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**FHWA-WY-01/03F**



## **EVALUATION OF THE FLASH (FLASHING LIGHT ANIMAL SENSING HOST) SYSTEM IN NUGGET CANYON, WYOMING**

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<p>Abstract</p> <p>U.S. Highway 30 between Kemmerer and Cokeville, Wyoming bisects the migratory route of the Wyoming Range mule deer (<i>Odocoileus hemionus</i>), herd and is the site of hundreds of deer vehicle collisions each year. The system consisted of infrared detectors that sensed deer as they passed through an opening in a deer proof fence and activated a sign with flashing lights to alert motorists to the presence of deer on or near the highway.</p> <p>The Flashing Light Animal Sensing Host (FLASH) system and a geophone deer detection system, were assessed in order to determine their reliability, or accuracy of hits, as the sensors picked up deer approaching the area. It was found that more than 50 % of the hits registered by the FLASH system were false hits not caused by deer, though the geophone system worked well throughout the study period, with no false hits detected.</p> <p>Vehicles did not slow down significantly for the warning signs. When deer or a stuffed decoy was adjacent to the road, and the lights activated, vehicles reduced their speed (12.32 and 6.63 mph on average for passenger vehicles and tractor trailers respectively). This lack of speed reduction may be attributed to non-local motorists unfamiliar with the danger of deer vehicle collisions in the area. Investigation into the application of the warning light system on stretches of road heavily used by local residents familiar with deer migratory patterns and deer-vehicle collisions is warranted.</p> <p>The geophone system is more reliable than the FLASH system and should be used as a model for development of similar systems in the future.</p>			
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# SI\* (Modern Metric) Conversion Factors

## Approximate Conversions from SI Units

Symbol	When You Know	Multiply By	To Find	Symbol
<b>Length</b>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
<b>Area</b>				
mm <sup>2</sup>	square millimeters	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	10.764	square feet	ft <sup>2</sup>
m <sup>2</sup>	square meters	1.195	square yards	yd <sup>2</sup>
ha	hectares	2.47	acres	ac
km <sup>2</sup>	square kilometers	0.386	square miles	mi <sup>2</sup>
<b>Volume</b>				
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m <sup>3</sup>	cubic meters	35.71	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.307	cubic yards	yd <sup>3</sup>
<b>Mass</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lbs)	T
<b>Temperature (exact)</b>				
°C	Centigrade temperature	1.8 C + 32	Fahrenheit temperature	°F
<b>Illumination</b>				
lx	lux	0.0929	foot-candles	fc
cd/m <sup>2</sup>	candela/m <sup>2</sup>	0.2919	foot-Lamberts	fl
<b>Force and Pressure or Stress</b>				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	pound-force	psi

## Approximate Conversions to SI Units

Symbol	When You Know	Multiply By	To Find	Symbol
<b>Length</b>				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
<b>Area</b>				
in <sup>2</sup>	square inches	645.2	square millimeters	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.836	square meters	m <sup>2</sup>
ac	acres	0.405	hectares	ha
mi <sup>2</sup>	square miles	2.59	square kilometers	km <sup>2</sup>
<b>Volume</b>				
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft <sup>3</sup>	cubic feet	0.028	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	cubic meters	m <sup>3</sup>
<b>Mass</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lbs)	0.907	megagrams	Mg
<b>Temperature (exact)</b>				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
<b>Illumination</b>				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m <sup>2</sup>	cd/m <sup>2</sup>
<b>Force and Pressure or Stress</b>				
lbf	pound-force	4.45	newtons	N
psi	pound-force	6.89	kilopascals	kPa

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## Table of Contents

<b>Chapter</b>		<b>Page</b>
1	<b>Problem Description</b>	1
2	<b>Objectives</b>	2
3	<b>Task Description</b>	3
	Study area	3
	Deer and vehicle detection systems	3
	Data collection	5
	Project chronology	8
4	<b>Results of Data Analyses</b>	10
	Deer activity and mortality	10
	Evaluation of FLASH and geophone system reliability	13
	Evaluation of FLASH system effectiveness	14
	Results of experimental manipulations	16
5	<b>Implementation Recommendations</b>	19
Appendix A	<b>Nugget Canyon Deer Detection Study Technical Report</b>	21
	<b>References</b>	40

<b>LIST OF FIGURES AND TABLES</b>	<b>PAGE</b>
Figure 1: Deer and vehicle sensing systems at Nugget Canyon.....	4
Figure 2: Average daily deer activity by month for three deer detection systems.....	11
Figure 3: Night/day deer activity measured by the geophone.....	11
Figure 4: Deer movement and average daily maximum temperature by month.....	12
Figure 5: Deer movement and average daily minimum temperature by month.....	12
Figure 6: Deer movement and average daily precipitation by month.....	13
Figure 7: Comparison of deer mortality and deer activity at Nugget Canyon.....	14
Figure 8: Vehicle-caused deer mortality in Nugget Canyon by sex and age.....	15
Figure 9: Percentage of false hits on the FLASH system.....	15
Figure 10: Vehicle speed reduction in response to the FLASH warning system.....	16
Figure 11: Change in speed of automobiles and tractor trailers in response to five different experimental treatments.....	17
Figure 12: Passenger vehicle categorical speed reductions in response to five experimental treatments.....	18
Figure 13: Tractor trailer categorical speed reductions in response to five experimental treatments.....	18
Table 1: Treatment schedule for experimental manipulations.....	7

## EXECUTIVE SUMMARY

U.S. Highway 30 between Kemmerer and Cokeville, Wyoming bisects the migratory route of the Wyoming Range mule deer (*Odocoileus hemionus*) herd and is the site of hundreds of deer vehicle collisions each year. We tested the effectiveness of a system designed to warn motorists of deer on the highway. The system consisted of infrared detectors that sensed deer as they passed through an opening in a deer proof fence and activated a sign with flashing lights that alerted motorists to deer presence on the road.

We compiled data on timing and seasonality of deer movement and deer mortality in order to determine at what time of day and year the risk of deer-vehicle collisions was highest. The FLASH (Flashing Light Animal Sensing Host) system as well as the back-up geophone deer detection system, were assessed in order to determine their reliability. In addition, we collected data on vehicle speed before and after entering the crossing to determine if motorists slowed down in response to the warning signs. We also conducted a series of experimental manipulations to determine motorist response to the warning system with the lights flashing or not flashing and with the presence or absence of a realistic deer decoy in the road.

The peak of fall deer migration occurred in November, and March and April were the peak months for spring deer migration. Deer moved primarily at night in all months. Peaks in deer mortality were congruent with peaks in deer movement, and adult females were killed more than any other age/sex class. It was found that more than 50% of the hits registered by the FLASH system were false hits not caused by deer, though the geophone system worked well throughout the study period, with no false hits detected.

Vehicles did not slow down significantly for the warning signs. When the lights were flashing and deer were present in the crossing, vehicles reduced their speed by an average of 3.6 mph, probably insufficient to reduce the occurrence of deer/vehicle collisions. During the experimental manipulations, vehicles only significantly reduced their speed (12.32 and 6.63 mph on average for passenger vehicles and tractor trailers respectively)



when the deer decoy was in the crossing. Vehicles responded to the other treatments by reducing their speed by an average of less than 5mph.

Primary recommendations stemming from these findings are as follows:

- 1.) The geophone system is more reliable than the FLASH system and should be used as a model for development of similar systems in the future. The high incidence of false hits on the FLASH system make it unsuitable as a trigger for the warning signs.
- 2.) An at-grade deer crossing is not appropriate for the Nugget Canyon site and solutions that involve a separated crossing should be investigated. Because of the high use of the road by non-local motorists who may be unfamiliar with the danger of a deer vehicle collision in the area, any warning signs associated with an at-grade crossing will probably be ineffective.
- 3.) Investigation into the application of the warning light system to other areas is warranted. Stretches of road heavily used by local residents who have more familiarity with the hazard of a deer-vehicle collision and who would become familiar with the system may be more suitable for the application of this type of system.
- 4.) More research into the impacts of U.S. 30 on the Wyoming Range mule deer herd is warranted. Decision-makers need more information about the impact of mitigation measures on deer movement and on the impact of vehicle cause deer mortality on the Wyoming Range population.

## CHAPTER ONE

### Problem Description

U.S. Highway 30 as it passes through Nugget Canyon between Kemmerer and Cokeville, Wyoming is the site of hundreds of deer/vehicle collisions each year as mule deer of the Wyoming Range herd cross the highway while migrating between their winter and summer ranges. In 1986, the Wyoming state legislature passed the Nugget Canyon Wildlife Migration Project Act calling for state agencies to work together in attempting to mitigate the problem of deer/vehicle collisions in this area. Several mitigation measures have been attempted in Nugget Canyon. In 1989 a seven-mile long eight-foot high deer proof fence was erected with a gap for mule deer crossings at milepost 30.5. Signs warning motorists of migratory deer crossings were installed in association with the fence, but deer mortality remained high. Swareflex reflectors were tested but were found to be ineffective in reducing deer/vehicle collisions (Reeve and Anderson 1993).

Deer mortality in Nugget Canyon is of particular concern because the Wyoming Range mule deer herd has been declining in numbers over the past several years. This deer herd is important to the state of Wyoming, with hunters and tourists visiting the state from all over the country to view and/or hunt these animals. The estimated value of an individual mule deer to the state is \$1,000. The majority of deer killed in Nugget Canyon are adult and yearling females, which could have an impact on herd objectives (Reeve 1990).

The risk to motorists is also an important concern. U.S. Highway 30 is a high-volume road that is used by many truck drivers and tourists as a cut-off from Interstate 80 to areas to the northwest of the state. Many of the motorists on the road are from outside the area and are unlikely to be familiar with the high risk of a deer/vehicle collision during peak mule deer migration times. Traditional "Deer Crossing" warning signs were found to be ineffective at causing these non-resident motorists to slow down.

As a potential solution to this problem, we tested a system designed to warn motorists when deer are on the road. The FLASH (Flashing Light Animal Sensing Host) system is comprised of a detector which is activated as deer enter the crossing and approach the road and triggers flashing lights associated with a sign that informs motorists that deer are on the road when the light is flashing. In this study we determined whether this system was effective in causing motorists to reduce their speed as they approached the crossing.

## CHAPTER TWO

### Objectives

The primary objectives of the study are as follows:

1. Determine how numbers of deer crossing US 30 in Nugget Canyon vary with time of day and season.
2. Determine how vehicle-caused deer mortality varies with season in Nugget Canyon.
3. Compare accuracy of FLASH system deer counts to counts made by other systems.
4. Evaluate the effectiveness of FLASH in causing motorists to reduce their speed approaching the deer crossing.

Objectives 1 and 2 were used to evaluate times during which risk of deer-vehicle collisions was particularly high. Objective 3 was necessary to determine the reliability with which the FLASH system detected deer. Objective 4 was used to determine motorist response to the FLASH system. Was the FLASH system successful in alerting motorists to deer in the road and averting potential deer-vehicle collisions?

## CHAPTER THREE

### Task Description

#### Study Area

The Nugget Canyon study area is in the southwest portion of Lincoln County, Wyoming, within a major mule deer winter range complex, the Cokeville-Rock Creek (C-RC) winter range. This is one of several winter ranges used by mule deer in the Wyoming Range mule deer herd unit.

Deer-vehicle collisions primarily occur along a 15 mile segment of US 30 from milepost 27 to milepost 42. This highway segment includes the area described in the Nugget Canyon Migration Project Act (milepost 27 to milepost 39.7). The Union Pacific Pocatello, Idaho rail line parallels US 30 through the project area. Twin Creek, a tributary of the Bear River, flows through Nugget Canyon and is fed by other streams in north-south oriented drainages. Major ridges, including Boulder Ridge, Rock Creek Ridge, Dempsey Ridge, and Sellem Ridge, orient mule deer migration patterns so that they cross US 30 during spring and fall migrations to and from their summer range to the north.

Elevations on the floor of Nugget Canyon range from 2000 m (6560 ft) at the east end to 1923 m (6307 ft) at Sage Junction. Big sagebrush (*Artemisia tridentata*) is the dominant vegetation in the area and is interspersed with mountain shrubs including Utah serviceberry (*Amelanchier utahensis*), antelope bitterbrush (*Purshia tridentata*) and snowberry (*Symphoricarpos* spp.) (Oedekoven and Lindzey, 1986). Riparian willow (*Salix* spp.) is common along creek margins. Most deer on the C-RC have been observed in sagebrush-grass vegetation throughout the winter period, though mountain shrub vegetation is used by mule deer in early winter (Edberg, 1990).

#### Deer and vehicle detection systems

The FLASH system and accompanying data collection systems have been installed in the deer crossing in Nugget Canyon at milepost 30. Technical specifications for all systems mentioned in the description below are included in the report prepared by Wyoming Department of Transportation engineers Bill Gribble and Matt Johnson, attached to this report as Appendix A. Three different systems are in place for detecting deer presence in the crossing (Fig. 1). The system of primary interest in this study, the FLASH system designed by Victoria Gooch and maintained and installed by George Twitchell of the Mid-American Manufacturing Technology Center (MAMTC) consists of infrared sensors that detect the body heat of animals. These sensors transmit a signal to a receiving unit, which activates a sign with flashing lights to warn motorists. The signs are located to the east and west of the crossing, approximately 300 m (984 ft) from the crossing. The signs can be flipped back and forth to display one of two messages: "Attention: Migratory Deer Crossing" or "Deer on Road when Lights are Flashing."

