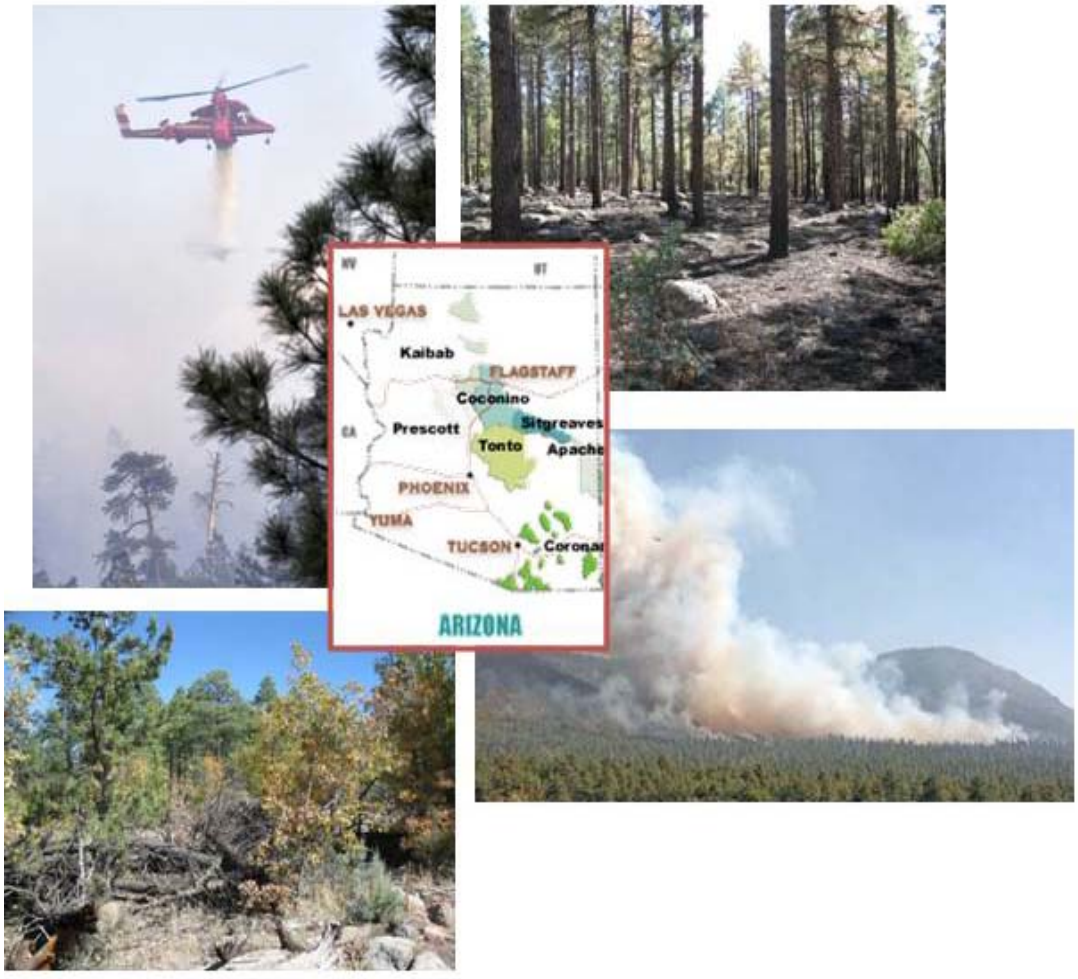
Twin Prescribed Fire
Escaped Fire Review

Kaibab National Forest
November 16, 2009



Williams Ranger District
Williams, Arizona

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EXECUTIVE SUMMARY

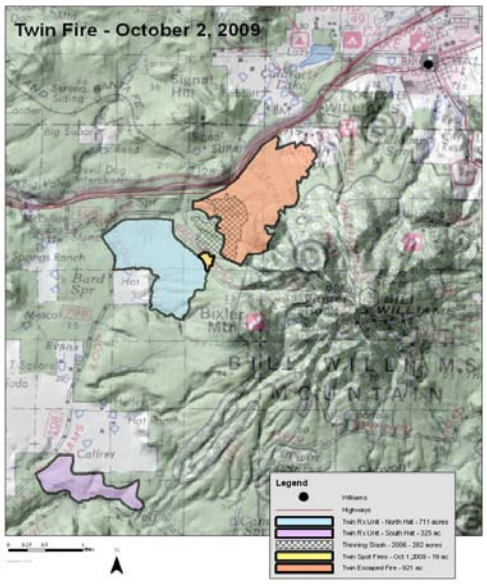


Figure 1. Twin Prescribed Fire Units and Vicinity.

On Thursday October 1, 2009, the Twin Prescribed Fire was ignited southwest of the town of Williams, AZ. Several spots occurred outside of the burn unit that afternoon. The next morning more spots were found east of the burn unit in heavy fuels and relatively inaccessible terrain. One of these spots became established beyond the capacity for control by ground forces resulting in an escape and a subsequent conversion to wildfire.

The Kaibab NF Forest Supervisor convened a review team to review key causal factors leading to the escape and subsequent wildfire declaration. The Review Team interviewed personnel associated with the implementation of the burn, and reviewed and examined the written record of events and actions leading up to the escape.

