

Wildland Fire Risk Assessment & Mitigation Report

Northern Arizona Healthcare, Proposed Health Village Flagstaff, Arizona



Prepared for Northern Arizona Healthcare by Fire Management Group, LLC

20 November 2021

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Executive Summary

This report addresses the possible wildland fire impacts of placing a 180-acre medical complex (NAH Health Village) near the local WUI area. This area is the far southwestern edge of the City of Flagstaff incorporated area. The proposed site is surrounded by a mix of private, state, county, and federal lands. This report addresses the impacts, both positive and negative, of this development and gives only recommendations and not requirements to reduce wildland fire impact.

We attempted to examine all aspects using a “best available science” approach. This included site visits, remote sensing data, and published research. The information included in this study addresses vegetation, topography, weather and climate, fire ecology, and fire history. Modeling using the latest national standard software was also used to show projected fire spread, burn probability, and flame length. All of these were modeled both with the current undeveloped parcel as-is and after the proposed development and mitigations. All modeling was done to show a “worst case” in the middle of June 2020.

This development plans to have a 20+ acre “natural area” along with using the native existing vegetation as land cover. As use of this area increases so does the possible impact of human caused ignitions.

This area is within the City of Flagstaff (City). The City has adopted the 2018 International Fire Code (IFC) along with the 2006 International Wildland Urban Interface Code (IWUIC). The building code that the City has adopted is the 2018 International Building Code (IBC). Between these codes the WUI risk is addressed with the required site and building codes. The Flagstaff Fire Department (FFD) would be the Authority Having Jurisdiction (AHJ) for plan fire code review and acceptance along with ongoing compliance inspections. The FFD is also responsible for fire suppression in this area.

Our findings show that the majority of this area, including the proposed development, is currently at low risk for wildland fire. The proposed development area was last thinned in 2009 (with the exception of an 18-acre parcel at the southern end of the development) and the surrounding area was thinned and treated between 2006 and 2018. The vegetation in the majority of this area is a healthy open ponderosa stand with a grass understory that would minimize crown fire or extreme fire activity.

Part 1: Understanding the local environment

Site description

The area where the development is proposed is enclosed in the southwestern area of the City of Flagstaff incorporated area. It is bounded to the east by State Highway 89A and Interstate 17, to the north by a utility easement and the Mountain Dell subdivision, to the west by an unnamed rural subdivision, and to the south and west by Fort Tuthill County Park.

The Flagstaff Urban Trail System (FUTS) runs through the western side of this property. There are several utility easements surrounding and through this property that will need to be addressed. At the very southern piece of this property there is an APS substation and a City of Flagstaff well site.

Fort Tuthill which bounds the southwestern side of this property is a high use area for recreation and regional activities. There is also a private company using a portion of this area (Flagstaff Extreme Adventure).

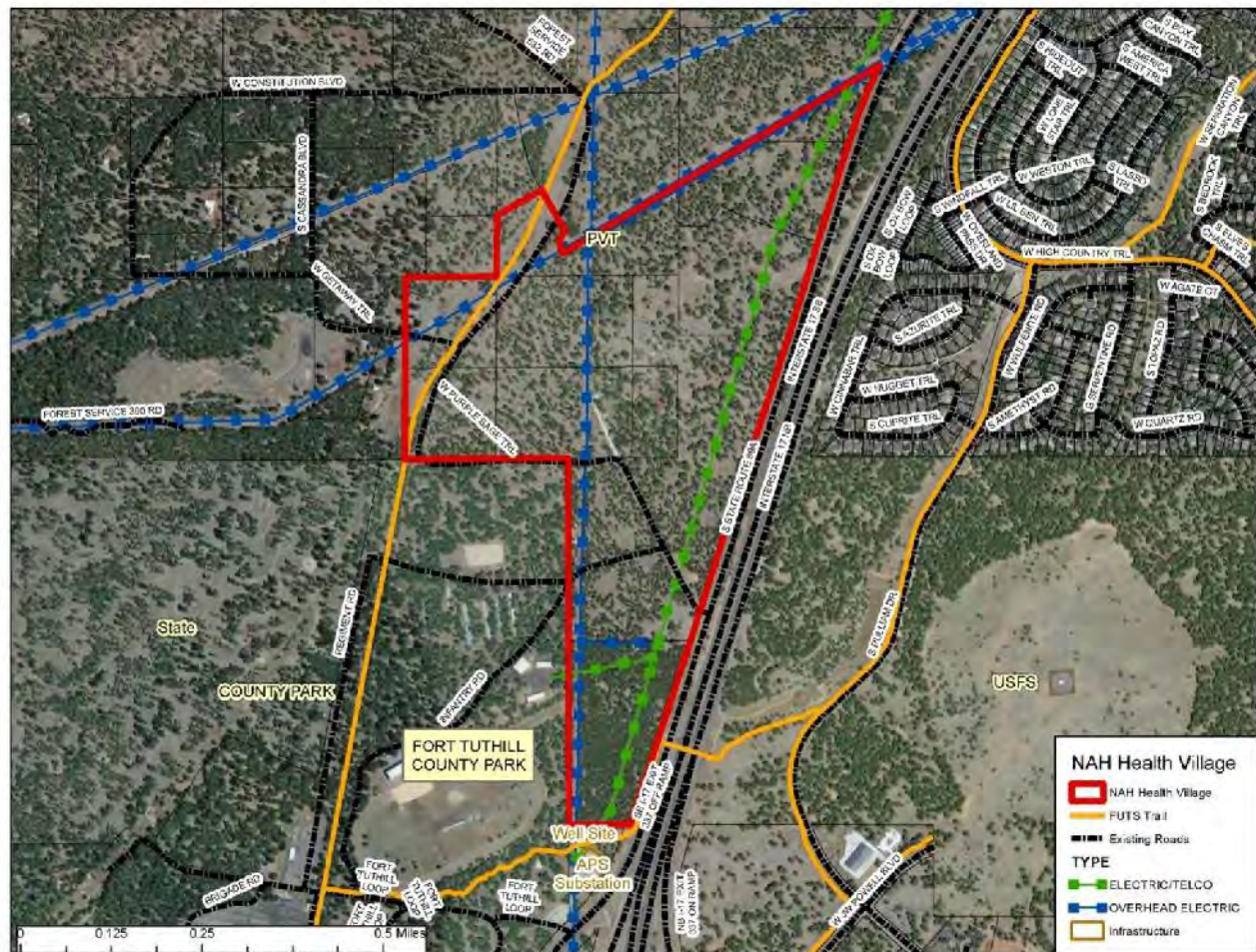


Figure 1. Current Site Overview

Topography

This proposed development is at an elevation of ± 7000 feet. In general, the site is flat with gradual drainages to the west and north into the Sinclair Wash area. The maximum slope is less than 17% and the property does not contain steep slopes or drop-offs. The soils in the project are clay loam topsoil with areas of exposed Kaibab limestone bedrock.

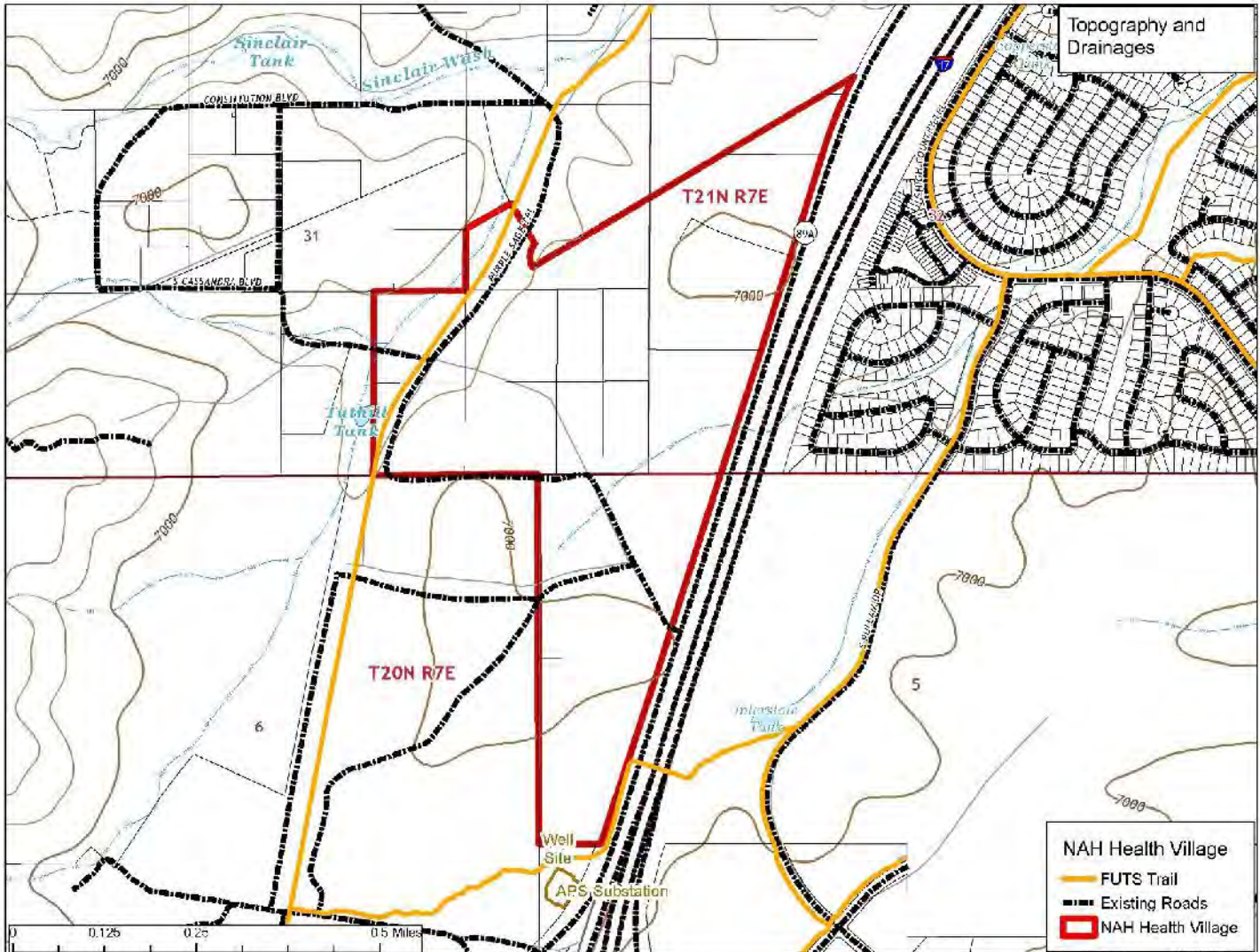


Figure 2. Area Topography

Weather/Climatology

This area is considered a high elevation forest in that it is situated at 7,000 feet. It remains relatively cool with approximately 19 inches of precipitation annually with an average rainfall of 6.22 inches occurring during July and August. During the summer months the temperature averages in the mid-eighties and may climb into the low 90's on occasion. The relative humidity averages in the 20-30% range dipping into the teens during mid-late June. The predominant summer winds in the area are from the Southwest and average from the low to mid-teens. The normal yearly maximum fire season for the area is early June to mid-July when the monsoon brings moisture into the area. The closest weather station to the project area is less than 1 mile to the northeast. This Remote Automated Weather Station (RAWS) QFLA3¹ is located at the Flagstaff Airport. All weather data used in this report is from this station and is a 20-year average.

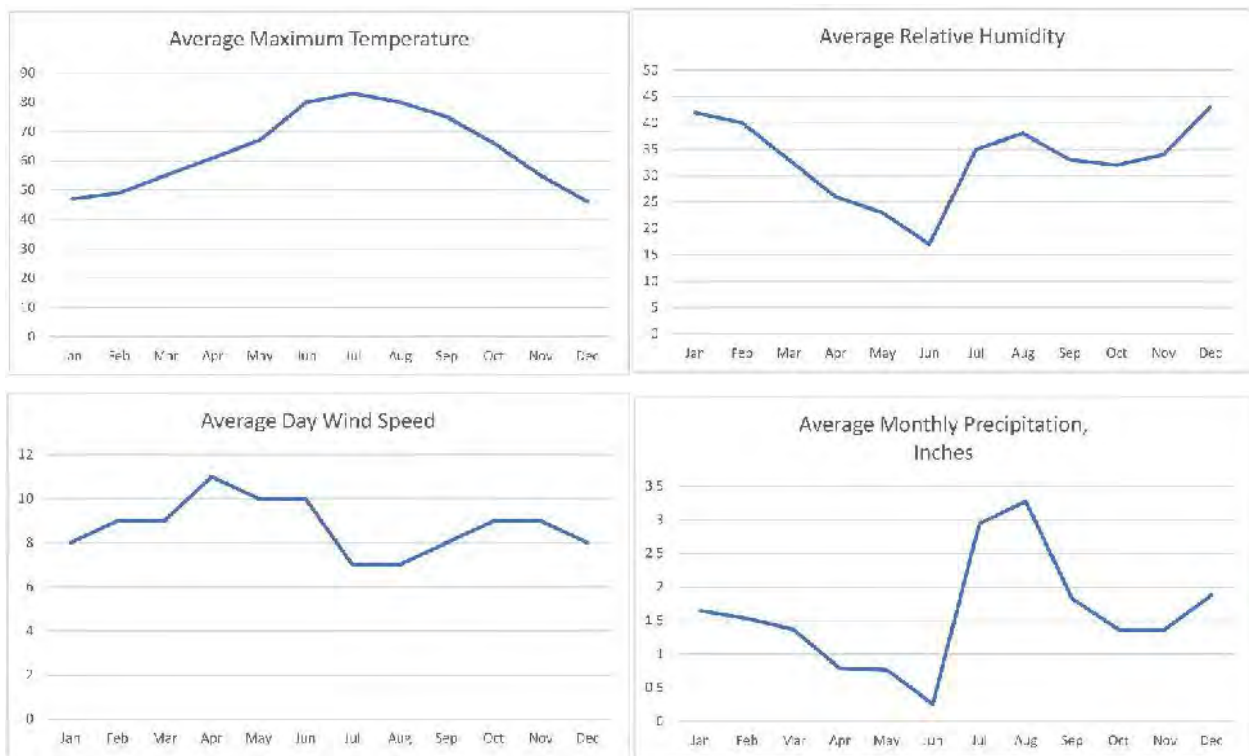


Figure 3. Monthly Weather Averages

¹ Flagstaff Airport RAWS, <https://mesowest.utah.edu/cgi-bin/droman/mesomap.cgi?state=AZ&rawsflag=3>