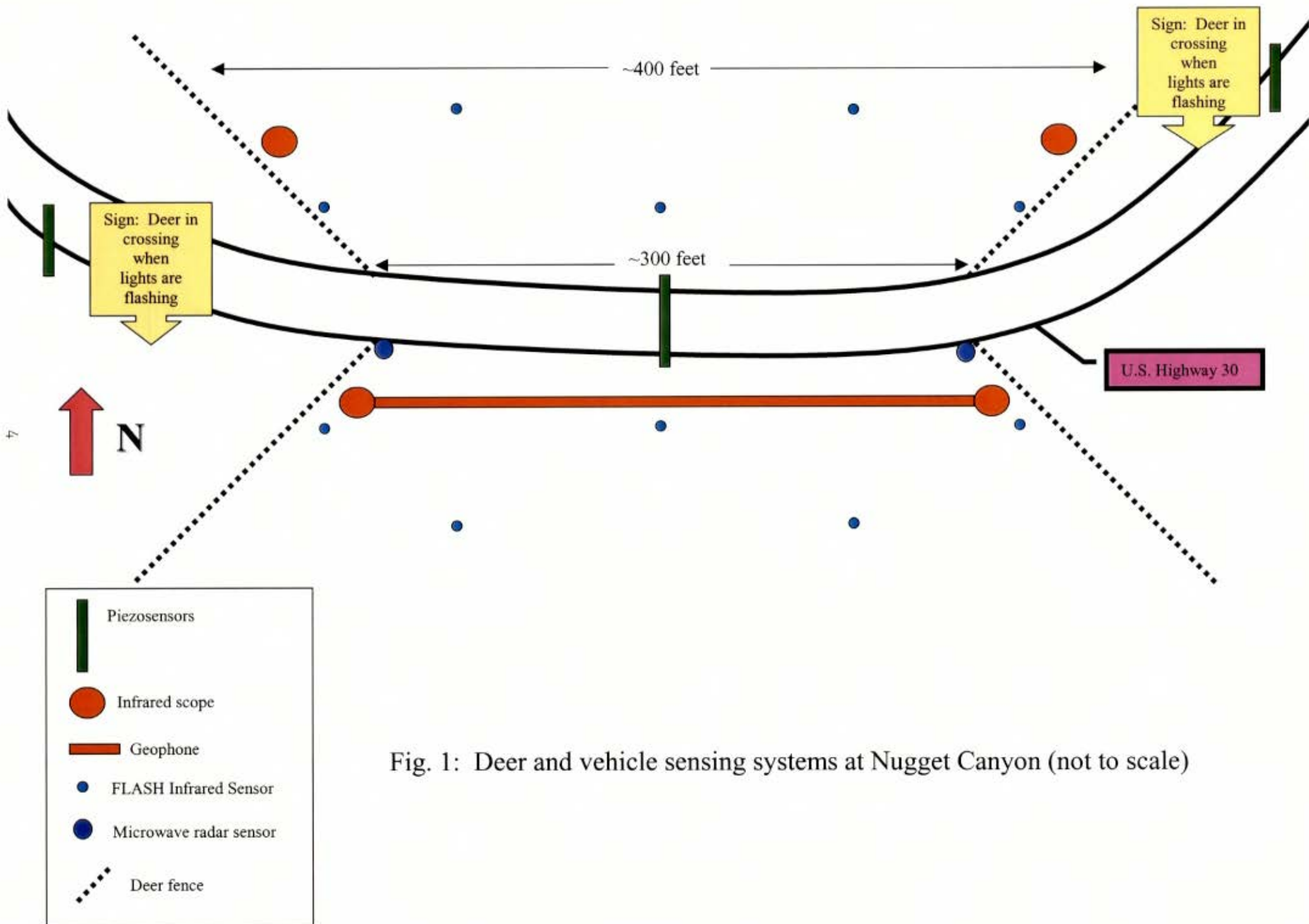


Fig. 1: Deer and vehicle sensing systems at Nugget Canyon (not to scale)

A geophone unit which detects ground vibrations caused by animals crossing at the south side of the site, paired with infrared scopes at the north and south sides of the site, acts as a back-up system for gathering data on deer crossings. A second backup system, consisting of microwave sensors flanking the south side of the site, was installed but is seldom used due to its tendency to register hits from passing trucks and other non-deer stimuli. The number of detections by all three deer systems were recorded by a counter.

Data consisting of speed, classification, and size of vehicles travelling along US 30 are collected by sensors located at points east and west of the crossing, as well as at the crossing itself. The east and west sensors gathered data on vehicles before the warning sign was encountered by motorists. These data as well as data collected by the deer detection systems were stored in a counter and downloaded remotely via modem into a database that allowed manipulation and analysis of the data.

### **Data collection**

#### *Deer activity and numbers*

Deer activity data were collected by three different systems. The FLASH and geophone systems transmitted number of hits on the system at 5-minute intervals to a data logger. Multiple hits could be registered by one deer moving back and forth through the crossing, or a single hit could be registered by multiple deer moving through the crossing simultaneously. Therefore, the data collected by the FLASH and geophone systems provide an estimate of deer activity but cannot be used to estimate number of deer moving through the crossing.

A videocamera system erected in December of 2000 to gather pre-data for an upcoming underpass study at the Nugget Canyon site was used to estimate numbers of deer passing through the crossing. The camera was activated each time the geophone sensor was tripped and the entire area of the crossing was filmed for two minutes. Number of deer crossing the highway, date, and time of day were obtained from the videotapes. Data from the three different systems were converted into average number of hits or deer per day for each month the system was active. The geophone system collected data for the entire 2000-2001 study period (October-May), but the videocamera and FLASH systems were not activated until December of 2000.

Weather data including daily maximum and minimum temperatures and daily precipitation were downloaded from the nearby Fossil Butte weather station in order to assess potential effects that specific weather events might be having on deer movement. These data were compared to data on deer movement.

#### *Deer mortality*

Vehicle-caused deer mortality data for US Highway 30 in Nugget Canyon has been collected by Wyoming Department of Transportation personnel and compiled by the Wyoming Department of Game and Fish since the mid 1980s. Deer carcasses are located by milepost, aged and sexed, and date of carcass removal is noted. Data from the 2000-2001 season were used to determine peak times of deer mortality by month.

#### *Evaluation of FLASH and geophone system reliability*

Activity on the FLASH and geophone systems was monitored via a remote link that allowed researchers to view hits on both systems as they occurred. Two-hour watches were conducted at varying times during daylight hours in conjunction with the collection of treatment data. During these watches, the crossing was monitored for deer activity, and FLASH and geophone systems were watched to determine if the deer were registering on the system. Data consisting of the number of accurately registered hits, number of false hits, and number of times deer crossed without being detected were collected. Due to a power failure in the trailer from which observations were conducted, the remote link was not used after January and instead times of deer crossings were noted and later confirmed when deer crossing data was downloaded. Additionally, times of deer crossings observed outside of watch times were noted and later confirmed by examining deer crossing data.

Problems that developed with the FLASH system which came to our attention in January prompted us to analyze further the number of false hits the FLASH system was registering. Three days of deer crossing data were selected at random from each month that the system was active (December- May). We compared the number of hits on the FLASH and geophone systems during those days and computed the percentage of hits that registered on the FLASH system with no confirming hits on the geophone system. Since the geophone system was never found to register false hits, we felt justified in using it as a gauge of the accuracy of the FLASH system.

#### *Evaluation of FLASH system effectiveness in reducing motorist speed.*

The FLASH system was engaged on December 8, 2000 and allowed to activate the warning signs until May 21, 2001, with the exception of times during which experimental manipulations were conducted and times during which the system was undergoing repairs. Vehicle speed data and deer crossing data were downloaded remotely every 3 days during this period. Two days were chosen at random from each month, and vehicle speed data was coded according to whether or not a deer was present at the time the vehicle moved through the crossing. Differences in vehicle speeds before and after viewing the warning sign were compared between times when the sign was activated (deer present) and times when the sign was inactive (deer absent). Later in the season the FLASH system started registering numerous false hits, as indicated by observation and by the geophone system (see Chapter Four: Results of Data Analysis). Consequently a third category was added to the analysis of vehicles that moved through the crossing when the sign was activated but no deer were present.

In addition to evaluation of the motorist response to the system under normal operating conditions, a series of experimental manipulations was performed in order to determine how different configurations of signs, lights, and presence or absence of deer affected vehicle speed. Vehicles were exposed to five different treatments that were switched at two-hour intervals. Each treatment was performed at four different times (Table 1), and two sets of four treatment blocks were conducted in each month. Change in vehicle speed was compared between each of the treatments. We also separated the data into

speed classes to determine what proportion of vehicles slowed down by 0-5mph, 5-10mph, etc. in response to each treatment. The treatments consisted of the following:

1. The sign read "Attention: Migratory Deer Crossing." Lights were left flashing continuously. This allowed us to determine a baseline change in speed through the crossing in response to a normal deer warning system.
2. The sign read "Deer on Road When Lights are Flashing." Lights were left flashing continuously. From this we can evaluate whether motorists reduce their speed in response to the lights even when deer are absent.
3. The sign read "Deer on Road When Lights are Flashing." Lights were left flashing continuously and a realistic-looking taxidermist's mount of a deer was placed on the shoulder about 3 m (10 ft) from the road. From this we determined the effect on motorist speed of an actual deer in the crossing, after having been warned by the flashing lights.
4. The sign read "Deer on Road When Lights are Flashing." Lights were deactivated and the deer was placed near the roadway. We used this treatment in conjunction with treatment 3 to evaluate whether the lights have an "alertness" effect. In other words, do motorists slow down less in response to the deer decoy when they haven't been forewarned of its presence by the lights?
5. The sign read "Deer on Road When Lights are Flashing." Lights were activated by a remote control as motorists approached, such that motorists could see the lights come on. This treatment was used to determine whether motorists were more likely to slow down given evidence that the system was active.

Treatment 4 was added in early February in response to preliminary analyses that showed that motorists slowed down significantly for the deer decoy.

Table 1: Treatment schedule for experimental manipulations. See text for explanation of treatment types

	Block 1	Block 2	Block 3	Block 4
1800-2000	1	FLASH	FLASH	4
2000-2200	2	FLASH	FLASH	5(westbnd)
2200-0000	3	FLASH	FLASH	5(eastbnd)
0000-0200	4	FLASH	1	FLASH
0200-0400	5 (westbnd)	FLASH	2	FLASH
0400-0600	5 (eastbnd)	FLASH	3	FLASH
0600-0800	FLASH	1	4	FLASH
0800-1000	FLASH	2	5(westbnd)	FLASH
1000-1200	FLASH	3	5(eastbnd)	FLASH
1200-1400	FLASH	4	FLASH	1
1400-1600	FLASH	5(westbnd)	FLASH	2
1600-1800	FLASH	5(eastbnd)	FLASH	3



## **Project chronology**

### **1998-1999 Season**

During the 1998-1999 field season, various problems with the deer detection systems prevented the collection of deer crossing data. The transmitters associated with the infrared FLASH system communicated only sporadically with the counters used to record the data, and observers witnessed deer crossing the highway that were not registered by the system. Additionally, the geophone system was registering false hits because of vibrations from train and vehicle traffic. This problem was corrected by installing the infrared scopes and requiring that both devices detect an animal in the crossing before registering a hit. The microwave radar system seemed to have several gaps in its coverage, and registered false hits due to factors such as blowing grass and birds. Repositioning the radar heads eliminated the gaps in coverage, but the problems with false hits remained.

Because of the problems with the deer detection systems, the warning lights associated with the FLASH system were left flashing continuously and data were collected on motorist reaction to the signs reading "Attention: Migratory Deer Crossing.". Data from the vehicle sensors indicated that 42% of motorists showed a decrease in speed between the outer sensors and the central one. Most of the vehicles that slowed down were passenger cars rather than tractor-trailers.

### **1999-2000 season**

Problems with the FLASH system continued into the 1999-2000 season. The passive infrared sensors did not function properly during the day because the low angle of the sun in winter interfered with their heat-sensing capability. The geophone system coupled with the infrared scopes worked reliably during this season, but the microwave radar system continued to register false hits. Since the FLASH system continued to be unreliable during this season, no data were collected evaluating the effectiveness of the system in slowing down traffic. A trial was conducted during the daylight hours on April 17 and 18 to determine whether vehicles slowed down in response to a stuffed deer placed near the highway. If the deer was within 3 m (10 ft) of the road, both tractor-trailers and passenger vehicles decreased speed. However, motorists did not seem to see the deer when it was placed further than 3 m (10 ft) off the road. Tractor-trailers reduced their speed by 8.2 mph on average, while passenger vehicles reduced their speed by an average of 14.5 mph.

### **2000-2001 Season**

The FLASH system was converted in October and November of 2000 from passive to active infrared sensors in an attempt to remedy the problem of reduced sensitivity due to sun exposure. George Twitchell (MAMTC) carried out these modifications and had the sensors installed in November 2000. The geophone system was working reliably as of October 1, 2000. All systems seemed to be working reliably until January 2001, at which

point researchers noticed that the FLASH system started exhibiting false hits due to frost on the sensors and birds in the crossing eating the carrion. Adjustments to the sensitivity of the system mitigated but did not entirely do away with the problem. The FLASH system experienced additional problems starting in early April, when a faulty transmitter started producing false hits in response to truck traffic on Highway 30. From May 4-May 15, a power failure caused the FLASH system to be shut down. During this time the lights were left operating continuously rather than activated by the FLASH system. The geophone system worked reliably throughout the data collection period.

Appendix A includes a detailed technical discussion of the problems encountered by Wyoming Department of Transportation systems over the course of the study.

## CHAPTER FOUR

### Results of Data Analyses

#### Deer activity and mortality

Deer activity was measured using three different systems, the FLASH system, the geophone system, and the videocamera system. Figure 2 shows the average number of hits per day during each month registered by the FLASH and geophone systems, and the average number of deer crossing per day during each month registered by the videocamera. Because of frequent false hits on the FLASH system after mid-January, the average number of hits per day recorded by the FLASH system is higher than that recorded by the geophone system, showing an inflated number of hits in January, March, and April in particular (Fig. 2). Because of the false hits, the FLASH system is not a good method for assessing seasonal variation in deer activity.