The Review Team found four causal factors contributing to the escape and conversion to wildfire. These four are:

- **Wind Direction Shift** - An unforecasted wind direction change resulted in a decision to change ignition operations to prevent established fire from reaching the east control line without a black buffer to protect it. Spot fires that ultimately led to the escape occurred on the east side of the burn unit and presented greater difficulty for holding due to complex terrain and changing fuel types outside the unit.
- **Exceeding Relative Humidity Parameter in Prescription in Combination with Changing Wind Direction** - Prescribed burning continued when actual relative humidity levels dropped below prescribed ranges, contributing to spot fire propagation and growth. It is not known if this situation alone would have caused escape of the prescribed fire – it did not in the other burn unit.**Fuel Type Differences Outside the Burn Unit -** Fuel loading northeast of the burn unit changes significantly to a heavier fuel type increasing resistance to control.
- **Contingency Resource Identification in the Burn Plan** - Contingency resources for this burn plan were calculated for fuel models and terrain inside the burn unit which differed significantly from terrain and fuels outside the burn unit. The resource capabilities were not adequate for the differing fuels and terrain.

Recommendations from the Review Team include:

- Ensure compliance with policy and direction regarding prescribed burn planning and implementation.
- Improve specificity and clarity of burn plans.
- Complete detailed reconnaissance of burn units and surrounding area.
- Verify weather forecasts and compare with prescription parameters.
- Ensure position qualifications, task book requirements, and documentations are complete and meet requirements.
- Increase integration and communication between resource areas to prevent conflicting management objectives.

Acronyms and terms used in this report are defined in the glossary at the end of the document.

INTRODUCTION

The Kaibab National Forest is located in northwestern Arizona and contains three Ranger Districts. The Williams Ranger District is the southern-most District on the Forest, situated around the town of Williams, AZ and bisected by Interstate Highway 40.

Throughout the Williams Ranger District, forest vegetation has increased in size and density due to a variety of reasons. As a result, the likelihood for high intensity wildland fire within this area is rapidly increasing. There is a growing need to implement fuel reduction measures that will decrease the risk of high intensity, stand-replacement wildland fire occurrence, limit potential for spread of wildland fire onto private property and into the City of Williams' watershed, and decrease firefighter exposure and risk to public safety during wildland fire situations.

In response to this situation, the Williams Ranger District has proposed and planned an aggressive prescribed fire project designed to alter fuel complexes and reduce potential fire intensity and spread rates around the town of Williams, AZ. Intensive treatments have been developed for implementation in areas within ⅛ mile of private land. These areas are considered to be the last line of defense against an advancing fire threatening private property. Those areas more than ⅛ mile from private land and the project boundaries will be treated to maintain natural fuels in conditions characterized by low volumes of dead and down woody material.

These actions are consistent with goals and objectives outlined in the Kaibab Forest Plan (Kaibab NF 1988 – 2004), the Williams Fire District Risk Assessment (Kaibab NF 1997), and the National Fire Plan (USDA/USDI 2000). These actions also meet the Forest Service's Southwestern Region definition for the wildland-urban interface (WUI) which includes "those areas of resident populations at imminent risk from wildfire, and human developments having special significance. These areas include critical communications sites, municipal watersheds, high voltage transmission lines and other structures that, if destroyed by fire, would result in hardship to communities. These areas encompass not only the sites themselves, but also the continuous slopes and fuels that lead directly to the sites, regardless of the distance involved" (Forest Service 2000).

BACKGROUND and OBJECTIVES

Background

The Twin Prescribed Burn Project has been developed by the Williams Ranger District to implement prescribed fire treatments and associated activities to reduce hazardous fuels within the project area (Figure 2). The planning area encompasses approximately 14,000 acres of national forest system lands, including lands adjacent to private property. The project area is a band at the southern base of Bill Williams Mountain, extending to the southwest. It is located in T21 N, R1 E, Sections 1-3, 10-15, 22-27, and 33-36; T21 N, R2 E, Sections 15, 16, 18-22, and 27-30; and T20N, R1E, Sections 1-4, 9-16, and 21-23. The project boundary primarily falls in Geographic Area (GA) 2, with a small portion of Land Use Zone 22. The project is in Arizona Game and Fish Department Game Management Unit 8, and includes a portion of the Hat Range Allotment.

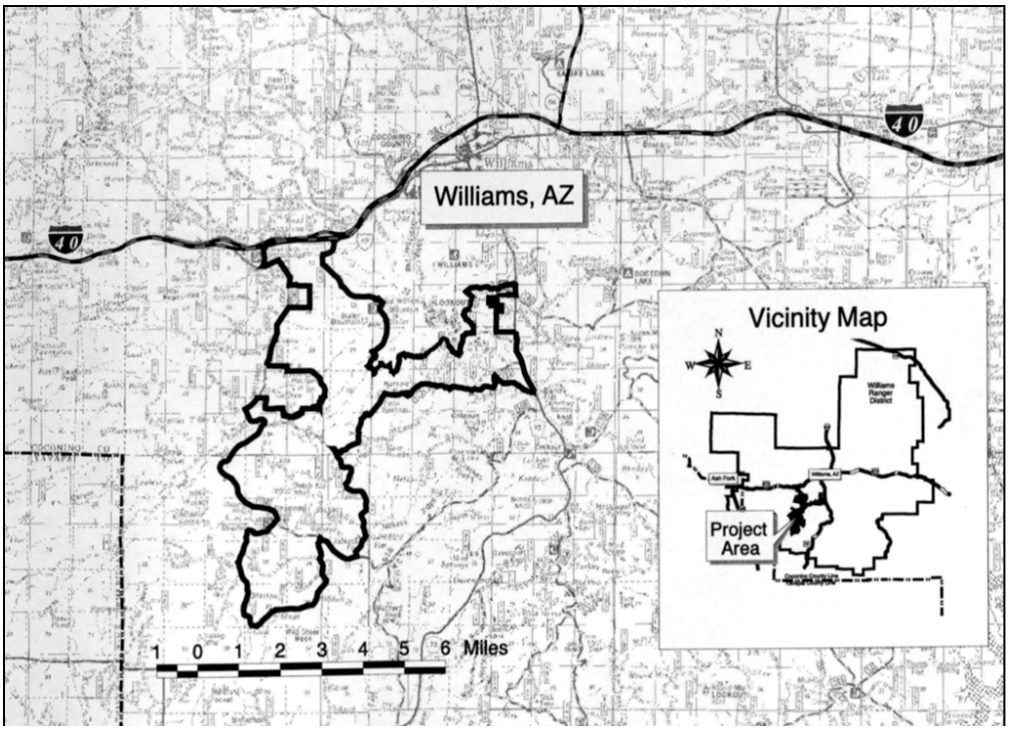


Figure 2. Twin Prescribed Burn Project Area Vicinity Map.

