National Park Service
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Wind Cave National Park
Division of Resource Management
Physical Science Section

Cave and Karst Resource Management Plan

Wind Cave National Park

2007

CAVE AND KARST RESOURCE MANAGEMENT PLAN

WIND CAVE NATIONAL PARK

March 2007

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I. BACKGROUND

A. Park Purpose

The park was originally established on January 9, 1903 to protect Wind Cave. In 1935, the purpose of the park was expanded to include the adjacent game preserve that had been managed by the USDA since 1912 as a range for bison and North American game animals.

B. Geographic Location & Description of the Park

Wind Cave National Park (hereafter referred to as the park) is located in Custer County on the southeastern flank of the Black Hills, in southwestern South Dakota. The park is located 11 miles north of the town of Hot Springs. The park is bounded by Custer State Park to the north, Black Hills National Forest to the west, and private property to the east and south. The park consists of 28,295 acres of mixed-grass prairie, ponderosa pine forest, and shrublands. The park's mixed grass prairie is one of the few remaining and is home to native wildlife such as bison, elk, pronghorn, mule and whitetail deer, coyotes, and prairie dogs. Pre-Cambrian through Tertiary rocks are exposed in the park. Wind Cave is found in the Mississippian-aged Madison Limestone, locally called the Pahasapa Limestone. The cave is located below a 1.1 by 1.3 mile rectangle and directly under 600 acres in the south-central portion of the park (Fig. 1). A total of 42 other caves are scattered throughout the park.

C. Park Significance

The park is known for having one of the most outstanding caves in the world as well as a mixed grass prairie ecosystem, home to a variety of native wildlife species. Wind Cave was formed within the Madison Limestone (Locally called the Paha Sapa) of the Black Hills (Fig. 2,9), probably during Paleocene-Eocene times (40-50 million years ago), definitely after Laramide uplift of the Black Hills (60-70 million years ago). The cave developed along gypsum deposits and paleokarst zones and is one of the oldest caves in the world (Palmer and Palmer, 2000). The cave intersects one of the worlds best examples of paleofill, ancient sediment that filled caves and sinkholes that exisited before Wind Cave formed. The cave has two natural entrances, one of which was modified, and the cave is associated with five natural blowholes (Fig. 3). More than 120 miles of passages have been explored and mapped making Wind Cave one of the longest caves in the world. Studies of the airflow for which the cave is named suggest that only a tiny fraction of the cave's potential extent has been discovered. Wind Cave is the world's best known example of a complex rectilinear maze cave. At any given point, from three to five interconnecting levels can occur within 250-vertical feet of rock, creating one of the world's premier maze caves.

Wind Cave's length and passage density are enough to put it into the ranks of world-class caves, but the cave is significant for many other reasons. The best known of these is boxwork. Boxwork is rarely found in other caves but is found in Wind Cave in quantities and qualities that are unparalleled in all of the world's known caves. The cave is known for its rare and unusual variety of minerals and speleothems. These include helictite bushes, quartz formations, large clusters of frostwork, and fragile growths of gypsum (Fig. 4). On-going survey projects continually make new discoveries of unusual features in the cave (Horrocks, 2005b). The cave has a simple, but highly specialized ecosystem that operates independently of photosynthesis (Moore, 1996). Finally, the lakes in Wind Cave are the only direct access point to the Madison Aquifer.

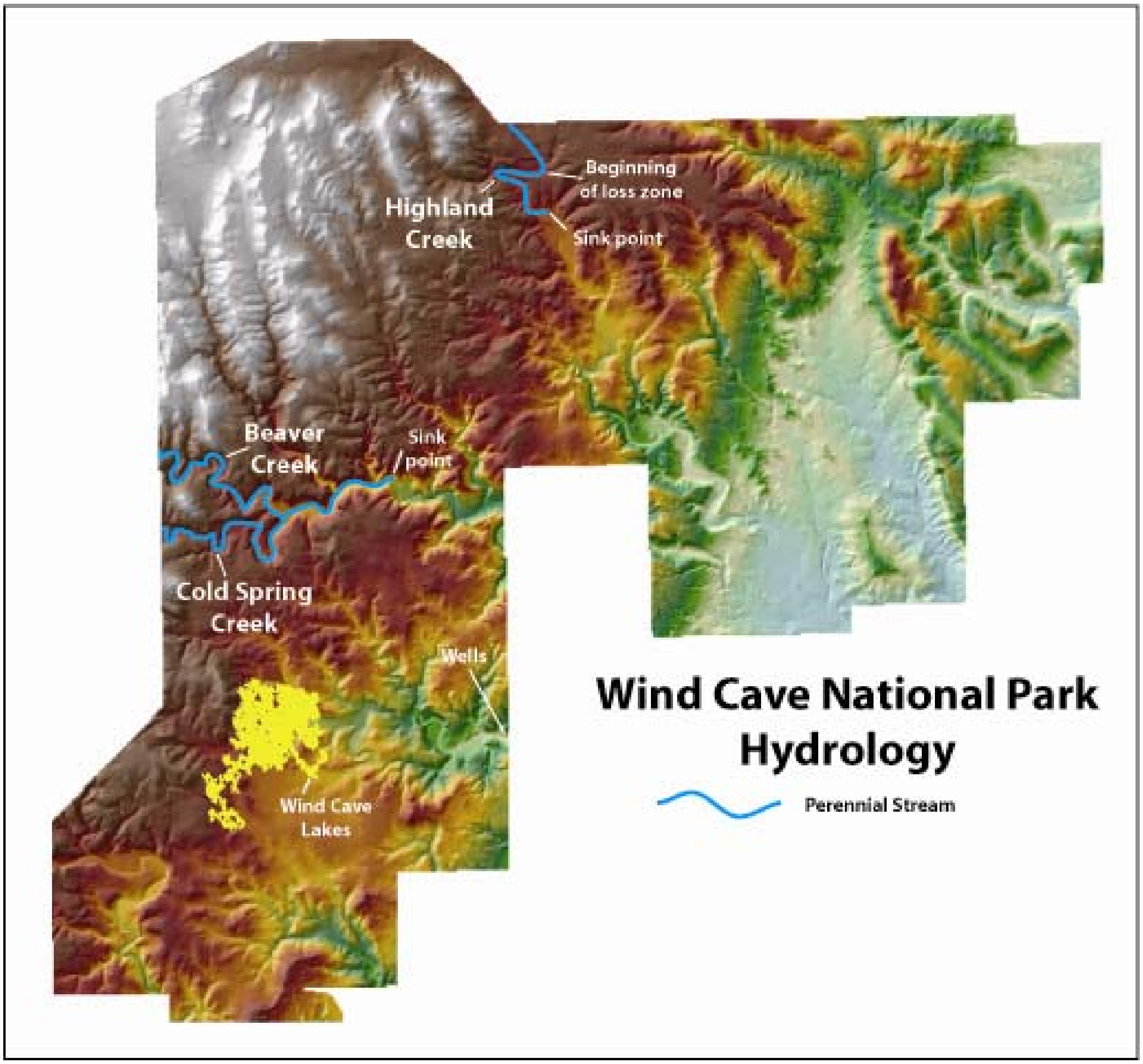

Figure 1: The location of Wind Cave and the three perenial streams, sink points, wells, and cave lakes within Wind Cave National Park.

The cave resources of the park are also valuable for the clues to human history of the area. Significant cultural resources, from signatures and drawings, to artifacts from previous mineral collecting, are found throughout the Historic Section of Wind Cave. Paleontological sites have been discovered in Wind Cave and other backcounrtry caves in the park, ranging from 250,000 years Before Present (BP) to recent. Flood debris found in several parts of Wind Cave have been radiocarbon dated to more than 4,000 years BP. This range of dates may provide valuable insights into past climates in the Black Hills region.

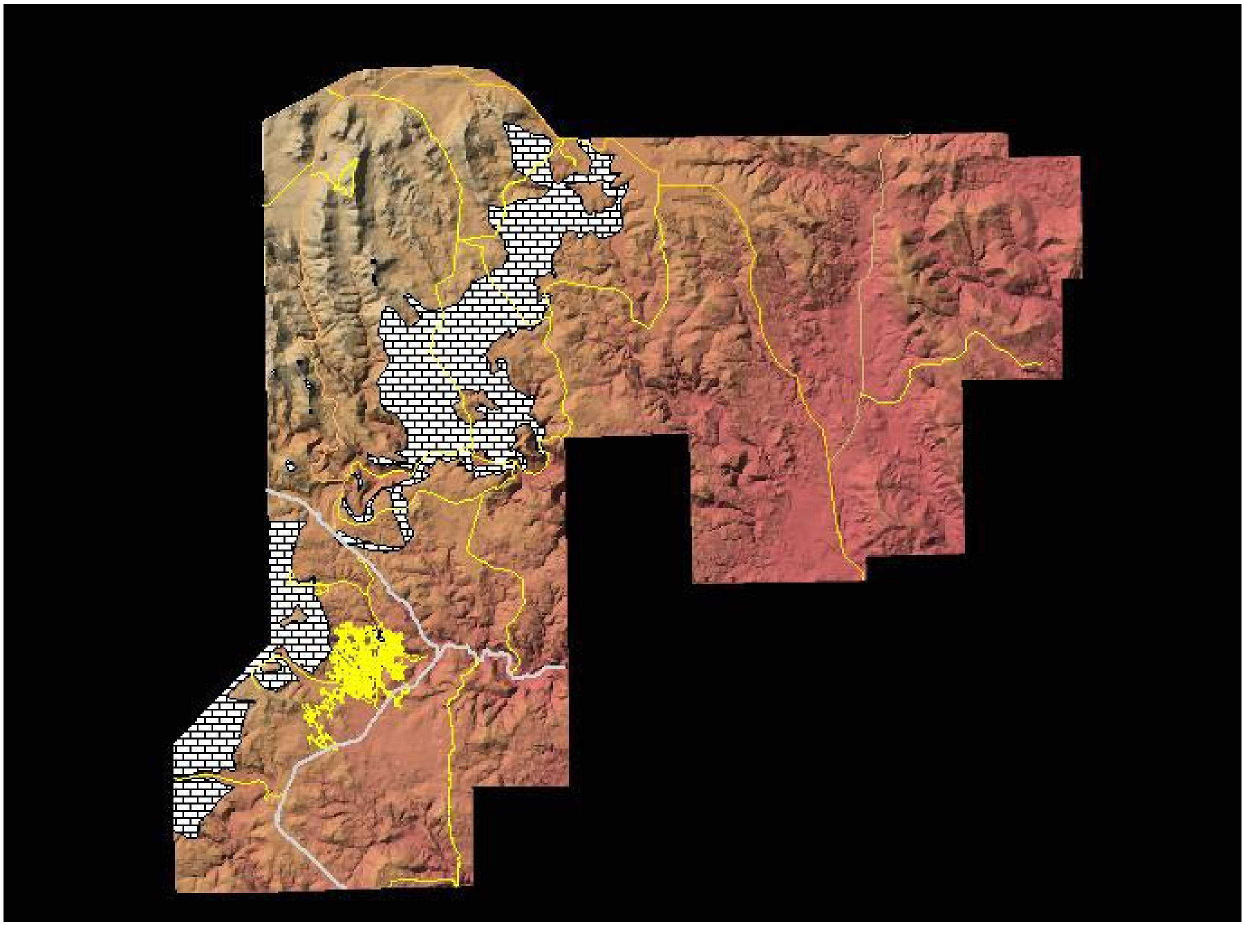

Figure 2: The relationship of Wind Cave to the Madison Limestone outcrops in the park.

The park contains mixed-grass prairie, ponderosa pine, and riparian ecosystems, and forms a transition zone between eastern and western biomes. The diversity of habitat supports a wide variety of plants and animals. The park has been called an exemplary example of a mixed-grass prairie, with low numbers of exotic species, and an unmatched diversity Black Hills plant species. The dynamic ecology of the surface resources has both direct and indirect affects on cave resources below.

The park has regionally significant vertebrate paleontological resources, including important sites that date back to 32 million years BP. In addition, internationally significant invertebrate paleontological sites have been found. The park contains important cultural resources, including prehistoric human activities that date back at least 10,000 years and a Civilian Conservation Corps (CCC) camp with its associated structures.

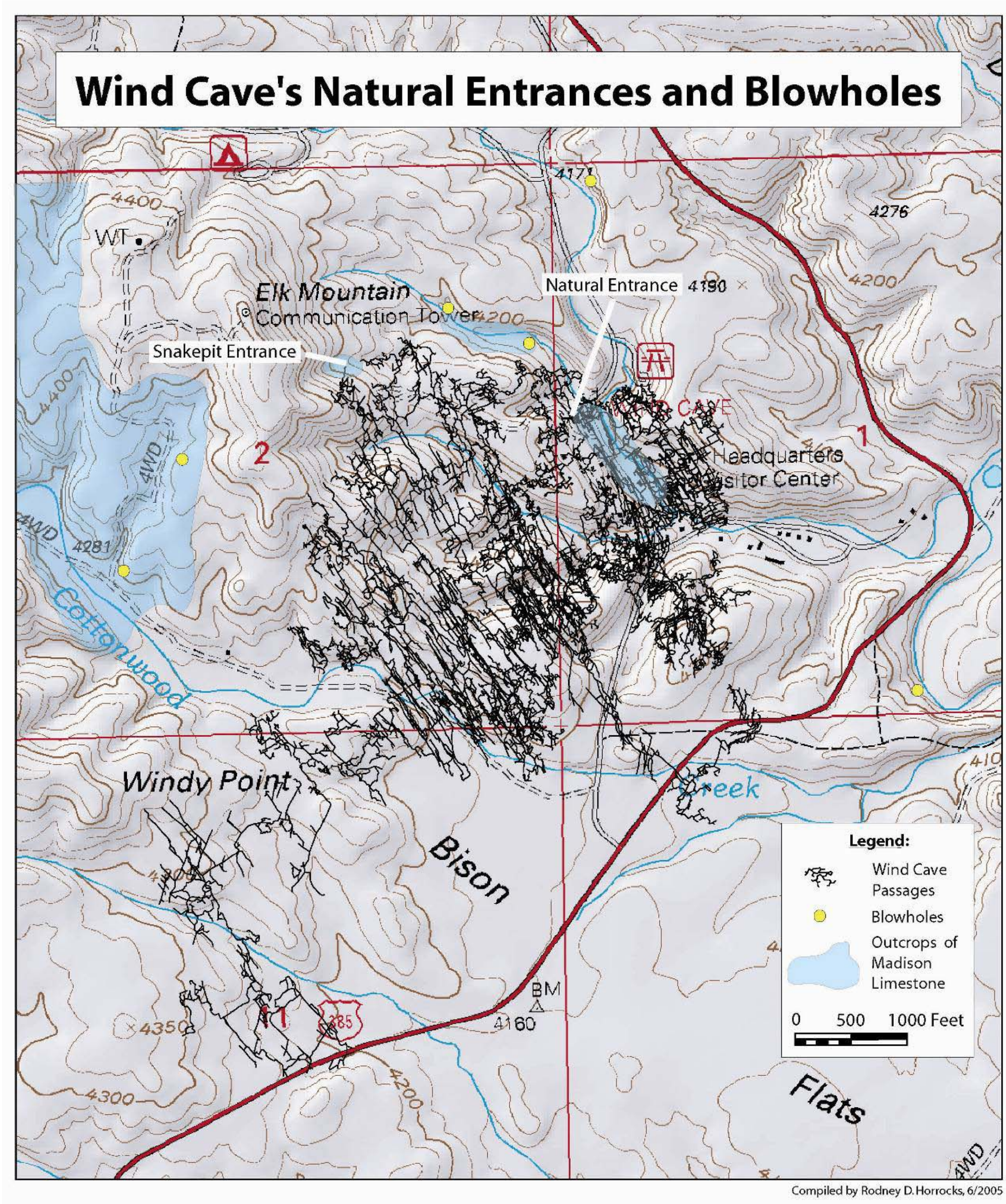

Figure 3: Wind Cave's Natural Entrances and Blowholes that are likely related to Wind Cave.

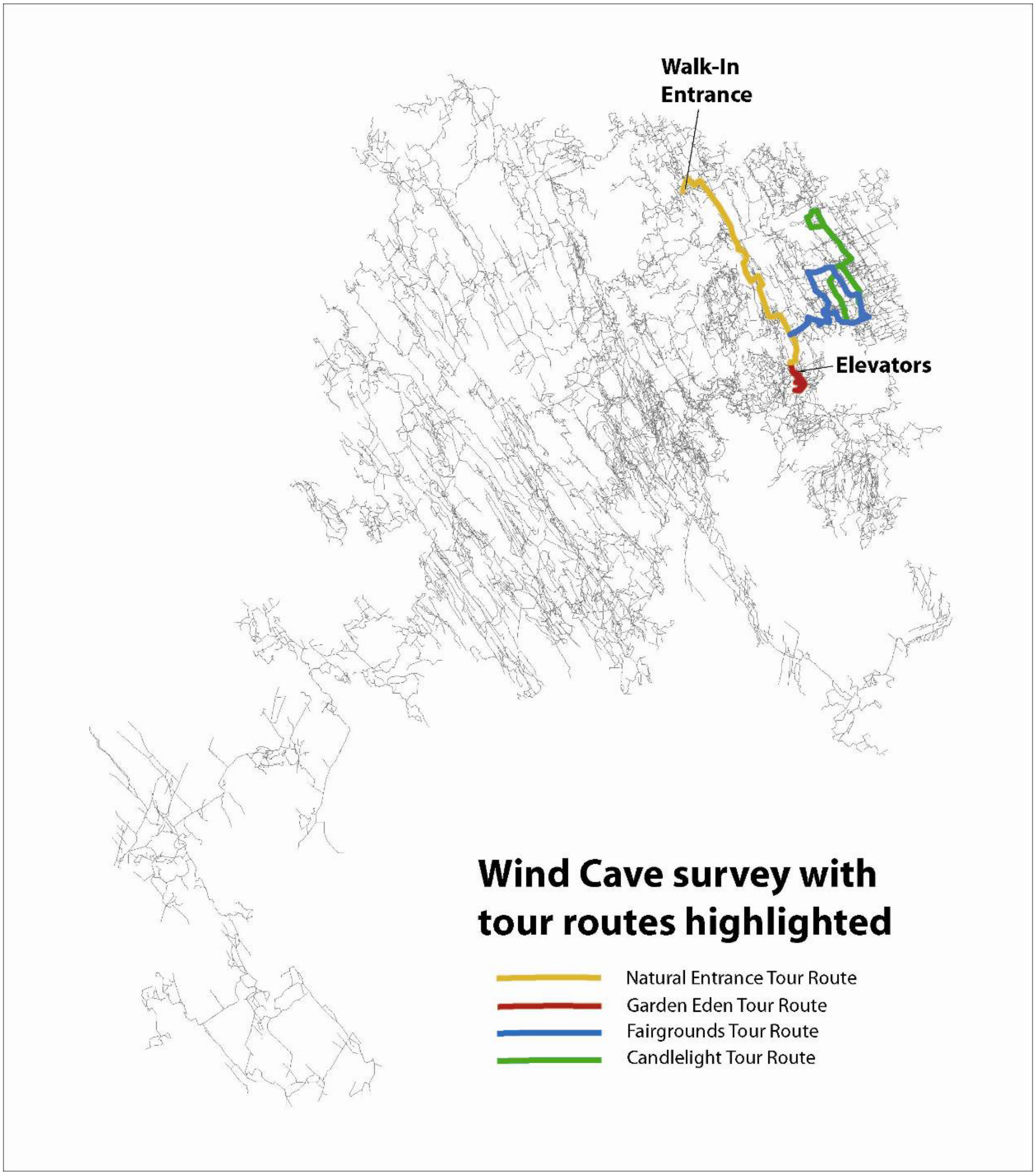

Figure 4: Wind Cave line plot with tour routes highlighted in color.

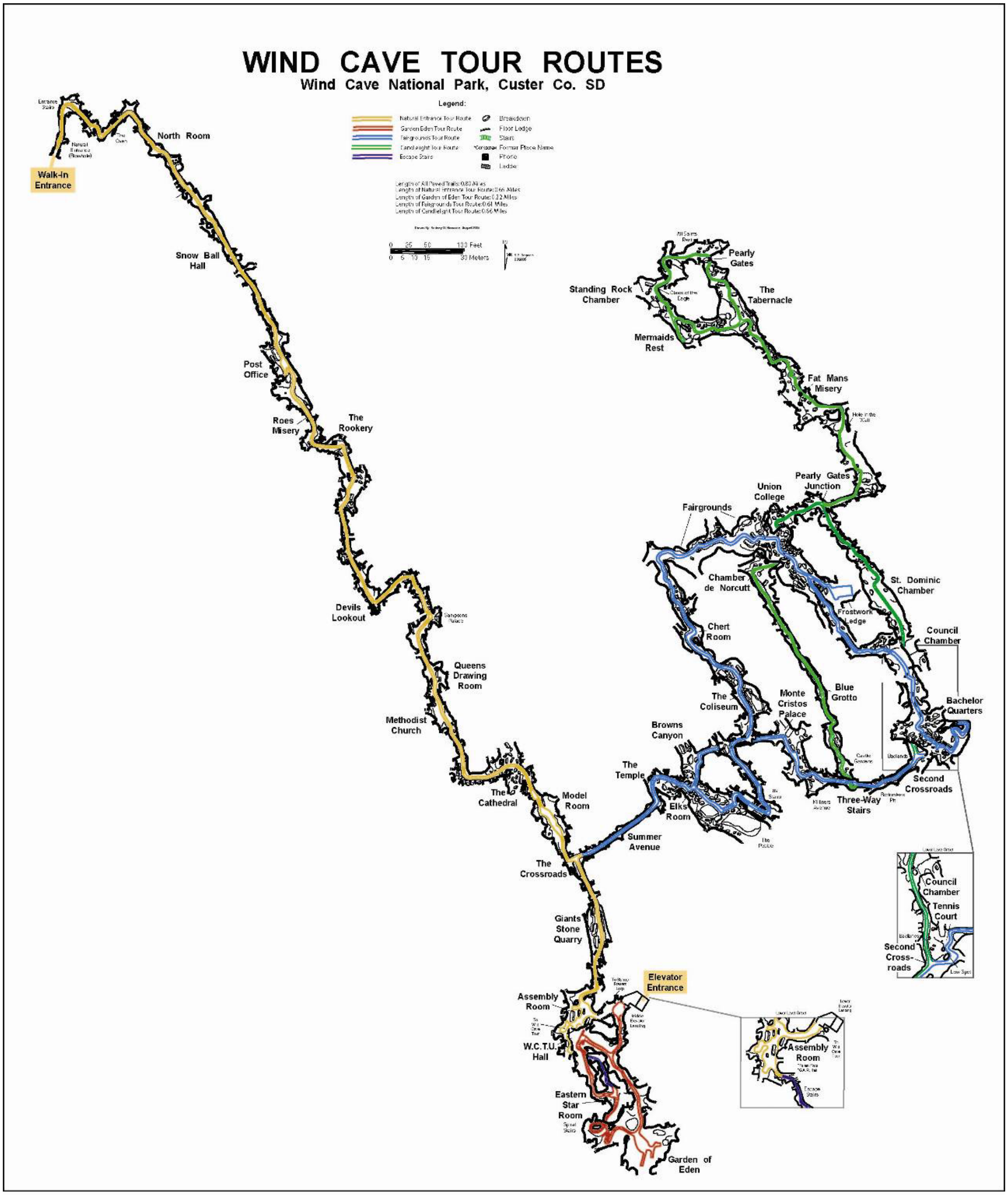

Figure 5: Wind Cave Tour Routes.

D. Surface Land Management Relationship to Karst

The land above, and the watersheds adjacent to the caves and karst areas in the park are a part of the whole cave and karst system. The park manages all activities within these areas with cave and karst issues in mind. Some of the known surface activity threats include, but are not limited to: parking lot runoff, hazardous material transportation via park roads, resurfacing park roads with oil-based products, sewage line and lagoon leakage, chemical exotic weed control, new construction, and expansion of the pine forest.

II. CAVE AND KARST RESOURCE MANAGEMENT

A. Purpose and Need for the Plan

The objective of this plan is to provide direction and to establish polices for the management of cave and karst resources in the park. This plan-will provide the direction to protect and perpetuate the park's delicate and non-renewable cave and karst resources. This plan is a revision of the signed 2000 Cave Management Plan.

The specific purposes of this plan are to:

- Define current cave and karst resource conditions within the park.
- Define desired future conditions of cave and karst resources within the park.
- Establish policies to manage cave and karst resources and the types of appropriate use.
- Establish methods for determining levels of acceptable impact from human use of the park's cave resources and suggest appropriate actions to mitigate those impacts.
- Establish methods for protection and perpetuation of natural cave, karst, and hydrological systems.
- Provide a platform for scientific studies and research in or about cave and karst resources and systems.
- Establish protocols for detailed inventories of resources within cave and karst resources.
- Provide educational and recreational opportunities for a broad spectrum of park visitors to discover, explore, study, respect, appreciate, and enjoy caves at their individual levels of interest and abilities.
- Establish park policy, guidelines, and/or permit stipulations that will ensure maximum safety of cavers and visitors while providing for the conservation of cave resources.

This plan is to be used in conjunction with the General Management Plan and the Resource Management Plan of the park. Whenever projects or actions are proposed that fall outside of this plan that may impact cave or karst resources, NEPA compliance work must be completed. This plan will be updated as needed.

This plan will adhere to policies established by the National Park Service's management policies, legislative mandates, and executive orders.

B. Relationship to Other Plans

The Cave and Karst Resource Management Plan is a stand-alone action plan that determines management prescriptions for cave and karst related issues that have been identified in the General Management and Resource Management Plans of the park. The Wind Cave National Park Cave and Karst Resource Management Plan tiers from the General Management Plan.

C. Legislative Mandates and Guidelines

1) Wind Cave National Park Enabling Legislation

The park was created by the Act of January 9, 1903 (32 Stat., 765-766, 16 USC 141-146). Its purpose is, “to prescribe rules and regulations and establish service as necessary for the care and management of the park.”

2) Wind Cave General Management Plan, 1994 (GMP)

Regarding Wind Cave, the GMP states that we will manage, “the undeveloped portion of the cave as *de facto* wilderness.” The plan also establishes four goals that pertain to cave and karst resources:

- Establish systems to monitor the condition of subsurface resources.
- Promote and conduct scientific study of natural resources.
- Establish limits of acceptable change for human use of the cave.
- Mitigate impacts of human use.

The GMP states that the Cave Resource Management Plan should establish that, “The long-term natural resource objectives for Wind Cave National Park are to establish guidelines, procedures, standards, and regulations that ensure the perpetuation of cave resources while allowing controlled access; to protect and perpetuate the natural systems and conditions that exist in Wind Cave; to ensure that the efforts of cooperating individuals or entities are coordinated and in concert with the needs of park management; and to integrate the surface and subsurface resources of the park, particularly in regard to the location of present or planned surface developments. A comprehensive series of studies and monitoring actions are needed to ensure that the cave is adequately protected from the effects of surface developments and activities.”

3) Statement for Management, 1994 (SFM)

The Wind Cave Statement for Management states that the purpose of the park is to, “Preserve and protect the surface and subsurface resources.”

4) Wind Cave National Park Draft Resource Management Plan, 2003 (RMP)

The plan identifies the following objectives for cave resources:

- To establish guidelines, procedures, and regulations that ensure the perpetuation of cave resources while allowing controlled access
- To protect and perpetuate the natural systems and conditions that exist in Wind Cave
- To ensure that the efforts of cooperating individuals or entities are coordinated and in concert with the needs of park management
- To integrate the surface and subsurface resources of the park, particularly in regards to the location of present or planned surface developments.

5) Superintendents Compendium, Compilation of Regulations for Wind Cave National Park

The Superintendents Compendium contains several specific regulations that go beyond 36 CFR, in order to provide public health and safety and protection of natural and cultural resources for the caves in the park.

1.5 Restricts access to all caves in the park except by authorized permit.

1.6 Restricts all people on guided cave tours in Wind Cave to the established trails or designated routes.

2.15 (a) (1) Establishes that all caves are closed to pets.

III. STATUS of CAVE & KARST RESOURCES

A. Cave & Karst Resources of Wind Cave National Park

1) Wind Cave

Wind Cave is the largest cave within the park. With over 120 miles of surveyed passage and an incredible potential for more, it ranks among the longest caves in the world. Recently, the on-going survey project has been documenting an average of five additional miles of passage a year. Currently the known cave is entirely within the boundaries of the park (Fig. 1). Public tours (Figs. 4,5) are provided on three paved tour routes, including the Natural Entrance (0.39 miles long), Garden of Eden (0.09 miles long), and the Fairgrounds (0.37 miles long) Tour Routes. A candle lantern tour is provided on the Candlelight Tour Route (0.42 miles long) and a wild cave experience is provided on the Wild Cave Tour Route (1,500 feet long). The main part of the tour routes vary from 80 to 210 feet below the surface, with the highest point being the top of the 89 stairs and the deepest point being the Blue Grotto. Within Wind Cave, three small streamlets drain towards the water table, where several large lakes and numerous smaller pools are found. There is a total of 636 feet of vertical relief between the highest point, the Bone Zone near the Snake Pit Entrance and the lowest point, the Lakes. The cave can be as deep as 510 feet below the surface. There are world-class exposures of paleokarst in the cave and it has a tremendous diversity of speleothems and mineral types. It contains more boxwork than any other known cave and contains other rare features such as helictite bushes, gypsum ropes, quartz formations, fossilized filamental iron-fixing bacterial strands, logomites, quartz rinds, dogtooth and nailhead spar, christmas trees, button popcorn, gypsum luster, flowers, starbursts, and hair, and hydromagnesite balloons. In 1893, John Stabler sent a collection of Wind Cave specimens to the Smithsonian Institution (Bohi, 1962). The microbial diversity in the cave is significant, with 12 divisions and subdivisions of bacteria found at Rainbow falls, including *Proteobacteria* and *Acidobacteria* and 2 divisions of microbes from the kingdom of *Archaea* (Euryarchaea and Crenarchaea) (Chelius, 2004).

