed to ensure that the unique elements of these areas are preserved while still keeping the glade habitat (and the right-of-way) clear of trees. This can often be done by making minor adjustments in the way in which herbicides are applied and/or in the specific chemicals used.

SIGNIFICANT AREA 1: Centrum = 36.33943, -94.09424

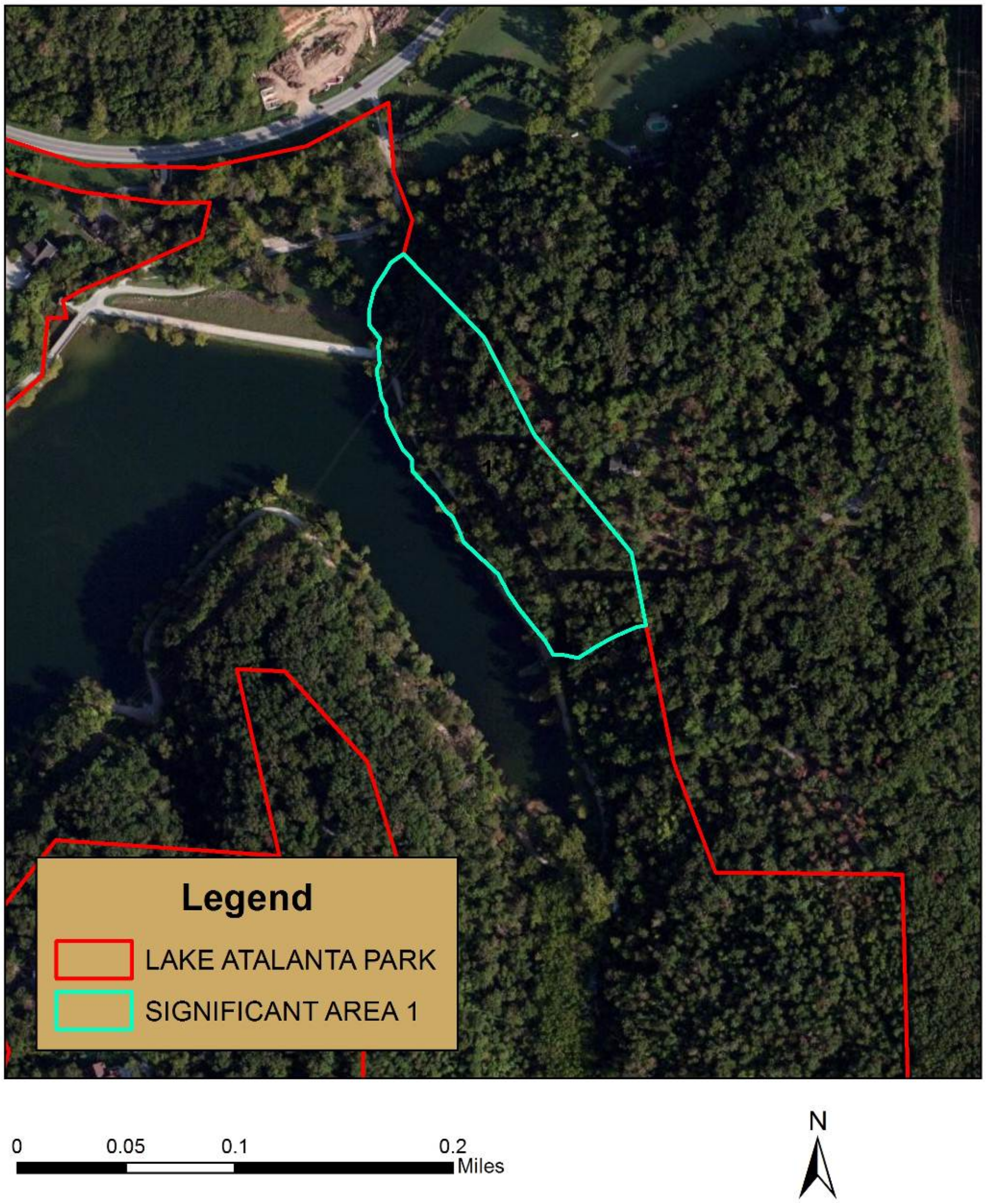

FIGURE 15. Map showing location of Significant Area 1. Map by Theo Witsell, ANHC, 2013.

SIGNIFICANT AREA 1: Centrum = 36.33943, -94.09424

This area includes the largest and most diverse pockets of limestone glade and woodland vegetation in the park (Figs. 8e, 8f, & Fig. 9) as well as good quality chert woodland. It also contains the highest concentration of rare plant species in the park, supporting at least four species listed as state species of conservation concern by the Arkansas Natural Heritage Commission. These are Church's wild rye (*Elymus churchii*), pale gentian (*Gentiana alba*), white rattlesnake-root (*Prenanthes alba*), and smooth rosinweed (*Silphium integrifolium* var. *laeve*). Details of the occurrence(s) of each are provided in Appendix D.

The geologic contact between the limestone and the overlying chert occurs near the upper edge of the main north-south trending powerline right-of-way that traverses the area. The slope below this contact is mostly underlain by limestone while the area above is entirely underlain by chert.

Limestone Glade and Woodland

The canopy layer of the limestone woodland consists mainly of scattered plants of chinquapin oak (*Quercus muehenbergii*), Shumard's oak (*Quercus shumardii*), and post oak (*Quercus stellata*). Glades support a few stunted examples of these species as well as scattered gum bumelia (*Sideroxylon lanuginosum*), white ash (*Fraxinus americana*), winged elm (*Ulmus alata*), dwarf hackberry (*Celtus tenuifolia*), and eastern redbud (*Cercis canadensis*). Eastern red-cedar (*Juniperus virginiana*) is also common in some areas.

Open areas are dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and side-oats grama (*Bouteloua curtipendula*). Other grasses include Indian grass (*Sorghastrum nutans*), switch grass (*Panicum virgatum*), three-flower melic grass (*Melica nitens*), purple-top tridens (*Tridens flavus* var. *flavus*), wiry witch grass (*Panicum flexile*), narrow-leaf rosette grass (*Dichanthelium aciculare*), hidden dropseed (*Sporobolus clandestinus*), tall dropseed (*Sporobolus compositus*), Ozark dropseed (*Sporobolus vaginiflorus* var. *ozarkanus*), hair-awn muhly (*Muhlenbergia capillaris*), and Church's wild rye (*Elymus churchii*). Forbs and other herbaceous plants present include blue waxweed (*Cuphea viscosissima*), purple-stem cliff-brake (*Pellaea atropurpurea*), goat's-rue (*Tephrosia virginiana*), snout-bean (*Rhynchosia latifolia*), yellow passion-flower (*Passiflora lutea*), one-seed mercury (*Acalypha monococca*), noseburn (*Tragia* sp.), slender mountain-mint (*Pycnanthemum tenuifolium*), narrow-leaf paleseed (*Leucospora multifida*), a rush (*Juncus secundus*), drooping bulrush (*Scirpus pendulus*), prairie-tea (*Croton monanthogynus*), flowering spurge (*Euphorbia corollata*), yellow false-foxglove (*Aureolaria grandiflora*), sensitive-brier (*Mimosa quadrivalvis* var. *nuttallii*), green-flower milkweed (*Asclepias viridiflora*), violet wood-sorrel (*Oxalis violacea*), diamond-flower (*Houstonia nigricans*), beaked panic grass (*Panicum anceps*), false spotted St. John's-wort (*Hypericum pseudomaculatum*), violet bush-clover (*Lespedeza frutescens*), wingstem crownbeard (*Verbesina helianthoides*), tall thistle (*Cirsium altissimum*), rough goldenrod (*Solidago radula*), common ragweed (*Ambrosia artemisiifolia*), false boneset (*Brickellia eupatorioides*), meadow-parsnip (*Thaspium chapmannii*), white-wand beardtongue (*Penstemon tubiflorus*), and rabbit-tobacco (*Pseudognaphalium obtusifolium*).

Downslope, toward Lake Atalanta Road, the woodland becomes more mesic and species diversity increases, adding species like winecup (*Callirhoe digitata*), prairie-dock (*Silphium terebinthinaceum*), starry rosinweed (*Silphium asteriscus*), smooth aster (*Symphyotrichum laeve*), pale gentian (*Gentiana alba*), white rattlesnake-root (*Prenanthes alba*), smooth rosinweed (*Silphium integrifolium* var. *laeve*), and many more. The slope immediately above the road through this area is one of the richest areas for plant viewing in the park.

Chert Woodland

The part of this area above the powerline supports acidic chert woodland dominated by black oak (*Quercus velutina*), white oak (*Quercus alba*), and post oak (*Quercus stellata*) with some blackjack oak (*Quercus marilandica*). The understory consists primarily of flowering dogwood (*Cornus florida*), white ash (*Fraxinus americana*), Carolina buckthorn (*Frangula caroliniana*), and winged elm (*Ulmus alata*). The ground cover is characteristic of acid woodlands and includes low-bush blueberry (*Vaccinium pallidum*), deerberry (*Vaccinium stamineum*), forked rosette grass (*Dichanthelium dichotomum*), Bosc's rosette grass (*Dichanthelium boscii*), dittany (*Cunila origanoides*), hawkweed (*Hieracium gronovii*), oldfield goldenrod (*Solidago nemoralis*), Muhlenberg's sedge (*Carex muehlenbergii* var. *enervis*), and several species of native bush-clovers (*Lespedeza* spp.) and tick-trefoils (*Desmodium* spp.). Few invasive species are present though several large eastern white pine (*Pinus strobus*) trees are present in the canopy in one area. This species is not native to Arkansas and these trees must have been planted, or naturalized from planted trees, long ago.

Management Recommendations

Though this site would get the most benefit from periodic prescribed burning, this may be difficult due to its location and landscape context.

In the absence of fire, cutting and removal of cedar trees would help to restore open conditions to the glades and woodlands. These cedars occur in close enough proximity to the lake that they could probably be dragged down to the shore, wired to cinder blocks, and sunk into the lake for fish habitat. The ANHC has found this to be an excellent project for volunteers at Devil's Eyebrow Natural Area on the north end of Beaver Lake. Following cedar removal, control of some of the smaller hardwood trees and shrubs should be considered. Unlike cedars, which do not re-sprout after cutting, the stumps of hardwoods will need to be carefully treated with herbicide to prevent re-sprouting.

The portions of the glades under the powerlines have a diverse grass component but few broadleaf forbs. This indicates that the right-of-way may have been sprayed with a broadleaf-specific herbicide to control woody vegetation. Rather than broadcast-spraying the right-of-way through this area, or even spot spraying shrubs with a foliar spray, a more delicate approach would be to cut the woody vegetation and then treat the stump directly with herbicide. This reduces overspray and thus collateral damage to desirable broadleaf glade species.

Infrastructure planning should take into account the locations of rare plant species and route trails away from them to the extent possible. In addition, because there are rare species in the roadside along Lake

Atalanta Road in this area, compatible roadside vegetation management is critical. Broadcast spraying of herbicides should be avoided in this area and vegetation management should be by mechanical treatment only. Furthermore, mowing or weed-eating should be timed to allow rare species to flower and make seed if possible.

Unfortunately, a number of invasive plant species have become established, primarily on the lower slope above Lake Atalanta Road. These include tree-of-heaven (*Ailanthus altissima*), Oriental bittersweet (*Celastrus orbiculatus*), and Japanese honeysuckle (*Lonicera japonica*). These species should be controlled by mechanical treatment, or by a mix of mechanical treatment and very careful use of herbicide so that desirable and rare species are not harmed in the process. Reduction of the park's deer herd would also benefit the native flora in this area.

SIGNIFICANT AREA 2: Centrum = 36.33838, -94.09591.

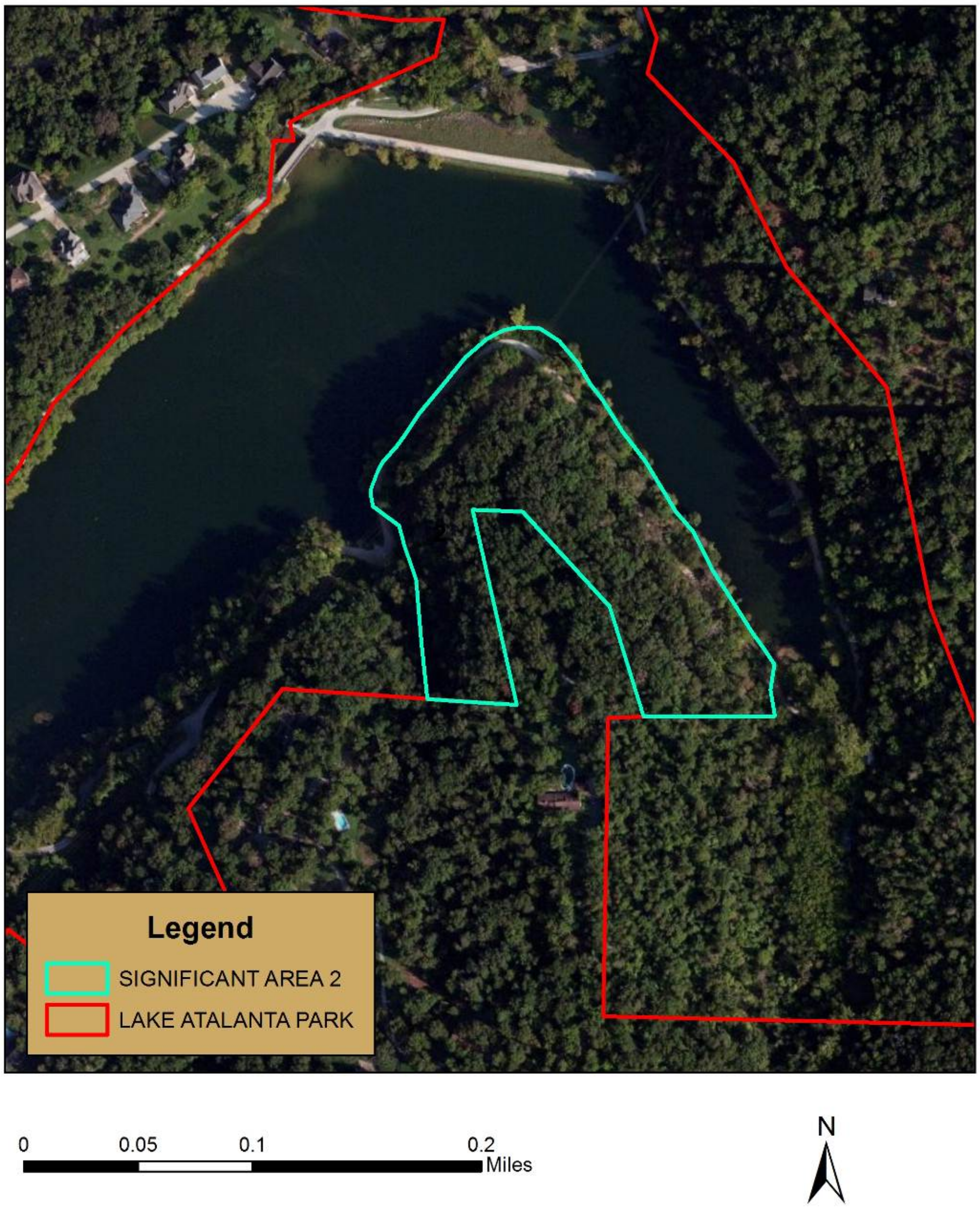

FIGURE 16. Map showing location of Significant Area 2. Map by Theo Witsell, ANHC, 2013.

SIGNIFICANT AREA 2: Centrum = 36.33838, -94.09591.

This area contains good representations of several communities including limestone glade and woodland, chert woodland, and mesic slope forest. It also contains a population of white rattlesnake-root (*Prenanthes alba*), a species of conservation concern.

Limestone Glade and Woodland

An area of glade vegetation is centered on a steep southwest-facing slope above Lake Atalanta Road, just northeast of a small cove in the lake (centrum = 36.33808, -94.09686.). The area under the powerline supports most of the remaining glade flora but the adjacent woodlands also support some species. The most diverse area is on steep slope under the powerline where there are limestone outcrops above the road. Here the herbaceous layer is dominated by little blustem (*Schizachyrium scoparium*) with an abundance of big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and tall thoroughwort (*Eupatorium altissimum*). Other species include hidden dropseed (*Sporobolus clandestinus*), hair-awn muhly (*Muhlenbergia capillaris*), New Jersey-tea (*Ceanthothus americanus*), wingstem crownbeard (*Verbesina helianthoides*), hairy wild petunia (*Ruellia humilis*), oldfield goldenrod (*Solidago nemoralis*), green-flower milkweed (*Asclepias viridiflora*), marbleseed (*Onosmodium bejariense* var. *subsetosum*), Scribner's rosette grass (*Dichanthelium oligosanthes* subsp. *scribnerianum*), late purple aster (*Symphyotrichum patens*), white prairie-clover (*Dalea candida*), purple prairie-clover (*Dalea purpurea*), prairie-tea (*Croton monanthogynus*), wiry witch grass (*Panicum flexile*), purple-top tridens (*Tridens flavus* var. *flavus*), side-oats grama (*Bouteloua curtipendula*), and yellow passion-flower (*Passiflora lutea*). The canopy of the adjacent woodland associated with this limestone glade area is primarily Shumard's oak (*Quercus shumardii*) and chinquapin oak (*Quercus muehlenbergii*).

Chert Woodland

The more gentle areas upslope of the limestone outcrops are underlain by chert and acid-loving shrubs such as farkleberry (*Vaccinium arboreum*) and low-bush blueberry (*Vaccinium pallidum*) are common here. Dominance in the herbaceous layer shifts to big bluestem (*Andropogon gerardii*) and little blustem (*Schizachyrium scoparium*) with variable rosette grass (*Dichanthelium commutatum*), forked rosette grass (*Dichanthelium dichotomum*), sensitive-brier (*Mimosa quadrivalvis* var. *nuttallii*), goat's-rue (*Tephrosia virginiana*), and hawkweed (*Hieracium gronovii*). The canopy here is dominated by black oak (*Quercus velutina*), mockernut hickory (*Carya alba*), and white oak (*Quercus alba*).

Mesic Forest

The eastern part of this area consists of a northeast-facing slope covered by a mesic hardwood forest with a rich ground flora. It includes a population of white rattlesnake-root (*Prenanthes alba*), a species of conservation concern, located on the slopes above and below Lake Atalanta Road. Other mesic forest species present include Solomon's-seal (*Polygonatum biflorum*), wild geranium (*Geranium maculatum*), large-flower bellwort (*Uvularia grandiflora*), meadow-parsnip (*Thaspium trifoliatum*), goat's-beard (*Aruncus dioicus*), wreath goldenrod (*Solidago caesia*), wild hydrangea (*Hydrangea arborescens*), blue wood aster (*Symphyotrichum drummondii*), hazelnut (*Corylus americana*), and black cohosh (*Actaea racemosa*).

Management Recommendations

Though this site would get the most benefit from periodic prescribed burning, this may be difficult due to its location and landscape context.

In the absence of fire, cutting and removal of cedar trees would help to restore open conditions to the glades and woodlands. These occur in close enough proximity to the lake that they could probably be dragged down to the shore, wired to cinder blocks, and sunk into the lake for fish habitat. The ANHC has found this to be an excellent project for volunteers at Devil's Eyebrow Natural Area on the north end of Beaver Lake. Following cedar removal, control of some of the smaller hardwood trees and shrubs should be considered. Unlike cedars, which do not re-sprout after cutting, the stumps of hardwoods will need to be carefully treated with herbicide to prevent re-sprouting.

The portions of the glades under the powerlines have a diverse grass component but few broadleaf forbs. This indicates that the right-of-way may have been sprayed with a broadleaf-specific herbicide to control woody vegetation. Rather than broadcast-spraying the right-of-way through this area, or even spot spraying shrubs with a foliar spray, a more delicate approach would be to cut the woody vegetation and then treat the stump directly with herbicide. This reduces overspray and thus collateral damage to broadleaf glade species.

Other invasive species should also be controlled in a manner that will not adversely impact desirable native species in this area. Reduction of the park's deer herd would also benefit the native flora in this area.