Prescribed Fire Objectives

The Twin Prescribed Burn Project is consistent with and designed to accomplish objectives stated in the Kaibab National Forest Plan (Kaibab NF 1988 – 2004) and the National Fire Plan (USDA/USDI 2000).

The Kaibab Forest Plan provides direction that states," use prescribed fire as a resource management tool where it can be used effectively to accomplish resource objectives." The Plan contains the following direction relating to the proposed project:

- Encourage prescribed fire and "wildland fire-use for resource benefit" (lightning caused) to reduce hazardous fuel accumulation. Thinning from below may be desirable or necessary before burning to reduce ladder fuels and the risk of crown fire.
- Treat fuel accumulations to abate fire risk.
- Do not allow fires to spread to lands of other ownership.
- Protect human life and improvements.
- Minimize acreage burned by high intensity fires.
- Maintain soil productivity and watershed condition.
- Use prescribed fire as a resource management tool where it can effectively accomplish research objectives.
- Improve wildlife habitats through…development of habitat quality and diversity, and the identification and protection of key habitats.

Objectives of the National Fire Plan include:

- Reduce the total number of acres at risk to severe wildland fire.
- Ensure communities most at risk in the wildland-urban interface receive priority hazardous fuels treatment.
- Expand and improve integration of the hazardous fuels management program to reduce severe wildland fires to protect communities and the environment.

In the Twin Prescribed Burn Project, the Williams Ranger District proposed to pre-treat and underburn areas that were burned in previous prescribed burns (1995-2001), as well as introduce prescribed fire to adjacent untreated areas. These treatments would improve protection to private property, the City of Williams' watershed, and habitat for threatened and endangered species from wildland fires. Fuel complexes in this area are shown in Figure 3.

Figure 3. Twin Prescribed Burn unit fuel complexes.

Actions were intended to extend and maintain existing fuelbreaks created by the earlier burns, and to reduce the probability of wildland fire ignitions becoming intense stand-replacement fires. The following objectives were identified for the Twin Prescribed Burn Project:

- Provide for firefighter and public safety in wildland fire situations.
- Reduce the potential of wildland fire to enter private property from the Forest.
- Reduce the risk for uncharacteristically intense stand-replacement wildland fires by creating openings in the forest canopy, reducing forest fuel loads (dead down woody debris), reducing ladder fuels (includes increasing the distance from the ground to lower live tree branches), and lowering tree densities.
- Protect wildland watershed condition and soil productivity. Prevent the spread of high-intensity wildland fire into the City of Williams watershed.

Additional information is available in the Twin Prescribed Fire Burn Plan (Kaibab NF 2008).

REVIEW PROCESS

Requirements

Forest Service Manual 5140.42 (Forest Service 2008) states that Forest Supervisors are responsible for, "conducting reviews of all prescribed fires that are converted to wildfire status," and for "reporting the review results to the Regional Forester within 60 days after the prescribed fire was declared a wildfire". The goal of this requirement is to guide future program actions by minimizing future resource damage and/or preventing future escapes from occurring by gathering knowledge and insight for incorporation into resource management and prescribed fire planning.

Consistent with this requirement, the Kaibab NF Forest Supervisor convened a team of six people to conduct a review of the prescribed fire. The number of individuals assigned to the team and their functional expertise were commensurate with the scope and focus of the review.

The Review Team consisted of:

Tom Zimmerman	Team Leader	Program Manager - Wildland Fire Management RD&A Rocky Mountain Research Station Boise, ID
Mary Farnsworth	Team Member	Deputy Forest Supervisor Deschutes NF Bend, OR
Robert Morales	Team Member	Forest Fire Staff Officer Santa Fe NF Santa Fe, NM
Dan Mindar	Team Member	Forest Fuels Specialist Apache-Sitgreaves NF Springerville, AZ
Colleen Loretto	Team Member	Supervisory Administrative Assistant Southwestern Region Albuquerque, NM
Rich Naden	Team Member	Meteorologist Southwestern Geographic Area Coordination Center Albuquerque, NM
Emily Irwin	Regional Office Liaison	AD, Fuels and Fire Ecology Southwestern Region Albuquerque, NM

The Review Team spent October 8, 9, 10, 2009, interviewing key personnel, examining planning, decision-making processes, and reviewing materials relevant to the implementation of the Twin Prescribed Fire. The Review Team interviewed personnel associated with the implementation of the burn, and reviewed written documentation of events and actions leading up to the declaration of the prescribed fire as a wildfire.

The level and scope of the review were consistent with agency policy as stated in FSM 5140.42 (Forest Service 2008) and the Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG 2008).

Review Objectives

The objectives of this review were developed from: guidance in the Forest Supervisor Delegation of Authority to the Review Team Leader, FSM 5100, Chapter 5140 (Forest Service 2008), the Interagency Standards for Fire and Fire Aviation Operations (USDI/USDA 2008), and the Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG 2008). These objectives were to:

- Review the seasonal severity, weather events, and on-site conditions leading up to the wildfire declaration.
- Determine if the Prescribed Fire Plan was adequate for the project and complied with policy and guidance related to prescribed fire planning and implementation.