2) Backcountry Caves

Currently there are over 42 known backcountry caves within the park (Ohms, 2004b). Although these caves are smaller than Wind Cave, each is significant. There is the potential for the discovery of additional caves, as the park contains large areas of exposed limestone and dolomite and other formations that may also contain caves. Backcountry caves will be managed under the policies and guidelines established in this plan. Currently, all backcountry caves are closed under authorization of the Superintendent's Compendium CFR 1.5 (a). Entry is by a permit issued from the Physical Science office of the park.

3) Karst Features

Karst features found in the park include but may not be limited to: features, rockshelters, springs, sinking streams, and blowholes.

a. Features

In the park, there are numerous small phreatic pockets, enlarged joints, and tubes that are too short to be considered caves. The differentiation between caves and features is subjective.

b. Rockshelters

There are several rockshelters in the park that have significant paleontological, archaeological, and biological resources.

c. Springs

Although there are over 90 springs within the park, none are known to be directly related to known caves. They will be monitored and managed as part of the park's water quality management program.

d. Sinking Streams

There are three major perennial streams in the park - Highland, Beaver, and Cold Spring creeks. Cold Spring Creek converges with Beaver Creek shortly after entering the park. Highland and Beaver Creeks both lose part or all of their flow to the subsurface. Beaver & Highland Creek average a combined loss of 2,514,240 gallons (9,554,112 liters) per day (Driscoll, 2002). Depending on time of year and precipitation, there may be several other streams flowing in the park. Reeves Gulch, Red Valley, Fuson Canyon, and Wind Cave Canyon occasionally have flowing water at least part of the year. Similar to the perennial streams, the intermittent streams lose their flow to the subsurface.

e. Blowholes

Blowholes are small holes in the ground that respond to barometric pressure changes just as the Natural Entrance in Wind Cave does. There are a number of blowholes found within the park (Fig. 3). Airflow from these features may indicate the potential for extensive cave passages somewhere below.

B. Cave and Karst Resource Baseline Data

1) Summary of Natural Resources Baseline Information

Although inventories and research have been conducted on cave and karst resources in the park since the mid 1950s, there is a tremendous need for additional work, as illustrated in the summary table below.

a. Summary Table of Natural Resources Baseline Information (As determined by the park's Physical Science staff)

INVENTORY COMPONENTS	LEVEL I DATA[1]	LEVEL II DATA[2]	LEVEL III DATA[3]
Historical Database		X	
Biological Information		X	
Species List		X	
Invertebrate/Vertebrate Surveys			X
Microbial Surveys		X	
Species Distribution		X	
Cartographic Maps			X
Survey Data		X	
Cave Feature Inventory		X	
Geology Map	X		
Watershed Map		X	
Hydrology		X	
Cave Climatological Data			X
Radon			X
Visitor Impact Studies		X	

1) Level I Data – No data to minimal data, insufficient to make management decisions
2) Level II Data – Baseline data sufficient for basic decision making processes
3) Level III Data – Completed research projects with sufficient data for most data management needs. Additional research projects may still be required.

2) History and Status of Natural Cave and Karst Resource Baseline Data

a. Historical Database

Cave exploration efforts in Wind Cave have been increasingly well documented through time. Documentation efforts began with Alvin McDonald and include:

- Alvin McDonald documenting his early explorations, 1890-1993, with a journal entry and sketch map of some of his major discoveries (McDonald, 1891).
- Beginning in 1895, stereo photographs were taken along the tour routes.
- Beginning in 1959, photographs started to be sporadically taken in conjunction with exploration and survey.
- In the mid 1960's Dave Schnute created an index card place name file.
- Beginning in 1984, the park began documenting each trip with a report completed by the trip leader.

- Beginning in 1988 cave inventory data started being collected. This cave feature inventory database contains records of most cultural items found in the cave.
- Historical graffiti has also been sporadically documented during this cave inventory data collection process.
- In 1988, seasonal Interpreter Bill Rodgers compiled a binder of cave management related documentation. This binder has become an important historic record of early cave management at the park.
- In 1999, a database of every surveyor that has worked in Wind Cave since 1934 and how many trips they have taken was compiled.
- To better preserve photographic slides, an archival cave management slide file was created in 1999.
- In 2000, a Place Name Lexicon for Wind Cave was created that currently contains over 1,850 place names and the reasons those names were chosen (Horrocks, 2005).
- In 2003, Rod Horrocks created a photographic timeline of the history of the park for a display in the Visitor Center during the park's 100-year celebration.
- In 2005, Horrocks completed a map of the developed tour routes that includes all identified historical place names (Horrocks, 2005i).
- In 2005, Horrocks created a list of all of the known Alvin McDonald signatures in Wind Cave. To date, 46 signatures have been documented and entered as a layer in the park's GIS (Horrocks, 2005g).
- Many of the historic stereo photographs originally taken during the 1890s were retaken by Mike Hanson during a volunteer project conducted between 2000-2006 (Hanson, 2004).
- The park has collected a large percentage of the historical articles written about Wind Cave and the exploration of the cave. These are contained in the park library and the Physical Science office files.
- In 2006, an Access database was created by Rene Ohms to enter all cave trip reports into a database that can be queried (Ohms, Rene, 2006).

b. Biological Information

Numerous cave biota projects have been conducted in Wind Cave and include:

- In 1927, Dr. H. C. Severin, from the Division of Agriculture Brookings Department of Entomology-Zoology, examined Wind Cave for insects. He identified five species, finding no cave adapted forms.
- As part of the 1959 NSS Expedition to Wind Cave, Stewart Peck, conducted a biological survey in the cave. He noted that biota in Wind Cave was scarce due to the lack of water and sediments. He also documented the long-legged Myotis from Wind Cave as well as a species of collembola previously only know from Montana, Oncopodura cruciata and another Parrhopalites, which had only been previously found in Mexico (Peck, 1959).
- In 1996, Dr. John Moore from the University of Northern Colorado completed a three-year project looking at cave biota and trophic interactions along the tour routes in Wind Cave. He found that human activity has impacted the cave ecosystem by introducing carbon. He also

found that heterotrophic bacterial and fungal densities along the tour routes approached those levels found in surface soils. (Moore, 1996).

- Moore also completed an invertebrate survey along the developed tour routes and nearby off-trail areas. He found bacteria, fungi, protozoa, nematodes, and micro arthropods (mites, collembola, and diplura) along the tour routes. He found that material shed from visitors allowed four trophic levels to exist, including predators, while other off-trail areas only possessed two trophic levels with no predators (Moore 1996, 1997).
- Renee Jesser (a graduate student working with Dr. John Moore) completed a Masters thesis on the effects of productivity on species diversity and trophic structure in Wind Cave. She found that there was a correlation between the rate of energy input and species diversity and trophic structure. She also found that species populations vary between different regions of the cave (Jesser, 1998).
- In 2002, the Biotechnology Institute of Western Kentucky University conducted preliminary work to determine microbial presence and diversity in Wind Cave. The results indicated that Wind Cave is highly microbiologically diverse (Moore, Rolland, 2002).
- Marisa Cheilus and Dr. John Moore did DNA fingerprinting of microbes in infiltration water at Rainbow Falls in the Historic Section of Wind Cave. She found four bacterial divisions and subdivisions representing 14 phylotypes. The predominant groups were from *Proteobacteria* and *Acidobacteria.* Although a few clones resembled sequences from other caves and mines in Italy and South Africa, she found no cave-specific communities (Cheilus and Moore, 2004).
- To date, a total of 7 species of bats have been identified from caves in the park.

d. Survey Data

Since cowboys found Wind Cave in 1881, several groups of professional surveyors have surveyed along the tour routes and over 1,000 volunteer cavers have documented their off-trail discoveries. These survey efforts include:

- Walter Scott completed a seven-day survey project in 1896 to find a spot for an exit tunnel and to create a tourist map of Wind Cave. No map was produced.
- The earliest existing survey was conducted in 1902 and produced about 1 mile of survey along the tour routes (Willsie, 1902).
- Between 1933 and 1934, NPS engineers supervised CCC survey crews as they surveyed all of the tour routes and a couple off-trail routes, including the Bishop Fowlers Loop and Silent Lake to Rome. They marked their stations with small painted red letters and included elevations next to each station.
- Between 1955 and 1963, the South Dakota School of Mines and Technology in Rapid City mapped another 1 mile of off-trail passage.
- In 1959, the National Speleological Society's Wind Cave Expedition attempted to gain a better understanding of the size and pattern of Wind Cave. They mapped 3 miles, primarily in three areas, the Attic, north of the Pearly Gates area, and in Browns Canyon (Brown 1959).

- In 1959, the Colorado Grotto, at the request of the park, entered a contract to conduct two survey projects in Wind Cave, one to find a route between the Garden of Eden and the Elks Room, in order to find a bypass of Summer Avenue for a tour route, and another to locate all leads between the Walk-In Entrance and the Post office (Borde 1960).
- In December of 1961, the Colorado Grotto began a survey project in the "Northwest Area", surveying passages located west of the Post Office.
- In 1962, seasonal Park Ranger Alan Howard began surveying in the cave, mapping several thousand feet of passage.
- In the mid-1960s, Dave Schnute and Herb and Jan Conn surveyed nearly three miles and made numerous important discoveries during a short period of time.
- In 1969, Bill Yett led a group of Colorado Grotto cavers on a trip that discovered the Colorado Grotto Section of the cave, starting a project that mapped a couple of miles.
- In 1970, John Scheltens and the Windy City Grotto began a four-year survey project. By 1973, they had surveyed 20 miles of passage (Scheltens, 1973).
- During the 1970s, park employees also contributed another 3 miles of survey.
- In 1980, John Scheltens and Dave Springhetti discovered an extensive area they named the Spaghetti Bowl that contained over a mile of walking passages.
- During the 1980s, the National Outdoor Leadership School (N.O.L.S.) surveyed in the cave, primarily in the western and northern portions of the Historic Section.
- In 1984, a cave known as The Blowhole to cavers was connected to the North Section of Wind Cave, adding 1,100 feet of passage and a second entrance to Wind Cave (The park called this cave the Horse Corral Blowhole).
- As the survey grew, the boundaries of the cave expanded to 0.80 miles north/south – 0.85 miles east/west.
- In 1990, the Wind Cave Weekend survey project was started by the Colorado Grotto. In 1991, Paul Burger discovered the Silent Struggle that led to over six miles of survey that came to be known as the Southern Comfort Section. By 1998, 19 miles had been added to the whole cave.
- Since 1999, the Wind Cave Weekend has continued and coupled with increased survey work by park staff and local cavers, an average of 5 miles a year is being surveyed. The total Wind Cave survey now exceeds 120 miles and the boundaries have expanded to fill a 1.1 by 1.3 mile rectangle (Fig. 1).

The park has established protocols for survey data collection to ensure that the highest quality data is obtained. The current Wind Cave survey consists of over 34,000 stations, 1,700 loops, and 1,500 surveys. To manage this large amount of survey data, the data has been subdivided into nine different linked sections (Fig. 6). All survey data collected in the park has been entered into a cave survey data processing computer program, known as COMPASS, and checked for blunders (fundamental human errors made during the collection of the data). The Wind Cave survey database contains 114 surveys, including nearly 15 miles of survey data that contains missing information or errors. Through error checking and resurveying, the percentage of loops that have unacceptable closure errors was reduced from 30% in 1999 to 15% in 2004. An additional 212 surveys do not meet today's survey standards for sketching. About 20% of the stations in the Wind Cave survey have yet to be inventoried. A digital copy of the trip reports has not been created and there is no easy way to search these records. Likewise, there are no backup copies of these reports.

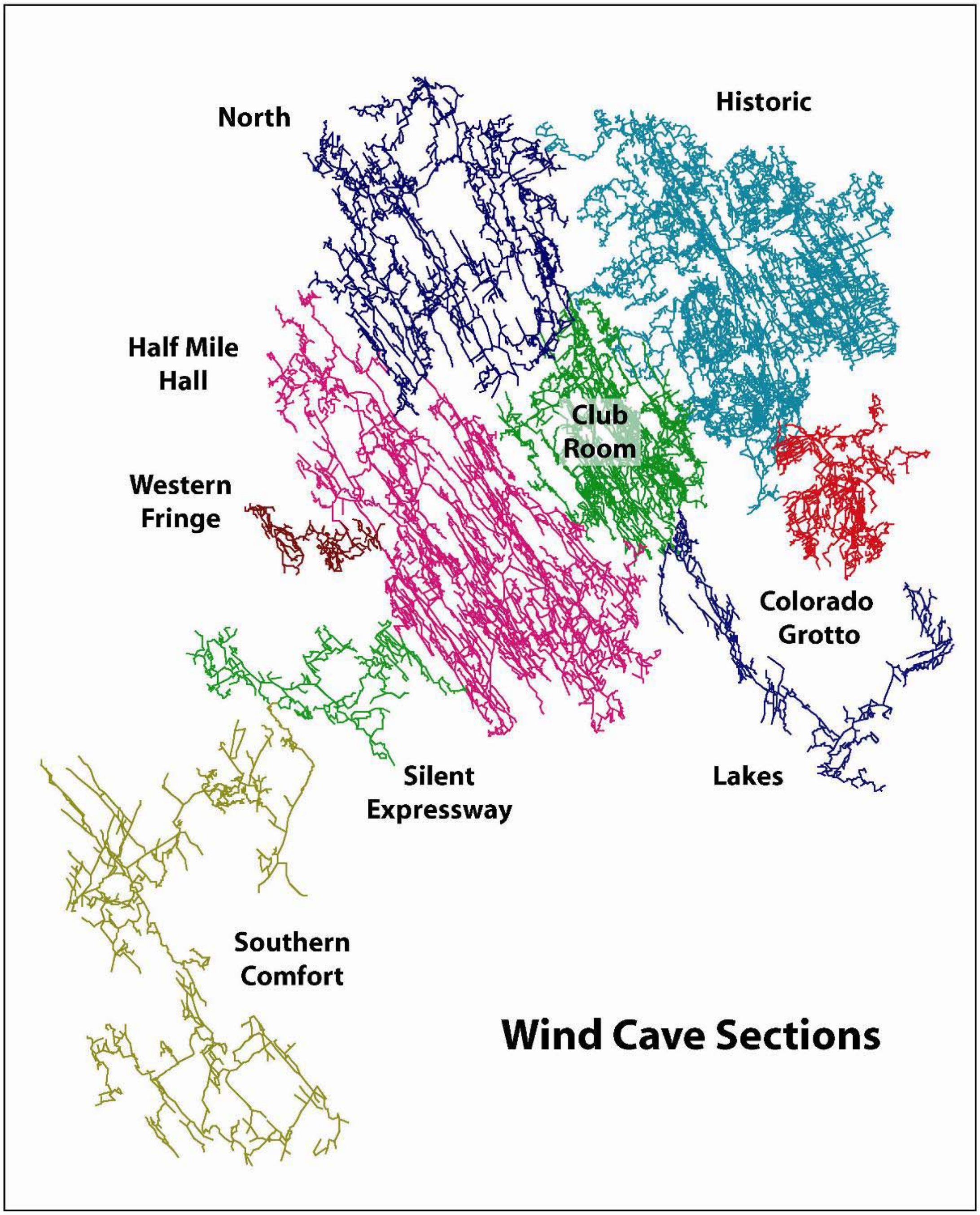

Figure 6: Sections in Wind Cave.

Wind Cave Quadrangles

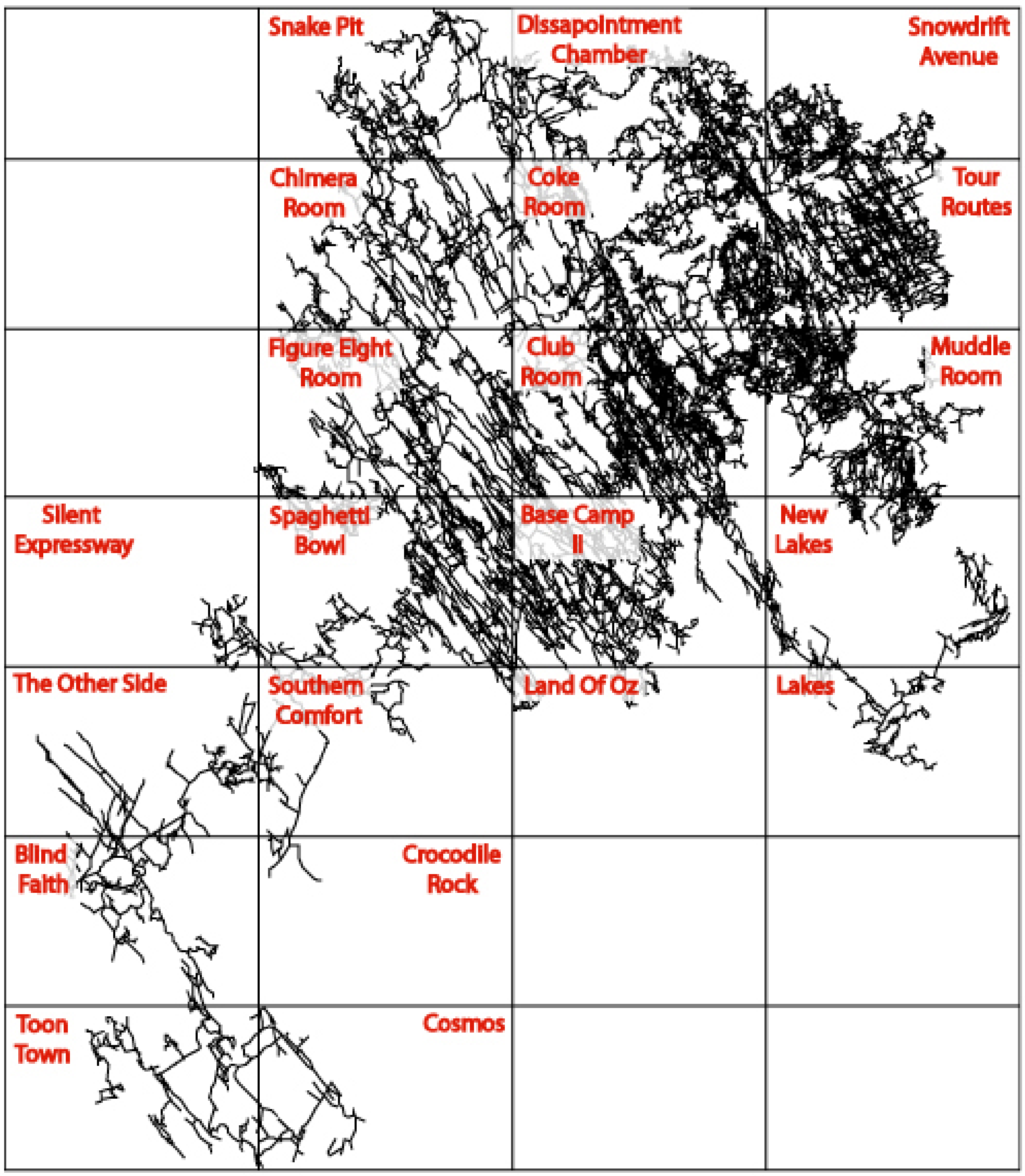

Figure 7: Wind Cave Quadrangle Maps.

c. Cartographic Maps

There have been many versions of cave maps drawn of Wind Cave, which include:

- In 1902, a map was produced of the tour routes from a transit survey. This map was used in park brochures for a long time.
- In 1934, the NPS office of Chief Engineer in San Francisco produced a simplistic map of the tour routes in Wind Cave at 10'/inch from a transit survey.
- In 1959, John L. Haas drew four quadrangle sheets showing three miles of survey from the 1959 NSS Wind Cave Expedition. These maps were drawn at a scale of 30'/inch and covered about 1,015 by 630-foot sections of the cave. These maps were drafted with ink and Leroy lettering on linen.
- In 1961, Pete Prebble compiled a map at 20'/inch from the surveys that the Colorado Grotto had done between the Garden of Eden and the Elks Room while looking for a way to bypass Summer Avenue.
- In 1961, Ken B. Carpenter compiled a map at 20'/inch of the Cathedral/Fairgrounds Loop surveyed by the Colorado Grotto.
- In 1962, Herb Conn was contracted to draw a map at 50'/inch of the tour routes and associated off-trail passages that roughly paralleled the main NW/SE passage trend with NE oriented upward. This map covered a 1,875 x 1,210 foot section of the cave and contained about 2.7 miles of survey.
- In 1962, Alan Howard drew a draft map of passages he surveyed in the Garden of Eden Tour Route area.
- In 1965, Dave Schnute produced a map of a new area discovered off of the Garden of Eden level.
- In 1966, the Colorado Grotto of the NSS produced a new map of Wind Cave that incorporated the surveys of several groups and included 10.53 miles of survey.
- Between 1970 and 1973, John Scheltens, from the Windy City Grotto, used a grid system to add several quadrangles to Conn's map. These Mylar quadrangles covered 1,600 by 1,050 foot sections of the cave. Scheltens divided the cave into two levels, using red for lower levels and green for upper. These maps contained about 19 miles of survey.
- In 1973, Jens Munthe drew a draft map of the Xerox Room area, which the Colorado Grotto had discovered in 1969.
- In 1974, Herb Conn was contracted to draft all completed surveys onto maps. He drew 14 cave quadrangle maps at 50'/inch. These maps covered 1,675 by 1,050 foot sections of the cave and contained about 19 miles of

passages. These maps were drafted with ink on Mylar with Leroy lettering.

- In 1975 John Scheltens drafted all of the known survey onto three large 6' x 3' maps, at a scale of 50'/inch. He rotated his maps so that north was oriented upwards. These maps originally contained 20.4 miles of survey and were updated yearly until 39.56 miles were included by 1984.
- In 1984, Warren Netherton divided Scheltens map into 18 quadrangles at 50'/inch. He then traced Scheltens maps with ink and Leroy lettering onto 22" x 36" Mylar sheets. Each quadrangle covered 1,800 by 1,100 foot sections of the cave that could be subdivided into quarter sections to make photocopying individual sections easier. These quadrangles included about 39.56 miles of survey.
- Between 1993 and 1995, Stan Allison, with the help of Colorado Grotto volunteers Doug Kent, Paul Burger, and Jim Wilson, redrew all 18 Wind Cave quadrangles sheets. These working maps were drawn in pencil on large pieces of plotter paper at a scale of 50'/inch and covered 1,500 by 1,000 foot sections of the cave. Three new quadrangles were also added to the original 18 (Fig. 7). These quads contained approximately 78 miles of survey.
- Between 2003 and 2006, Rod Horrocks, Marc Ohms, Jason Walz, Steve Lester, Evan Anderson, Matt Reece, and Bonnie Curnock updated and redrafted all 21 quadrangles. These were drawn with pencil on 20 x 30 inch Mylar sheets that included a preprinted border and legend. The eight most complex quadrangles were divided into three layers each, which increased the total number of sheets to 37. These were scanned as digital images and compiled into a Wind Cave Atlas by Horrocks. These maps are up-to-date as of July 2006 and include 121.02 miles of drafted survey.
- By 2005, cave maps were completed for all but one of the 42 backcountry caves known in the park (Wild Tick Hole has not been relocated).

e. Cave Feature Inventory

There have been several attempts to modify how cave feature inventory data is collected in the park.

- In the 1950s, several South Dakota School of Mines & Technology (SDSM&T) undergraduate students conducted Bachelor thesis mineral inventories in the Historic Section of Wind Cave, covering a total of about one mile of passage. However, these inventories have not been incorporated into the SpeleoWorks Cave Inventory database.
- In 1988, a cave feature inventory requirement was added to the cave surveying protocols. This involved using three bound cave inventory books with facing pages. The first included minimum size, level, floor, and water with a blank facing page for notes, the second included geological, airflow, vertebrates, invertebrates, organic material, recent, cultural, and hazards features with a blank facing page for notes, and the last book included speleothem features with another blank facing page for notes.

- In 1999, the cave inventory forms were reduced to a front and back single sheet printed on water-resistant paper that was hole-punched to fit into the six-ring yellow survey binders. This form was extensively revised in 2006 to correct mistakes, alphabetize features, and eliminate features that could be sketched. This form included cave level, speleothems, and geological features on the front and floor geology, water, biological, and cultural features on the back.
- In 2001, Matt Reece designed a customized Access database and interface for entering cave inventory data. However, this was only used for a short time period due to the laborious nature of entering data a feature at a time.
- In 2002, the park's computer specialist, Will Powers, created a MySQL database to make the cave inventory data more GIS compatible. Powers imported Reece's database into his new database. Although, Jason Walz entered cave inventory data for a couple thousand stations using this new interface it also was too laborious to continue using. Once Powers left the park, this database was also abandoned.
- In 2005, park volunteer Tom McBride used his programming skills to write 800 lines of code for a new Microsoft Access data inventory program he named SpeleoWorks (McBride, 2005). McBride removed nearly 7,000 redundant survey stations that had somehow been entered into the old database, reducing the number of stations to 13,550. A project was immediately started to enter 350+ backlogged cave inventory sheets and the comments from all of the old bound inventories into the new database (Horrocks, 2005h). As of 2006, this database currently contains feature data for 20,000+ survey stations. An effort to inventory the final 19% of the surveys in Wind Cave that have no inventory data collected as of yet, is planned.

f. Geologic Mapping

There have been a few efforts to map the geological resources of the park, which include:

- In 1953, a Geophysicist from Continental Oil Company placed electrical recording and meter instruments within the cave and on the ground, so a specially equipped airplane flying overhead could measure electrical resistance of the Madison Limestone (1953 Superintendents Annual Report).
- In 1973, Dave Eddy mapped the surficial geology of the entire park at a scale of 1:24,000. This map was digitized in the early 1990s (Fig. 9). This map shows that 36% of the park has karstic rocks exposed on the surface (10,120 acres), including 5,461 acres of Minnelusa Formation, 3,022 acres of Madison Limestone, and 1,637 acres of Minnekahta Limestone.
- In the late 1990s Ted Jennings and Mark Fahrenbach, field mapped the contact of the Madison and Minnelusa Formations within the park. This included the lower three members of the Minnelusa Formation.
- Tim and Beth Lincoln began a detailed mapping project in 2004 of the igneous rocks in the northwestern section of the park.

- The USGS and the state of South Dakota, have agreed to publish the geology maps of the six quadrangles that cover portions of the park once they have been completely mapped.

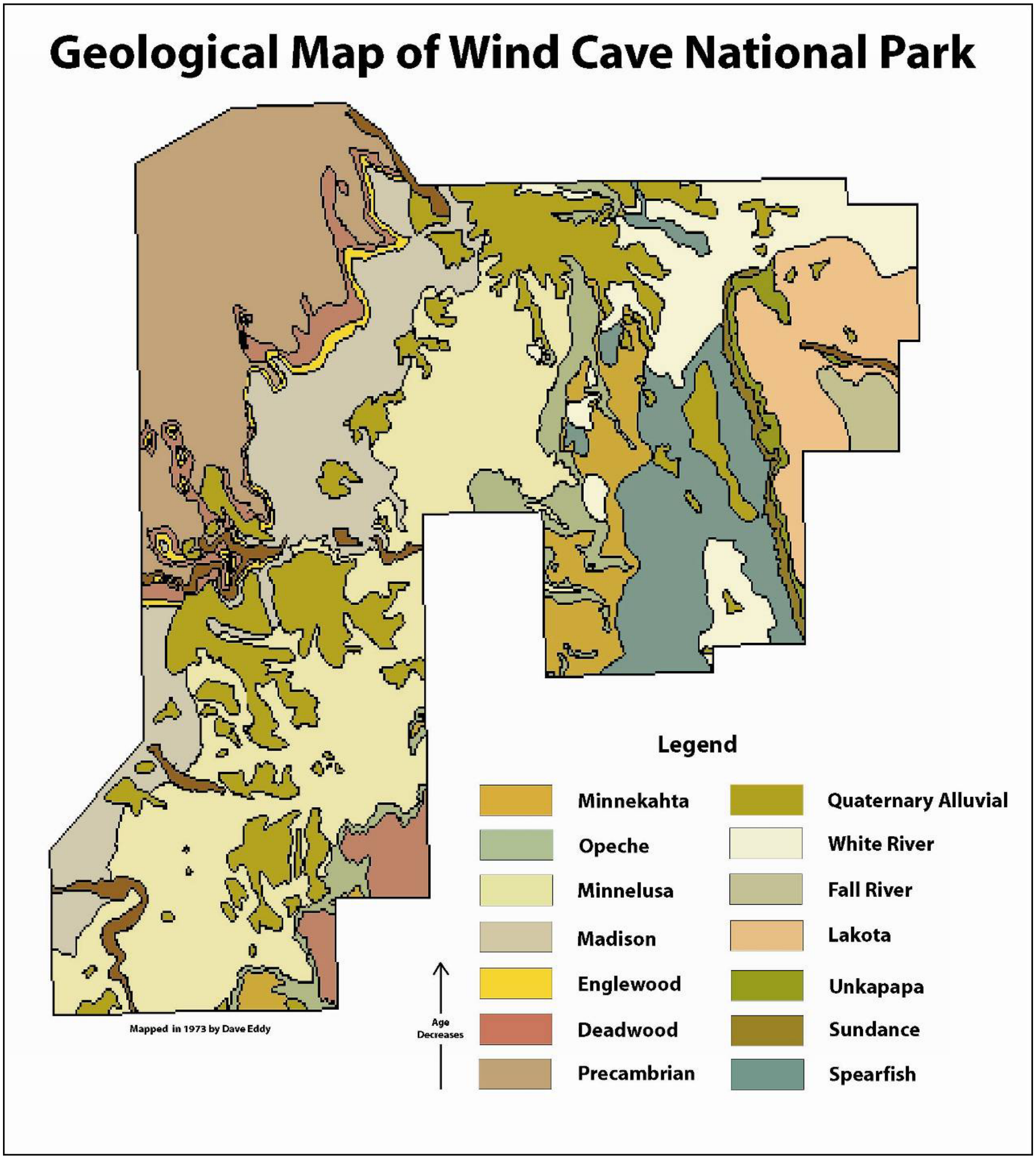

Figure 9: Geological Map of Wind Cave National Park.

g. Watershed Maps

In 1988, Wayne Schroeder determined the acreage of the drainage basins for the park. This was a mathematical exercise and no map was produced. In 2006, the park's GIS Specialist, Bill Koncerak, used GIS to create watersheds for the three perennial streams in the park, Highland Creek, Beaver Creek, and Cold Spring Creek. These were based on Hydrologic Unit Code (HUC) lines obtained from the U.S. Geological Survey and the Black Hills National Forest (Fig. 10).

