MASON, GRIFFIN & PIERSON

A PROFESSIONAL CORPORATION

COUNSELLORS AT LAW

101 Poor Farm Road
Princeton, NJ 08540
Tel 609.921.6543
Fax 609.683.7978
www.mgplaw.com

Celebrating 70 Years

Email: trishka@mgplaw.com
Direct Dial: (609) 436-1211

June 21, 2025

Via email (jodi.powers@dep.nj.gov)
Jodi Powers, Supervising Biologist
New Jersey DEP Fish and Wildlife
Bureau of Wildlife Management
One Eldridge Road
Robbinsville, New Jersey 08691

Re: Princeton, New Jersey: Application for Special Permit to Inhibit Wildlife Reproduction

Dear Jodi:

As you know, Princeton remains committed to incorporating surgical sterilization as part of its overall efforts to manage the white-tailed deer population within the municipality. To that end, we are formally applying to the Division for a Special Permit to Inhibit Wildlife Reproduction. The permit would be to conduct a five-year scientific study to evaluate the effectiveness, safety, and population-level impacts of surgical sterilization in conjunction with lethal management methods.

The details of the study are set forth in the attached proposal by White Buffalo, Inc., entitled "Surgical Sterilization and Integrated Management for Suburban White-Tailed Deer Population Reduction in Princeton, New Jersey: Special Permit Application to Inhibit Wildlife Reproduction, Municipality of Princeton, New Jersey," prepared by Drs. Anthony J. DeNicola and Jason R. Boulanger and dated June 21, 2025.

We would welcome the opportunity to meet in person to address any questions about the proposal and/or provide more information. We are offering to host the meeting in Princeton, as this would give the Division representatives the opportunity to see first-hand the areas in which we seek to conduct the study, together with the areas in which lethal management has been taking and will continue to take place. That said, we do not wish to inconvenience the Division and would therefore have no objection to meeting in Trenton instead.

I will be out of the country until July 12. In my absence, please contact Tony DeNicola or Jay Boulanger directly for any additional information you require, including copies of any unpublished reports or research referenced in the proposal.

Very truly yours,

Trishka Waterbury Cecil
Princeton Municipal Attorney

TWC:haf
Encl.

cc: Hon. Mark Freda, Mayor (mfreda@princetonnj.gov)
Dawn M. Mount, Clerk (dmount@princetonnj.gov)
Bernard P. Hvozdovic, Administrator (bhvozdovic@princetonnj.gov)
Jeffrey C. Grosser, Deputy Administrator/Health Officer (jgrosser@princetonnj.gov)
James Ferry, Animal Control Officer (jferry@princetonnj.gov)
Dr. Anthony J. DeNicola (tony.denicola@whitebuffaloinc.org)
Dr. Jason R. Boulanger (jason.boulanger@whitebuffaloinc.org)

Surgical Sterilization and Integrated Management for Suburban White-Tailed Deer Population Reduction in Princeton, New Jersey: Special Permit Application to Inhibit Wildlife Reproduction

The Municipality of Princeton, New Jersey

21 June 2025

Submitted by

Drs. Anthony J. DeNicola and Jason R. Boulanger

White Buffalo, Inc.

Introduction

This proposal is submitted as a scientific research application in accordance with the regulatory requirements for a Special Permit to Inhibit Wildlife Reproduction. The project is designed to evaluate the effectiveness, safety, and population-level impacts of integrated surgical sterilization and lethal management methods for white-tailed deer (*Odocoileus virginianus*), as required by state wildlife regulations governing research on wildlife reproduction.

Deer overpopulation and related conflicts are widespread across the United States. A variety of alternative management strategies, including controlled hunting, sharpshooting, trap-and-relocation efforts, and fertility control research, have been implemented or studied in states ranging from Georgia to Texas, Minnesota to Maine, and nearly all states in between. Throughout this large geographic region, deer are creating both social and ecological conflicts in suburban, corporate, and park environments. Many federal, state, and local agencies are struggling to address this ever-increasing problem. Most communities that are confronted with deer overabundance issues pursue a single dimensional approach to solve the problem. However, significant variations in landscape, deer populations, and negative impacts lend themselves to different solutions. We suggest that it is often optimal to use more than one mitigation technique and tailor the deer management plan to the spectrum of potential scenarios present in each unique community.

In areas where hunting has not reduced the local deer population to acceptable levels, and an immediate population decline is preferred, sharpshooting methods are often chosen. Sharpshooting has been proven to be effective at rapidly reducing local deer populations and maintaining the lower densities long-term, resulting in a reduction of deer-vehicle collisions (DVCs; DeNicola and Williams 2008) and an increase in tree regeneration (Abella et al. 2021). Sharpshooting (i.e., use of trained professionals using culling techniques outside of permitted recreational hunting methods) can reduce local deer populations lower than what has been achieved historically using recreational hunters. Professional sharpshooting programs have been implemented throughout the U.S. over the past three decades without a public safety incident. However, the effectiveness of sharpshooting can be hampered by restrictions on discharge distances from occupied dwellings, limiting access to local deer populations. In these situations, capture and euthanasia or fertility control techniques have been used.

Fertility control technology has been shown to be effective for use on white-tailed deer and several other mammalian species. The public has expressed considerable interest in this approach to managing deer, and it has promise for use on localized deer populations (Rutberg et al. 2013). The goal for this management approach is short- and/or long-term population management to minimize human-deer interactions or disease outbreaks in areas with high deer populations where hunting is limited, controlled, or prohibited, and where other management tools are difficult or impossible to implement. However, when fertility control is used in isolation, it requires a longer timeframe to see significant population declines through natural attrition (Merrill et al. 2003), and the cost per animal handled is 2–3 times the cost of other professional methods. Therefore, use on a larger landscape level (e.g., >2–3 mi^2) can often be cost prohibitive.

We suggest use of surgical sterilization, versus vaccine technology, because it is safe for treated deer (Maclean et al. 2006, DeNicola and DeNicola 2021), does not require EPA permits, and is more cost effective than all present vaccine technology in many situations (Boulanger et al. 2012, Evans et al. 2016, DeNicola and DeNicola 2021). The efficacy of some vaccines has also been questioned (Walker et al. 2021), and immunocontraceptive vaccines such as GonaCon™ (Walker et al. 2021) or PZP-22 (Rutberg et al. 2024) require booster shots, are less effective, and can be more expensive. Immunocontraceptive vaccines, such as SpayVac® and GonaCon™, have been evaluated for managing suburban white-tailed deer populations, including in the Municipality of Princeton (hereafter Princeton), New Jersey (White Buffalo, Inc., 2006, unpublished report). Early treatments demonstrated initial efficacy, but a change in the SpayVac® manufacturing process led to reduced effectiveness and higher reproduction rates among treated female deer.