SIGNIFICANT AREA 3: Centrum = 36.33719, -94.09836

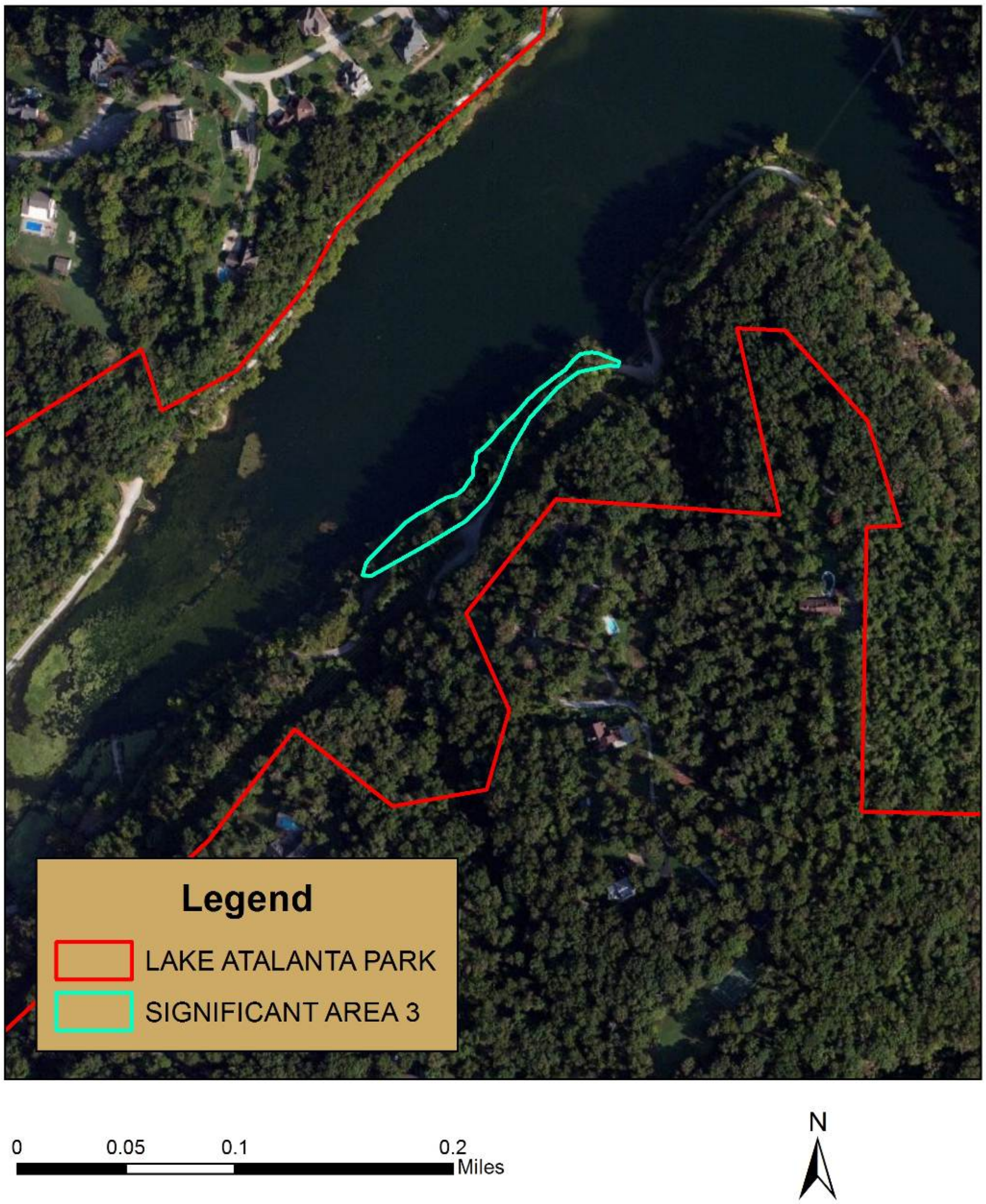

FIGURE 17. Map showing location of Significant Area 3. Map by Theo Witsell, ANHC, 2013.

SIGNIFICANT AREA 3: Centrum = 36.33719, -94.09836

Chert Woodland and Barrens

This unusual natural community (Fig. 5) is found on a moderately steep northwest-facing slope between two small coves on the east side of Lake Atalanta, between Lake Atalanta Road and the shore of the lake (centrum = 36.33668, -94.09905). Soils in this area are very thin and consist mostly of broken chert rubble over acidic clay. It is possible that this community represents an extremely open phase of the surrounding chert woodland or that past human activities related to the construction of Lake Atalanta contributed to its development. Whatever its origin, it is a unique area with a diverse native flora containing several species that were not found elsewhere in the park. For lack of a better term, I am calling it a "chert barrens" here.

This community has a few scattered trees and shrubs; mostly black-gum (*Nyssa sylvatica*), rusty blackhaw (*Viburnum rufidulum*), hazelnut (*Corylus americana*), American holly (*Ilex opaca*), deerberry (*Vaccinium stamineum*), and fragrant sumac (*Rhus aromatica*), but is mostly open grassland dominated by little bluestem (*Schizachyrium scoparium*) and Indian grass (*Sorghastrum nutans*) with high forb diversity. Common herbaceous species include dittany (*Cunila origanoides*), wild quinine (*Parthenium integrifolium*), flowering spurge (*Euphorbia corollata*), hairy goldenrod (*Solidago hispida*), rattlesnake-master (*Eryngium yuccifolium*), white-leaf mountain-mint (*Pycnanthemum albescens*), slender bush-clover (*Lespedeza virginica*), hairy bush-clover (*Lespedeza hirta*), beebalm (*Monarda fistulosa*), late purple aster (*Symphyotrichum patens*), manyray aster (*Symphyotrichum anomalum*), white woodland aster (*Symphyotrichum lateriflorum*), trailing bush-clover (*Lespedeza procumbens*), big bluestem (*Andropogon gerardii*), tall tickseed (*Coreopsis tripteris*), star tickseed (*Coreopsis pubescens*), oldfield goldenrod (*Solidago nemoralis*), panicled tick-trefoil (*Desmodium paniculatum*), hairy woodland sunflower (*Helianthus hirsutus*), false boneset (*Brickellia eupatorioides*), tall thoroughwort (*Eupatorium altissimum*), poverty oat grass (*Danthonia spicata*), southeastern wild rye (*Elymus glabriflorus*), goat's-rue (*Tephrosia virginiana*), downy milk-pea (*Galactia volubilis*), wingstem crownbeard (*Verbesina helianthoides*), Maryland tick-trefoil (*Desmodium marilandicum*), tick-trefoil (*Desmodium perplexum*), rock muhly (*Muhlenbergia sobolifera*), woodland muhly (*Muhlenbergia sylvatica*), Canada wild lettuce (*Lactuca canadensis*), Baldwin's ironweed (*Vernonia baldwinii*), prairie rose (*Rosa setigera*), rough blazing-star (*Liatris aspera*), and violet bush-clover (*Lespedeza frutescens*). It is surrounded by more typical chert woodland.

Non-native invasive species are remarkably sparse in this area as compared to much of the park. The most common ones in this area are Oriental bittersweet (*Celastrus orbiculatus*) and sericea lespedeza (*Lespedeza cuneata*). Both could be controlled here without an excessive amount of effort or expense.

Management Recommendations

Prescribed burning should be considered as a management option for this area. It is well-suited to this management with a road above and lakeshore below to serve as fire breaks.

In the absence of fire, removal of some of the smaller hardwood trees and shrubs should be considered. Unlike cedars, which do not re-sprout after cutting, the stumps of hardwoods will need to be carefully treated with herbicide to prevent re-sprouting.

Oriental bittersweet, sericea lespedeza, and other invasive species should also be controlled in a manner that will not adversely impact desirable native species in this area. Reduction of the park's deer herd would also benefit the native flora in this area.

SIGNIFICANT AREA 4: Centrum = 36.32833, -94.10032

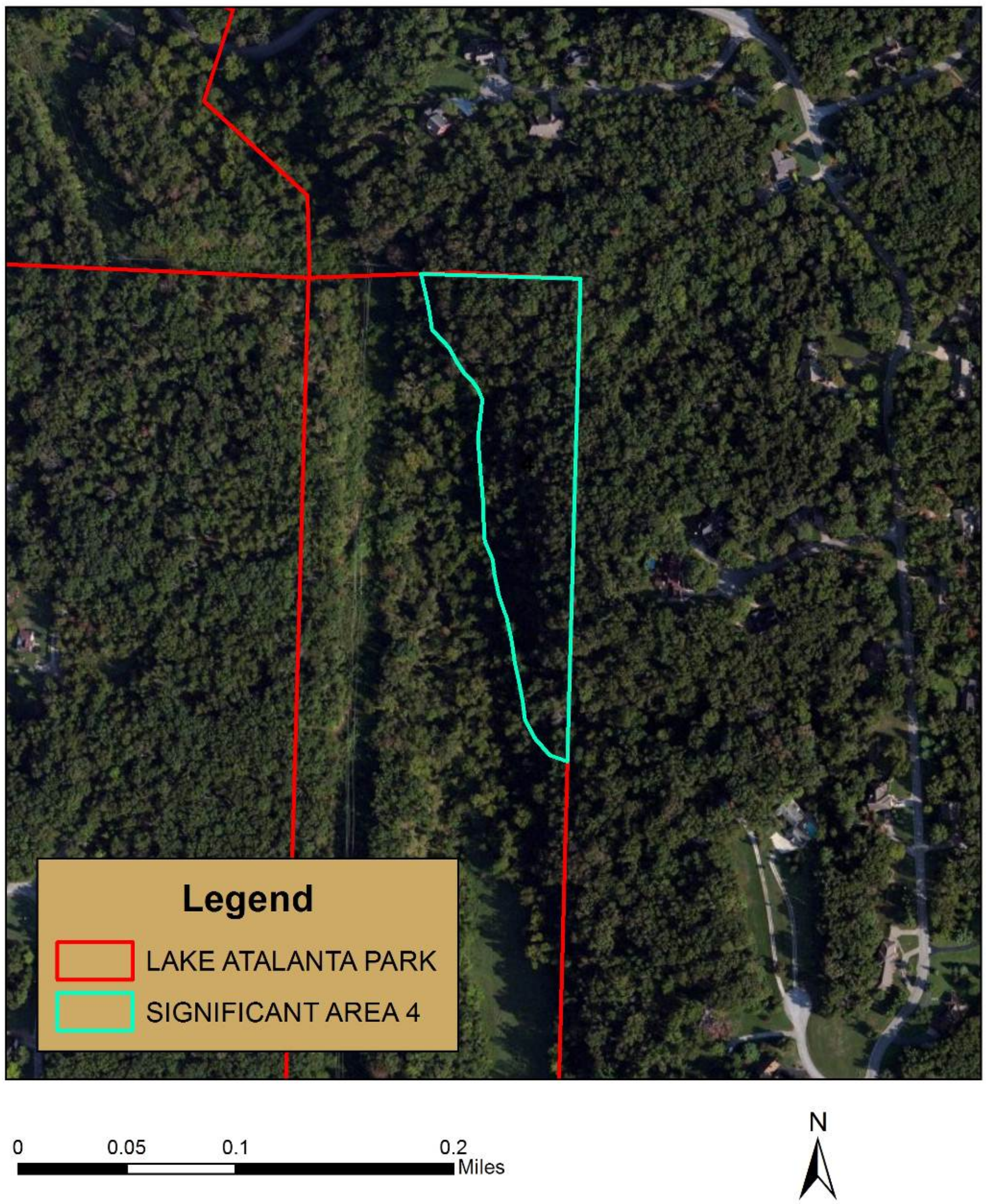

FIGURE 18. Map showing location of Significant Area 4. Map by Theo Witsell, ANHC, 2013.

SIGNIFICANT AREA 4: Centrum = 36.32833, -94.10032

This area extends from the east edge of a weedy forested stream terrace (formerly cleared) up a west-facing slope to the park boundary and includes some of the best chert woodland remaining in the park. Part way up this slope is a low limestone outcrop and above this is chert woodland.

Chert Woodland

Above the limestone outcrop is an area of good quality chert woodland (Fig. 4a). The canopy is dominated by large, well-spaced white oak (*Quercus alba*) and black oak (*Quercus velutina*) trees, with an understory of black-gum (*Nyssa sylvatica*), Carolina buckthorn (*Frangula caroliniana*), and flowering dogwood (*Cornus florida*). The understory is overly dense in some areas but most of the chert woodland here is relatively open with a sparse but native understory containing a few scattered plants of sun-loving species like big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Arkansas bedstraw (*Galium arkansanum*), hawkweed (*Hieracium gronovii*), and bird's-foot violet (*Viola pedata*). There are remarkably few invasive species present though several small patches of Japanese stilt grass (*Microstegium vimineum*) were observed.

Mesic Hardwood Forest

In the northern part of this area there is a small west-flowing drainage containing an ephemeral creek with a limestone bottom (Fig. 8a & 8b). Centrum coordinates = 36.32898, -94.10032. Unlike most of the other creeks in this area, which have a chert bottom and are badly incised, this small hollow appears to be relatively hydrologically intact (perhaps due to the presence of the limestone bedrock preventing head cutting). The slopes on the sides of this hollow are moderately steep and support a mesic hardwood forest with surprisingly few invasive plant species. Understory species present in the fall include northern maidenhair fern (*Adiantum pedatum*), Christmas fern (*Polystichum acrostichoides*), and spicebush (*Lindera benzoin*). This area may have a diverse assemblage of Spring-blooming wildflowers and should be surveyed during that season.

Management Recommendations

Though this site would get the most benefit from periodic prescribed burning, this may be difficult due to its location and landscape context.

In the absence of fire, removal of some of the smaller hardwood trees and shrubs in the chert woodland might be considered. Unlike cedars, which do not re-sprout after cutting, the stumps of hardwoods will need to be carefully treated with herbicide to prevent re-sprouting.

Patches of Japanese stilt grass should be sprayed with herbicide before they make seed in the fall. Other invasive species should also be controlled in a manner that will not adversely impact desirable native species in this area. Reduction of the park's deer herd would also benefit the native flora in this area.

SIGNIFICANT AREA 5: Centrum = 36.32926, -94.10945

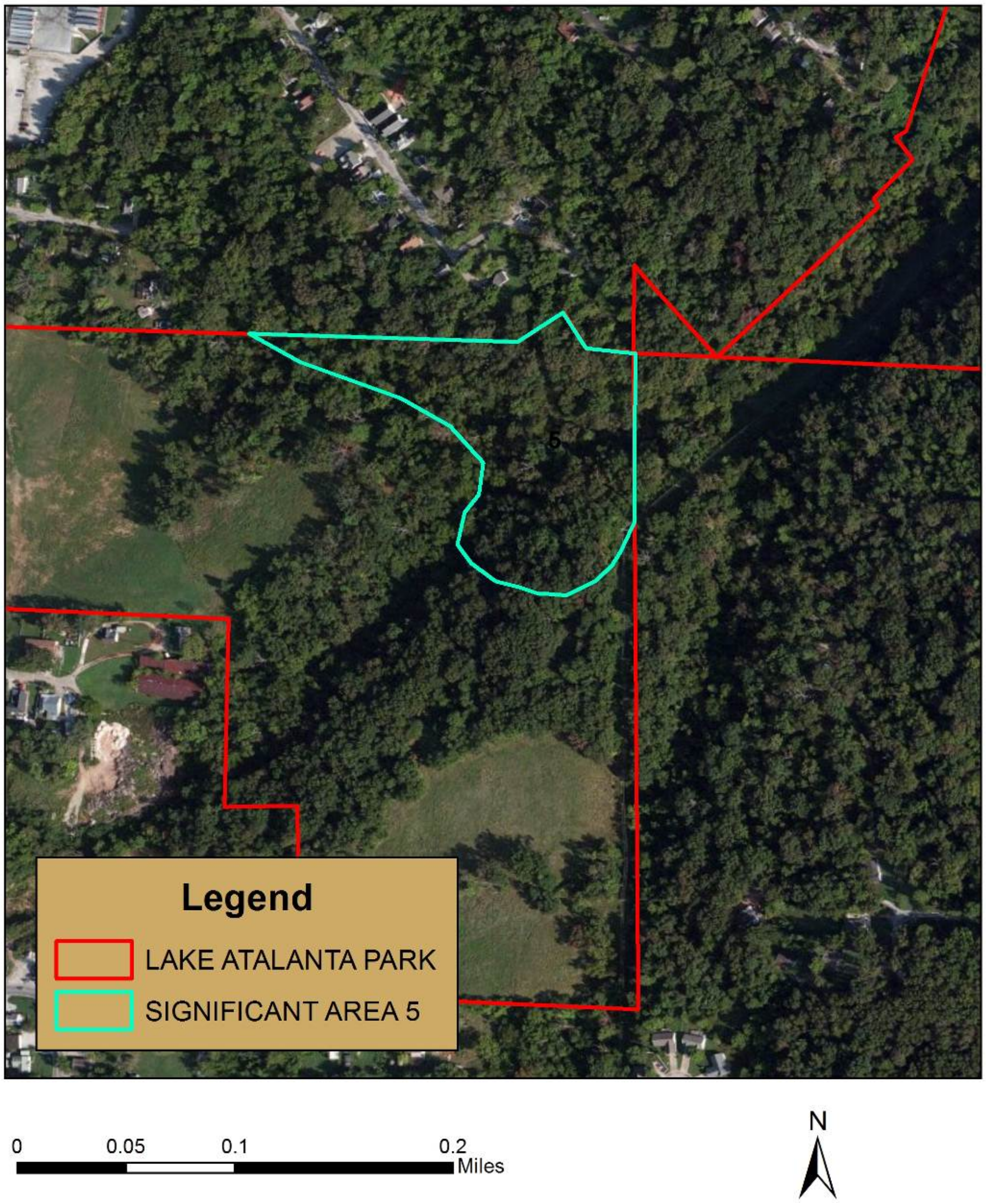

FIGURE 19. Map showing location of Significant Area 5. Map by Theo Witsell, ANHC, 2013.

SIGNIFICANT AREA 5: Centrum = 36.32926, -94.10945

This area contains relatively good quality chert woodlands, mesic slope and riparian forest, and supports populations of two rare plant species: Ozark trillium (*Trillium ozarkanum*) (Figs. 4c & 4d), and taper-tip wild ginger (*Asarum canadense* var. *acuminatum*) (Fig. 8c & 8d). Details of the occurrence(s) of each of these species are provided in Appendix D.

Chert Woodland

Uplands in the southern part of this area support good quality chert woodland habitat (Fig. 4a) and are home to the only population of Ozark trillium (*Trillium ozarkanum*), a globally-rare plant species, known in the park. The canopy is dominated by large, well-spaced white oak (*Quercus alba*) and black oak (*Quercus velutina*) trees, with an understory of sassafras (*Sassafras albidum*), black cherry (*Prunus serotina*), flowering dogwood (*Cornus florida*), and spicebush (*Lindera benzoin*). The understory is overly dense in some areas but most of the chert woodland here is relatively open with a mostly native understory containing species characteristic of acidic chert woodlands like mayapple (*Podophyllum peltatum*), tick-trefoils (*Desmodium* spp.) and blueberries (*Vaccinium* spp.). There are not as many invasive species present here as there are in most areas of the park though there is a fair amount of Oriental bittersweet (*Celastrus orbiculatus*).

Mesic Hardwood Forest

North of the chert woodland with the Ozark trillium, two streams converge in a mesic limestone hollow that supports mesic hardwood forest with understory species including Virginia waterleaf (*Hydrophyllum virginianum*), wild blue phlox (*Phlox divaricata* subsp. *laphamii*), northern maidenhair fern (*Adiantum pedatum*), southern bladder fern (*Cystopteris protrusa*), Christmas fern (*Polystichum acrostichoides*), and spicebush (*Lindera benzoin*). This area is one of two sites in the park for taper-tip wild ginger (*Asarum canadense* var. *acuminatum*), a very rare species in Arkansas. This area may also have a diverse assemblage of Spring-blooming wildflowers and should be surveyed during that season. Unfortunately a number of invasive plant species are found in this hollow including Oriental bittersweet (*Celastrus orbiculatus*), Japanese stilt grass (*Microstegium vimineum*), burningbush (*Euonymus alatus*), wintercreeper (*Euonymus fortunei*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and others.

Management Recommendations

Infrastructure planning should take into account the locations of rare plant species and route trails away from them to the extent possible.