- Determine if the prescribed fire prescription set forth in the Prescribed Fire Plan was adequate.
- Determine if the prescription, actions, and procedures set forth in the Prescribed Fire Plan were followed.
- Determine if the approving line officer's qualifications, experience, and involvement met required standards.
- Determine if the qualifications and experience of key personnel involved met required standards.
- Determine the level of awareness and the understanding of the personnel involved, in regard to procedures and guidance.
- Identify and document factors that contributed to the escape.

SYNOPSIS OF EVENTS LEADING UP TO WILDFIRE DECLARATION FOR THE TWIN PRESCRIBED FIRE

Specific preparation for prescribed burning on the Williams Ranger District during this fall period began around September 24, with preparation for a conference call with the Arizona Department of Environmental Quality (ADEQ) on Friday, September 25 to discuss upcoming projects. Acquisition and review of fire weather forecasts indicated that positive opportunities for burning in two areas: one of the City Units near Williams on Thursday, October 1, and the Twin Unit Black-lining on Tuesday, September 29. Coordination with ADEQ took place and communication on specific firing patterns and desired effects were discussed. Discussions focused on actions that would minimize smoke descent and stagnation into Williams.

On Monday, September 28, weather forecasts indicated red flag warnings for windy conditions. The forecasted situation would also yield wind directions unfavorable for desired smoke management for the Twin Unit blacklining operation. As a result, prescribed fire personnel cancelled burning for Tuesday, September 29. At this time, other burning opportunities were reviewed and with forecasts for northwest winds, favorable conditions for burning units east of Williams would occur. One specific unit, in the City Project burn units, located adjacent to Interstate 40 and east of Williams, would best be burned under a northwest wind which would move smoke away from both the highway and the city. A decision was made to plan to implement operations on this unit on Thursday, October 1. On Wednesday, September 30, the latest weather forecast indicated northeast winds; wind from this direction would not facilitate accomplishment of the City burn unit objectives. Over a period of about four days, weather forecasts had not been consistent and indicated forecasted winds first being northeast winds, then at excessive speeds, then from the northwest, and finally back to northeast flows. Prescribed fire personnel then reviewed all options and concluded that the Twin Project units were now the most viable burning option. There were two separate burn units within the Twin Project located southwest of the city of Williams. The decision was made to proceed with these units beginning on October 1. Special considerations necessary for implementation included helicopter utilization for aerial ignition and obtaining weather forecasts and verifying their accuracy with the National Weather Service (NWS).

Prescribed fire personnel confirmed availability of necessary resources, reviewed the Burn Plan, and felt all concerns were met. Communication with NWS did verify the forecasted wind direction with high confidence from the forecasters. However, while the Burn Plan was considered adequate and participants understood its direction and intent, a statement was made that indicated the Contingency Action section was somewhat confusing and could have been more clearly presented.

On Thursday, October 1, a test fire was ignited and confirmed that fire behavior was within desired ranges, controllable, and would accomplish objectives. All personnel were briefed at 0700 hours with a goal to complete all burning as quickly as possible, as an attempt to minimize duration of activities and minimize potential for smoke impacts to Williams.

Burning was initiated in both the north and south units but by 1000 hours a wind change was noted on the south unit. Winds had begun to shift to more from the south and it was decided to modify the ignition patterns to mitigate effects of this situation. Efforts were made to secure the northeast side. At this time, no wind shifts were observed on the north unit.

At 1100 hours, the wind continued to shift and was more consistently from the south on the south unit. NWS fire weather forecasters were contacted to ascertain what the situation was and would be throughout the remainder of the day. The forecasters were unsure of why these wind shifts were occurring but speculated that transport winds aloft were possibly breaking down and being affected by terrain features. They reviewed the forecasts and changed them to match the actual observations which when extended into amended forecasts, indicated that more southwest winds were probably likely. At 1406 hours, suppression actions were initiated on the north unit to respond to spot fires on the northeast side of the unit. The south unit ignition was completed by this time.

By 1745 hours, it was believed that all spot fires had been contained but personnel remained on the lines for patrol. Although fire activity was diminishing for the day, no fire runs were occurring and the most active areas of burning were in dead and down woody material concentrations, it was believed that additional spot fires would surface tomorrow. Around this time, communications with the NWS confirmed that forecasters were having difficulty identifying with precision what the wind situation was in the fire area. Observed winds were coming from different directions all around the burn units. Communication with the ADEQ and their meteorologist contacts showed that they were also unable to pinpoint what was happening. Prescribed burn personnel left the burn units at 2030 hours with plans to return early the next morning. Ignition had been suspended in the southeast portion of the north unit and about 100 acres remained to be burned. An additional Holding Specialist was added to the organization for the next day's operations to deal specifically with the spotting area.

Figure 4. Terrain and fuel limitations outside prescribed burn unit.

Early in the morning of Friday, October 2 personnel arrived at the unit and found a spot fire about ¾ acre next to the dozer line in the southern portion of the unit. Another ¼ acre spot fire was located next to the previous night's spot fires along the most northern edge of the previous night's spot fires. The dozer was requested to build line in this area but was having trouble accomplishing this. An illustration of why the dozer encountered difficulty is shown in Figure 4.