The first assessment of surgical sterilization in deer occurred in the early 1990s (Frank and Sajdak 1993), with subsequent research in the 2000s further evaluating surgical methods (MacLean et al. 2006, Boulanger et al. 2012). Surgical sterilization, particularly via ovariectomy, was recognized as a permanent infertility solution, especially valuable where repeated treatments are impractical or costly. Research has shown that rendering 60–80% or more of a deer population infertile is necessary to stabilize or reduce populations (Grund 2011, Boulanger et al. 2012).

Recent studies have demonstrated that high-percentage surgical sterilization—primarily via ovariectomy—can result in substantial reductions in suburban deer populations, even in geographically open environments where immigration is possible. Across six study sites in California, Maryland, Michigan, New York, Ohio, and Virginia, an average population reduction of approximately 26% (range: 17–36%) was observed from Year 1 to Year 2, and a mean total reduction of 45% (range: 29–56%) was documented four years after initial treatment (DeNicola and DeNicola 2021). These findings challenge earlier assumptions that fertility control is only viable in small, insular, or fenced populations (Seagle and Close 1996, Merrill et al. 2006, Boulanger et al. 2012, Boulanger and Curtis 2016), and suggest that, with sustained effort and high treatment coverage (>90% of females), surgical sterilization can be an effective management tool for localized population reduction in suburban landscapes (DeNicola and DeNicola 2021).

Surgical sterilization programs for deer have demonstrated potential to reduce DVCs, with studies showing decreased carcass removals over time. For example, in Staten Island, New York City, where a male deer sterilization program is underway, the Department of Sanitation (DSNY) documented a significant decline in deer carcass removals from public and private properties, dropping from 299 in 2018 to 36 in 2024, an 88% reduction (White Buffalo, Inc. 2025, unpublished report).

All surgical sterilization field efforts for deer conducted by White Buffalo, Inc., including those detailed in the DeNicola and DeNicola (2021) publication and additional projects summarized in Table 1—were completed efficiently and safely. These efforts span a broad range of suburban and urban communities, each with varying housing densities and firearm or archery discharge distance regulations. For example, surgical sterilization projects have been implemented in high-density areas such as Staten Island, NY (3,083 units/mi^2), as well as in lower-density locations like East Hampton, NY (135 units/mi^2), with discharge distances ranging from 300 to 500 feet for firearms and 150 to 250 feet for archery. Princeton, with a housing density of 882 units/mi^2 and discharge distances of 450 feet for firearms and 150 feet for archery, falls squarely within the spectrum of communities where these procedures have been conducted safely, humanely, and effectively, often with police notification or assistance as an added precaution.

Table 1. Summary of suburban and urban white-tailed deer surgical sterilization projects conducted by White Buffalo, Inc., including community housing density, firearm and archery discharge restrictions, and local law enforcement participation. *Proposed sterilization area.

	Housing - Building Units	**Area (mi^2)**	**Housing - Building density/mi^2**	**Discharge Distance**	**Police participation**
Staten Island, NY	184959	60.0	3083	500' firearm 250' crossbow 150' other archery	informed
South Euclid, OH	9363	4.7	1992	400' firearm and archery	informed/assist
City of Fairfax, VA	8347	6.3	1325	300' firearm and archery	escort
Clifton, OH	910	0.9	979	400' firearm and archery	informed
Cayuga Heights, NY	1696	1.8	942	500' firearm 250' crossbow 150' other archery	escort
Princeton, NJ*	2206	2.5	882	450' firearm 150' archery	informed
Ann Arbor, MI	2616	3.1	844	450' firearm and archery	informed
Town & Country, MO	1232	2.7	456	450' firearm 200' archery	informed
Village of East Hampton, NY	635	4.7	135	500' firearm 250' crossbow 150' other archery	informed

Fertility control also appears to be safe for motorists. Research has demonstrated no correlation between deer treated with fertility control and increases in DVCs (Boulanger and Curtis 2016, DeNicola and DeNicola 2021, DeNicola et al. 2025, Rutberg et al. 2004). Moreover, DVCs tend to decrease as local populations decline through attrition following the implementation of sterilization projects.

Over the past three decades, both professional sharpshooting and surgical sterilization programs—including multiple years of fieldwork in Princeton and numerous projects by White Buffalo, Inc. nationwide—have been conducted without a single public safety incident. This extensive operational record, supported by peer-reviewed research and experience in communities with varying densities and regulations, demonstrates that these methods can be implemented safely with established protocols and coordination with local authorities. Specifically, we have captured and sterilized thousands of deer in a similar manner as proposed for Princeton without a public complaint or safety incident. The consistent absence of safety incidents across these diverse settings directly challenges any assertion that surgical sterilization field operations, including the use of dart projectors, are unsafe.

Princeton features a mosaic of suburban and commercial development, agricultural fields, parks, and open grasslands. Due to limited legal hunting opportunities and the availability of high-quality deer habitat, the local deer population grew to levels that conflicted with some land uses and human activities. While the physical condition of the deer was not a primary concern, there was significant worry about the increasing number of DVCs and the damage caused to gardens and landscape plantings. In response, population reduction measures-including sharpshooting and managed archery hunts-were introduced to supplement recreational hunting from 2001 to 2010 and again from 2012 to 2025, under the New Jersey Division of Fish and Wildlife's community-based deer management program. These efforts remain ongoing. Notably, DVCs in Princeton rose sharply as of July 2024 compared to the same period in 2023, increasing from 31 incidents in 2023 to 64 in 2024.

Lethal deer removal and deer sterilization may be combined to enhance the effectiveness of both approaches (Curtis 2020). In communities where there are great disparities in development density, we have often recommended a combination of methods. However, deer management is very polarizing and local leadership typically votes in favor of lethal or nonlethal, rarely a combination. In a community like Princeton, with a diverse development pattern, we recommend combining management methods across the community; nonlethal surgical sterilization in the more densely developed areas surrounding the downtown area (Fig. 1) to supplement ongoing annual hunting, sharpshooting, and capture and euthanize efforts. This approach should result in population declines in developed areas that have exhibited population increases over the past several years. Save for the below mentioned South Euclid, OH management program, there are few data on the empirical benefits of this proposed strategy.