Invasive species in this area should be controlled in a manner that will not adversely impact desirable native species in this area. This would be a good area in which to focus volunteer invasive species control efforts. Reduction of the park's deer herd would also benefit the native flora in this area.

APPENDIX D: SPECIES OF CONSERVATION CONCERN FOUND AT LAKE ATALANTA PARK

The following species occurring at Lake Atalanta Park have been identified by the Arkansas Natural Heritage Commission as being of conservation concern in Arkansas. Each species is presented with general information on its range and habitat followed by specific information on populations found at Lake Atalanta Park. Each species is also given along with its global (G) and state (S) conservation status ranks. A legend explaining these rank codes is provided in appendix E.

1) **Ozark Trillium (*Trillium ozarkanum*) – G3S3**
2) **White Rattlesnake-root (*Prenanthes alba*) – G5S1S2**
3) **Pale Gentian (*Gentiana alba*) – G4S1**
4) **Church's Wild Rye (*Elymus churchii*) – G2G3S2?**
5) **Taper-tip Wild Ginger (*Asarum canadense* var. *acuminatum*) – G5TNRS1**
6) **Smooth Rosinweed (*Silphium integrifolium* var. *laeve*) – G5T4?S1**
7) **Slender Nettle (*Urtica gracilis*) – G5S1**

Ozark Trillium (*Trillium ozarkanum*) – G3S3

Ozark trillium (Figs. 4c & 4d) is found only in the Ozark Plateau and Ouachita Mountains of Arkansas, Missouri, and Oklahoma and is a species of conservation concern in all of these states. It is typically found in acidic woodlands on chert substrates and is one of the first woodland wildflowers to bloom in the Spring, beginning to flower in early March in some years. A single population is known from Lake Atalanta Park, which I observed on 15 May 2011 on a field trip with the Arkansas Native Plant Society. However, much additional suitable habitat for the species occurs in the park and should be surveyed for Ozark trillium between March and June, when plants are observable.

SITE 1: Centrum = 36.32871, -94.10900; Upslope edge of population = 36.32868, -94.10899; Downslope edge of population = 36.32874, -94.10902

Several hundred plants were observed on 15 May 2011 on both sides of a spur trail 0.35 mile S of E. Walnut Street. Habitat is an open, northwest-facing dry-mesic forest on chert substrate, dominated by white oak (*Quercus alba*) and black oak (*Quercus velutina*). Associate species include Oriental bittersweet (*Celastrus orbiculatus*), mayapple (*Podophyllum peltatum*), spicebush (*Lindera benzoin*), Virginia-creeper (*Parthenocissus quinquefolia*), and sassafras (*Sassafras albidum*). The population extends 25 feet upslope from bottom to top and extends away from trail in both directions (exact limits were not mapped on this axis).

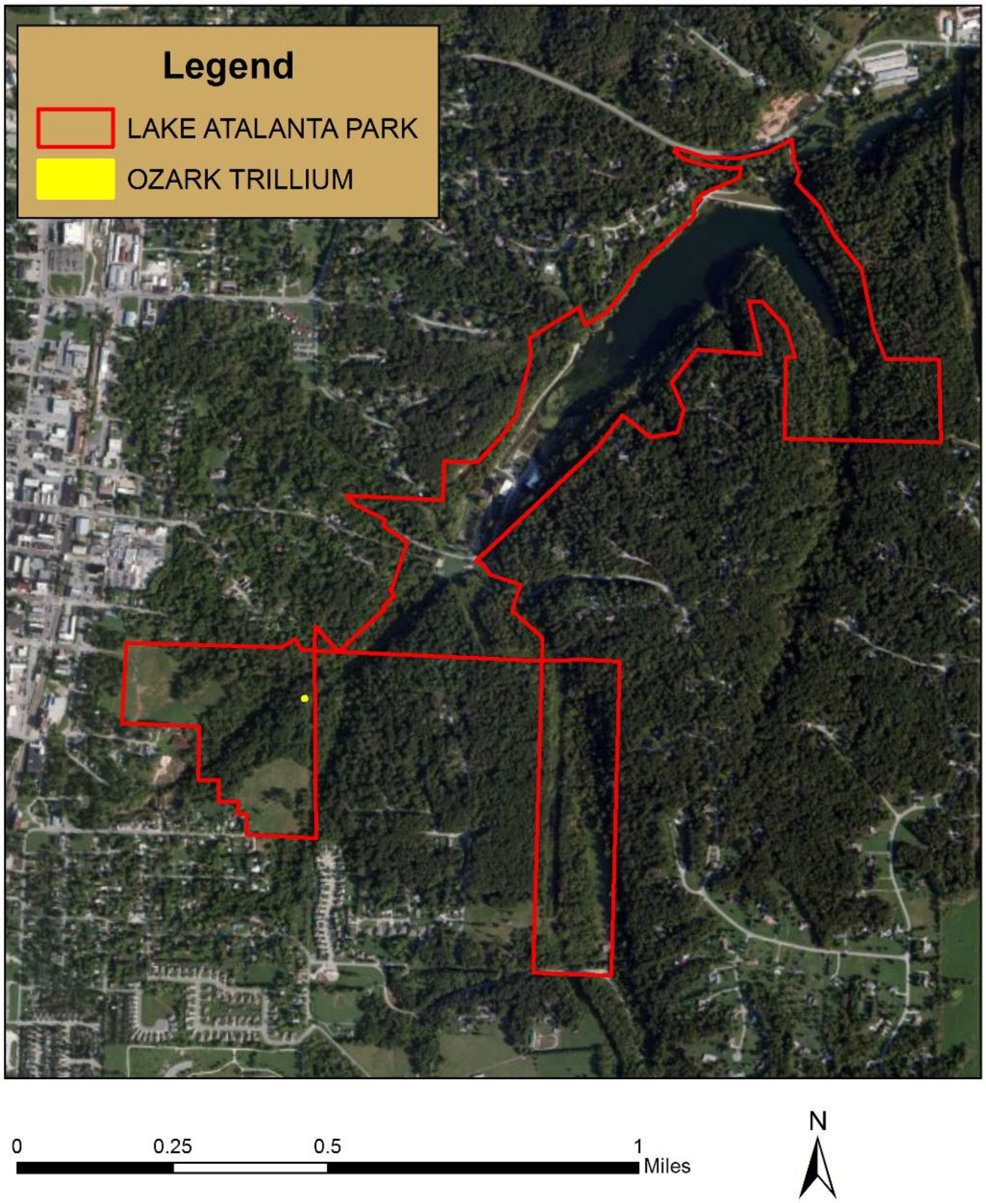

FIGURE 20. Map showing location of Ozark trillium at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

White Rattlesnake-root (*Prenanthes alba*) – G5S1S2

White rattlesnake-root (Figs. 10a & 10b) is a northern species with its main range in the Midwest (where it occurs from central Illinois and southern Iowa north) and in the Appalachians (where it occurs from Virginia and West Virginia north). It is rare in northwestern Arkansas where it is disjunct from its main range and is known from only a few populations. It is identified as a species of state conservation concern by the Arkansas Natural Heritage Commission. As is common with other species in the genus *Prenanthes*, only a small percentage of plants in a population typically flower in a given year and since sterile (non-flowering) plants typically go dormant in the summer, populations discovered in the late summer or fall may be larger than they appear. White rattlesnake-root is known from two areas at Lake Atalanta Park:

SITE 1: Centrum = 36.33778, -94.09476

15 to 20 sterile plants were observed on a rich, northeast-facing slope above Lake Atalanta Road on 15 May 2011. This population extends downslope of the road where a single plant was observed in fruit just above water line on 18 October 2013 in the vicinity of 36.33805, -94.09478. Associate species include Solomon's-seal (*Polygonatum biflorum*), wild geranium (*Geranium maculatum*), large-flower bellwort (*Uvularia grandiflora*), meadow-parsnip (*Thaspium trifoliatum*), goat's-beard (*Aruncus dioicus*), wreath goldenrod (*Solidago caesia*), wild hydrangea (*Hydrangea arborescens*), smooth sumac (*Rhus glabra*), blue wood aster (*Symphyotrichum drummondii*), hazelnut (*Corylus americana*), flowering dogwood (*Cornus florida*), Carolina buckthorn (*Frangula caroliniana*), black cohosh (*Actaea racemosa*), and tall tickseed (*Coreopsis tripteris*). Additional plants are likely present in this area.

SITE 2: Centrum = 36.34003, -94.09495

40 to 50 sterile plants were observed above Lake Atalanta Road just east of the Lake Atalanta dam on 15 May 2011 and a single fruiting plant and several sterile ones were observed here on 10 & 11 September 2013. Also, several fruiting plants were observed between the road and lakeshore nearby (centrum = 36.33999, -94.09513) on 18 October 2013. Associate species include hairy woodland sunflower (*Helianthus hirsutus*), a goldenrod (*Solidago arguta*), prairie-dock (*Silphium terebinthinaceum*), coral-berry (*Symphoricarpos orbiculatus*), blue wood aster (*Symphyotrichum drummondii*), smooth wild petunia (*Ruellia strepens*), thimbleweed (*Anemone virginiana*), eastern redbud (*Cercis canadensis*), persimmon (*Diospyros virginiana*) and elm (*Ulmus* sp.).

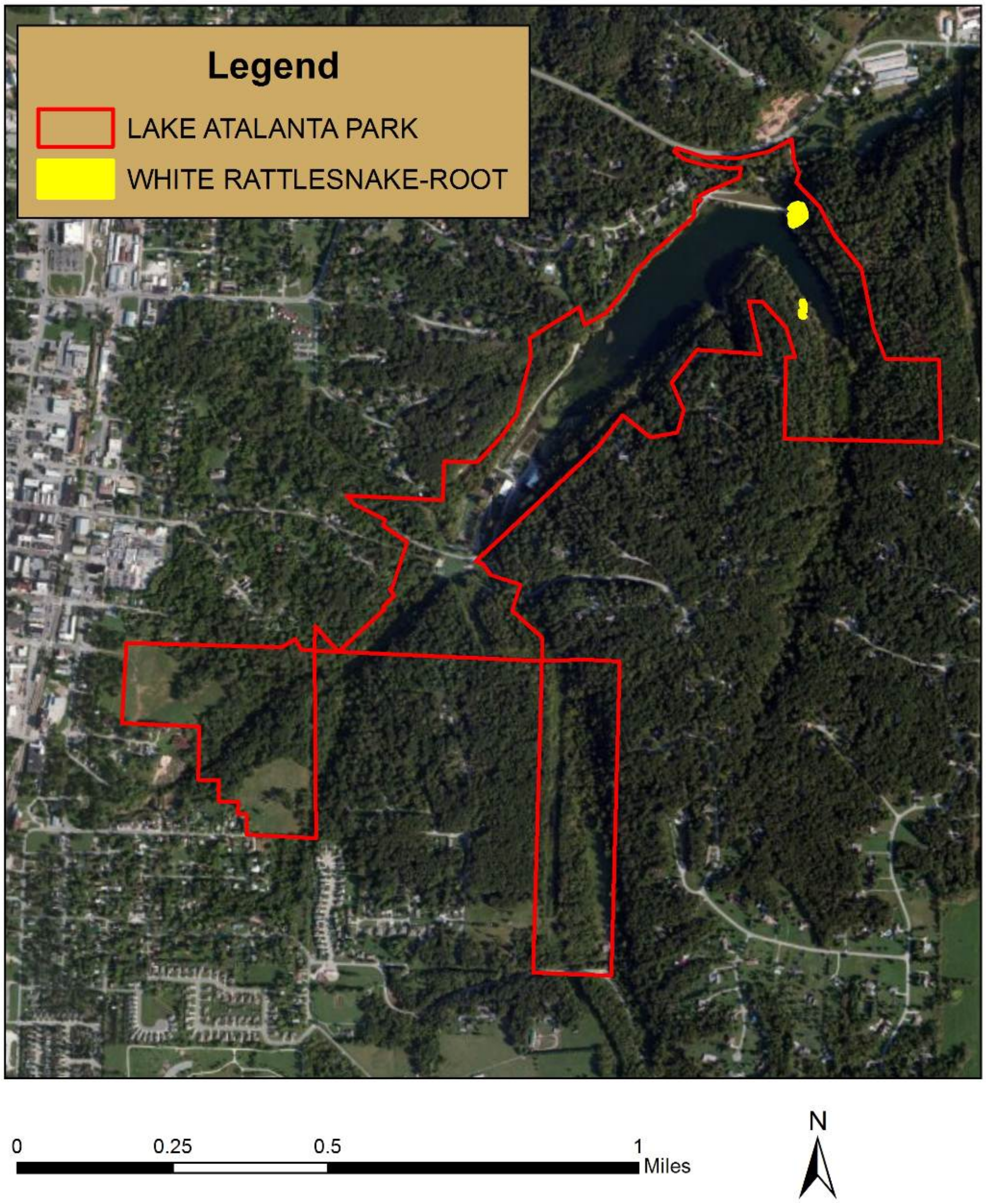

FIGURE 21. Map showing location of white rattlesnake-root at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

Pale Gentian (*Gentiana alba*) – G4S1

Pale gentian (Fig. 11d) is a northern species with its main range in the Upper Midwest, centered in Missouri, Iowa, Illinois, Wisconsin, and Minnesota, and with a few scattered populations east across the Cumberland Plateau to the Appalachians. It is rare in Arkansas where most of the known sites are based on historical records and only a few have been recently observed.

SITE 1: Centrum = 36.33934, -94.09475 (S end) to 36.33999, -94.09515 (N end)

6 large clumps were observed in flower on 18 October 2013 scattered on the slope above the shoreline between these points. Location of plants ranged from 15 inches to 4 feet above water line. Associated species include common scouring-rush (*Equisetum hyemale*), false boneset (*Brickellia eupatorioides*), smooth aster (*Symphyotrichum laeve*), flowering spurge (*Euphorbia corollata*), American germander (*Teucrium canadense*), big bluestem (*Andropogon gerardii*), tall thistle (*Cirsium altissimum*), wax-leaf meadow-rue (*Thalictrum revolutum*), persimmon (*Diospyros virgiana*), star tickseed (*Coreopsis pubescens*), hazelnut (*Corylus americana*), wild potato vine (*Ipomoea pandurata*), summer sedge (*Carex lurida*), tall thoroughwort (*Eupatorium altissimum*), golden alexanders (*Zizia aurea*), and sycamore (*Platanus occidentalis*).

SITE 2: Centrum = 36.33885, -94.09427

4 clumps were observed on 10 September 2013 on a somewhat mesic but gladey limestone slope above Lake Atalanta Road. Associated species include tall tickseed (*Coreopsis tripteris*), beebalm (*Monarda fistulosa*), smooth aster (*Symphyotrichum laeve*), white arrow-leaf aster (*Symphyotrichum urophyllum*), gray-headed coneflower (*Ratibida pinnata*), Oriental bittersweet (*Celastrus orbiculatus*), sassafras (*Sassafras albidum*), and hairy woodland sunflower (*Helianthus hirsutus*).

SITE 3: Centrum = 36.33468, -94.10156

A single clump was observed on 15 May 2011 and again on 10 September 2013 growing on a rich, mesic, rocky northwest-facing limestone slope about 4 feet above Lake Atalanta Road. Associated species include Canadian black-snakeroot (*Sanicula canadensis*), poison-ivy (*Toxicodendron radicans*), Virginia-creeper (*Parthenocissus quinquefolia*), Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), and wild strawberry (*Fragaria virginiana*).

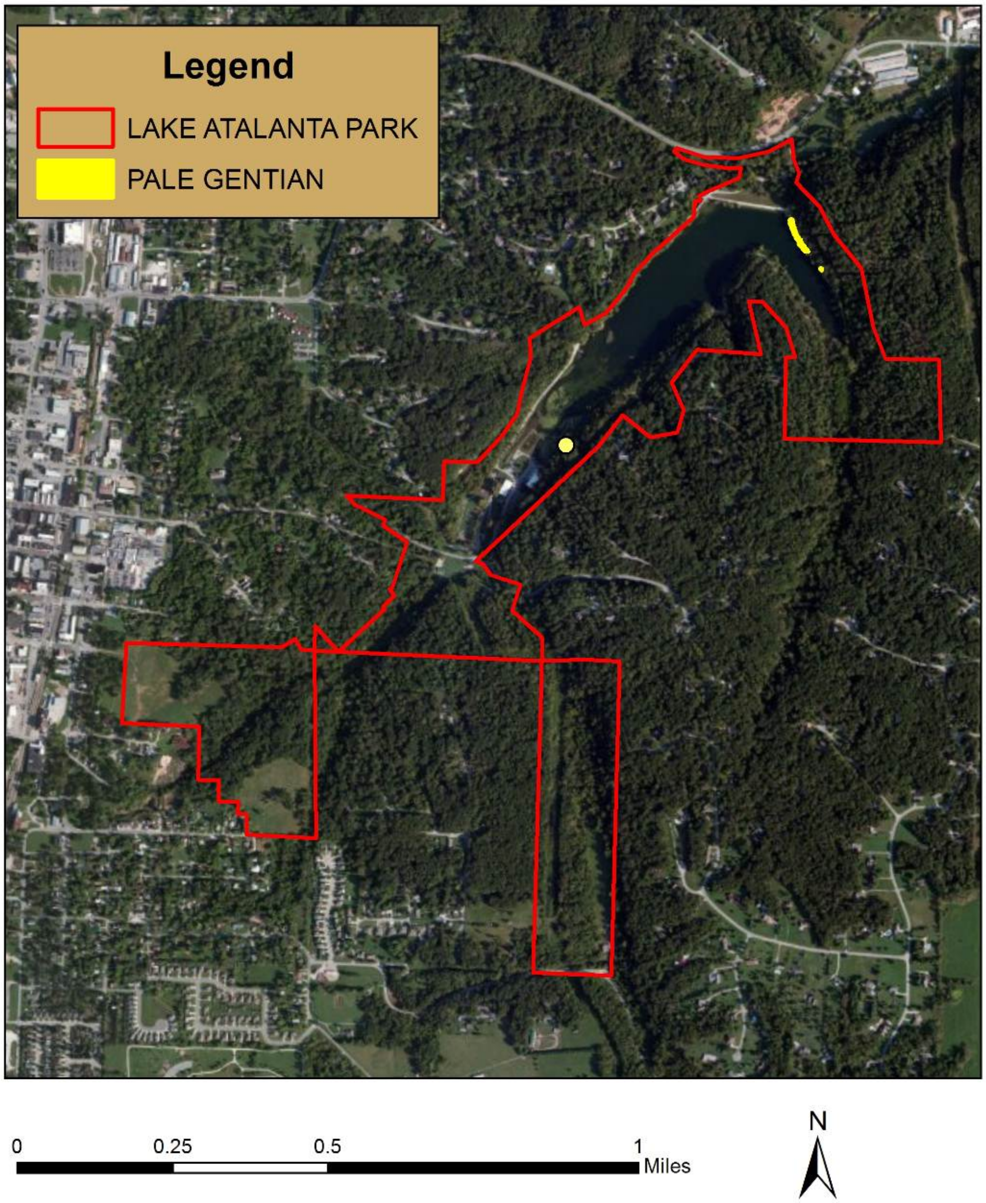

FIGURE 22. Map showing location of pale gentian at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

Church's Wild Rye (*Elymus churchii*) – G2G3S2?

Church's wild-rye (Figs. 9e & 9f) is a rare grass species known only from the Interior Highlands (Ozark Plateau, Arkansas Valley, and Ouachita Mountains) in portions of Arkansas, Missouri, and Oklahoma. It was first described in 2006 and is tracked by the Arkansas Natural Heritage Commission as a species of state conservation concern. Typical habitat includes bluffs, margins of glades, and rocky, open woodlands on a variety of geologic substrates. Two sites for Church's wild-rye were found at Lake Atalanta Park, both on a steep, gladey hillside east of the dam where they are associated with limestone outcrops.

Site #1: Centrum = 36.33899, -94.09400

30+ clumps were observed on 11 September 2013 scattered in a limestone glade and adjacent woodland at the downhill edge of a powerline right-of-way. Associate species include wiry witch grass (*Panicum flexile*), side-oats grama (*Bouteloua curtipendula*), little bluestem (*Schizachyrium scoparium*), purple-top tridens (*Tridens flavus* var. *flavus*), purple-stem cliff-brake (*Pellaea atropurpurea*), three-flower melic grass (*Melica nitens*), and eastern red-cedar (*Juniperus virginiana*), growing under chinquapin oak (*Quercus muehlenbergii*), white ash (*Fraxinus americana*), winged elm (*Ulmus alata*), dwarf hackberry (*Celtis tenuifolia*), and eastern redbud (*Cercis canadensis*).