Fire activity on the spot began to pick up. Actions initiated included setting a priority for this morning to try and locate all spot fires and have personnel prepare for completing the remaining blacklining. A small test fire was completed and results were that it was burning "kind of hot" but that some fuels were hard to burn. In response to this information, it was decided to have crews construct line directly along the fire edge and contain all areas of active fire. Line construction was started when a call reported that another spot fire had been located in a drainage; the dozer was set to build line and control this spot but was having trouble accessing the area. A call was then placed for the helicopter assigned to the burn with a bucket to be available. By this time, the dozer had accessed the area of the spot fire and reported that any fire activity to the east of his location would be difficult to control. Prescribed burn personnel decided to order additional resources to strengthen the holding capability on the fire and placed an order for two handcrews.

After the order for more resources had been placed and the ETA for them was still indefinite but certainly a few hours at best, another spot fire was located further to the northeast at ¼ acre in size. This fire was outside the prescribed burn unit and in slash fuels. Reports were that the winds were getting erratic and the fire was too hot to work. An order was given to pull all firefighters and equipment out of this area to ensure safety. The helicopter was preparing for an aerial reconnaissance flight but had this mission cancelled and shifted to bucket work to deliver water to spot fires. After initial water bucket drops, it was apparent that this was ineffective and the spot fire of most concern to the northeast had grown to 10 acres in size.

At 1245 hours, the spot fire was at 10 – 15 acres in size and began moving. The situation was reported to Agency Administrators and alternatives were reviewed. The decision was made to convert the prescribed burn to a wildfire at 1300. An Incident Commander assumed oversight of the escape. From an aerial recon at 1330, it was determined that the fire was now at 30 acres and orders were placed for air tankers. The strategy being on was that if air tankers could slow the fire spread and prevent uphill movement, decreases in fire behavior during nighttime hours would allow firefighters to get in and work on establishing containment lines and direct the fire into a brushfield where fire behavior would be more favorable for firefighting efforts.

FINDINGS

Information presented in this section may not necessarily identify all areas in prescribed fire planning and implementation where improvements are possible. The Review Team was tasked with addressing the specific elements for reports identified above and have focused this review on the clarification of all events contributing to escape of the prescribed fire and factors contributing to the wildfire declaration.

The timeframe involved with this review ends once the prescribed burn was considered an escape and declared a wildfire; none of the actions implemented during suppression of the fire by the Incident Management Team are addressed in this report.

The emphasis of the Review Team's findings corresponds to the objectives stated above and are presented by objectives in the following section. Findings are described in terms of environmental, human, administrative, and process/system factors and discussed as contributing directly or indirectly to the escape of the prescribed fire. The following eight elements are discussed in this section:

- Seasonal severity, weather events, and on-site conditions leading up to the wildfire declaration.
- Adequacy of the Prescribed Fire Plan for the project and compliance with policy and guidance related to prescribed fire planning and implementation.
- Adequacy of the prescribed fire prescription.
- Compliance and consistency with the prescription, actions, and procedures set forth in the Prescribed Fire Plan.
- Line officer's qualifications, experience, and involvement.
- Qualifications and experience of key personnel involved in the prescribed fire.
- Level of awareness and understanding of prescribed fire planning and implementation procedures and guidance of the personnel involved.
- Factors that contributed to the escape.

The information under each element of the review is organized leading with a finding, followed by supporting discussion and background information. Recommendations are summarized in a separate section that follows the element reviews.

Seasonal Severity, Weather, and On-Site Conditions Leading Up to the Wildfire Declaration:

Seasonal Severity, Weather and On-Site Conditions - The 2009 season has been unusual in many ways from a climatological perspective. Weather patterns have not followed usual trends in winds, temperature or precipitation. Precipitation has occurred in a cyclic pattern throughout the summer including normally dry periods and monsoons rains have failed to materialize in the typical pattern. The result of such a precipitation pattern has left the fire area in a deficit of annual moisture in spite of the regular rains. Monsoons typically account for 40 percent of the annual moisture for the area.

The Twin Prescribed Fire is located within Fire Weather Forecast Zone 115 which is forecasted from the Flagstaff, Arizona Office of the National Weather Service. The Kaibab NF uses two Remote Automated Weather Stations (RAWS) to track fire danger and potential fire severity for the South Zone of the Forest including the fire area. Greenbase RAWS and Tusayan RAWS are the two stations used for analysis.

Overall Weather Situation - A strong mid-upper level trough of low pressure moved from west to east across the central/northern Rockies on Wednesday, September 30th through the first half of Thursday, October 1st, 2009. A shift from breezy southwesterly flow to brief northerly component winds and then back to a west-southwesterly component would be a normal result to the above synoptic situation and this indeed appeared to be the case. The main issue is when winds became more west-southwesterly compared to an expected east-northeast component in/around the Twin Project area.

National Weather Service Forecasts:

- **Issued 257PM MST 9/30/09 (FWF) -** The FWF for Zone 115 for Thursday October 1st was for minimum RH values between 9-14% and for northeast winds ~ 10 mph w/higher gusts until late afternoon becoming light. Light winds were forecast for Thursday night.
- **Issued 328AM MST 10/1/09 (FWF) -** Light winds becoming northeast around 10 mph early in the afternoon…then becoming light late in the afternoon. Minimum RH to be near 8%.
- **Issued 300PM MST 10/1/09 (FWF) -** Light winds expected overnight with max RH values between 48-68%
- **3 Spot Forecasts were issued For the Twin Rx (337AM, 840AM, and at 1120AM on 10/1/09):**
    - 337AM MST for Thursday – east-northeast winds up to 10 mph…becoming light and variable during the afternoon.
    - 840AM MST for Thursday - east winds 3-5 mph…becoming light and variable during the afternoon.
    - 1120AM MST for Thursday – Upslope/Upvalley (Southwest) 3-5 mph with occasionally higher gusts….becoming light and variable by late afternoon.