These combined management efforts propose to further the benefits of managing Princeton's deer population.

The South Euclid, Ohio deer management program began in 2020 with a sharpshooting initiative and, in 2021, expanded to a combined research project utilizing both sharpshooting and surgical sterilization under a permit from the Ohio Department of Natural Resources (White Buffalo, Inc., 2025, unpublished report). Surgical sterilization treatments commenced in 2022 and continued for four consecutive years, resulting in the sterilization of 159 female deer. This dual approach led to a 37% reduction in city-wide deer density within the first three years, and in neighborhoods where over 95% of females were sterilized, fawn recruitment was nearly eliminated. In late 2024, the program transitioned from research to an officially recognized management strategy, permitting the continued use of both sterilization and culling to achieve population control. As of today, Ohio has joined Maryland and South Carolina in recognizing surgical sterilization—without the need for a research permit—as a legitimate tool for reducing deer populations and mitigating their impacts in urban and suburban settings.

Research Objectives

The use of surgical sterilization in Princeton is intended to supplement current hunting and nontraditional lethal methods (i.e., sharpshooting and capture/euthanize), particularly in areas where dense development, small parcel sizes, limited open space, and authorization requirements restrict the use of these traditional approaches. Our primary objective and measurement of success is to achieve and empirically document at least a 40% reduction in the local white-tailed deer population within targeted management zones over 5 years, through high-percentage (>95%) surgical sterilization of female deer in accessible areas and continued lethal management nearby. We will then determine whether a further reduction is feasible over the next 5 years to assess if immigration constrains further population reduction. This target is substantiated by population reduction outcomes reported in DeNicola and DeNicola (2021)-demonstrating average declines of 29–56% with sterilization alone in open suburban environments-and by a 37% reduction achieved in South Euclid, Ohio, using a combined sterilization/sharpshooting strategy, which effectively suppressed fawn recruitment and reduced herd size (White Buffalo, Inc., 2025, unpublished report). The anticipated rate of population decline in Princeton will depend on the proportion of the population sterilized or culled, as well as local demographic factors such as fecundity, mortality, and immigration/emigration rates (Etter et al. 2002, DeNicola 2006, DeNicola et al. 2008, Grund 2011). Rigorous population monitoring via distance sampling or sUAS surveys will be used to assess progress and evaluate the additive effectiveness of integrating lethal and non-lethal management approaches. Additionally, we will compare annual mortality rates of surgically sterilized females to those treated with immunocontraceptive agents used in a previous Princeton study (2003–7; see Appendix A) to better understand the expected population trajectory in densely developed treatment areas.

Study Area

Princeton is in central New Jersey and contains approximately 18.4 $miles^2$. The municipality represents one of the most challenging situations for deer managers. The community is densely developed in many areas but still provides excellent deer habitat (as of 2022 census data, there were 30,377 people, 9,120 households). Within these development patterns the 450' firearm discharge restriction limits the amount of access and effectiveness of lethal options. There are no non-human predators present that can limit a deer population in Princeton.

Hunting and sharpshooting efforts have been applied across Princeton where habitat and permission dictate. We depict historical sharpshooting access locations within the polygons in Fig. 1. For security reasons, we generalize these locations as shown rather than depict actual sharpshooting locations. We also note that we do not currently have access to all the locations depicted, and that additional locations may be added for future sharpshooting efforts.

The areas proposed for the addition of non-lethal management, as recommended by Princeton's Animal Control Officer (ACO), comprise ~2.5 mi^2 of dense suburban landscape within the municipality where deer complaints are frequent and we have been unable to secure the authorizations necessary for lethal management. Four areas of suburban landscape surrounding downtown Princeton have been identified as suitable for an annual sterilization approach (Fig. 1) as follows: 1) The area bounded by US 206 to the north, municipality line to the west, Mercer Road to the south, and Hutchinson Drive and the eastern boundary of Historic Overlook Park to the east. 2) Mountain Avenue to the North, Elm Road to the west, US 206 to the south, and Bayard to the east. 3) A triangle formed by Valley Road to the south and US 206 and North Harrison Street to the west and east, respectively. 4) Terhune and Van Dyke Roads to the north; North Harrison Street, Clearview, and Grover Avenues to the west (minus a small parcel of Butler Picnic Area), Snowden Lane, Abernathy Drive, Littlebrook and Roper Roads to the east, and Carnegie Lake/Princeton-Kingston Road to the south and east.

All four of these proposed areas as described above will be targeted annually for surgical sterilization efforts. While we have conducted contraceptive vaccine research in Princeton previously, we note that this area coincides with one of the four currently proposed for sterilization treatment.

- Extensive research has documented the home range sizes of suburban white-tailed deer, with studies consistently reporting that female deer in suburban landscapes typically maintain small, stable home ranges. Suburban white-tailed deer, especially females, typically maintain annual home ranges of less than 150 acres, with core areas often under 30 acres, and exhibit strong site fidelity, rarely leaving these established ranges unless forced by significant external pressures (Swihart et al. 1995, Kilpatrick and Spohr 2000, Williams and DeNicola 2001, DeNicola et al. 2024, 2025). Moreover, previous research in

Princeton documented that few female deer immigrated into the study area over a four-year period (2003–2007), demonstrating that female deer immigration rates are low in this suburban landscape (see Appendix A for details). Given these well-established movement patterns, there is no reason to expect that deer in the Princeton sterilization zones would exhibit substantially different home range behavior than those studied elsewhere. The identified sterilization zones are composed of dense residential neighborhoods where lethal management is restricted by discharge regulations and lack of access. If deer residing in these zones were routinely accessible to sharpshooting or other lethal methods, it would preclude the need for a fertility control permit for these areas. One of the objectives of this research is to empirically evaluate whether these previously documented patterns of limited female deer movement and low immigration rates also hold true within the specific context of Princeton's sterilization zones. By monitoring marked individuals and population trends, this study will provide site-specific data to confirm or challenge the assumption that female deer in these suburban neighborhoods exhibit high site fidelity and minimal immigration—information essential for assessing the long-term effectiveness of localized fertility control as a management tool.