The geophone and the videocamera showed similar trends in deer activity during the time that the videocamera system was operating (Figure 2). This could be due to the fact that the geophone system was used to activate the videocamera system. However, because the geophone system was found to be extremely reliable in detecting deer it is safe to assume that the similarity in trends is reflective of a real relationship between number of hits registered by the geophone and number of deer recorded by the videocamera. Because of the fact that the geophone can register multiple hits for a single deer moving back and forth through the crossing, the average number of hits per day registered by the geophone is higher than the average number of deer per day recorded by the videocamera. However, because of its reliability and the fact that it closely relates to the videocamera data, the geophone is valuable in assessing trends in deer movement.

According to the geophone data, the peak fall migration occurred primarily in November, and the peak spring migration occurred in March and April (Figure 2). The fall migration happened over a much shorter duration, while the return to the summer range in the spring was staggered out over a longer period. During all months of the study period, most deer movement occurred at night, but during the fall migration a higher proportion of movement occurred during the day than during the spring migration (Fig. 3).

Average daily maximum and minimum temperatures and average precipitation are graphed against deer movement as indicated by geophone data in figures 4, 5, and 6 respectively. Peaks in deer movement in the fall and the spring were both preceded by steep changes in average daily minimum temperatures and, to a lesser extent, average daily maximum temperatures. No pattern was evident with average daily precipitation, but it should be noted that precipitation data was missing for many days out of each of the months, and consequently major precipitation events may have been missed. Also, deer movement may be more dependent on short-term, intense episodes of snow or rainfall, rather than the overall precipitation occurring during a particular time of year.

Figure 2: Average daily deer activity by month for three deer detection systems

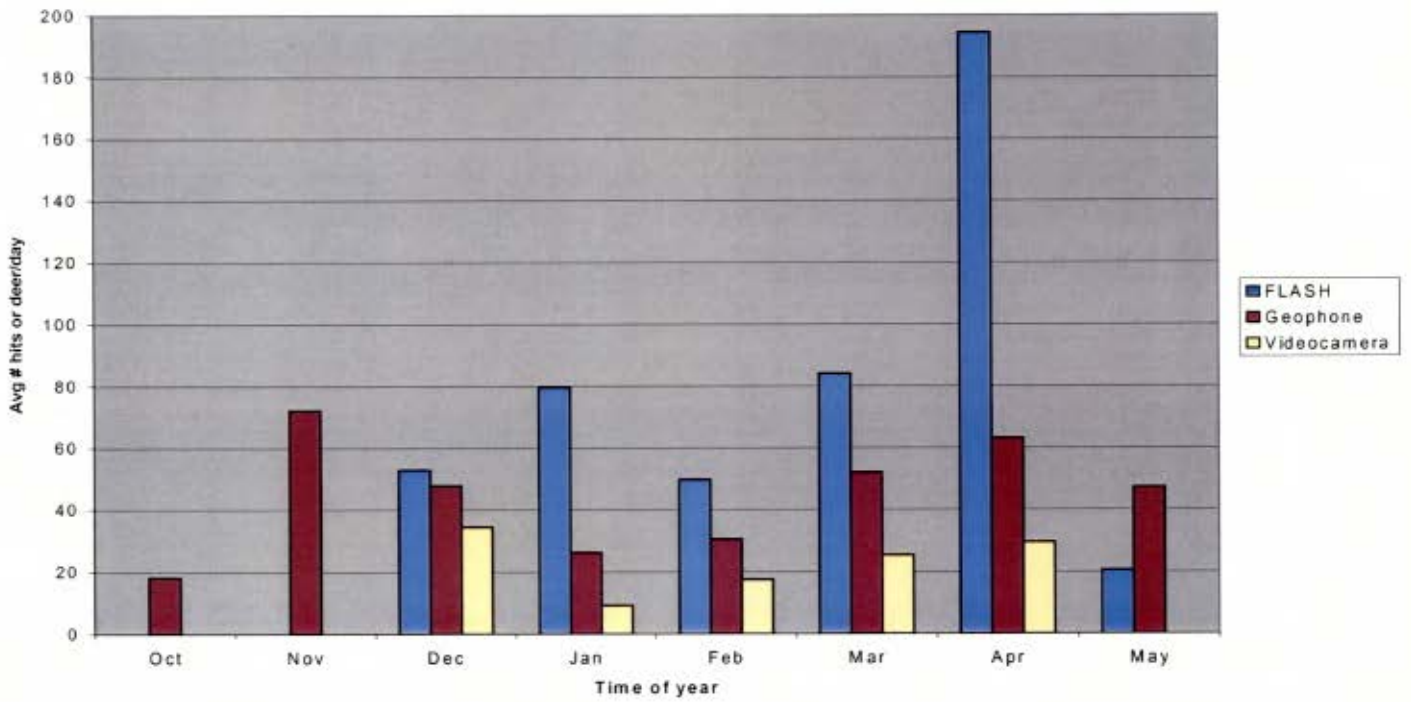
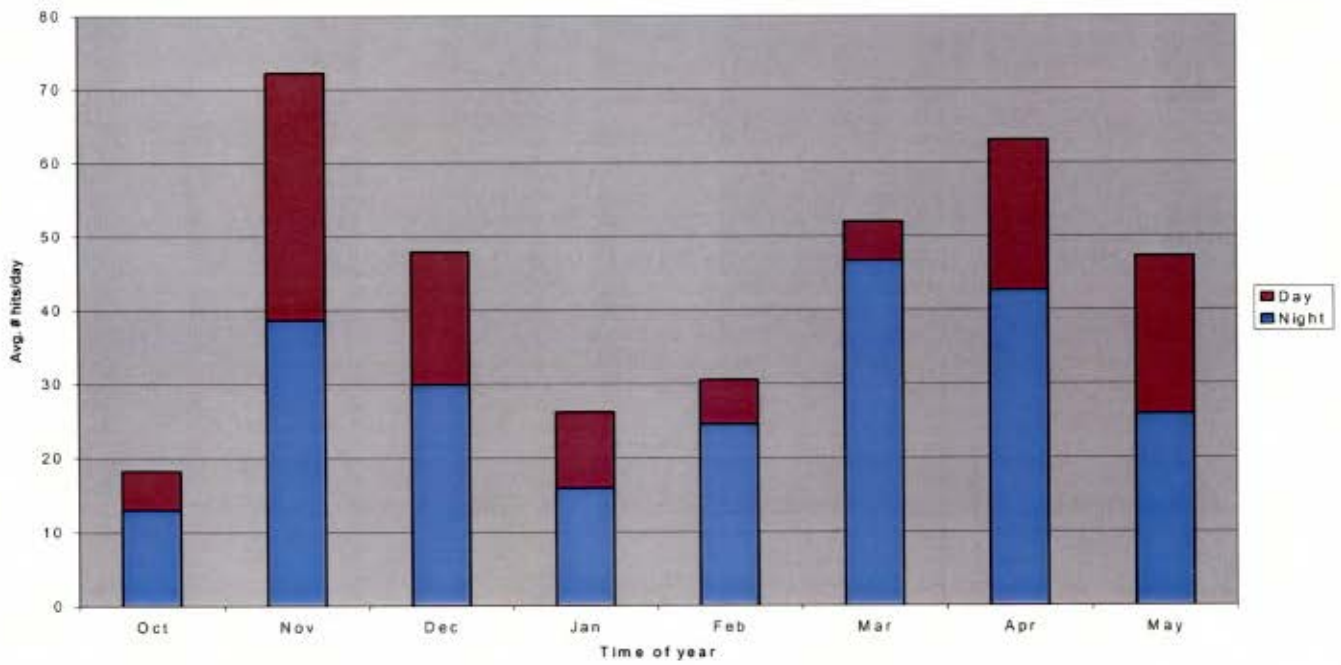
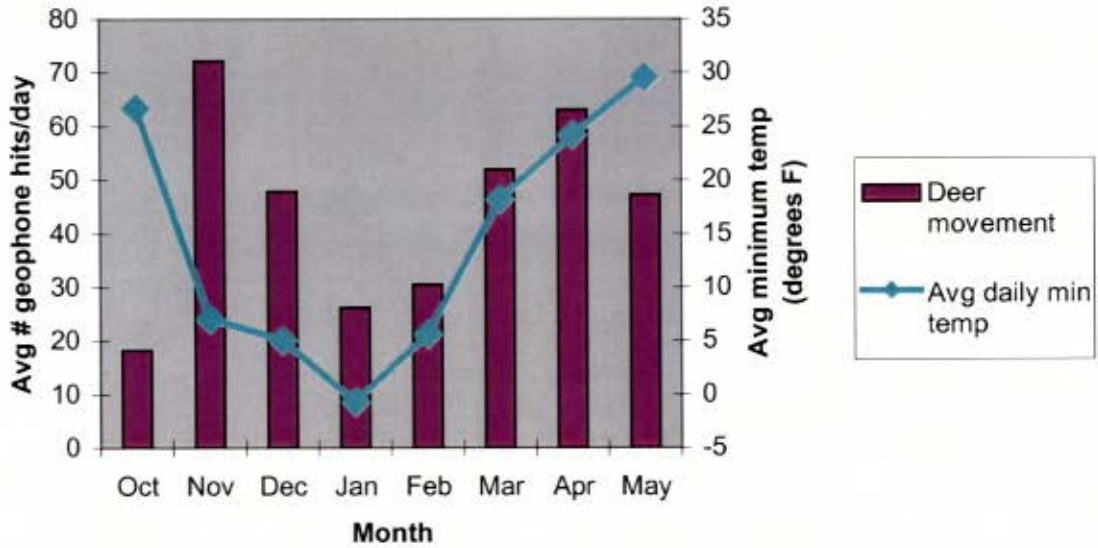


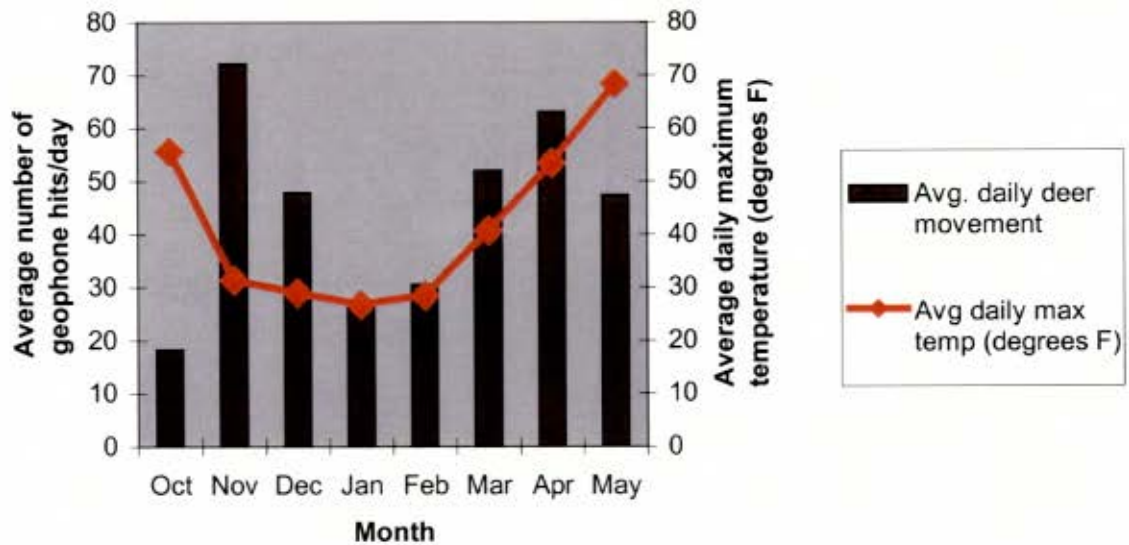
Figure 3: Night/Day Deer Activity Measured by the Geophone



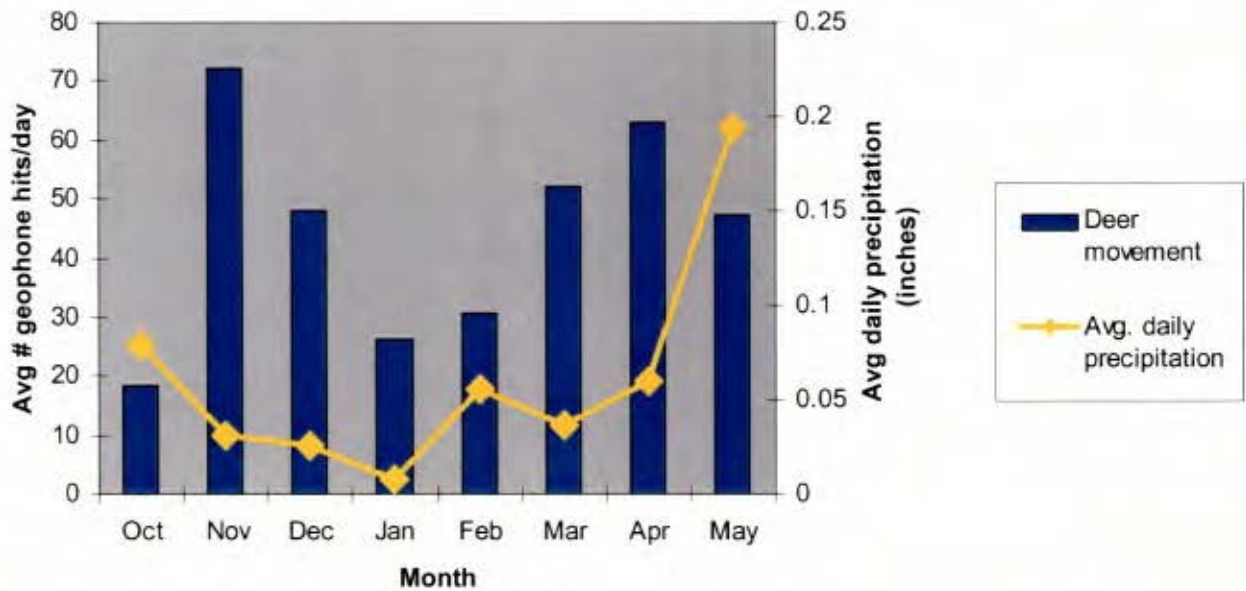
**Fig. 4: Deer movement and average daily minimum temperature by month**



**Fig. 5: Deer movement and average daily maximum temperature by month**



**Fig. 6: Deer movement and average daily precipitation by month**



Seasonal variation in vehicle-caused deer mortality closely tracked deer movement (Fig. 7), with the highest number of deer killed per month occurring in November, March, and April during the peak migration times. Adult females were killed more frequently than any other age/sex class (Fig. 8), with 122 killed over the course of the season. Fifty-eight yearling females were killed, followed by 42 adult males and 8 yearling males. A higher proportion of adult males were killed in December, late in the fall migration period, and in February, early in the spring migration period, tentatively indicating that males of this herd may be spending less time on the winter range than females.