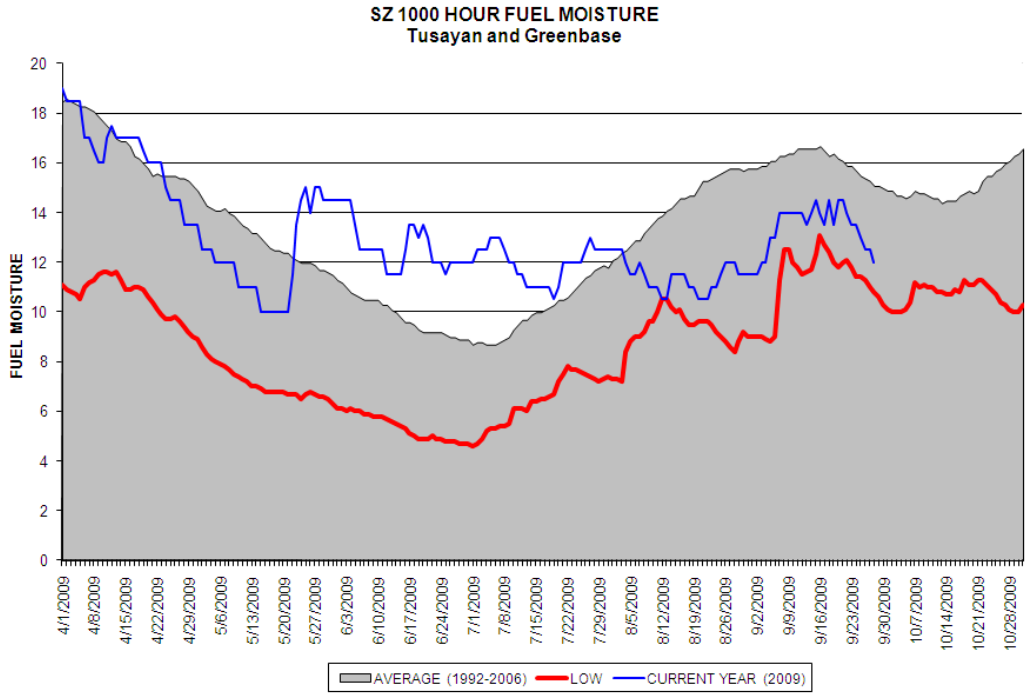
Upon review of the available forecast and weather information the following conclusions can be drawn. Expected southwesterly component winds further to the south and west began impacting the burn area earlier than anticipated during the morning and early afternoon hours of October 1st. The first indication of this from the National Weather Service was from the amended spot forecast issued at 1120AM MST on 10/1/09. All forecasts up to this point indicated east-northeast winds for the burn area into the afternoon when the winds would become light.

> **Note:** This was likely a tough forecast with a narrow zone in/around the burn that received the southwest-westerly component winds that were in place in earnest further to the west and south (see aforementioned Iron Springs discussion). The Kaibab-SK-Micro experienced the exception for about a 2 hour window from ~1215 MST (1915Z) through ~ 1415 MST (2115Z).

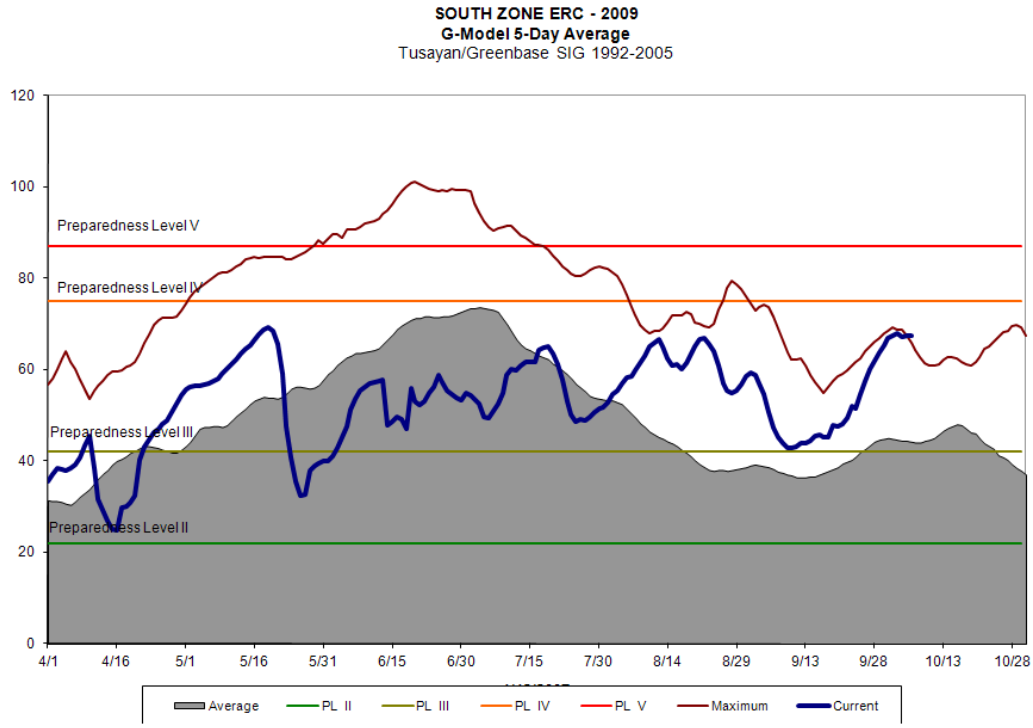
The National Weather Service did do a very good job underlining the significant dry air around the area as well as the upcoming stronger southwesterly winds anticipated beginning on Friday October 2nd.

Fuel Moisture Analysis - The moisture content of woody debris greater than three inches in diameter (1,000 hour timelag fuels) is used as an indicator of drought severity and resistance to fire control. The following graphic depicts the calculated 1,000 hour timelag fuel moisture from the weather observations for the South Zone.