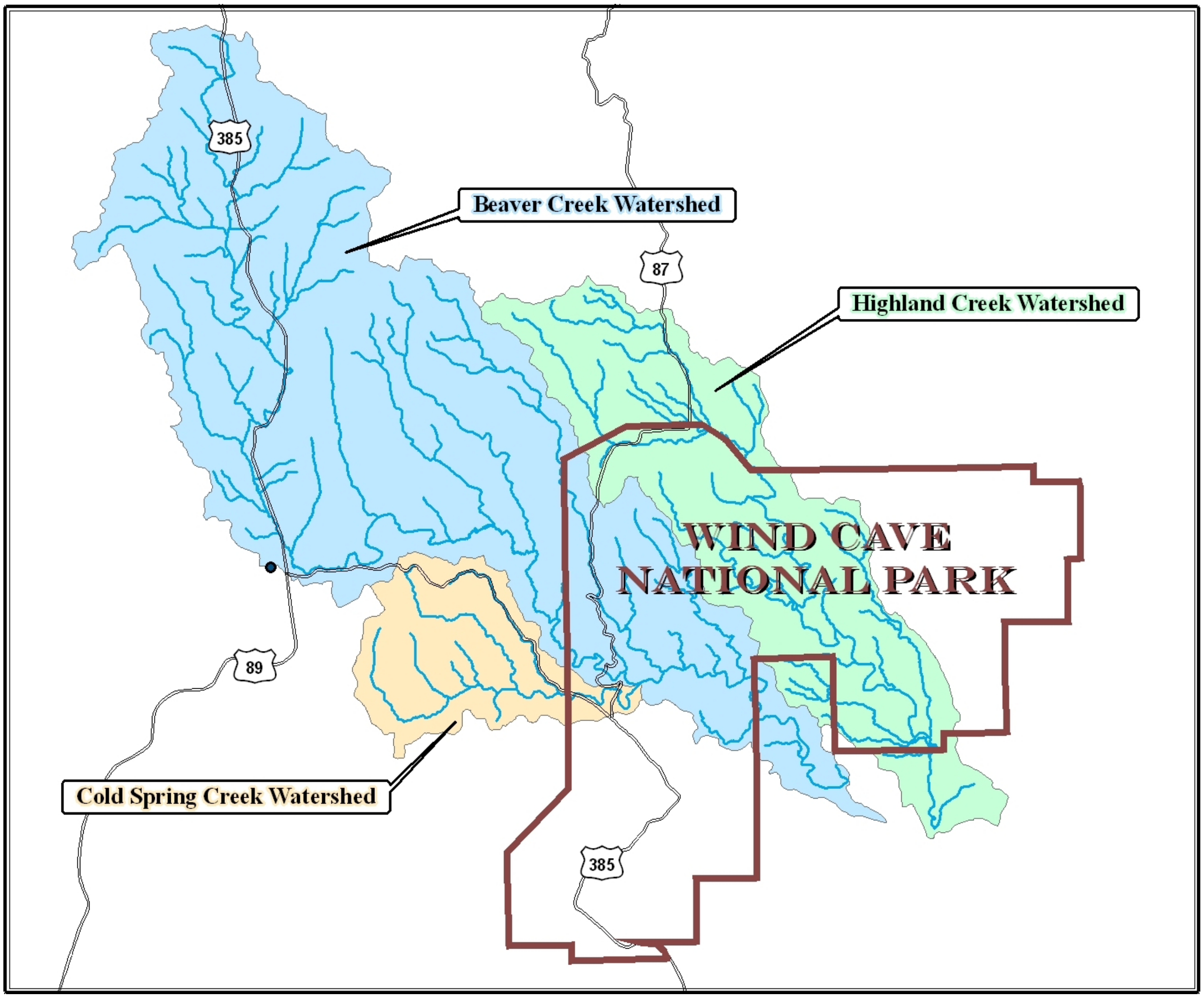

Figure 10: Watershed map for the three perennial streams in the park, Highland, Beaver, and Cold Spring Creeks.

h. Hydrologic Data

There have been numerous hydrological related projects over the years, including:

- The park has maintained precipitation data since 1934.
- Beginning in 1956, the park has maintained water quality data from the park well.
- In 1987, Ford determined that the water table in Wind Cave has been dropping at a rate of 1.3 ft/1,000 years, beginning 470,000 years ago (Ford, Palmer, Bakalowicz, and Miller, 1987, 1989).
- Extensive dye tracing was completed by Calvin Alexander and Marsha Davis in 1988 to determine flow paths between the surface and Wind Cave. In addition, they conducted a successful dye trace between Beaver Creek and the

park's water well in Wind Cave Canyon. The flow through time was less than two months. Age dating of the well water indicated that is was under two years old. They also studied water quality and did isotopic work in Wind Cave (Alexander and Davis, 1989).

- In 1989, Thomas E. Miller noted that the water in the cave lakes is similar to water in nearby artesian springs and wells outside of the park (Miller, 1989).
- From 1988 to 1992 the U.S. Geological Survey monitored lake levels, water temperature, and barometric air pressure with data loggers at Windy City Lake in Wind Cave. Earl A. Greene found that the cave lakes were 56.8 degrees F. (13.8 degrees C) while the air temperature above the lakes was 59 degrees F. (15 degrees C). He also documented that the lakes fluctuated daily, probably in response to barometric pressure changes (Greene, 1990).
- Between 1992 and 1996, Jim Nepstad conducted quantitative dye traces between surface drainages and Wind Cave. This data includes flow paths, flow quantity rates, and flow times (Nepstad, 1993b, 1993c, 1995, 1996b, 1996c, 1997).
- The park has monitored and maintained records of the Lakes within Wind Cave since 1986.
- The U.S. Geological Survey has maintained a gauging station on Beaver Creek within the park since 1990.
- In 1992, Mike Wiles completed a Master's thesis on a comparison of drip rates and evapotranspiration, correlating those with rainfall, between Wind and Jewel caves. For Wind Cave, he determined that the infiltration zones he identified at Jewel Cave do not apply to Wind Cave and that drip rates in the cave cluster below surface drainages (Wiles, 1992).
- The NPS Water Resource Division conducted a flood elevation report for Wind Cave Canyon in 1993. Michael Martin determined flood magnitudes for 100 and 500 year peak discharges for structures in Wind Cave Canyon. He found that the Walk-In Entrance to Wind Cave would be inundated during a 100-year flood event (Martin, 1993).
- In 1994 Dina Venezky studied contamination of water at Upper Minnehaha Falls in Wind Cave. She found heavy hydrocarbons reached the cave from the parking lot after 19 hours (Venezky, 1994).
- Beginning in 1998 the park has conducted monthly water quality monitoring of the three perennial streams.
- The stable and unstable isotopes in the waters of Wind Cave have been studied by Tim Millen in 1985, Dawn Cardace in 2000, and Dr. Jake Turin in 2001. Tim found that the water in the Lakes Section of Wind Cave is supersaturated in terms of calcite, but varies seasonally, and is of meteoric (atmospheric) origin (Millen and Dickey, 1987). Dr. Turin theorized that the new lake in Wind Cave named What the Hell was actually old water, based on preliminary findings of low levels of tritium (Turin, 2001).
- During the years 1991 to 1994, the park in conjunction with the Environmental Protection Agency (EPA) conducted extensive water quality monitoring from sites throughout the cave.
- In 1998, Marc Ohms determined that 3.68 cfs (27.5 gallons/sec) of Beaver Creek's water was lost underground in Beaver Creek Cave (Ohms, 2006b).

- During 2002 and 2003, Allen Heakin, with the USGS investigated levels of hydrocarbons in runoff from the parking lot to determine the influence of that runoff on water at Upper Minnehaha Falls in Wind Cave. They found traces of acetone, benzene, and xylene, but at lower levels than found during Venezky's 1994 study (Heakin, 2004).
- During 2002 and 2003, Allen Heakin, conducted water quality characterization of the park's three perennial streams. He found E. coli and coliform bacteria in Beaver Creek, indicating septic system contamination from outside of the park, which has ramifications on the park's wells (Heakin, 2004).
- In comparing the lakes in Wind Cave with nearby wells, Marc Ohms found that fluctuating water levels do not correspond well, except for occasionally with the well on the 7-11 Ranch to the east of the park (Ohms, 2004c).
- In 2006, two HOBO water level data loggers were installed in Calcite Lake and Headquarters Well #2 that automatically record water level every 12 hours (Ohms, 2006a).

i. Cave Environmental Data

Many early accounts report that the temperature of Wind Cave varied between 42 and 47 degrees, with the Superintendents Annual Report in 1920 stating that one could see their breath anywhere in the cave, a situation that does not exist today, but has been observed recently at the low spot on the Blue Grotto Loop. There have been numerous efforts to study the climatological conditions of Wind Cave, which include:

- In 1960, Henry Shillinglaw studied air movement in Wind Cave.
- In 1963, Jon T. Schnute proposed a method to calculate the volume of Wind Cave based on airflow and temperature at the Natural Entrance (Schnute, 1963).
- Between 1964 and 1966, Herb Conn used Schnute's airflow method during a 16-day measurement period, to determine that the winds at the Natural Entrance were barometric in origin and that much of the cave is close to the entrance. He also calculated a volume of 2 billion cubic feet for the cave (Conn, 1966).
- In 1976, interpreter Don Mitchinson conducted a temperature variation study along the tour routes using thermometers. He detected up to a 2 degree variation in temperature (Mitchinson, 1976).
- In 1989, Thomas E. Miller theorized that a dike intrusion below Wind Cave may be responsible for the high geothermal gradient (Miller, 1989).
- In 1984-1985, Jim Nepstad and Jim Pisarowicz conducted extensive temperature and humidity monitoring of the Natural Entrance Tour Route and the Walk-In Entrance to document impacts caused by not having an airlock. They found that temperature and humidity levels were impacted nearly the entire length of the Natural Entrance Tour Route (Nepstad, 1985a). They determined that the average temperature of Wind Cave away from the Natural Entrance Tour was 55 degrees F (Nepstad and Pisarowicz, 1989c). Since the average surface temperature is 47 degrees F, they theorized that the cave has elevated temperatures due to thermal sources from below. They also

determined that dry air entering the cave causes the temperature to drop as evaporation takes place. He theorized that this could be a real threat to speleothems and cave biota (Nepstad and Pisarowicz, 1989c).

- In 2000, Noah Daniels calculated the volume of Wind Cave. He included the Natural and Snake Pit Entrances in his calculations (Daniels, 2000).
- In 2001, Dr. Andreas Pflitsch began studying the climate and airflow of Wind Cave. He demonstrated that wind blows primarily into Wind Cave during the winter and primarily outward during the summer, a condition not found at nearby Jewel Cave. He also found that the average inward flow velocity is quite stable in the summer in Wind Cave, but higher during the winter, while the average outward flow velocity is almost always higher than the inward velocity year-round. Additionally, he found that the average mean temperature of air flowing outwards at Wind Cave is quite stable, which is not the case at Jewel Cave. He also demonstrated that Coyote Cave is probably not connected to Wind Cave, however, the blowholes surrounding Wind Cave probably are (Pflitsch, 2002).
- In 2003, Marc Ohms conducted extensive temperature monitoring in order to determine if there are artificial temperature fluctuations caused by the lighting system on tours. He found that the lighting system has local impact on cave resources, creating “hot spots” that are dried out and provide an environment for increased algae growth. He also found that the tours were raising the temperature by 0.7 to 2.0 degrees F at several locations and that the temperature would not return to normal until fall when the tours ceased (Ohms, 2004d).
- In 2006, Dr. Pflitsch reported that winds can switch as often as one minute intervals or blow in one direction as long as 81 hours through the Natural Entrance. The longest documented outflow was 54 hours (5/2005), while the longest inflow was 81 hours (3/2005) (Pflitsch, 2006).

j. Radon

There has been extensive radon monitoring efforts over the years, including:

- In 1976, the department of Mining Enforcement and Safety Administration conducted a radon survey in Wind Cave at the request of the NPS. This data indicates that the radon levels within Wind Cave appear to be stable and the levels are low enough not to pose a threat or concern for those working in the cave or the visiting public.
- In 1977, the park hired Tom Farrell to monitor radon levels in both Wind and Jewel caves. These efforts found that radon levels were elevated somewhat during the summer months, but still low enough not to pose a threat or concern for those working in the cave or the visiting public, with the only potential threat being to long-term employees (Frederick, 1977). Radon levels average 0.23 working levels between May – August and vary between 0.27-0.34 working levels between October and November.
- In 2002, Marc Ohms placed ten radon detectors in Wind Cave, including five on-trail and five off-trail. This project showed that radon levels throughout the cave are low, averaging around 0.2 working levels (Ohms, 2003b).

- In 2004, Marc Ohms summarized twenty years of radon monitoring and determined that the radon levels within Wind Cave appear to be stable, averaging around 0.2 working levels throughout the cave (Ohms, 2003b). The US Department of Health and Human Services recommends that the annual exposure level for occupational exposures not exceed 1.0 WLM (*Working Level Month= radon working level X time spent in exposure area/ 170*). If an interpretive ranger at Wind Cave conducts three tours a day for a total of five hours their annual exposure would be 0.13 WLM, well below the recommended exposure. Since visitors are in the cave for such a short time period their risk is far below the recommended exposure limit (Ohms, 2003a).

k. Visitor Impact Studies

There are been several impact studies along the tour routes in Wind Cave, including:

- In the early 1980s, Bob Hirschy and Bill Gilbert, placed numerous small geodes along the tour routes in Wind Cave to determine if visitors would remove them. By the end of the summer they were all gone.
- In 1989, Jim Pisarowicz and Jim Nepstad planted six and ten pound geodes in the Oven, on the Natural Entrance Tour Route. They both disappeared between one and two weeks (Pisarowicz, 1988a).
- In 1994 Pat Jablonsky, Sandy Kramer, and Bill Yett studied lint introduction and distribution along the tour routes in Wind Cave. They found that the “lint” was composed of numerous types of particles, with the majority of the lint fibers being natural instead of synthetic. They also found that lint migrated along and away from the trails, with the majority deposited within a few meters horizontally or vertically (Jablonsky, Kramer, and Yett, 1994).
- In 2001 Marc Ohms monitored off-trail foot print traffic on the Fairgrounds Tour Route, finding substantial off-trail incursions.
- In 2002 Marc Ohms conducted a dust monitoring study along the Candlelight Tour Route, and in 2004 initiated dust monitoring along flagged trails (Fig. 11). Ohms found that during the summer tour months dust deposition increased ten fold on the Blue Grotto Loop of the Candlelight Tour (Ohms, 2004a). During his off-trail dust study, he found that cavers crawling along the Pink/Black route in the Thomas Paine area, of the Colorado Grotto Section, deposited the most dust per individual, while the Wild Cave Tour Route had the most dust deposited overall due to shear number of visitors, nearly four times the amount of any other off-trail travel route (Ohms, 2005).

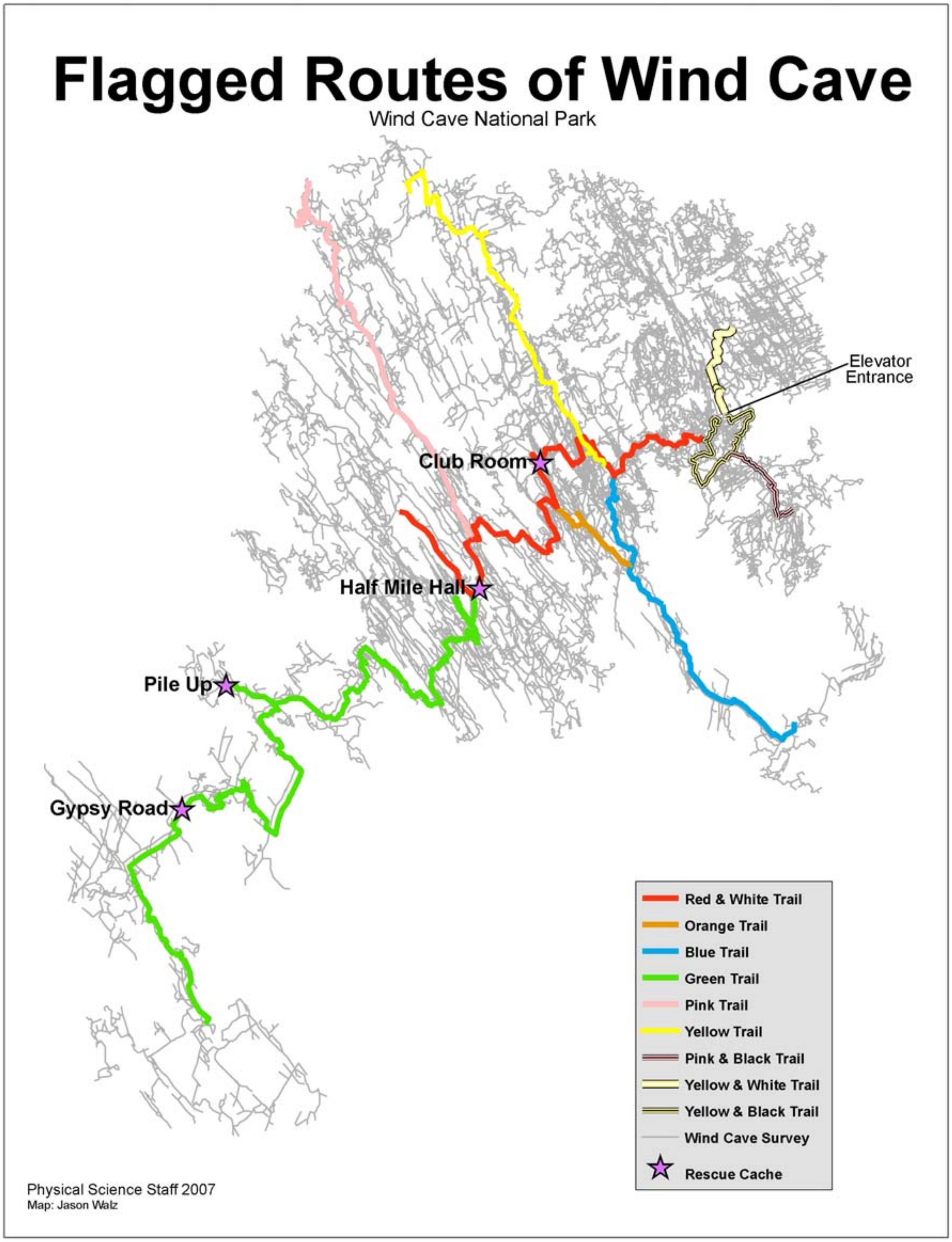

Figure 11: Off-trail Flagged Routes and Rescue Cache's in Wind Cave.

IV. MANAGEMENT ACTIONS

Key management issues for cave and karst resources in the park have been identified. These issues are divided into three sections: the developed section of Wind Cave, off-trail areas of Wind Cave along with backcountry caves, and surface management. Most of the desired future conditions in this plan are general in nature. It is anticipated that after much of the baseline data is collected, standards, thresholds, and more detailed action plans will be developed for future revisions of this Cave and Karst Resource Management Plan.

A. Developed Section of Wind Cave

(Each section is followed by the “current condition of resources,” then by the “desired future conditions (DFC’s),” and finally by the “methods to achieve DFC’s”)

1) *Current Condition of Resources:* The developed corridor in Wind Cave is the most impacted cave and karst resource in the park (Fig. 12). This human-caused impact primarily resulted from trail development. However, the presence of on-going tours continues to impact cave resources. The developed corridor includes four tour routes, the Natural Entrance, Garden of Eden, Fairgrounds, and Candlelight Tour Routes. The most impacted areas occur at and immediately adjacent to these developed trails. Generally, the degree of impact diminishes the farther one travels away from these trails. Impacts include: artificial entrances, concrete paving, asphalt from previous trail surfacing, discarded wood from past construction, wax drippings, artificial roof supports, electrical systems, handrails, foreign debris from visitors, CO_2, blasted sections, displaced sediment and rock, blocked side passages, rubble filled pits, and dust-covered walls.

   In 1887, a trap door Entrance was added next to the Natural Entrance and then in 1935, an elevator shaft was added to the end of the current Natural Entrance Tour Route. In 1996, airlock structures were added to each elevator landing to reduce the unnatural air exchange through the elevator shaft. Before these structures were built, strong air exchange would occasionally prevent the elevator doors from opening or closing. Both the Walk-In Entrance airlock and elevator shaft provide unnatural routes for biota to enter the cave and unnatural amounts of airflow exchange. Due to the immense volume of Wind Cave, the cap-like nature of the overlying less-permeable Minnelusa Formation, and the small entrances to the system, airflow reacts dramatically to surface pressure changes. Airflow speeds have been documented at35 mph through the Natural Entrance. Airflow has also been documented blowing in the same direction in excess of 81 hours (Pflitsch, 2002, 2006). Natural airflow patterns along the developed tour routes were altered when blasting was conducted during the 1890s and 1930s. By enlarging these passages, more air is allowed to move through them. The blast rubble was often placed into side passages or pits, altering or restricting natural airflow patterns. There were several large collapses along the entrance stairs due to frost wedging from the artificial Walk-In Entrance. Roof supports, including rock bolting, chain link fencing, and concrete pillars have been added to these unstable areas. A study by Nepstad and Pisarowicz determined that air temperature is affected 600 feet into the cave along the Natural Entrance Tour Route (Nepstad, 1986). These conditions convinced the park to install a revolving door at the Walk-In Entrance in 1992, in order to create an airlock. However, Dr. Andreas Pflitsch's study in 2002 determined that the revolving door allows between half and the same amount of air to pass as does the Natural Entrance (Pflitsch, 2002).

Open flame candle lanterns are used on the Candlelight Tour Route. In 2002, these lanterns were redesigned by Jason Walz to minimize wax dripping in the cave (Walz, 2002a). These redesigned lanterns greatly reduced the amount of wax left in the cave, although if tilted and they still drip wax. These candle lanterns also introduce soot into the air which is deposited on cave surfaces.

Trail construction debris has been stashed into side passages and used to level floors, potentially altering air flow patterns (Horrocks and Roth, 2004b). Visitors unintentionally disturb dust, which becomes airborne and settles on cave surfaces. Water condenses on these particles and dissolves cave surfaces and minerals. This is an especially serious problem along the Candlelight Tour Route where the asphalt trail was removed.

The electrical system adds heat to the cave and encourages algal growth. The cables that supply the lights with electricity are often covered with wire mesh and concrete, making them inaccessible. In an attempt to make them not visible from the developed trails, they often snake through off-trail passages, some of which are delicate and vulnerable to impact.

The developed corridor is impacted from the presence of visitors on public tours in Wind Cave. Impacts from visitation include shedding of foreign debris, disturbed sediment, introduction of heat, oil staining and polishing from touching, and vandalism. Visitors unintentionally shed lint, hair, skin cells, shoe rubber, microbes, and spores (Horrocks and Ohms, 2004c). Spores shed by visitors cause algal growths in artificially lit areas. The natural lint fibers degrade more quickly, while the synthetic fibers remain longer in the cave (Jablonsky, Kramer, and Yett, 1994). Water condenses on these fibers and dissolves cave surfaces and minerals. These fibers affect cave biota by providing unnatural carbon and nitrogen sources for their consumption (Moore, 1997). This condition supports unnaturally high cave biota population levels and introduces non-native species. Intentional vandalism includes boxwork breakage, graffiti, leaving trails, the removal of cave formations, and litter. The cave is additionally impacted from visitors occasionally urinating and defecating along tour routes.

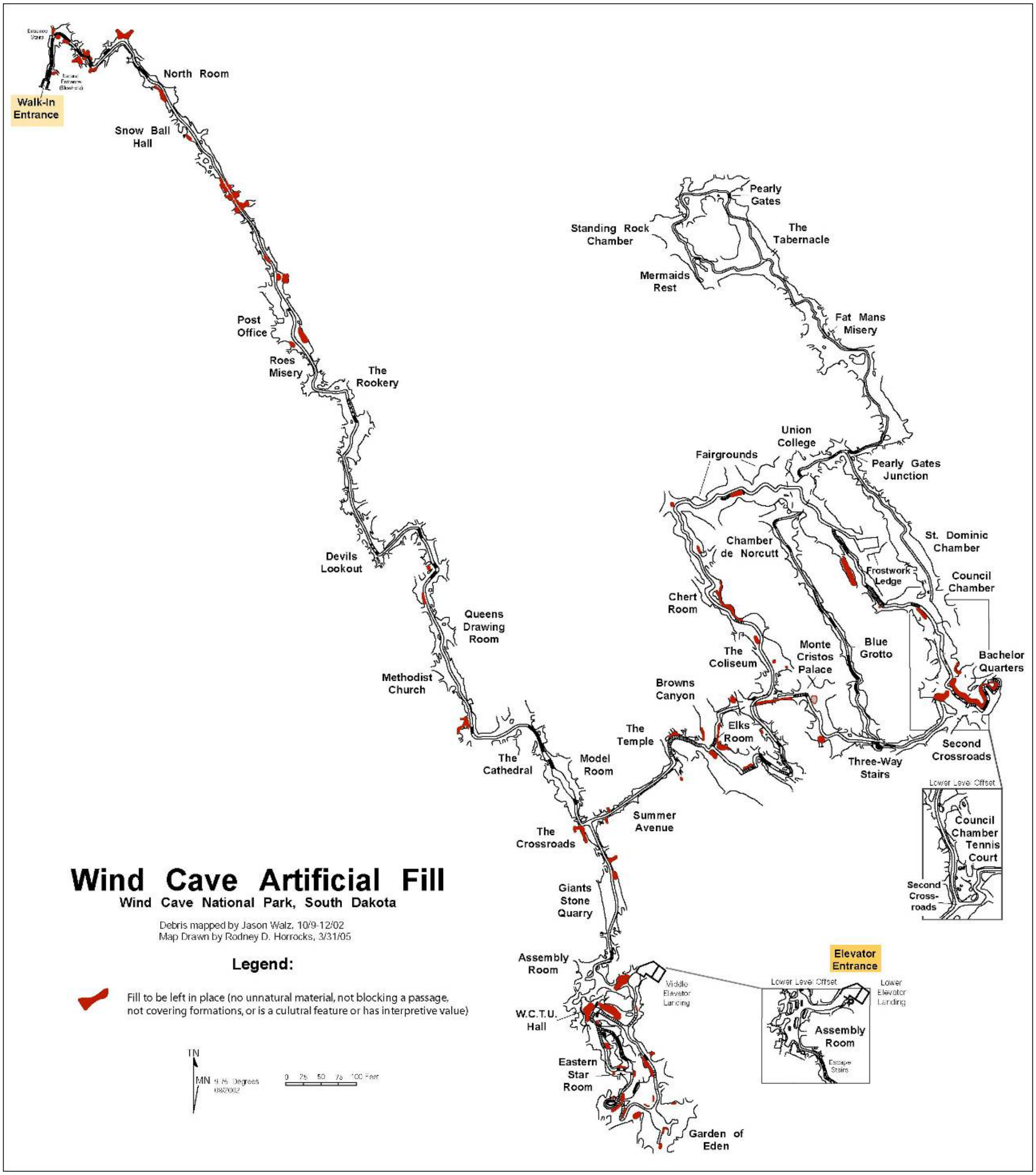

Figure 12: The Location of artificial fill removal sites tagged to be left in Wind Cave.

Unnatural species have been introduced to the cave by being inadvertently carried in by park visitors or provided artificial travel corridors by lights and paved trails. Studies have shown greater species diversity along the developed tour routes, including several species common to the surface or humans (Moore, 1996). Some species, such as wood rats or bats, can leave waste on the trails that are undesirable for visitor contact.

Due to the decomposition of flood debris and degassing of infiltrating water, it is common for CO_2 levels in caves to be slightly higher than on the surface. In Wind Cave, tours consist of up to 40 individuals that exhale CO_2 into the cave environment. Carbon Dioxide levels have not been monitored in Wind Cave. No studies have been undertaken to determine if people elevate natural levels to unsafe or resource impacting levels.

2. Key Management Issues:

a. Human Impact:

Desired Future Conditions: Minimize impacts along tour routes.

Methods to achieve DFC:

- Determine current impacts, causes, and rates of change.
- Conduct a carrying capacity study, possibly through a contract.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible.

b. Infrastructure:

Desired Future Conditions: In-cave infrastructure necessary to provide safe access will have minimal impacts on cave and karst resources.

Methods to Achieve DFC:

- Inventory current infrastructure for impacts to cave resources.
- Evaluate urgency of impacts.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

c. Biotic Resources:

Desired Future Conditions: Activities in Wind Cave will be managed to have minimal impact on the cave's natural biotic communities.

Methods to Achieve DFC:

- Inventory and document biotic communities in Wind Cave.
- Monitor biotic communities for any changes.
- Develop species dependant thresholds for naturally occurring species with management actions when reached.
- Where possible, remove unnaturally occurring biotic communities.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

d. Cultural Resources:

Desired Future Conditions: Cultural resources are identified, documented, and protected.

Methods to Achieve DFC:

- Identify and document cultural resources.
- Evaluate condition of specific resources and determine appropriate course of action, which can include documenting and removing to museum collection, documenting and disposing, or documenting and leaving in place.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

e. Geologic Resources:

Desired Future Conditions: Geological resources are identified, documented, and protected.

Methods to Achieve DFC:

- Inventory and document geologic resources.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

B. Off-Trail Areas of Wind Cave & Backcountry Caves

(Each section is followed by the "current condition of resources," then by the "desired future conditions," and "methods to achieve DFC's")

1) Current Condition of Resources: Much of the off-trail sections of Wind Cave show no to very little evidence of human-caused change, except in portions of the Historic Section, where early explorers in the late 19th century routinely visited. Materials left behind by these groups include string, candles, wax drippings, signatures, vandalized surfaces, newspaper, and miscellaneous items such as flash powder bottles, liquor bottles, tobacco tins, cigarette packs, and candle lanterns. In some areas the string and wax are now covered with mold, which can impact cave biota by providing unnatural food sources. In some wet areas, evidence of the string is only marked by black stains stretched across the floor. The early explorers heavily damaged some areas during the pursuit of mineral specimens to sell. They also left behind large amounts of the newspaper that was used to protect these specimens for removal from the cave. These early explorers left signatures by several methods, including candle soot, scratching, and finger rubbing in corrosion residue.