Justification For Surgical Sterilization as a Deer Research Component

The municipality of Princeton has used every tool and resource available to reduce the white-tailed deer population within the community since 2000. Deer management has been a consistent priority and has included extensive hunting (both by recreational hunters on private properties and by bowhunters under contract with Princeton to bow hunt on public lands), sharpshooting, and capture and euthanasia along with a host of non-lethal management strategies. This included the very expensive use of *Strieter-Lite* reflectors and early research on chemical sterilization. The community has made great gains in reducing deer densities in many areas within the municipality. Unfortunately, due to limited safe shooting sites, or drop-netting locations, in combination with restrictive 150- and 450-foot discharge regulations, lethal management in some highly developed portions of the community is not feasible. Using drop nets for deer capture in a suburban landowner setting is problematic because it requires a large, open and relatively flat area (approximately 70 x 70-foot), explicit landowner permission, the ability to set up discreetly, and alignment with deer movement patterns—challenges compounded by the fact that most suburban properties lack adequate space and such operations can be disruptive to residents. These areas continue to experience significant conflicts with deer. Our request for a Special Permit to Inhibit Wildlife Reproduction is intended to supplement ongoing traditional (recreational hunting) and non-traditional (sharpshooting and capture and euthanize) deer management that is, and has been, occurring for the last 24 years.

Field Methods

Site Visit, Planning, and Permitting

We will continue to partner with Princeton staff to coordinate public and private property access for the sharpshooting portion of deer management. Private property access throughout the community is critical to the success of the lethal management portion of this research program. It also would be beneficial to have access to all suitable public properties. We will facilitate obtaining all necessary permitting from NJDFW.

Deer Population Estimate

Steward Green™ conducted a FLIR survey in January 2023 in Princeton, as they have done elsewhere (Steward Green™, 2021, unpublished report). This survey provided a deer population estimate of 51 deer per square mile. White Buffalo, Inc. has been regularly conducting town-wide distance sampling in Princeton since 2014 (every 2–3 years), including efforts in December 2023, which resulted in an estimated population density of 42.6 deer per square mile. Importantly, both the FLIR survey and the Distance Sampling survey indicated a substantial number of deer in the proposed sterilization areas. In addition to these comprehensive surveys, White Buffalo, Inc. conducted a sUAS survey in a select area of the municipality after management activities in Winter 2024. This survey was intended for internal methodology comparison purposes. The survey area was within the proposed fertility control area and resulted in a nearly identical number of deer observations to the FLIR survey conducted by Steward Green™ a year earlier in the same location.

We will continue to conduct periodic town-wide distance sampling (Pfeffer et al. 2024). In addition, we will conduct drone survey population assessments in each sterilization area in Year 1, as well as at the 5- and 10-year milestones, to demonstrate short- and long-term reductions in open environments. We depict previous distance sampling routes used in Princeton in Fig. 2. Drone surveys will be conducted using sUAS equipped with thermal cameras (Thomas et al. 2010). Together, these surveys will be used to monitor deer population trends and evaluate the combined effects of sterilization, regulated hunting, sharpshooting, and capture-euthanasia over the 10-year study period (2026–2035). In sum, drone population assessments in the study areas will supplement periodic distance sampling surveys and occur at 5-year intervals to measure changes in density by comparing pre-treatment baseline data from 2025 with mid-term and final outcomes.

Recreational Hunting, Managed Archery Hunts, Professional Sharpshooting, and Capture and Euthanasia

These management activities will continue as they have since 2000, as we are investigating the benefit of an additional management tool when combined with all the other methods that are currently utilized in Princeton. Despite sustained application of recreational hunting, managed archery hunts, professional sharpshooting, and capture and euthanasia for over two decades, these methods have not resolved chronic deer conflicts in certain areas of Princeton, underscoring the need for a research permit to evaluate the effectiveness of integrating surgical sterilization as an additional management tool.

Additional lethal management, including both firearms and archery equipment, cannot address the inaccessibility of female deer in the proposed sterilization areas. The contracted hunting organization has already exhausted all feasible access options, systematically reducing deer numbers in accessible locations to the point of diminishing returns over several months each season. Despite these sustained efforts, minimal access has been available in the proposed sterilization zones for over two decades, and neither the Municipality of Princeton nor the contractors can compel cooperation or grant access on private properties.

Given these limitations, sharpshooting has been employed as an alternative tool for reducing deer populations where access is possible. Intensive monitoring at every bait and shooting location ensures that culling efforts are focused and cost-effective, but once camera data indicate minimal deer activity, further operations yield no additional benefit. Simply increasing the duration of lethal efforts is not viable where deer do not respond to bait or where legal and logistical barriers exist. This protocol, validated by over 25 years of experience in communities nationwide, including Princeton, demonstrates that once the accessible segment of the population is removed, additional effort does not result in greater population reduction. Therefore, integrating surgical sterilization is necessary to address persistent deer conflicts in areas where lethal methods are not feasible or effective.

Drop nets (Beaver et al. 2022) and captive bolt guns (American Veterinary Medical Association 2020) will continue to be used annually to supplement management efforts. These nets will be used in areas where 450' firearms discharge authorizations cannot be obtained and conducive sites with cooperative landowners exist. It's important to remember that drop netting in suburban areas remains challenging due to the need for a very sizable, unobstructed space, landowner cooperation, minimal visibility, and appropriate deer activity—all factors that are often difficult to accommodate and can inconvenience property owners. We note that while darting and euthanasia is another option for deer management, it creates several challenges which preclude consideration for this research proposal. One issue is the need to properly dispose of carcasses, which can be logistically complex. Additionally, deer euthanized by chemical immobilization and euthanasia cannot be consumed by humans, removing a condition that often makes lethal control more acceptable to residents in urban and suburban landscapes. Thus, there is likely to be resistance from residents regarding the retrieval of deer from private property when euthanasia is involved. In contrast, during our sterilization efforts across eight communities—where we have retrieved over 3,000 deer—we have not encountered any conflicts with residents.