### **Evaluation of FLASH and geophone system reliability**

During 30 hours of observation, neither the FLASH nor the geophone system registered false hits. Additionally, all deer that passed through the crossing during the observation periods were picked up by both systems. Incidental observations of deer crossings outside the observation periods were also confirmed by hits on both systems when these were checked after the fact. No evidence of false hits or failure to detect deer was ever found for the geophone system; it appeared to work perfectly throughout the study period. No evidence was found of the FLASH system failing to detect deer moving through the crossing. However, the FLASH system started registering numerous false hits starting in January due to birds feeding on carrion in the crossing, frost, and snow thrown by passing snowplows. Observations of birds in the crossing in the absence of deer were later confirmed to have registered hits on the FLASH system, but not on the geophone system. In April, a faulty transmitter caused the FLASH system to start registering false hits in response to tractor-trailers. Figure 9 shows percentage of false hits on the FLASH system by month from December until May.

### Evaluation of FLASH system effectiveness in reducing motorist speed.

The effect of the FLASH system on motorist speed is shown in Figure 10. When the FLASH sign was off and no deer were present in the crossing, motorists on average reduced their speed by .7 mph (95%CI +/- .09 n=8153) between the outside sites and the center site. When the FLASH sign was activated due to a false hit and no deer were in the crossing, motorists reduced their speed by an average of 1.4 mph (95%CI +/- .22 n=1965). When the FLASH sign was activated and deer were present in the crossing, motorists reduced their speed by 3.6 mph on average (95%CI +/- .71 n=655). Because of very large sample sizes, confidence intervals around these speed differences indicate a statistically significant difference between the three groups of cars, but it is unlikely that a reduction in speed of 3.6 miles per hour would in reality significantly reduce the likelihood of a deer-vehicle collision.

Analyses of these data by month showed no seasonality effect, so data from December through May were analyzed together. Time of day and vehicle type were also separated out and analyzed but no effect was found; speed differences at night were comparable to day and tractor trailers and cars showed no differences in change in speed.

Figure 7: Comparison of deer mortality and deer activity at Nugget Canyon

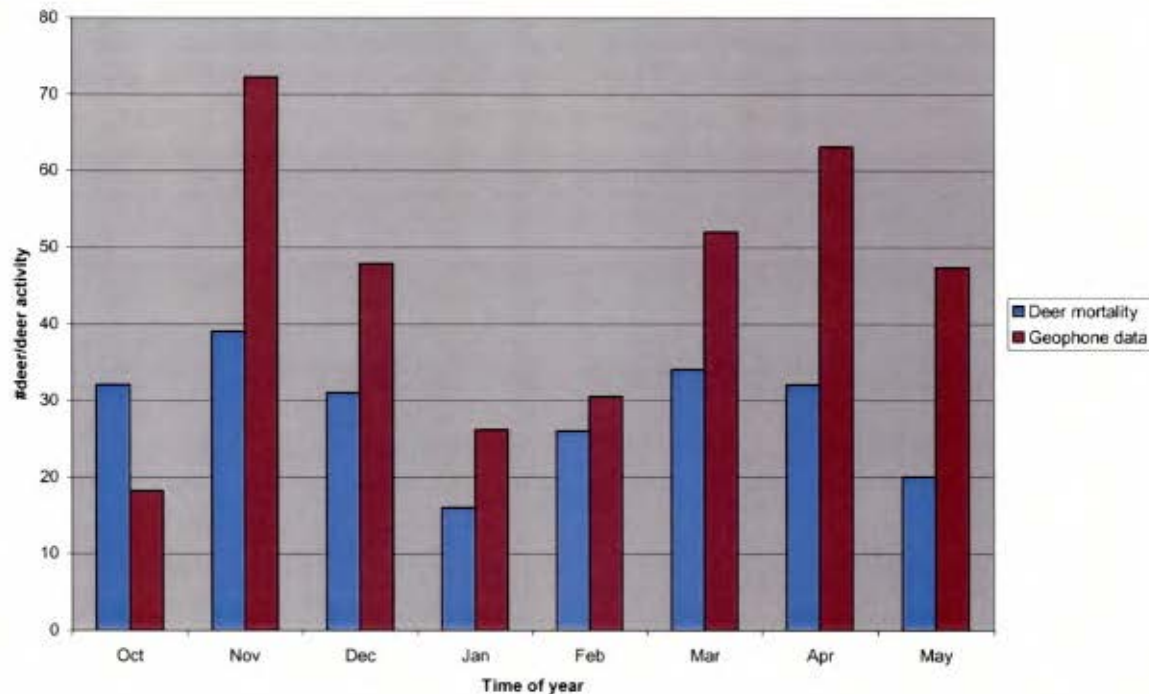


Figure 8: Vehicle-caused deer mortality in Nugget Canyon by sex and age

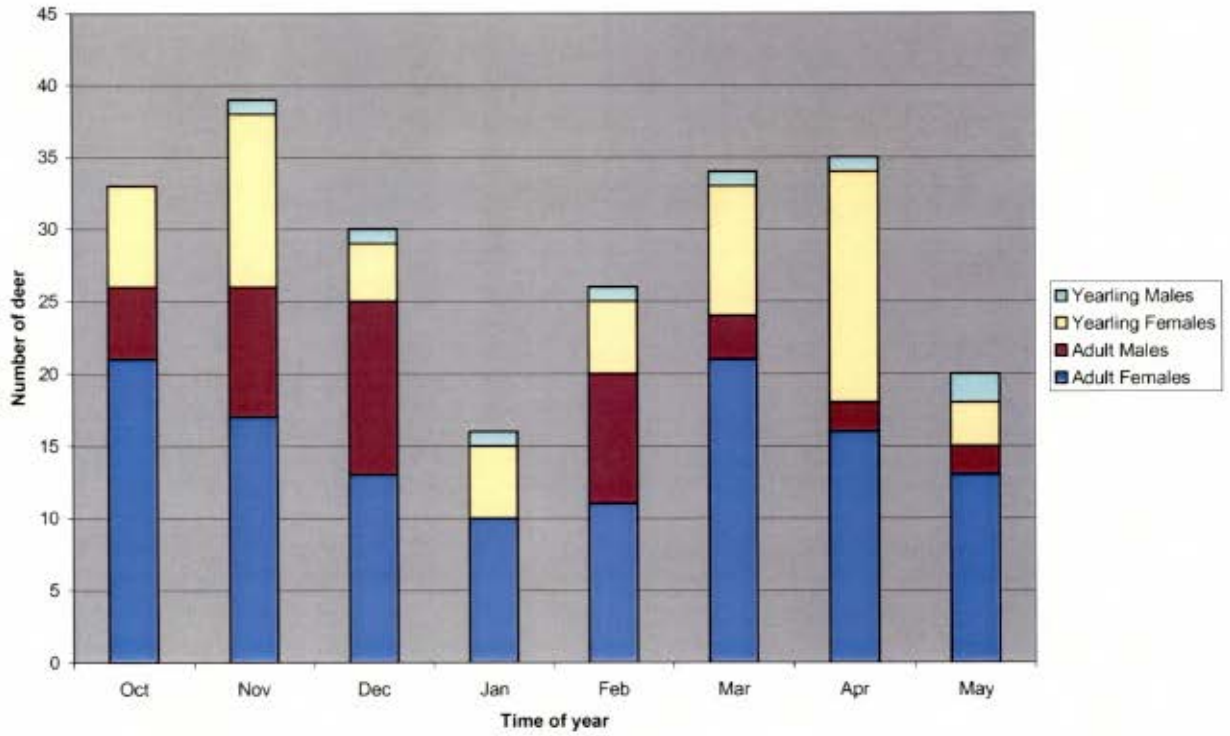
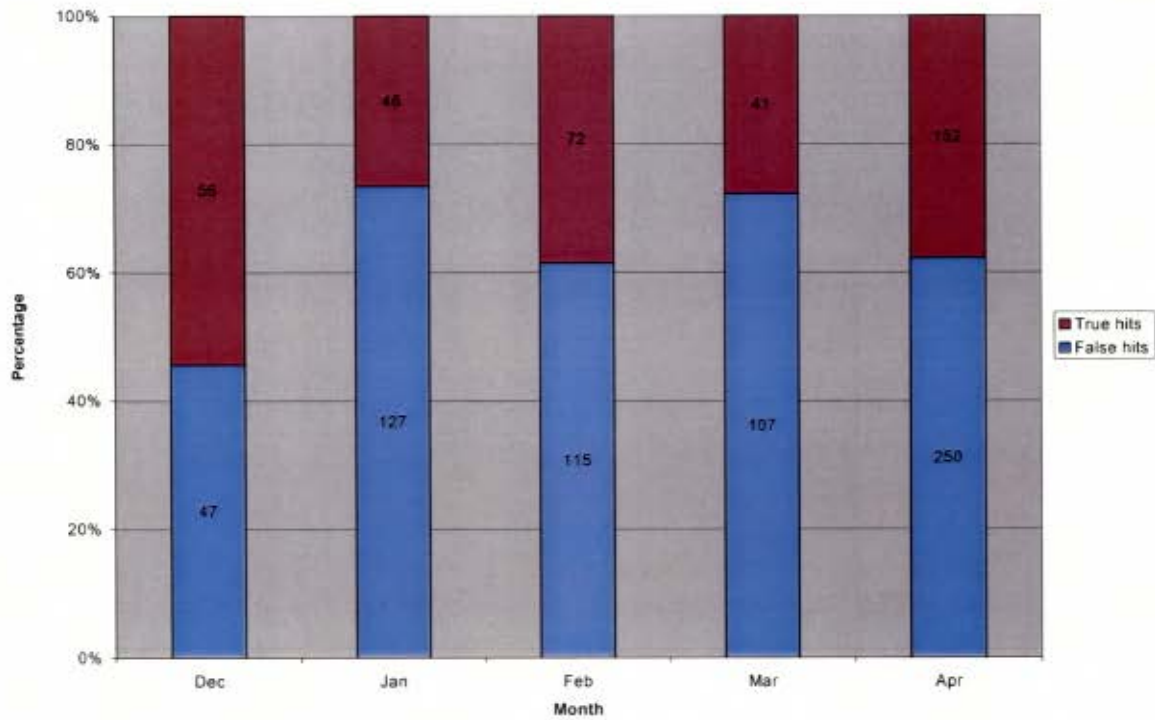
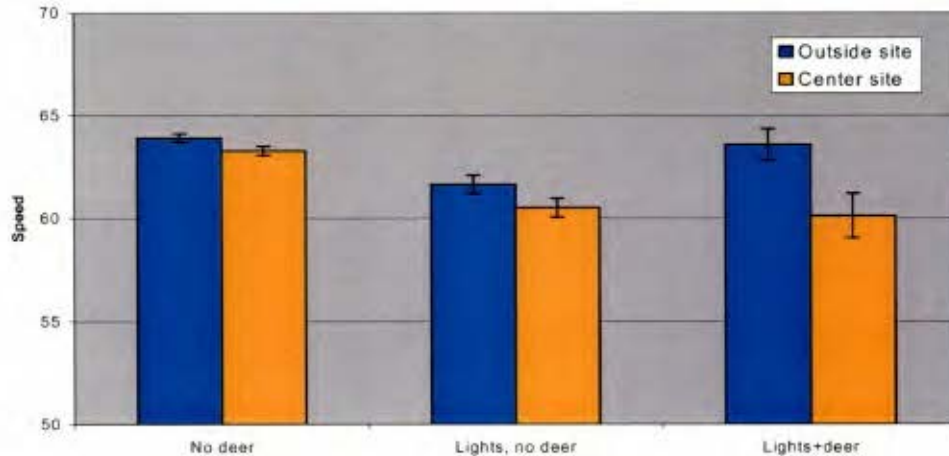


Fig. 9: Percentage of false hits on the FLASH system by month





**Figure 10: Vehicle speed reduction in response to the FLASH warning system**



The warning lights associated with the FLASH system are set to be activated for two minutes after a hit is registered. Consequently, motorists may travel through the crossing while the lights are still on but after the deer have crossed the road. To the motorist, it may appear that the system is not functioning properly even when a deer was actually detected. This may explain why only a minor speed reduction was seen in response to genuine hits on the FLASH system.