Caving unintentionally affects cave resources. Organized projects or events, such as the N.O.L.S. training, cave rescues, recreation trips, research, and exploration have all had or do have impacts. Cavers unintentionally compact sediment as well as disturb loose sediment, which becomes airborne and settles on cave surfaces. Although, this is an especially serious problem along the Wild Cave Tour Route due to the high number of people, it is also a problem with cavers traveling along all the flagged trails (Ohms, 2006). In some areas cave floor crusts have been broken, causing increased dust production. Any time a caver enters an unexplored area, impact occurs. These impacts become more pronounced as traffic to these areas significantly increases. If a caver drops food crumbs, mold may grow. These crumbs provide unnatural food sources for biota. Cavers also shed lint, hair, and skin cells, which become more noticeable along heavily traveled routes.

Backcountry caves have remained relatively un-impacted. However, the entrance to Elk Antler Cave was modified and a trench was dug in an attempt to dig into Salamander Cave in the early 20th century. Graffiti was left in Stacked Shack Shelter and a still was abandoned in Vultures Lair. A gate was installed by Cave Management in Coyote Cave during the 1990s to protect cave resources. In addition, park-approved paleontological excavations have been conducted in Salamander and Graveyard Caves as well as Beaver Creek Shelter.

2) Key Management Issues:

a. Cultural Resources:

Desired Future Condition: Cultural resources are identified, documented, and protected.

Methods to Achieve DFC:

- Complete a systematic cultural survey of all park caves.
- Record locations of cultural resources in conjunction with cave feature inventory and data collection.
- Implement and enforce the permit system for all cave access.
- Acquire American Indian histories and perspectives regarding caves.
- Research historic literature sources regarding caves.
- Collect oral histories relating to caves.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.
- Cultural resources in highly traveled areas of caves are marked with flagging tape so they will be avoided and protected.

b. Biological Resources:

Desired Future Conditions: Biological resources are identified and natural biodiversity is maintained.

Methods to Achieve DFC:

- Complete systematic biological surveys of caves
- Record locations of biological resources in conjunction with cave feature inventory data collection.
- Research historic literature sources regarding biological resources of the cave(s).
- Implement and enforce the permit system for all cave access.
- Monitor biotic conditions.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

c. Paleontological Resources:

Desired Future Conditions: Paleontological resources are identified, documented, and protected.

Methods to Achieve DFC:

- Complete a systematic paleontological survey of caves.
- Record locations of paleontological resources in conjunction with cave feature inventory data collection.
- Research historic literature sources regarding paleontological resources in caves.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.
- Paleontological resources in highly traveled areas of the caves are marked with flagging tape so they will be avoided and protected.

d. Geologic Resources:

Desired Future Conditions: Geological resources are identified, documented, and protected.

Methods to Achieve DFC:

- Complete a systematic geologic survey of park caves.
- Record locations of geologic resources in conjunction with cave feature inventory data collection.
- Research historic literature sources regarding geologic resources of the caves.
- Sensitive geologic resources in highly traveled areas of caves are marked with flagging tape so they will be avoided and projected.

e. Data Collection and Management:

Desired Future Conditions: All data are collected and maintained in accordance with National Park Service policies and guidelines and is integrated in a Park-wide GIS or other appropriate database.

Methods to Achieve DFC:
- Ensure that all data reside with the park, and ensure confidentiality of cave location information.
- Data will be collected in accordance with the NPS guidelines found in the cave management section of RM-77.

f. Environmental Considerations:

Desired Future Conditions: Identify and maintain natural environmental conditions.

Methods to Achieve DFC:
- All caves and their entrances and off-trail areas in Wind Cave are managed as backcountry.
- Mitigate the dust issues on the Wild Cave and Candlelight Tour Routes.
- Implement the permit system for all cave access.
- Inventory environmental processes to determine natural conditions.
- Monitor Wind Caves microclimate and determine its relationship to natural conditions.
- Establish levels of acceptable impacts with thresholds and management actions when reached.
- Establish monitoring for impact thresholds.
- Mitigate impacts where possible, develop plans to remove impacts that cannot be mitigated.

C. Surface Management

(Each section is followed by the "current condition of resources," then by the "desired future conditions," and "methods to achieve DFC's")

1) Current Condition of Resources: Portions of Wind Cave have been impacted by surface activities. These areas are located below or down dip from drainages that have cut downward into the Minnelusa Formation, occasionally exposing the Madison Limestone. In Wind Cave Canyon, much of the park's infrastructure was built right above Wind Cave and on top of the Madison Limestone. High nitrate levels have been found in cave drip waters below this area (Alexander, 1989, Nepstad, 1993b, & Heakin, 2004). Water from the parking lot has appeared at Upper Minnehaha Falls in Wind Cave in as little as 9.5 hours (Nepstad, 1996b). At this site, trace amounts of chloroform, caffeine, toluene, acetone, benzene, ethyl benzene, meta and para-xylene, ortho-xylene, methyl isobutyl ketone, and styrene have been found in the drip water (Heakin, 2002). In addition, Alexander, Nepstad, and Venesky found trace amounts of hydrocarbons in other locations in Wind Cave. Passages in Wind Cave are located down dip from the Mixing Circle, an open-air storage area for unused miscellaneous supplies and equipment, winter storage of excess vehicles, or for temporary storage of garbage or road-building supplies.

Some materials discarded at the Mixing Circle have been dumped directly into the Cottonwood Creek drainage, an intermittent stream. A slash burn pile is located adjacent to the drainage. Historically, treated fence posts were also burned at this site. Metals, arsenic, and Pentachlorophenol, from the post treatment process, were found in cave drip waters (Nepstad, 1992c; 1992e). Although burning of fence posts has been stopped, wind throw and slash are still burned at this site.

Much of the flow of Beaver Creek is lost underground at Beaver Creek Cave, where it enters the Madison Aquifer and has been traced to the park's drinking well in Wind Cave Canyon in under two months (Alexander and Davis, 1989). The majority of the watershed for this creek lies outside the park (Fig. 10). Cold Spring Creek joins Beaver Creek shortly after it enters the park. The vast majority of its watershed lies outside of the park. Development outside the park is currently happening within these watersheds. A recent study of the stream has found caffeine in Beaver Creek, which suggests septic tank influence (Heakin, 2002). Highland Creek looses its entire flow to the subsurface within the park. The majority of its watershed lies within the park, with the remainder in Custer State Park (Fig. 10).

Wildland fires are currently suppressed and prescribed fire is used as a tool to restore natural ecosystems in the park. Due to the lack of wildfire in many areas of the park, ponderosa pine is more widespread than it was historically. Antidotal evidence indicates that a mature ponderosa may suck up hundreds of gallons of water a day if it is available. Most of this water would then be lost to the atmosphere through the process of evapotranspiration. This could potentially result in a reduction in the amount of water entering the cave (Fig. 13).

The park currently uses manual, mechanical, biological, prescribed fire, and chemical treatments to control exotic plant species within the park. Due to the potential for negative impacts to park resources resulting from chemical applications, a Pesticide Spray Model was developed in 2006 to indicate resource areas most sensitive to chemical control methods. The Model established three zones: Restricted Spray Zone, Limited Spray Zone, and Spray Zone. The term "chemical treatments" is defined as "applying pesticides as prescribed by their labels, using a variety of application methods. Examples of application methods include portable sprayers, all-terrain vehicles (ATVs) equipped with sprayers, and aerial application (helicopter and fixed-wing)."

2) Key Management Issues:

a. Management Activities:

Desired Future Conditions: Management activities will have minimal or no negative impact on karst and cave resources.

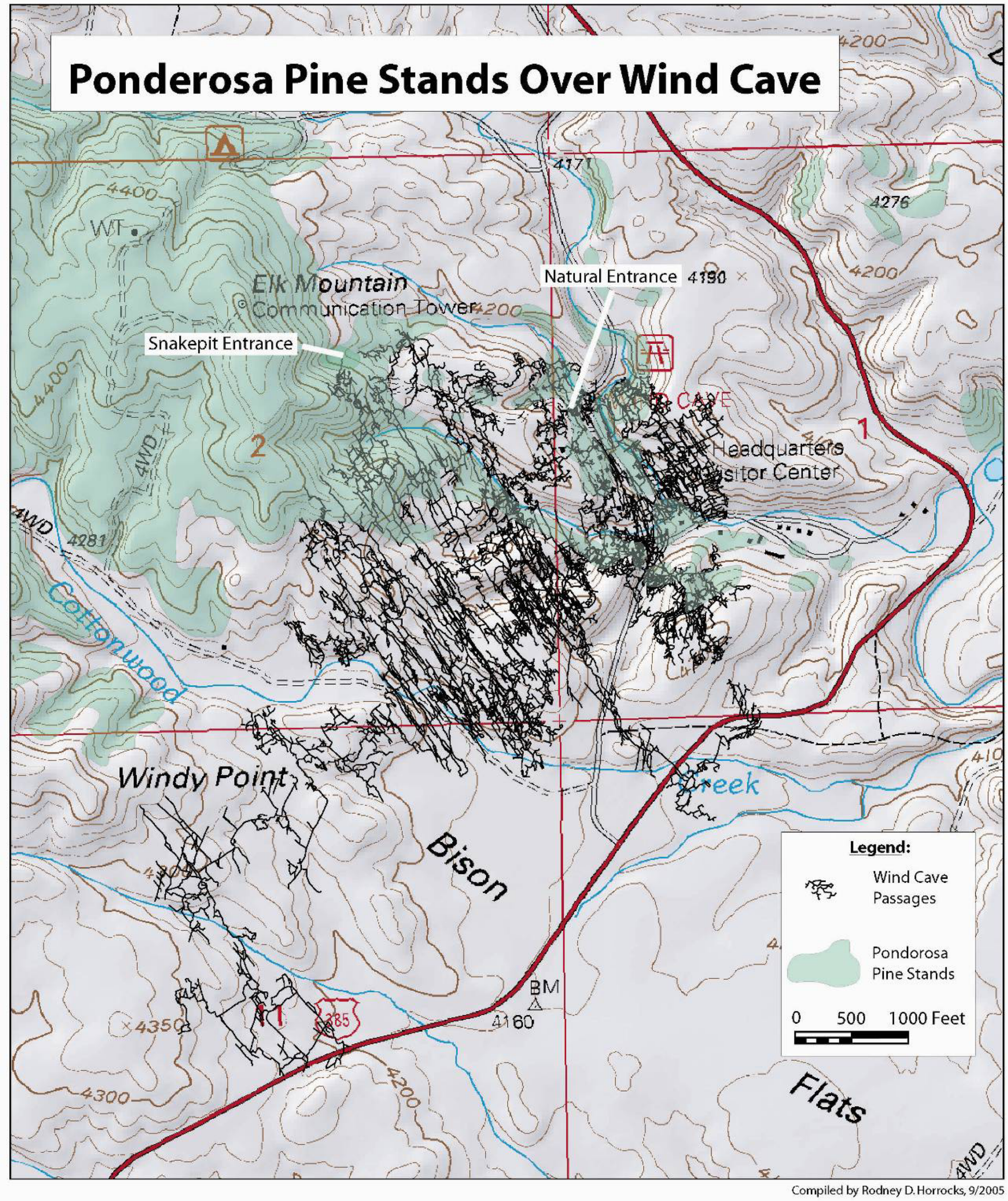

Figure 13: Distribution of Ponderosa above Wind Cave.

Methods to Achieve DFC:

- Any action or activity affecting natural resources (flora, fauna, geology, hydrology, etc.) will be analyzed to mitigate adverse impacts and promote natural processes.
- Develop standards that refine surface resource management activities which have the potential to affect cave and karst resources.

- Evaluate existing activities and infrastructure to identify potential impacts to cave and karst resources.
- Develop a strategy to remove or mitigate potential adverse impacts.

b. Infrastructure:

Desired Future Conditions: Working within the guidelines of the General Management Plan and the Developed Zone defined therein, proposed development will not alter or adversely impact karst or cave processes.

Methods to Achieve DFC:

- Identified impacts will be mitigated when practicable.
- Evaluate use at existing infrastructure before considering new construction.
- Develop a comprehensive ten year facility needs assessment that supplements the GMP.
- Consider the possibility of moving functions/infrastructure before seeking funding for new infrastructure.

V. MANAGEMENT POLICIES FOR CAVE USE

Depending on established management policies, the caves in the park may be used in some or all of the following ways: recreation, education, survey, exploration, or research. Special use permits may be granted for additionally requested activities. Because caves are easily impacted, non-renewable, and difficult or impossible to restore, any potential cave use must be accountable to the cave management policies defined in this section.

USE: The term "use" shall correspond to the entry of a person into a cave. All uses of caves result in impact to resources; however some uses are more beneficial to the management and preservation of the caves than others. For this reason, different uses will be defined and addressed separately.

A. Employee Responsibilities and Use

Virtually every park employee participates in some aspect of the cave and karst resource management program. The following paragraphs describe who is responsible for which aspects of the cave and karst resource management program at the park.

1) Superintendent

The Superintendent has overall responsibility for the management of the cave and karst resources of the park. The Superintendent approves all cooperative agreements, special use permits, and collecting permits. He or she makes the final decision on all proposed management actions. As the highest level supervisor in the park, the Superintendent is responsible for ensuring that all park activities are compatible with this plan. The Superintendent has overall responsibility for search and rescue or other emergency activities taking place in park caves.

2) Interpretative Staff

The Interpretative staff works with the Physical Science staff to ensure a high level of visitor understanding and satisfaction for cave and karst resources in the park is achieved while minimizing impacts from tour operations. The Chief of Interpretation will ensure that interpretive activities on the surface and in the cave are compatible with polices and goals of this plan. Tools, materials, and supplies used in interpretative programs will not be stored in the cave unless approved by the Physical Science Specialist.

3) Maintenance Staff

The Maintenance staff is responsible for maintaining the cave lighting and electrical systems, elevators, airlocks, handrails, phones, and trails in the developed section of the cave. They work closely with the Physical Science staff in dealing with any hazards along the developed tour routes that threaten the safety of the public or employees. The Facility Manager will ensure that maintenance activities on the surface and in the cave are compatible with the policies and goals of this plan.

No project will be conducted by any division that affects the cave trail or related maintenance maintained systems prior to consulting with the Physical Science Specialist and the Facility Manager. Any maintenance project inside the cave must be a cooperative effort between the Physical Science and Maintenance staff. All refuse from maintenance activities must be removed from the cave. Tools, materials, and supplies used in maintenance activities will be stored outside the cave, except for multi-day projects in which temporary storage locations will be designated by the Physical Science Specialist. The Physical Science Specialist must approve any materials or chemicals used by Maintenance inside the cave.

4) Resource Management Staff

a. Chief of Resource Management

The Chief of Resource Management has management responsibility for all natural resources within the park, including cave and karst resources. That person recommends all cooperative agreements, special use permits, and collecting permits dealing with cave or karst resources to the Superintendent. The Chief of Resource Management will ensure that resource management activities on the surface and in the cave are compatible with polices and goals of this plan.

b. Physical Science Staff

The Physical Science staff is responsible for the development and execution of the Cave and Karst Resource Management Plan. The staff will coordinate all survey, inventory, research, monitoring, restoration, trail cleaning, and other cave and karst management activities. All off-trail cave trip reports will be issued through this office. The Physical Science Specialist acts as the liaison between the park and cave users and coordinates activities with other divisions. The Physical Science Specialist may recommend area closures, use restrictions, and limits on the amount of use that will take place in park caves. That person may recommend approval or rejection of special use permits pertaining to cave and karst resources to the Chief Ranger of Resource and Visitor Protection. The Physical Science staff is responsible to train other divisions on cave and karst conservation. In consultation with other park staff, the Physical Science Specialist will ensure that activities on or below the surface are compatible with the policies and goals of this plan.

c. GIS Specialist

The GIS Specialist will work with the Physical Science staff in managing cave GIS data and ensuring that data are secure, up-to-date, available to park managers, and meets NPS GIS standards.

5) Resource and Visitor Protection Staff

The Resource and Visitor Protection staff is responsible for ensuring that all resource violations involving cave resources are dealt with according to established guidelines and laws. They are responsible for managing all cave search and rescue operations. The Chief Ranger of Resource and Visitor Protection is responsible for issuing special use permits dealing with cave and karst resources.

6) Fire Management Staff

The Fire Management staff will work with the park's Fire Coordinator and the Chief of Resource Management when planning a prescribed fire or suppressing a wildfire in the park to mitigate impacts to cave and karst resources within the park.

B. Wind Cave Public Tour Use

Since 2000, an average of 115,000 visitors a year stopped at the park's visitor center, with an average of 80,000-90,000 going on cave tours in Wind Cave. A cave tour is defined as a formal, park staff-led trip. The following policies pertain to public tours in Wind Cave.

1) Tour Size

The optimal group size for each tour in Wind Cave varies and will be based on a combination of cave resource management and interpretive concerns. Pending future research on acceptable levels of impact and interpretive issues, tour size may be adjusted.

2) Regulations

In order to properly protect the cave the following will not be allowed on cave tours, based on conditions of permit (36 CFR 1.6):

- touching cave surfaces
- food, drink, or chewing gum (except for medical reasons)
- tobacco
- stepping off the established trails
- backpacks
- walking sticks (canes are allowed)
- pets (see section below on service animals)
- bare feet

3) Employee Led Informal Tours

Employee led informal tours will not be allowed in Wind Cave. Informal tours are defined as non-scheduled tours or trips on established tour routes. This includes, but is not limited to; employees taking friends, family, or other employees into the cave for unauthorized, non-work related activities.

4) Established Tour Routes

Tour use of Wind Cave will be limited to the five established tour routes. This includes three tours along fully developed trails (trails that have been modified and have electric lighting added, such as a, b, and c below), one tour on a partially developed trail (i.e., trails that have been modified, but have no electric lighting, such as d below), and one tour on an established route with no developed trail or electric lighting (such as "e" below). These routes may be adjusted based on Interpretive and Resource Management needs. These routes are defined as:

a. Natural Entrance Tour

The Natural Entrance Tour enters the cave via the Walk-In Entrance and proceeds through the Post Office, Model Room, Assembly Room, and finishes at the Lower Elevator landing. The current tour size is forty persons per tour.

b. Garden of Eden Tour

The Garden of Eden Tour starts at the Middle Elevator landing and proceeds to the Garden of Eden, the Eastern Star Room, and ends back at the Middle Elevator landing. The current tour size is thirty persons per tour.

c. Fairgrounds Tour

The Fairgrounds Tour starts at the Lower Elevator landing and proceeds to the Assembly Room, Temple, Fairgrounds, Bachelor's Quarters, Monte Cristos Palace, and back to the Temple, Assembly Room, and the Lower Elevator landing. The current tour size is forty persons per tour.

d. Candlelight Tour

The Candlelight Tour starts at the Lower Elevator landing and proceeds to the Three-Way Stairs, continuing north on the Blue Grotto Loop to the Chamber de Norcutt and to the Catacombs, then on to the Pearly Gates. Returning to the Catacombs, the route continues south through the Council Chamber and to the Badlands area near the deep point along the Fairgrounds tour. The current tour size is ten persons per tour.

e. Wild Cave Tour

The Wild Cave Tour is an off-trail tour that starts at the lower elevator landing. The route is marked with black and yellow flagging and ends at the Middle Elevator landing. This tour includes a short side spur to the gypsum needles from the Muddle Room. Although this tour is considered an established route, it will be considered "off-trail" and will be managed under the guidelines set forth in the Off-Trail portion of this plan. Deviations from the flagged route are not allowed. Both Minnehaha Falls and Upper Minnehaha Falls are not on the established route and therefore are not to be visited on this tour. Each trip will have one leader and up to ten participants.

5) Access for Mobility and Visually Impaired Persons

a. Wheel Chairs and Walkers

Due to potential damage to cave resources from wheel chairs and walkers in narrow passages, alternative tours are available to mobility challenged visitors. These will include the Middle Landing and the Assembly Room, via the Lower Landing. Only the Middle Landing immediately outside of the airlock meets the accessibility for visitors with disabilities requirements for unassisted wheelchair access (Directors Order #42). The Assembly Room, via the Lower Landing, is accessible with assistance.

b. Service Animals

Service animals will be allowed to accompany their owner on any of the paved tour routes. In order to help a visually impaired person negotiate low ceilings, an additional ranger or another assistant must accompany the owner and animal.

6) Animals in Caves

Animals - Any native animal (i.e. bat, wood rat, snake, etc.) which naturally uses a cave, will not be disturbed or removed from the cave unless public safety is at risk. Any non-native animal (e.g., feral cats, dogs, etc.) found in a cave will be removed.

C. Off-Trail Cave Use

Off-trail use is defined as any travel off of the developed tour trails, or any travel into backcountry caves. All off-trail trips must complete a trip report form and obtain approval from the Physical Science staff in addition to signing the following forms (except for public Wild Cave Tours) (see Appendix A):

- Acknowledgement of Off-Trail Policies
- the Agreement for Individual Voluntary Services (form 10-85*)
- the WICA Job Hazard Analysis Form for caving

* Staff orientation trip participants will not have to sign form 10-85.

All participants in off-trail trips must use the following equipment:

- UIAA approved helmet with a four point attachment chin strap
- Total of three sources of electric light (no candles)
- Two of three light sources must be helmet mounted (except for public Wild Cave Tours)
- Treaded boots or hiking shoes
- Pee bottle and burrito bag for human waste
- Gloves
- Knee and elbow pads

Every off-trail trip will be led by a Trip Leader approved by the Physical Science staff (See section 3 below for information on trip leaders). The Interpretive staff may approve interpreters for the Wild Cave Tour.

Four categories of off-trail trips have been defined for this plan: work, survey, orientation, and recreation trips. Although these are broad categories, combined they represent the variety of off-trail uses of park caves. Each type of use will be managed differently. Trips that do not fit into one of these four categories, will require a special use permit. Below, each of these individual uses is more precisely defined and discussed.

a. Work trips - work trips are defined as any trip into the cave for the purpose of gathering scientific data, collecting samples, maintaining facilities, training Wild Cave Tour leaders, photography, or other cave resource management related tasks. All off-trail work trips will be conducted by or approved by the Physical Science staff. Depending on the destination and nature of the work, trips may consist of one to five participants.

b. Survey trips - survey trips are defined as cave trips where survey data (distance, azimuth, inclination, and sketch) and inventory data are collected. Survey trips will only be allowed during two Wind Cave Weekends (the 2nd and 4th weekends of each month) and on the 1st Tuesday. The VIP Center is reserved for the 2nd weekend of each month and on an "as available" basis at other times. Volunteers may stay in the VIP center for up to two nights for each eight hours of volunteer work completed. Use of the VIP center is limited to 16 individuals per night. Survey trips will have either three or four participants, including the trip leader. In the Historic Section, survey trips may consist of a leader and only one other participant. Surveys will be on a "survey as you go" basis. Standard survey gear (i.e., survey tapes, notebooks, instruments, etc.) will be provided by the park. Cavers may use their own survey equipment if they get pre-approved by the Physical Science office.

c. Orientation trips –These include all trips used to introduce employees or volunteers to off-trail sections of Wind Cave. Orientation trips will only be allowed on three routes, the Wild Cave Tour Route, the Bishop Fowler's Loop, and the Club Room Route. These routes will have a limit of three trips per calendar year per route. Orientation trips will have one trip leader, with a minimum of two participants and a maximum of six including the trip leader, except for the Wild Cave Tour Route where ten people may participate. Each orientation trip will be advertised park-wide and participants who have not been on that trip before will be given first opportunity to fill the available spaces. If applicants have equal need, participants will be selected by drawing. Prior to participating on the Club Room trip, an employee must have been on a previous off-trail trip in Wind Cave or have previous caving experience. At least two hours of time must separate different groups if they are using the same route on the same day. All orientation trips on the Bishop Fowler's Loop or the Club Room Route not used by August 15th, will become available for recreation trips (except for those on the Wild Cave Tour Route).

d. Recreation trips - this includes all off-trail trips that do not collect data or aid with the management of Wind Cave. These trips are intended only for organized groups. Examples include but are not limited to: education programs, scout groups, regional caving events, or grotto caving trips. Groups must obtain a Special Use Permit to use these routes. An application fee may be charged for these permits. Off-trail recreation trips in Wind Cave will be allowed on two designated routes - the Club Room Route (to the Club Room and back) or the Bishop Fowlers Loop (begins at the Fairgrounds/Chert Room junction and goes to the Middle Cave Landing). Recreation trips may only be led by a park approved Trip Leader. The recreation routes will have a limit of three trips per calendar year per route. These trips will be limited to participants that have their own gear and previous caving experience. Recreation trips will have one trip leader with a minimimum of two participants and a maximum of six participants, inculding the trip leader. At least two hours of time must separate different groups if they are using the same route on the same day. Trips will be distributed on a first come, first served basis; however, no group or organization may use more than two recreation trips per route in any calandar year.

The following policies apply to off-trail use within the caves of the park.

1) Flagged Trails in Wind Cave

To reduce the impact from cavers traveling through the cave, and to facilitate exploration through complex routes, all of the major off-trail travel routes in Wind Cave are flagged with strips of nylon flagging, including the recreation and Wild Cave Tour Routes. Additonal routes may be flagged if the need arises. Each route is marked with a distinctive color, with an obliquely cut end pointing towards the established exit route from the cave.

Yellow and Black- Wild Cave Tour Route (Lower Elevator Landing to Silent Lake)
Yellow and White- Bishop Fowler's Loop (Chert Room to Upper Elevator Landing)
Red and White- Rome to Deep Confusion
Blue- Buffalo Gap to City Hall
Green- Half Mile Hall to Route 66
Pink and Black- Station CL18 to Mammoth Canyon
Yellow- Hobson's Choice to Archimedes Pool
Orange- Club Room to Base Camp #1
Pink- Red/white trail to Snake Pit Entrance

2) Delicate Areas

Delicate areas are indicated by blue and white striped flagging and may not be crossed for any reason.

3) Trip Leaders

Trip Leaders serve as extended park staff on off-trail trips. Trip Leaders will be able to lead any type of off-trail trip in Wind Cave. They will be VIP's (Volunteers In Parks) and treated as park employees to the extent allowed by the NPS VIP program. On survey and work trips, each participant is a VIP. For recreation trips, only the leader will be a VIP.

a. Acquiring Trip Leader Status

All Trip Leaders will be approved by the Physical Science staff. Trip Leader qualifications include but are not limited to: past caving experience, knowledge of routes in Wind Cave, and leadership skills. A person may be considered for trip leader training after they have completed at least 10 off-trail trips into Wind Cave. These canidates will be required to attend a training course conducted by the Physical Science staff. The Physical Science staff may assign temporary trip leader status to qualified individuals leading special trips or working on specific projects.

b. Maintaining Trip Leader Status

To maintain Trip Leader status, leaders are required to take part in at least two trips per year. If a Trip Leader fails to go on two trips during a given year, their trip leader status will be revoked. Trip Leader status can be renewed by attending a Trip Leader class or going on two trips (not leading) the following year and reviewing recent policy changes with the Physical Science staff. If two years have elapsed, they will be required to retake the Trip Leader training class. Unacceptable incidents on a trip or repeated problems constitute grounds for revoking trip leader status. Examples of unacceptable incidents include, but are not limited to: repeatedly getting out of the cave late, unacceptable resource impacts, violation of off-trail policies, repeatedly recording data improperly, entering closed areas, or failure to comply with instructions from park staff.

c. Responsibilities of Trip Leaders

Trip Leaders are responsible for ensuring that safe caving pracitces are used on their trips, minimal impact of cave resources occurs, and data is properly collected (if data is collected on the trip). Specifically, each Trip Leader will be responsible for ensuring that:

- A trip report is properly filled out and left in the VIP Center or the Physical Science office during the trip.
- Trip members are prepared for the trip.
- Trip members are familiar with and comply with the off-trail policies.
- An approved sketcher is present on survey trips.
- All data is recorded according to park standards.
- There is an established surface watch (all surface watches must have a copy of the current Emergency Contact Phone List).
- A trip is called if serious safety or resources issues arise.
- All park-owned gear is cleaned and returned.

d. Approved Sketchers

On survey trips, only sketchers approved by the Physical Science staff may sketch. To become approved, a sketcher must meet the requirements on the sketcher evaluation form in appendix A.

4) Backcountry caves

All backcountry caves are closed to recreational caving activities, as established in the Superintendents Conpendium, (CFR 1.5 (a)) except by authorized permit. Only work or research trips are allowed into these caves.

5) Underage Cavers

No one under the age of 16 is permitted off-trail. This includes participation on the Wild Cave Tour or Recreation trips. Individuals aged sixteen and seventeen must have written parental permission.

6) Alcohol and Tobacco Use

Alcoholic beverages and tobacco products of any kind are not allowed in the cave.

7) Food

All food must be carried in closed containers or sealed packaging. Crumbs, packaging, and other food material must be carried out of the cave.

8) Caving Lights and Packs

Carbide lamps and candles are not allowed off-trail. Only electric lights are allowed. Only side-mounted packs may be used in park caves. Ammo boxes and other metal containers are not allowed.

9) Caving Clothes

Caving clothes and equipment must be clean and free of sediment, hair, or chemicals that can be shed or deposited in the cave. Clothing must not be in such shape (i.e., frays or tears) or of such material that it sheds excessive lint or fibers (sweaters or loosely woven).

10) Human Waste

All human waste must be removed from caves - both liquid and solid. A pee bottle and burrito bag are required on all off-trail trips. On camp trips, only urine that has been treated with a urine reprocessor and is mostly free of contaminants may be dumped in Wind Cave. Reprocessed urine may only be dumped in dry areas and in sandy or silty sediments.

11) Alteration of Resources

a. Bolting

Permission must be obtained from the Physical Science Specialist prior to placing a bolt. Permission will only be considered when a safe natural anchor is unavailable.

b. Digging

Digging is defined as any alteration or breaking of a cave passage to allow human entry. Permission must be obtained from the Physical Science Specialist prior to any digging activities. Permission will not be considered or granted until all other possibilities are exhausted. Requests will be granted on a case by case basis and based upon considerations such as the potential benefit, resources impacted, and the scope of work.