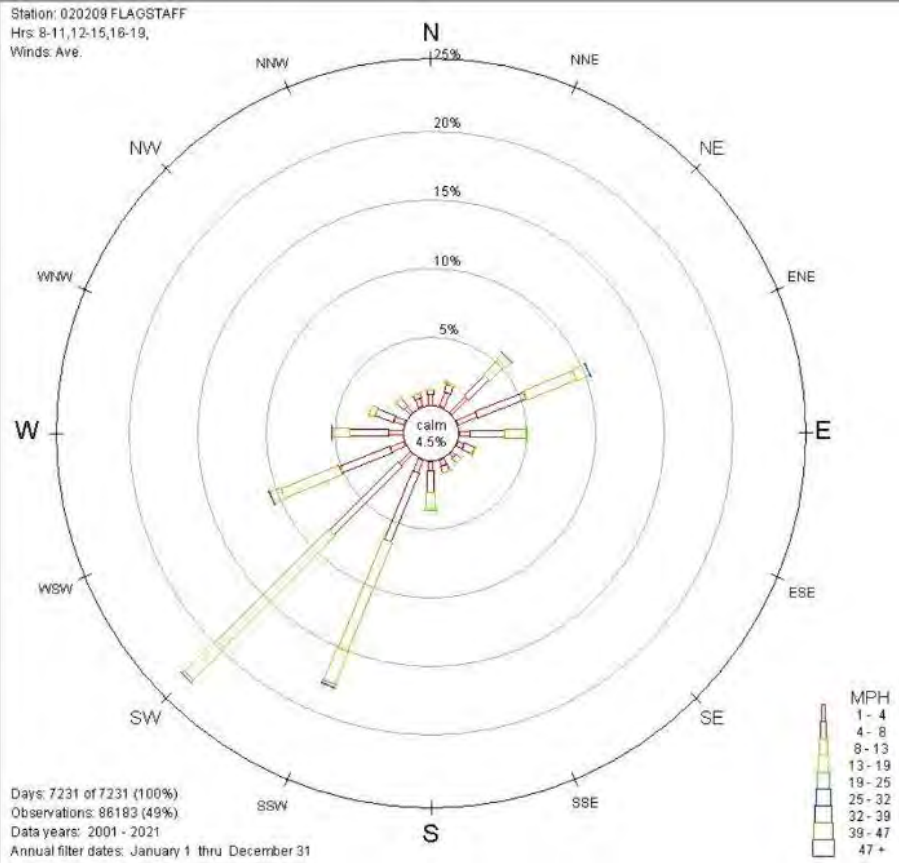


Figure 4. Yearly Average Daytime Winds

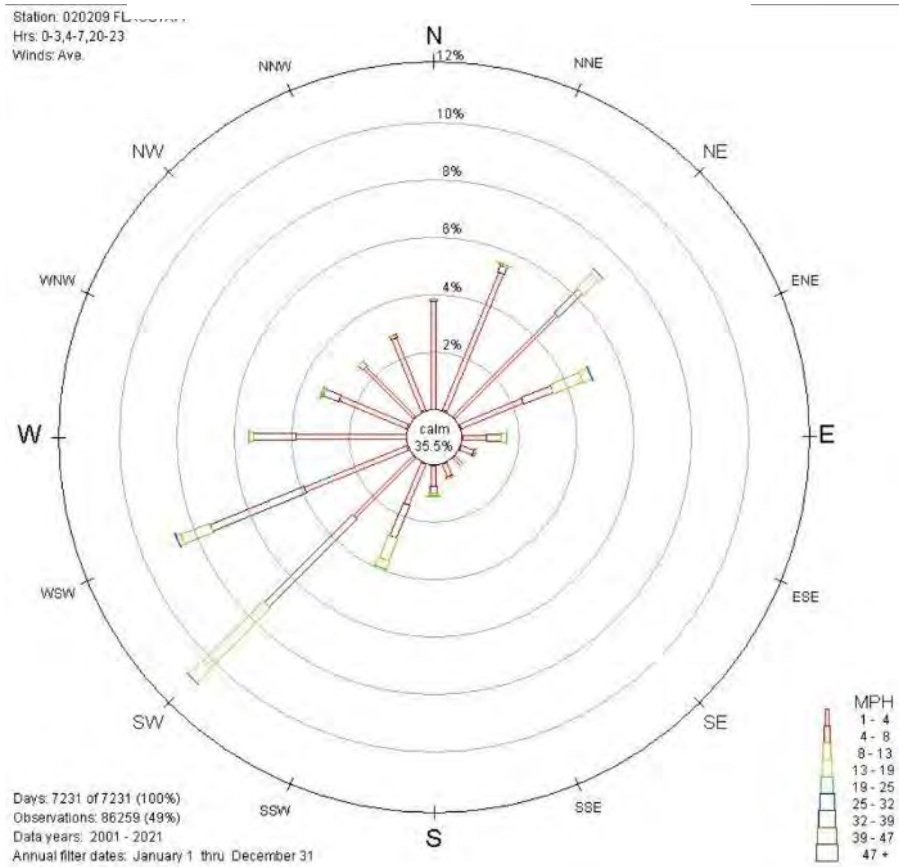


Figure 5. Yearly Average Nighttime Winds

Fire ecology

The ponderosa pine forest ecosystem is fire-dependent, meaning that fire is a natural ecosystem process contributing to overall ecosystem health.² Prior to European settlement, the fire regime (frequency of burning, how hot it burns, and vegetation response after a fire) was frequent and low-severity, contributing to an open forest structure with uneven-aged trees and a lush grass, forb and shrub understory. Lt. Edward Beale described the ponderosa pine forests of northern Arizona in 1857: “It is the most beautiful region I ever remember to have seen in any part of the world. A vast forest of gigantic pines, intersected frequently with open glades, sprinkled all over with mountains, meadows, and wide savannahs, and covered with the richest grasses, was traversed by our party for many days.”³ Lightning, a natural ignition source, caused low-intensity surface fires fueled by leaf litter, needles and cured native grasses recurring every two to ten years.^{4 5} Frequent fires allowed grasses and forbs to thrive while suppressing the growth of less fire-adapted shrubs and young trees, increasing the overall biological diversity and ecological value of this forest type.⁶

The current fire regime is drastically different due to more than a century of fire exclusion and the deleterious effects of logging and livestock grazing following the European-American settlement of northern Arizona.⁷ Compositional and structural changes include increased tree densities of younger and smaller trees, accumulation of heavy fuel loads on the forest floor and decreased grasses, forbs and shrubs.⁸

It is now commonly understood that to increase the forests’ resiliency to fire, insects, and disease, we must emulate the pre-settlement forest structure and fire disturbance pattern by thinning and safely re-introducing fire with prescribed fire.⁹

² Wright, H.A. 1990. Role of Fire in the Management of Southwestern Ecosystems. In: Krammes, J., technical coordinator. Effects of Fire Management of Southwestern Natural Resources. USDA Forest Service General Technical Report RM-GTR-191. p. 1-5.

³ Bell, W. A. 1870. New tracks in North America. 2nd Ed., 2 Vols. London: Chapman & Hall.

⁴ Zwolinski, M. 1996. Effects of Fire on Montane Forest Ecosystems. In: Ffolliott, P.; DeBano, L.; Baker, M., Jr.; Gottfried, G; Solis-Garza, G.; Edminster, C.; Neary, D.; Allen, L.; Hamre, R., technical coordinators. Effects of Fire on Madrean Province Ecosystems: A Symposium Proceedings. USDA Forest Service General Technical Report RM-GTR-289. p. 55-63.

⁵ Covington, W., P. Fulè, M. Moore, S. Hart, T. Kolb, J. Mast, S. Sackett, and M. Wagner. 1997. Restoring ecosystem health in ponderosa pine forests of the Southwest. *Journal of Forestry*. 95(4): 23-29.

⁶ Dolan, C., and A. Rogstad. 2007. Ponderosa Pine Forest. Living with Wildfire in Arizona. University of Arizona Cooperative Extension Publication AZ1423. College of Agriculture and Life Sciences, University of Arizona. p. 15-32.

⁷ Cooper, C. F. 1960. Changes in vegetation, structure, and growth of southwestern pine forests since white settlement. *Ecological Monographs*, 30: 129-164.

⁸ Covington, W., and M. Moore. 1994. Southwestern ponderosa pine forest structure: Changes since Euro-American settlement. *Journal of Forestry*. 92: 39-47.

⁹ Covington, W. and L. DeBano; technical coordinators. 1994. Sustainable ecological systems: Implementing an ecological approach to land management, implications for ponderosa pine/bunchgrass ecological systems. USDA Forest Service General Technical Report GTR-RM-247. 363 p.

It is our recommendation to engage in ecological restoration activities on this parcel to reduce the risk of extreme fire behavior and improve the overall stand conditions. The majority of this parcel was thinned in 2009 and we recommend another treatment to further increase crown spacing and remove small trees and shrubs and any invasive mullein. The desired result would be less evenly-spaced trees and more grouped in clumps to mimic the natural condition. The proposed plan for the “natural or wellness” area will require regular maintenance to simulate the custodial effects of fire (removal of pine needle accumulation, small trees, etc.), but efforts will be rewarded with increased overall biological diversity with more insects, birds, and mammals enjoying the space.



The southern section of the parcel is a dense and even-aged stand of trees that are unhealthy and at risk of undesirable fire behavior and disease. We recommend this be thinned to achieve the desired forest conditions mentioned above.



For more information on recommended treatments, see Part 5: Mitigation Recommendations on page 20.

Part 2: Fire modeling

Fire behavior modeling methodology

This area was modeled with the latest version of Farsite (FlamMap 6.1)¹³ which is the national standard for modeling fire effects. Fire activity was modeled both with a fire starting at the south end of the NAH Health Village property and in the proposed NAH open Wellness Area. This was modeled both before and after development and mitigation on the property.

All models used “us_210 LCP 40 Fire Behavior Fuel Models-Scott/Burgan (2021)” from Landfire¹⁴, which is the latest update showing the fuel models at a 30m resolution. The weather station used was the Flagstaff Airport.

All runs were started using the weather that occurred on June 28th, 2020. This time of the year is historically when the highest fire danger occurs in the area and will model the “worst case scenario”. 2020 had minimal moisture and consistently higher winds than 2021.

All models were run to show 12 hours of fire spread in 1-hour increments. With the Flagstaff Fire Department and Forest Service fire response, initial units should be on scene within the first ½ hour.

For more modeling methodology and full-size maps, see Appendix B.

¹³ FlamMap, Rocky Mountain Research Station Online: <https://www.firelab.org/project/flammap>

¹⁴ LandFire Fuel Models Online: <https://landfire.gov/fbfm40.php>

Burn Probability

A Burn Probability Model was used to locate the most fire-prone areas. This model shows where, if a fire started, the fire would have the highest likelihood of growing and spreading across the landscape. This model is based strictly on fuel, weather, and topography and does not include any development to the NAH Health Village. This shows the effect of the 1900's logging and 2009 thinning along the west side of I-17 in and around the proposed NAH Health Village. If a fire was to start in this area there would be a less than 10% chance of large fire growth.

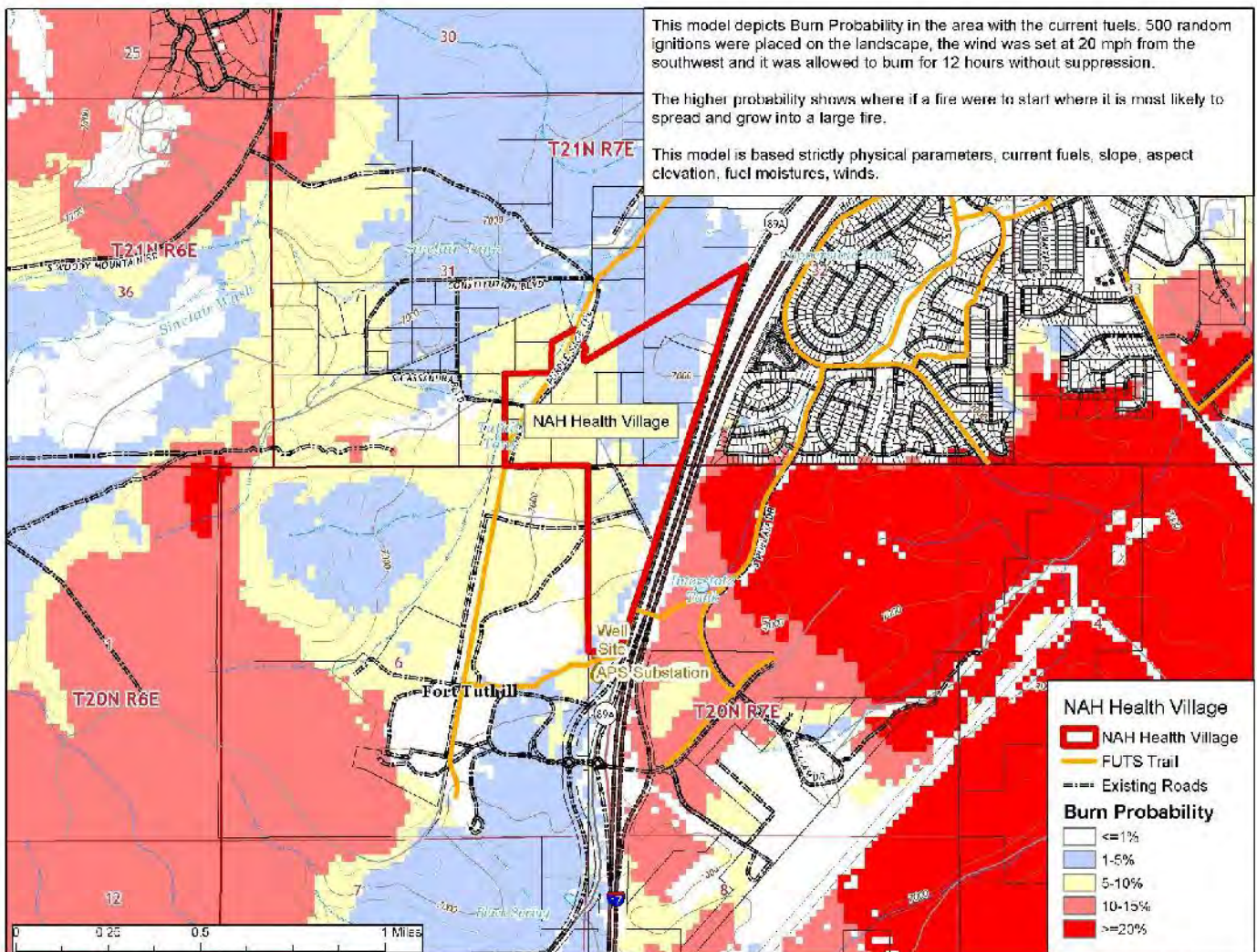


Figure 7. Burn Probability Modeling

Fire Spread

Fire Spread Models were performed with two 2-acre ignitions (one in the Wellness Area and one at the south end of the property) and run twice: (1) with the current fuels and current roadways, and (2) with the proposed NAH Medical Center and Ambulatory Center¹⁵ along with the associated roadways, parking lots, and recommended treatment to the southern area.

The first run (below) was done using the current fuels and roadways. *Note: the southern 19 acres of this property appears to have been logged in the early 1900s but was not thinned after that and has very heavy fuel loading. This area consistently shows high fire behavior and spotting across the roadways.*

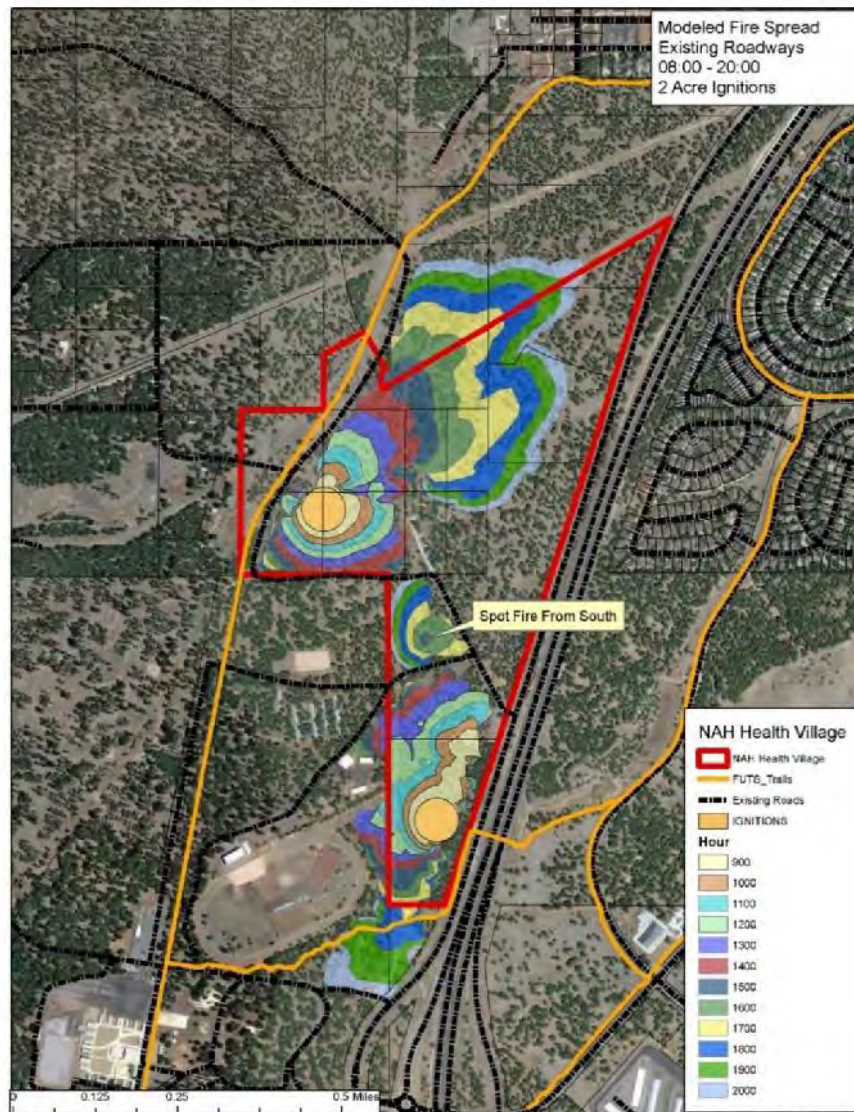


Figure 8. (1) Fire Spread Modeling with Current Fuels & Roadways

¹⁵ Shephard-Wesnitzer, Inc., File: ACAD-XB-21045-Model.dwg

This second Fire Spread Model (below) was done using the proposed roadways, Medical Center and Ambulatory Center. This also shows the results of proposed treatment to the southern portion of the property.