Site #2: Centrum = 36.34044, -94.09446

20+ clumps were observed on 16 October 2013 scattered on a steep west-facing slope above dam, above power line right-of-way and extending downslope into the powerline right-of-way that leads to picnic area below the dam.

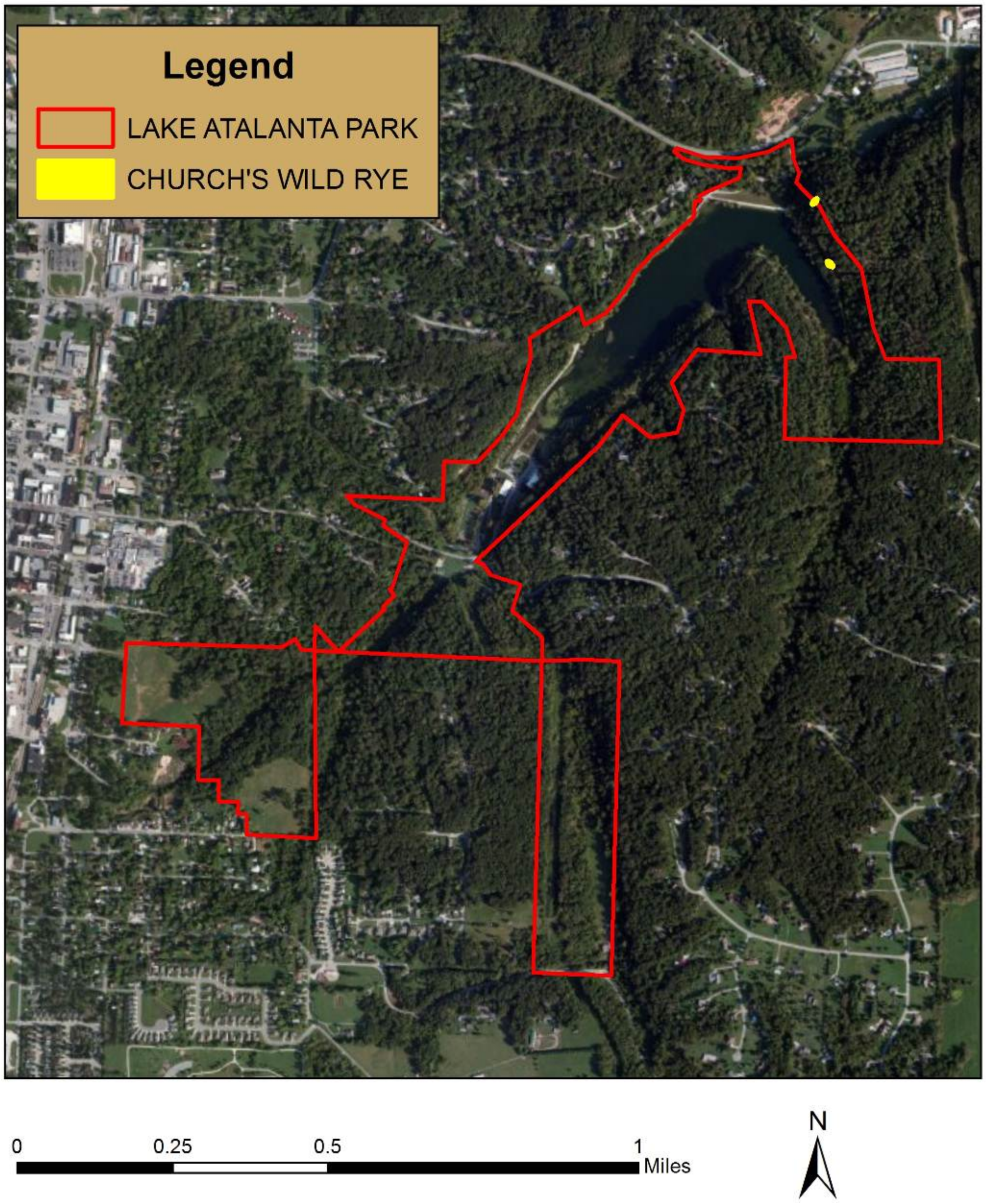

FIGURE 23. Map showing location of Church's wild rye at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

Taper-tip Wild Ginger (*Asarum canadense* var. *acuminatum*) – G5TNRS1

This variety of wild ginger (Fig. 8c & 8d) is characterized by its large size, acuminate leaf tips, and flowers with long, tapering tips. Its distribution is primarily northern and Appalachian. It is rare in Arkansas where it is known only from mesic calcareous forests in Benton and Stone counties. It was first documented in Arkansas from Lake Atalanta Park on 15 May 2011 from at least two sites, both associated with mesic hardwood forests along small streams.

SITE 1: Centrum = 36.33608, -94.10279

50+ plants were observed on 15 May 2011 scattered in a mesic ravine on the west side of Lake Atalanta.

SITE 2: Centrum = 36.32919, -94.10961

100+ plants were observed on 15 May 2011 scattered in a mesic ravine upstream of Lake Atalanta near the junction of two streams near trail crossing.

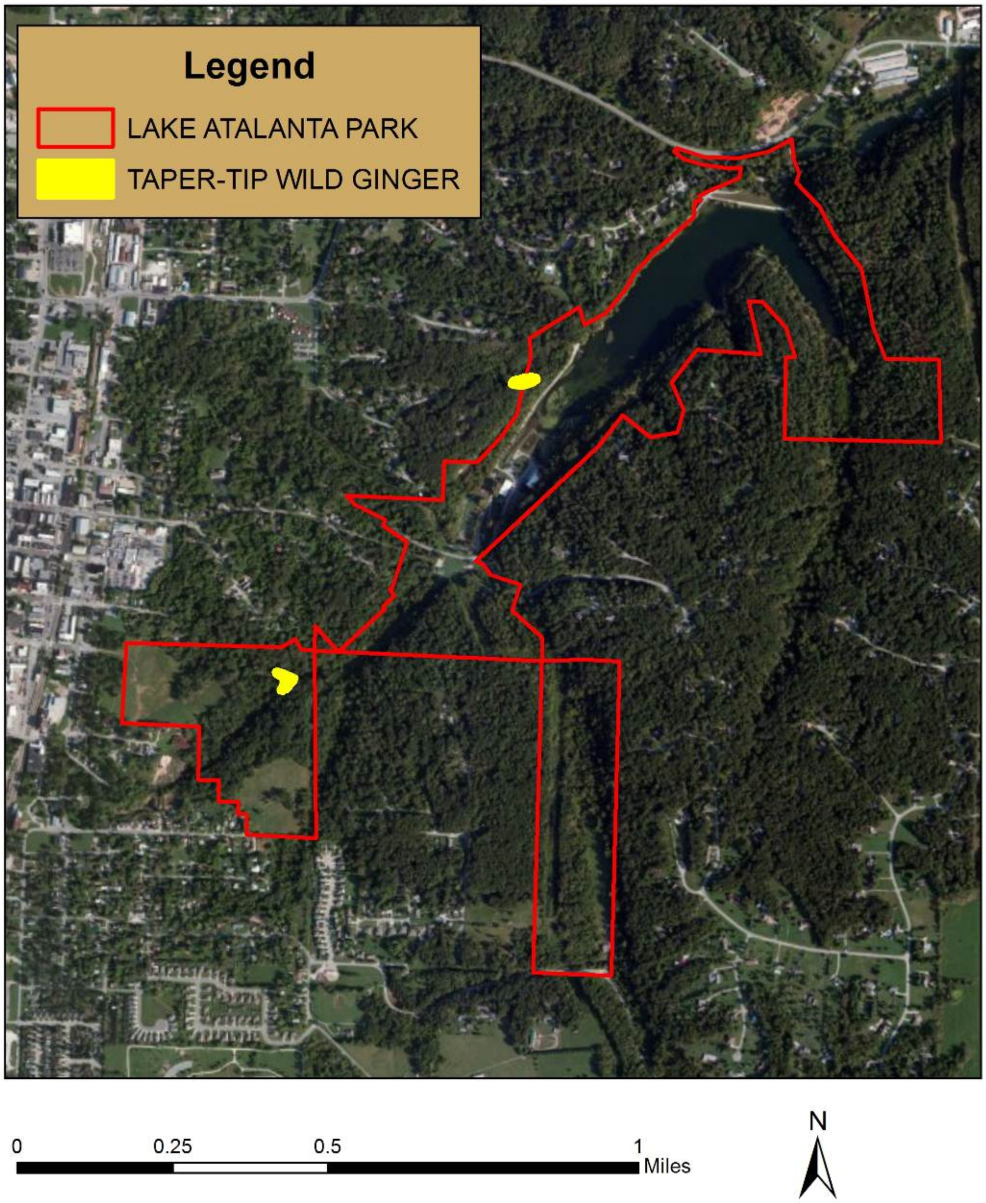

FIGURE 24. Map showing location of taper-tip wild ginger at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

Smooth Rosinweed (*Silphium integrifolium* var. *laeve*) – G5T4?S1

This variety of rosinweed (Fig. 11a & 11b) is sometimes treated as a separate species under the name *Silphium speciosum*. It has a limited range in the southern Great Plains, centered in the eastern parts of Nebraska and Kansas with outlying populations in western Missouri, northern Oklahoma, and extreme northwestern Arkansas. In Arkansas, it is known from just a few sites, several of which have been destroyed.

SITE 1: Centrum = 36.33866, -94.09410

50+ plants were observed on 10 September 2013 growing on a south-facing slope just above Lake Atalanta Road with prairie-dock (*Silphium terebinthenaceum*), pale leather-flower (*Clematis versicolor*), hairy angelica (*Angelica venenosa*), Indian-plantain (*Arnoglossum plantagineum*), winecup (*Callirhoe digitata*), Seneca snakeroot (*Polygala senega*), butterfly milkweed (*Asclepias tuberosa*), whorled milkweed (*Asclepias verticillata*), Missouri coneflower (*Rudbeckia missouriensis*), heart-leaf skullcap (*Scutellaria ovata*), and a tick-trefoil (*Desmodium cuspidatum*).

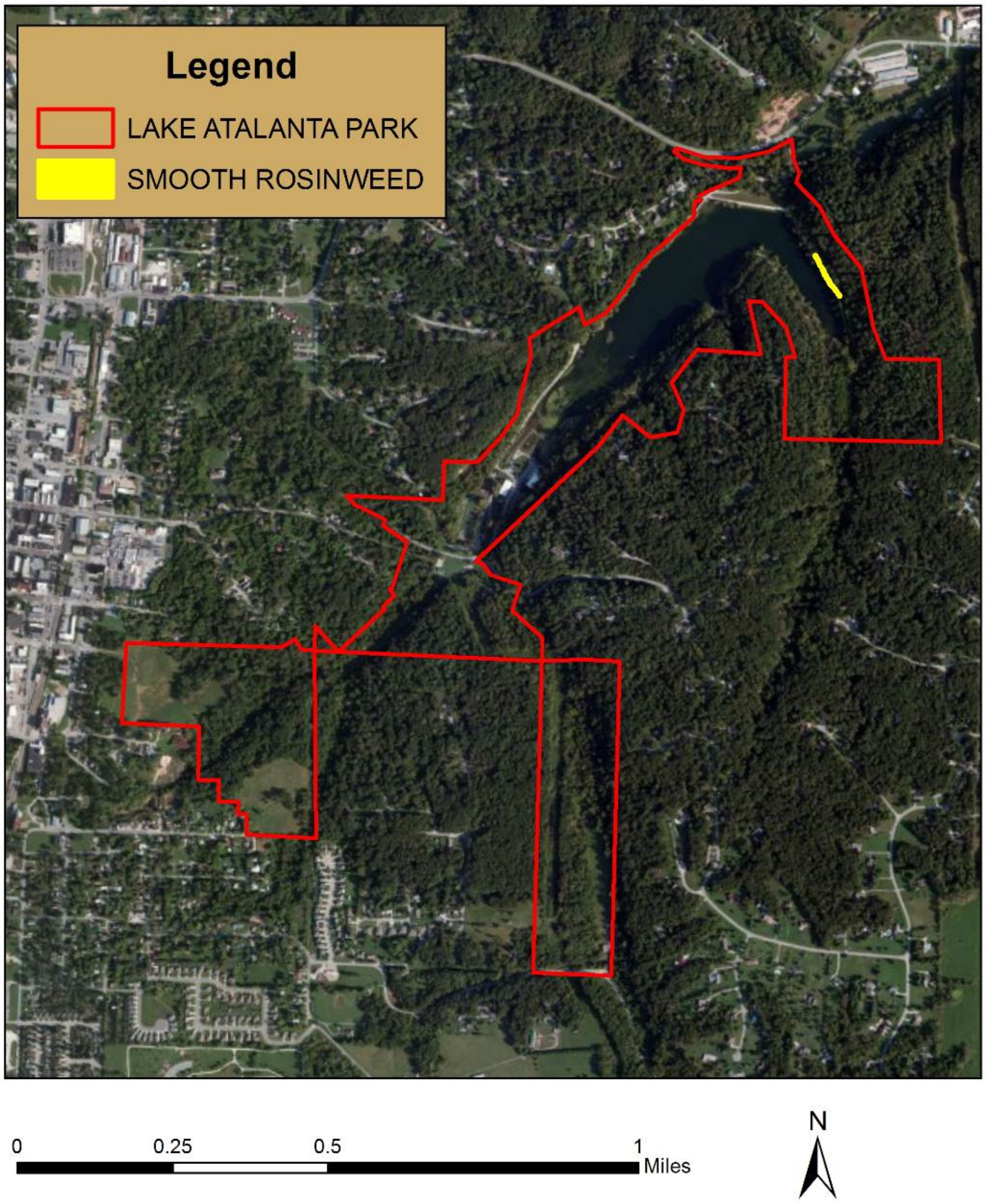

FIGURE 25. Map showing location of smooth rosinweed at Lake Atalanta Park. Map by Theo Witsell, ANHC, 2013.

Slender Nettle (*Urtica gracilis*) – G5S1

Slender nettle (Fig. 7a & 7b) is a northern species with the main part of its range north of central Missouri. It was found at a single site at Lake Atalanta in an area where the creek issuing from Frisco Spring crosses private land adjacent to one of the Park's trails. Slender nettle was first documented from Arkansas in 2012 when it was found on islands of the Mississippi River in Mississippi County in the northeastern part of the state. The population at Lake Atalanta is the first documented from northwestern Arkansas and only the second in the state.

SITE 1: Centrum = 36.32937, -94.10778

Several patches of plants were observed on 10 and 11 September 2013 in a wet meadow along a spring-fed creek issuing from Frisco Spring. Associate species include spotted jewelweed (*Impatiens capensis*), yellow ironweed (*Verbesina alternifolia*), beefsteak-plant (*Perilla frutescens*), cinnamon vine (*Diocorea polystachya*), Johnson grass (*Sorghum halepense*), sedges (*Carex* spp.), poison-hemlock (*Conium maculatum*), great blue lobelia (*Lobelia siphilitica*), and tall fescue (*Schedonorus arundinaceus*).

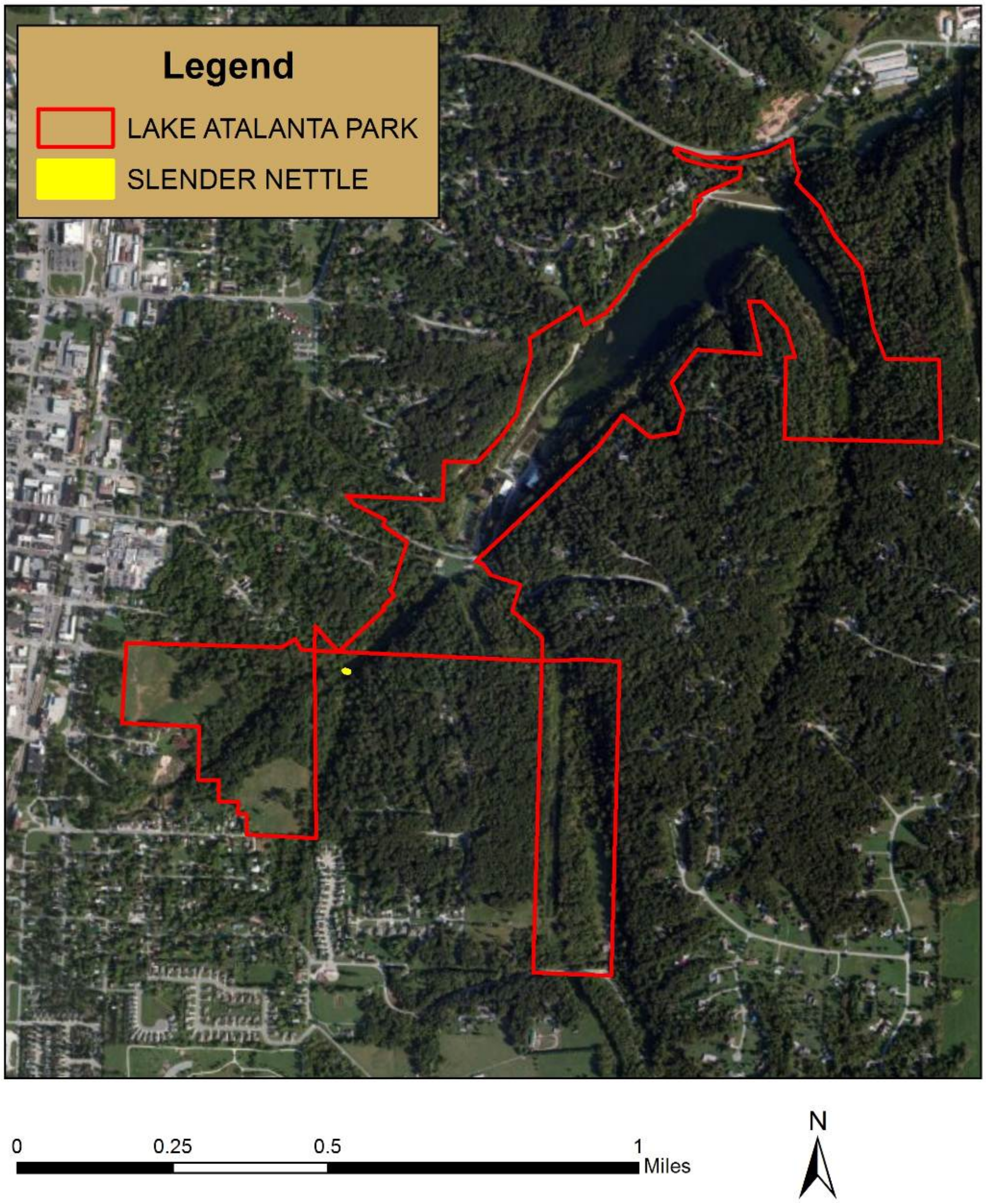

FIGURE 26. Map showing location of slender nettle at Lake Atalanta. Map by Theo Witsell, ANHC, 2013.

APPENDIX E: CONSERVATION STATUS CODE/RANK LEGEND

DEFINITION OF RANKS

GLOBAL RANKS

G1	=	**Critically Imperiled Globally.** At a very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2	=	**Imperiled Globally.** At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	=	**Vulnerable Globally.** At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4	=	**Apparently Secure Globally.** Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	=	**Secure Globally.** Common, widespread and abundant.
GH	=	**Of Historical Occurrence, Possibly Extinct Globally.** Missing; known from only historical occurrences, but still some hope of rediscovery.
GU	=	**Unrankable.** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
GX	=	**Presumed Extinct Globally.** Not located despite intensive searches and virtually no likelihood of rediscovery.
GNR	=	**Unranked.** The global rank not yet assessed.
GNA	=	**Not Applicable.** A conservation status rank is not applicable.
T-Ranks	=	**T subranks are given to global ranks when a subspecies, variety, or race is considered at the state level.** The subrank consists of a "T" plus a number or letter (1, 2, 3, 4, 5, H, U, X) with the same ranking rules as a full species.