While digging, if paleontological, cultural artifacts, or other features deemed potentially significant are encountered, activities must stop and the Physical Science Specialist must be contacted as soon as possible.

c. Collecting

Any collecting of natural cave resources will only be done through proper research and collecting permits issued from the park. Speleothems will not be broken or destroyed for such purposes.

12) Disturbance of cultural artifacts

Cultural items such as string, newspaper, signatures, and candles can be found virtually throughout the Historic Section of Wind Cave. These items must not be disturbed, except by authorized persons after obtaining approval from the park's Curator.

13) Cave Camping

Cave camping will only be allowed at a campsite that is established by the Physical Science staff and will only be allowed to support survey, research, work, or rescue trips. The Physical Science staff will provide basic camping gear (sleeping gear, stoves…) that will be left at the site. All waste generated during the camp will be removed from the cave by those that created it. Camp trips will be limited to a maximum of four days and three nights and a maximum of six participants. Camp trips will be associated with Wind Cave Weekends. All participants must have had significant caving experience in Wind Cave with at least one trip to an area of equivalent difficulty. Up to four camp trips will be allowed per year.

14) Cave Diving

Only National Speleological Society (NSS) Cave Diving Section or equivalent certified cave divers (this does not include "Cavern Diving Certification", which is for open water sinkholes) will be allowed to dive in Wind Cave. Cave diving requires permission from the Physical Science Specialist and will only be allowed as an aid for survey or research activities (see section II D).

The park will require that the following stipulations be met before a permit is issued for cave diving:

a. A complete dive plan will be submitted with each application for a permit to conduct cave diving activities (these must also meet the guidelines found in DO-4).
b. A contingency plan for emergencies must be submitted with the request for permit.
c. All divers requesting permits will provide proof of current certification by the Cave Diving Section of the NSS or a nationally recognized cave diving certification agency.

The following rules must be adhered to during any diving in Wind Cave:

a. All tanks will be padded for transportation through the cave
b. Tanks and equipment will be roped in on climbs
c. Divers and Sherpas must have been to the dive site before diving is permitted
d. A minimum of three light sources must be carried by each diver with the battery capacity to provide light exceeding the dive time indicated in the dive plan
e. The RULE of THIRDS will be practiced on all cave dives
f. The lead diver will lay guideline solo with a fully suited diver waiting at the staging area in case of emergency
g. Survey work and photo documentation will not be attempted on the initial exploration dive
h. All original survey data will become the property of the park (the park will provide any surveying supplies required)

15) Handlines, Ropes, Water Collectors, and Rescue Caches

All handlines, ropes, water collectors, and rescue caches (Fig. 11) left in the cave must be approved by the Physical Science staff.

16) Survey Areas and Leads

Trip leaders will be allowed to take on areas of Wind Cave as individual survey projects. The idea is to have an area that the Trip Leader knows well and will return to until that area is completed. The Physical Science office will not allow anyone else to visit that area until one of the following conditions have been met, 1) the Trip Leader has declared that they are finished with the area, 2) the trip leader opens it up to others, or 3) the park declares the area open after one year of inactivity by the Trip Leader. Only surveys that a Trip Leader has done may be claimed by that Trip Leader. A Trip Leader can not claim areas previously surveyed by others. Trip Leaders must request a particular survey designation for it to become their official survey area. Each Trip Leader may have up to two survey areas at any given time. The park will maintain a list of current survey areas and their approved Trip Leaders.

17) Place Naming Rules

All historic place names in Wind Cave that are not vulgar are automatically accepted into the park's official Place Name Lexicon, regardless of how they were chosen. For names such as "Adam's Well", all of the " ' " before the "s" are dropped, since none of the people in those historic names own those places nor do the names refer to that person now. The name is now simply considered a "place name". Cave surveyors are allowed to name places as they survey. The official trip leader on each trip can recommend names to the park after a trip is over. The following naming guidelines/rules apply:

a. Nothing can be named after a living person.
b. Nothing can be named with vulgar or offensive names.

c. A trip leader must survey the passage in question in order to name it.

18) Volunteer in the Park (VIP) Status

Anyone participating in a work trip, survey trip, or leading a recreational trip will be enlisted in the park's Volunteers in the Park (VIP) program.

International volunteers must provide proof of insurance. International volunteers working 7 days or more must also obtain a J1 work visa and coordinate their activities through the NPS Office of International Affairs.

D. Special Use Permits

Special Use Permits are requested activities that fall outside of normal cave use. All Special Use Permits must be acquired from the Chief Park Ranger and approved by the Superintendent. Special Use Permits will be considered on a case-by-case basis. For all cave use, the permittee must be accompanied by an approved leader (off-trail by a Trip Leader; on-trail by qualified park staff). All Special Use Permits in caves must abide by the policies established within this plan.

E. Research

1) General

a. All researchers obtaining research permits must have proof of insurance.
b. All researchers intending to lead their own off-trail trips must complete the Wind Cave National Park Trip Leader training course.
c. International researchers must provide proof of insurance, obtain a J1 work visa, and coordinate their activities through the NPS Office of International Affairs.
d. Approved research will only take place in areas designated on the permit.

2) Proposals

Each initial application for a permit must include a formal study proposal regardless of the perceived simplicity of the proposed study.

To obtain permission to conduct field research and/or collecting of specimens at the park, a research proposal must be submitted to the park through the National Park Service Research Permit and Reporting System (RPRS) found on the Internet at: *http://science.nature.nps.gov/servlet/Prmt_PubIndex*

International researchers must provide proof of insurance, coordinate their activities through the NPS Office of International Affairs, and obtain the necessary visa(s).

3) Investigator's Annual Report

The permit holder is required to submit an Investigator's Annual Report and may be asked in their permit to provide copies of notes, final reports, publications, or other materials resulting from studies in the park. Instructions for how and when to submit the on-line annual report can be found on the RPRS web site. The permit holder is responsible for the content of reports and data provided to the National Park Service.

4) Alteration and Removal of Resources

Research requiring alteration and removal of resources must follow standard NPS collection guidelines (available at the Internet address above). Additional restraints and/or restrictions as well as protocols may be imposed by the park. Any resource that is not consumed during analysis must be returned to the park after the research ends. Application for exemptions will be reviewed on a case by case basis in conjunction with the park's Curator. No resources may be sold or used for profit.

5) Research Equipment

Any equipment that researchers want to leave in a cave will have to be approved by the Physical Science Specialist.

F. Cave Search and Rescue

Cave search and rescue will be carried out as stipulated in the Wind Cave Search and Rescue portion of the park's Emergency Management Plan. The cave rescue cache equipment will be maintained by the Physical Science staff in conjunction with the Visitor and Resource Protection staff.

VI. DATA MANAGEMENT POLICIES

Any data collected during survey or work trips will be analyzed and properly stored by the Physical Science staff.

A. Notes and Reports

1) Survey & Inventory Notes

All survey/inventory will follow established park protocols and be recorded on official park data forms. Survey and inventory data will conform to the park's written survey and inventory standards. Individual standards are addressed in Appendix C: Survey and Inventory Standards. All original survey data sheets will remain in the park and be properly curated in the park's museum collection.

2) Trip Reports

The front of a trip report form must be completed and submitted prior to each off-trail trip, and the trip summary must be completed within 48 hours of the trip's completion.

B. Electronic Data

All survey and inventory data collected in the park will be entered into and processed by computer databases.

1) Global Positioning Systems (GPS) Data

All cave entrances and karst features will be located using GPS receivers. This data will be collected under the park's established GPS protocols, and incorporated into the park's Geographic Information Systems (GIS). This data is considered 'sensitive information', and is protected from FOIA requests under the Federal Cave Resource Protection Act.

2) GIS Data

A cave GIS database is being developed in cooperation with the park's GIS Specialist. The cave GIS database will incorporate cave survey and inventory data, surface features (such as cave entrances, karst features, and surficial geology), and other relevant information. All GIS data will be developed under standards set by the Federal Geographic Data Committee, including FGDC-compliant metadata as described in the Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998) and the Content Standard for Digital Geospatial Metadata Workbook (ver 2.0). This data is considered 'sensitive information', and is protected under the Federal Cave Resource Protection Act.

C. Ownership of Data

Original survey and inventory data collected in the park during work trips is the property of the National Park Service. All original datasheets will remain in the park. Copies of survey and inventory datasheets, as well as electronic data may be available upon request from the Physical Science office. Scientific data collected by researchers and park staff is dealt with in Section II, F: Cave and Karst Research.

D. Cave Records and Files

Each cave in the park has a file in the Physical Science office files. Copies of maps, survey and inventory datasheets, photos, trip reports, research reports, and other relevant information will be kept in these files. Information from cave records and files may be available upon request from the Physical Science office. If deemed sensitive, this information may be withheld under authority of the Federal Cave Resource Protection Act of 1988.

VII. PROCEDURES FOR REVISING THE PLAN

The Cave & Karst Management Plan should be updated as needed. The Physical Science staff will coordinate updates with input from park staff. The plan will then be submitted to the Superintendent for approval and signature.

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IX. APPENDIXIES

APPENDIX A: Definitions of Caves and Karst Terms

(as found in NPS 77 and the Federal Cave Resources Management Act of 1988)

Cave: The Federal Cave Resources Protection Act defines a cave as any naturally occurring void, cavity, recess, or system of interconnected passageways beneath the surface of the earth or within a cliff or lodge that is large enough to be traversed by people, whether or not the entrance is naturally formed or manmade. The term includes any natural pit, sinkhole, or other feature which is an extension of the entrance. Types of caves include lava tubes, limestone and gypsum caves, tectonic fractures (earth cracks), littoral (sea) caves, ice caves, and talus caves. In the National Park Service Natural Resources Management Guidelines, NPS-77, a cave is defined as any naturally occurring void, cavity, or system of interconnected passageways beneath the surface of the earth that is large enough to be traversed by people, that extends into total darkness, that may or may not have a natural opening to the earth's surface, or have at least 50 feet of passageway. At the park, a feature that meets any of the above criteria will be considered a cave.

Cave & Karst Resource Management: A discipline involved in protecting and perpetuating natural cave and karst systems by developing guidelines and protocols for all cave uses, inventorying and monitoring cave and karst resources, and restoring impacted resources.

Backcountry Caves: Backcountry caves will be defined as all undeveloped caves within the park that have not been physically connected to Wind Cave.

Karst: A landform comprised of sinkholes, sinking streams, caves, and spring resurgences, occurring in a soluble rock such as limestone or gypsum.

Rock shelter: A concavity in rock that may not have extensive passageways but is a large enough cavity or rock overhang to provide shelter for humans. Rock shelters usually do not extend into total darkness.

Speleothems: A secondarily deposited mineral feature that occurs in a cave, such as a stalactite, stalagmite, flowstone, or helictite.

Feature: A “speleological” site that is judged to be too short to be considered a cave.

APPENDIX B: History of Cave & Karst Resource Management at Wind Cave National Park

American Indians were likely the first people to discover the natural entrance of what would eventually be called Wind Cave. However, there is no evidence that the Native Americans ever entered Wind Cave. The first recorded group of American Indians to enter Wind Cave occurred in 1910. The need for cave resource management of Wind Cave actually did not exist until 1881, when recorded history started to be made in and above Wind Cave. The first person reported to have entered the cave was Charlie Crary that fall, who reported that he left twine to mark his trail. Others entering the cave later reported that they found twine, verifying his claim. By 1886, it was realized that the mysterious wind, by which the cave got its name, was caused by barometric pressure changes (Bohi, 1962).

Much of the early work completed in Wind Cave was done to facilitate visitor access. In 1887, an artificial entrance was opened near the Natural Entrance. In 1890 Alvin McDonald, started blasting a tourist trail, reportedly using blankets to protect cave features from flying rocks (Bohi, 1962). At the same time McDonald started exploring and documenting the cave with simple maps, place names, and diary entries. Unfortunately, this map may have been destroyed when the McDonald's cabin burned down in 1899. In 1893, a mining engineer from Deadwood, George S. Hopkins, produced a 10' x 10' foot map from McDonald's map for the World's Fair in Chicago. However, this map has not been found to date. It has been pointed out that McDonald's descriptions and maps are a form of early cave survey and inventory (Rohde, 1984a). However, much of McDonald's work seemed to be motivated by making a living and a love of exploration, not necessarily a desire to conserve or protect the cave, except where it made financial sense. In 1895, stereo photographs began to be taken along the tour routes in Wind Cave. Although, these were intended to be sold to visitors, they provide important early documentation of cave resources. In the late 1890's, numerous organizations named and dedicated various rooms in Wind Cave after their individual clubs (Bohi, 1962).

Much of the earliest cave management efforts involved survey work, primarily on the developed trails in the cave. Although, a story in the Hot Springs Star reported that Mr. Walter Scott had completed a seven-day survey project in 1896 to find a location for an exit tunnel and to create a tourist map of Wind Cave, the actual survey has not been found. The first known survey that produced a map was directed by the Secretary of the Interior in May of 1902 and consisted of over 95 stations and 1.2 miles of survey. This survey was conducted in order to determine how large of an area had to be set aside for the park (WICA Nat. Resource Mgmt. Plan, 1983). The next survey project was a CCC resurvey of the trails between 1933 and 1934, to aid in the selection of a site for an elevator shaft (Freeland, 1933). The office of the NPS Chief Engineer from San Francisco used this survey to produce a simplistic map of the Short Route (now the Natural Entrance and Garden of Eden Tours) and the Long Route (now the Natural Entrance and Fairground Tours). The first off-trail surveys were conducted by the CCC survey crew, who surveyed the Bishop Fowlers Loop and Silent Lake to Rome. These surveys were probably undertaken in order to create off-trail caving routes.

An early and significant cave management action taken in behalf of Wind Cave was the creation of Wind Cave National Park on January 3, 1903, creating the eighth national park and the first to protect a cave. The park was created in order to protect a significant cave from commercial exploitation (Taylor, 1994). One of the first acts taken by the new Superintendent was to build a rock retaining wall around the Natural Entrance, so the tour route would not flood when it rained. Work started immediately on upgrading the trails in Wind Cave. In 1904, 300 yards of trail were blasted out along the Blue Grotto Tour Route and new wooden stairways were built on the three main tour routes. Between 1905-1907, a Park Service crew was hired to build stairs and open up the Blue Grotto Loop and the Coliseum portion of the Fairgrounds Tour Route. Other projects were completed in the cave to reduce maintenance problems such as using creosote soaked wood for all of the stairs in 1910 in order to prevent dry rot. However, these were the last projects completed in the cave for nearly 20 years, primarily due to a report in 1910 by the Secretary of the Interior, Richard Ballinger. He stated in his annual report, "Owing to its (Wind Cave's) inaccessibility and the fact that its scenic attractiveness is not sufficient in all probability, to inspire a greater number of visitors to the park, it should be classed as a local or state park and can never in any sense of the word become a national park". That same year, Superintendent Pilcher guided a General John J. Pershing on the tour where they used an aneroid barometer to establish elevations for various points along the tour routes. By 1915, it was decided that the stairs along the tour routes had to be made of more durable materials, such as stone, because the wood kept rotting out and workers were limited to 12-foot long boards that could be carried through the cave. That same year the Superintendent and Landscape Engineer for the NPS recommended that Wind Cave be electrically lighted, as it is, "one of the most startling and fascinating wonders of this country". Tours at this time were three-hours long and the visitors carried candle lanterns while their guide carried a roll of magnesium to light up the larger rooms. By the late 1920's every fifth visitor carried a gasoline lantern. Although, no projects were actually done inside of the cave during the 20-year lull, a new building was built over the cave entrance in 1925 at a cost of $800. The next year, the park started looking into the cost of electrically lighting the cave.

In 1931, a visitor was required to erase his name from a cave wall using a wire brush. In 1931-1932, electric lights were finally added to the tour routes. With this new electrical system a few colored lights were briefly experimented with along the Natural Entrance Tour and in the Garden of Eden. In 1933, the light fixtures and cables were concealed in order to provide indirect illumination of the cave so they did not blind the visitors (Freeland, 1933). In 1934 the narrow sections of the short route were widened and graveled, cutting off a half hour of that tour. In 1935, CCC laborers were used to carry out several projects including, constructing the Walk-In Entrance, the elevator shaft, the concrete replacement of the wood stairs, and the addition of iron handrails (Superintendents Annual Report, 1935). The Walk-In Entrance was excavated that year by digging down six feet to a fissure and stacking weathered rocks to create a "natural-looking cave opening in a rocky hillside". As part of this project, large rock slabs were laid on top of the side walls along the entrance section and fill was dumped over the whole structure. This project was considered one of the most important improvements completed by the CCC (Superintendents Annual Report, 1936). At the same time, radiators and 2,300 feet of coiled pipes were installed in the Isolation Room in order to cool the park's power plant. Although, this project solved a maintenance problem in keeping the power plant cool, it caused significant impact on cave resources (Horrocks, 2006h). In October, the NPS Acting Assistant Director, Earl A. Trager, complained that in several places the floors of Wind Cave were blasted unnecessarily deep and the walls unnecessarily wide by the CCC crews. He also thought that the concrete stairs were an eyesore and that only rock stairs should be used in the cave. He recommended that all work stop until a geologic technician could supervise the work. The next year he complained that the CCC crew was removing natural projections from the ceilings and walls in order to give the cave passage a more "tunnel like" appearance.

In 1936, narrow sections of the cave trail were widened and the floor deepened in low roofed sections. It was decided that the floors could be sacrificed, but the overall shape of the passage and the ceilings had to be preserved. At the same time, much of the trail construction debris that had been left along side of the cave trail was cleaned up while white gravel was laid down on the Short Route for safety reasons.

In 1937, the lighting of the Blue Grotto Loop was completed but the main power cable along the Long Route had to be replaced due to moisture problems. In 1939, a plaster scale model of a section of cave passage was constructed from a profile of 140 feet of the tour route with cross sections taken every three feet. The model was then placed in the Odd Fellows Hall and the name of the room was changed to the Model Room (Bohi, 1962). That fall the elevator and cave lights were not used for several months when the diesel engine broke down. In 1940, a proposal was made to tunnel from the Natural Entrance Tour Route to a passage that connects with the Fairgrounds (possibly via the Bishop Fowler Loop) so visitors did not have to retrace their steps anywhere on the Long Route. However, nothing became of the proposal. In 1942, one of the last remaining sets of wooden stairs, which was located along the Long Route, was replaced with concrete.

One of the earliest cave management recommendations made, was to install a double-door airlock on the Walk-In Entrance after frost wedging caused a 2-ton collapse in 1916, another in 1943, an 8-ton collapse in 1946, and a 20-ton collapse in 1957 (Superintendents Annual Reports, 1946, 1957). Although architect Halsey M. Davidson looked at ways to change the door in 1947, nothing resulted from his visit. When it was noticed that same year that warm air from the cave was causing considerable damage to the Elevator Building, airtight doors on the elevator landings were proposed. Finally, when a significant increase in vandalism was noticed after the maximum tour size was increased that year, serious consideration was given to reducing the tour size. However, nothing was done, nor was anything done to address any of the other problems (Superintendents Annual Report, 1947). In the spring of 1946, a 7 ½" rain caused a food that washed out the first 500 feet of electrical cables in Wind Cave, which closed the cave for three days (Bohi, 1962). It has been said that during the 1940's, the cave was left to manage itself for the most part (Rohde, 1984a).

In 1953, the first real off-trail survey work in Wind Cave was started by students and volunteer groups. The earliest work was completed under contract by geology students of Dr. Paul Gries from the South Dakota School of Mines and Technology (SDSM&T) from 1955-63. Then by seasonal Park Rangers in 1956 and finally by cavers from the National Speleological Society (NSS) beginning in 1959 (Brown, 1959). The Colorado Grotto, an affiliate of the NSS, became involved in the survey of Wind Cave when they were asked by the park to find a route around Summer Avenue, which was viewed as a bottleneck in the tours and to locate all of the leads between the Walk-In Entrance and the Post Office (Nepstad, 1993a). Although, a route was found between the Garden of Eden and the Elks Room, nothing became of that project. All of these survey efforts resulted in 4.31 miles of survey being added to the length of Wind Cave.

Several research projects were conducted in Wind Cave involving biotic, meteorological, and mineralogical surveys during the 1959 NSS Wind Cave Expedition (Brown, 1959). As part of this expedition, Stewart Peck, noted that biota in Wind Cave was scarce due to the lack of water and sediments. He also documented the long-legged Myotis from Wind Cave as well as a species of collembola previously only know form Montana, Oncopodura cruciata and another Parrhopalites, which had only been previously found in Mexico (Peck, 1959). George H. Deike also reported the presence of paleofills in the upper levels of the cave in his report from the NSS expedition. He also studied boxwork and passage orientations, determining the two do not coincide (Deike and White, 1959). During this ten-day expedition, 22 cavers surveyed 3 miles of passage and prepared a surface topographic map using a plane table and alidade to show the cave's relationship to the surface. John L. Haas drew four quadrangle sheets of Wind Cave using ink and Leroy lettering on linen from this survey data. These maps were drawn at a scale of 30'/inch and covered about 1,015 by 630-foot sections of the cave.

Before cave tours were started in April of 1960, the rusted iron handrails in Wind Cave were all sanded down and painted with "Rustoleum". In an attempt to reduce the number of tort claims from visitors slipping on the asphalt cave trails, the rangers were required to report the location of any slippery portions of the trail for immediate action. Finally, in order to extend the life of the bulbs in the cave lighting system, all of the bulbs were replaced that year with Luxor bulbs.

In December of 1961, the Colorado Grotto begun a survey project in the "Northwest Area", surveying passages located west of the Post Office. At that time, Pete Prebble compiled a map at 20'/inch from the surveys that the Colorado Grotto had done between the Garden of Eden and the Elks Room while looking for a way to bypass Summer Avenue. Ken B. Carpenter also compiled a map at 20'/inch of the Cathedral/Fairgrounds Loop surveyed by the Colorado Grotto. That same year the leading edges of all of the stairs in Wind Cave were painted white for safety reasons.

In 1962, the park made it a requirement that all exploration trips be cleared through the Chief Ranger's office. Park Ranger Alan Howard began surveying in Wind Cave at this time, mapping several thousand feet of passage. In order to determine the total length of all four tour routes, a survey was conducted along each route, arriving at a total length of 1.24 miles of developed trails in Wind Cave. Water continued to be an issue when a slippery rubber mat caused a visitor to fall and break her arm and dripping water in the elevator shaft had to be captured using a drain installed at the Garden of Eden level of the shaft. During 1962, a total of 0.92 miles of survey was added to the length of Wind Cave.

In 1963, Jon T. Schnute proposed a method to measure the volume of Wind Cave by using the Natural Entrance, temperature, barometric pressure changes, and wind speed (Schnute, 1963). In 1964, Herb Conn started that volume calculation project, completing it in 1966. Herb estimated that based on the volume measurement he calculated for Wind Cave, the cave was only half of the size of nearby Jewel Cave (not accounting for the elevators, Snakepit Entrance, and blowholes at WICA which would have actually increased the size of Wind Cave) and that most of the cave is located near the entrance, unlike Jewel Cave (Conn, 1966). That same year, a project was conducted to replace the top rail of all of the iron handrails in Wind Cave with stainless steel. At this time, Wind Cave became an official Civil Defense Fallout Shelter with supplies for over a 1,000 individuals stored at the Middle Elevator Landing.

Between 1964 and 1968, several significant discoveries were made in Wind Cave by Herb and Jan Conn and Dave Schnute, including the Spillway (which led to most of the western portion of the cave), the Club Room (the largest room at the time), and Calcite Lake (where the cave intersected the water table). These discoveries led to a significant increase in survey work in Wind Cave.

The struggle with slippery cave trails continued. In 1965 abrasive surfaces were applied and then in 1966 flexible steel mats were installed on slippery sections of the cave trail. At the same time, 106 feet of new handrails were constructed along the tour routes. That same year, the first cave rescue plan was completed (Superintendent's Annual Report, 1966). At the same time, the Colorado Grotto submitted an eight-page document to the park called the, "Wind Cave Project – A Petition." This document established rules and regulations for the exploration of Wind Cave by the Colorado Grotto. This document possessed similarities with a cave management plan as well as a cooperative agreement.

In 1967, a "Cave Entry Checkout" procedure was started for off-trail trips that became the foundation for today's cave permit system. At the Frostwork Ledge on the Fairgrounds Tour Route, tiered steps and a stand for the black light, which started to be used in 1956, were completed. In July, a flashflood entered the Walk-In Entrance, washed out eight feet of trail and caused a six-person tour on the Natural Entrance Tour Route to climb onto a ledge as the waters flowed by. After being plagued with moisture problems, moisture resistant boxes were obtained to house the Civil Defense Fallout Shelter supplies. That same year two new Wild Cave Tour Routes were created for Wind Cave visitors, including the Attic and Mound Builders Rest Routes. The Mound Builders Rest Route started at the Second Crossroads and chimneyed down to Mound Builders Rest, where the visitors were given flagging and an hour to explore on their own. The Attic Route started at Pecks Pit, off of the Pearly Gates, and went down the Attic, with a side trip to Plumbers Pit, before rejoining the paved trail at Johnstones Campground. In 1968, the Muddle Room Wild Cave Tour Route was added to the list. This route started from Dantes Inferno (next to the Eastern Star Room) on the Garden of Eden Tour Route and continued to the Muddle Room and then to Rome (Frankfort, 2006). That same year, two telephones were added to the Fairgrounds Tour Route.

It was not until 1969 that the Colorado Grotto once again started surveying in the cave. They subsequently discovered what would later be called the Colorado Grotto Section of the cave, before once again becoming inactive after disagreements with the park over survey notes and maps (Nepstad, 1993a). A total of 0.45 miles was added to the surveyed length of Wind Cave during the year.

In 1970, the Windy City Grotto, from Chicago, Illinois started a major four-year effort to make a complete map of the cave and in the process discovered Emperor Maximus (the cave's largest known helictite bush), Windy City Lake, and Half Mile Hall (the longest known passage in the cave), at the same time doubling the length of the cave. A backcountry cave named Elk Antler Cave was documented by Mark Stock that year. However, he wasn't the first to find it, as it contained several signatures from the 1940s and had obviously been enlarged using mining techniques.

In 1971, the Windy City Grotto experimented unsuccessfully with a base camp to achieve multi-day survey trips in Wind Cave. This four-week camp, located along the OF survey route near the Master Room, had a 7,000-foot long communication wire run from the surface and was serviced by support teams that ferried food and supplies in sausage-shaped inner tubes. Each day, another of these support teams rotated into the camp schedule, which left three teams surveying in the cave each day, but only two teams staying at camp each night. The failure of this type of camp ultimately led to a decision to stick with single day trips (Pisarowicz, 1985). That winter a blowhole was blasted open. It had originally been found by Elmer McDonald in the 1890s and then relocated in 1956 by the park's Naturalist, Mr. Bryant, after McDonald had told him about the breathing hole the previous year. The park had been referring to the relocated blowhole as the "Horse Corral Blowhole," after the nearby horse corral. After Maintenance employees expanded the hole to human size, cavers started exploring the new cave, which they referred to as "The Blowhole", with the anticipation that it would eventually connect with Wind Cave proper. While attempting to connect the Half Mile Hall area with the Blowhole in 1972, the Windy City Grotto worked with some Chicago area TV technicians to film their exploration efforts. That same year the last remaining wooden stairs, known as the Rescue Stairs, were replaced with aluminum left over from the Jewel Cave project. Finally, the park used a Capacity Survey to determine that a maximum of 40 individuals would be allowed on cave tours.

Between 1970 and 1973, Wind Cave was largely managed by the park Interpreters, while the surface was managed by the Rangers (Frederick, 2006). Although most of the emphasis was on exploration at this time, Chief of Interpretation, John C. O'Brien, recommended that a new Visitor Center be built at the junction of 385 and 87, because no one knew what the consequences of expanding the existing Visitor Center over the cave would be (Frederick, 2006). Unfortunately, this visionary cave protection recommendation was not heeded. Slippery areas along the cave trails were addressed by putting in some shallow concrete stairs. During that same time period, John Scheltens, from the Windy City Grotto, used a grid system to add several quadrangles to Conn's map. These Mylar quadrangles covered 1,600 by 1,050 foot sections of the cave. Scheltens divided the cave into two levels, using red for lower levels and green for the upper. These maps contained about 19 miles of survey. That year the Upper Specimen Wild Cave Tour Route was added to the off-trail tour routes available to visitors. This started at the Corkscrew Stairs and went to the Cataract Room where the visitors were allowed to explore on their own before climbing down to the Post Office (Frankfort, 2006). With the addition of the SK Wild Cave Tour Route in 1973, the park was using three different wild cave tour routes interchangeably (Frankfort, 2006). The park installed mercury vapor lights on the cave tours to better light the larger rooms and to increase the amount of reflected light on the cave trails. At this time, Jens Munthe drew a draft map of the Xerox Room area, which the Colorado Grotto had discovered in 1969. A largely unsuccessful experiment was tried that year to control algae on the Garden of Eden Tour Route using diluted Thimersol (Frederick, 1979).

In 1974, Interpreter Larry Frederick introduced lard buckets for candle lanterns on the Candlelight Tour because they did a better job of catching wax and they prevented visitors from applying the flames directly to cave surfaces (Frederick, 2006). That year, John Scheltens processed 20 miles of Wind Cave survey data on a very early computer program to produce line plots as an aid in drawing cave maps. This process involved 4000 punch cards on an IBM Main Frame computer at the University of Illinois (Scheltens, 2004). That same year, Herb Conn was contracted to draft all completed surveys onto maps. He drew 14 cave quadrangle maps at 50'/inch, which covered 1,675 by 1,050 foot sections of the cave and contained about 19 miles of passages. These maps were drafted with ink on Mylar with Leroy lettering. The first inventory of algae along the tour routes was conducted that summer. Finally, Boundary Cave, Salamander Cave, and Coyote Cave (originally known as Blo-Suk and then Highland Creek Cave) were discovered by Interpreter Tom Miller.

In 1975 John Scheltens drafted all of the known survey onto three large 6' x 3' maps, at a scale of 50'/inch. He rotated his maps so that north was oriented upwards. These maps originally contained 20.4 miles of survey. A total of 1.15 miles of passage was surveyed in Wind Cave between 1974 and 1975.