The decreased spread to the north of the property is due to the proposed roadways acting as a fuel break in the grass fuel type.

Note: the fire to the south remains as a surface fire with greatly minimized fire activity. This is due to proposed thinning and the lack of a grass crop in this area.

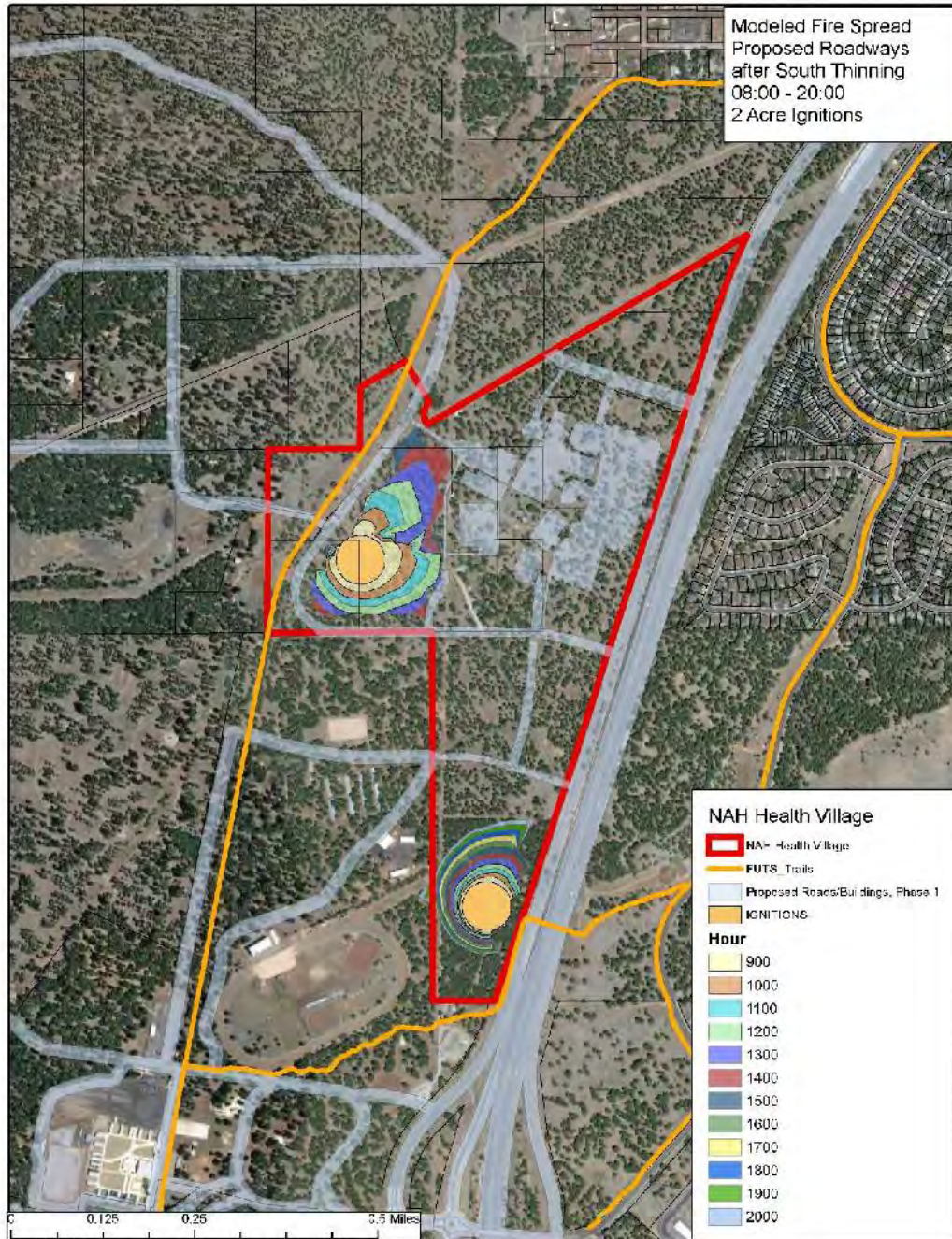


Figure 9. (2) Fire Spread Modeling with Proposed Roadways, Buildings, and Treatment

Crown Fire

Crown Fire Modeling was done with the same two 2-acre ignitions, one at the south end of the property and one in the Wellness Area.

Note: the southern 19 acres of this property appears to have been logged in the early 1900s but was not thinned after that, and has very heavy fuel loading. This area consistently shows that any fire in this area would torch and spot across roadways and fuel breaks. The crown fire would also extend onto Fort Tuthill and would impact the electrical and fiber optic lines that run across the southern end of this property.

This model was run twice: (1) with the current roadways and current fuels, and (2) with the proposed NAH Medical Center and Ambulatory Center along with the associated roadways, parking lots and recommended treatment to the southern area.

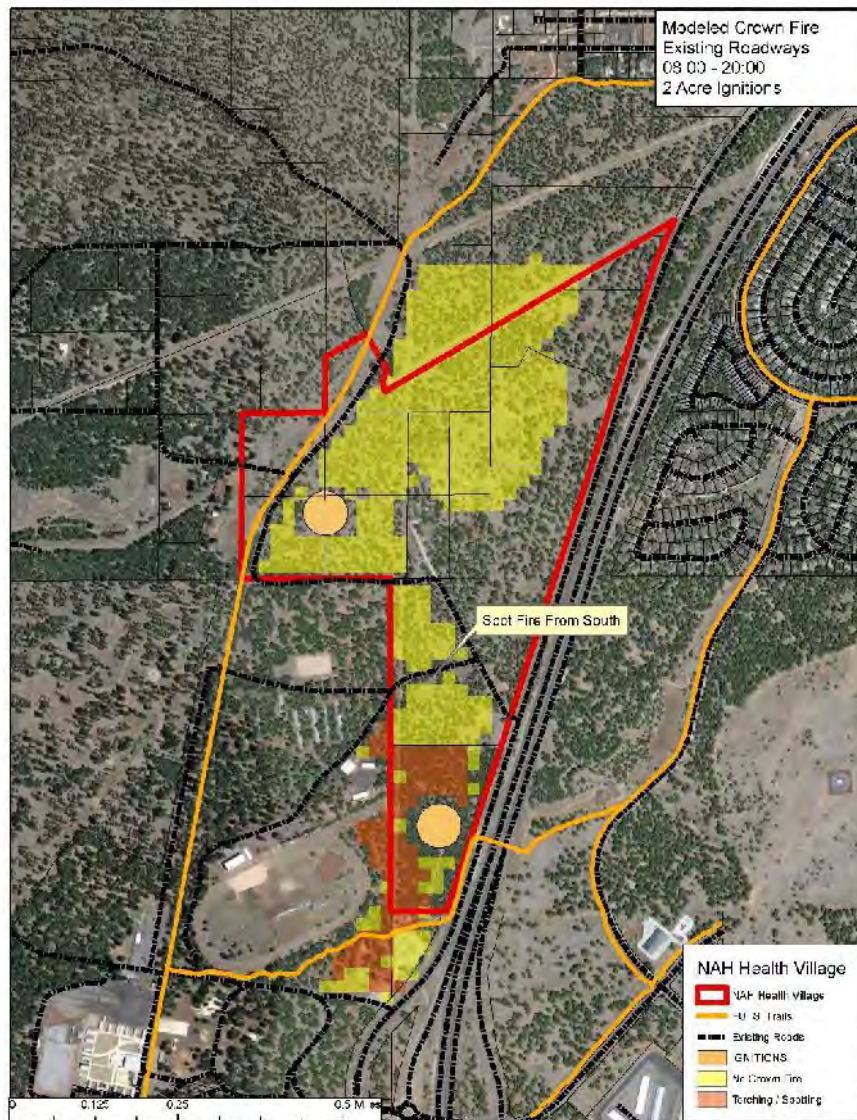


Figure 10. (1) Crown Fire Modeling with Current Fuels & Roadways

This Crown Fire Model (below) was done using the proposed roadways, Medical Center and Ambulatory Center. This also shows the results of proposed treatment to the southern portion of the property.

The lack of crown fire to the north of the property is due to the proposed roadways acting as a fuel break in the grass fuel type.

Note: the fire to the south remains as a surface fire with greatly minimized fire activity. This is due to proposed thinning and the lack of a grass crop in this area. Any fire in this area after thinning would be minimized and not impact the associated infrastructure.

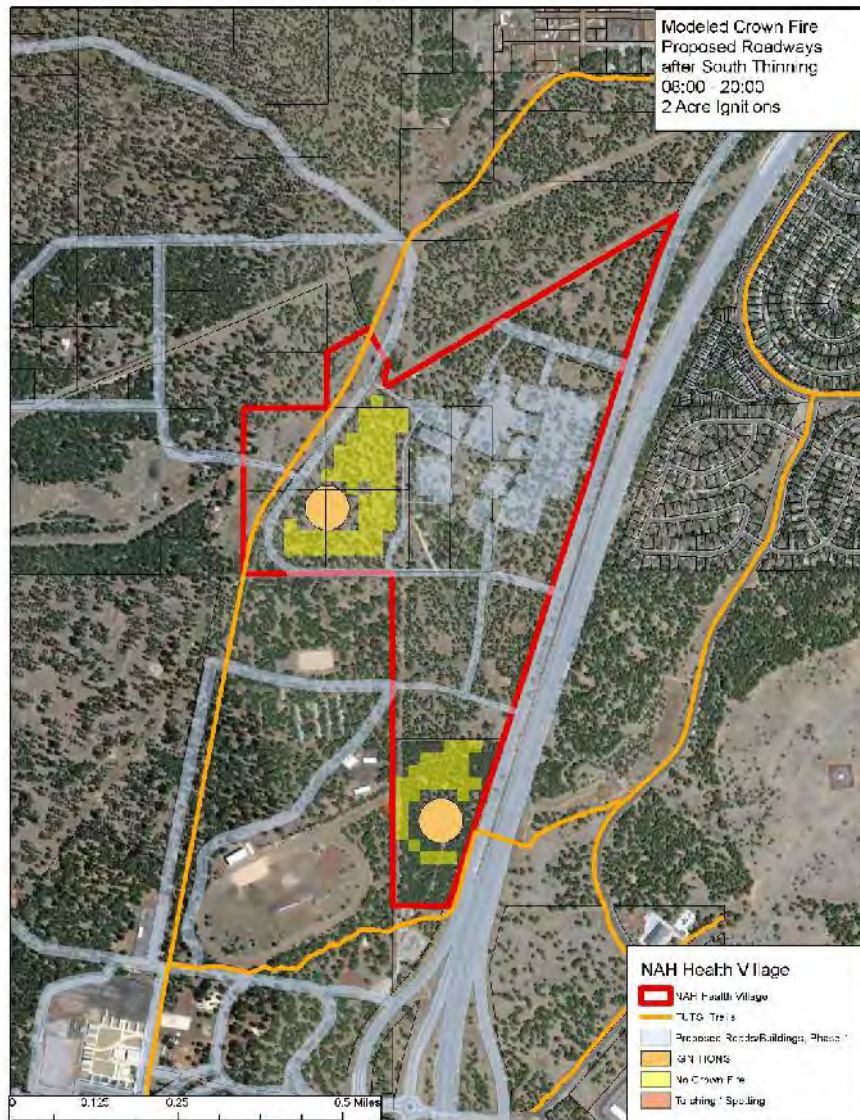


Figure 11. (2) Crown Fire Modeling with Proposed Roadways, Buildings, and Treatment

Flame Length

Flame Length Modeling was done with the same two 2-acre ignitions, one at the south end of the property and one in the Wellness Area. The first run (1) was done using the current fuels and roadways, the second run (2) was done using proposed roadways and after fuel treatment of the southern 19 acres.

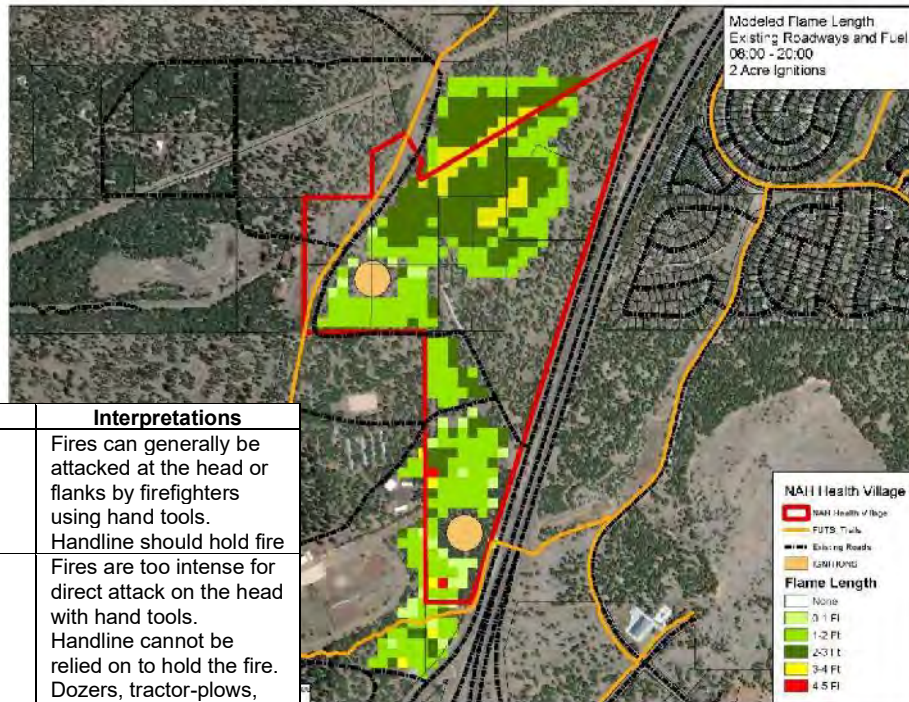


Figure 12. (1) Flame Length Modeling with Current Fuels & Roadways

Flame length	Interpretations
Less than 4 feet	Fires can generally be attacked at the head or flanks by firefighters using hand tools. Handline should hold fire
4 to 8 feet	Fires are too intense for direct attack on the head with hand tools. Handline cannot be relied on to hold the fire. Dozers, tractor-plovers, engines and retardant drops can be effective.
8 to 11 feet	Fire may present serious control problems; torching, crowning, and spotting. Control efforts at the head will probably be ineffective.
Over 11 feet	Crowning, spotting, and major fire runs are probable. Control efforts at the head of the fire are ineffective.