### **Results of experimental manipulations**

Data from experimental manipulations were analyzed for seasonal variation and variation for time of day. Neither of these factors affected vehicle speed so data were analyzed from all months and times of day together for effect of treatment and vehicle type. Additionally, data were analyzed to determine what proportion of vehicles subjected to each treatment reduced their speed by categorical five mile per hour increments. Results are summarized in Figures 11, 12, and 13. Because samples sizes were large for all treatments, all of the differences in speed were significantly different from zero. However, slight reductions in speed will probably not reduce the chance of a deer vehicle collision. Of the five treatments, only the two that involved the deer decoy resulted in reductions of speed of greater than 5 miles per hour. Treatment 3, in which the motorist was exposed to the deer decoy and flashing lights, resulted in an average speed decrease of 12.32 mph for passenger vehicles and 6.63 mph for tractor-trailers. Treatment 4, in which the motorist was exposed to the deer decoy without the flashing lights, resulted in an average speed decrease of 7.97 mph for passenger vehicles and 4.66 mph for tractor trailers. These results indicate that the flashing lights may have the effect of alerting some motorists to the possibility that there is a deer in the crossing and preparing them to slow down. However, the difference between treatment 3 and treatment 4 was only 4.35 mph and 1.97 mph respectively for passenger vehicles and tractor trailers. This seems to

indicate that the lights play a trivial role in causing motorists to slow in comparison with the presence of deer in the crossing. When data are broken down into speed reduction categories, treatments 3 and 4, with deer present, had the highest proportion of vehicles slowing down by 10 mph or more for both automobiles (Fig. 12) and tractor trailers (Fig. 13). Only a small percentage (9.6% for passenger vehicles and 6.8% for tractor-trailers) of the vehicles slowed down by more than ten mph in response to the warning lights without the deer. These data, combined with the data gathered when the FLASH system was running continuously during non-treatment periods, demonstrate that the FLASH warning system by itself does not cause motorists to reduce their speed enough to prevent deer-vehicle collisions along U.S. Highway 30 in Nugget Canyon.

**Figure 11: Change in speed of automobiles and tractor trailers in response to five different experimental treatments.**

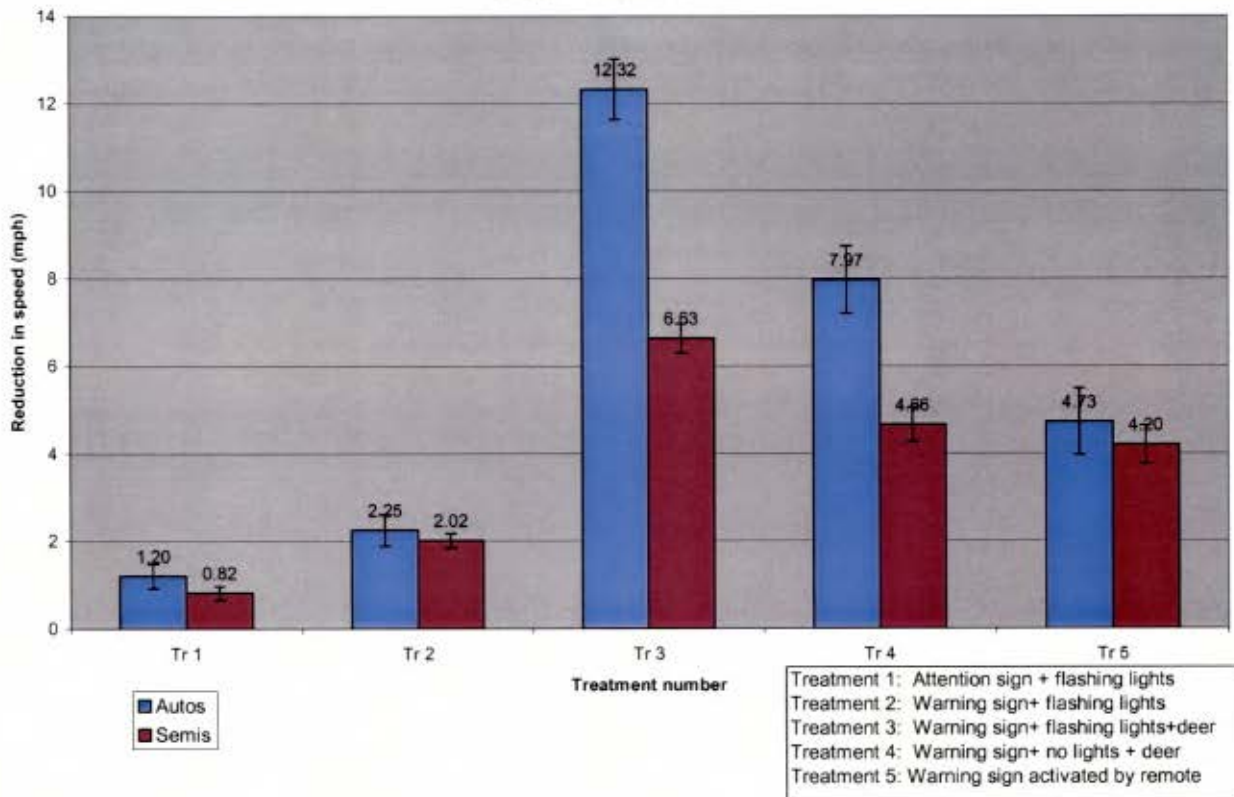


Figure 12: Passenger vehicle categorical speed reductions in response to five experimental treatments

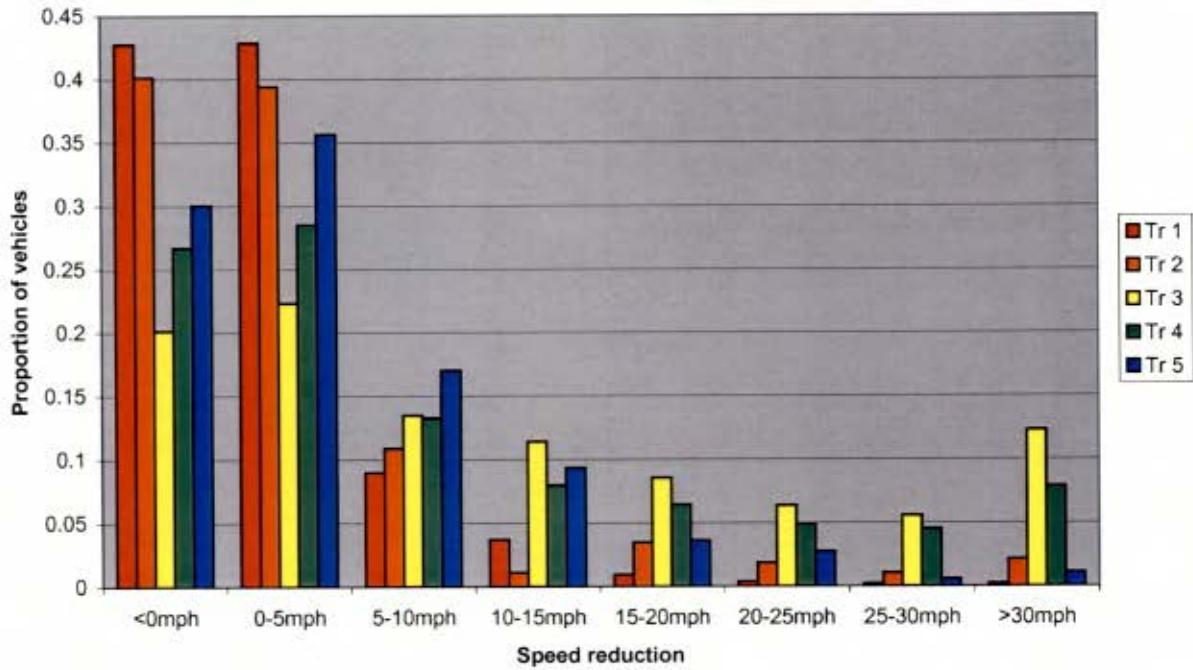
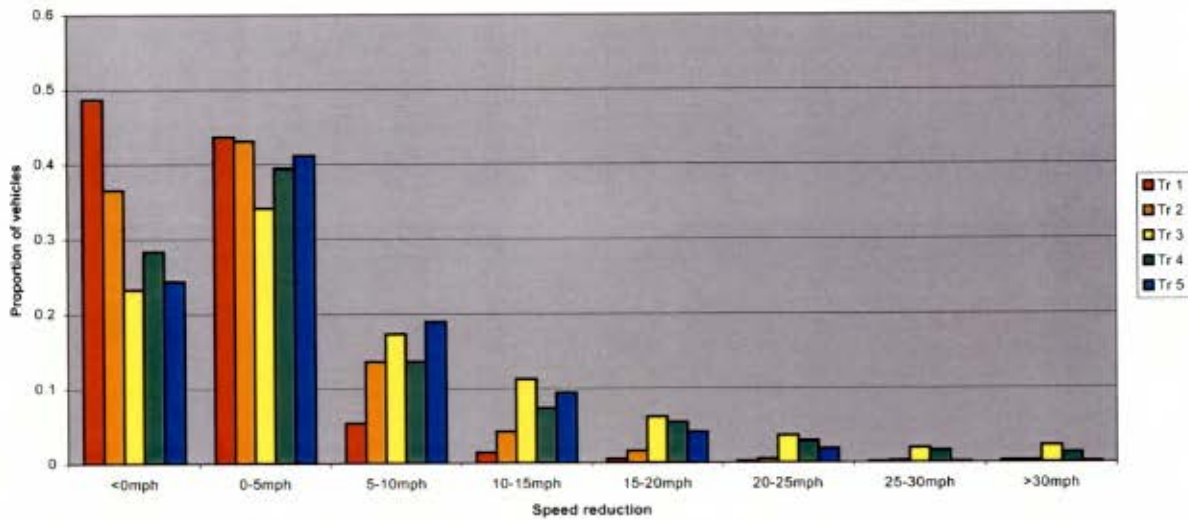


Figure 13: Tractor trailer categorical speed reductions in response to five experimental treatments



## **CHAPTER FIVE**

### **Implementation Recommendations**

#### **Primary recommendations**

- 1.) The geophone system is more reliable than the FLASH system and should be used as a model for development of similar systems in the future.

The active infrared sensors used by the FLASH system to detect deer were too prone to false hits and malfunctions to reliably operate a warning system. Over 50% of the hits registered by the FLASH system were not caused by deer. If motorists perceive the system to be unreliable, they will be less likely to respond to the warning that deer are in the road. The geophone system proved to be more reliable and is more appropriate as a trigger for the flashing lights than the FLASH system. One of the advantages of the FLASH system is the ability to move the system fairly easily to different sites as needed. Perhaps the issue of portability could be addressed by modifying the geophone to incorporate only the infrared scopes without the buried sensors that detect vibrations. Once it was properly aimed, the infrared scope on the north side of the crossing appeared to operate quite reliably independently of the buried sensors on the south side.

- 2.) An at-grade deer crossing is not appropriate for the Nugget Canyon site: solutions that involve a separated crossing should be investigated.

Unless a deer or deer decoy was physically in the crossing, motorists did not slow down in response to the warning signs sufficiently to prevent a deer-vehicle collision. The warning lights appeared to have little effect even in terms of alerting motorists to be prepared to slow down: when the lights were turned off and a deer decoy was placed in the crossing motorists slowed down by about the same amount that they did when the lights were operational and the deer was in the crossing. Traffic on U.S. 30 is comprised primarily of people from outside the area who may be ignorant of the risk of a deer-vehicle collision during migratory periods. Additionally, the road is heavily used by tractor-trailers that are far less likely to receive damage from a deer vehicle collision and thus are less motivated to slow down. The non-local people who pass through the crossing will encounter the sign only one time and during their brief encounter probably will not fully understand how it functions. Unless the system becomes widespread enough that a large number of people are familiar with it, it will probably not be suitable for an area such as Nugget Canyon. Consequently, we recommend that options involving underpasses or overpasses for movement of deer across the road be explored for this particular site. Research that will commence in September of 2001 on an underpass at the present deer crossing will hopefully prove useful in determining if underpasses are a viable alternative for deer crossings.

- 3.) Investigation into the application of the warning light system to other areas is warranted.

Although the FLASH system is not suitable for use on U.S. 30, it may be adaptable for use in other areas. Places that have a great deal of local traffic, where the citizens are concerned about the danger of deer-vehicle collisions, may be ideal for the application of this system. It would be necessary to perfect the system such that deer were reliably detected. A deer-proof fence that funnels the animals into a discrete crossing would be necessary in order for the system to be effective. Additionally, a program educating the local citizens about how the system works would be appropriate in conjunction with the system's installation.

- 4.) More research into the impacts of U.S. 30 on the Wyoming Range mule deer herd is warranted.

Data are needed regarding the current movements of the Wyoming Range mule deer herd to determine how measures taken to mitigate the problem of deer-vehicle collisions along U.S.30 will affect migration patterns of the herd in the future. To the extent that it is possible, an analysis of past migration patterns of the herd would be useful as well. Additionally, it would be worthwhile to determine to what extent the loss of hundreds of deer, largely adult females, impacts the Wyoming Range herd. Is vehicle-caused deer mortality significantly contributing to the decline of the herd? The Wyoming Game and Fish Department may want to investigate the possibility of coordinating a research program that would include questions such as these.

### **Secondary recommendations**

- 5.) Determine at what speed a vehicle needs to be travelling in order to reduce the risk of a deer/vehicle collision.

In order to properly implement a system such as the one tested in the current study, it would be beneficial to know at what speed a motorist would need to be travelling in order to significantly reduce the risk of a deer-vehicle collision. The system could then be modified to include this information: for instance, a sign could advise slowing to 30 mph when deer have been detected by the sensors.

- 6.) The use of deer decoys as deterrents to speeding may be worth investigating.