The current situation (blue line) shows 1,000 hr fuel moistures to be near record low and drier than average for this time of year. Higher values in fuel moistures indicate wetter fuels. The higher moisture values are evident when large sound logs are not completely consumed in the fire.



Energy Release Component - The National Fire Danger Rating System (NFDRS) index used to track the combined effects of fuel dryness on fire potential is called the Energy Release Component (ERC). The following table displays current ERCs (blue) and compares them to historic readings. ERC values were near historic highs for this time of year on the day the fire escaped. Current ERC values are below peak fire season averages (June), indicating that while indices are near record for October they are still moderate compared to peak fire season. Keep in mind the NFDRS System is somewhat skewed this time of year failing to take into account the shorter days and cold nights, however the trends comparative to past years is important to note.



Adequacy of the Prescribed Fire Plan for the Project and Compliance with Policy and Guidance Related to Prescribed Fire Planning and Implementation

The Burn Plan has some good written elements. However, some elements are difficult to understand. Construction of this burn plan could result in burning out of prescription in element 7 (prescription), element 11 (organization and equipment), and element 17 (contingency). The burn plan package is complete and very well put together. All necessary documents are present and in order. Even though element 11 is confusing, the organization for the burn on the actual burn day was well organized, clear and staffed above what the burn plan called for. Table 1 shows specific findings and potential contribution to the escape for prescribed fire plan elements.

Table 1. Prescribed fire plan elements, findings, and potential contributions.

PRESCRIBED FIRE PLAN ELEMENTS:	COMMENTS/FINDINGS	DID THIS PLAY A ROLE IN ESCAPED FIRE?
1. Signature page	The signature page has some critical information about the burn on the top page which can be easily missed; also all copies of this burn plan need to be in color due to the critical items in blue text.	NO
2. GO/NO-GO Checklists	This was completed. The GO/NO-GO was approved by the qualified Agency Administrator.	NO
3. Complexity Analysis Summary	There are three complexity analyses for this burn. One for aerial ignition, one for ground ignition and one for WUI/Northern Boundary. Even though they are all rated at High it is confusing, cumbersome, and not necessary.	NO
4. Description of the	Good description but did not address the different fuel types	

	Prescribed Fire Area	outside the burn areas in sufficient depth. Just briefly mentioned them. Adequate description of fuels outside the burn units would increase awareness of fire behavior potential there and was needed for full understanding of potential contingency actions and necessary resources (fuel complex example from outside burn units shown in Figure 5).	Potential Factor
5.	**Goals and Objectives**	Good objectives of the burn stated in measurable terms.	NO
6.	**Funding**	Good	NO
7.	**Prescription**	This is a hard prescription to understand and follow. Not knowing for sure which parameter to use, you can very easily go out of prescription, especially in the fine fuel moisture and winds categories. The RH on the forecast was predicting an RH of 7%, the prescription calls for 12%. The test fire was conducted at 0800 hrs, the RH was at 17%. This prescription can be very restrictive. Did not model the adjacent fuel models for the contingency aspect of the plan.	Potential Factor
8.	**Scheduling**	Part of a larger landscape scale project and scheduled within that project.	NO
9.	**Pre-burn Considerations**	Very detailed. The numerous pre-burn considerations were met.	NO
10.	**Briefing**	Good, easy to follow and understand.	NO
11.	**Organization and Equipment**	This element for a burn boss coming in from the outside would be very hard to understand. You would need to calculate the production rates and figure out what kind of resources you would need to order to meet the intent of the burn plan. It calls for certain types of resources but does not say how many, like water tenders. The plan does say that the burn boss needs to determine this. This element also mentions that personnel in dual roles will not occur. The RXM1 and RXB1 is the same person on the organizational chart. An RXM1 was not required for the burn.	NO
12.	**Communications**	Communications Plan is adequate for the project	NO
13.	**Public, Personnel Safety and Medical Procedures**	Covers fire fighter safety in depth, but there is no mention of public safety.	NO
14.	**Test Fire**	Test fire was documented. Spot weather forecast information in combination with observations from the test fire could have yielded relevant information.	NO
15.	**Ignition Plan**	This element is good.	NO
16.	**Holding Plan**	The Holding Plan is good. It does have a strict patrol schedule that needs to be followed.	NO
17.	**Contingency Plan**	This contingency plan can be difficult to understand. The type and kind of resources are not stated on the burn plan. This needs to be figured out through use of the fire line	Potential Factor

	handbook prior to implementing the burn. Assurance is then needed to verify that those resources are available if needed. For this burn the contingency resources were on site, but were also assigned specific tasks during the burn. There was really no clear direction how those resources were to be used exactly. Some of the resources were committed to critical holding assignments when the spotting occurred.	
18. Wildfire Conversion	This element is clear. It does reference WFSA (The plan was signed in 2008). We no longer use this term. WFDSS was implemented in the 2009 season.	NO
19. Smoke Management and Air Quality	This element is very detailed and understandable. Smoke issues are a big concern, especially when it comes to impacting the city of Williams. The predicted NE winds were desirable in order to minimize smoke impacts to Williams. With the predicted winds, there was a one day window to implement this burn. This may have caused a sense of urgency to implement the burn in one operational period.	Potential Factor
20. Monitoring	Good.	NO
21. Post-burn Activities	Good.	NO

Figure 5. Fuel structure outside the planned prescribed burn units.

Adequacy of the Prescribed Fire Prescription

Review of the prescription elements indicates it is sound and provides adequate sideboards for environmental conditions to achieve the desired objectives. Multiple prescriptions within the plan make it difficult to understand which prescription to use and could lead to inadvertently burning out of prescription. There is little difference between the two prescriptions and may be better served with one prescription.