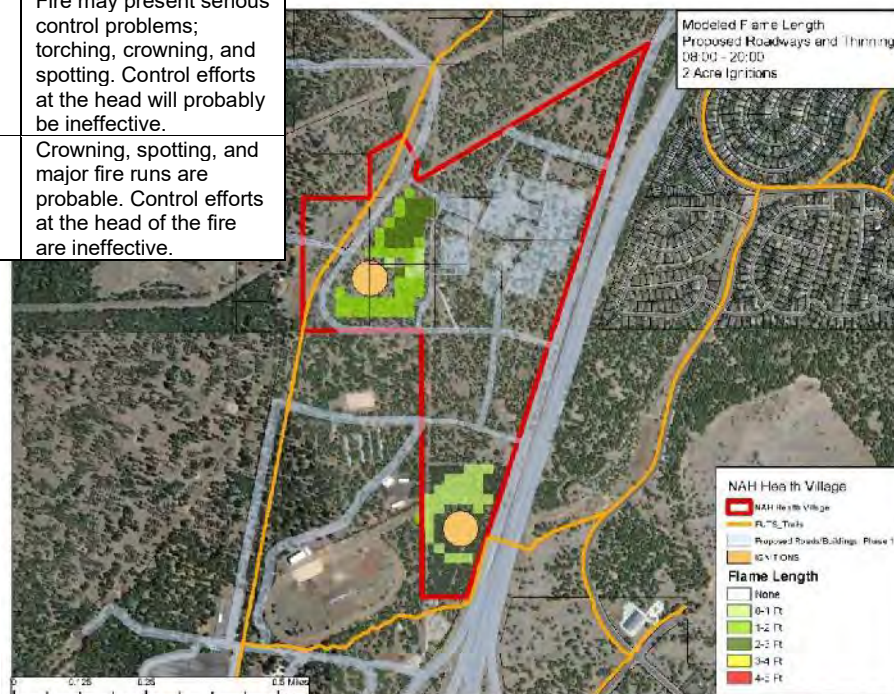


Figure 13. (2) Flame Length Modeling with Proposed Roadways, Buildings, and Treatment

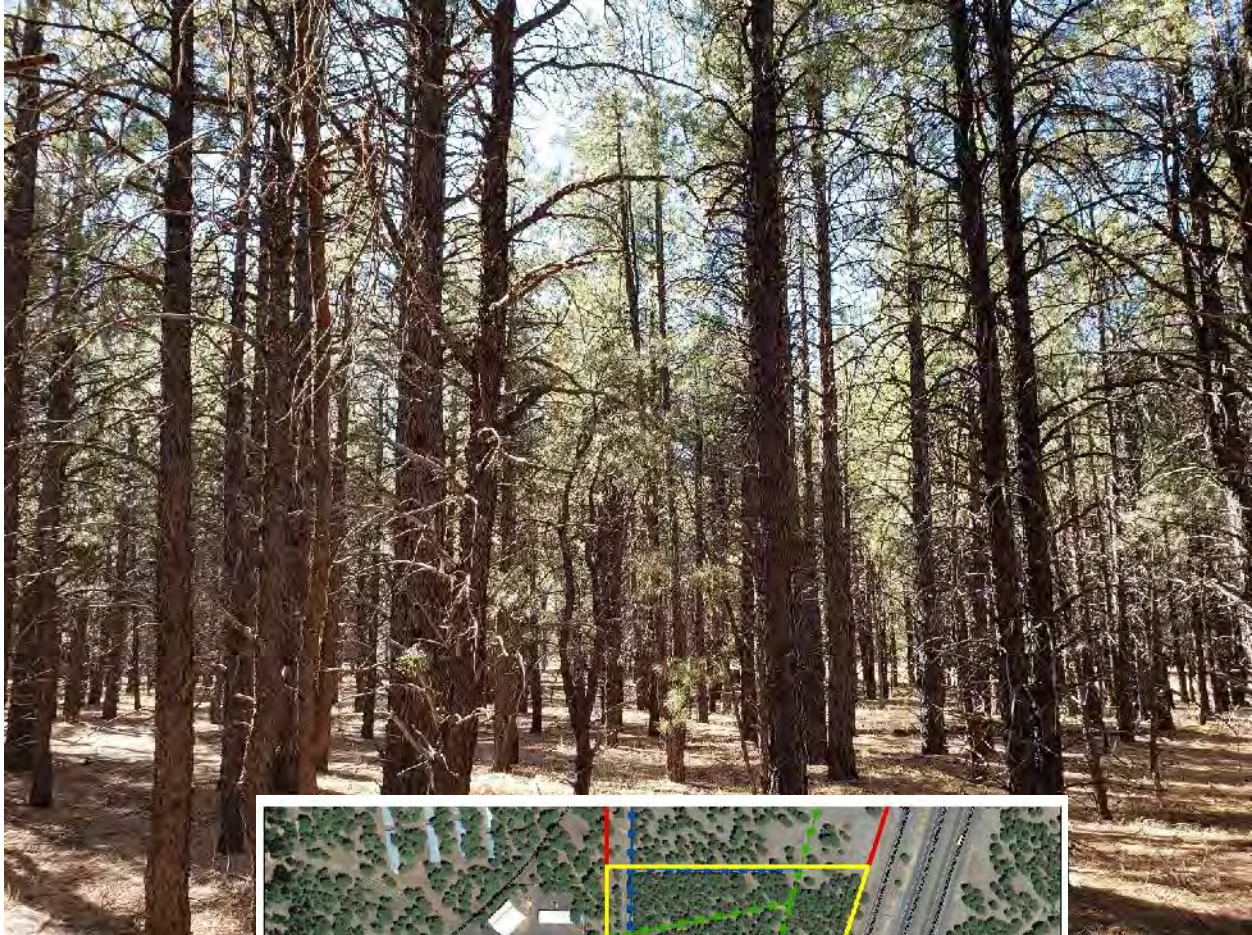
Part 3: Risk assessment

Fuels

This property has two distinct fuel types with different types of fire behavior. The northern \pm 160 acres of the property was first logged in the early 1900's and then was commercially thinned in 2009. The majority of this area is a healthy open ponderosa pine stand that has a canopy base height of greater than 10 feet. The fuels that would burn in this area are the needle-cast and grass crop that comprises the surface fuels. It is unlikely that this fire would be able to climb into the tree canopy to initiate a crown fire. The flame length in this fuel type is mainly 1-3 feet tall and would be easily suppressed.



The southern ± 19 acres of this property appears to have been logged in the early 1900's but it was not included in the 2009 treatment. This area averages several hundred trees per acre, the majority of these trees are small and sickly with available ladder fuels. If a fire were to start in this area it would most likely be able to climb into the tree crowns and spread and spot both onto Fort Tuthill and across the roadways to the north. This area would present major firefighting problems due to crown fire and rapid-fire movement.



Other Factors

1. Humans are potential ignition sources – with the proposed NAH Health Village this area would see an increase in both local and out of town visitation into the WUI area. There would be an increased possibility of ignitions in the area. This hazard could be minimized by ongoing vegetation management along with improved roadways to stop off-road travel.
2. Topography – This property is mostly flat and has minimal natural barriers to limit fire spread. This could be mitigated with improved all-weather roadways and paths throughout the property.
3. Aspect – With the flat topography aspect should not be a concern
4. Winds – The dominant winds during the summer fire season are from the southwest.
5. Vegetation – For the most part the area fuels have been treated. The northern portion of the property that was treated in 2009 will need the treatment refreshed to remove the growth from the last 12 years and to open the canopy. The southern portion will need an extensive initial thinning to minimize extreme fire behavior and impact to the park and local infrastructure.

Fire Modeling Summary

The results of the fire modeling show that with the development of NAH Health Village:

1. There is a low likelihood of crown fire on the treated portion of the property. This is due to the low flame heights and high crown base heights in this area.
2. As it currently stands the southern 19 acres of the property could have high severity crown fire that would impact the county park, water, fiber optic, and electrical infrastructure. This could be mitigated with aggressive thinning in this area.
3. The grass fuels in the area will have a minimal flame height which will increase the ability of suppression efforts.
4. With development, the addition and upgrade of existing roadways, along with the addition of all-weather paths and building pads, the grass fuels in the area would be broken up minimizing fire spread.
5. With the development and establishment of a water system and installation of fire hydrants on this property, any fire suppression, both on the property and for the surrounding areas, will be greatly enhanced.

A completed International Wildland Urban Interface Code (IWUIC) “Appendix C” Fire Hazard Severity Form for the proposed NAH Health Village development shows a rating of Low Hazard (Appendix C) if NAH Health Village complies with the mitigation measures proposed in this document.

Part 4: Suppression and code enforcement

The proposed NAH Health Village parcel is covered for Fire Suppression, and Building and Fire Code enforcement by the City of Flagstaff.

Fire suppression

The closest Flagstaff fire stations to this property are Station 6 (2.6 miles) and Station 1 (3.6 miles) both which meet the Insurance Services Office rating for the Fire Department location. The Flagstaff Fire Department has Mutual Aid Agreements with the surrounding communities when additional resources are needed. The U. S. Forest service would also respond to this area if fire threatened public lands, with the closest station located 2.8 miles away in Flagstaff.

Water supply

The current firefighting water supply for this area is either at Fort Tuthill County Park or north along Highway 89. With this development an established water supply would be installed, per Fire and Building Codes prior to building on the property. Hydrants would be installed at least every 600 feet where building development would occur. All occupied buildings would be sprinklered. This established water supply would also assist with any firefighting efforts in the surrounding area.

Fire code enforcement and plan review

Flagstaff Fire Department would be the “Authority Having Jurisdiction” (AHJ) for this area for both fire plan review/acceptance and fire code enforcement. The City of Flagstaff has adopted all or portions of the following fire and building codes:

1. 2018 International Building Code (IBC)
Online Link: <https://codes.iccsafe.org/content/IBC2018>
2. 2018 International Fire Code (IFC)
Online Link: <https://codes.iccsafe.org/content/IFC2018>
3. 2006 International Wildland Urban Interface Code (IWUI)
Online Link: <https://codes.iccsafe.org/content/IWUIC2006>

All proposed building and fire mitigation plans would have to be accepted by the AHJ and would meet the adopted standards.

Part 5: Mitigation recommendations

The following mitigation recommendations for the proposed NAH Health Village development would minimize wildland fire impacting the parcel as well as slowing fire spread across the landscape. These are general recommendations that would meet the IWUI Fire Code recommendations. This project shall comply with all City of Flagstaff fire and building code requirements.

Fuels

Under the current fuel and weather conditions, the undeveloped area that has been thinned in 2009 would be able to sustain a fast-moving low severity grass fire. It is unlikely this area would experience a sustained crown fire and suppression efforts would likely be successful due to the low flame lengths.

- Mitigation Recommendations:
 - This area was thinned in 2009 and the vegetation has grown over the last 12 years. The thinning and treatment in this area should be refreshed.
 - Increase the ponderosa crown spacing - there should be open areas between individual tree crowns or between clumps of trees.
 - Trim up all low hanging branches to a height of 6 feet or more above the ground
 - Remove all ladder fuels, small trees, etc.
 - Minimize the height of the grasses throughout the area by mowing to a height of \pm 6 inches where needed.

The 19 acres at the south end of the property has not been thinned and has an overabundance of small ponderosa that are not healthy. This area would sustain a fast-moving high intensity crown fire that would impact area infrastructure and be difficult to suppress.

- Mitigation Recommendations:
 - This area is very heavily overgrown and will need a major thinning effort. Some general recommendations:
 - Remove the majority of the smaller trees, these are not healthy and would die over time.
 - All ladder fuels should be removed.
 - The remaining larger healthy trees should be trimmed up to a minimum of 6 feet from the ground and the crowns should have open space between them.
 - Create clear space around the City well site and APS substation that are located to the south just off the property.
 - If the Fiber Optic and Electrical lines that run through the area are not going to be relocated there should be clear space along these easements.

Construction materials

- All construction material would meet or exceed both the IBC as well as the IWUI codes for flammability.
- All landscaping adjacent to buildings should be sprinklered and the FFD should have access to turn this on, thus minimizing any embers from an area fire. The recommendation for landscaping vegetation is to utilize the Arizona Cooperative Extension “Firewise Plant Materials for 3,000 ft. and Higher Elevations” (Appendix D) as much as is possible for landscaping. These identified trees, shrubs, and plants will minimize the flammability of the landscaping on the property.

Other general recommendations

- Water supply should be established with hydrants in place throughout the property.
- All of the proposed main roads should be put in with an all-weather surface to allow suppression efforts as well as break up the grass fuel crop.
- The first phase building pads (Ambulatory Center and Medical Center) should be established down to mineral soil.
- The overhead Fiber Optic/Electrical line to the east of the property should be put underground. This line is low hanging on wooden poles and has overhead transformers that may spark.
- The NAH Wellness Area that is proposed to be left in a natural state should be mowed to reduce the grass crop. This area should also have all-weather established trails bisecting the area to minimize the fire spread possibility.

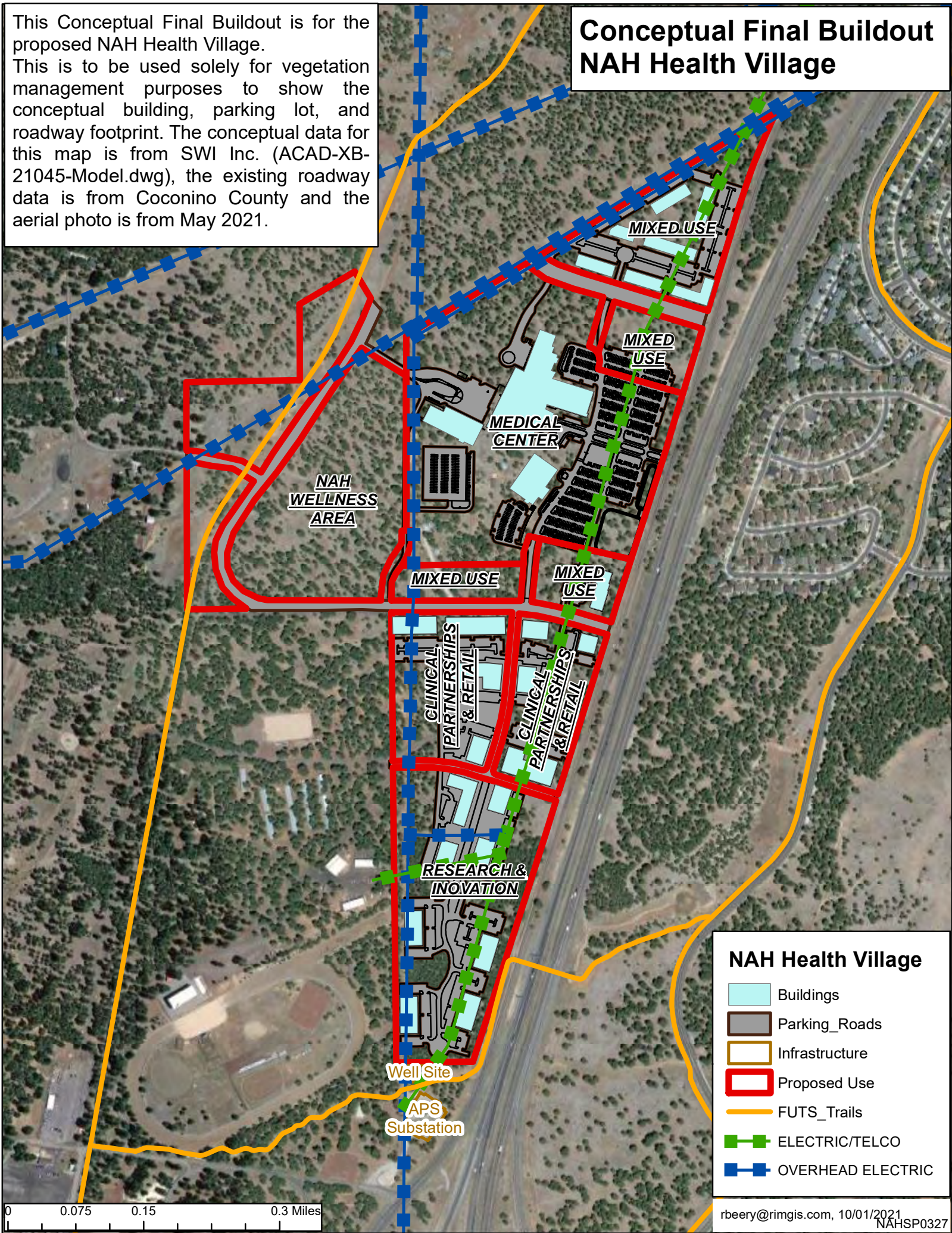
Appendix A

Conceptual Final Site Buildout Image

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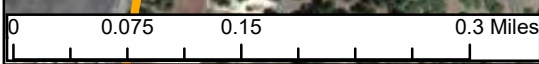
This Conceptual Final Buildout is for the proposed NAH Health Village. This is to be used solely for vegetation management purposes to show the conceptual building, parking lot, and roadway footprint. The conceptual data for this map is from SWI Inc. (ACAD-XB-21045-Model.dwg), the existing roadway data is from Coconino County and the aerial photo is from May 2021.