Passenger vehicles slowed down by 12.32 mph on average in response to the presence of the deer decoy. In areas where there is a large amount of non-repeating, non-local traffic, where underpasses are not feasible, the use of deer decoys placed along the side of the road as a deterrent to speeders may be an option worth investigating. Animated deer decoys that raise their heads and flick their ears and tails are currently being used to catch poachers and may increase realism.

# **NUGGET CANYON DEER DETECTION STUDY**

**Technical Report**  
by **BILL GRIBBLE**

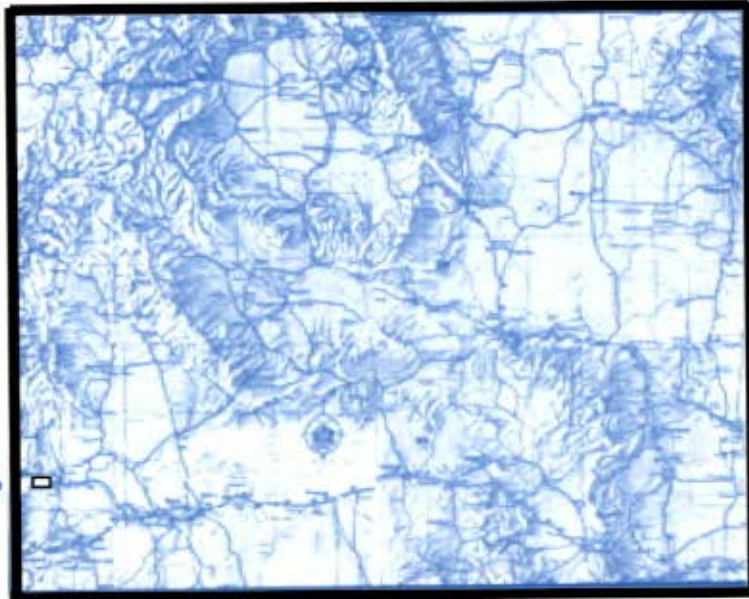
**The Wyoming Department of Transportation**



# TABLE OF CONTENTS

<b>COUNTER SHOP NUGGET CANYON FINAL REPORT .....</b>	<b>23</b>
<b>Summary .....</b>	<b>32</b>
<b>Study Contacts .....</b>	<b>38</b>
<b>Technical Information .....</b>	<b>39</b>
<b>SET-UP SCHEMATICS</b>	
<b>Site Monitoring Set-Up .....</b>	<b>33</b>
<b>F.L.A.S.H. System Detection Zones .....</b>	<b>34</b>
<b>Microwave Detection Areas .....</b>	<b>35</b>
<b>Geophone &amp; Infrared Scope Detection Zones.....</b>	<b>36</b>
<b>Video Camera View .....</b>	<b>37</b>

NUGGET  
CANYON  
LOCATION >



# WYDOT Counter Shop Deer Detection Study: Final Report

This narrative covers the second half of the FLASH study and begins in the winter of 1999-2000. At that time the Geophone system with accompanying infrared scopes as well as the microwave radar were installed on the south side of the animal crossing area. The contractor supplied FLASH system was installed on both sides of the crossing. The in-road vehicle monitoring equipment and communications gear was in place. All systems were operational.

Monitoring of deer activity and sensor operation continued through the Winter and into the Spring of 2000 by Matt Buhler of the U.W. co-op unit and technicians from the counter shop. During this time, counter shop technicians developed and then improved a low power radio link to monitor site operation from a location 1/4 mile away. The link was connected to the second traffic counter at the center site, which in this application was recording the "hits" produced by the three deer detection systems. Real time activity was then displayed on a laptop computer in a vehicle parked inconspicuously in the tall sage brush. Deer migration and movement was not disturbed by these activities. This monitoring proved that the microwave radar was unsuited for the role of deer detection, and that the FLASH system had problems with both over and under detection.



*Real time remote monitoring of site operation was done from the trailer parked approximately one-fourth mile south of the crossing zone. Visual observation of deer in the crossing zone was compared to the recording of sensor hits on a second traffic counter at the center site. A low power radio linked the computer at the site to a laptop computer in the University of Wyoming's trailer.*





*A deer just outside the boundary fence of the crossing zone in an area leading to the one-way jump over point. Deer continue to be hit at the crossing and their carcasses attract a large number of scavenger birds who often set off the deer detectors. Maintenance crews regularly patrol and haul away the carcasses.*

*One of two microwave radar transmitters on the south side of the crossing zone. A number of locations and modes of operation were tried, but the result was always intermittent, wild counts. The units were designed to count motor vehicles and became unstable when sensitivity was increased to levels necessary to consistently detect deer.*



*Microwave radar mounted just outside the boundary fence pointed into the crossing zone. Visible in the background is the one-way jump over. One is located on each side of the crossing zone and on both sides of the highway. Most deer walked or trotted straight through the crossing, but occasionally they would drift or be driven by traffic to one side or another on the highway. These sites channeled the deer off the highway where they would use the jump area where the dirt was sloped toward the fence in the corner.*

*A steep vertical wall in line with the fence prevented their return. Tracks in the mud and snow indicated regular use.*



The radar had to be set to high sensitivity levels in order to consistently detect deer, which then made it susceptible to false hits caused by blowing grasses, fences flexing back and forth in the wind, snowfall, birds flying through the zone and possibly other sources. The contractor supplied FLASH system seemed to be suffering from the effects of bright sunlight at different times of the day. This seemed to cause false hits when the sun would first rise or when the sun would emerge from behind clouds, particularly in the afternoon. Eventually, it seemed, the sensors would become saturated in continuous bright sunshine and then not detect deer even when they walked very close to the sensors. (See the F.L.A.S.H. schematic on page 34 and the Microwave schematic on page 35.)

Throughout this period, the Geophone system continued to perform extremely well. This system had started with string of 10 sensors buried in a line across the south side of the crossing. When the system picked up occasional false hits caused by passing trains and truck traffic, it was modified with the addition of two infrared scopes which were set on each end of the opening, pointed toward the center. The system required a "hit" to be detected by both the ground sensor and a scope to be considered valid. It was this system that worked so well throughout the Winter and Spring. In March of 2000, in order to assess the feasibility of expanding the Geophone system at minimal cost to both sides of US 30 at the deer crossing, the Geophone system was re-programmed to only require a hit on the infrared scopes for a valid detection. This test proved successful. Several trips were made to the site following the change, and monitoring of site activity showed that the scopes alone detected deer extremely well and did not produce false hits. (See the Geophone schematic on page 36.)

*The ground sensors for the Geophone System were installed in a shallow trench in a string just over 300 feet long. Sensor spacing was approximately 32 feet. While the initial installation detected deer well, it also detected trains and the occasional passing truck. The addition of infrared scopes cured the problem. Scopes alone were used on the north side of the road.*





*Matt Johnson installs the controller and transmitter for the Geophone scopes on the north side of the crossing zone.*

*East boundary fence on north side of crossing zone. A F.L.A.S.H. sensor and a Geophone scope are shone mounted on the boundary fence. The cabinet housing for the Geophone transmitter is located further up the slope to allow un-broken transmission over the truck traffic.*



*South side of crossing zone looking west. Some of the revised F.L.A.S.H. System sensors are shown in center, while some of the overhead lighting is visible on the right. A train and a truck approach from the west. Trains, heavy truck traffic and the curved road created problems in setting and tuning the Deer Detectors. None of the conditions were present at the initial testing done at the Sybille Canyon Research Center.*



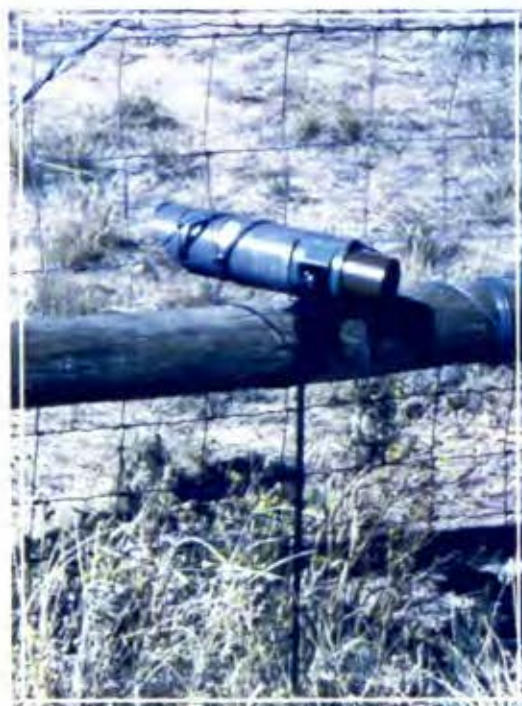
*Close up of active infrared sensor for the revised F.L.A.S.H System. The modification changed their system into a "break the beam" technology.*

Several changes occurred during the summer of 2000. Matt Buhler left U.W. and was replaced on this project by Kelly Gordon. Vickie Gooch brought George Twitchell of MAMTC into the FLASH project to address the problems in her system. The expansion of the Geophone system to the north side of the crossing zone was approved and funded.

The infrared scopes were installed on the north side of U.S. 30 in September of 2000. The output from these scopes was designed to be transmitted to the base Geophone system across the U.S. 30 traffic stream with a low powered radio link. This was done for two reasons; 1) there was little room in the conduit under U.S. 30 for additional wiring, and 2) if this system was to be installed at another location at some point in the future, the ability to do so without first making a bore under the road is highly desirable.

The installation of the scopes on the north side of the road proved more difficult than the south had. Tuning and aiming of the scopes was more difficult because the north location is on the inside of a curve, and the heat signatures from passing trucks was causing occasional false hits, even when they were quite some distance away from the crossing zone. We began detecting deer behind the right-of-way fence when the scopes were aimed at too great an angle from the highway, and the goal, of course, was to only detect them in the right-of-way when they were a hazard to traffic. The deer often did mill around for quite awhile behind the fence before entering the crossing zone, and many times would not enter the crossing point for hours, alternately approaching and then fleeing the opening. During the time the effort to place and tune the scopes was going on, a problem surfaced with the low power transmitter.

In an effort to increase battery life, the transmitter was designed with a power save feature that would put the unit in a "sleep mode" after a period of time with no hits. Our unit would not "wake up" and transmit valid hits after several hours of no activity. A similar problem had developed during the previous year when the scopes were added to the Geophone system on the south side of the road. In that case the new controller had been at fault. Working with the manufacturer, Eagle Telonics, several remedies were tested, but the problem persisted. In late September they sent a replacement transmitter. By October 12, 2000 the Geophone installation was fully proofed and functional on both sides of U.S. 30. The



*Geophone scope installed on the north side of the Highway. Shrouds of plastic PVC pipe were made and installed by Counter Shop Personnel early in the testing of the original scopes. Factory sun shades proved inadequate, leading to an eventual saturation condition which resulted in "under-detection". The pvc shrouds cured the problem and did not reduce coverage area.*

*Main Control Cabinet. On the top shelf are the A-B switch, Cell Phone brick and Modem. The middle shelf contains the Geophone Controller and the Phoenix Traffic Counter/Classifier. The bottom shelf holds the second Phoenix Counter/Classifier used to record the time of each Deer Detector activation. The power supply for the radar is under the bottom shelf. A remote data link was added later.*



*Personnel from the Counter Shop and District 3 Traffic work with a District 3 bucket truck to mount the low-light cameras on the power pole. The cooperation of District 3 Traffic personnel was essential to the project. In addition to providing the auger and bucket trucks, they upgraded the power service at the center site, changed motorist warning signs and modified controller to allow the F.L.A.S.H. System to turn on warning lights.*



*Video Controller and special VCR for the ATD Video System. Recordings can be made from one, two or all 4 cameras in a split screen format. John Reed, the Cokeville maintenance crew foreman often chnged the 8-hour tapes. John provided a tally of the number of deer killed in the crossing zone, kept the zone mowed, and raised and lowered the right-of-way fence in response to deer migration and livestock grazing patterns.*

new transmitter was in place, the location, sensitivity settings and aiming point for each scope were finalized and providing excellent deer detection only in the right-of-ways and exhibiting no false hits. The original Geophone system on the south side of the road was returned to the mode that required hits on both the ground sensors and infrared scopes to be considered valid. The final change in the system was a modification of the transmitter installation to allow solar charging of a larger external battery. The unit installed in October only had provision for internal alkaline batteries. This mod was done in December of 2000. (See the Schematic on page 36.)

In October, Kelly Gordon of U.W. approached Matt Johnson of the Counter Shop about the purchase of video equipment. The RAC committee had approved a video system for installation at the animal underpass to be constructed in the summer of 2001. The university was contracted to study several facets of use of the underpass by wildlife, and the thought was that by purchasing the video system early and installing it at the current Nugget Canyon site, a baseline study of numbers and herd make-up could be documented. The video equipment would also aid in documenting the performance of the systems installed as part of the ongoing FLASH study.