Capture and Dart Projectors

Our goal is a high percentage capture and sterilization (>95% of females total among the four zones) combined with maximal efficiency (i.e., lowest cost). To achieve this, there should be complete access to the select local deer populations from roadways. Female deer will be captured using remote immobilization (darting) equipment from a vehicle. We anticipate handling a minimum of 40 female deer within the sterilization zones (Fig. 1). The FLIR survey conducted by Steward Green™ in January 2023 indicated a minimum of 136 deer within the proposed sterilization zones. Therefore, it seems reasonable that a minimum of 40 female deer would need to be sterilized in these areas. This is based on ~35–40% of the population being adult female through past harvest data and our research on immunocontraceptives from 2003–7 (White Buffalo, Inc., 2006, unpublished report).

Female white-tailed deer of all age classes will be immobilized remotely using projectors with 2-ml transmitter darts (Pneu-dart, Inc., Williamsport, PA, USA). Deer will be illuminated with small LED flashlights and darted opportunistically along roadsides. Our dart projectors (i.e., Pneu-Dart - X-caliber) are .50 caliber and cannot shoot a projectile over 600 fps using compressed air. Air rifles in New Jersey are considered firearms if they are under 3/8", so dart projectors would not fall under this category. In addition, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) does not consider dart projectors firearms. In our experience, less than 4% of deer are not captured after darting efforts. Less than 3% of treated deer die from the capture or surgery efforts (DeNicola and DeNicola 2021).

See Table 2, which depicts the effective range of a crossbow discharged from a ground blind, with both the discharge elevation and aim point set at approximately 2 feet above ground level. There is no requirement to discharge a crossbow out of a treestand. There is an intent to kill with a crossbow and hence the energy and effective range and a need for a safety setback. For example, a TenPoint crossbow firing a 445-grain (29-gram) arrow at 505 feet per second generates 252 foot-pounds of kinetic energy when discharged from a blind with a 20-yard point of aim. Under these conditions, the arrow can travel nearly 220 feet before striking the ground at a very shallow angle, which increases the risk of ricochets and extended arrow travel.

Table 2. Projectile characteristics of a crossbow arrow discharged from a ground blind, illustrating the energy and velocity considerations relevant to suburban deer management operations.

Drag Function: G1	Wind Speed: 10 mph	International Standard Atmosphere
Ballistic Coefficient: 0.05	Wind Angle: 90°	Altitude: Sea Level (0 ft)
Bullet Weight: 445 gr	Zero Range: 20 yd	Barometric Pressure: 29.92 Hg
Initial Velocity: 505 fps	Chart Range: 200 yd	Temperature: 59° F
Sight Height : 2.5 in	Maximum Range: 616 yd	Relative Humidity: 50%
Shooting Angle: 0°	Step Size: 5 yd	Speed of Sound: 1116 fps

Range (yd)	Elevation (in)	Elevation (MOA)	Elevation (MIL)	Windage (in)	Windage (MOA)	Windage (MIL)	Time (s)	Energy (ft.lbf)	Vel[x+y] (ft/s)
- Sound Barrier (1116 fps) -									
0	-2.50	0.00	0.00	0.17	0.00	0.00	0.00	252	505
5	-1.31	24.15	7.02	0.21	3.94	1.14	0.03	245	498
10	-0.51	4.76	1.38	0.32	3.00	0.87	0.06	239	492
15	-0.07	0.42	0.12	0.50	3.12	0.91	0.09	233	486
20	0.01	-0.03	-0.01	0.74	3.52	1.02	0.12	227	479
25	-0.30	1.14	0.33	1.06	4.03	1.17	0.16	221	473
30	-1.00	3.15	0.92	1.45	4.60	1.34	0.19	216	467
35	-2.09	5.67	1.65	1.92	5.20	1.51	0.22	210	461
40	-3.59	8.54	2.48	2.45	5.84	1.70	0.25	205	455
45	-5.51	11.66	3.39	3.07	6.49	1.89	0.29	199	449
50	-7.86	14.97	4.36	3.76	7.16	2.08	0.32	194	443
55	-10.66	18.46	5.37	4.53	7.84	2.28	0.35	189	438
60	-13.91	22.08	6.42	5.38	8.54	2.48	0.39	184	432
65	-17.62	25.83	7.51	6.31	9.25	2.69	0.42	180	426
70	-21.81	29.70	8.64	7.32	9.96	2.90	0.46	175	421
75	-26.50	33.67	9.79	8.41	10.69	3.11	0.49	170	415
80	-31.68	37.75	10.98	9.59	11.42	3.32	0.53	166	410
85	-37.39	41.93	12.20	10.85	12.17	3.54	0.57	162	404
90	-43.62	46.22	13.44	12.20	12.92	3.76	0.60	157	399
95	-50.40	50.59	14.72	13.64	13.69	3.98	0.64	153	394

In comparison, Table 3 presents a dart trajectory scenario in which a transmitter dart is fired from an SUV at a mirror height of approximately 4 feet, with the target located 15 yards away and the impact height at about 2 feet (mid-thigh). Under these conditions, the dart will strike the ground in less than 100 feet. The transmitter dart, traveling at 160 feet per second and weighing 230 grains, has roughly one-third the velocity and half the weight of a crossbow arrow, resulting in a kinetic energy of just 13 foot-pounds-compared to 252 foot-pounds for a crossbow arrow, or nearly 20 times less energy. This substantial reduction in velocity and energy is intentional, as the goal is to use the minimum force necessary to safely immobilize the animal while minimizing the risk of injury.

Table 3. Projectile characteristics of a dart discharged from a vehicle, illustrating the energy and velocity considerations relevant to suburban deer management operations.

Drag Function: G1
Ballistic Coefficient: 0.05
Bullet Weight: 230 gr
Initial Velocity: 160 fps
Sight Height : 2.5 in
Shooting Angle: -3°

Wind Speed: 10 mph
Wind Angle: 90°
Zero Range: 15 yd
Chart Range: 100 yd
Maximum Range: 269 yd
Step Size: 5 yd

International Standard Atmosphere
Altitude: Sea Level (0 ft)
Barometric Pressure: 29.92 Hg
Temperature: 59° F
Relative Humidity: 50%
Speed of Sound: 1116 fps