STATE RANKS

S1	=	**Critically Imperiled in the State.** At a very high risk of extirpation due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
S2	=	**Imperiled in the State.** At high risk of extirpation due to very restricted range, very rew populations (often 20 or fewer), steep declines, or other factors.
S3	=	**Vulnerable in the State.** At moderate risk of extirpation due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
S4	=	**Apparently Secure in the State.** Uncommon but not rare; some cause for long-term concern due to delines or other factors.
S5	=	**Secure in the State.** Common, widespread and abundant.
SH	=	**Of Historical Occurrence, with Some Possibility of Rediscovery.** Its presence may not have been verified in the past 20-40 years. A species may be assigned this rank without the 20-40 year delay if the only known occurrences were destroyed or if it had been extensively and unsuccessfully sought.
SU	=	**Unrankable.** Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SX = **Presumed Extirpated from the State.** Not located despite intensive searches and virtually no likelihood of rediscovery.

SNR = **Unranked.** The state rank not yet assessed.

SNA = **Not Applicable.** A conservation status rank is not applicable.

GENERAL RANKING NOTES

Q = A "Q" in the global rank indicates the element's taxonomic classification as a species is a matter of conjecture among scientists.

Ranges = Ranges are used to indicate a range of uncertainty about the status of the element.

? = A question mark is used to denote an inexact numeric rank.

APPENDIX F: NON-NATIVE INVASIVE PLANT SPECIES FOUND AT LAKE ATALANTA PARK

The following table is a list of non-native invasive plant species at Lake Atalanta Park with information on their life form, local severity (major, moderate, or minor), and habitat(s) occupied. This table is followed by an annotated list, organized by severity with more information on each species.

Scientific Name	**Common Name(s)**	**Plant Type**	**Severity at Lake Atalanta Park**	**Habitat(s)**
Ailanthus altissima	Tree-of-heaven	Tree	Major	Disturbed woods, fields, powerlines, roadsides
Albizia julibrissin	Mimosa, Silktree	Tree	Moderate	Stream banks, disturbed woods, fields, powerlines, roadsides
Arthraxon hispidus	Small carp grass	Grass	Moderate	Stream banks, ditches, lake margins, wet open areas
Berberis thunbergii	Japanese barberry	Shrub	Minor	Woods, roadsides
Celastrus orbiculatus	Oriental bittersweet	Woody vine	Major	Woods, roadsides, powerlines, etc.
Centaurea stoeba subsp. micranthos	Spotted knapweed	Forb	Moderate	Roadsides, fields, and other open, disturbed areas
Conium maculatum	Poison-hemlock	Forb	Moderate	Stream banks, fields, roadsides, and other open, disturbed areas
Dioscorea polystachya	Air potato, cinnamon vine	Herbaceous Vine	Major	Streambanks, moist woods, roadsides, powerlines, and other moist disturbed areas
Elaeagnus umbellata	Autumn-olive	Shrub	Minor	Woods, roadsides, field margins,

				powerlines
Euonymus alatus	Burningbush	Shrub	Major	Mesic woods
Euonymus fortunei	Wintercreeper	Woody vine	Major	Mesic woods
Glechoma hederacea	Ground-ivy	Forb	Minor	Floodplain forests, low fields, lawns, and other disturbed areas
Houttuynia cordata	Chameleon	Forb	Minor	Spring run
Lespedeza cuneata	Sericea lespedeza	Forb	Moderate	Roadsides, fields, powerlines, and other open areas
Leucanthemum vulgare	Ox-eye daisy	Forb	Minor	Roadsides, fields, powerlines, and other open areas
Ligustrum sinense	Chinese privet	Shrub	Major	All habitats
Lonicera japonica	Japanese honeysuckle	Woody vine	Major	All habitats
Lonicera maackii	Amur honeysuckle, bush honeysuckle	Shrub	Major	Mesic woods, field margins, powerlines
Melilotus albus	White sweet-clover	Forb	Minor	Open areas
Microstegium vimineum	Japanese stiltgrass	Grass	Major	Moist woods, shaded field margins, roadsides, powerlines, wetlands
Miscanthus sinensis	Chinese silver grass	Grass	Minor	Lakeshore, upland woods
Morus alba	White mulberry	Tree	Minor	Edges of woods, roadsides
Nandina domestica	Nandina	Shrub	Minor	Woods, roadsides
Oenanthe javanica	Java water-dropwort	Forb	Minor	Spring run

Perilla frutescens	Beefsteak plant	Forb	Major	Disturbed moist woods, roadsides, fields, lakeshores
Persicaria longiseta	Bristly lady's-thumb	Forb	Major	Disturbed moist woods, roadsides, fields, lakeshores
Phalaris arundinacea	Reed canary grass	Grass	Moderate	Spring runs and other open wetlands
Pueraria montana	Kudzu	Woody vine	Major	Roadsides, disturbed woods, fields
Pyrus calleryana	Callery pear	Tree	Moderate	Roadsides, fields, lakeshores, powerlines, and other open disturbed areas
Rosa multiflora	Multiflora rose	Shrub	Major	Disturbed moist woods, roadsides, fields, lakeshores
Rubus phoenocolasius	Wineberry	Shrub	Moderate	Roadsides, disturbed woods, fields
Schedonorus arundinaceus	Tall fescue	Grass	Moderate	Streambanks, roadsides, fields, spring run, powerlines
Securigera varia	Crown-vetch	Forb	Minor	Distrurbed open areas
Sorghum halepense	Johnson grass	Grass	Moderate	Distrurbed open areas
Vinca major	Big-leaf periwinkle	Forb	Moderate	Woods and roadsides near old plantings

MAJOR SEVERITY INVASIVE SPECIES

Tree-of-heaven (*Ailanthus altissima*) – Scattered throughout the park, tree-of-heaven is actively spreading into the more remote and intact areas of the park. It is known for colonizing forest edges at roadsides and utility rights-of-way and then taking advantage of disturbances (such as gaps in the forest canopy that form when native trees die) to colonize the forest interior. This process was observed to be most advanced on the Fleming tract at the south end of the park where tree-of-heaven had become dominant in an area of a wooded hillside northwest of the old house and shop building. It also spreads along stream corridors.

Oriental Bittersweet (*Celastrus orbiculatus*) – This woody vine has become a common groundcover in forests and woodlands throughout Lake Atalanta Park. Where there is sufficient sunlight at forest edges along roads, fields, and powerlines, bittersweet has climbed into the tree canopy where it flowers and makes large quantities of seed.

Air-potato, Cinnamon Vine (*Dioscorea polystachya*) – This non-native herbaceous vine has widely naturalized in Arkansas, especially along streams and moist field margins. It is common in Lake Atalanta Park along the main spring run/ditch carrying water from Frisco Spring to Lake Atalanta, but was also found at a number of other sites. This species is easily identified during the summer and fall by the aerial tubers, or "potatoes" that form along its stem as it climbs over other vegetation.

Burningbush (*Euonymus alatus*) – This shrub is common in some areas of the park where it forms dense understory thickets, shading out native ground flora and suppressing young native trees and shrubs. It is especially dense in the hollows upstream from Frisco Spring, but is found at many sites throughout the park.

Wintercreeper (*Euonymus fortunei*) – This creeping woody vine is common at scattered sites throughout the park. It commonly forms a solid evergreen groundcover but can only flower and fruit where it climbs trees, which it can eventually strangle, kill, and crush.

Chinese Privet (*Ligustrum sinense*) – One of the most widespread and aggressive invasive shrubs in Arkansas, Chinese privet is capable of forming a nearly solid semi-evergreen shrub layer that will displace native ground flora over time. It is common in the park, especially along streams and on lower slopes.

Japanese Honeysuckle (*Lonicera japonica*) – This woody vine has become a dominant groundcover in forests and woodlands throughout Lake Atalanta Park. Where there is sufficient sunlight at forest edges along roads, fields, and powerlines, Japanese honeysuckle has climbed into the tree canopy where it flowers and fruits.

Amur Honeysuckle, Bush Honeysuckle (*Lonicera maackii*) – This non-native invasive shrub favors soils derived from limestone and is most abundant in Arkansas in urban woodlands of Benton and Washington counties where it often dominates the shrub layer and excludes native flora. It is scattered across Lake Atalanta Park and is most common along streams and on lower slopes.

Japanese Stilt grass (*Microstegium vimineum*) – Perhaps the most abundant invasive plant in Lake Atalanta Park (and one of the most abundant species in the park), Japanese stilt grass has become the dominant groundcover in most of the riparian forests and lower slopes in the park. It is also common to dominant in many of the powerline rights-of-way through the park where the spraying of herbicide has reduced native perennial species and favored weedy annuals (Fig. 13a).

Beefsteak Plant (*Perilla frutescens*) – An abundant invasive plant in Lake Atalanta Park, beefsteak plant has become has become a common groundcover in many of the riparian forests and lower slopes on the park. It is also common to dominant in many of the powerline rights-of-way through the park where the spraying of herbicide has reduced native perennial species and favored weedy annuals (Figs. 13a & 13b).

Bristly lady's-thumb (*Persicaria longiseta*) – This aggressive forb has become one of the dominant species in some areas of the park. It favors moist, shaded habitats with rich soils including stream banks, floodplain forests, margins of spring runs and hillside seeps, gravel bars, low fields, and other disturbed areas. At Lake Atalanta Park, it is especially common in open areas below the dam.

Kudzu (*Pueraria montana*) – This conspicuous woody vine was observed at two localities in the park: 1) on the east side of Lake Atalanta Road just north of Walnut Street, in the vicinity of 36.33306, -94.10315 and 2) on a wooded slope southwest of the pavilion in the vicinity of 36.33133, -94.10617 (Fig. 13c). A comprehensive survey for the species was not conducted.

Multiflora Rose (*Rosa multiflora*) – This shrub is a major invasive species across the Ozarks and is capable of making large quantities of seed, which are dispersed by birds and other animals. At Lake Atalanta Park it is common in a variety of habitats including riparian forests, roadsides, powerline rights-of-way, and the shores of the lake.

MODERATE SEVERITY INVASIVE SPECIES

Mimosa (*Albizia julibrissin*) – Mimosa, or silktree, takes advantage of disturbed areas such as roadsides, rights-of-way, and streamsides. It is thinly scattered throughout the park.

Small Carp Grass (*Arthraxon hispidus*) – This introduced grass can become dominant to the point of excluding all other species in wet fields and on stream banks, gravel bars, and lakeshores. It has become dominant in areas along the margins of spring runs and the shores of Lake Atalanta.

Spotted Knapweed (*Centaurea stoebe* subsp. *micranthos*) – This introduced forb has been the focus of much research on allelopathy, the capability of some species to inhibit germination and growth of other species by the release of chemicals into the soil. It is becoming a major invasive species in dry, open habitat across northern Arkansas and appears to be spreading along highways and into fields by mowing equipment. It was found at two sites at Lake Atalanta Park: 1) under powerlines northwest of the bathrooms and playground and 2) in fields on the Fleming Tract. A comprehensive survey for the species was not performed.

Poison-hemlock (*Conium maculatum*) – One of the most deadly toxic plants in the North American flora, this European species has naturalized across northern Arkansas, especially along streams, roadsides, and in open fields. It was found scattered in the park but was most concentrated along the main spring run/ditch carrying water from Frisco Spring to Lake Atalanta. It was also observed under powerlines where the spraying of herbicide has reduced native perennial species and favored weedy annuals.

Sericea Lespedeza (*Lespedeza cuneata*) – Introduced for erosion control and wildlife planting, this species spreads aggressively in all but the wettest open habitat. Especially harmful in glades and prairies, it is very common across the state. At Lake Atalanta Park, it can be found along roads, powerlines, streams banks, and in fields.

Reed Canary Grass (*Phalaris arundinacea*) – This large, colony-forming wetland grass, introduced from Europe, is a major problem in the Upper Midwest and Northeast U.S. It is rapidly spreading in wetlands across northern Arkansas. At Lake Atalanta Park, it is especially common along the main spring-fed stream/ditch that issues from Frisco Spring upstream from Walnut Street and east of the playground and pavilion. There it forms large, single-species colonies that have excluded all other species.

Callery Pear (*Pyrus calleryana*) – Callery pear is an invasive colony-forming tree that is used as the rootstock for the widely-planted Bradford pear. Callery pear fruit are popular with birds and the seeds are spread far and wide. It is found at scattered locations in the park.

Wineberry (*Rubus phoenocolasius*) – This introduced raspberry rapidly colonizes disturbed areas such as field margins, roadsides, and utility rights-of-way and is capable of displacing native vegetation. It is scattered in these habitats at Lake Atalanta Park.

Tall Fescue (*Schedonorus arundinaceus*) – This cool season European grass has been widely planted in pastures across the state. It can become dominant in a variety of open habitats including stream banks, gravel bars, roadsides, fields, and utility rights-of-way. It is a common species in all of these habitats in the park.

Johnson Grass (*Sorghum halepense*) – This invasive warm-season grass species is widespread throughout the region where it can dominate pastures, roadsides, utility rights-of-way, and other open habitats. It is found in all of these habitats in Lake Atalanta Park.

Big-leaf Periwinkle (*Vinca major*) – This invasive creeping vine was widely planted as an ornamental groundcover and has now spread from old home sites and other areas to cover large areas. At the park, it is especially common in areas that were formerly developed along the west side of Lake Atalanta but is also found at other sites.

MINOR SEVERITY INVASIVE SPECIES

Japanese Barberry (*Berberis thunbergii*) – This Asian shrub is a problematic invasive pest in the Upper Midwest and Northeastern U.S. but has only recently been documented as a naturalized component of the Arkansas flora. It was observed at two sites in Lake Atalanta Park in areas where it does not appear to have been planted.

Autumn-olive (*Elaeagnus umbellata*) – Once widely planted for its ornamental value and as cover for wildlife, this introduced shrub has naturalized extensively across Arkansas. It was found at scattered sites across the park, especially along the edges of powerline rights-of-way through the forest.

Ground-ivy (*Glechoma hederacea*) – This aromatic, creeping groundcover spreads to cover the ground in floodplain forests, low fields, lawns, and other disturbed areas. It was found scattered in moist habitats in the park.

Chameleon (*Houttuynia cordata*) – This species, not previously documented from Arkansas, was found recently at Lake Atalanta Park by Burnetta Hinterthuer of the Northwest Arkansas Community College. It has dominated a portion of a muddy spring run just south of the pavilion where it grows with Java water-dropwort (*Oenanthe javanica*), another invasive species recently documented new-to-Arkansas from Lake Atalanta Park.

Ox-eye Daisy (*Leucanthemum vulgare*) – This European species was commonly planted for its showy flowers and has naturalized across Arkansas. It spreads with mowing along roadsides, in powerline rights-of-way, and in fields. It is scattered in these habitats in the park.

White Sweet-clover (*Melilotus albus*) – This invasive forb can become dominant in open habitats with limestone-derived soils. It is scattered along roadsides, in fields, and in powerline rights-of-way in the park.

Chinese Silvergrass (*Miscanthus sinensis*) – Only recently discovered in the wild in Arkansas, this large grass is known outside of cultivation only from Washington and Benton counties. It is apparently just beginning to naturalize in Arkansas, but is a major invasive in other states. Two clumps were discovered at Lake Atalanta Park, clearly outside of cultivation; one on the shoreline of Lake Atalanta and one in a disturbed upland chert woodland on the Shelton Tract.

White Mulberry (*Morus alba*) – This introduced tree has naturalized across Arkansas, especially in urban areas. It is scattered in disturbed woodlands, field margins, roadsides, and under powerlines at Lake Atalanta Park.

Nandina (*Nandina domestica*) – This evergreen ornamental shrub, widely planted in Arkansas, has naturalized extensively in some urban areas. The berries can be toxic to birds such as Cedar Waxwings when eaten is large quantities. It was observed in several remote wooded areas in the park.

Java Water-dropwort (*Oenanthe javanica*) – This species, not previously documented from Arkansas, was found recently at Lake Atalanta Park by Joan Reynolds of the Northwest Arkansas Master

Naturalists. There, it has dominated a muddy spring run just south of the pavilion where it grows with chameleon (*Houttuynia cordata*), another invasive species recently documented new-to-Arkansas from Lake Atalanta Park.

Crown-vetch (*Securigera varia*) – Widely planted as an erosion control, crown-vetch has naturalized in a variety of open habitats in the state. It can become dominant in a variety of open habitats including stream banks, gravel bars, roadsides, fields, and utility rights-of-way. It is found in all of these habitats in the park.

APPENDIX G: LIST OF PLANT SPECIES FOUND AT LAKE ATALANTA PARK

List of Plant Species Occuring at

Lake Atalanta Park

Nomenclature according to Gentry et al., eds. 2013. *Atlas of the Vascular Plants of Arkansas.*

Scientific Name*	Common Name	Habitat(s)	Source
Acalypha monococca	one-seed mercury	A,B	1
Acalypha ostryifolia	hop-hornbeam copperleaf	G,H	1
Acalypha rhomboidea	rhombic copperleaf	D,H,F	1
Acalypha virginica	Virginia copperleaf	A,B,F,G,H	1
Acer ginnala	Amur maple	H	5
Acer negundo	box elder	D,G,H	1
Acer rubrum	red maple	C,D,F	1
Actaea racemosa	black cohosh	C	2
Adiantum pedatum	northern maidenhair fern	C,D	1
Aesculus pavia	red buckeye	C,D	3
Agalinis gattingeri	Gattinger’s false foxglove	B	1
Agastache nepetoides	yellow giant-hyssop	C,D	5
Ageratina altissima	white snakeroot	C,D,H	1
Agrimonia cf. pubescens	agrimony	C,D	1
Agrimonia parviflora	agrimony	G	1
Agrostis gigantea	redtop	G,H	1
Agrostis perennans	autumn bent grass	B,C,D,H	1
Ailanthus altissima	tree-of-heaven	A,B,C,D,G,H	1
Albizia julibrissin	mimosa	G,F,G,H	1
Allium vineale	field garlic	D,F,G,H	1
Ambrosia artemisiifolia	common ragweed	A,D,F,G,H	1
Ambrosia trifida	giant ragweed	D,F,G,H	1
Amelanchier arborea	downy service-berry	B,D	1
Ampelopsis cordata	false grape	D,E,F,G	1
Amphicarpaea bracteata	hog-peanut	B,C,D,H	1
Amsonia tabernaemontana	eastern bluestar	C,D	5
Andropogon gerardii	big bluestem	A,B,F	1
Andropogon virginicus	broomsedge	A,B,F,G,H	1
Anemone virginiana	thimbleweed	A,C,F	1
Angelica venenosa	hairy angelica	B,C	1
Antennaria parlinii	pussytoes	B	1
Apios americana	groundnut	D,E,F	1
Apocynum cannabinum	dogbane	F,G,H	1
Arctium minus	common burdock	D,G,H	1
Arisaema triphyllum	Jack-in-the-pulpit	C,D	4
Aristida purpurascens	arrow-feather three-awn	A,B	2

* Bold Blue = ANHC Tracked; Bold Green = AR Endemic and Tracked;
Red = Non-native; Bold Red = Non-native Invasive

Scientific Name*	Common Name	Habitat(s)	Source
Aristolochia serpentaria	Virginia snakeroot	B,C	1
Arnoglossum plantagineum	Indian-plantain	A	5
Artemisia annua	sweet wormwood	G,H	1
Arthraxon hispidus	small carp grass	E,F,G,H	1
Aruncus dioicus	goat's-beard	C,D	1
Asarum canadense var. acuminatum	taper-tip wild ginger	C,D	5
Asarum canadense var. reflexum	wild ginger	C	5
Asclepias purpurascens	purple milkweed	A,C	1
Asclepias quadrifolia	four-leaf milkweed	B,C	3
Asclepias tuberosa subsp. interior	butterfly milkweed	A,B	1
Asclepias verticillata	whorled milkweed	A	1
Asclepias viridiflora	green-flower milkweed	A	1
Asimina triloba	pawpaw	C,D	1
Asplenium platyneuron	ebony spleenwort	B,C,D	1
Aureolaria grandiflora	yellow false foxglove	A,B	1
Baptisia bracteata	cream wild indigo	B	5
Barbarea vulgaris	yellow-rocket	G,H	4
Berberis bealei	mahonia	A,C,H	1
Berberis thunbergii	Japanese barberry	C,G	5
Bidens bipinnata	Spanish-needles	H	1
Bidens frondosa	beggar-ticks	E,F	1
Boechera canadensis	Canadian rockcress	A	5
Boehmeria cylindrica	false nettle	D,E,F	1
Botrychium dissectum	cut-leaf grape fern	C,D	1
Botrychium virginianum	rattlesnake fern	C,D	1
Bouteloua curtipendula	side-oats grama	A	1
Brachyelytrum erectum	bearded shorthusk	C,D	1
Brickellia eupatorioides	false boneset	A,B	1
Bromus	bromus	G,H	1
Bromus pubescens	hairy woodland brome	C,D	1
Callirhoe digitata	winecup	A	1
Calystegia sepium	hedge bindweed	D,E,F,H	2
Campanula americana	tall bellflower	C,D	1
Campsis radicans	trumpet-creeper	B,D,F,G,H	1
Capsella bursa-pastoris	shepherd's-purse	G,H	4
Carex	sedge	C,D	1
Carex albicans	sedge	A	1
Carex annectens	sedge	G	2
Carex aureolensis	sedge	D,E,F	1