Conceptual Final Buildout NAH Health Village



NAH Health Village

- Buildings
- Parking_Roads
- Infrastructure
- Proposed Use
- FUTS_Trails
- ELECTRIC/TELCO
- OVERHEAD ELECTRIC



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Appendix B

Modeling Methodology and full-size modeling images

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Fire behavior modeling methodology

This area was modeled with the latest version of Farsite (FlamMap 6.1)¹ which is the national standard for modeling fire effects. Fire activity was modeled both with a fire starting at the south end of the NAH Health Village property and in the proposed NAH open Wellness area. This was modeled both before and after development and mitigation on the property.

All models used “us_210 LCP 40 Fire Behavior Fuel Models-Scott/Burgan (2021)” from Landfire², which is the latest update showing the fuel models at a 30m resolution. The Landscape was modified to show the thinning of the area between 2006-2018 within the thinned areas:

If Fuel Model was 102, “Low Load, Dry Climate Grass” it was changed to Fuel Model 188 “Long-Needle Litter” to account for the Ponderosa overstory.

This area also had the Crown Base Height raised to 3 meters to account for the lack of ladder fuels.

In the un-thinned area to the south:

If the Fuel Model was 102 “Low Load, Dry Climate Grass” or 188 “Long-Needle Litter” the fuels were changed to 183 “Moderate Load Conifer Litter” to account for the heavy fuel loading. Crown Base Height was left at 0.5 meters.

The fuel moistures were set at an initial fuel moisture of 1 hour = 3%, 10 hour = 4%, 100 hour = 5%, Grasses = 30%, Brush = 90%. The weather station used was the Flagstaff Airport (QFLA3). Gridded winds from Weather Inputs were used. The weather file (wxs) was compiled from WRCC³ for June 2020. All runs were started using the weather that occurred on June 28th, 2020. This time of the year is historically when the highest fire danger occurs in the area and will model the “worst case scenario”. 2020 had minimal moisture and consistently higher winds than 2021. Ember Spot Probability was set to 0.05 and Finney(2004) was used for Crown Fire Method.

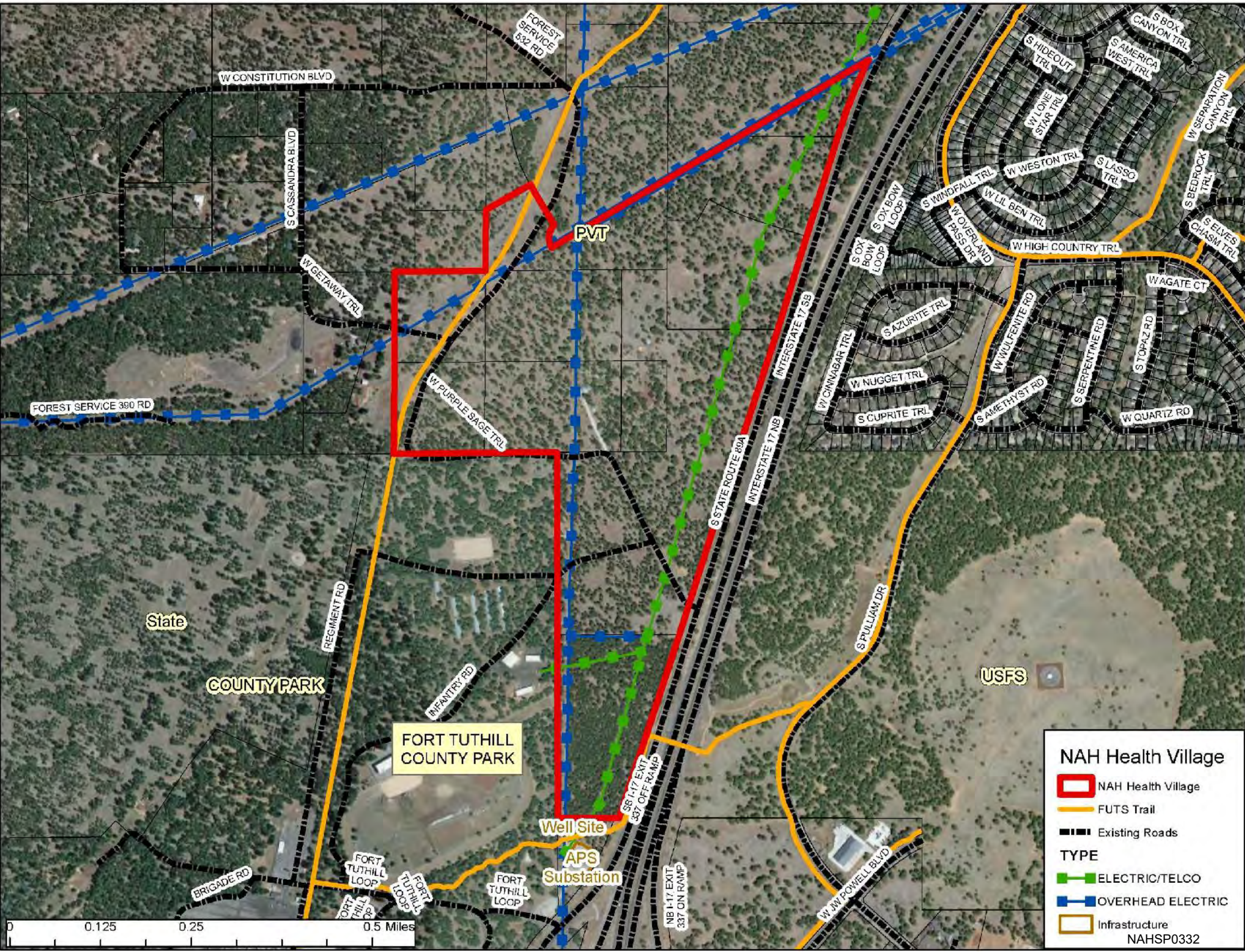
A Barrier was placed over the area roadways to simulate the fuelbreak action. In the model with NAH Health Village mitigations, the proposed roadways and parking lots were included.

All models were run to show 12 hours fire behavior (0800-2000) in 1-hour increments. With the Flagstaff Fire Department and Forest Service fire response, initial units should be on scene within the first ½ hour.

¹ FlamMap, Rocky Mountain Research Station Online: <https://www.firelab.org/project/flammap>

² LandFire Fuel Models Online: <https://landfire.gov/fbfm40.php>

³Western Region Climate Center (WRCC) Online: <https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?azAFLG>



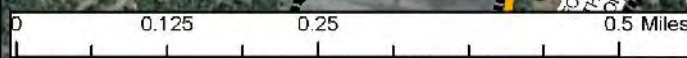
NAH Health Village

- NAH Health Village
- FUTS Trail
- Existing Roads

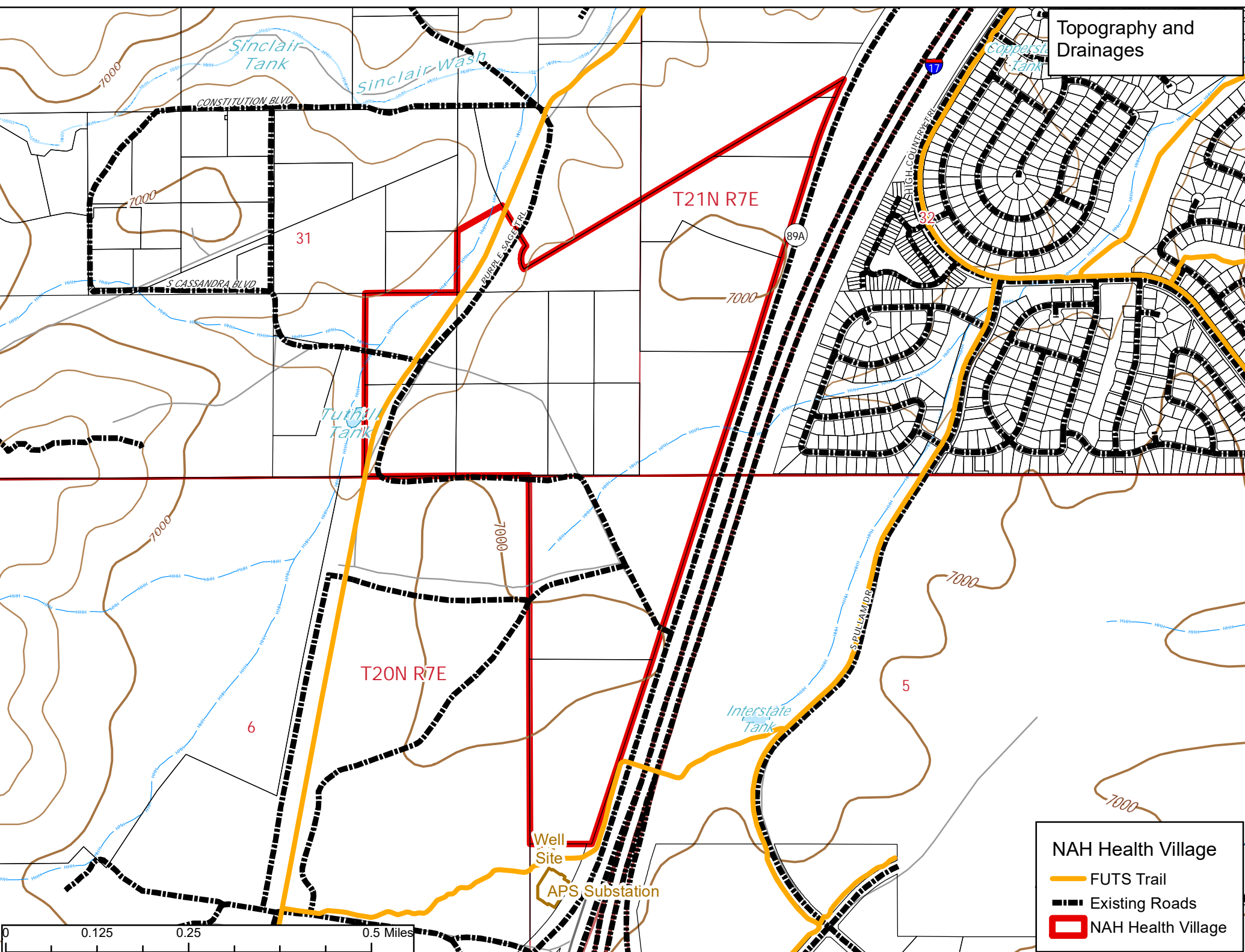
TYPE

- ELECTRIC/TELCO
- OVERHEAD ELECTRIC
- Infrastructure

NAHSP0332



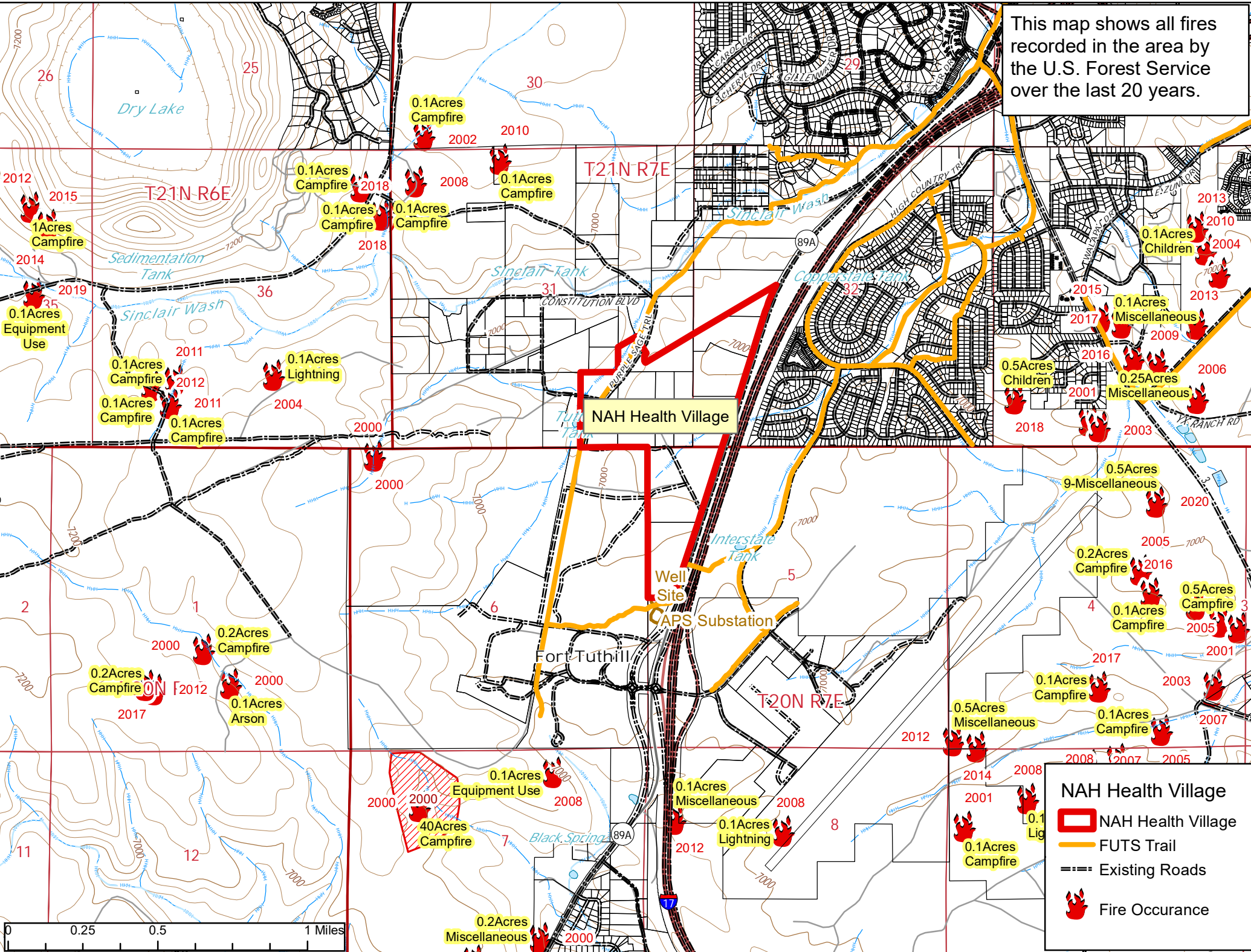
Topography and Drainages



NAH Health Village

- FUTS Trail
- Existing Roads
- NAH Health Village

This map shows all fires recorded in the area by the U.S. Forest Service over the last 20 years.