Range (yd)	Elevation (in)	Elevation (MOA)	Elevation (MIL)	Windage (in)	Windage (MOA)	Windage (MIL)	Time (s)	Energy (ft.lbf)	Vel[x+y] (ft/s)
- Sound Barrier (1116 fps) -									
0	-2.50	0.00	0.00	0.55	0.00	0.00	0.00	13	160
5	2.06	-38.11	-11.09	0.70	12.89	3.75	0.10	13	158
10	2.92	-27.41	-7.97	1.09	10.20	2.97	0.20	12	155
15	0.17	-1.07	-0.31	1.72	10.84	3.15	0.29	12	153
20	-6.28	29.76	8.66	2.60	12.34	3.59	0.39	12	151
25	-16.53	62.77	18.26	3.74	14.21	4.13	0.49	11	149
30	-30.67	97.19	28.27	5.13	16.27	4.73	0.59	11	147
35	-48.79	132.66	38.59	6.78	18.45	5.37	0.70	11	145
40	-70.96	169.01	49.16	8.69	20.71	6.02	0.80	11	144
45	-97.26	206.11	59.95	10.86	23.03	6.70	0.91	10	142
50	-128.84	245.15	71.31	13.37	25.48	7.41	1.02	10	141
55	-163.70	283.56	82.48	16.07	27.89	8.11	1.12	10	139
60	-204.23	323.83	94.20	19.13	30.42	8.85	1.23	10	138
65	-249.35	364.63	106.07	22.47	32.98	9.59	1.35	10	137
70	-299.10	405.93	118.08	26.08	35.56	10.34	1.46	9	136
75	-355.31	449.01	130.61	30.10	38.25	11.13	1.58	9	135
80	-414.44	491.14	142.87	34.26	40.88	11.89	1.70	9	134
85	-480.30	534.97	155.62	38.84	43.61	12.69	1.82	9	133
90	-553.29	580.48	168.85	43.85	46.44	13.51	1.94	9	132
95	-628.93	624.85	181.76	48.99	49.21	14.31	2.06	9	132

In summary, while a dart projector may resemble a firearm in appearance, its operational range and kinetic energy are substantially lower—even compared to a crossbow—and are specifically chosen to facilitate the humane capture of deer. Given these significant differences in projectile performance, a safety setback requirement is not warranted. Additionally, safety will be further enhanced by the presence of law enforcement personnel, who will provide an added layer of oversight during darting operations.

Each dart administers BAM (Butorphanol 0.65 mg/kg, Azaperone 0.22 mg/kg, Medetomidine 0.26 mg/kg) into the proximal muscle mass of a pelvic limb or the epaxial muscles of each deer (Boesch et al. 2011). Once a dart is deployed and 10–15 minutes has elapsed, the deer will be located via radio-telemetry or through direct observation. Deer will be captured in early winter to minimize difficulties of performing the sterilization procedure later in gestation. We will approach deer in a vehicle on public roadways and private roadways/properties where permission has been granted after ~2100 h. Whenever possible, a police officer will accompany the capture professionals during mobile operations. Once deer are located, masks will be placed over the eyes and ophthalmic ointment will be applied to prevent ocular desiccation. Deer then will be transported to a temporary veterinary surgical sterilization site that will be set up in close coordination with Princeton's Health Officer, most likely in an unoccupied building owned by Princeton that previously housed the Princeton First Aid & Rescue Squad (237 North Harrison Street).

Marking

We will administer radio-collars to 30 treated females to facilitate future capture efforts (e.g., to locate unmarked deer for subsequent capture) and to assess survival rates. All sterilized animals will be fitted with livestock ear tags labeled "Call Before Consumption – 860-385-4725." We will use Extra Large DuFlex ear-tags and modified traditional VHF radio-collars (1/3 the size of traditional deer collars – ~5-year battery life) to lessen the unnatural appearance of deer. VHF frequencies for all radio-collars used will be supplied to NJDFW as soon as operations are complete. We also will collect data on deer weight, age, and general health.

Surgical Sterilization

Surgical procedures generally follow DeNicola and DeNicola (2021), but we provide additional detail here. All surgeries will be performed by New Jersey-licensed veterinarians to ensure compliance with state regulations and the highest standards of animal care. After capture, all female deer will be premedicated with flunixin meglumine at a dosage of 1–3 mg/kg intramuscularly or intravascularly for the control of pain, as well as a long-acting antibiotic (ceftiofur - Excede) at 3–6 mg/kg, also intramuscularly, for the prophylactic prevention of infection. To maintain anesthesia, supplemental doses of ketamine HCl may be given intravenously at dosages up to 5 mg/kg, as needed. Routine prepubic ventral midline laparotomy will be used to expose the uterine horns and ovaries. We will then perform bilateral ovariectomy. Ovarian isolation will be achieved via clamping and gentle traction, while hemorrhage control and ovarian excision will be achieved via thermal vessel sealing and/or electrocautery. In select cases the ovarian artery will be ligated with 0 PDS suture or a titanium hemostatic clip. Routine three-layer closure of the abdomen will be performed to complete the procedure. This will include simple interrupted or simple continuous closure patterns of the linea alba using appropriately-sized absorbable suture, followed by closure of the subcutaneous layer utilizing either running a Cushing or simple continuous suture patterns with appropriately-sized absorbable suture. Finally, the skin will be closed using 35W skin staples of number and spacing appropriate for complete appositional closure of the surgical incision. In over 600 sterilization surgeries in deer (black-tailed and white-tailed deer) we have never had a known dehiscence (DeNicola and DeNicola 2021). The suture materials and patterns support continued use, as does the use of stainless-steel staples for skin closure. We have recaptured many of the previously sterilized deer and found the staples absent after only a few months.

Reversal and Release

All deer will be released proximate to the capture location, in areas with the lowest likelihood of human disturbance during recovery. We will administer the reversal agent atipamezole hydrochloride (3 ml IM) for the antagonism of the medetomidine and naltrexone hydrochloride (0.5 ml IM) for the antagonism of butorphanol. We will monitor each deer during recovery until they are ambulatory.

Report Submission

We will be responsible for the submission of annual reports to designated agents of the NJDFW and Princeton. All data will be made available upon request at any time to authorized agents of the State and/or Princeton. In addition to other results from these management efforts, the final report will include the detailed costs associated with both the sterilization and the lethal removal aspects of the management.

Project Supervisors

Dr. Anthony J. DeNicola is CEO of White Buffalo, Inc., a non-profit research organization dedicated to conserving ecosystems through wildlife population control. He received a M.S. degree from the Yale School of Forestry and Environmental Studies and a Ph.D. from Purdue University. Dr. DeNicola has conducted contraceptive and sterilization projects throughout the United States over the last 30 years. Dr. DeNicola's research interests include ecological approaches to control wildlife damage, control of introduced vertebrate species, and wildlife reproductive control.