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Red = Non-native; Bold Red = Non-native Invasive

Scientific Name*	Common Name	Habitat(s)	Source
Carex flaccosperma	blue sedge	D,E,G	1
Carex frankii	Frank's sedge	F	2
Carex lurida	sedge	E,F	2
Carex muehlenbergii var. enervis	Muhlenberg's sedge	B	1
Carex nigromarginata	sedge	B	1
Carex vulpinoidea	fox sedge	E,F	2
Carya alba	mockernut hickory	A,B,C	1
Carya cordiformis	bitternut hickory	C,D	1
Carya ovata	shagbark hickory	A,C,D	1
Carya texana	black hickory	B	1
Castanea pumila var. ozarkensis	Ozark chinquapin	B	2
Catalpa	catalpa	G,H	1
Ceanothus americanus	New Jersey-tea	A,B	1
Celastrus orbiculatus	Oriental bittersweet	A,B,C,D,E,F,G,	1
Celastrus scandens	American bittersweet	A,B	3
Celtis occidentalis	hackberry	C,D,H	1
Celtis tenuifolia	dwarf hackberry	A	1
Centaurea stoebe subsp. micranthos	spotted knapweed	G,H	1
Cercis canadensis var. canadensis	eastern redbud	A,C,D,F,H	1
Chaerophyllum procumbens	spreading chervil	C,D	4
Chamaecrista fasciculata var. fasciculata	showy partridge-pea	G,H	1
Chamaecrista nictitans var. nictitans	sensitive partridge-pea	F,H	2
Chasmanthium latifolium	river-oats	C,D	1
Chenopodium missouriense	Missouri lamb's-quarters	H	1
Cinna arundinacea	stout wood-reed	D	1
Circaea canadensis subsp. canadensis	enchanter's-nightshade	C,D	1
Cirsium altissimum	tall thistle	A,B,F,H	1
Claytonia virginica	spring-beauty	A,B,C,D,H	3
Clematis catesbyana	Catesby's virgin's-bower	B,D,F	2
Clematis terniflora	sweet autumn virgin's-bower	A,C,D,H	1
Clematis versicolor	pale leather-flower	A	1
Cocculus carolinus	Carolina snailseed	C,D,F,G,H	1
Comandra umbellata	bastard-toadflax	B	1
Commelina communis	Asiatic dayflower	D,E,F,G,H	1
Commelina diffusa	spreading dayflower	F	1
Conium maculatum	poison-hemlock	D,E,F,G,H	1
Conyza canadensis	horseweed	A,F,G,H	1
Conyza ramosissima	dwarf fleabane	H	1
Coreopsis palmata	tickseed	A,B	1

Scientific Name*	Common Name	Habitat(s)	Source
Coreopsis pubescens	star tickseed	B	1
Coreopsis tripteris	tall tickseed	A	1
Cornus cf. racemosa	gray dogwood	A	1
Cornus drummondii	rough-leaf dogwood	A,D,G	1
Cornus florida	flowering dogwood	B,C,D	1
Corylus americana	hazelnut	B,C,D	1
Crataegus crus-galli	cockspur hawthorn	B	1
Croton monanthogynus	prairie-tea	A	1
Cryptotaenia canadensis	honewort	C,D	1
Cunila origanoides	dittany	B	1
Cuphea viscosissima	blue waxweed	A	1
Cuscuta cuspidata	cusp dodder	E,F	1
Cynanchum laeve	sandvine	F,H	1
Cynodon dactylon	Bermuda grass	G,H	1
Cyperus bipartitus	flatsedge	F	1
Cyperus echinatus	globe flatsedge	B,G,H	1
Cyperus esculentus	yellow nutsedge	F	1
Cyperus flavescens	yellow flatsedge	F	1
Cyperus odoratus	rusty flatsedge	F	2
Cyperus strigosus	false nutsedge	F,G	1
Cystopteris protrusa	southern bladder fern	C	1
Dactylis glomerata	orchard grass	G,H	1
Dalea candida	white prairie-clover	A	1
Dalea purpurea	purple prairie-clover	A	1
Danthonia spicata	poverty oat grass	B	1
Dasistoma macrophylla	mullein-foxglove	A,D	5
Daucus carota	Queen Anne's-lace	G,H	1
Desmodium cuspidatum	tick-trefoil	B,C	1
Desmodium glutinosum	tick-trefoil	B,C,D	1
Desmodium marilandicum	tick-trefoil	B	1
Desmodium nudiflorum	naked-flower tick-trefoil	B	1
Desmodium nuttallii	Nuttall's tick-trefoil	B	1
Desmodium obtusum	tick-trefoil	F,G,H	1
Desmodium paniculatum	panicled tick-trefoil	B,F	1
Desmodium pauciflorum	few-flower tick-trefoil	C,D	1
Desmodium perplexum	tick-trefoil	B	1
Dichanthelium aciculare	narrow-leaf rosette grass	A	1
Dichanthelium acuminatum	hairy rosette grass	A	1
Dichanthelium boscii	Bosc's rosette grass	B	1

* Bold Blue = ANHC Tracked; Bold Green = AR Endemic and Tracked;
Red = Non-native; Bold Red = Non-native Invasive

Scientific Name*	Common Name	Habitat(s)	Source
Dichanthelium clandestinum	deer-tongue rosette grass	D,E,F	1
Dichanthelium commutatum	variable rosette grass	B	1
Dichanthelium dichotomum	forked rosette grass	B	1
Dichanthelium laxiflorum	open-flower rosette grass	B	1
Dichanthelium malacophyllum	soft-leaf rosette grass	A,B	1
Dichanthelium oligosanthes subsp. scribnerianum	Scribner's rosette grass	A	1
Dicliptera brachiata	dicliptera	C,D	1
Digitaria	digitaria	F,G,H	1
Diodia teres	poor-Joe	A,B,F,G,H	1
Diodia virginiana	Virginia buttonweed	E,F,H	1
Dioscorea polystachya	cinnamon vine	C,D,E,F,G,H	1
Dioscorea villosa	wild yam	A,B,C	1
Diospyros virginiana	persimmon	A,B,C,D,E,F,G,	1
Duchesnea indica	Indian-strawberry	F,H	2
Echinacea pallida	pale purple coneflower	A	1
Echinochloa crusgalli	barnyard grass	E,F	1
Eclipta prostrata	false daisy	E,F	1
Elaeagnus umbellata	autumn-olive	B,G,H	1
Eleocharis	spike-rush	F	1
Elephantopus carolinianus	Carolina elephant's-foot	A,C,D,G	1
Eleusine indica	goose grass	F,G,H	1
Elymus churchii	Church's wild rye	A	1
Elymus glabriflorus	southeastern wild rye	B,G,H	1
Elymus hystrix	bottle-brush grass	C,D	1
Elymus villosus	hairy wild rye	D	1
Elymus virginicus var. jejunus	Virginia wild rye	D	2
Elymus virginicus var. virginicus	Virginia wild rye	C,D,G	1
Equisetum hyemale	common scouring-rush	D,E,F	1
Eragrostis hirsuta	big-top love grass	A	1
Eragrostis intermedia	plains love grass	A,H	1
Eragrostis pilosa	Indian love grass	H	1
Erechtites hieraciifolius	fireweed	H	1
Erigeron annuus	daisy fleabane	G,H	1
Erigeron philadelphicus	Philadelphia fleabane	D,G,H	1
Erigeron pulchellus	Robin's-plantain	A,C	1
Eryngium yuccifolium	rattlesnake-master	B	1
Euonymus alatus	burning-bush	B,C,D,H	1
Euonymus atropurpureus	wahoo	A,F	1
Euonymus fortunei	winter-creeper	C,D	1

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Scientific Name*	Common Name	Habitat(s)	Source
Eupatorium altissimum	tall thoroughwort	A,B	1
Eupatorium serotinum	late boneset	D,E,F,G,H	1
Euphorbia corollata	flowering spurge	A,B	1
Euphorbia dentata	toothed spurge	A,H	1
Euphorbia maculata	spotted spurge	F,G,H	1
Euphorbia nutans	nodding spurge	A,F,H	1
Eutrochium purpureum	Joe-pye-weed	C	3
Fallopia scandens	climbing false buckwheat	D,E,F	1
Fleischmannia incarnata	pink thoroughwort	C,D,E,F,G	2
Forsythia suspensa	weeping forsythia	C,H	2
Fragaria virginiana	wild strawberry	A	1
Frangula caroliniana	Carolina buckthorn	A,B,C	1
Fraxinus americana	white ash	A,B,C	1
Galactia volubilis	downy milk-pea	A,B	1
Galium aparine	cleavers	C,D,E,G	1
Galium arkansanum var. arkansanum	Arkansas bedstraw	B	1
Galium circaezans	wild licorice	B,D	1
Galium concinnum	shining bedstraw	B,C	1
Galium triflorum	sweet-scent bedstraw	C,D	1
Gaura longiflora	biennial gaura	A,H	1
Gentiana alba	pale gentian	A,C,F	1
Geranium maculatum	wild geranium	C,D	4
Geranium molle	dove’s-foot crane’s-bill	F,H	4
Geum canadense	white avens	D	1
Geum vernum	spring avens	D,E	1
Glechoma hederacea	ground-ivy	D,G,H	1
Glyceria striata	fowl manna grass	E	1
Hackelia virginiana	beggar’s-lice	C,D	1
Helianthus divaricatus	woodland sunflower	B	1
Helianthus hirsutus	hairy woodland sunflower	A,B	1
Helianthus tuberosus	Jerusalem artichoke	D,F,H	1
Heliopsis helianthoides	ox-eye	A	1
Hemerocallis fulva	orange day-lily	B,G,H	1
Hibiscus syriacus	rose-of-Sharon	G,H	2
Hieracium gronovii	hawkweed	B	1
Houstonia nigricans	diamond-flower	A	1
Houstonia purpurea var. purpurea	mountain houstonia	C,D	1
Houttuynia cordata	chameleon	E	1
Hydrangea arborescens	wild hydrangea	C,F	1

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Scientific Name*	Common Name	Habitat(s)	Source
Hydrophyllum virginianum	Virginia waterleaf	C,D	1
Hypericum hypericoides subsp. multicaule	St. Andrew's-cross	B	1
Hypericum pseudomaculatum	false spotted St. John's-wort	A	1
Hypericum sphaerocarpum	round-fruit St. John's-wort	A	1
Ilex aquifolium	English holly	B,C	1
Ilex decidua	deciduous holly	A,C,D	1
Ilex opaca	American holly	B,C	1
Impatiens capensis	spotted jewelweed	D,E,F	1
Impatiens pallida	yellow jewelweed	D,E	1
Ipomoea coccinea	red morning-glory	H	1
Ipomoea lacunosa	small white morning-glory	F,G,H	1
Ipomoea pandurata	wild potato vine	F	1
Juglans nigra	black walnut	A,B,C,D,G	1
Juncus secundus	rush	A,F	1
Juncus tenuis	path rush	F,G,H	1
Juniperus virginiana	eastern red-cedar	A,C,D,F,G	1
Kickxia elatine	cancerwort	F,G	1
Koelreuteria paniculata	golden-rain-tree	C,D	1
Krigia biflora	two-flower dwarf-dandelion	B,C	1
Kummerowia striata	Japanese bush-clover	G,H	1
Kyllinga pumila	spikesedge	F	1
Lactuca canadensis	wild lettuce	B	1
Lactuca floridana	Florida wild lettuce	D,F	1
Lamium purpureum	purple dead-nettle	C,D,G,H	1
Laportea canadensis	wood-nettle	C,D	1
Lathyrus latifolius	everlasting-pea	G,H	1
Leersia oryzoides	rice cut grass	E,F	1
Leersia virginica	white grass	C,D,E,F	1
Lemna	duckweed	F	1
Lespedeza cuneata	sericea lespedeza	B,F,G,H	1
Lespedeza frutescens	violet bush-clover	A,B	1
Lespedeza hirta	hairy bush-clover	B	1
Lespedeza procumbens	trailing bush-clover	B	1
Lespedeza violacea	bush-clover	B	A
Lespedeza virginica	slender bush-clover	A,B	1
Leucanthemum vulgare	ox-eye daisy	G,H	1
Leucospora multifida	narrow-leaf paleseed	A,F	1
Liatris aspera	rough blazing-star	B	1
Ligustrum sinense	Chinese privet	C,D,E,F,G,H	1

Scientific Name*	Common Name	Habitat(s)	Source
Lindera benzoin	spicebush	B,C,D,E	1
Lindernia dubia	false pimpernel	F	1
Liriodendron tulipifera	tulip-tree	A,B,C,G,H	1
Liriope spicata	creeping lily-turf	B	1
Lithospermum canescens	hoary puccoon	A	1
Lobelia siphilitica	great blue lobelia	E,F	1
Lolium perenne	rye grass	G,H	1
Lonicera japonica	Japanese honeysuckle	A,B,C,D,E,F,G,	1
Lonicera maackii	Amur honeysuckle	A,C,D,G,H	1
Lonicera sempervirens	trumpet honeysuckle	A	1
Lycopus americanus	American bugleweed	F	1
Lysimachia lanceolata	yellow-loosestrife	A	1
Maclura pomifera	Osage-orange	D,G	1
Matelea	matelea	A,B,F	1
Melica nitens	three-flower melic	A	1
Melilotus albus	white sweet-clover	H	1
Melothria pendula	creeping-cucumber	C,D.F.H	1
Menispermum canadense	moonseed	C,D	1
Mentha ×piperita	peppermint	E,F	1
Mentha spicata	spearmint	E,G	1
Microstegium vimineum	Japanese stilt grass	A,B,C,D,E,F,G,	1
Mimosa quadrivalvis var. nuttallii	sensitive-brier	A,B	1
Mimulus alatus	monkey-flower	D,E,F	1
Mirabilis albida	white four-o'clock	A	3
Mirabilis nyctaginea	wild four-o'clock	H	3
Miscanthus sinensis	Chinese silver grass	B,F	2
Monarda bradburiana	Bradbury's beebalm	B	3
Monarda fistulosa	beebalm	A,B	1
Monarda russeliana	Russell's beebalm	A	3
Monotropa uniflora	Indian-pipe	C	3
Morus alba	white mulberry	F,G,H	2
Morus rubra	red mulberry	C,D,F,G	1
Muhlenbergia capillaris	hair-awn muhly	A	1
Muhlenbergia frondosa	wire-stem muhly	E,F	1
Muhlenbergia schreberi	nimblewill	B,D,F,G,H	1
Muhlenbergia sobolifera	rock muhly	A,B,C	1
Muhlenbergia sylvatica	woodland muhly	B,D,F	1
Nandina domestica	nandina	B	2
Nasturtium officinale	watercress	E	1

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Scientific Name*	Common Name	Habitat(s)	Source
Nothoscordum bivalve	crow-poison	A,B	1
Nyssa sylvatica	black-gum	B,C	1
Oenanthe javanica	Java water-dropwort	E	1
Oenothera biennis	evening-primrose	E,F,G,H	1
Onosmodium bejariense var. subsetosum	marbleseed	A	1
Osmorhiza longistylis	aniseroot	C,D	3
Ostrya virginiana	hop-hornbeam	B,C,D,E	1
Oxalis dillenii	yellow wood-sorrel	A,B,D,F,G,H	1
Oxalis stricta	yellow wood-sorrel	C,D	1
Oxalis violacea	violet wood-sorrel	A,B	1
Packera aurea	golden ragwort	E	2
Panicum anceps	beaked panic grass	A,F,G	1
Panicum capillare	witch grass	H	1
Panicum flexile	wiry witch grass	A	1
Panicum philadelphicum	witch grass	A	1
Panicum virgatum	switch grass	A	1
Parthenium integrifolium	wild quinine	B	1
Parthenocissus quinquefolia	Virginia-creeper	B,C,D	1
Paspalum dilatatum	Dallis grass	F,G,H	1
Paspalum floridanum	Florida paspalum	E,F	1
Paspalum laeve	field paspalum	E,F	1
Paspalum pubiflorum	hairy-seed paspalum	F	1
Passiflora incarnata	purple passion-flower	E,F,G,H	2
Passiflora lutea	yellow passion-flower	A	1
Pellaea atropurpurea	purple-stem cliff-brake	A	1
Penstemon digitalis	foxglove beardtongue	A,B	3
Penstemon tubiflorus	beardtongue	A	1
Perilla frutescens	beefsteak-plant	B,C,D,E,F,G,H	1
Persicaria hydropiper	water-pepper	E,F	1
Persicaria hydropiperoides	swamp smartweed	E,F	1
Persicaria longiseta	bristly lady's-thumb	C,D,E,F,G,H	1
Persicaria pensylvanica	pink smartweed	D,E,F,H	1
Persicaria punctata	dotted smartweed	D,E,F,H	1
Persicaria virginiana	jumpseed	C,D	1
Phalaris arundinacea	reed canary grass	E	1
Phaseolus polystachios	wild bean	A,C,F	1
Phegopteris hexagonoptera	broad beech fern	C,D	1
Phlox divaricata subsp. laphamii	wild blue phlox	C,D	1
Phlox paniculata	perennial phlox	D	1

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Scientific Name*	Common Name	Habitat(s)	Source
Phryma leptostachya	lopseed	C,D	1
Physalis cordata	heart-leaf ground-cherry	F	1
Physalis heterophylla	clammy ground-cherry	A,B	1
Physocarpus opulifolius	ninebark	C,D	1
Physostegia angustifolia	narrow-leaf false dragonhead	A,F	3
Phytolacca americana	poke	E,F,G,H	1
Pilea pumila	clearweed	C,D	2
Pinus strobus	eastern white pine	C	1
Pinus taeda	loblolly pine	C	1
Plantago lanceolata	English plantain	F,G,H	1
Plantago major	great plantain	F	1
Plantago rugelii	black-seed plantain	F,G	1
Platanus occidentalis	sycamore	D,F,G,H	1
Poa annua	annual blue grass	F,H	2
Podophyllum peltatum	May-apple	B,C,D	3
Polemonium reptans	Jacob's-ladder	C,D	1
Polygala senega	Seneca snakeroot	A,C	1
Polygonatum biflorum	Solomon's-seal	C	3
Polygonum aviculare	knotweed	H	1
Polygonum erectum	erect knotweed	G,H	1
Polymnia canadensis	leafcup	C	1
Polystichum acrostichoides	Christmas fern	C,D	1
Potamogeton crispus	curly pondweed	F	5
Prenanthes alba	white rattlesnake-root	A,C	1
Prenanthes altissima	tall rattlesnake-root	B,C	1
Primula meadia	shooting-star	A	3
Prunella vulgaris	heal-all	D,F	1
Prunus mahaleb	perfumed cherry	C,H	1
Prunus serotina	black cherry	C,D,F	1
Pseudognaphalium obtusifolium	rabbit-tobacco	A,B	1
Pteridium aquilinum	bracken fern	B	1
Pueraria montana	kudzu	A,B,H	1
Pycnanthemum albescens	white-leaf mountain-mint	B	1
Pycnanthemum cf. virginianum	Virginia mountain-mint	B	1
Pycnanthemum tenuifolium	slender mountain-mint	A,B	1
Pyracantha coccinea	scarlet firethorn	H	1
Pyrus calleryana	Callery pear	B,F,G,H	2
Quercus alba	white oak	B,C,D	1
Quercus marilandica	blackjack oak	B	1