Installation of a video system that would function at both the current crossing and at the proposed underpass posed problems. The current crossing zone is lighted, while the proposed underpass will not be, and the coverage area to be filmed was both longer and wider at the current site than at the proposed underpass. Several contacts were made with vendors of video systems and we settled on a system



*The grey cabinet houses the Controller and VCR for the Video System. The two infrared cameras are seen mounted to the pole above the cabinet. These small cameras feature wide-angle lenses which allow coverage from the highway to the right-of-way fence. They were*



*aimed to avoid wash-out from the overhead lighting on the north side of the highway and the headlights of passing traffic. The cameras are mounted 10 feet above ground level. The Directional antenna used for remote monitoring of site operation is mounted on a pole to the left.*

*Conditions at Nugget Canyon can be harsh, and this was a new application for most of the equipment. As shown in a picture to the right, a thick coat of frost covers the low-light camera housings and Geophone receiver on a bitter December morning. Despite the cold temperatures and heavy frost on the antennas, all systems continued to operate normally.*



*Looking south from the highway toward the control cabinet area. The low-light cameras are mounted in housings near the top of the power pole at approximately 26 feet above ground level; the Geophone receiver is just below these at approximately 22 feet. The video system had to be able to see over passing trucks into the north side of the crossing zone. The Geophone system utilized a low powered line-of-sight transmitter which required the high mounting to avoid broken transmissions from the north side zone to the controller in the south zone.*

proposed by ATD Northwest. This company had an excellent reputation among states we contacted who were already using their system in other tasks, was compact in size, and the company was willing to change their set-up to meet our needs. A four camera system was selected which utilized 2 infrared and 2 low light cameras. The system was ultimately installed in early December of 2000. The cabinet and cameras were installed on the power pole on the south side of the crossing zone. AC power was used to operate the system. The 2 low light cameras were mounted high on the pole and were aimed across the highway at the north side of the crossing zone. They were selected because the overhead lighting is located on the north side of the highway and the cameras had to be aimed toward that light in order to see the area on the north side of U.S. 30. These cameras were equipped with long range lenses with auto-focus, and were aimed so that each covered approximately half of the width of the shoulder area on the north side of the highway. The infrared cameras were mounted much lower on the pole and were aimed sharply left and right of the pole to avoid wash-out by the lighting. These were equipped with wide angle lenses and were aimed so each provided a view of approximately half of the shoulder on the south side of the highway. (See the Schematic on page 37.)

The System included a VCR machine that can be set to tape the image from one, two or all four cameras simultaneously in a split screen format. The VCR records in a time lapse mode on an 8 hour tape, can be triggered remotely, and the interval for each taping session is fully adjustable. For this application, the VCR was triggered by the Geophone system and was set to tape for 5 minutes with each actuation. Taping began immediately. There was some minor shifting of camera angles to better display the boundary fences, and the taping interval was reduced to 3 minutes per actuation a few weeks after installation, but the system has worked well throughout the study. With the exception of a narrow north/south strip in the center of the crossing zone, video coverage extends from the right-of-way fence on the south side of U.S.30 to just beyond the fence on the north side and the entire width between boundary fences, including the highway surface.

George Twitchell changed the FLASH system from a passive to an active infrared operation in the Fall of 2000. This change meant a reduced area of coverage, as the original sensors had a fan shaped detection zone and the new sensors can be thought of as "breaking the beam" technology. George completed the installation in mid November. As before, the FLASH system was the only deer detector wired to the light controller for the warning signs. The timing remained at 2 minutes per detection, and coverage continued on both sides of U.S. 30. Initial testing showed favorable results as the system suffered far fewer instances of both false hits and failure to detect. (See the Schematic on page 34.)

As the systems installed by the Counter Shop were tested and made operational, our role became that of limited maintenance and support for Kelly Gordon as she performed her study treatments. The Geophone system was operational throughout the entire migration period, while the FLASH and video systems appear to have been installed in time to catch the majority of the south bound migration and all of the north bound. The traffic information including vehicle classification by type, speed monitoring and count were available throughout this study period, as was the communications set-up used to download the information remotely. The traffic counter used to document the time of animal detection by each of the 3 systems was also available throughout the study period. (See Schematic on facing page 33.)



## SUMMARY

At the time of this writing, Kelly Gordon has completed her study treatments in the field and is compiling the data and writing the final report for the RAC committee. Her report will encompass all aspects of the study from equipment operation to animal and motorist behavior. This report centers on the efforts by the Counter Shop.

When this study was started, there was no system on the market designed specifically to detect deer on a highway right-of-way and then warn motorists. The emphasis from the beginning was to provide the means for U.W. to thoroughly test the product that Vicky Gooch proposed. This led to our assisting in the installation of her system, and installing the three classifier/speed monitoring sites and associated communications system. In addition, from the beginning we were tasked with developing two additional methods of deer detection to expand the scope of study. The microwave radar was a product that was already in our inventory of traffic counting equipment, while the Geophone system was purchased just for this study.

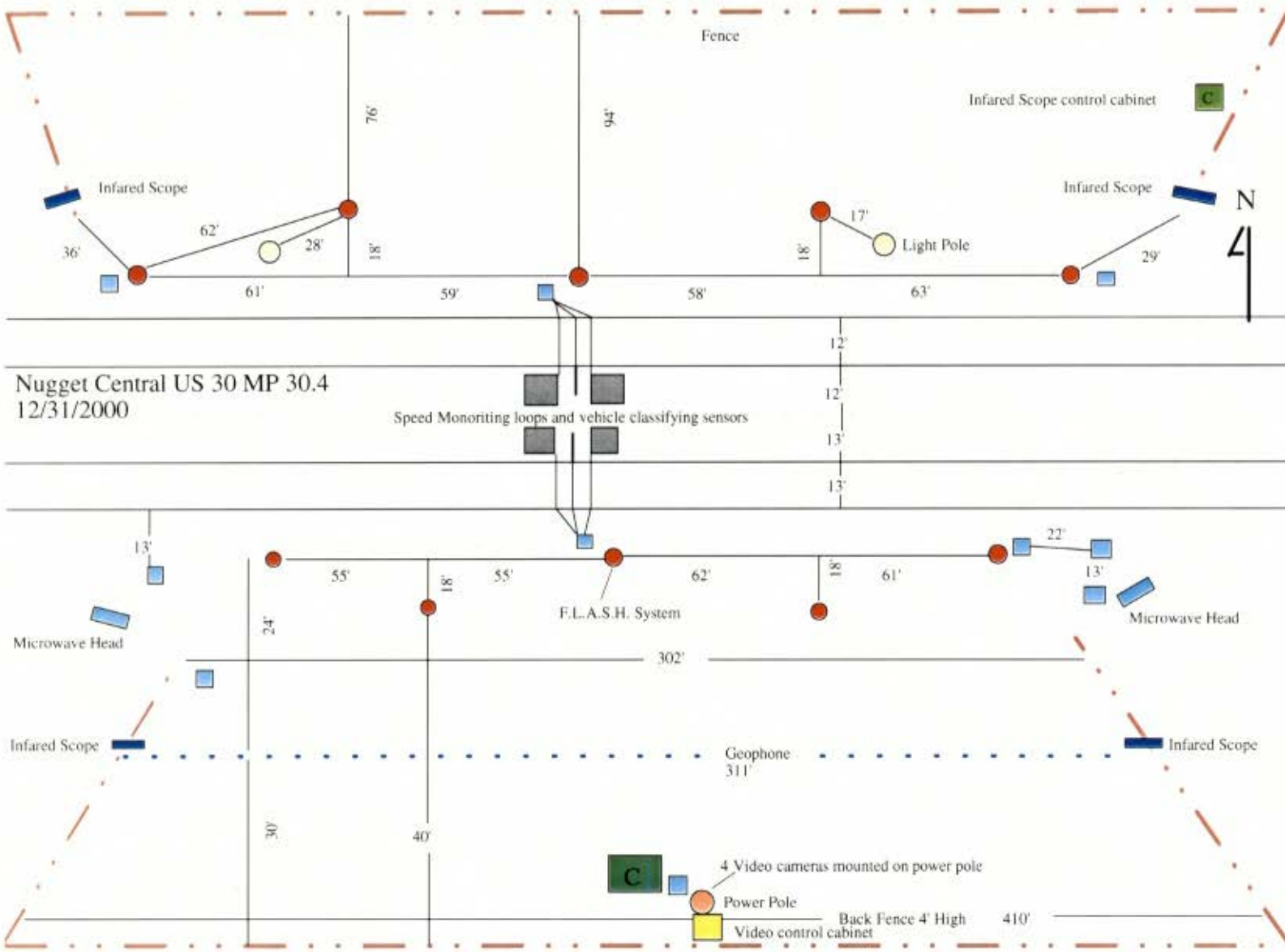
While a great deal of time was spent in trying to get the microwave radar to function in this role, in the end it proved totally unsuited. The effort was not wasted, however, as we learned far more than we would have otherwise about the operation of the system and truly exhausted all possible remedies.

The Geophone system was eventually developed into the most accurate and reliable of the animal detection systems tested. Even the revised FLASH system was not able to match the abilities of the Geophone.

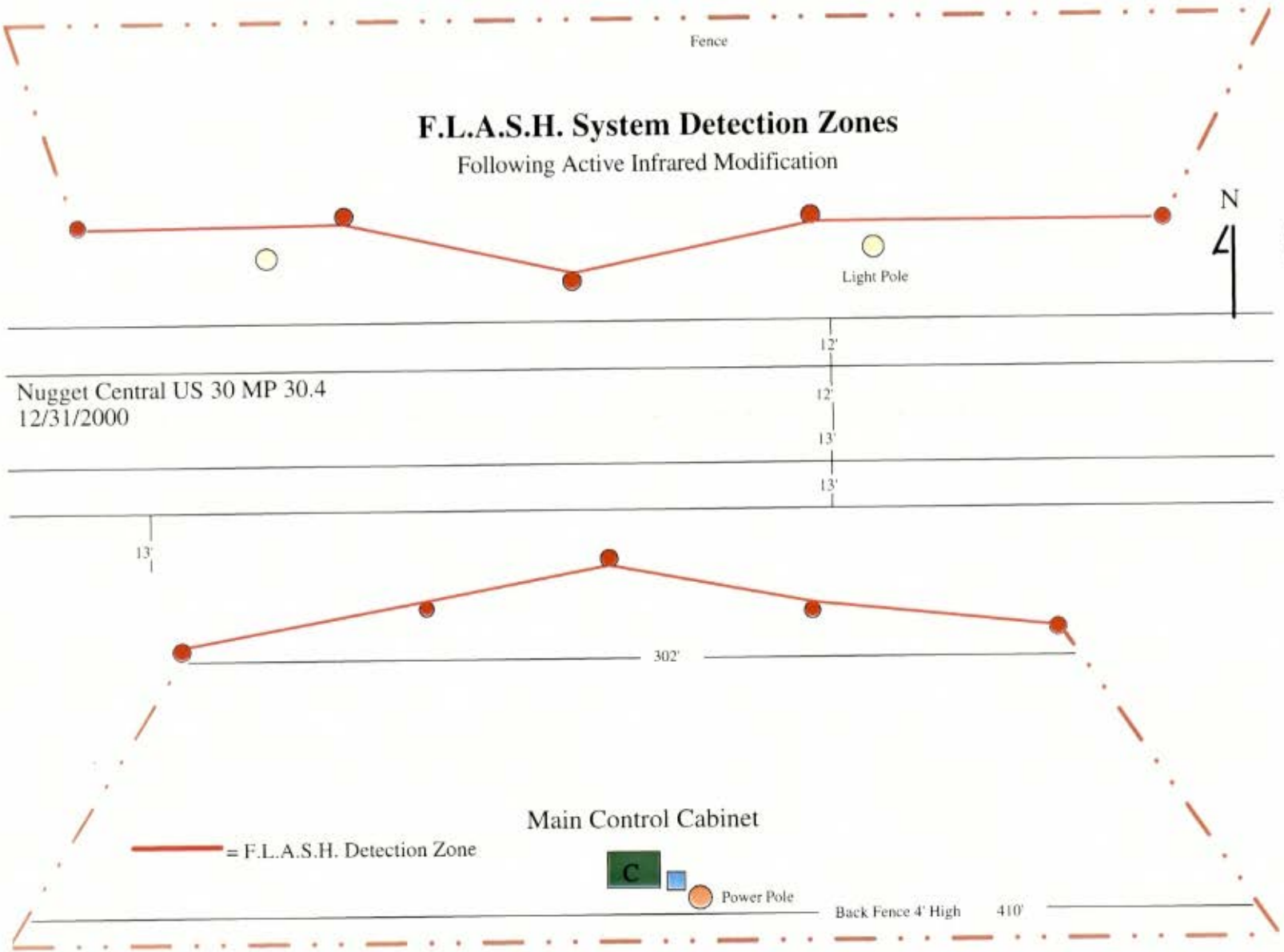
This project has been challenging, sometimes frustrating, but always interesting. The knowledge acquired by the members of the counter shop team in developing the cell phone communications package, A-B switch operation, and radio data links has proven useful in the day to day operation of this shop. The process of fighting through the inevitable problems that develop when new systems are installed and operated in tough environments, particularly in roles not planned for when the products were developed has been rewarding, as has working with contractors, vendors, other WYDOT departments and the University to make this study possible.