Dr. Jason "Jay" R. Boulanger is Head of Research of White Buffalo, Inc. He received his Ph.D. in Wildlife Science from Cornell University, M.S. in Wildlife and Fisheries Sciences from South Dakota State University, and B.S. in Natural Resources from the University of Vermont. His dissertation and post-doctoral research focused on controlling suburban raccoon rabies via a novel bait station and overabundant deer populations via fertility control, respectively. Jay also served as a tenured wildlife professor at the University of North Dakota where he conducted applied research and taught courses on mammalogy, large mammal ecology and management, and human dimensions of wildlife. Jay is a long-standing member of The Wildlife Society and a Certified Wildlife Biologist®.

Licensed Veterinarians

Dr. Nathan Kotschwar, DVM has been an employee of White Buffalo, Inc for 7 years, and has participated in several deer field surgical sterilization projects, including in Ohio, Michigan, and NY. He is licensed to practice veterinary medicine in Nebraska, California, and New Jersey. Nate has worked on the Princeton deer management program as part of the culling operations, so is intimately familiar with the municipality and its overall deer management project (see credentials included as part of the application documents).

Dr. Clayton Hilton, DVM has participated in previous deer field surgical sterilization projects in New York and South Carolina. He is licensed to practice veterinary medicine in Texas, Ohio, and New Jersey.

Literature Cited

Abella, S. R., T. A. Schetter, and T. D. Gallaher. 2022. Rapid increase in sensitive indicator plants concurrent with deer management in an oak forest landscape. Wildlife Society Bulletin 46:e1377.

American Veterinary Medical Association. 2020. AVMA guidelines for the euthanasia of animals: 2020 edition. American Veterinary Medical Association, Schaumburg, Illinois, USA. 121 pp.

Beaver, J. T., C. Grantham, M. L. Cooksey, K. Skow, B. L. Pierce, and R. R. Lopez. 2022. Effectiveness, economics, and safety of drop nets and helicopters with net-gunning for capturing white-tailed deer. Wildlife Society Bulletin 46:e1365.

Boesch, J. M., J. R. Boulanger, P. D. Curtis, H. N. Erb, J. W. Ludders, M. S. Kraus, and R. D. Gleed. 2011. Biochemical variables in free-ranging white-tailed deer (*Odocoileus virginianus*) after chemical immobilization in clover traps or via ground-darting. Journal of Zoo and Wildlife Medicine 42:18–21.

Boulanger, J. R., and P. D. Curtis. 2016. Efficacy of surgical sterilization for managing overabundant suburban white-tailed deer. Wildlife Society Bulletin 40:727–735.

Boulanger, J. R., P. D. Curtis, E. G. Cooch, and A. J. DeNicola. 2012. Sterilization as an alternative deer control technique: a review. Human-Wildlife Interactions 6:273–282.

Curtis, P. D. 2020. After decades of suburban deer research and management in the eastern United States: where do we go from here? Human-Wildlife Interactions 14:111–128.

DeNicola, A. J., and V. L. DeNicola. 2021. Surgical sterilization as a management technique in suburban deer populations. Wildlife Society Bulletin 45:445–455.

DeNicola, A. J., D. Etter, and T. Almendinger. 2008. Demographics of non-hunted white-tailed populations in suburban areas. Human-Wildlife Conflicts 2:102–109.

DeNicola, A. J., and S. C. Williams. 2008. Sharpshooting suburban white-tailed deer reduces deer-vehicle collisions. Human-Wildlife Conflicts 2:28–33.

DeNicola, V. L., S. Mezzini, and F. Cagnacci. 2024. The impact of ovariectomy on seasonal movement behavior in female white-tailed deer: a comparative study. Wildlife Research. *In review*.

DeNicola, V., Mezzini, S., Bursać, P., Minasandra, P., & Cagnacci, F. 2025. Effects of vasectomy on breeding-related movement and activity in free-ranging white-tailed deer. Movement Ecology 13(1):Article 5. https://doi.org/10.1186/s40462-025-00554-5.

Etter, D.R., K.M. Hollis, T.R. VanDeelen, D.R. Ludwig, J.E. Chelsvig, C.L. Anchor, R.E. Warner. 2002. Survival and movements of white-tailed deer in suburban Chicago, Illinois. Journal of Wildlife Management 66:500–510.

Evans, C. S., DeNicola, A. J., and R. J. Warren. 2016. Immunocontraceptive vaccines or surgical sterilization for deer? A question of effort and efficacy. Wildlife Society Bulletin 40:593–598.

Frank, E. S., and S. L. Sajdak. 1993. Sterilization as a method of controlling an urban white-tailed deer population. American Association of Zoological Parks and Aquariums Regional Conference Proceedings 1:485–490.

Grund, M. D. 2011. Survival analysis and computer simulations of lethal and contraceptive management strategies for urban deer. Human–Wildlife Interactions 5:23–31.

Kilpatrick, H. J., and S. M. Spohr. 2000. Spatial and temporal use of a suburban landscape by female white-tailed deer. Wildlife Society Bulletin 28:1023–1029.

MacLean, R. A., N. E. Mathews, D. M. Grove, E. S. Frank, and J. Paul-Murphy. 2006. Surgical technique for tubal ligation in white-tailed deer (*Odocoileus virginianus*). Journal of Zoo and Wildlife Medicine 37:354–360.

Merrill, J. A., E. G. Cooch, and P. D. Curtis. 2003. Time to reduction: factors influencing management efficacy in sterilizing overabundant white-tailed deer. Journal of Wildlife Management 67:267–279.

Merrill, J. A., E. G. Cooch, and P. D. Curtis. 2006. Managing an overabundant deer population by sterilization: effects of immigration, stochasticity and the capture process. Journal of Wildlife Management 70:268–277.

Pfeffer, D. G., J. A. Foster, and J. C. Kinsey 2024. Using unmanned aerial vehicles equipped with thermal cameras to survey a known population of white-tailed deer. Journal of Fish and Wildlife Management 15:283–295.

Rutberg A. T., R. E. Naugle, and F. Verret. 2013. Single-treatment porcine zona pellucida immunocontraception associated with reduction of a population of white-tailed deer (*Odocoileus virginianus*). Journal of Zoo and Wildlife Medicine 44:75–83.