In 1976, Don Mitchinson conducted a temperature variation study along the tour routes using thermometers. He was able to detect up to a 2 degree variation in temperatures away from the Natural Entrance (Mitchinson, 1976). John Scheltens produced a multicolored map of Wind Cave that contained everything surveyed up to that date (Scheltens, 1976). A total of 0.69 miles of passage was surveyed in Wind Cave that same year. At this time, employee safety came to the forefront as the park asked the Mining Enforcement Safety Administration to conduct radon monitoring in Wind Cave. After attending MESA radon training at Carlsbad Caverns National Park, Assistant Chief of Interpretation and Information, Larry Frederick, started weekly radon testing at six sites along the tour routes. He found that radon averaged 0.19 working levels (Frederick, 1977).

In 1977, three cave management programs were started: controlling algae with bleach applied by a backpack sprayer, conducting cave restoration, and photo monitoring cave resources (Frederick, 1977b). Tom Farrell was hired to monitor radon in both Wind and Jewel caves for one year. Although, the highest readings were recorded during the summer season when the cave was exhaling, the levels were low enough not to be considered a health risk (Frederick, 1977). As part of this monitoring program, several hygrothermographs were installed along the tour routes in Wind Cave to constantly monitor RH and temperature (Frederick, 2006). Nine employees also participated in a hazard and medical evaluation conducted by the National Institute for Occupational Safety and Health. All nine participants produced negative results for respiratory irregularities (Gunter & Meyer, 1977). With Frederick's return to the park, the SK Route became the exclusive Wild Cave Tour Route used in Wind Cave. It was decided that the Attic Route required too much paved trail travel and the Upper Specimen Route was too delicate (Frankfort, 2006). John Scheltens presented a 104-page guideline to the park Superintendent that year to, “lay the foundation for the long-term investigations that Wind Cave deserves and requires” (Scheltens, 1977). This guideline was written by numerous authors, including the park’s Assistant Chief of Interpretation, Larry Frederick. However, the park replied that although cavers were free to use these guidelines, the park would not adopt a plan from an outside source. A total of 0.43 miles of passage was surveyed in Wind Cave during the year.

In 1978, the first written cave management policy, a 15-page off-trail access policy, was completed by Larry Frederick (Frederick, 1978). This early plan, which was called the Cave Travel Policies, addressed restricted areas, cave search and rescue, and survey techniques. The first survey standards for a National Park Service cave were established in this plan. The plan also established cave rescue caches in Wind Cave in areas where active exploration was ongoing. Two caches, which consisted of sleeping bags and other supplies inside of inner tubes, were actually placed in the cave. That same year a relationship was started with the National Outdoor Leadership School (N.O.L.S.) that would last for nearly 20 years. The Superintendent asked Frederick to decide where the N.O.L.S. caving section for their semester-long course could be held within Wind Cave. Frederick directed them to the area around the Walk-In Entrance and N.O.L.S. began exploration and survey between Room Draculum and Ranibow Falls that spring (Frederick, 2006). Although, some cave surveyors began using Mylar reflective survey tags to mark station locations at this time, others continued using the traditional carbide bull’s-eyes (Frederick, 1978). After attending the National Cave Management Symposium in Carlsbad, NM, Frederick recommended that the park change the vertical bar gate on the Walk-In Entrance to a more bat friendly horizontal bar gate; however, this proposal was rejected by the park (Frederick, 2006).

In 1980, a new indirect cave lighting system using fluorescent lights was installed that placed many lights, for the first time, off of the paved trails (WICA Nat. Resource Mgmt. Plan, 1983). During the year, cavers discovered nearly a mile of walking passages in the Spaghetti bowl area of Wind Cave. Between 1978 and 1981, a total of 10.84 miles of passage was surveyed in Wind Cave.

In 1982, the “Cave Travel Policies” were updated by Kay Rohde, the Assistant Chief of Interpretation. In this version, she updated the contents of the cave rescue caches and listed qualified people for cave search and rescue operations (Rohde, 1982). On May 19th, Resource Biologist Rich Klukas reported the capture of Beaver Creek into “Beaver Creek Cave” (Klukas, 1985). In an attempt to determine visitor impact at the unsupervised end of tours, Bob Hirschy and Bill Gilbert did an experiment where they planted numerous small geodes along the tour routes. By the end of the summer, all of geodes were gone. Between 1982 and 1983, a total of 2.57 miles of passage was surveyed in Wind Cave.

In 1984, an important year for cave management at the park; Kay Rohde was designated the Cave Management Coordinator and the first official cave management program was started. This program was the second cave management program to be started at a National Park Service site, following the lead by Carlsbad Caverns National Park. Rohde felt that it was impossible to have a cave management program without significant volunteer help (Rohde, 1984a). Towards this end, volunteer caver John Scheltens, who had moved to the area in 1978 and was surveying in the cave under a special use permit, was given the responsibility of data management for the Wind Cave survey. Scheltens started by organizing all the cave surveys alphabetically into 3-ring binders and drafting one master map. Although a few cave survey teams had occasionally compiled a report on their survey trips, it was not until April that it became mandatory that official trip report forms be filled out for every trip (Rohde, 1984a). That same year, Carlsbad's Cave Specialist, Ronal Kerbo, spent two weeks at the park and recommended nine topics to be addressed in a Cave Management Plan, including: resource inventory, survey and mapping, cave microclimate, cave research, safety, cave vista monitoring, maintenance of cave facilities, caver restoration, and recreational use of the undeveloped portion of the cave (Rohde, 1984b). One of the things that Kerbo recommended be stopped was the practice of letting visitors explore on their own from the Muddle Room on the SK Wild Cave Tour Route. Beginning that year, seasonal interpreters Jim Pisarowicz and Warren Netherton conducted a cave climatology study in Wind Cave. This study showed that unnatural airflow through the open Walk-In Entrance caused temperature fluctuations as far as the Post Office, 600 feet into the cave, and removed hundreds of thousands of gallons of water from the cave air, significantly impacting natural humidity levels (Nepstad, 1991a). Netherton was actually hired to split his time between Cave Management and Interpretation that year. His major project was dividing Scheltens map into 18 cave quadrangles at 50'/inch (Fig. 7). He traced Scheltens maps with ink and Leroy lettering onto 22" x 36" Mylar sheets. Each quadrangle covered 1,800 by 1,100 foot sections of the cave that could be subdivided into quarter sections to make photocopying individual sections easier. These quadrangles included about 39.56 miles of survey. Netherton was also assigned algae removal, numbering all of the lights along the tour routes, cave climate monitoring, developing a cave inventory procedure, and supervising the N.O.L.S. program. The first inventory procedure involved teams recording noteworthy features on a cave map. These features were then transferred to colored overlays showing speleothems, cave levels, biota, cultural features, and hazards. However, because everybody was recording different noteworthy features and because of the advent of personal computers, this system quickly became obsolete (Nepstad, 1991d). Rohde also introduced the concept of an employee orientation trip to familiarize employees with the cave, which was allowed as long as a trip report was written on what was observed. In June a training seminar by the National Cave Rescue Commission (NCRC) was sponsored by Wind Cave. The N.O.L.S. students were allowed off-trail in Wind Cave and in return were asked to spend one day helping to haul out old electrical cables and switch boxes or cleaning algae. On October 17, The Blowhole was connected to Wind Cave proper by two survey teams. Scheltens led a trip from the Wind Cave side and Dave Springhetti, whose team eventually made the connection, led a team from The Blowhole side. This connection created a cave over 41-miles long and added a second natural entrance, albeit a modified one, to Wind Cave.

Seasonal interpreter Jim Nepstad was hired into the seasonal Cave Coordinator's position in the summer of 1985. The park started transferring the tasks of cave survey data processing and map drafting to Nepstad that year, tasks that were gradually taken away from John Scheltens. Although, this change was controversial among some cavers, it still allowed cavers access to copies of all the data. Nepstad completed much of the initial data entry work while in school the following winter in Wisconsin, where he entered the

Wind Cave survey data into SMAPS, a computer-based data processing program. With this change, Wind Cave became one of the first National Parks to manage its own cave survey data, thereby avoiding the problems that were happening with volunteer groups at other National Parks. That same year, Kay Rohde completed the first official Cave Management Plan for the park, with assistance from Jim Pisarowicz, Scheltens, and N.O.L.S. instructors (Rohde, 1985). Additional topics addressed in this expanded document included: cave management objectives, inventory categories, N.O.L.S. trips, orientation trips, and environmental monitoring. In July, Dr. James Martin, a Paleontologist from the South Dakota School of Mines & Technology, started a project to identify some bones from the Chamber of Lost Souls, a project that still has not been completed. That same month, the use of propane torches to dry the slick asphalt cave trails, a technique that had been used for more than 17 years, was abandoned after a letter from the National Parks and Conservation Association questioned the environmental consequences of the technique. In August, Frank Reid completed 32 cave radio locations in and above Wind Cave. Most of these surface points were then marked on the surface with rebar or cement (Nepstad, 1985b). During the year, a total of 2.46 miles of passage was surveyed in Wind Cave.

During 1985 and 86, the National Park Service funded Dr. Calvin Alexander and Marsha Davis from the University of Minnesota to conduct dye traces in Wind Cave Canyon. Their hydrological study, which included work at Jewel Cave National Monument, demonstrated that water can enter Wind Cave from the overlying canyon in as quickly as two days, that elevated nitrate levels occurred in cave water at a few sites, and toluene was found at another, presumably originating from the parking lot (Davis and Alexander, 1989).

In 1986, the Wind Cave map was redrawn when Mr. Reid's cave radio project revealed major inaccuracies (Nepstad, 1988). That same year, the park installed a staff gage to monitor lake levels in Windy City Lake. That winter the first major cave restoration project in Wind Cave was conducted when most of the asphalt from the cave trails was removed and replaced with concrete to eliminate the slipping hazards and the potential input of petrochemicals into the cave (Pisarowicz, 1988b). This project led to the realization that there were numerous other types of restoration projects that needed to be completed in Wind Cave (Nepstad, 1991a). During the year, a total of 2.86 miles of passage was surveyed in Wind Cave.

In 1987, Nepstad digitized and published the Coyote Cave map in AutoCAD (Nepstad, 1987). He also developed a new set of cave inventory procedures that tied inventoried items to survey stations and provided preprinted lists of features (Nepstad, 1991d). On August 16, the Wind Cave survey arrived at the 50-mile mark. Twenty nine cavers participated in a "ribbon-cutting" type of event in which they mapped the Natural Entrance, which at that point, had never been mapped (LaRock, 1987). That year, Derek Ford, a researcher from McMaster University in Ontario, determined that the water table in Wind Cave has been dropping at a rate of 1.3 ft/1,000 years, beginning 470,000 years ago (Ford, Palmer, Bakalowicz, and Miller, 1987, 1989). After studying stable and unstable isotopes in the waters of Wind Cave, Tim Millen reported that the water in the Lakes Section of Wind Cave is supersaturated in terms of calcite, but varies seasonally, and is of meteoric (atmospheric) origin (Millen and Dickey, 1987). During the year, a total of 1.17 miles of passage was surveyed in Wind Cave.

In 1988, cave management activities increased significantly when interpreters Jim Pisarowicz and Darren Ressler shared cave management duties with Jim Nepstad. That year, a cave feature inventory requirement was added to the cave surveying protocols. For special inventory trips, this involved using three bound cave inventory books with facing pages. The first included minimum size, level, floor, and water with a blank facing page for notes, the second included geological, airflow, vertebrates, invertebrates, organic material, recent, cultural, and hazards features with a blank facing page for notes, and the last book included speleothem features with another blank facing page for notes. For survey trips, these three books were combined into one book that was given to a designated inventory person. That summer, the first Cave Restoration Field Camp in Wind Cave was created for cavers attending the National Speleological Society Convention in nearby Hot Springs. Various volunteer groups continued this work throughout that year, which eventually resulted in the removal of 200 tons of trail construction and electrical lighting system debris (Nepstad, 1991a). At this point, cave restoration was still in the experimental stage and tests were done with various lint cleaning tools (Ressler, 1988b). Pisarowicz used a magnifying lens to determine that there was no cave biota on the discarded pieces of wood along the tour routes and recommended that this wood should be removed from the cave (Pisarowicz, 1988c). This work was only partially accomplished. At the same time, the park started maintaining USGS equipment used to continuously monitor the lakes in Wind Cave. They monitored lake levels, water temperature, and barometric air pressure in one hour intervals. They found that the lake fluctuated 0.24 feet daily (probably as a result of barometric pressure changes), water temperature was 56.7 – 57.2 degrees F (13.7 – 14.0 degrees C), and barometric pressure was 1.03 inches of mercury (Greene, 1990). That same year, the fluorescent lighting system was removed from Wind Cave because that system was too bulky and the color spectrum was inadequate to highlight natural colors in Wind Cave. It also caused prolific amounts of algae to grow, especially around fixtures. The new incandescent lighting system was designed to better illuminate the trail and to highlight special features (Nepstad, 1991a). Ressler, with help from seasonal Interpreter Bill Rogers, mapped all of the algae sites along the tour routes and found that 24% of the lights had algae problems (Ressler, 1988a). With only a couple of miles of survey inventoried at this point, Rogers, wrote a program to enter the data into dBase III (Nepstad, 1992a). He also compiled a binder of cave management related documentation, divided into ten subdivisions, in order to make cave management documentation more readily available to the Interpretive staff (Rogers, 1988). This binder has become an important historic record of early cave management at the park. One of the last things that Rohde did before leaving the park for another position, was to enter the Cave Management Plan into a computer and then divide Wind Cave into four zones; 1) Developed Cave, 2) Historic Zone, 3) Travel Corridors, and 4) Wild Cave Tour (Rohde, 1988). Extensive dye tracing was completed by Calvin Alexander and Marsha Davis during the year to determine flow paths between the surface and Wind Cave. In addition, they conducted a successful dye trace between Beaver Creek and the park's water well in Wind Cave Canyon. The flow through time was less than two months. Age dating of the well water supported this as it indicated that is was under two years old. They also studied water quality and did isotopic work in Wind Cave (Alexander and Davis, 1989). During the year, a total of 1.39 miles of passage was surveyed in Wind Cave.

In 1989, after two years of campaigning by Kay Rohde for a permanent cave management position at the park, Jim Nepstad was hired as the first permanent Cave Management Specialist. He became only the third permanent Cave Management Specialist in the history of the National Park Service. In February, a historic well was relocated after a reference was found in the files to an old blowing well on the north border of the park, possibly hinting at the existence of another large cave system straddling the boundary with Custer State Park or a continuation of Wind Cave. In March, planning began to divide the Wind Cave survey data into seven, more manageable sections (Fig. 7) (Nepstad and Pisarowicz, 1989c). After the new incandescent lighting system had been in place for one year, Nepstad found algae growing at 109 lights along the tour routes in Wind Cave, but it was not as spread out as it had been with the fluorescent lighting system (Nepstad, 1989a). Following up on Hirschy's and Gilbert's experiment, Jim Pisarowicz and Nepstad planted six and ten pound geodes in the Oven area on the Natural Entrance Tour Route to see if visitors would remove them. They both disappeared within two weeks (Pisarowicz, 1988a). In October, a N.O.L.S. student became lost during a mock rescue practice. The resulting 34-hour search, which involved more than 100 people and made national news, was one of the larger cave rescues in the National Park Service. As a result of this rescue, N.O.L.S. was no longer allowed to hold a mock rescue as part of their training (Ressler, 1990). In a published paper, Thomas E. Miller noted that the water in the cave lakes is similar to water in nearby artesian springs and wells outside of the park (Miller, 1989). At the same time, Miller theorized that a dike intrusion below Wind Cave may be responsible for the higher geothermal gradient that is found in Wind Cave than would be expected (Miller, 1989). During the year, a total of 0.50 miles of passage was surveyed in Wind Cave.

In early 1990, flagged trails similar to those already established at Jewel Cave, were created throughout off-trail portions of Wind Cave, primarily to increase the numbers of cavers that could help with the huge cave inventory project (Fig. 11). This change also opened up the survey of the cave from a handful of people who knew the cave well, to virtually anyone. With this change, on-going survey activities would no longer be disrupted when cavers left the project. This had the added benefit that no single caver was indispensable to the project (Nepstad, 1990e). That year a formal cave survey project was created, primarily partnering with the Colorado Grotto. Cavers participating in this monthly event, named the Wind Cave Weekend (2nd Saturday of each month), were provided with sleeping arrangements and survey gear. With this project, a Memorandum of Understanding was established between the park and the Grotto for the purpose of, "researching, exploring, surveying, and inventorying caves in the park" (Nepstad, 1990b). The park also revamped the cave inventory process and the requirement to show the location of each feature on a map was dropped at this time (Nepstad, 1990c). Special inventory trips were started in April and an attempt was made to balance those trips with survey trips. With this new system, the Grotto inventoried 4 miles of Wind Cave, bringing the total survey that was inventoried to 6 miles. Cave Management then set a goal to complete the inventory of Wind Cave by the end of the 1990s (Nepstad, 1991b).

However, as of 2006, this goal still has not been attained (about 80% has been completed to date). As a result of years of monitoring temperature, humidity, and water levels in Wind Cave, Nepstad had recognized and reported that changes in environmental conditions in Wind Cave could have a profound impact on biotic and mineralogical resources (Nepstad, 1990d). At this time, a radon monitoring program was initiated along the tour routes, and which, continued sporadically until 1997 (Ohms, 2003a). In November, N.O.L.S. helped install a gate on Coyote Cave, the second longest cave in the park, in order to protect cave resources (Nepstad, 1989b). During the year, a total of 1.70 miles of passage was surveyed and inventoried in Wind Cave.

In 1991, Stan Allison was hired as a part-time cave management assistant. With the discovery of Southern Comfort in Wind Cave in 1991, a new section by that name was created, expanding the number of named sections to eight. This discovery was the first breakout from the box-shaped boundaries that had characterized the cave up to that point. Higher survey standards were established at the same time, which called for <1% loop closure errors for loops greater than 500 feet and <2% for loops under that length (Nepstad, 1991e). Meanwhile, 20 monitoring sites were established throughout Wind Cave for a three-year water quality study that would develop a baseline data set (Nepstad, 1993b). Initial testing found elevated levels of several metals, which were attributed to runoff from a forest fire that spring (Nepstad, 1997a). Beginning that year, the park, in conjunction with the Environmental Protection Agency (EPA), conducted extensive water quality monitoring from sites throughout the cave. Another funded project was started to study cave lint and ways to reduce it along the tour routes (Jablonsky, Kramer, and Yett, 1994). By the end of 1991, cavers had conducted cave feature inventories of 20 miles of surveyed passages in Wind Cave (Nepstad, 1991c).

Using a Challenge Cost Share Grant in 1992, Stan Allison was changed from a part-time Cave Management Assistant to full time. His primary duties were to coordinate activities between the park and volunteer cavers. One of the volunteer projects he coordinated was the drafting of some of the cave quadrangle maps. Colorado Grotto cavers, Doug Kent and James Wilson, helped volunteer for that project. By this time, 40% of the surveyed cave had been inventoried (Nepstad, 1992d). A revolving door was added to the Walk-In Entrance that year to create an airlock and restore natural conditions (Nepstad, 2002b). On-going water quality testing demonstrated that there were elevated levels of copper and chromium in Windy City Lake (Nepstad, 1992c). In his Masters Thesis, Mike Wiles found that the main part of Wind Cave does not have the same obvious impermeable layers in the overlying Minnelusa Formation that Jewel Cave has. He also reported that the bedrock in the Wind Cave area seems to be more sandy and permeable and that drip rates in the cave cluster below surface drainages (Wiles, 1992). During the year, a total of 9.2 miles of passage was surveyed and inventoried in Wind Cave.

In 1993, cave management activities were moved from the Division of Interpretation and reassigned to the Division of Resource Management. In the same year, a document was written that described the park's Cave Management program, which stated, "The program directs and supports the exploration, mapping, inventory, monitoring, and study of Wind Cave" (Nepstad, 1994a). With this identified direction, the cave management staff began a long-term dye tracing project to track water flow-through times and routes between the surface and the cave (Nepstad, 1993c). Water-quality testing reveled that pentachlorophenol, chromium, copper, and arsenic were detected in cave water at two sites down dip from the Mixing Circle. This led to the General Management Plan recommending the removal of that storage facility to a point not above the cave, a task which has never been carried out. The NPS Water Resource Division conducted a flood elevation report for Wind Cave Canyon that year. Michael Martin determined flood magnitudes for 100 and 500 year peak discharges for structures in Wind Cave Canyon. He found that the Walk-In Entrance to Wind Cave would be inundated during a 100-year flood event (Martin, 1993). With the discovery of the Western Fringe area in 1993 by volunteer cavers, a new section by that name was created, expanding the number of named sections in Wind Cave to nine. During the year, a total of 6.12 miles of passage was surveyed and inventoried in Wind Cave.

In 1994, the Wind Cave Weekend survey project was temporarily stopped after an incident where cave resources in the new section were damaged by a few volunteer cavers. The Cave Management Specialist had additionally grown concerned about the 2:1 ratio of survey to inventory trips. As a result, off-trail policies were developed for Wind Cave, which established exploration ethics, ownership of data, trip leader responsibilities, and VIP status of volunteers. In addition, the N.O.L.S. organization was informed that the number of off-trail trips they would be allowed during a course would be drastically reduced in the future, in order to better manage the cave for future generations and for anticipated requests from other caving groups (Nepstad, 1994b). As part of the water quality study, 20 cave drip sites were tested for total hydrocarbons, to determine the influence of the parking lot on the cave. That year, Dina Venezky studied contamination of water at Upper Minnehaha Falls in Wind Cave. She found heavy hydrocarbons reached the cave from the parking lot after 19 hours (Venezky, 1994). In Coyote Cave a tight bellycrawl known as the "Vise" was passed, which eventually led to a major extension of that cave. Beginning that year, an annual Wind Cave/Jewel Cave Lint Camp was held jointly with nearby Jewel Cave National Monument. At the same time, Pat Jablonsky, Sandy Kramer, and Bill Yett studied lint introduction and distribution along the tour routes in Wind Cave. They found that the "lint" was composed of numerous types of particles, with the majority of the lint fibers being natural instead of synthetic. They also found that lint migrated along and away from the trails, with the majority deposited within a few meters horizontally or vertically (Jablonsky, Kramer, and Yett, 1994). In December, as part of a national effort tied to the 1988 Federal Cave Resource Protection Act, the park submitted significant cave nominations for eight of its caves, including Wind Cave, to be listed as significant caves (Nepstad, 1994c). By this point, the National Park Service had already made the decision that all caves on NPS lands would be considered and managed as significant. During the year, a total of 2.3 miles of passage was surveyed and inventoried in Wind Cave.

Both in 1993 and 1995, Nepstad updated the Cave Management Plan. The park tried to develop a parallel plan with Jewel Cave National Monument, so the two plans could share as much as possible, but that joint attempt was unsuccessful and the updated plan was never signed. Additional issues dealt with in these updated versions included an expanded cave use section and surface management considerations. In an attempt to reduce impact on the Club Room Loop in Wind Cave, the number of authorized recreation trips was reduced to six trips per year in the 1995 version. During the same time period, Stan Allison, with the help of Colorado Grotto volunteers Doug Kent, Paul

Burger, and Jim Wilson, redrew all 18 Wind Cave quadrangles sheets. These working maps were drawn in pencil on large pieces of plotter paper at a scale of 50'/inch that covered 1,500 by 1,000 foot sections of the cave. Three new quadrangles were also added to the original 18 (Fig. 7). These quads contained approximately 78 miles of survey.

In 1995, the cave management staff used a sewer line monitoring camera to evaluate the integrity of the sewer lines in the historic district. They discovered numerous breaks in the aging system (Nepstad, 1997b). During the year, a total of 1.6 miles of passage was surveyed and inventoried in Wind Cave.

In 1996, the rubber raft at the Lakes was hauled out of the cave when a new lake started forming on the route to the Lakes. It was feared that this new lake, named What the Hell, would sump that route and trap the raft at the lakes (Nepstad, 1996a). That same year, dye introduced into the system in 1993, showed up at five of the sixty monitored drip sites in Wind Cave (Nepstad, 1996b). That year, Dr. John Moore, a researcher from the University of Northern Colorado, completed a three-year project looking at cave biota and trophic interactions along the tour routes in Wind Cave. He completed an invertebrate survey along the developed tour routes and nearby off-trail areas, where he found bacteria, fungi, protozoa, nematodes, and micro arthropods (mites, collembola, and diplura). He found that material shed from visitors allowed four trophic levels to exist, including predators, while other off-trail areas only possessed two trophic levels with no predators (Moore 1996, 1997). He found that human activity has impacted the cave ecosystem by introducing carbon. He also found that heterotrophic bacterial and fungal densities along the tour routes approached those levels found in surface soils. Finally, he reported that nematodes and arthropods were largely restricted to the entrance areas, tour routes, and flagged off-trail cave trails, while Protozoa were found throughout the cave (Moore, 1996). In an experiment to determine if hydrocarbons from the parking lot were reaching Wind Cave, dye was injected below the largest parking lot drain on July 29, 1996. To simulate a 1" rainfall, 30,000 gallons of water, along with 1.8 liters of Rhodamine WT was injected. Dye began arriving at Upper Minnehaha Falls within six hours of injection (Nepstad, 1996c). Elevated hydrocarbon levels were later found at Upper Minnehaha Falls (Nepstad, 1997a). An airlock structure was added to each of the elevator landings in an attempt to help the elevators work more efficiently. During the year, a total of 1.65 miles of passage was surveyed and inventoried in Wind Cave.

In 1997, Nepstad began working once again on updating the unsigned 1995 Cave Management Plan, as the 1988 signed version was still in effect. However, he was unable to get that version signed before he left the park in 1998. Renee Jesser (a graduate student working with Dr. John Moore), completed a Masters thesis on the effects of productivity on species diversity and trophic structure in Wind Cave. She found that species diversity was higher and trophic structure more complex where there was higher energy input from visitors or cavers. She also found that species populations vary between different regions of the cave (Jesser, 1998). During the year, a total of 1.9 miles of passage was surveyed and inventoried in Wind Cave.

In 1998, after several years of gradual decline in numbers of trips, this was the last year that N.O.L.S. brought one of their cave leadership training courses to the park. With his time at the park coming to an end, Nepstad finished his six-year dye-tracing project, which demonstrated that flow through times from the surface to the cave ranged from a low of six hours to a high of nearly five years. Due to problems with the electric lights on the Candlelight Tour Route, they were removed that same year. By this time, ten back country caves had been documented in the park. In October, Marc Ohms replaced Stan Allison (who went to Carlsbad Caverns) as the Cave Management Technician. Drawing upon his personal experience and interest, Ohms quickly turned his attention to hydrological issues in the park. He started by determining that 3.68 cfs (27.5 gallons/sec) of Beaver Creek's water was lost underground in Beaver Creek Cave (Ohms, 2006b). During the year, a total of 1.22 miles of passage was surveyed and inventoried in Wind Cave.

In March of 1999, Rod Horrocks replaced Jim Nepstad as the Cave Management Specialist. Drawing upon his previous experience and expertise, he immediately began concentrating on cave cartographic projects. He also expanded cave resource management in the park from its primary focus on off-trail areas of Wind Cave to include the tour routes and backcountry caves and karst as well as. That summer, a seasonal Physical Science Technician position was added to the staff, first filled by Rene Rogers, followed by Matthew Reece. Under the assumption that nearly 80% of the survey stations in the Wind Cave survey had been inventoried by that point, a decision was made to stop requiring an equal number of inventory and survey trips. Once that decision had been made known to the Wind Cave Weekend cavers, all special inventory trips essentially stopped. At the same time, cavers were verbally encouraged to take on project areas in Wind Cave, where they would return to an area until it was completely surveyed. This policy had the effect of giving cavers ownership in their own areas and making surveying more productive, as the cavers got to really know their individual project areas. They were also encouraged to write up a history of the exploration of their area and then publish them with an accompanying map. In May, 17 cavers participated in the Black Hills Restoration Camp, where they helped to remove 885 pounds of lint and dust from along the Natural Entrance Tour Route (Horrocks, 1999a). With the switch from film to digital cameras underway, all of the cave management photographic slides were added to archival files that summer. Horrocks then simplified the four-page cave inventory system to a one-page (front and back) form and printed on water-resistant paper that would fit into the six-ring survey notebooks. He then designed custom Wind Cave survey data pages and printed those on the same water-resistant paper, in order to encourage cavers to collect certain types of data at a set scale and orientation and to make it unnecessary to take previous surveys back into the cave in the form of bound books. The increased emphasis placed on ridgewalking and documenting caves and karst features in the park resulted in the documentation of three additional caves that year. After noticing an unusual number of bats during public tours, the cave management staff conducted a visual survey of the Natural Entrance and Walk-In Entrance at dusk. Seventy five bats were observed and video taped exiting the cave through a small ½" x 4" hole on top of the revolving door in the Walk-In Entrance (Horrocks, 1999c). The Lakes in Wind Cave continued to rise during this unusually wet year. Between May and August, they rose 1.3 feet, with a total rise of 19.6 feet since 1993. This caused the six main lakes to merge into a single large lake. On September 27, it was discovered that a new perched lake, named What the Hell, which is located on the route to the Lakes Section and the deep point in Wind Cave, had risen four feet over the previous two months, completely sumping that passage and blocking access to the lakes and 2.5 miles of passage beyond (Horrocks, 1999b). In November, the Cave Management staff resurveyed Salamander Cave, which is an important Black Hills Pleistocene paleontological site. This cave, investigated by Dr. Jim Mead from the University of Northern Arizona in 1993, contains horse and camel remains dated to 252,000 years ago. This new survey added more detail, a surface survey, a profile view, and cave inventory data to the data set (Horrocks, 1999b). Dr. John Moore started an NSF funded, three-year study in Wind Cave to look at functional diversity in the biomass of cave sediments and how humans have impacted the cave. During the year, a total of 4.28 miles of passage was surveyed and inventoried in Wind Cave.