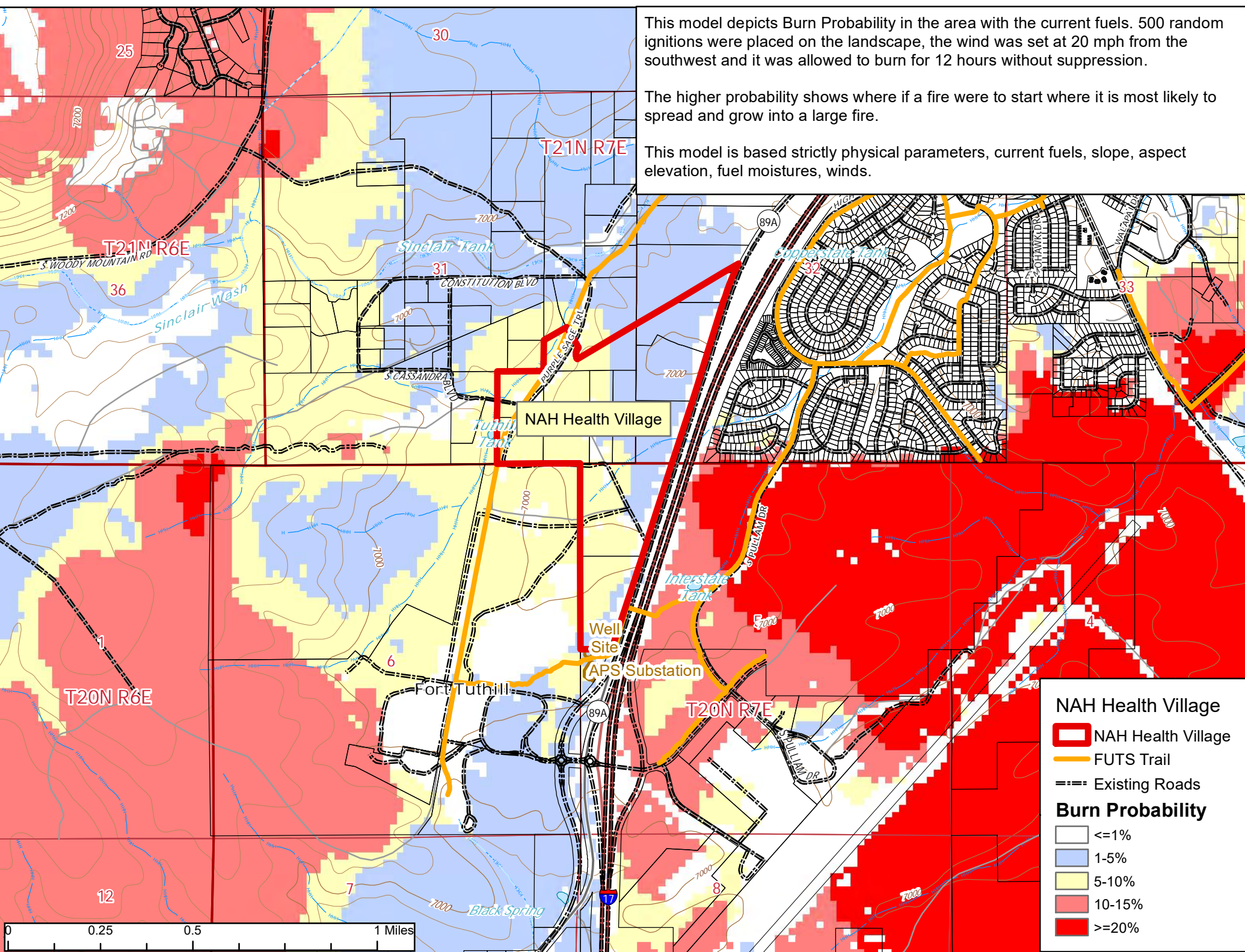
NAH Health Village

- NAH Health Village
- FUTS Trail
- Existing Roads
- 🔥 Fire Occurance

This model depicts Burn Probability in the area with the current fuels. 500 random ignitions were placed on the landscape, the wind was set at 20 mph from the southwest and it was allowed to burn for 12 hours without suppression.

The higher probability shows where if a fire were to start where it is most likely to spread and grow into a large fire.

This model is based strictly physical parameters, current fuels, slope, aspect elevation, fuel moistures, winds.



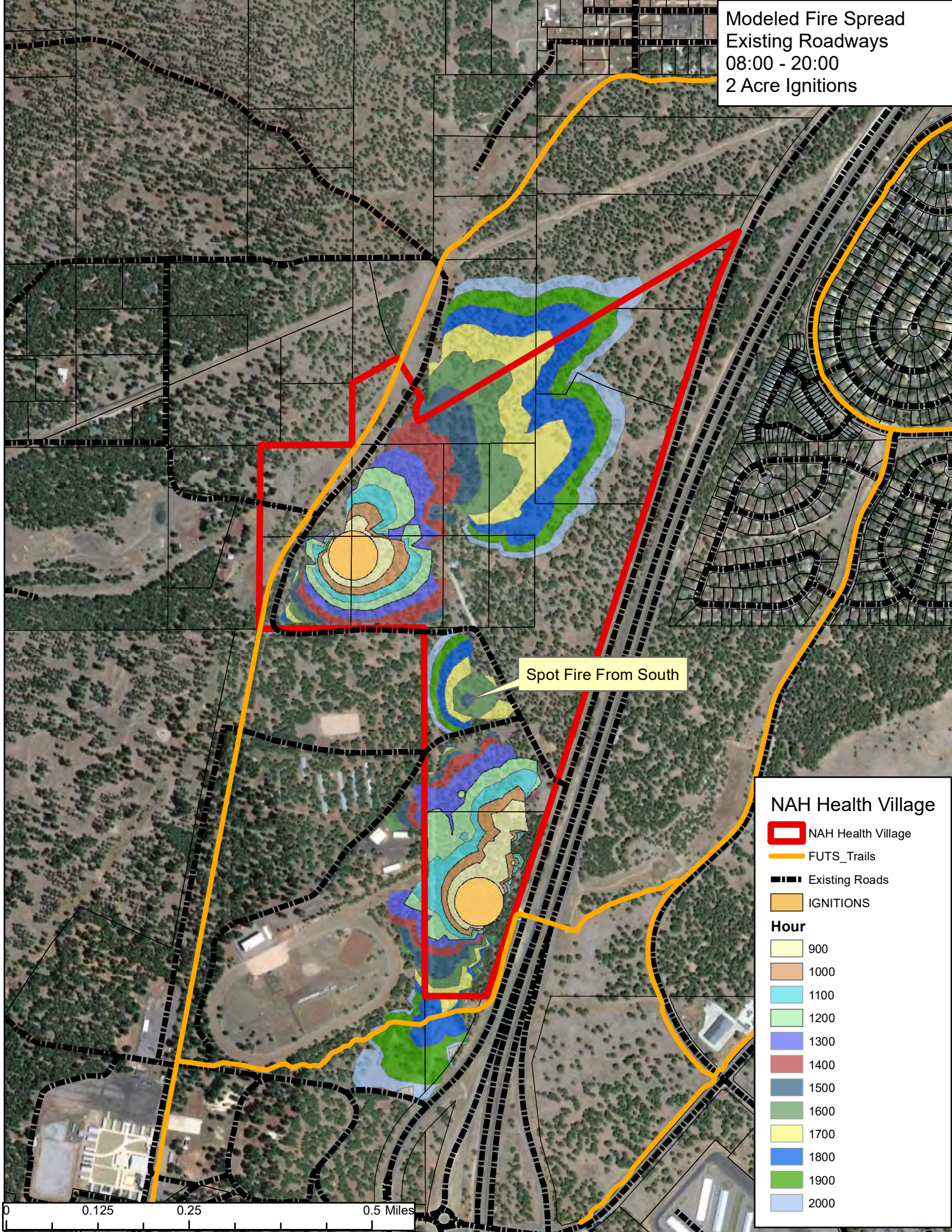
NAH Health Village

- NAH Health Village
- FUTS Trail
- Existing Roads

Burn Probability

- <=1%
- 1-5%
- 5-10%
- 10-15%
- >=20%

Modeled Fire Spread
Existing Roadways
08:00 - 20:00
2 Acre Ignitions



Spot Fire From South

NAH Health Village

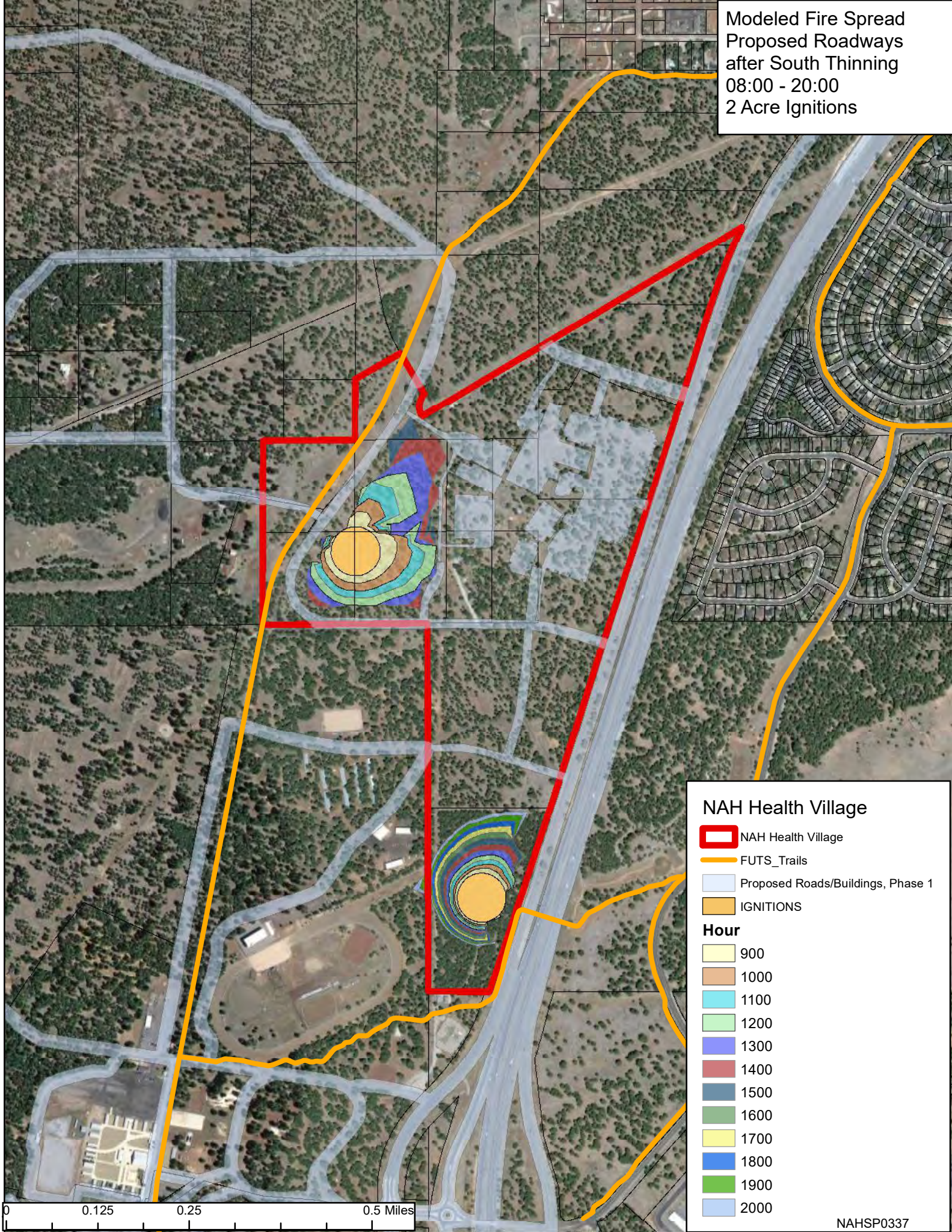
- NAH Health Village
- FUTS_Trails
- Existing Roads
- IGNITIONS

Hour

- 900
- 1000
- 1100
- 1200
- 1300
- 1400
- 1500
- 1600
- 1700
- 1800
- 1900
- 2000

0 0.125 0.25 0.5 Miles

Modeled Fire Spread
Proposed Roadways
after South Thinning
08:00 - 20:00
2 Acre Ignitions



NAH Health Village

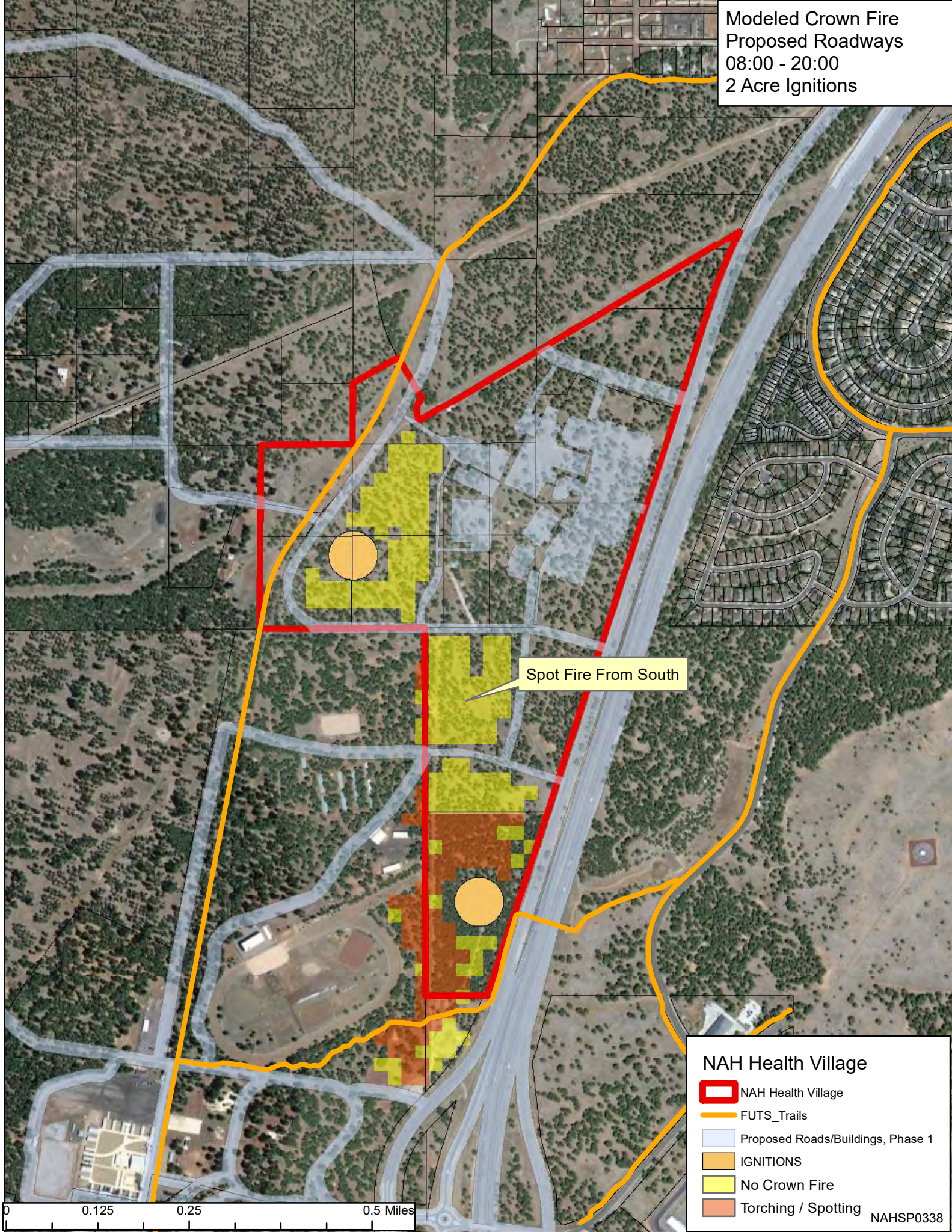
- NAH Health Village
- FUTS_Trails
- Proposed Roads/Buildings, Phase 1
- IGNITIONS