Rutberg, A. T., R. E. Naugle, L. A. Thiele, and I. K. M. Liu. 2004. Effects of immunocontraception on a suburban population of white-tailed deer Odocoileus virginianus. Biological Conservation 116:243–250.

Rutberg, A. T., K. M. Pereira, K. A. Grams, and J. W. Turner, Jr. 2024. Multi-year effectiveness of PZP-22 in free-roaming suburban white-tailed deer. Human-Wildlife Interactions 18:*in pres*s.

Seagle, S. W., and J. D. Close. 1996. Modeling white-tailed deer population control by contraception. Biological Conservation 76:87–91.

Steward Green™. 2021. White-tailed deer (*Odocoileus virginianus*) population density survey using sUAS infrared: Arlington County, Virginia - Spring 2021. Final report to Arlington County Parks and Recreation, Arlington, Virginia, USA. Unpublished report.

Swihart, R. K., P. M. Picone, A. J. DeNicola, and L. Cornicelli. 1995. Ecology of urban and suburban white-tailed deer. Pages 35-44 *in* J. McAninch, editor. Urban deer - a manageable resource? North Central Chapter of The Wildlife Society.

Thomas, L., S. T. Buckland, E. A. Rexstad, J. L. Laake, S. Strindberg, S. L. Hedley, J. R. B. Bishop, T. A. Marques, and K. P. Burnham. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5–14.

Walker, M. J., G. C. Shank, M. K. Stoskopf, L. J. Minter, and C. S. DePerno. 2021. Efficacy and cost of GonaCon™ for population control in a free-ranging white-tailed deer population. Wildlife Society Bulletin 45:589–596.

White Buffalo, Inc. 2006. Experimental control of a suburban population of white-tailed deer using immunocontraception: year 4 (2006) interim summary report. White Buffalo, Inc., Chester, Connecticut, USA. Unpublished report.

White Buffalo, Inc. 2025. 2025 suburban deer management program summary report, South Euclid, Ohio. White Buffalo, Inc., Chester, Connecticut, USA. Unpublished report.

White Buffalo, Inc. 2025. Deer research program final summary report, year 9: Borough of Staten Island, New York. White Buffalo, Inc., Chester, Connecticut, USA. Unpublished report.

Williams S. C., and A. J. DeNicola. 2001. Spatial movements in response to baiting female white-tailed deer. Proceedings of the Ninth Wildlife Damage Management Conference. State College, Pennsylvania.

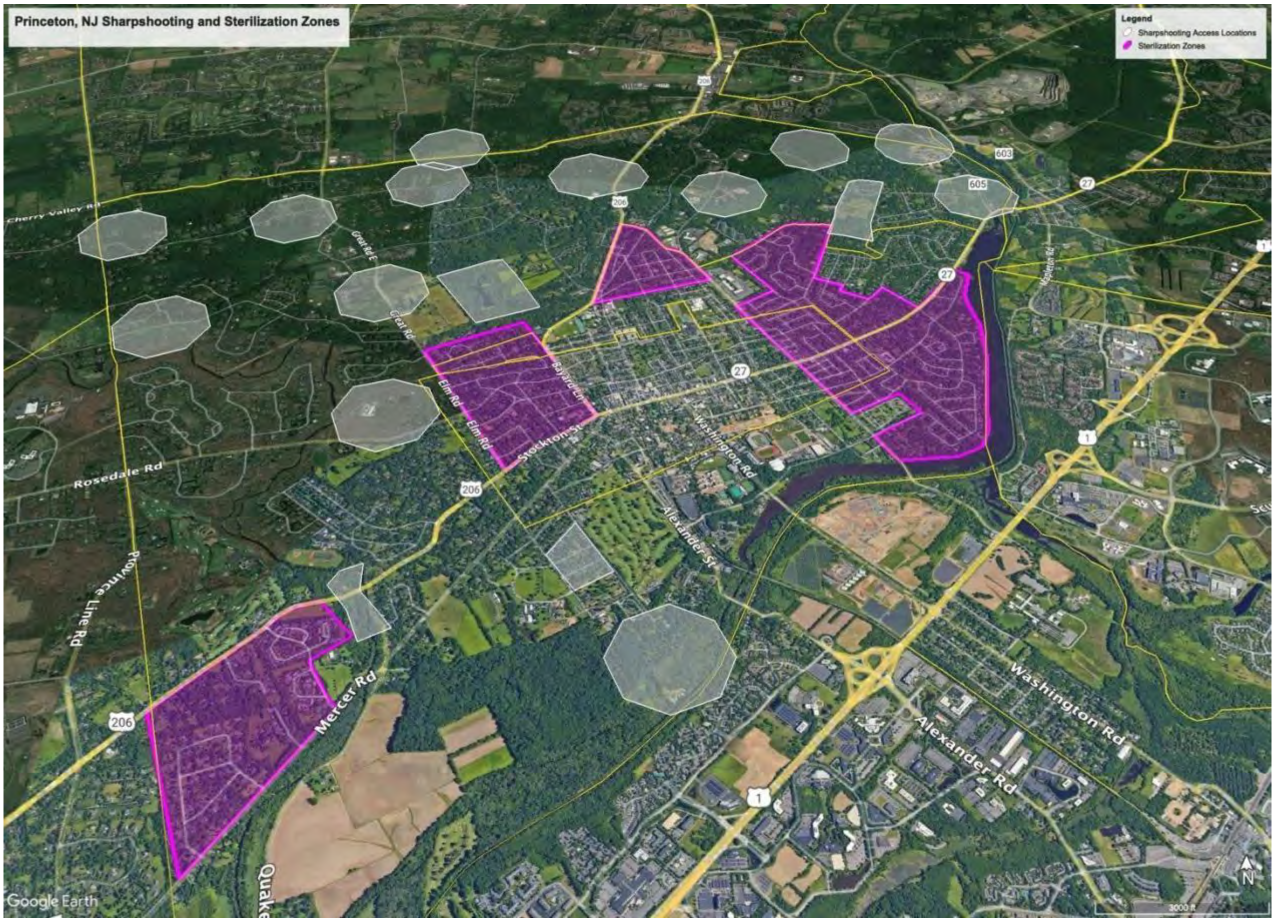

Figure 1. Princeton, New Jersey 2025–2026 proposed sharpshooting and sterilization zones highlighted in white and purple boundaries, respectively.

Figure 2. Previous Distance Sampling Route for Princeton, New Jersey.