In 2000, funding for the permanent Physical Science Technician position was received as part of a general Resource Management base funding increase. In February, the park hosted a Sketchers Training workshop for participants of the monthly Wind Cave Weekend survey project. This included an in-class and an in-cave section. Over 20 cavers from Colorado and South Dakota attended the workshop (Horrocks, 2000d). Using the COMPASS software, the volume of the surveyed passages in Wind Cave was calculated to be 47,843,909 cubic feet. Ohms completed entering in the left, right, up, and down data (L.R.U.D.'s) into COMPASS for the first 40 miles of the Wind Cave survey. On May 22, when the Wind Cave survey hit 91.16 miles, it passed Siebenhengste of Switzerland to regain the position as seventh longest cave in the world and the fifth longest in the US (Horrocks, 2001b). During a survey trip an apparent old entrance to Wind Cave, now plugged with debris, was discovered in the bottom of Wind Cave Canyon and 50 feet upstream from the natural entrance. This entrance was apparently the source for the stream-rounded bones found by Dr. Martin in the Chamber of Lost Souls (Horrocks, 2000b). During the 2000 Black Hills Restoration Camp, several deep asphalt dumps were discovered in Wind Cave while 2,980 pounds of trail construction debris was removed from along the Natural Entrance Tour Route (Horrocks, Ohms, and Reece, 2001c). Ohms and a volunteer created a database of all the cave surveyors that had surveyed in Wind Cave. This database indicated that 822 people had surveyed in Wind Cave to that point, while 435 had only gone on a single survey trip. In addition, a total of 83 cavers had gone on more than 10 trips, 40 had gone on more than 20 trips, and only 10 cavers had gone on more than 50 trips (Ohms, 1999, Horrocks, 2000c). It was apparent that interest in the Wind Cave survey project had noticeably increased, expanding survey to nearly 7 miles a year, likely due to the new survey policies and emphasis. During the year, an Access database, named the Wind Cave Place Name Lexicon, was designed by Matt Reece to create an official place name list, to better document the reasons that place names were chosen, and to prevent duplication of names. Horrocks then used a place name card file created by Dave Schnute, cave survey notes, and interviews of cave surveyors to populate the database with over 1,100 names and accompanying explanations (Horrocks, 2000a). Finally, the unsigned 1997 draft version of the Cave & Karst Management Plan was updated by 1) refining off-trail procedures and reclassifying the types of off-trail trips, 2) standardizing terms, 3) rewriting the survey and inventory standards, 4) adding a glossary, 5) updating facts, and 6) redoing the cave inventory procedures. This 31-page plan was signed by Superintendent, Jimmy Taylor, and officially replaced the 1988 signed Cave Management Plan (Horrocks, 2000d). During the year, a total of 7.6 miles of passage was surveyed and inventoried in Wind Cave.

In 2001, in an attempt to minimize leaks, the sewer lines in the park were replaced with dual walled HDPE lines with detection ports. This line-item funded project was a result of the dye-tracing and sewer cam projects conducted by Jim Nepstad. In preparation for redesigning the parking lot in 2004, Matt Reece used Arc View to determine the depths of the ceilings of all cave passages located below the lot. He found that most of the passages varied from 42 feet to 136 feet below the surface with the deepest point being 222 feet (Horrocks, 2001i). Former cave management specialist Jim Nepstad spent a week at the park to wrap up his dye tracing project. He learned that several of his monitoring sites still showed some dye four years after first going positive. A decision to ban carbide use on off-trail trips into Wind Cave was made after numerous problems were identified (Horrocks, 2001e). Three cave restoration projects during the year resulted in the removal of 7,250 pounds of trail construction debris from two locations along the Natural Entrance Tour (Horrocks, 2001f). Dr. Jake Turin and two of his students spent a week at Wind Cave collecting water samples for a radioactive isotope study looking for tritium and chlorine-36. Dr. Turin theorized that the new lake in Wind Cave named What the Hell was actually old water, based on preliminary findings of low levels of tritium (Turin, 2001). This project was conducted jointly with a project at Lechuguilla Cave at Carlsbad Caverns National Park. Noah Daniels incorporated the Snake Pit Entrance into a revised volumetric calculation of Wind Cave. He found that the wind from the Snake Pit Entrance of Wind Cave was 40% of the volume of the Natural Entrance. He estimated a volume of 6-10 million cubic meters for Wind Cave. This volume differed significantly from Conn's 1966 estimate of 56 million cubic meters. Estimates for the volume of the surveyed passages in Wind Cave was approximately 1.4 million cubic meters (Daniels, 2000). Dr. Andreas Pflitsch from Ruhr University in Germany set up a ultrasonic anemometer, which measures wind speed down to 3cm/sec, in the natural entrance of Wind Cave, so he could measure the direction and speed of the barometric winds. Reece designed a customized Access database and interface for entering cave inventory data. He nearly completed entering the backlogged cave inventory data into the new database (Horrocks, 2001h). Ohms monitored off-trail traffic along the Fairgrounds Tour Route for one month, finding substantial off-trail incursions up to twelve feet off of the trail and two cigarette butts (Ohms, 2003c). On August 11, the Wind Cave survey reached the 100-mile mark and passed Fisher Ridge Cave of Kentucky to become the sixth longest cave in the world (Horrocks, 2001a, Horrocks and Ohms, 2004d). Sixteen cavers participated in this historic event. That same month, Horrocks and Jeremy Duckwitz surveyed an 89-foot long cave in the park that Duckwitz found and named Bridger Cave. This and two other newly documented caves brought the total number of caves known in the park to 16 (Horrocks, 2001g). Horrocks and Steve Schrempp, the park's Facility Manager, wrote a proposal to address some of the lighting deficiencies on the tour routes in Wind Cave. At the same time, Horrocks identified nine problems with the existing incandescent cave lighting system and recommended an overall cave lighting design concept for Wind Cave in an in-house report (Horrocks, 2001d). During the year, a total of 7.54 miles of passage was surveyed and inventoried in Wind Cave.

In 2002 Ohms began dust accumulation and temperature fluctuation studies along the tour routes in Wind Cave. Ohms found that during the summer months dust deposition increased ten fold on the Blue Grotto Loop of the Candlelight Tour (Ohms, 2004a). During his off-trail dust study, he found that cavers crawling along the Pink & Black route in the Thomas Paine area, of the Colorado Grotto Section, deposited the most dust per individual, while the Wild Cave Tour Route had the most dust deposited overall due to shear number of visitors, nearly four times the amount of any other off-trail travel route (Ohms, 2003, 2004, 2005). He also placed ten radon detectors in Wind Cave, five on-trail and five off-trail. This project showed that radon levels throughout the cave are low, averaging around 0.2 working levels (Ohms, 2003b). The candle lanterns for the Candlelight Tour were redesigned by Jason Walz so they would not drip wax into the cave. After photomonitoring the existing wax deposits, a restoration project removed 30 years of wax deposits so that the effectiveness of the new lanterns could be determined (Walz, 2002a). Horrocks and Walz mapped the location and composition of every pile of trail construction debris dumped in Wind Cave along the tour routes (Fig.12). At the same time, the first Cultural Landscape Survey ever to be conducted in any National Park Service cave was started along the tour routes in Wind Cave. The final report attempted to balance cultural and natural resources when cave restoration work is conducted in Wind Cave (Horrocks and Ohms, 2003b). This report recommended that all restoration activities be based on defensible scientific investigations, all efforts to re-open plugged passages be undertaken only if essential for cave health, all harmful materials should be documented and removed from the cave, and manmade artificial stone structures should be preserved. It also recommended that electrical cabling match the colors of the cave and not be buried in trenches in undisturbed floors and that all historic graffiti in Wind Cave be documented and mapped (John Milner Associates, 2005). Rene Ohms and Matt Reece used GIS to determine that the deepest point in Wind Cave below the surface was 528 feet (Ohms & Reece, 2002). In August, Ron Kerbo and Dr. John Moore assisted in representing Cave Management during a Resource Management Plan scoping meeting. A total of 30 people participated in portions of this three-day meeting (See Appendix I). It was decided that the four most important areas of cave resource management in the park are, in priority order: the developed corridor in Wind Cave, off-trail Wind Cave use, backcountry caves, and finally cave research needs. Each of these areas was then broken into numerous individual projects or issues. On August 12, a local contractor spilled several gallons of diesel fuel on the visitor center parking lot. This spill entered the Wind Cave Canyon drainage after 20 minutes and disappeared underground within 50 feet of the culvert outlet. Samples were collected in the cave from 9-18 hours after the spill and then once each day for several days thereafter to determine if the fuel appeared at that cave site (Horrocks, 2002c). USGS hydrologist Allen J. Heakin had these samples analyzed, but found nothing that could be attributed to the spill. He then started a project to create a background characterization of hydrocarbons levels in cave drip water at sites located below or near the asphalt parking lot. This project was in preparation for the upcoming parking lot resurfacing project. Heakin had already detected Acetone and Toluene in these cave waters from a previous test (Heakin, 2004). Dawn Cardace, a graduate student at Washington University in Saint Louis, started a project to compare isotopes between Wind Cave waters and meteoric waters. She analyzed drip and pool water from the various levels of the cave as well as snow melt and water from Beaver Creek. Rolland Moore, from the Biotechnological Institute of Western Kentucky University, started a project to create DNA fragment profiles of bacteria to determine community diversity in Wind Cave sediments and corrosion residues. He found there is a lot of diversity in the microbial community in Wind Cave (Moore, Rolland, 2002). In October, the park electrician hooked power up to the Walk-In Entrance so that Dr. Pflitsh's equipment could remain in the Natural Entrance for the long term. Two of Dr. Pflitsch's interns serviced this equipment that fall and recreated Nepstad's and Pisarowicz's temperature studies between the entrance and the Post Office (Walz, 2002e). Horrocks completed two profile views of Wind Cave, one along the dip and the other along the strike, showing the relationship of the surface, cave, water table, and geology. He also created a geologic profile view showing the parking lot and underlying cave passages (Horrocks, 2002b). He then created a GIS model to predict in which directions Wind Cave could likely be expanded by human exploration. He predicted that there is tremendous potential along the major trend of the cave, both to the northeast and the southwest, but limited potential to the northwest and southeast. He predicted that 140 additional miles of cave could be found without ever expanding the existing boundaries of the cave. He also voiced his opinion that is was unlikely that Wind Cave would ever be connected with Jewel Cave, which is 18 miles away and 1,026 feet higher in elevation (Horrocks and Szukalski, 2002a, 2003a). After four years of intensive error checking, adjusted declinations, and resurvey work, Ohms was able to reduce the unacceptable loop closure errors in the Wind Cave survey from 33% to 15%. During a 1 ½" rainstorm, a survey party led by Rene Ohms noticed a waterfall entering Wind Cave from the top of a rubble-chocked dome. This water took less than ½ hour to enter the cave. Paul Whitman used a cave radio to determine that the top of that dome was 100 feet south of the Walk-In Entrance and only three to five feet-below the surface and next to the sidewalk in Wind Cave Canyon. Computer specialist, Will Powers created a MySQL database to make the cave inventory data more GIS compatible. Walz entered cave inventory data for a couple thousand stations using the new interface created by Powers (Walz, 2002c). Walz took more than 400 digital photographs of cave related subjects over the summer, which he processed and refined into a catalog containing 330 photographs. The photographs were placed on a CD that is contained within the easy to use catalog (Walz, 2002b). Walz used a graduated cylinder to monitor flow rates at "Upper Minnehaha Falls" in Wind Cave, in preparation for a USGS parking lot hydrocarbon study. With the discovery of four new caves during the year, the total number of caves in the park was increased to 21. By this point, four rock shelters and thirty-one karst features had been documented within the park (Horrocks, 2002b). During the year, a total of 5.38 miles of passage was surveyed and inventoried in Wind Cave.

In 2003, a Standard Operating Procedure (SOP) was written to assign specific dates for all survey work in Wind Cave and to temporally stop recreation trips until the new cave management plan established new policies. In addition to the existing Wind Cave Weekend, the first and third Tuesdays of each month were set aside for survey work. These more restrictive policies had the effect of reducing the total amount of survey per year to more manageable levels. A major cave restoration project was started on the Natural Entrance Tour Route in the winter of 2003 (Horrocks and Ohms, 2004a). For the first time, an attempt was made to balance natural and cultural resources during a restoration project (Horrocks and Ohms, 2003b). During this six-month project, a six-person crew removed 36 tons of trail construction debris and cleaned along a 600-foot section of the trail, which extended from the Assembly Room to the Methodist Church (Horrocks, 2003c). This included a separate project to remove an abandoned transformer on the Candlelight Tour Route. As a result of this project, Dr. John Moore was asked to study what remained of the discarded wood along the tour routes to determine if biota were using that organic debris. Marisa Chielus and Dr. John Moore did DNA fingerprinting of microbes in infiltration water at Rainbow Falls in the Historic Section of Wind Cave. She found four bacterial divisions and subdivisions representing 14 phylotypes. The predominant groups were from *Proteobacteria* and *Acidobacteria.*

Although a few clones resembled sequences from other caves and mines in Italy and South Africa, she found no cave-specific communities (Cheilus and Moore, 2004. Ohms conducted dust accumulation studies along the Candlelight Tour Route. He found that during the summer when the Candlelight Tours were offered, dust accumulates at ten times the rate it naturally accumulates during the off season (Ohms, 2003a). In 2003, Allen J. Heakin completed a two-year project to test water quality of runoff from the parking lot that appears at Upper Minnehaha Falls in Wind Cave. He found trace amounts of caffeine, metals, and hydrocarbons (Heakin, 2004). That same year the responsibilities of the Cave Management staff were expanded to include other physical sciences, including air quality, hydrology, paleontology, and geology and their titles were changed to Physical Science Specialist and Technician. By the end of 2003, a total of 26 caves had been documented in the park (Ohms, 2004b). During survey work in Wind Cave, two additional types of speleothems were discovered, including a coiled gypsum rope and iron-fixing bacterial strands (Horrocks, 1999c). During the year, a total of 2.91 miles of passage was surveyed and inventoried in Wind Cave.

In 2004, all cave features that could be sketched were removed from the two-page cave inventory form. However, due to the large number of remaining 1999 forms, the old form continued to be used for a couple more years. Ohms concluded temperature fluctuation studies along the tour routes in Wind Cave, where he determined that the lights do raise the temperature immediately around the fixtures, but did not seem to affect a larger area (Ohms, 2004a). He additionally found that the temperature rose up to 2.0 degrees after tours passed through an area, not returning to normal until two hours after the last tour. He found two interpretive stops (the Fairgrounds and Assembly Room) where the temperature quit returning to normal midway through the season, not returning to normal levels until after the season ended (Ohms, 2004d). During the summer, two Physical Science Technicians, Seth Spoelman and Jason Walz, were hired to conduct a cave and karst inventory project of the whole park (Ohms, 2004e). They documented caves as well as karst features, raising the total number of caves from 26 to 42, the number of rock shelters from 8 to 27, and the number of features from 150 to 254 (Walz and Spoelman, 2005). After skipping a year, the annual Black Hills Restoration Camp was once again held jointly between Wind and Jewel Caves. The 2004 group volunteered 117 hours and removed 1,432 pounds of sediment, dust, hair, and lint from along the trail on the Fairgrounds Tour Route. Between this project and winter work conducted by Ohms, the entire Fairgrounds trail was cleaned during the year (Horrocks, 2004h). After a slow decline in lake levels, What the Hell lake dropped enough in August to allow access to the Lakes and deep section of the cave for the first time since 1999. Once the deep point in the cave could be accessed, it was found that the water table had dropped 2.5 feet since the last visit in July of 1999. Ohms and Walz discovered cave rafts on top of the staff gage, indicating that it had reached an even higher stage at some point during the previous five years. Work on the redesign and complete replacement of the cave lighting system in Wind Cave was started at this time. The goals for the new system were to replace deteriorating elements, increase energy efficiency, and address resource protection. In order to determine which type of lights discourages lamp flora growth, Horrocks started an experiment to test five different types of lights, including: incandescent, LED, compact fluorescent, mercury vapor, and quartz halogen. The experiment used electric lamps that are white to slightly yellowish or slightly bluish, and where possible with a color temperature ranging between 2800 K and 3200 K (Horrocks, 2005c). To determine the effect of light duration, motion sensors were added to the experiment. These experiments were carried out at existing light locations along the Natural Entrance Tour Route (Horrocks, 2004e). All of the existing aluminum and steel handrails along the Natural Entrance and Fairgrounds Tour Routes were replaced by stainless steel, which created a standardized design, size, and height (Horrocks, 2004g). The park decided to trap wood rats from the Natural Entrance Tour Route to prevent Deer Mice, which can carry Hantavirus, from nesting in wood rat nests adjacent to tour route trails (Horrocks, 2004f). In December Dr. Andreas Pflitsch installed a sonic anemometer in Summer Avenue for one week and confirmed the general perception that the wind always blows in the same direction in that passage (Horrocks, 2005d). During the year, a total of 4.09 miles of passage was surveyed and inventoried in Wind Cave.

In 2005, the park completed a project to stop contaminated runoff from the parking lot from entering Wind Cave by replacing the asphalt lot with concrete. This project was a result of dye tracing work conducted by Jim Nepstad, Calvin Alexander, and Marsha Davis and water quality testing by Dena Venezky (Nepstad, 1996b). The concrete mitigated the effect of dripping gasoline and antifreeze “melting” the asphalt and releasing hydrocarbons which were washed into the cave in as little as 6 hours. With the concrete lot, it is no longer necessary to conduct annual chip sealing of cracks in the asphalt, a major hydrocarbon source. In addition, culverts in the new lot capture hillside runoff above the lot and redirect it into Wind Cave Canyon in an attempt to restore natural drainage patterns in the canyon. All runoff from the new concrete lot is captured and funneled through an oil and grease separator before being released beyond the VIP Center in Wind Cave Canyon (Horrocks, 2005e). Because of all the loop closure problems and in anticipation of the recommendations in the revision of the 2000 Cave and Karst Management Plan, the park started asking cave surveyors to voluntarily do back sights on all survey shots, getting back to the policy that was in the first cave management plan (1978) and had been abandoned sometime in the early 1990s. During the Wind Cave Weekend on January 9, the Wind Cave survey passed Lechuguilla Cave of New Mexico to become the fifth-longest cave in the world (Horrocks, 2005a). Walz completed a project to document all of the flagged off-trail routes used by cavers in Wind Cave. In the process, he extended the Pink Trail from the Chimera Room up to the Snake Pit Entrance. Using COMPASS and Arc View 9.0, Walz added all six trails into the park’s GIS. This year marked the completion of a five-year project to update all 21 of the Wind Cave quadrangles, the last eight by contract with Colorado Grotto cavers Steve Lester and Evan Anderson. These standardized quadrangles were drawn with pencil on pre-printed Mylar sheets so they could be easily updated as new survey was completed. This major effort brought the total Wind Cave survey that has been drawn on cave quadrangle maps, to 108.3 miles. In April, Walz updated all 21 of those quads, which brought the total survey drawn up to 115.54 miles. This marked the first time in 20 years that all the cave quadrangles were up to date. At the same time, Horrocks finished a four-year project to create a new detailed plan and profile view map of the paved tour routes in Wind Cave in digital format. This map has separate layers that can be turned on or off including: cave restoration, lighting systems, handrails, current place names, historic place names, and research and monitoring sites (Horrocks, 2005i). With the abandonment of the Powers and Reece cave inventory databases, volunteer Tom McBride created an Access database and interface, which he named SpeleoWorks, for the entry and storage of Wind Cave feature inventory data. McBride wrote over 800 lines of code to customize this database to park needs. After deleting seven thousand duplicate records from the old Reece Access database he imported the remaining 13,550 records into the new SpeleoWorks database (Horrocks, 2005h). In May, the Coyote Cave survey was extended over a mile, the seventh cave in the state to reach that milestone (Ohms, 2005a). In conjunction with recommendations in the Milner Associates Inc. Cultural Landscape Report, sites along the tour routes were identified where blast rubble would not be cleaned up during cave restoration activities. Anything that didn't have foreign material in it, covers significant formations, was a health hazard, would not adversely impact the cave to remove, have cultural significance, or have interpretive value was tagged to remain where it was, producing a list of 72 sites (Fig. 12). A list of 46 Alvin McDonald signatures in the Historic Section of Wind Cave was compiled and then added as a layer to the park's GIS (Horrocks, 2005g). The annual Black Hills Cave Restoration Camp cleaned dust, hair, and lint between the Post Office and the Natural Entrance, a stretch that had been cleaned as recently as 2000. A surprising total of 17 plastic trash bags of debris were removed by the crew of five volunteers (Horrocks, 2005e). Ohms taught a two-day NCRC cave search and rescue training class for park staff. The second day was a mock search and rescue to find and remove an injured patient from the half way point on the Wild Cave Tour Route. It took the team two hours to haul the patient to the surface. A cooperative agreement was signed between Wind Cave National Park and the University of Northern Colorado so they could study the impact that tours have on the microbial community in Wind Cave (Horrocks, 2005e). Bjoern Zindler, from Ruhr University in Germany, completed his Masters Thesis on the microclimate of the Walk-In Entrance and Natural Entrance Tour Route. He found that if the Walk-In Entrance was sealed to prevent leaks, it reduces the impact from sub-zero air on the roof above the entrance stairs (Zindler, 2005). Nearly four years of environmental monitoring led to several interesting discoveries by Dr. Pflitsch. He found that Wind Cave could blow in one direction for up to three days, while Jewel Cave could blow for up to four days. He also documented a pronounced pattern that is present at Wind Cave, but not at Jewel Cave, as wind blows primarily into Wind Cave during the winter and primarily outward during the summer, a condition not found at Jewel Cave. He also found that the average inward flow velocity is quite stable in the summer in Wind Cave, but higher during the winter, while the average outward flow velocity is almost always higher than the inward velocity year-round. Additionally, he found that the average mean temperature of air flowing outwards at Wind Cave is quite stable, which is not the case at Jewel Cave. He also found that Wind Cave is 6.3 degrees F (3.5 degrees C) warmer than it should be. His sensitive heat probes also showed that there are daily fluctuations in the cave on the order of a tenth of a degree. Finally, he demonstrated that Coyote Cave is probably not connected to Wind Cave, however, the blowholes surrounding Wind Cave probably are. However, each of these blowholes is different from the main cave, supporting the multi-balloon theory for Wind Cave. This means that there is still undiscovered cave outside the current boundaries of Wind Cave, but it may be very difficult for humans to access (Pflitsch, 2006). Horrocks continued populating the new Place Name Lexicon with Wind Cave place name data, raising the number of records from 1,100 to 1,780 (Horrocks, 2005). In September, the park was one the stops on the Southern Black Hills Karst Hydrology Fieldtrip for the USGS Karst Interest Group (KIG) Workshop. Horrocks wrote an article for the symposium proceedings that expounded on the things that make Wind Cave significant (Horrocks, 2005f). During the year, a total of 4.72 miles of passage was surveyed and inventoried in Wind Cave.

On 2/11/2006, the Wind Cave survey passed Holloch Cave to become the fourth longest cave in the world (Horrocks, 2006, 2006g). That spring, Horrocks created an oblique cutaway view of a potion of the tour routes for a new interpretive sign that will be erected between the Visitor Center and the Elevator building. During the Black Hills Restoration Camp held in May, ten volunteers removed 3,175 pounds of debris from the long neglected Garden of Eden Tour Route (Horrocks, 2006a). This was the most debris removed during a restoration camp since Horrocks and Ohms had been at Wind Cave. The Wind Cave Quadrangle maps were updated by Walz, raising the total mileage that has been drafted on maps from 115.54 to 120.02 miles. Ohms compiled a document titled the Hydrology and Water Resources of Wind Cave National Park, which summarized what is known about precipitation, the three perennial streams, and all 92 springs found in the park (Ohms, 2006). Dr. Andreas Pflitsch and Julia Ringeis presented a research update by PowerPoint presentation to all park staff on March 31. Dr. Pflitsch reported that winds can switch as often as one minute intervals or blow in one direction as long as 81 hours through the Natural Entrance. The longest documented outflow was 54 hours (5/2005), while the longest inflow was 81 hours (3/2005) (Pflitsch, 2006). In recreating Herb Conn's volume measurements based on wind flow, Ringeis established a smaller volume for Wind Cave than did Conn, 710 million cubic meters compared to 2 billion cubic meters. Due to pressure to allow pesticide spraying in the park, three spray zones were established for the park based upon resource concerns regarding geology, hydrology, and biology. Those zones were: Spray, Limited Spray, and Restricted Spray Zones. A Pesticide Water Quality Plan was completed for the park that established monitoring protocols for each of the three spray zones (Ohms, 2005b). The Physical Science staff took 35 photos at each of 15 off-trail sites in Wind Cave for a 360 degree photo CD sales item that will allow visitors to see rooms in the cave that they would never have an opportunity to visit otherwise (Horrocks, 2006e). The Wind Cave Lakes were threatened by a proposal from the Southern Black Hills Water System to drill two source wells for a rural water system near the south and east boundaries of the park. The park filed a petition to intervene with the state of South Dakota and testified at a South Dakota Department of Environment and Natural Resources (DENR) Water Management Board hearing held in Pierre (Horrocks, 2006b). During the year, cave inventory data for over seven thousand stations was added to the SpeleoWorks cave inventory database, bringing the total number of stations in that database to over 20,000 (Horrocks, 2006f). Horrocks completely revised and updated the two-page cave inventory form, correcting mistakes, alphabetizing features, and making it more user friendly. Volunteers Darren Ressler and Seth Spoelman helped with this effort. Rene Ohms created a front end user interface for an Access database so that digital versions of cave trip reports could be entered, stored electronically, and queried (Ohms, 2006a). Ohms installed HOBO water level data loggers in Calcite Lake in Wind Cave and in the new Headquarters Well in Wind Cave Canyon. The Calcite Lake instrument automatically recorded water level every 12 hours. Horrocks continued populating the Place Name Lexicon with Wind Cave place name data, raising the total number of records from 1,780 to 1,850. After a year long photo project, Horrocks added over 90 photographs of features found in Wind Cave to the Cave Inventory Photo Album. He also worked on adding hundreds of digital photos to the photographic library of features found in Wind Cave. Horrocks used the SpeleoWorks cave inventory database to create a map of all the paleontological sites in Wind Cave. The nineteen sites shown on the resulting map mainly represented isolated bat and wood rat individuals that had gotten lost in the cave (Horrocks, 2006f). Horrocks completed a year-long project to scan all of the newly updated quadrangles sheets and create digital maps of each for the first Wind Cave Atlas (Horrocks, 2007). During the year, a total of 4.41 miles of passage was surveyed and inventoried in Wind Cave. At the same time, ten resurvey trips were taken where 1,706 feet of problem surveys were resurveyed (Horrocks, 2006e). A three-year project to completely rewrite the park's Cave and Karst Resource Management Plan was completed by the end of the year. This huge project increased the plan from 31 to 105 pages in length (Horrocks and Ohms, 2006c).

APPENDIX C: Additional Legislative Mandates & Guidelines

1) NPS Organic Act of 1916

Congress has directed NPS to manage the parks "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations" (The NPS Organic Act of 1916 - PL 64-235).

2) Federal Cave Resources Protection Act of 1988

An additional source for the authority to manage Wind Cave comes from the "Federal Cave Resources Protection Act of 1988." The Act establishes that, "It is the policy of the U.S. that federal lands be managed in a manner which protects and maintains, to the extent practical, significant caves." The stated purposes of the Act are to:

* to secure, protect and preserve significant caves on Federal lands for the perpetual use, enjoyment, and benefit of all people; and
* to foster increased cooperation and exchange of information between governmental authorities and those who utilize caves located on Federal lands for scientific, education, or recreational purposes.

Agencies are required to use full public participation to determine their own management actions necessary to carry out the objectives of the act. To achieve these purposes, the act instructs Federal agencies to take action including (but not limited to):

- Identification of significant caves on Federal land
- Regulation or restriction of use of significant caves, as appropriate
- Entering into volunteer agreements with persons of the scientific and recreational caving community

The act specifically addresses the confidentiality of information concerning the nature and location of significant caves, in order to protect these delicate resources. It states:

"Information concerning the specific location of any significant cave may not be made available to the public under section 552 of title 5, United States Code, unless the Secretary determines that disclosure of such information would further the purposes of this Act and would not create a substantial risk of harm, theft, or destruction of such cave.

3) NPS 77

NPS 77 (Natural Resources Management Guidelines) provides guidance on NPS policies relating to cave resource management.

Referring to the Federal Cave Resources Protection Act of 1988, NPS policy states that, "Accordingly, all caves on NPS-administered lands are deemed to fall within the definition of significant cave."

NPS 77 states that the major objectives of a park's cave resource management program should include:

- protection and perpetuation of natural cave, karst, and hydrological systems;
- opportunities for scientific studies and research in or about cave and karst resources and systems;
- detailed inventory of resources within cave systems;
- provision of educational and recreational opportunities for a broad spectrum of park visitors to discover, explore, study, respect, appreciate, and enjoy caves at their individual levels of interest and abilities; and
- establishment of regulations, guidelines, and/or permit stipulations that will ensure maximum safety of the cave visitor and conservation of cave resources.

d. NPS 14

NPS 14 (Cave Radon) provides guidelines regarding cave radon monitoring in National Park Service caves. NPS 14 is currently being replaced by Directors Order, Reference Manual 50B.

e. NPS Management Policies

The mandate to protect caves and karst is further defined in the NPS Management Policies 2006, 4.8.1.2 and 4.8.2.2 which state that, "The Service will manage karst terrain to maintain the inherent integrity of its water quality, spring flow, drainage patterns, and caves." It also states that, "The Service will manage caves in accordance with approved cave management plans to perpetuate the natural systems associated with caves…" In addition, "No development or uses, including those that allow for general public entry, … will be allowed in, above, or adjacent to caves until it can be demonstrated that they will not unacceptably impact natural cave conditions, including sub-surface water movements. Developments already in place above caves will be removed if they are impairing or threatening to impair natural conditions or resources."

APPENDIX D: Forms

1) Cave Trip Report
2) Agreement of Individual Voluntary Services Form (#10-85)
3) Acknowledgment of Off-trail Policies Form
4) Sketchers Evaluation Form

WIND CAVE NATIONAL PARK

CAVE TRIP REPORT

Permission is requested to enter the following cave or section of Wind Cave:

Historic Club Room North Lakes Half-Mile Hall

Colorado Grotto Silent Expressway Southern Comfort Western Fringe

Other Cave: ___________________________________

Purpose of trip: Survey Work Recreation

Trip Leader: _____________________________ Phone #: _______________

Group Members:
1__________________________________
2__________________________________
3__________________________________
4__________________________________
5__________________________________

Date of Trip: __________Time in: __________Time out (planned): __________

Planned Route:

____
____
____

Surface Watch: _____________________ Phone #: __________________

(Revised 1/02)

Actual Time in: _______________ Time out: _______________

TRIP SUMMARY

(In the trip summary please include information such as impacts or changes noted, accidents, unusual speleothems and features, the amount of cave inventoried, the survey designations, new names, work that was done, etc...)