Hour

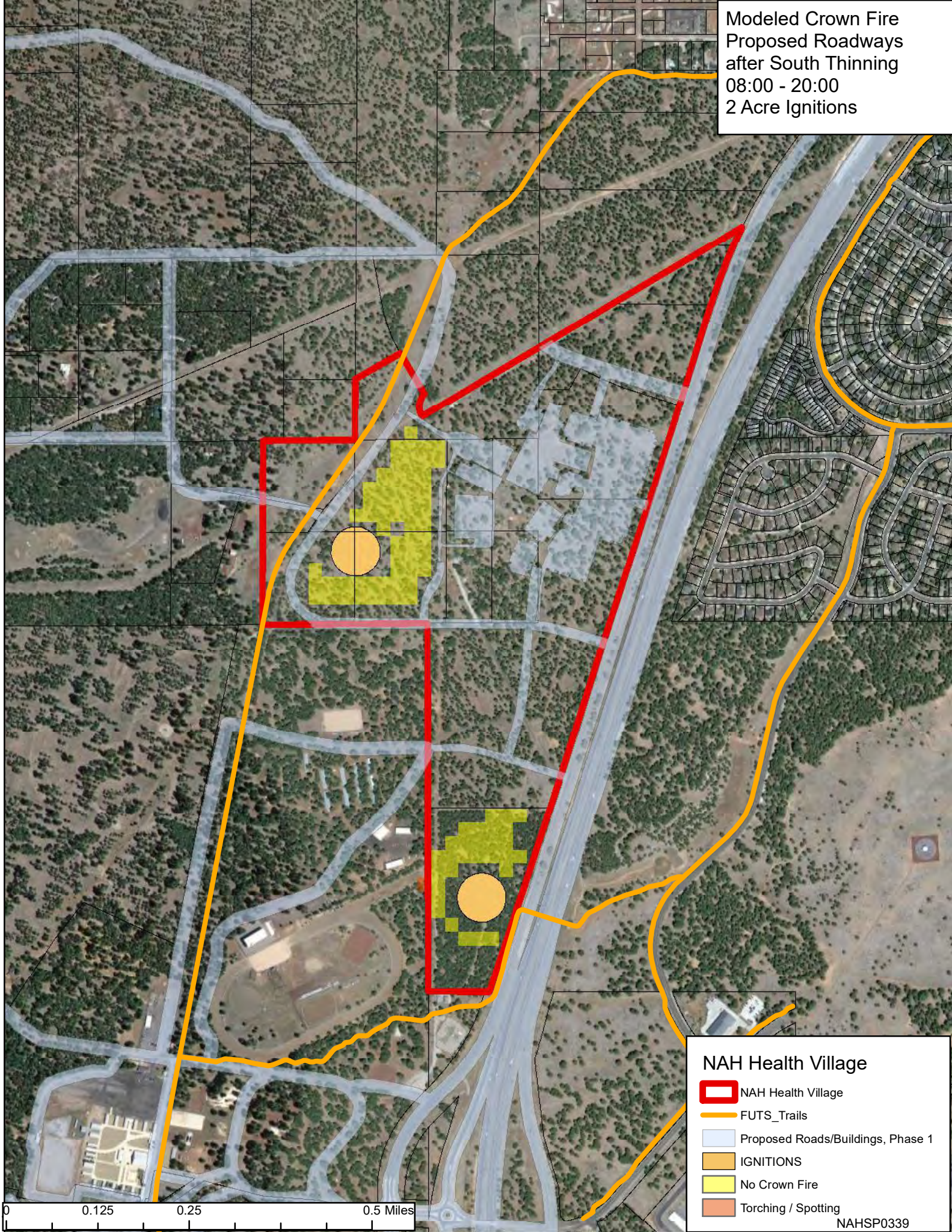
- 900
- 1000
- 1100
- 1200
- 1300
- 1400
- 1500
- 1600
- 1700
- 1800
- 1900
- 2000

0 0.125 0.25 0.5 Miles

Modeled Crown Fire
Proposed Roadways
08:00 - 20:00
2 Acre Ignitions



Modeled Crown Fire
Proposed Roadways
after South Thinning
08:00 - 20:00
2 Acre Ignitions

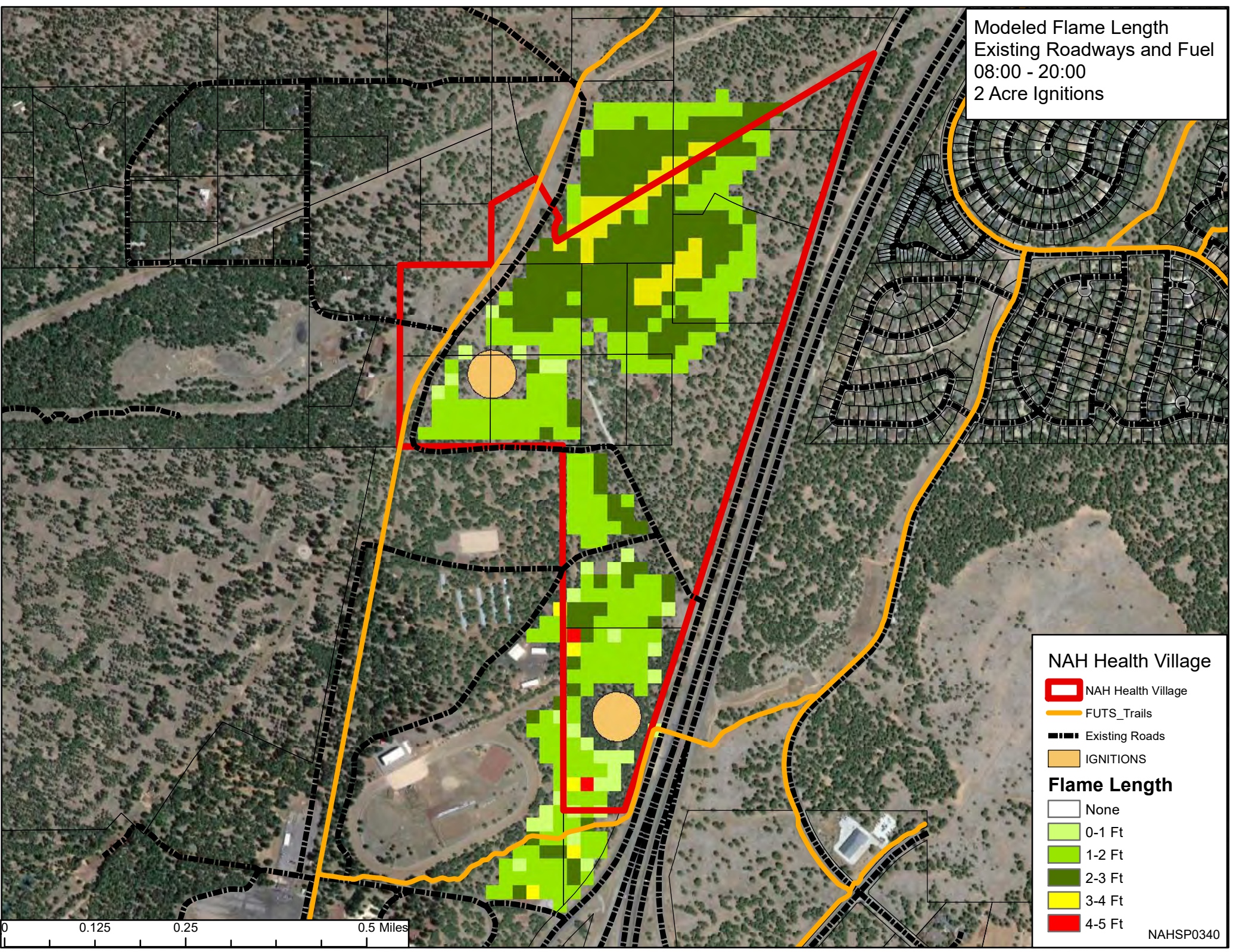


NAH Health Village





- NAH Health Village
- FUTS_Trails
- Proposed Roads/Buildings, Phase 1
- IGNITIONS
- No Crown Fire
- Torching / Spotting

NAHSP0339







Modeled Flame Length
Existing Roadways and Fuel
08:00 - 20:00
2 Acre Ignitions



NAH Health Village

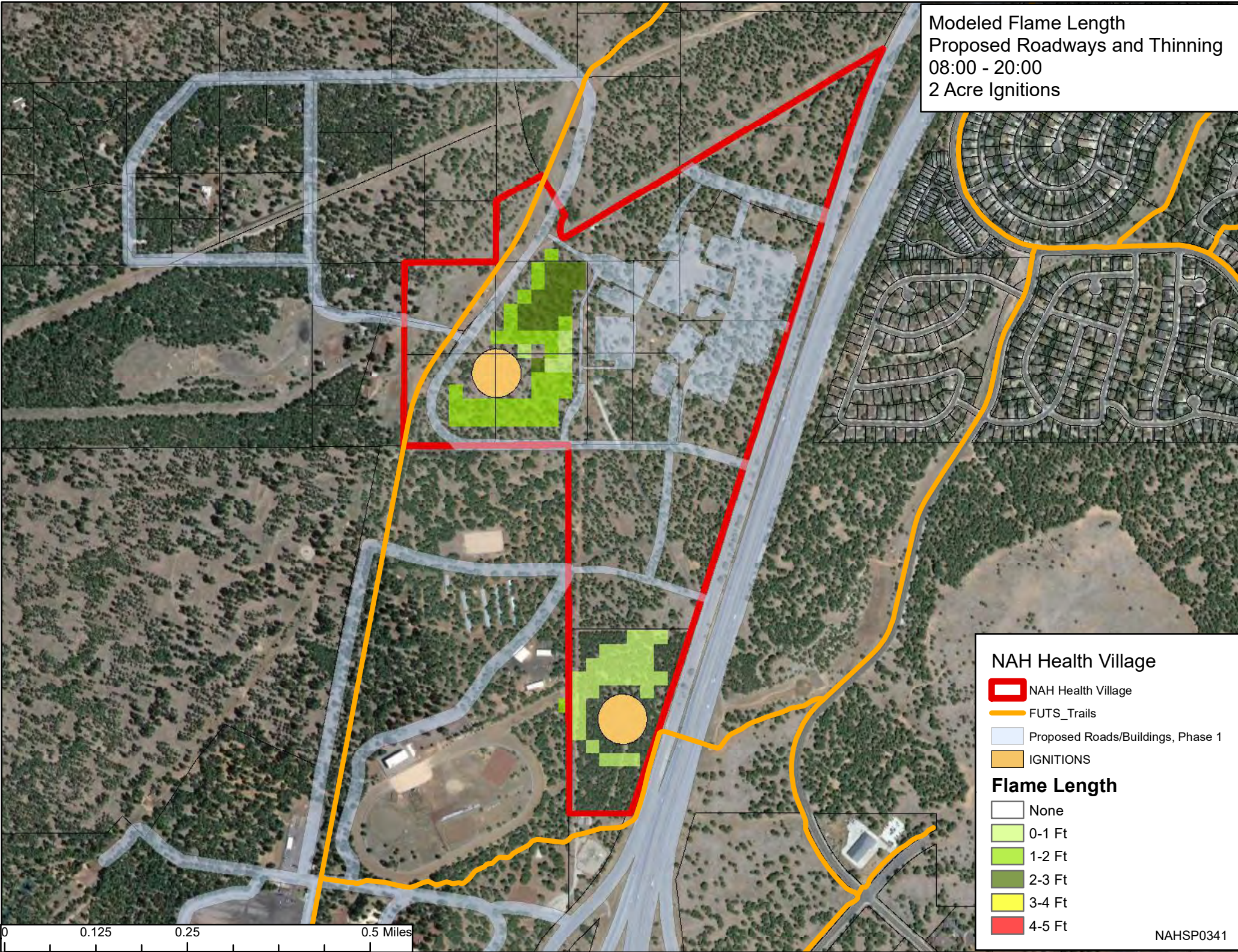
-  NAH Health Village
-  FUTA Trails
-  Existing Roads
-  IGNITIONS

Flame Length

-  None
-  0-1 Ft
-  1-2 Ft
-  2-3 Ft
-  3-4 Ft
-  4-5 Ft

0 0.125 0.25 0.5 Miles

Modeled Flame Length
Proposed Roadways and Thinning
08:00 - 20:00
2 Acre Ignitions



NAH Health Village

- NAH Health Village
- FUTS_Trails
- Proposed Roads/Buildings, Phase 1
- IGNITIONS

Flame Length

- None
- 0-1 Ft
- 1-2 Ft
- 2-3 Ft
- 3-4 Ft
- 4-5 Ft

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Appendix C

Completed IWUIC “Appendix C” Fire Hazard Severity Form for proposed Health Village

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APPENDIX C

FIRE HAZARD SEVERITY FORM

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

When adopted, this appendix is to be used in place of Table 502.1 to determine the fire hazard severity.

	Points		
A. Subdivision Design		C. Topography	
1. Ingress/Egress		8% or less	1__
Two or more primary roads	1__	More than 8%, but less than 20%	4__
One road	3__	20% or more, but less than 30%	7__
One-way road in, one-way road out	5__	30% or more	10__
2. Width of Primary Road		D. Roofing Material	
20 feet or more	1__	Class A Fire Rated	1__
Less than 20 feet	3__	Class B Fire Rated	5__
		Class C Fire Rated	10__
		Nonrated	20__
3. Accessibility		E. Fire Protection—Water Source	
Road grade 5% or less	1__	500 GPM hydrant within 1,000 feet	1__
Road grade more than 5%	3__	Hydrant farther than 1,000 feet or draft site	2__
		Water source 20 min. or less, round trip	5__
4. Secondary Road Terminus		Water source farther than 20 min., and 45 min. or less, round trip	7__
Loop roads, cul-de-sacs with an outside turning radius of 45 feet or greater	1__	Water source farther than 45 min., round trip	10__
Cul-de-sac turnaround			
Dead-end roads 200 feet or less in length	3__		
Dead-end roads greater than 200 feet in length	5__		
		F. Existing Building Construction Materials	
5. Street Signs		Noncombustible siding/deck	1__
Present	1__	Noncombustible siding/combustible deck	5__
Not present	3__	Combustible siding and deck	10__
		G. Utilities (gas and/or electric)	
B. Vegetation (IWUIC Definitions)		All underground utilities	1__
1. Fuel Types		One underground, one aboveground	3__
Light	1__	All aboveground	5__
Medium	5__		
Heavy	10__		
		Total for Subdivision	
2. Defensible Space		Moderate Hazard	40–59
70% or more of site	1__	High Hazard	60–74
30% or more, but less than 70% of site	10__	Extreme Hazard	75+
Less than 30% of site	20__		

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Appendix D

Firewise Plant Materials for 3,000ft and Higher Elevations



FIREWISE PLANT MATERIALS FOR 3,000 FT. AND HIGHER ELEVATIONS

Tom DeGomez, Jeff Schalau, Chris Jones, and Steve Campbell

Introduction

Creating defensible space around your home is one of the most important and effective steps you can take to protect you, your family, and your home from catastrophic wildfire. Defensible space is the area between a structure and an oncoming wildfire (or between a burning structure and wildland vegetation) where nearby vegetation has been modified to reduce a wildfire's intensity and ability to spread.

All vegetation, naturally occurring and otherwise, is potential fuel for fire. Its type, amount and arrangement can have dramatic effects on fire behavior. There are no "fireproof" plant species. Plant choice, spacing and maintenance are critical; where and how you plant can be more important than what species you use. However, given options, choose plant species for your landscape that are more fire resistant.