Scientific Name*	Common Name	Habitat(s)	Source
Quercus muehlenbergii	chinquapin oak	A,D	1
Quercus rubra	northern red oak	C	1
Quercus shumardii	Shumard's oak	A,C	1
Quercus stellata	post oak	A,B	1
Quercus velutina	black oak	B	1
Ranunculus abortivus	small-flower crowfoot	D,G,H	1
Ranunculus recurvatus	hooked buttercup	C,D,E	1
Ranunculus sardous	hairy buttercup	E,F,G,H	4
Ratibida pinnata	gray-head coneflower	A	2
Rhus aromatica	fragrant sumac	A,B	1
Rhus copallinum	winged sumac	A,B,F,G,H	1
Rhus glabra	smooth sumac	B,F,G,H	1
Rhynchosia latifolia	snout-bean	A,B	1
Ribes missouriense	Missouri gooseberry	C	1
Robinia pseudoacacia	black locust	B,F,G,H	1
Rosa carolina	Carolina rose	A,B	1
Rosa multiflora	multiflora rose	B,C,D,E,F,G,H	1
Rosa setigera	climbing rose	A,B,E	1
Rotala ramosior	toothcup	E	1
Rubus	rubus	B,C	1
Rubus occidentalis	black raspberry	C,D	1
Rubus phoenicolasius	wineberry	C,D,E,F,G,H	1
Rudbeckia hirta	black-eyed Susan	A,F,G,H	1
Rudbeckia laciniata	wild goldenglow	D,E,F	2
Rudbeckia missouriensis	Missouri coneflower	A	1
Rudbeckia triloba	brown-eyed Susan	A,C,F	1
Ruellia humilis	hairy wild petunia	A	1
Ruellia strepens	smooth wild petunia	A,C,D	1
Rumex	rumex	E	1
Rumex crispus	curly dock	F,G,H	1
Sabatia angularis	rose-gentian	A,H	1
Sagittaria latifolia	arrowhead	F	1
Salix nigra	black willow	F	1
Sambucus canadensis	elderberry	D,F,G	1
Sanguinaria canadensis	bloodroot	C,D	1
Sanicula canadensis	Canadian black-snakeroot	A,B,C,D	1
Sanicula odorata	clustered black-snakeroot	C,D	1
Saponaria officinalis	bouncing-bet	H	1
Sassafras albidum	sassafras	B,G	1

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Scientific Name*	Common Name	Habitat(s)	Source
Schedonorus arundinaceus	tall fescue	D,E,F,G,H	1
Schizachyrium scoparium	little bluestem	A,B	1
Scirpus atrovirens	bulrush	E	1
Scirpus pendulus	bulrush	A	1
Scrophularia marilandica	carpenter's-square	C,D	1
Scutellaria elliptica	hairy skullcap	C,D,F	1
Scutellaria lateriflora	mad-dog skullcap	F	1
Scutellaria ovata	heart-leaf skullcap	A,B	1
Securigera varia	crown-vetch	D,F,G,H	1
Sedum ternatum	woodland stonecrop	C,E	2
Senna marilandica	wild senna	A,C,H	1
Setaria faberi	Chinese foxtail	G,H	2
Setaria parviflora	knot-root bristle grass	B,F,G,H	1
Setaria pumila	yellow bristle grass	G,H	1
Sherardia arvensis	field-madder	H	4
Sicyos angulatus	bur-cucumber	D,E	1
Sideroxylon lanuginosum	gum bumelia	A,B	1
Silene virginica	fire-pink	B	3
Silene vulgaris	bladder-campion	H	5
Silphium asteriscus	starry rosinweed	A	1
Silphium integrifolium var. laeve	rosinweed	A	1
Silphium perfoliatum	cup-plant	D,F	1
Silphium terebinthinaceum	prairie-dock	A	1
Sisyrinchium	blue-eyed-grass	A,B	1
Sisyrinchium angustifolium	blue-eyed-grass	A,D	1
Smallanthus uvedalius	bear's-foot	D	1
Smilax hispida	bristly greenbrier	C,D	1
Smilax pulverulenta	carrion-flower	C	5
Solanum carolinense	Carolina horse-nettle	G,H	1
Solanum ptychanthum	black nightshade	C,D,H	1
Solidago altissima	tall goldenrod	F,G,H	1
Solidago arguta	goldenrod	A,C,D	1
Solidago caesia	wreath goldenrod	C,D	1
Solidago hispida	hairy goldenrod	B	1
Solidago nemoralis	oldfield goldenrod	A,B	1
Solidago petiolaris	goldenrod	A,B	1
Solidago radula	rough goldenrod	A,B	1
Solidago ulmifolia	elm-leaf goldenrod	A,B	1
Sorghastrum nutans	Indian grass	A,B	1

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Scientific Name*	Common Name	Habitat(s)	Source
Sorghum bicolor	sorghum	H	1
Sorghum halepense	Johnson grass	F,G,H	1
Sporobolus clandestinus	hidden dropseed	A	1
Sporobolus compositus	tall dropseed	A	1
Sporobolus vaginiflorus var. ozarkanus	Ozark dropseed	A	1
Staphylea trifolia	bladdernut	C,D	1
Strophostyles helvola	wild bean	F	1
Stylosanthes biflora	pencil-flower	A,B	1
Symphoricarpos orbiculatus	coral-berry	A,B,C,D	1
Symphyotrichum anomalum	aster	B	1
Symphyotrichum drummondii	blue wood aster	A,C,D	2
Symphyotrichum laeve	smooth aster	A	1
Symphyotrichum lanceolatum	tall white aster	D,E	1
Symphyotrichum lateriflorum	white woodland aster	B,D,F	1
Symphyotrichum oblongifolium	aromatic aster	A	1
Symphyotrichum patens	late purple aster	A,B	1
Symphyotrichum pilosum	white heath aster	F,G,H	1
Symphyotrichum turbinellum	prairie aster	B	1
Symphyotrichum urophyllum	white arrow-leaf aster	A	1
Taraxacum officinale	common dandelion	G,H	2
Tephrosia virginiana	goat's-rue	A,B	1
Teucrium canadense	American germander	D,F,G	1
Thalictrum revolutum	wax-leaf meadow-rue	A,D,F	1
Thaspium chapmanii	meadow-parsnip	A,B,F	5
Thaspium trifoliatum	meadow-parsnip	F	3
Tilia americana	basswood	C,D	1
Torilis arvensis	field hedge-parsley	G,H	1
Toxicodendron radicans	poison-ivy	A,B,C,D,F	1
Tradescantia ohiensis	Ohio spiderwort	A	2
Tragia	noseburn	A	1
Tragia cordata	heart-leaf noseburn	A,B,D	1
Tridens flavus var. flavus	purple-top tridens	A,B,F,G,H	1
Trifolium pratense	red clover	F,G,H	1
Trifolium repens	white clover	G,H	1
Trillium ozarkanum	Ozark trillium	B	5
Trillium sessile	wakerobin	C,D	3
Trillium viridescens	green trillium	C,D	5
Triosteum	horse-gentian	A	1
Ulmus alata	winged elm	A,B	1

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Scientific Name*	Common Name	Habitat(s)	Source
Ulmus americana	American elm	D	1
Ulmus rubra	slippery elm	C,D,F	1
Urtica gracilis	slender nettle	E	1
Uvularia grandiflora	large-flower bellwort	C	1
Vaccinium arboreum	farkleberry	B	1
Vaccinium pallidum	low-bush blueberry	B	1
Vaccinium stamineum	deerberry	B	1
Valerianella radiata	cornsalad	H	3
Verbascum blattaria	moth mullein	G,H	1
Verbascum thapsus	woolly mullein	G,H	1
Verbena urticifolia	white vervain	B,F	1
Verbesina alternifolia	yellow ironweed	C,D,E,F,G	1
Verbesina helianthoides	crownbeard	A,B	1
Verbesina virginica	frostweed	C,D,E,F,G	1
Vernonia arkansana	Arkansas ironweed	B,E,F	1
Vernonia baldwinii	Baldwin's ironweed	B	1
Vernonia missurica	Missouri ironweed	B,F	2
Veronica anagallis-aquatica	water speedwell	E,F	2
Veronica persica	Persian speedwell	F,H	1
Viburnum prunifolium	blackhaw	A,D	2
Viburnum rufidulum	rusty blackhaw	B	1
Vicia caroliniana	wood vetch	A,B	1
Vinca major	big-leaf periwinkle	C,H	1
Viola bicolor	Johnny-jump-up	H	3
Viola pedata	bird's-foot violet	A,B	2
Viola pubescens	downy yellow violet	C,D	4
Viola sororia	blue violet	C,D	2
Viola striata	cream violet	C,D	1
Vitis aestivalis	summer grape	B,C,D	1
Vitis cinerea	winter grape	D,E	1
Vitis vulpina	frost grape	D	3
Woodsia obtusa	blunt-lobe cliff fern	A	1
Yucca cf. arkansana	Arkansas yucca	A	1
Zizia aptera	heart-leaf golden Alexanders	A,B	1
Zizia aurea	golden Alexanders	C,F	1

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Total Taxa: 539

Habitats:

A = limestone glade and woodland

B = chert woodland

C = mesic hardwood forest

D = riparian forest

E = spring run

F = lakeshore

G = field

H = disturbed area

Sources:

1 = Theo Witsell, 9-11 September 2013 site inventory

2 = Theo Witsell, 16-18 & 20 October 2013 site inventory

3 = Joan Reynolds, plant list

4 = Deb Bartholomew, April 2009 photographs

5 = Theo Witsell, 15 May 2011 site inventory/Arkansas Native Plant Society field trip

APPENDIX C

KARST INVESTIGATION PHOTOGRAPHS

Photo 1. Numerous seeps emerging from base of Boone Formation along a solution enhanced bedding plane. Stream formed by pictured seeps and upgradient Springs SW-01 and SW-03. (SW-04 on Figure 2.1).

Photo 2. Limestone outcrop of Boone Formation with solution enhanced bedding planes and fracture. Spring emerges from base of fracture (SW-05 on Figure 2.1).

Photo 3. Limestone outcrop of Boone Formation with solution enhanced bedding planes near base of outcrop (SW-13 on Figure 2.1).

Photo 4. Small spring emerging from Boone Formation along a solution enhanced bedding plane (SW-18 on Figure 2.1).

Photo 5. Limestone outcrop of Boone Formation with solution enhanced bedding planes and fracture (LA-02 on Figure 2.1).

Photo 6. Limestone outcrop of Boone Formation with solution enhanced bedding planes. Small spring emerges from bedding plane just below bottom of picture (LA-05 on Figure 2.1).

Photo 7. Limestone outcrop with solution enhanced bedding plane and fracture forming an open fissure (SE-03 on Figure 2.1).

Photo 8. Large spring emerging from limestone outcrop of Boone Formation along a solution enhanced bedding plane (SE-08 on Figure 2.1).

Photo 9. Well developed karst features in outcrop upgradient of Spring SE-08 (SE-09 on Figure 2.1).

Photo 10. Platform of bare limestone (limestone pavement) containing ubiquitous small-scale solution features known as karren (SE-09 on Figure 2.1).

APPENDIX D

BEST MANAGEMENT PRACTICES

Community Growth Best Management Practices for Conservation of the Elm Springs/Tontitown Recharge Zone

September 2007

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Introduction

Benton and Washington County with all or parts of 19 other counties in northern Arkansas are included in the Ozark Highlands. The Ozark Highlands include portions of Arkansas, Oklahoma, Kansas, Missouri, and Illinois. This is a region of karst topography, eroded to form steep hills, valleys, and bluffs. Karst is a distinctive topography in which the landscape is largely shaped by the dissolving action of water on carbonate bedrock (usually limestone, dolomite, or marble). This geological process which occurred over thousands of years resulted in unusual surface and subsurface features ranging from sinkholes, losing streams, and springs, to complex underground drainage systems and caves. Surface waters transported through underground conduits, contribute to the groundwater basin.

The area once covered in a shallow tropical sea, formed when ancient marine organisms died, and their calcium rich shells and skeletons sank to the bottom of the sea forming thick calcareous deposits. These deposits became today's bedrock of limestone and dolomite. Subsequent to the deposition, a magma pulse pushed up and fractured the limestone. Fractures enlarged through dissolution by mildly acidic waters formed various surface and underground karst features.

Northwest Arkansas contains numerous surface and underground karst features and subterranean passageways. Surface water enters groundwater systems rapidly through thin layers of permeable soil and fractured bedrock, potentially traveling over a mile per day underground. Surface water contamination does contribute to groundwater contamination and affects habitat supporting sensitive cave animals. The Elm Springs/Tontitown recharge zone is one example of this kind of surface/groundwater interaction. These characteristics of karst landscapes make the environment fragile and highly susceptible to human disturbance.

Many highly specialized and sensitive fish and wildlife species such as bats, salamanders, cavefish, and crustaceans (e.g., cave crayfish, isopods, and amphipods) spend all or part of their life in these unique and sensitive habitats. The Elm Springs/Tontitown recharge zone contains the endangered Benton County Cave Crayfish (*Cambarus aculabrum*). The species was listed as endangered by the U.S. Fish and Wildlife Service (Service) in 1993 with a recovery plan completed in 1996.

A recharge zone study involving the injection of dye into karst features conducted in 2005-2006 determined the area where surface water enters underground conduits and flows to specific springs along Brush creek. The recharge zone as delineated by Tom Aley of the Ozark Underground Laboratory encompasses 2,260 acres and is 3.53 square miles which includes the communities of Tontitown and Elm Springs, Arkansas.

To minimize threats to groundwater quality and endangered species in the Elm Springs/Tontitown recharge zone, the Service and our partners recommend the following Community Growth Best Management Practices (BMPs) for the Conservation of the Elm Springs/Tontitown Recharge Zone.

Erosion and Sediment Control

BMPs should be implemented for all construction projects within karst landscapes. BMPs should include filter fences, straw bales, interceptor dikes and swales, sediment traps, ditch checks, detention basins, mulching, seeding, and/or revegetation as appropriate. Mats or netting should be applied on steep slopes and stream banks. Erosion and sediment control measures should be sized to handle at least the 25 year flood and 24-hour storm event. Erosion and sediment control BMP's should be implemented to prevent sediment and contaminants from entering groundwater.

It is important that construction plans reduce erosion and sedimentation into streams and karst features by:

- Identifying areas with potential for erosion problems prior to construction initiation.

- Avoiding wetlands and low lying areas.

- Restoring steep embankments with seed, mulch, fertilizer, and implementing erosion control measures such as silt fences, straw bales, matting, and sediment traps. Soil stabilization immediately after earth work is complete is critical.

- Restoring steep approaches to stream crossings by seeding, mulching, fertilizing, and implementing erosion control measures such as silt filter fences, ditch checks, straw bales, matting, and sediment traps. It is critical that restoration be implemented immediately after construction.

- On approaches to stream crossings, drainage control structures should be located at the top and base of the slope/bank. Runoff should be routed to stable slopes on either side of the right of way, or routed via temporary conveyance structures to the base of the approach slope where it can infiltrate into the stream bank and eventually seep back to the channel.

1. Silt Fence and Straw Bales

Silt fence or a combination of silt fence and straw bales, should be installed to prevent or minimize sediment from steep slopes and disturbed areas leaving the construction site and entering streams or karst features. Sediment detention structures should be used in areas with moderate to high erosion potential. Silt fence are useful to intercept and retain small amounts of sediment under sheet flow conditions and should be placed along the borders of water bodies wherever disturbance or construction occurs. Silt fences should be installed immediately adjacent to disturbed soils and a minimum of 10 feet from the ordinary high water mark of wetlands, streams, and rivers. Natural vegetation should be retained within the 10 foot buffer zone. Silt fence should be used in areas subject to erosion where the drainage area is one acre or less, but for larger areas a sediment basin should be also used. Silt fences should be used on slopes no greater than 1:1. The maximum flow path to each fence should be no more than 100 feet. Concentrated flows should not be directed toward any fence. Silt fence should be trenched up slope from the barrier and supported by posts spaced a maximum of six feet apart.

Straw bales are one of the most common sediment control methods. Straw bales should be used in areas subject to sheet flow and erosion where the drainage area is no greater than 1/4 acre per 100 foot of barrier length and the maximum slope behind the barrier is 50 percent (2:1). In most cases, bales should be placed in single rows along contours with ends tightly butted together. To discourage underflow, bale barriers should be entrenched. The back side of the bale should be an undisturbed natural area. If the area behind the barrier has been disturbed or is naturally subject to erosion, the barrier should be back filled. All bales should be tied and staked. Silt fence and straw bales should be maintained throughout the construction period and inspected daily during prolonged rainfall and immediately after each rainfall event.

2. Sediment Traps

Sediment traps are small temporary ponds used to detain stormwater runoff and allow sediment deposition, thereby minimizing the quantity of sediment entering water bodies. Sizing considerations for traps include inflow and sediment load, but traps are generally used for small drainage areas less than three acres. Because sediment traps filter out all but the finest sediments, silt fence is necessary at the outfall to retain silt and clay-size particles.

Sediment traps should be located to intercept runoff from disturbed areas and should be located away from stream channels. A sufficient number of traps should be constructed to intercept runoff from disturbed areas and have adequate capacity for potential storm events and accumulated sediment. Sediment traps should be designed for the specific site, for bare soil, and typically for a 75 percent removal efficiency. Sediment traps should consist of check dams located within an enlarged section of the interception ditch on stable ground. Stable ground is identified as areas with well drained soils and/or where vegetation remains in place providing sufficient root strength to prevent sliding. In areas where stable ground is not available, several check dams should be used to prevent buildup of excess water. Traps should have both a low-flow outlet and an emergency overflow. Rock should be placed at the outlet and overflow to prevent erosion where the water enters the downstream drainage way. The outlet pipe, if needed, should be sized to pass runoff from a 25 year flood and/or 24-hour storm event. Traps should not be constructed on fill material.

3. Mulch and Revegetation

Mulch and prompt revegetation should be used to minimize erosion of exposed soils. Vegetation should be re-established as soon as possible on all disturbed ground, including access roads and trench backfill. Vegetation (use native vegetation when possible) should be planted in the same growing season as construction or immediately following construction, or if not possible disturbed areas should be covered with straw, mats, or some other erosion control material in the interim. At most locations, broadcast seeding and the replacement of saplings should be the predominant method of revegetation. Seed should be planted by hydroseed method or by a mulch covering. A grass and forb mixture recommended by the Natural Resource Conservation Service (NRCS) and the Service should be used to reseed slopes and fertilized where suitable (do not over fertilize). Where terrain or other conditions combine to cause a high risk of erosion, the revegetation method should be to drill/plant grasses or hydroseed over steep slopes then cover with straw or mats.

4. Permanent Stabilization

Material pushed aside to make temporary level working areas should be replaced onto disturbed areas. Original contours should be restored as closely as possible. Equipment access crossings should be removed and stabilized. After contours have re-established, topsoil previously segregated should be redistributed across the surface. Water bars should be graded horizontally across the slope to aid in gully and erosion prevention. Areas compacted by construction equipment should be chiseled and disc-plowed to loosen compacted soil. Following final grading, the disturbed area should be stabilized by replanting with non-invasive plant species. Forest and shrub areas impacted by construction not requiring maintenance as part of the right-of-way access road should be replanted with suitable native tree and shrub species. Within floodplains, ground stabilization should include rooted or anchored features, used to slow runoff velocity and erosion until vegetation is re-established. Steep slopes may require the use of mats to help stabilize soil while new vegetation is established. Disturbed stream banks should be stabilized using appropriate vegetation (native if possible). Wetlands should be stabilized by replacing the original subsoil and topsoil, replacing vegetation, and returning the topography and hydrologic characteristics of the wetland as closely as possible to their original form. Disturbed wetland buffers should be stabilized by replanting appropriate vegetation.

Construction in Sensitive Areas

As the true extent of the underground environment is difficult to clearly delineate, undiscovered karst features; such as cave openings, sinkholes, and underground passages may occur on or near a project site, even in previously developed areas. Therefore, the Service recommends the following precautionary measures be taken to avoid impacts to groundwater and sensitive or endangered species which may inhabit karst features not previously surveyed.

1. Survey existing and any new right-of-ways for karst features such as caves, sinkholes, losing streams, and springs.

2. Establish a natural area of 300 feet or greater around any cave, sinkhole, losing stream, or spring found during the survey (or during any aspect of project implementation). The Service should be contacted for further evaluation to determine if caves are used by sensitive or federally listed species.