# SCHEMATICS for DEER STUDY

## MONITORING SET-UP on SITE Nugget Central US 30, MP 30.4 - 12/31/2000

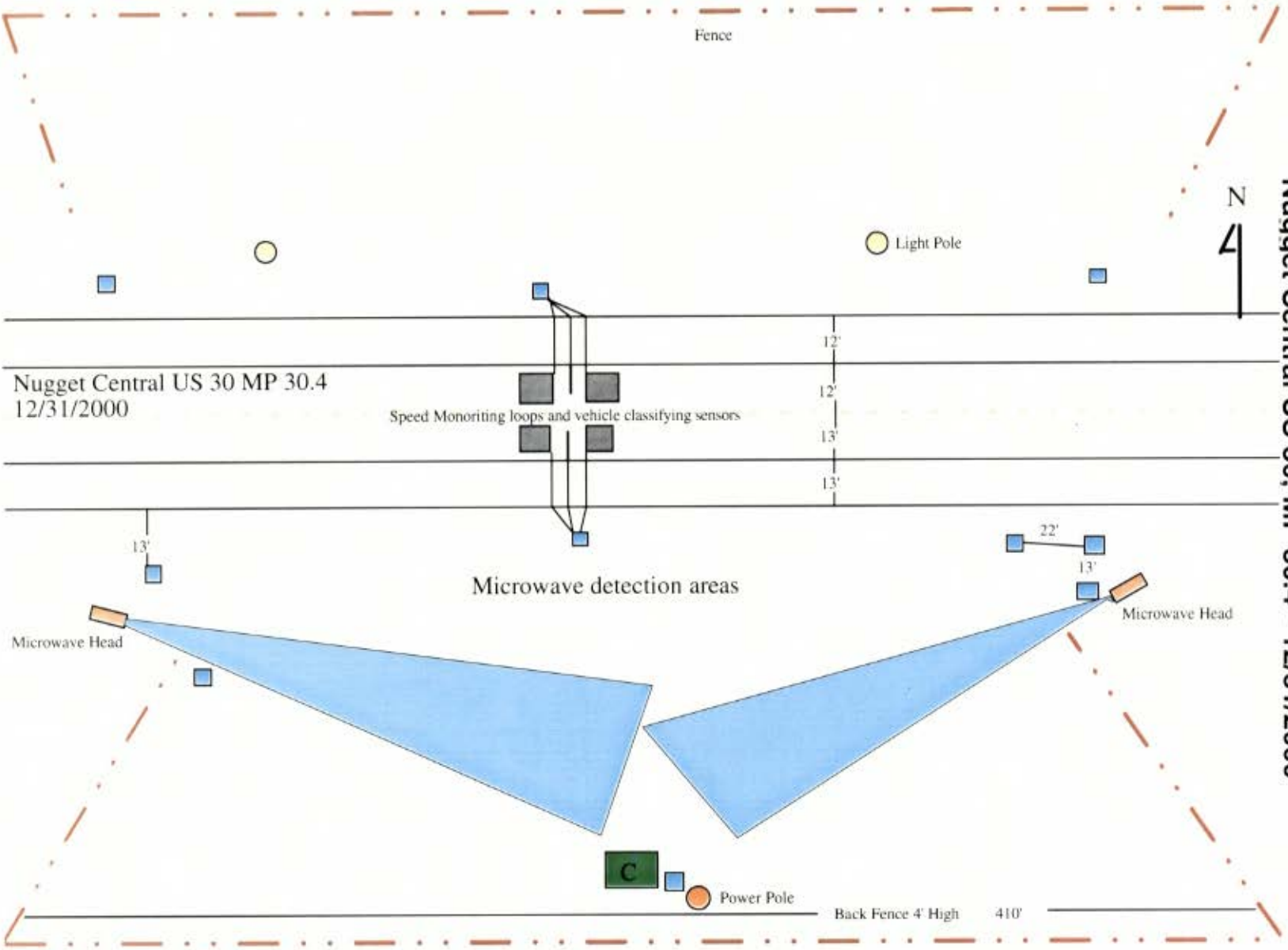


**F.L.A.S.H. SYSTEM DETECTION ZONES**  
Nugget Central US 30, MP 30.4 - 12/31/2000



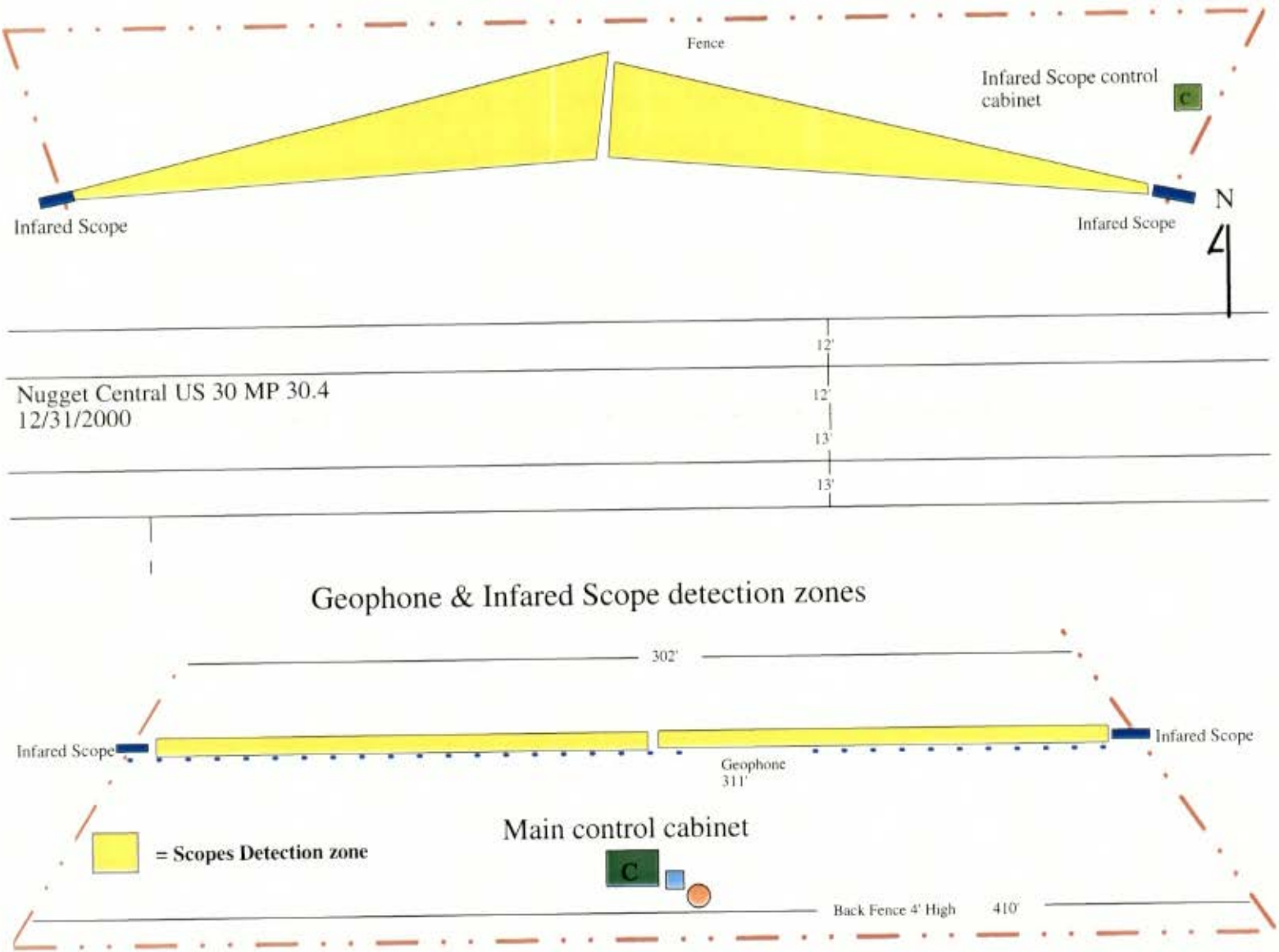
SCHEMATICS for DEER STUDY

MICROWAVE DETECTION AREAS  
Nugget Central US 30, MP 30.4 - 12/31/2000

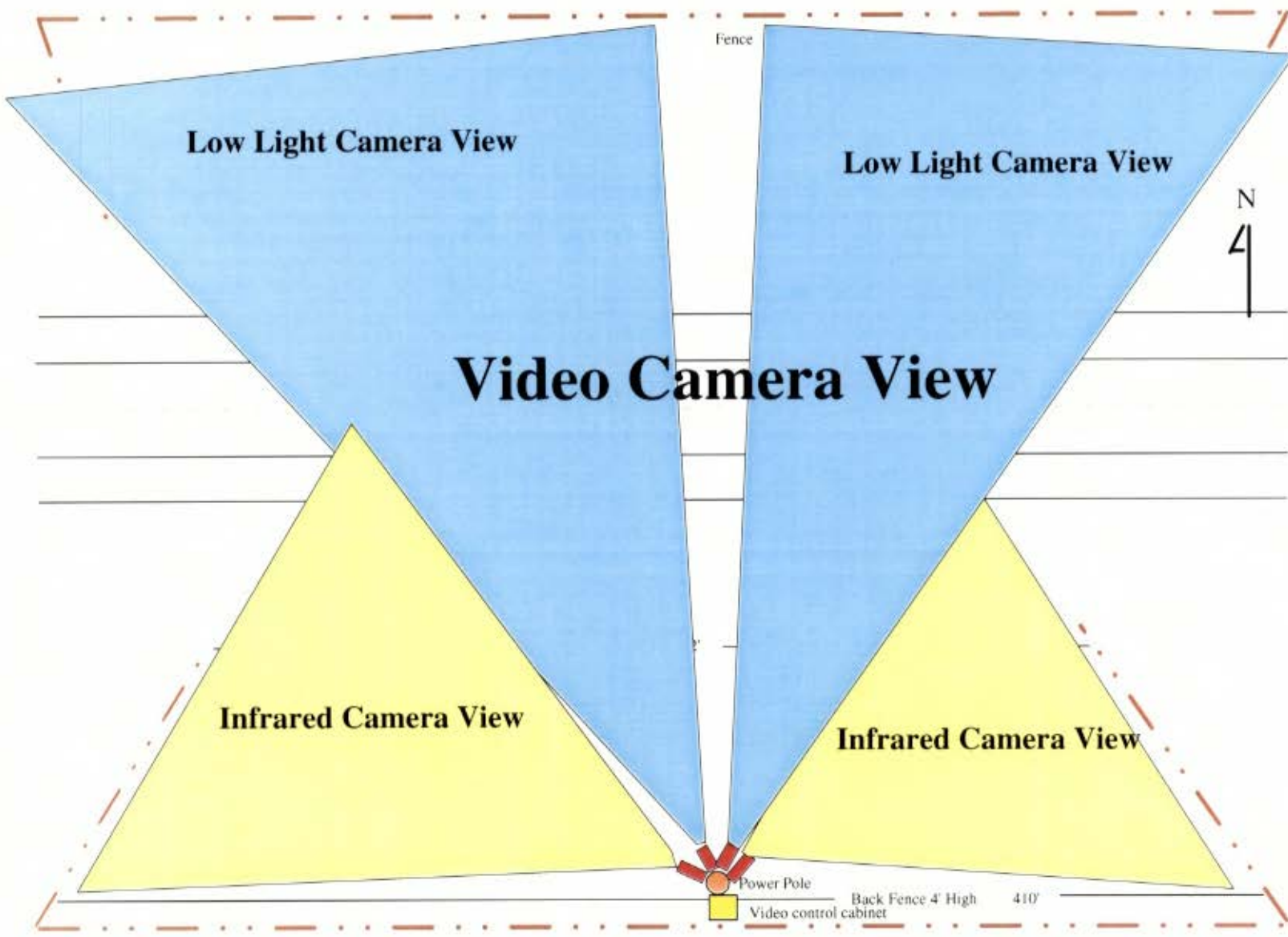


SCHEMATICS for DEER STUDY

GEOPHONE & INFRARED SCOPE DETECTION ZONES  
Nugget Central US 30, MP 30.4 - 12/31/2000



**SCHEMATICS for DEER STUDY**  
**VIDEO CAMERA VIEW**  
**Infrared Camera View**



# **NUGGET CANYON DEER DETECTION STUDY**

## **CONTACTS**



**While all members of the Counter Shop contributed to the success of the study, certain personnel were key, and they and their special area of expertise are listed below.**

### **MATT JOHNSON**

**Transportation Tech 2**

**Lead project technician and principal contact, microwave radar, geophone and video systems**

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### **SHERMAN WISEMAN**

**Transportation Tech 2**

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**Transportation Tech 1**

**Project manager and report author**

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### **WYOMING DEPARTMENT OF TRANSPORTATION**

**Attn: Planning Counter Shop**

**5300 Bishop Blvd.**

**Cheyenne, WY 82009-3340**

**Phone: (307) 777-4192**

**Fax: (307) 777-4759**

## TECHNICAL INFORMATION

The following is a list of principal vendors and specific equipment installed by Counter Shop personnel for use in this study.

### 1. Microwave Radar

**Item:** RTMS Model X2A

**Contact:** EIS Electronic Integrated Systems, Inc.  
150 Bridgeland Ave.  
Toronto, Ontario, Canada M6A 1Z5

Phone: (416) 785-9248

### 2. Geophone System

**Items:** PT-200 Processor/Transmitter  
TT-100 Wireless remote intervalometer system (transmitter/receiver)  
SP-500P Seismic detector string  
IF-540 Long range passive infrared detector (scopes)

**Contact:** Telonics, Inc.  
932 E. Impala Ave.  
Mesa, Arizona 85204

Attn: Scott Jarvis, Manager of Special Projects  
e-mail: [scott@telonics.com](mailto:scott@telonics.com)  
Phone: (480) 892-4444 x110  
Fax: (480) 892-9139

### 3. Video System

**Items:** PATH-CV99MKII Color Portable Archival Traffic History  
Video System PATH-CCZ-32 Low light color cameras  
PATH-EMC-2000 Infrared camera with wide angle lense

**Contact:** ATD Northwest, Inc.  
18080 NE 68th ST. #A-150  
Redmond, WA 98052  
Attn: Ken Kaylor

e-mail: [atd@atdnw.com](mailto:atd@atdnw.com)  
Phone: (425) 558-0359  
Fax: (425) 558-9413

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## REFERENCES

- Edberg, S.C. 1990. Wyoming Range mule deer mortality study, fourth year summary 1989- 1990. Unpubl. Report, Wyoming Game and Fish Department, Jackson, WY
- Reeve, A.F. 1986. Vehicle related mortality of big game in Nugget Canyon, Wyoming. A review of the problem, mitigation alternatives, and recommendations. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie. 87 pp.
- Reeve, A. F. and Anderson, S.H. 1993. Ineffectiveness of Swareflex Reflectors at Reducing Deer-Vehicle Collisions. *Wildlife Society Bulletin*, 21: 127-132