Choosing FIREWISE Plants

Keep in mind these general concepts when choosing FIREWISE plant species for your home landscape plan:

- A plant's moisture content is the most important factor governing its volatility. However, resin content and other factors in some species keep them flammable even when the plant is well watered. Conifers such as pines, firs, spruces, junipers, and Arizona cypress tend to be flammable due their oil and pitch content, regardless of moisture status or content.
- Deciduous plants tend to be more fire resistant, because their leaves have higher moisture content. Also, when trees drop their leaves in the winter, there is less fuel to carry fire through their canopies.

In some cases, drought tolerance and fire resistance are related. Here are some general plant characteristics that can provide drought tolerance and increase fire resistance in your landscape:

- Drought-adapted plants that have smaller leaves or very succulent leaves that store water.

- Salt tolerant plants that show natural fire resistance. A notable exception is salt cedar, which is highly salt tolerant but contains extremely volatile oils and burns very hot.

Plants that are more resistant to wildfire have one or more of the following characteristics:

- They grow without accumulating large amounts of combustible dead branches, needles, or leaves (e.g. aspen).
- They have open, loose branches with a low volume of total vegetation (e.g. currant and mountain mahogany).
- They have low resin content (many deciduous species).
- They have high-moisture content (succulents and some herbaceous plants).
- They grow slowly and do not need frequent pruning.
- They are short and grow close to the ground, such as small wildflowers and non-coniferous groundcovers.
- They can re-establish following a fire, reducing the costs of planting new trees (aspen, locust).

At a Glance

- FIREWISE landscaping can be aesthetically pleasing while reducing potential wildfire fuel.
- Plant choice, spacing, and maintenance are critical.
- Your landscape, and the plants in it, must be maintained to retain their FIREWISE properties.
- Many native and local species are appropriate for FIREWISE plant materials.

FIREWISE Trees

Scientific Name	Common Name	Water Needs	Sun / Shade	Mature Height	Elevation (1000')							
					3	4	5	6	7	8	9	
<i>Acer glabrum</i>	Rocky Mountain maple	M-H	S/PS/Sh	6-10	N	N	Y	Y	Y	Y	Y	Y
<i>Acer grandidentatum</i>	big-tooth maple	M-H	S/PS	10-20	N	Y	Y	Y	Y	Y	Y	Y
<i>Acer ginnala</i>	amur maple	M	S/PS	15-20	N	Y	Y	Y	Y	Y	Y	Y
<i>Acer negundo</i>	boxelder	H	S/PS/Sh	30-50	Y	Y	Y	Y	Y	Y	Y	N
<i>Alnus tenuifolia</i>	thin leaf alder	H	S/PS	10-20	N	?	Y	Y	Y	Y	Y	Y
<i>Betula occidentalis</i>	water birch	M	S/PS/Sh	20-30	N	N	Y	Y	Y	Y	Y	N
<i>Catalpa speciosa</i>	northern catalpa	M-H	S/PS	25-60	?	Y	Y	Y	Y	?	?	?
<i>Celtis reticulata</i>	netleaf hackberry	L-M	S	10-20	Y	Y	Y	Y	Y	N	N	N
<i>Cotinus coggyria</i>	purple smoketree	M	S	20-30	?	N	Y	Y	Y	?	?	?
<i>Crataegus oxyacantha</i>	English hawthorn	M-H	S	20-25	?	Y	Y	Y	Y	?	N	N
<i>Forestiera pubescens</i>	New Mexican olive	L-M	S/PS	10-20	Y	Y	Y	Y	Y	N	N	N
<i>Fraxinus pennsylvanica</i>	green ash	M-H	S	30-40	N	N	N	Y	Y	Y	Y	N
<i>Gleditsia tricanthos</i>	honeylocust	M	S	35-70	Y	Y	Y	Y	Y	N	N	N
<i>Juglans major</i>	Arizona walnut	M-H	S	20-40	Y	Y	Y	Y	Y	N	N	N
<i>Malus spp.</i>	crabapple	M-H	S	8-30	Y	Y	Y	Y	Y	Y	Y	?
<i>Platanus x acerifolia</i>	sycamore or London planetree	M-H	S	20-80	?	?	Y	Y	Y	Y	Y	?
<i>Populus acuminata</i>	lanceleaf cottonwood	H	S	40-70	Y	Y	Y	Y	Y	Y	Y	N
<i>Populus angustifolia</i>	narrow-leaf cottonwood	H	S	30-90	N	Y	Y	Y	Y	Y	Y	Y
<i>Populus tremuloides</i>	quaking aspen	H	S	20-60	N	N	N	Y	Y	Y	Y	Y
<i>Prunus americana</i>	American wild plum	M	S/PS	10-20	Y	Y	Y	Y	Y	Y	Y	?
<i>Prunus virginiana</i>	western chokecherry	H	S/PS	10-30	N	Y	Y	Y	Y	Y	Y	N
<i>Prunus padus</i>	mayday tree	M-H	S	15-29	N	N	Y	Y	Y	Y	Y	N
<i>Robinia neomexicana</i>	New Mexico locust	L	S/PS	10-20	Y	Y	Y	Y	Y	Y	Y	N
<i>Robinia pseudoacacia</i>	black locust	L	S/PS	50-75	Y	Y	Y	Y	Y	Y	Y	N
<i>Sambucus nigra</i>	mexican elder/blue elderberry	M	S/PS	10-20	N	Y	Y	Y	Y	Y	Y	Y

Grasses

Scientific Name	Common Name	Seeding Rate (lbs/acre)	Water Needs	Cool/ Warm Season	Sun/ Shade	Mature Height (feet)	Elevation (1000')						
							3	4	5	6	7	8	9
<i>Achnatherum hymenoides</i>	Indian ricegrass	5	9- 13"	Cool	S	1-2, B	Y	Y	Y	Y	Y	N	N
<i>Agropyron smithii</i>	western wheatgrass	10	11 - 17"	Cool	S	1-2, S	N	Y	Y	Y	Y	N	N
<i>Bouteloua curtipendula</i>	sideoats grama	3-4	12 - 16"	Warm	S	2-3, B	Y	Y	Y	Y	Y	N	N

Sun/Shade: S = full sun, PS = partial sun, Sh = shade

Mature Height: feet, B = bunchgrass, S = sod forming

Water Needs: VL = very low, L = low, M = moderate, H = high

Elevation in 1000': Y = yes, N = not recommended, ? = unknown or doubtful

Grasses (cont'd)

Scientific Name	Common Name	Seeding Rate (lbs/acre)	Water Needs	Cool/Warm Season	Sun/Shade	Mature Height (feet)	Elevation (1000')						
							3	4	5	6	7	8	9
<i>Bouteloua dactyloides</i>	buffalograss	3-4	12 - 16"	Warm	S	1, S	Y	Y	Y	N	N	N	N
<i>Bouteloua gracilis</i>	blue grama	4-8	VL-L	Warm	S	1, S	N	Y	Y	Y	Y	Y	N
<i>Elymus elymoides</i>	bottlebrush squirreltail	8-10	VL-L	Cool	S-PS	1-2, B	Y	Y	Y	Y	Y	Y	Y
<i>Festuca arizonica</i>	Arizona fescue	3	VL-L	Cool	S-PS	2-3, B	N	N	N	N	Y	Y	Y
<i>Hesperostipa comata</i>	needle-and-thread	8	VL-L	Cool	S	1-2, B	Y	Y	Y	Y	Y	Y	N
<i>Hilaria jamesii</i>	galleta grass	3-4	9-12"	Warm	S	1-2, B	Y	Y	Y	Y	Y	N	N
<i>Koeleria macrantha</i>	Junegrass	1-2	VL-L	Cool	S-PS	1-2, B	N	Y	Y	Y	Y	Y	Y
<i>Leptochloa dubia</i>	green sprangletop	6	L	Warm	S	1-2, B	Y	Y	Y	Y	Y	N	N
<i>Muhlenbergia rigens</i>	deergoass	1-2	L-M	Warm	S	2-5, B	Y	Y	Y	Y	Y	Y	N
<i>Muhlenbergia wrightii</i>	spike muhly	2	12 - 16"	Warm	S	1-2, B	Y	Y	Y	Y	Y	Y	Y
<i>Poa fendleriana</i>	muttongrass	1-2	VL-L	Cool	PS	1-2, B	Y	Y	Y	Y	Y	Y	Y
<i>Sporobolus cryptandrus</i>	sand dropseed	2	VL-L	Warm	S	2-3, B	Y	Y	Y	Y	Y	N	N
<i>Stipa hymenoides</i>	Indian ricegrass	5	9 - 13"	Cool	S	1-2, B	Y	Y	Y	Y	Y	N	N

FIREWISE Shrubs

Scientific Name	Common Name	Water Needs	Sun / Shade	Mature Height	Elevation (1000')							
					3	4	5	6	7	8	9	
<i>Acer glabrum</i>	Rocky Mountain maple	M-H	S/PS/Sh	6-10	N	N	Y	Y	Y	Y	Y	Y
<i>Agave parryi</i>	mescal/Parry's agave	VL	S	2-12	N	Y	Y	Y	Y	Y	Y	N
<i>Amelanchier alnifolia</i>	Saskatoon alder-leaf / serviceberry	L-M	S	6-15	N	Y	Y	Y	Y	Y	Y	Y
<i>Amelanchier utahensis</i>	Utah serviceberry	VL-M	S	5-10	Y	Y	Y	Y	Y	Y	N	N
<i>Amorpha fruticosa</i>	false indigo, indigobush	M-H	S/PS	2-3	Y	Y	Y	Y	Y	Y	N	N
<i>Arctostaphylos uva-ursi</i>	kinnikinnick, bearberry	M-H	PS/Sh	1-2	N	N	N	N	Y	Y	Y	Y
<i>Atriplex canescens</i>	four-wing saltbrush	L	S	3-6	Y	Y	Y	Y	Y	Y	N	N
<i>Berberis fremontii</i>	Fremont's mahonia	L	S	6-8	Y	Y	Y	Y	Y	Y	N	N
<i>Berberis repens</i>	creeping barberry/creeping mahonia	L-H	S/Sh	1-2	?	Y	Y	Y	Y	Y	Y	Y
<i>Ceanothus fendleri</i>	buckbush, Fendler's ceanothus	M	S	2	N	N	Y	Y	Y	Y	Y	Y
<i>Cercocarpus intricatus</i>	dwarf mountain mahogany	VL-L	S	4-6	?	?	Y	Y	Y	?	?	N
<i>Cercocarpus montanus</i>	mountain mahogany	L-M	S/PS	6-8	N	Y	Y	Y	Y	Y	N	N
<i>Chrysothamnus spp.</i>	rabbitbrush	VL-L	S	2-4	Y	Y	Y	Y	Y	Y	Y	Y
<i>Cornus sericea</i>	red osier dogwood	H	S/Sh	4-6	N	Y	Y	Y	Y	Y	Y	Y
<i>Dasiphora fruticosa</i>	shrubby cinquefoil	M	S/PS	2-3	N	N	N	Y	Y	Y	Y	Y
<i>Fallugia paradoxa</i>	Apache plume	VL-L	S	2-4	Y	Y	Y	Y	Y	Y	Y	N
<i>Fendlera rupicola</i>	cliff fendlerbush	L-M	S/PS	4-6	Y	Y	Y	Y	Y	Y	N	N
<i>Holodiscus dumosus</i>	ocean spray/ rock cliff/ rock spirea	L-M	S/PS	4	N	N	Y	Y	Y	Y	Y	Y
<i>Lonicera involucrata</i>	twin-berry/bearberry honeysuckle	M-H	PS/Sh	4	N	N	N	N	Y	Y	Y	Y
<i>Nolina microcarpa</i>	beargrass/sacahuista	VL-L	S	3	Y	Y	Y	Y	N	N	N	N
<i>Opuntia spp.</i>	cholla and prickly pear cactus	VL-L	S	3	Y	Y	Y	Y	Y	Y	N	N

FIREWISE Shrubs (cont'd)

Scientific Name	Common Name	Water Needs	Sun / Shade	Mature Height	Elevation (1000')						
					3	4	5	6	7	8	9
<i>Penstemon ambiguus</i>	sand penstemon	VL-L	S	1-3	Y	Y	Y	Y	N	N	N
<i>Physocarpus monogynus</i>	mountain ninebark	M	S/Sh	2-4	N	N	N	N	N	Y	Y
<i>Ribes aureum</i>	golden currant	M	S/PS	2-3	N	Y	Y	Y	Y	N	N
<i>Rosa woodsii</i>	Wood's wild rose	M	S/PS	2-3	N	N	Y	Y	Y	Y	Y
<i>Shepherdia argentea</i>	silver buffaloberry	M	S/PS	10-15	?	?	Y	Y	N	N	N
<i>Symphoricarpos spp.</i>	snowberry	M-H	S/PS	2-3	Y	Y	Y	Y	Y	Y	Y
<i>Syringa vulgaris</i>	common lilac	M	S	6-8	Y	Y	Y	Y	Y	Y	Y
<i>Yucca baccata</i>	banana yucca	VL-L	S	2-3	Y	Y	Y	Y	Y	N	N
<i>Yucca elata</i>	soaptree yucca	VL-L	S	3-15	Y	Y	Y	Y	N	N	N
<i>Yucca glauca</i>	Great Plains yucca	VL-L	S	2-3	Y	Y	Y	Y	Y	Y	N

Sun/Shade: S = full sun, PS = partial sun, Sh = shade

Mature Height: feet, B = bunchgrass, S = sod forming

Water Needs: VL = very low, L = low, M = moderate, H = high

Elevation in 1000': Y = yes, N = not recommended, ? = unknown or doubtful

Designing the Landscape

When planning a FIREWISE landscape consider the following:

- The plants nearest your home should be more widely spaced and smaller than those farther away. Landscape according to the recommended defensible-space zones.
- Choose plants of high moisture content and low potential for flammability in particular, and remove and avoid highly resinous plants in this area.
- Plant in small, irregular clusters and islands, not in largemasses.
- Break up the continuity of the vegetation with decorative rock, gravel, and stepping stone pathways. This will slow the spread of fire across your property
- Use a variety of plant species to support a mixed and healthy landscape. Diversity of plants in the landscape will result in fewer insects and diseases and will better resist catastrophic fires.

Don't Forget Maintenance

A landscape is a dynamic, constantly changing system. Your landscape and the plants in it must be maintained to retain their FIREWISE properties.

- Rake up and dispose of excess litter as it builds up over the season.
- Remove annual plants after they have gone to seed or when the stems dry out.

- Remove any damaged plant parts. Timely pruning is critical. It reduces fuel volume and maintains healthier plants with more succulent, vigorous growth.
- Mow or trim grasses to a low height within your defensible space. Keep grass shortest in the inner part of your defensible space and no more than 6 inches high in the outer portions.
- Be particularly vigilant with maintenance activities during seasons of high fire danger.
- Use mulch to conserve moisture and reduce weed growth. Mulch can be organic (wood chips or small bark pieces) or inorganic (gravel or rock). Avoid pine bark, thick layers of pine needles or other materials that can easily catch fire.
- In the event of drought and water rationing, prioritize the plants you wish to save. Provide supplemental water to those nearest your home.
- Water trees and other plants during the winter dry periods, before water rationing becomes necessary in the summer.

List of Fire Resistant Plant Materials for Arizona

The list of trees and shrubs in this bulletin are plants that are known to have fire resistant characteristics. No annual, biennial, or perennial flowers are listed; however, most do have fire resistant characteristics. Given the arid climate of

Arizona and the fact that some of the species listed have higher water requirements, homeowners are encouraged to work closely with their county extension agent or a local plant materials specialist in selecting plants for use in their home landscape.

The listed grasses may also be used to reduce erosion or as landscape plants.

This publication is based on and borrowed heavily from publications titled "FIREWISE Plant Materials" by Chuck Dennis of the Colorado State Forest Service, Colorado State University and also by New Mexico State University Cooperative Extension Service. FIREWISE is a multi-agency program that encourages the development of defensible space and the prevention of catastrophic wildfire.



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This information has been reviewed by University faculty.
cals.arizona.edu/pubs/natresources/az1289.pdf

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