3. If a cave is used by sensitive or federally listed species, the Service may request that the cave be mapped to determine if additional openings or passages may be affected by the project. The Service may recommend modifications of the proposed project to allow natural areas to be established. Incorporation of natural areas may be necessary to avoid impacts.

4. If caves or other openings are encountered during construction, the Service requests that work efforts cease within 300 feet of the opening. The opening should be adequately marked and protected from work activities, and the Service should be contacted immediately. No fill materials should be placed into the opening until Service or Service approved personnel have the opportunity to inventory the site.

5. The Service should assess caves located prior to or during construction for sensitive/endangered species and provide recommendations before activities proceed.

6. No blasting should be permitted in the vicinity of any known karst feature without previous consultation.

Additional measures may be required for construction near sensitive areas including stream channels and karst features. Care should be taken when working around streams and karst features to prevent unnecessary damage to or removal of vegetation. If a cave or fracture is breeched or surface water is rerouted into a karst feature, all activities should cease and the Service should be contacted to assess the situation and provide further consultation before proceeding.

Staging areas should be at least 300 feet away from streams, wetlands, and karst features. All streams, wetlands, and karst features adjacent to disturbed areas should be protected by the use of silt fence, straw bales, and other BMPs necessary to prevent sediment from entering water bodies. A combination of several measures may be necessary to decrease damage at stream crossings. In streams with enough flow, temporary in-stream settling ponds should be used to catch sediment generated by construction. Sediment should be removed as soon as construction is completed. For smaller streams or where appropriate, water could be bypassed through construction areas by the use of flume pipes, pumps, or coffer dams. Stream can be bypassed using directional drilling techniques, as discussed later.

Streams and karst areas should be restored and stabilized immediately following construction activities. Native plants, mats, netting, and other BMPs should be used to stabilize banks. Instream deflectors and anchored logs should be used in high velocity streams to protect vulnerable banks and allow for reestablishment of vegetation. Riprap revetment should also be used, if necessary, to help stabilize slopes in areas of high velocity stream flows. The use of riprap should, however, be minimized. Rock typical of the local geology should be used if available. Monitoring of BMP performance in critical areas, particularly at sensitive stream crossings and stream approach slopes should be conducted and documented on a routine basis prior to and after storms during construction and operation. Based on monitoring, additional BMPs or other improvements may be necessary to insure minimization of impact.

All efforts should be made to minimize stream alterations which could impact water quality and fish and wildlife resources. Construction along streams should not take place during fish spawning seasons if possible.

Vehicle Maintenance, Petroleum, and Chemicals

To prevent petroleum products from contaminating soils and water bodies, the following BMPs should be implemented:

- Construction equipment and vehicles should be properly maintained to prevent leakage of petroleum products.

- Staging areas for equipment maintenance and chemical storage should be established 300 feet or more away from wetlands, streams, or karst features.

- Drip pans and tarps or other containment systems should be used when changing oil or other vehicle/equipment fluids.

- Any contaminated soils or materials should be disposed of off-site in proper receptacles at an approved disposal facility.

- Vehicle and equipment fueling should be attended at all times by site personnel. Spill cleanup materials should be stored on site and employees should be trained in spill control procedures.

- Vehicle washing should not occur on the project site, but at an area with appropriate wash facilities to manage contaminated wash water. Wash water should never be discharged directly into water bodies or karst features.

- Petroleum products and other chemicals should be properly stored in appropriately labeled containers under sheltered areas. Storage shelters should be designed with an impermeable floor area.

- Materials for cleaning up spills should be kept on site. Spills should be cleaned up immediately in accordance with state and federal regulations.

Solid Wastes

Solid wastes, such as vegetation removed during clearing, sanitary waste, food and food container waste, and metal and wood scraps, should be collected and disposed of according to applicable regulations or recycled/reused. Sanitary facilities should be well maintained and conveniently located. Waste containers should be labeled and located in a sheltered area at least 300 vegetated feet away from water bodies and drainage pathways. Erosion and sediment control structures should be frequently inspected for accumulations of solid waste and any waste removed immediately.

Chemical Controls

Herbicides, fertilizers, vehicle maintenance fluids, petroleum products, and drilling fluids should be discarded, stored, and/or changed in staging areas established at least 300 vegetated feet from streams or karst features. Spill response protocols and kits should be maintained on site to address these concerns.

Areas where discharge material, overburden, fuel, and equipment are stored should be designed and established at least 300 vegetated feet from the edge of streams and karst features. Further distance is recommended, but with proper barrier fences, surface design, and/or maintaining a vegetated buffer, most impacts can be avoided or significantly reduced.

Stream Crossings/Pipelines

Several methods could be used for stream crossings, including open cut channels and directional drilling. The standard BMPs for pipeline construction in trenches, construction near sensitive areas, and construction staging areas should be applicable to each of water crossing methods. Construction at stream crossings should be according to the selected stream crossing method (wet trench, dry trench, or drilling) and specific mitigation concerns associated with the level of disturbance and stream sensitivity. General construction sequences for trenched stream crossings include the following basic steps.

1. Construct a flow by-pass structure (for dry trenching) to create a relatively dry stream bed or backwater condition. Flow by-pass structures should cross the full width of channel (including side channels) in one span or in stages.

2. Once flow is controlled (in the case of wet trenching, step one above is not needed), route flow into the by-pass and trench across the entire channel width to the appropriate depth below maximum scour and install the pipeline.

3. Backfill the trench with native bed material, and stabilize the bed and bank with armoring matched to baseline flow conditions.

4. Re-introduce flow and monitor performance.

Temporary in-stream settling ponds should be constructed without significantly dredging or altering the natural hydrology and channel of a stream. Settling ponds should be constructed using fill rock or screens with disturbance or alteration of the channel kept to a minimum. Natural stream bed alteration necessary for diversions should be minimal and restored upon completion of activities. Riprap and filter screens used to create traps or diversions should be removed upon completion of the activities.

Critical slopes are characterized as steep approaches to stream crossings where the pipeline trench is parallel to the slope angle, areas where bank erosion can destabilize slopes, drainage is concentrated, and areas where sediments can directly enter receiving waters. Stringent erosion and sediment control measures, aggressive slope stabilization measures, and frequent monitoring should be implemented during and after construction.

Use directional drilling methods for proposed pipeline crossings of losing streams, perennial streams, and wetlands. Prior to directional drilling, a geotechnical investigation using the least intrusive means possible (e.g. ground penetrating radar, minimal exploratory bore hole drilling, seismic refraction and reflections, cave radio, resistivity, magnetometry, etc.) should be conducted to determine subsurface/geologic conditions encountered along the drill path to ensure that a directional drill pipeline at the location would be feasible and not result in unnecessary damage to a sensitive area, such as a karst void. All drilling fluids should be captured and accounted for during drilling activities.

If directional drilling is not feasible, it is recommended that stream crossings be conducted during periods of low flow (July-September), and that limited amounts of riparian vegetation be removed during installation.

Stream channel disturbance using directional drilling is greatly reduced compared to trenching. Prevent runoff and contaminants from staging areas on either side of the crossing from entering the stream. This should require construction of secondary containment structures (i.e. berms and filter fences) along with runoff dispersion and sediment traps to prevent any runoff generated in the staging areas from reaching the stream. Additionally, equipment should not be run through stream channels.

Where excavation involves native or established wetland/riparian vegetation, the top 6-12 inches or more of vegetation and topsoil including the vegetation and root mass should be carefully removed and stockpiled separately into a dedicated deposition area. After completion of site disturbance this vegetated material and its associated soils should be placed as the surface material.

Wells located should be evaluated for closure methodology and potential biological inventories. Wells should be documented and evaluated for future monitoring opportunities. If wells are located which require closure, coordination with the USFWS should occur prior to closure.

Natural Area Establishment

Within the delineated Elm Springs/Tontitown recharge zone two primary losing streams convey surface waters underground to springs along Brush Creek. If other karst features occur in the recharge zone such as springs, caves, or sinkholes, they would also convey surface water to the same springs. Contaminants from any source entering these karst features would likely contribute to water quality impairment and reduce site suitability for the cave crayfish. Based on the knowledge and function of hydrogeology within this recharge zone, it's recommended that identified karst features receive a 300 foot vegetative natural area where development is restricted. This distance is based on the need for a large area of natural infiltration and percolation of climatic events. This also gives a sufficient area to reduce the potential for contaminants to be directly input to the karst features. Otherwise, the entire influx of precipitation would be stormwater runoff from development activities. These are not "no touch" areas, but should be considered as conservation areas where a community trail system might be established or subdivision open space should be maintained. Natural areas may also meet city ordinance for a specific amount of the land to remain open.

While the distance of 300' is difficult to embrace, there are alternatives to reduce the impact to developers, including tax deductions and conservation easements. The Service is willing to discuss this recommendation in order to establish understanding and some level of agreement.

Stormwater

Stormwater concerns occur during construction and after the site is developed and stabilized. Threats to groundwater shift from sediment and fuel/oil/grease, to lawn chemicals, oil and grease from personal vehicles, brake dust, chip seals, roof tar, and other household contaminants. Plans should be made to address post construction stormwater contaminants.

The Arkansas Department of Environmental Quality and the Environmental Protection Agency oversee and permit stormwater runoff. In 2003, the Northwest Arkansas Regional Planning Commission developed the Northwest Arkansas Stormwater Quality Best Management Practices Preliminary Guide Manual for community use. The manual was developed with six control measures including public education and outreach, public participation and involvement, illicit discharge, detection and elimination, construction site runoff control, post-construction runoff control, pollution prevention, and good housekeeping. When open land is developed the hydrology of the site completely changes. Possible contaminants associated with development include sediment, nutrients, microbes, organic matter, toxic contaminants, trash, and debris. Each of these together or separately can pollute groundwater. Once contaminants leave the site and enter drainage within a groundwater recharge zone, whatever the water was carrying is now contributing to groundwater contamination threatens rare and endangered karst animals.

Please contact Jeff Hawkins Director of the Northwest Regional Planning Commission at 406 N. Shiloh, Springdale, Arkansas 72764 or call him at 479-751-7125 for a copy of their stormwater BMPs. BMPs summarized above are presented in greater depth in this publication.

Post Construction Stormwater Management

Stormwater runoff contains sediment, fuel/oil/grease, brake dust, herbicide, pesticide, and other contaminants. In order to reduce potential contaminants contained in stormwater during and after construction activities, the following recommendations apply.

Establish a permanent stormwater detention basin capable of capturing contaminates from the development. This basin can be rough initially, then refined once construction is complete and the site stabilized

Detention basins should be designed and constructed to capture the first ½ inch of a climatic event from the entire site proposed for development. These basins should be fenced and contain a 3:1 slope for safety reasons. The basin should not be constructed in a stream drainage, but may be constructed adjacent to it. A spillway should be established to allow for precipitation events in excess of ½ inch to be discharged based on state permitting. The bottom of the pond should be lined with a textile or bentonite type material to capture the rain and not allow infiltration. This should then be covered by approximately 1-2 feet of gravel, so that during maintenance the impenetrable lining would not be breeched.

Sediment monitoring should occur in the detention basin to document the filling rate and to determine when excess sediment should be removed. At least once a year the pond should be inspected for trash and debris which should be removed. At least every five years, the pond should be drained, sediment deposition monitored, and if necessary the pond dredged to its original depth. Dredged sediment should be removed to an appropriate location due to probable concentrated contaminants.

After capture of the first ½ inch of a precipitation event, additional flow should be directed to a 50-100 foot bioretention treatment area consisting of a vegetated strip, sand bed, organic or mulch layer, planting soil, and hydrophilic plants. This area provides additional filtration prior to proposed outfall. Plants can remove contaminants while a clay layer can absorb hydrocarbons, heavy metals, nutrients and other contaminants. Organic mulch filters contaminants and provides an environment conducive to growth of microorganisms, which degrade petroleum based products and other organic materials. Bioretention areas require maintenance. Due to potential high flows and scouring of the bioretention area, it's recommended that a foundation of rock be used as a base, with soil and vegetation placed on top.

Another alternative for treatment of stormwater are separation systems. These systems allow for sediment, oil and grease, and floatable debris to be collected. They require periodic maintenance, but may provide a reasonable alternative to detention basins. While these systems do reduce contaminants, outflow from the systems should run through a bioretention filter prior to leaving the site. One example can be found on the internet at baysaver.com

"Rain gardens" that drain internally may be suitable for certain sites. Site specific requirements and developer needs should be considered prior to selecting a preferred option.

A final alternative is to connect into an established community stormwater collection system which transfers and discharges to a permitted location. All regulations established and required by the Arkansas Department of Environmental Quality must be followed. Dependent on the site and its relation to a sensitive area, the development may still be required to implement post construction stormwater management controls prior to release in a stormwater system.

While options are discussed for post construction stormwater management, the Service recognizes we're not experts and are willing to discuss alternatives presented to us. The premise on which an alternative is founded is that each development be responsible for their stormwater and to reduce the threat to surface and groundwater from unregulated discharge.

Wastewater

Alternatives for managing wastewater are either currently available or possible in the future. These include regional or municipal sewage treatment plants, decentralized wastewater treatment facilities, or septic systems. Tontitown is currently installing a community sewer system, although septic tanks still occur in the recharge zone. Based on the density of large scale development, municipal facilities are the primary option.

Karst landscapes have limited soils which reduce effectiveness of decentralized and septic systems. Generally, shallow soils exist close to karst features limiting wastewater treatment potential. The Arkansas Department of Health (ADH) must be contacted for decentralized wastewater treatment facilities and septic systems in order for to characterize soils as capable of functioning effectively as part of the treatment process. In the case of decentralized wastewater treatment facilities, the ADH and Arkansas Department of Environmental Quality conduct reviews before permits are issued. Septic systems are reviewed and permitted by the ADH.

Where stream channels are located within the Elm Springs/Tontitown recharge zone, a setback of at least 300 feet should be the minimum for driplines or drainfields. Soils should meet more than the minimum criteria for wastewater detention time, given the fact that karst geology lies just beneath that transfers contaminants directly to groundwater.

Decentralized wastewater treatment is generally considered to be an extension of onsite wastewater treatment or conventional wastewater systems that includes some form of voluntary management practices. Decentralized systems employ a combination of technologies and are used to treat and dispose of wastewater from dwellings and businesses close to the source. Decentralized wastewater systems allow for flexibility in wastewater management, and different parts of the system may be combined into "treatment trains," or a series of processes to meet treatment goals, overcome site conditions, and to address environmental protection requirements. Each technology has advantages, as well as limitations, so a treatment technology must be selected specifically to meet local conditions and treatment objectives. Similarly, every community's own financial, physical, and regulatory factors must be evaluated to find the best technology for their circumstances.

Many considerations would determine how close to the source of generation it is practical to place the treatment center. One very important factor is the potential for beneficial reuse of reclaimed water. Other considerations include topography, soil conditions, development density (existing or desired), type of land use, and environmental impacts of the wastewater management function in any given locale.

Management is the key to keeping decentralized treatment systems functioning properly. Management can encompass planning, design, installation, operation, maintenance, and monitoring onsite and cluster systems. Regular inspection and maintenance form the basis of any management program.

Procedures for Subdivisions Using On-site Sewage Disposal

According to the Arkansas Department of Health’s RULES AND REGULATIONS PERTAINING TO SEWAGE DISPOSAL SYSTEMS, a subdivision is defined as “land divided or proposed to be divided by a common owner or owners for predominantly residential purposes into three or more lots or parcels, any of which contain less than three acres, or into platted or unplatted units any of which contain less than three acres, as a part of a uniform plan of development.”

1. You must contact an authorized Designated Representative to start the process. Designated Representative lists are available at the County Health Department.

2. The Designated Representative will submit the subdivision plans, in triplicate to the County Health Department.

3. The Arkansas Department of Health's Environmental Health Specialist will evaluate the site and write a letter with their findings to the Arkansas Department of Health Engineering Division. Special consideration will be given to sites that may pose a potential problem for ecologically sensitive areas, areas of shallow bedrock, fractured rock formations, and/or other conditions that may adversely affect renovation of wastewater before re-entering the true water table.

4. Following a recommendation from the Environmental Health Specialist, the Engineering Division will write a letter of approval or denial, usually in conjunction with the subdivision's water system, to the property owner. Water supply, treatment, and distribution plans for the subdivision, other than individual wells for each lot, must be prepared by a registered professional engineer and submitted to the Division of Engineering for review and approval. If you have any questions, please contact the County Health Department and speak to an Environmental Health Specialist.

Summary of Septic tanks from EPA website:

> If properly designed, constructed, and maintained, a septic system can provide an effective treatment of household wastewater. Malfunctioning systems can contaminate groundwater that might be a drinking water source or home to rare karst dependent animals. A typical septic system has four main components: a pipe from the home, a septic tank, a drainfield, and the soil. Microbes in the soil digest or remove contaminants from wastewater. A septic tank is buried in a watertight concrete, fiberglass, or polyethylene container. It holds wastewater long enough to allow solids to settle out and oil and grease to float to the surface. It also allows for partial decomposition of solid materials. A T-shaped outlet in the septic tank prevents sludge and scum from leaving the tank and traveling to the drainfield. Screens are also recommended to keep solids from entering the drainfield. Wastewater exits the septic tank and is discharged into the drainfield for further treatment by the soil. Microbes in the soil provide final treatment by removing harmful bacteria, viruses, and excess nutrients.

Procedures for Obtaining an Individual Septic System Permit

The Arkansas Department of Health requires all property owners using individual sewage disposal (septic system) for their property to follow the steps outlined below. You must contact an authorized designated representative to design the individual sewage disposal system or a repair to the individual sewage disposal system. Designated representative lists are available at the county health department. The following steps are in accordance with the Arkansas Department of Health's Rules and Regulations Pertaining to Individual Sewage Disposal Systems:

1. The Designated Representative will submit an application for a PERMIT FOR CONSTRUCTION for the individual sewage disposal system to the Arkansas Department of Health.

2. The Arkansas Department of Health's Environmental Health Specialist will evaluate the design and issue a PERMIT FOR CONSTRUCTION if the submitted application meets all current regulations and is appropriate for the site.

3. If approved, a copy of the permit will be mailed to the property owner at this time.

4. Upon receipt of the PERMIT FOR CONSTRUCTION, the approved individual sewage disposal system may be installed. A list of septic system installers licensed by the Arkansas Department of Health is available at the County Health Department.

5. After installation, and before the system is covered, the property owner and or the licensed installer will contact the Arkansas Department of Health's Environmental Health Specialist to conduct a final evaluation of the system. If the system is approved the Environmental Health Specialist will issue a PERMIT FOR OPERATION.

If you have any questions regarding on-site sewage disposal or septic systems, please contact the County Health Department and speak to an Environmental Health Specialist.

Development of the original BMP's

In December of 2004, a public meeting was held to discuss the Cave Springs Cave recharge zone (16 square miles). One task was developing a set of karst best management practices for establishment of common ground between the steady growth of three communities within the recharge zone and the conservation of groundwater, whereby protecting two endangered and several rare species. The document above is the product of that meeting with many of the agencies and organizations below either reviewing and/or providing comment. Of the 110 participants, over forty provided comment which was incorporated into the final document. This document minus incorporated recent changes was adopted by the community of Cave Springs as part of their planning ordinance. The Service appreciates those who participated in the original meeting and who took time to provide comment. The following is not a comprehensive list of participants, but represents many of the groups involved in developing these "Karst Best Management Practices."

- Private landowners
- Developers
- Attorneys
- Local engineering firms
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- Natural Resources Conservation Service
- Federal Highway Administration
- Arkansas Highway and Transportation Department
- Karst Resources Support Team
- Arkansas Game and Fish Commission
- Arkansas Department of Environmental Quality
- Arkansas Natural Resources Commission

- Arkansas Department of Health
- The Nature Conservancy
- Arkansas Natural Heritage Commission
- Cities of Cave Springs, Rogers, Lowell, and Bentonville
- Northwest Arkansas Regional Airport
- University of Arkansas professors

If you have any questions regarding the Community Growth Best Management Practices for the Conservation of the Elm Springs/Tontitown Recharge Zone and their application, please contact:

U.S. Fish and Wildlife Service, Arkansas Field Office
David Kampwerth, Karst Biologist
110 South Amity, Suite 300
Conway, Arkansas 72032
501-513-4477
David_Kampwerth@fws.gov