Total Survey: _______________

ACKNOWLEDGMENT OF OFF-TRAIL POLICIES

Each person entering any off-trail section of Wind Cave or any backcountry caves within Wind Cave National Park must sign this form. By signing this form you acknowledge that you have read, understand, and agree to abide by all policies set forth in the Cave and Karst Resource Management Plan.

Signature________________________ Written Name________________________

Date____________________

Parent or Guardian if under 18______________________________ Date____________

Emergency contact_____________________ Phone_________________________

(revised 10/01)

SKETCHER EVALUATION SHEET
WIND CAVE NATIONAL PARK

Updated JAN 31, 2000, WICA Cave Mgmt. Spec.

(This evaluation is being provided to help you meet the cave survey standards required at Wind Cave National Park)

SKETCHER: ***CAVE:***				***EVALUATED BY:***
SURVEY: ***DATE:***				
This sheet is designed to evaluate the pre-printed WICA Cave Survey sheets (4/29/99)	YES	PARTIAL	NO	COMMENTS
SURVEY SHEETS: Were the pre-printed pages used as designed?				
Is the title page completely filled out (All blanks filled in)?				
DATA PAGES: Is the data complete, legible, and straight forward?				
Has the L, R, U, D data been recorded for each station?		----------		
Have all the pages been numbered (1 of 3, 2 of 3, 3 of 3)?				
Are backsights recorded on all shots with an inclination >30 degrees?				
Are lengths carried out to two decimal points and azimuth and inclinations to one (e.g. 4.35 feet, 25.0 degrees, and –3.5 degrees)?				
Do foresights & backsights agree within 2 degrees for azimuth & inclination?				
SKETCH: Is the cave name and date filled out for each page?				
Is the passage drawn to scale and survey lines drawn in at the approximate orientation (within 10 degrees)?				
Are the stations clearly labeled (outside of walls)?				
Is the sketch legible?				
Are standard symbols used? Are any non-standard symbols defined in a legend?				
Is there adequate floor and ceiling detail?				
Does the sketch contain sufficient cross sections?				
Is the nature of all leads indicated (2'x4', dig, too tight, etc.)				
Have sufficient ceiling and ledge heights been included?				

APPENDIX E: Volunteer Job Description

Volunteer Job Description

National Park Service

Job Title:	Cave Surveying
Supervisor:	Physical Science Specialist
Location:	Off trail in Wind Cave or backcountry caves
Project Duration:	Caving trips may be single day or multi-day camping trips.
Description of Duties:	The volunteer will assist the park's Physical Science office by assisting with data collection projects. This may include collecting survey or inventory data, or monitoring resources.
Benefits to VIP:	For each eight hours volunteered, the volunteer may stay up to two nights in the VIP Center. Cots, kitchen, and showers will be provided at that facility.
Goal/Outcome of Job:	Volunteer will use the provided survey and inventory sheets to record all data. After each trip, a detailed trip report will be completed by the volunteer.
Knowledge/Skills/Experience Desired:	The volunteer will: - Have knowledge of basic caving skills, including chimneying, bridging, and climbing. - Be able to recognize and avoid delicate speleothems. - Understand the off-trail policies for Wind Cave. - Have the ability to interpret cave maps and line plots. - Knowledge of surveying techniques
Special Requirements:	The volunteer will need to provide the following personal equipment: - UIAA helmet with helmet-mounted light - Two backup light sources - Ankle-supporting boots - Knee and elbow pads - Side mounted cave pack - Extra batteries and bulbs for lights - Pee bottle and burrito bags for human waste

Volunteer Job Description

National Park Service

Job Title: Cave Restoration

Supervisor: Physical Science Specialist

Location: On or off trail in Wind Cave

Project Duration: May work up to eight hours per day.

Description of Duties: The volunteer will assist the park's Physical Science office by removing artificial fill, lint, dust, or lamp flora.

Benefits to VIP: For each eight hours volunteered, the volunteer may stay up to two nights in the VIP Center. Cots, kitchen, and showers will be provided at that facility. A stipend may be provided by the park.

Goal/Outcome of Job: Volunteer will help restore areas along the tour routes to a more natural state.

Knowledge/Skills/Experience Desired: The volunteer will:

- Have knowledge of basic caving skills, including chimneying, bridging, and climbing.
- Be able to recognize and avoid delicate speleothems.
- Have knowledge of cave restoration techniques

Special Requirements: The volunteer will need to provide the following personal equipment:

- UIAA helmet with helmet-mounted light
- Two backup lights
- Ankle-supporting boots
- Knee and elbow pads

APPENDIX F: Cave Survey & Inventory Standards

The following are a set of standards, which must be met by every survey party at Wind Cave National Park.

1) Surveying Standards

a. Accuracy

Loops should have a closure error of less than 2%. If a loop does not meet park standards, the trip leader may be required to return to fix the error.

b. Data Collection

Exploration will be on a "survey as you go" basis. All survey and inventory will follow established park protocols and be recorded on park-provided data forms.

c. Equipment

Standard survey gear (i.e., survey tapes, books, instruments, etc.) will be provided by the park. Cavers wishing to use their own survey gear must have it approved by the Physical Science staff.

d. Duties

The following will be the minimum standards of performance for each of the duties.

Point- Survey tapes or laser range finders will be read to the nearest five-hundreths of a foot (e.g. 10.25 ft). To avoid unnecessary damage to the cave resources, the writing of station names on cave surfaces is not allowed. Survey stations will consist of an unobtrusive Sharpie mark along with a reflective Mylar tag with the written station name. The survey station designation should be clearly written on each Mylar tag.

Instruments - Both compass and clinometer will be read to the nearest half degree. Foresights and backsights will be read and recorded on all shots. The two shots must agree within two degrees of each other. If a double front or back sight is required due to the difficulty of obtaining one of the readings, two different team members should take each of those double shots.

Book – Only park-approved sketchers will be allowed to sketch. All sketches will be done on park provided datasheets. Room and station names will be included on the sketch. If non-standard symbols are used in the sketch a legend will be included. Indications will be made to show what any unsurveyed passage does (e.g.: too tight, 2' x 4', to the "UB" survey, "to the Chimera Room" etc.) Passage dimensions will be drawn to scale, and ceiling heights will be noted at regular intervals. Cross sections should be drawn whenever the passage shape changes significantly, with a minimum of one per page. The sketch should contain as much floor and ceiling detail as possible without cluttering the sketch. The distance will be recorded in decimal feet, and should be recorded to two decimal places, even those that come out to an even foot (i.e. 11.00, not 11). All compass readings will be followed by one decimal place. All clinometer readings will be preceded by either a "+" or "-" and will be followed by one decimal place.

2) Inventory Standards

The items on the inventory form are not provided as an all-inclusive list of features found in the caves of Wind Cave National Park; they are however a collection of the most commonly found features. Extra effort should be made to document features not included on the list, including notes and a descriptive sketch where necessary, as these are often the most significant features.

A book with representative photographs of items on the inventory form is kept in the VIP center. Anyone performing inventory should review and become familiar with these items.

When inventorying as a survey progresses, one person is selected for the job. This must not be the sketcher but can be done by any other member of the survey party. It is very important to record a level and floor description for every station. General descriptions of the levels are located on a card in the pocket of the inventory book. Items will be referenced to the closest survey station. Tie-in or redundant stations should not be recorded.

APPENDIX G: Cave Restoration & Cleaning Guidelines

Cave Restoration

1) Safety

The most important aspect of cave restoration is safety. Pre-planning can greatly increase safety in restoration projects. Inspecting the restoration site before hand, while looking specifically for potential safety hazards, is important.

During restoration work each worker must wear gloves, helmet, sturdy boots, and appropriate clothing. For larger groups, there should be at least a one to six supervisor to worker ratio to ensure worker safety. Supervisors should make sure that workers are wearing appropriate safety gear, they are not overworked, the buckets and backpack sprayers are operated by individuals physically capable of handling them, and workers bend properly in order to lift heavy loads without causing back strain.

There are other potential hazards to be aware of:

- Overheating
- Respiratory diseases (Dust masks should be used in any dusty environment or especially where animal waste may be present).
- Electrical cables

2) Resource Concerns

Restoration work must not cause more impact than it mitigates. See appendix E, the EA covering all cave restoration work in the park.

3) Artificial Fill Removal

These projects involve removing trail construction debris typically resulting from trail development. This may include but not limited to blasting debris, wooden supports and forms, and disturbed sediment and rock. All debris removed from the cave will be disposed of in a proper landfill outside the park. Care will be taken not to include speleothems or bedrock with attached speleothems in this fill.

It is common to find cultural items mixed in with artificial fill. Whether or not is shall be collected or left in place can be based upon: the preservation, historical significance, threats, or age. Cultural artifacts include, “any manufactured item that is over 50 years old,” (counting from the current date). If cultural items are collected, they will be bagged with a completed artifact label. Their location will be documented and the burial depth will be recorded. Each item will be numbered and bagged separately. It is necessary to record this data at the time of collection as data can not be recreated at a later date. The presence of datable artifacts may aid in determining when overlying layers of fill were deposited.

4) Speleothem Repair

a. Epoxy

Only epoxies determined by specialists to be best suited for cave use will be used to repair broken speleothems.

b. Hardware

Any permanent hardware used will be stainless steel or other non-corrosive materials.

5) Lamp Flora Mitigation

Light management may be used to reduce lamp flora in problem areas. This will include using fixtures that discourage lamp flora growth and moving lights aimed at wet areas.

The current method for mitigating lamp flora is using hypochlorite bleach sprayed directly onto the lamp flora. The bleach is used in small amounts and if possible not sprayed from a distance, as these practices would increase harmful chlorine gasses into the cave air. Lamp flora mitigation will be done after hours or during the off season.

6) Lint, Hair, Dust Removal

Lint and dust will be removed using brushes or HEPA type vacuum cleaners. Water cleaning may be used after the lint and dust is removed as long as speleothems would not be damaged by using water. All debris removed from the cave will be disposed of in a proper landfill outside the park.

7) Water Use

Only water collected from drip points or non-chlorinated water with no added commercial chemicals will be used for restoration work. Letting tap water sit in an open container for 24 hours, so that the chlorine dissipates is an option, especially for use along the heavily impacted tour routes in Wind Cave. Water should never be transported from chlorinated sources to a restoration site for immediate use.

b. Sprayers

Only hand-pumped sprayers will be used for restoration work. High-pressure sprayers will not be used in the cave.

c. Cleaning Trails

If water is used to clean concrete walkways the resulting wastewater will be collected and not allowed to run off the trail into adjoining cave passages.

APPENDIX H: Cave Safety Standards & Job Hazard Analysis

CAVE SAFETY STANDARDS FOR WIND CAVE NATIONAL PARK

Caver safety is a primary objective of Wind Cave National Park's Cave and Karst Resource Management program. The purpose of the Cave Safety Standards is to establish a course of action that can be followed to minimize the risk to cavers (both NPS employees and volunteers) entering caves within Wind Cave National Park. These standards consist of Cave Safety Guidelines and a Job Hazard Analysis.

Safety is dependent on making sensible decisions and staying within one's abilities. Like other outdoor activities, there are inherent risks and hazards associated with caving. Most cave accidents are avoidable and result from poor judgment or poor physical conditioning.

Our obligation is not to protect people from the natural environment of the cave, but to inform them so that they can make better decisions as they manage their own risks.

CAVE SAFETY GUIDELINES:

The park will take the necessary steps to inform and educate cave users of potential threats to their safety. These steps will include listing potential hazards as a part of training of trip leaders.

A review of the findings of many cave related accidents traces problems to poor technique and poor judgment. Training will be provided to Physical Science staff in first aid and cave rescue techniques. Employee training and experience are very valuable in the prevention of mishaps and enables employees to better judge the skills of cavers.

The following guidelines are intended to serve as a recommended course of action for cavers:

1. Light sources will be helmet mounted in order to leave the hands free for negotiating the cave. It is required that one of the back-up light sources also be helmet mounted. The third light source is usually a small flashlight.

2. Disturbing animal droppings may lead to this matter being inhaled or ingested by the cavers. Since the inhalation or ingestion of animal droppings can be a health hazard, dust masks are recommended when rodent and other animal concentration areas are encountered within caves.

3. Cavers will be informed of the special hazards (crumbly hand and footholds, false floors, and complex mazes) unique to caves in the park as well as general caving hazards (i.e., tight squeezes and hypothermia, etc.)..

Job Hazard Analysis (JHA):
This section identifies general safety procedures developed to lessen the chance of accidents during caving trips. These procedures include cave trip preparation, caving techniques, and follow-up procedures. The main component of this section includes the recommended protective measures for safe caving in Wind Cave.

Even though this JHA pertains to NPS employees in the course of their jobs, most of the recommended protective measures can be applicable to volunteer cavers as well. This JHA is not meant to be an all-inclusive analysis of the hazards of caving associated with on-the-job activities for all locations. Additional JHAs, which will be completed for individual cave projects, will not be included with this plan.

WIND CAVE NATIONAL PARK
JOB HAZARD ANALYSIS FORM

JOB TITLE: Caver

DATE OF ANALYSIS: 06/06/06

JOB LOCATION: WICA

REQUIRED EQUIPMENT & TOOLS FOR JOB	REQUIRED SAFETY EQUIPMENT
* knee/elbow pads * treaded boots * gloves * side-mounted pack * adequate drinking water * adequate quick energy food supply * cave map	* three reliable independent light sources * extra batteries and bulb * UIAA approved helmet with four-point suspension chin strap * Watch

POTENTIAL HAZARDS	SAFETY CONTROL FACTORS
Unprepared / Lost	Before a Cave Trip: * Obtain a cave map and study intended route * Identify hazards along the route * Inspect and test equipment before using. Be sure all equipment is adequate for the cave trip * Stick to planned route
Overdue party	* Complete a Trip Report * Establish surface watch * Allow reasonable amount of time to leave cave by set exit time
Special Hazards in Wind Cave	* When climbing, make sure of three good holds before moving, especially in the unstable Upper Middle Level * When in lower levels, be aware of false floors * Exposed climbs * Slippery surfaces * Tight squeezes * Complex mazes * 53 degree temperatures and near 100% humidity
Exertion/exhaustion	* Recommend proper physical conditioning. The trip leader should inquire about people with known potentially dangerous physical conditions and treatment needs before entering the cave * Quick energy foods should be consumed to keep up with calorie utilization * Sufficient water * Avoid overexertion * The group should pace itself for the slowest member

SIGNATURES: ____

WIND CAVE NATIONAL PARK
JOB HAZARD ANALYSIS FORM

JOB TITLE: Cave Restoration Worker

DATE OF ANALYSIS: 06/06/06

JOB LOCATION: Wind Cave

REQUIRED EQUIPMENT & TOOLS FOR JOB	REQUIRED SAFETY EQUIPMENT
* paint brushes and tweezers * HEPA vacuum cleaners * buckets, backpacks, and truck cart * sponges, squirt bottles * Hammer, chisels * toothbrushes and scrub brushes	* UIAA approved helmet with four-point suspension chin strap * helmet-mounted light * ankle-supporting boots * ear plugs * safety goggles * dust masks * knee/elbow pads and gloves

POTENTIAL HAZARDS	SAFETY CONTROL FACTORS
* Electrocution	* Avoid all electrical lines when power is turned on * Turn off power in Ready Room and lock down switch when uncovering, moving, or covering power lines
* Vacuum cleaner noise	* Use ear plugs when using the vacuum cleaners
* Lights	* Avoid spraying or splashing water on any light * Don't touch bulbs with bare skin
* Chipping concrete	* Use safety goggles whenever a tool is being used * Wear gloves
* Lifting heavy loads	* Use truck cart and proper lifting techniques when lifting heavy buckets or backpacks * Don't over fill buckets
* Uneven surfaces	* Wear proper fitting boots with good traction. * Pay careful attention to where you're stepping

SIGNATURES: ____

WIND CAVE NATIONAL PARK
JOB HAZARD ANALYSIS FORM

JOB TITLE: Lamp flora Mitigation

DATE OF ANALYSIS: 06/06/06

JOB LOCATION: Wind Cave

REQUIRED EQUIPMENT & TOOLS FOR JOB	REQUIRED SAFETY EQUIPMENT
* Hand-held squirt bottles (for H2O & bleach) * Hypochlorite bleach (2.5% solution)	* rubber gloves * safety goggles * portable eye wash bottle * UIAA approved helmet with four-point suspension chin strap * helmet-mounted light * ankle-supporting boots * knee/elbow pads

POTENTIAL HAZARDS	SAFETY CONTROL FACTORS
• Chlorine gas	• Carefully spray bleach onto lamp flora, getting as close as possible to surface
• Splash backs	• Avoid using stream or mist settings on spray bottles
• Lights	• Avoid spraying or splashing solution on any light bulb that is turned on
• Spilling bleach	• Don’t fill bottles in the cave

POTENTIAL IMPACTS	PROCEDURES
• Killing cave biota	• Check lamp flora surface for any biota

SIGNATURES: ____

APPENDIX I: List of Participants

Planning Team Participants

The following Wind Cave National Park employees participated in two internal planning and scoping meetings. The first meeting was held on 12/07/2001 at Wind Cave National Park. The second was by invitation to government cave and karst related specialists and WICA employees on 05/18/2004. Participants in 12/07/2001 internal meeting:

Name:	Position:
Linda Stoll	*Superintendent*
Steve Schrempp	*Facilities Manager*
Tom Farrell	*Chief of Interpretation*
Rod Horrocks	*Physical Science Specialist*
Marc Ohms	*Physical Science Technician*
Jim Dahlberg	*Maintenance Foreman*
Dan Foster	*Chief of Resource Management*
Rick Mossman	*Chief Ranger*
Mary Laycock	*Interpreter*

Participants in 05/18/2004 cave and karst specialist meeting:

Name:	Position:
Linda Stoll	*Superintendent*
Ron Kerbo	*Cave and Karst Coordinator, NPS Geo. Resource Division (GRD)*
Dan Foster	*Chief of Resource Management*
Tom Farrell	*Chief of Interpretation*
Rick Mossman	*Chief of Visitor Protection*
Steve Schrempp	*Facilities Manager*
Rod Horrocks	*Physical Science Specialist*
Marc Ohms	*Physical Science Technician*
Rene Ohms	*Physical Science Technician*
Mike Wiles	*Cave Management Specialist*
Jim Pisarowicz	*Interpreter*
Mary Laycock	*Lead Interpreter*
Jim Dahlberg	*Maintenance Foreman*
Allisa Kiesow	*Wildlife Biologist, SDGF&P*

Preparers

Name	Contribution
Rodney D. Horrocks *Physical Science Specialist*	Draft Plan
Marc Ohms *Physical Science Technician*	Section writing and editing
Jason Walz *Seasonal Physical Science Technician*	Policy discussions
Matt Reece *Seasonal Physical Science Technician*	Section writing and editing
Dan Foster *Chief of Resource Management*	Editing

APPENDIX J: Environmental Screening Form

WIND CAVE NATIONAL PARK

A. PROJECT INFORMATION

Park Name: Wind Cave National Park

Project Number: ____________ PMIS #: ____________

Project Type (*Check*):
- ☐ Cyclic
- ☐ NRPP
- ☐ Fee Demo
- ☐ Cultural Cyclic
- ☐ CRPP
- ☐ Concession Reimbursable
- ☐ Repair/Rehab
- ☐ FLHP
- ☒ ONPS
- ☐ Line Item
- ☐ Other (specify) : ____________

Project Location: Parkwide

Project Originator/Coordinator: Rod Horrocks

Project Title: WIND CAVE NATIONAL PARK CAVE AND KARST RESOURCE MANAGEMENT PLAN

Contract #: ____________

Contractor Name: ____________

Administrative Record Location: Wind Cave N.P. Central Files

Administrative Record Contact: Sandy Meyer

B. PROJECT DESCRIPTION/LOCATION

Please see attached Bison Management Plan

Preliminary drawings attached? ☐ Yes ☒ No

Background info attached? ☐ Yes ☒ No

Date form initiated: January 15, 2007

Anticipated compliance completion date: March 2007

Projected advertisement/Day labor start: ____________

Construction start: ____________

C. RESOURCE EFFECTS TO CONSIDER

Are any measurable[1] impacts possible on the following physical, natural or cultural resources?	Yes	No	Data Needed to Determine
1. Geological resources – soils, bedrock, streambeds, etc.		X	
2. From geohazards		X	
3. Air quality		X	
4. Soundscapes		X	
5. Water quality or quantity		X	
6. Streamflow characteristics		X	
7. Floodplains or wetlands		X	
8. Land use, including occupancy, income, values, ownership, type of use		X	
9. Plant species or habitats of special concern: state-listed, proposed for state or federal listing		X	
10. Species of special concern (plant or animal; state or federal listed or proposed for listing) or their habitat		X	
11. Unique ecosystems, biosphere reserves, World Heritage Sites		X	
12. Unique or important wildlife or wildlife habitat		X	
13. Unique or important fish or fish habitat		X	
14. Introduce or promote non-native species (plant or animal)		X	
15. Recreation resources, including supply, demand, visitation, activities, etc.		X	
16. Visitor experience, aesthetic resources, including impacts to interpretive operations and interpretive facilities		X	
17. Cultural resources including cultural landscapes, ethnographic resources		X	
18. Socioeconomics, including employment, occupation, income changes, tax base, infrastructure		X	
19. Minority and low income populations, ethnography, size, migration patterns, etc.		X	
20. Energy resources		X	
21. Other agency or tribal land use plans or policies			
22. Resource, including energy, conservation potential		X	
23. Urban quality, gateway communities, etc.			
24. Long-term management of resources or land/resource productivity		X	
25. Other important environment resources (e.g. geothermal, paleontological resources)?		X	

[1] **MEASURABLE IMPACTS ARE THOSE THAT THE INTERDISCIPLINARY TEAM DETERMINES TO BE GREATER THAN NEGLIGIBLE BY THE ANALYSIS PROCESS DESCRIBED IN DO-12 §2.9 AND §4.5(G)(4) TO (G)(5).**

D. Mandatory Criteria

Mandatory Criteria: If implemented, would the proposal:	Yes	No	Data Needed to Determine
A. Have material adverse effects on public health or safety?		X	
B. Have adverse effects on such unique characteristics as historic or cultural resources; park, recreation, or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands; floodplains; or ecologically significant or critical areas, including those listed on the National Register of Natural Landmarks?		X	
C. Have highly controversial environmental effects?		X	
D. Have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risks?		X	
E. Establish a precedent for future action or represent a decision in principle about future actions with potentially significant environmental effects?		X	
F. Be directly related to other actions with individually insignificant, but cumulatively significant, environmental effects?		X	
G. Have adverse effects on properties listed or eligible for listing on the National Register of Historic Places?		X	
H. Have adverse effects on species listed or proposed to be listed on the List of Endangered or Threatened Species or have adverse effects on designated Critical Habitat for these species?		X	
I. Require compliance with Executive Order 11988 (Floodplain Management), Executive Order 11990 (Protection of Wetlands), or the Fish and Wildlife Coordination Act?		X	
J. Threaten to violate a federal, state, local, or tribal law or requirement imposed for the protection of the environment?		X	
K. Involve unresolved conflicts concerning alternative uses of available resources (NEPA sec. 102(2)(E)?		X	
L. Have a disproportionate, significant adverse effect on low-income or minority populations (EO 12898)?		X	
M. Restrict access to and ceremonial use of Indian sacred sites by Indian religious practitioners or adversely affect the physical integrity of such sacred sites (EO 130007)?		X	
N. Contribute to the introduction, continued existence, or spread of federally listed noxious weeds (Federal Noxious Weed Control Act)?		X	
O. Contribute to the introduction, continued existence, or spread of non-native invasive species or actions that may promote the introduction, growth or expansion of the range of non-native invasive species (EO 13112)?		X	
P. Require a permit from a federal, state, or local agency to proceed, unless the agency from which the permit is required agrees that a CE is appropriate?		X	
Q. Have the potential for significant impact as indicated by a federal, state, or local agency or Indian tribe?		X	
R. Have the potential to be controversial because of disagreement over possible environmental effects?		X	
S. Have the potential to violate the NPS Organic Act by impairing park resources or values?		X	

E. OTHER INFORMATION

Are personnel preparing this form familiar with the site? ☒ Yes ☐ No

Did personnel conduct a site visit? ☐ Yes ☒ No

(If yes, attach meeting notes or additional pages noting when site visit took place, who attended, etc.)

Is the project in an approved plan such as a General Management Plan or an Implementation Plan with an accompanying environmental document? ☐ Yes ☒ No

If so, plan name ______________________________

Is the project still consistent with the approved plan? ☐ Yes ☐ No *(If no, prepare plan/EA or EIS.)*

Is the environmental document accurate and up-to-date? ☐ Yes ☐ No *(If no, prepare plan/EA or EIS.)*

FONSI☐ ROD ☐ Date approved ______________________________

Are there any interested or affected agencies or parties? ☒ Yes ☐ No

Did you make a diligent effort to contact them? ☐ Yes ☒No

Has consultation with all affected agencies or tribes been completed? ☒ Yes ☐ No

Are there any connected, cumulative, or similar actions as part of the proposed action? ☐ Yes ☒ No
(If so, attach additional pages detailing the other actions.)

F. LEGAL REVIEW

National Environmental Policy Act

Data entered by: ______________________________

(*Choose one and fill in blanks*)

☐ undocumented CE; CE Citation: Sec 3.3______________________

☒ documented CE; CE Citation: Sec 3.4 B. (1) Changes or amendments to an approved plan, when such changes have no potential for environmental impact.

Excepted actions apply? ☐ Yes ☐ No (*If yes, do EA or EIS*)
(Attach signed CE form)

☐ EA — EA release to public ________________
FONSI date ________________

☐ EIS — ROD date ________________

National Historic Preservation Act

Data entered by: ______________________________

Ground disturbance involved? ☐ Yes ☒ No

Historic structures involved? ☐ Yes ☒ No

Cultural landscapes involved? ☐ Yes ☒ No

Ethnographic concerns involved? ☒ Yes ☐ No

If yes, interested parties contacted? ☒ Yes ☐ No

(*Choose one and fill in blanks*)

☒ No historic properties affected

☐ Programmatic exclusion Citation _________Date AEF to SHPO/THPO __________

Determination of effect ☐ No effect ☐ No adverse effect ☐ Adverse Effect

Date to SHPO/THPO _______ Date to ACHP _______________

Date consultation completed ________________

Endangered Species Act

Data entered by: Dan Foster

Any threatened/endangered species in area? ☐ Yes ☒ No

If species in area ☐ No effect ☐ Not Likely to Adversely Affect ☐ Likely to Adversely Affect

Date Section 7 to FWS ________________ Date FWS response ________________

Floodplains/Wetlands/§404 Permits

Data entered by: Dan Foster

Is project in 100- or 500-year floodplain?	☐ Yes	☒ No; (If yes, *attach SOF)*
Is project in wetlands?	☐ Yes	☒ No; (If yes, attach SOF)
404 permit needed?	☐ Yes	☒ No; Date ________________
State 401 certification?	☐ Yes	☒ No; Date ________________
State DENR permit?	☐ Yes	☒ No; Date ________________

G. MITIGATING MEASURES TO BE INCLUDED IN PROJECT:

(Specify here or attach appropriate pages from EA, EIS, FONSI, or ROD)

H. INSTRUCTIONS FOR DETERMINING APPROPRIATE NEPA PATHWAY

Complete the following tasks: conduct a site visit or ensure that staff is familiar with the site's specifics; consult with affected agencies, and/or tribes; and interested public and complete this environmental screening form.

> If your action is not described in DO-12 § 3.4 or if you checked yes or identified "data needed to determine" impacts in any block in Section D (Mandatory Criteria), you must prepare an environmental assessment or environmental impact statement.
>
> If you checked no in all blocks in Section C (resource effects to consider) and checked no in all blocks in Section D (Mandatory Criteria) and if the action is described in DO-12 § 3.4, you may proceed to the categorical exclusion form. (Appendix 2 of DO-12 Handbook)

I. INTERDISIPLINARY TEAM SIGNATORY (All interdisciplinary team members must sign.)

By signing this form, you affirm the following: you have either completed a site visit or are familiar with the specifics of the site; you have consulted with affected agencies and tribes; and you, to the best of your knowledge, have answered the questions posed in the checklist correctly

Req'd	Technical field or expertise	Signature	Date
☒	Superintendent (acting) Phil Heckman		
☒	Chief of Resource Management Dan Foster		
☒	Cultural Resource Coordinator Tom Farrell		
☐	Biologist Dan Roddy		
☒	Chief Park Ranger Rick Mossman		
☒	Chief of Maintenance Steve Schrempp		
☒	Physical Science Specialist Rod Horrocks		

WIND CAVE NATIONAL PARK

Categorical Exclusion Form

Project Name: CAVE AND KARST MANAGEMENT PLAN **Date:** March 2007

Describe project, including location (reference the attached Environmental Screening Form (ESF), if appropriate):

Adoption of the revised Cave and Karst Management Plan

Describe the category used to exclude action from further NEPA analysis and indicate the number of the category (see section 3–4 of DO-12):

CE Citation: Sec 3.4 B. (1) Changes or amendments to an approved plan, when such changes have no potential for environmental impact.

Describe any public or agency involvement effort conducted (reference the attached ESF):
Please see attached Environmental Screening Form.

On the basis of the environmental impact information in the statutory compliance file, with which I am familiar, I am categorically excluding the described project from further NEPA analysis. No exceptional circumstances (i.e., all boxes in the ESF are marked "no") or conditions in section 3-6 apply, and the action is fully described in section 3-4 of DO-12.

______________________________ ______________________________
Superintendent or Designee **Date**

____
Chief of Resource Management, NPS Contact Person
Wind Cave National Park
RR 1, Box 190 Hot Springs, SD 57747
605-745-1190