Maximum spotting distance should be calculated based on maximum wind speed allowed by prescription to give the Burn Boss or Holding Boss an indication of how far out to look for potential spots.

Compliance and Consistency with the Prescription, Actions, and Procedures Set Forth in the Prescribed Fire Plan

Review of the observed as well as forecasted weather revealed on site conditions were out of prescription with respect to relative humidity and fine dead fuel moistures; these two parameters are directly related to one another as one goes up so does the other. Fine dead fuel moisture is calculated from relative humidity. The prescription calls for relative humidity of 12% to 60%. The forecasted minimum relative humidity from the spot forecast October 1 predicted 7%. Observed weather on this date indicated 8% by 0900 hours.

Figure 6. Example of fire effects from low intensity fire behavior.

Interviews with Prescribed Burn personnel indicated they were aware that burning conditions were exceeding the prescription parameter for relative humidity during the day. Due to fire behavior still achieving the objectives of the burn, fire effects within a desirable range, the fire still being controllable, and a large amount of fire on the ground already, it was decided to continue with ignition. The Agency Administrator was not notified of this situation and it was not documented. The Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG 2009) states that when prescriptive elements are being exceeded during burning operations, personnel should take actions to ensure that objectives can still be met. An example of fire effects for much of the burn unit is shown in Figure 6, however, examples of higher intensity fire behavior and resulting fire effects are present in isolated areas within both the burn unit and wildfire areas.

Low relative humidity drives up probability of ignition. Probability of ignition is the likelihood that an ember will ignite fuels if brought into contact with it. The consequence of low relative humidity is that embers that did drift outside the burn unit found receptive fuels with elevated probability of ignition. Probability of ignition would have been greater than 60% at the time spots began to occur. Those embers created more spot fires that grew quickly and were more difficult to control.

Line Officer's Qualifications, Experience, and Involvement

The Agency Administrator has responsibility to ensure that all prescribed fires are conducted in accordance with the approved implementation plan and established standards and guidelines.

The Forest Supervisor, of the Kaibab National Forest is the primary Agency Administrator (Journey Level) for wildland and prescribed fire activities. He attended the "Fire Management Leadership for Line Officers" course in March of 2003, meeting the training criteria for Agency Administrator certification. In addition his experience includes serving as a District Fire Management Officer from 1984 to 1986 on the Salmon River Ranger District of the Klamath National Forest. The Forest Supervisor signed the Twin Prescribed Burn Plan on September 15, 2008.

The Kaibab NF Fire Staff Officer, of the Kaibab National Forest (since 2005) was delegated Agency Administrator for Wildfire Suppression and Prescribed Fire Activities in an April 18, 2009, Delegation of Authority Letter signed by Kaibab Forest Supervisor. He has attended "Fire Program Management," is currently qualified as a Type 2 Safety Officer, and is qualified as a Type 2 Burn Boss, therefore meeting the training criteria for Agency Administrator certification. As Agency Administrator, the Fire Staff

Officer signed the Twin Prescribed Burn Go/No Go checklist with the understanding that weather and fuel conditions were within prescription parameters (signed 9/30/09, valid through 10/2/09).

Qualifications and Experience of Key Personnel Involved in the Prescribed Fire

Key positions on the prescribed fire and their qualifications are listed in Table 2.

Table 2. Qualifications of key personnel involved in the Twin Prescribed Fire.

Position	Qualification Date	Meets Requirements	Other Qualifications
Prescribed Burn Manager	RXM1-November 2002	Yes	ICT1 (t), ICT2, SOPL, RXB1, FIRB
Burn Boss Type 1	RXB1-November 2002	Yes	ICT1 (t), ICT2, SOPL, RXB1, FIRB
Burn Boss Type 1 Trainee	RXB1(t)-Task Book activated June 2009	Yes	RXB2, PLDO, HEB1, ICT4
Firing Boss (North)	FIRB-February 2006	Yes	ICT4, STCR, TFLD
Firing Boss (South)	FIRB-June 2009	Yes	ICT4, ENGB, CRWB
Firing Boss (Trainee)	No Task Book initiation on Record	Yes *	ICT5, FFT1, HECM, ENGB (T), FIRB (T)
Holding Specialist (North)	TFLD-February 2003 (as required by the Burn Plan)	Yes	ICT4, STLC, FOBS, ENGB, CRWB, RXB3 (t)
Holding Specialist (South)	TFLD-Task Book issued April 2008-no record of certification (as required by the Burn Plan)	Yes**	RXB2, ICT4, FEMO, STEN
Helicopter Manager	HMGB January 05	Yes	RXB2, SOPL, ICT4, FIRB, FEMO
Plastic Sphere Dispenser Operator	PLDO-June 2004	Yes	FIRB, ICT4, HMGB, HEB2
Aerial Firing Boss	FIRB-June 2006	Yes	RXB3, ICT4, TFLD, HECM
Weather Observer	No Qualification Required	Yes	ICT4, CRWB, ENGB, FFT1

***** ENGB task book documentation was located in wrong section of this employee's file at the time of the burn. FIRB was intended to be added to the employee's record but was not completed prior to the burn implementation. Employee did meet minimum qualifications based on 310-1 and FSH 5109.17 at the time of the burn and had completed other assignments as a FIRB prior to this burn. No task book was on record at the time of the burn but it is now and the employee's qualifications are fully documented.

****** Employee was a Coconino NF employee. The employee had met all requirements for qualification but the completed task book was sitting on Coconino NF Fire Leadership's desk awaiting final certification. The task book has since been certified by the Kaibab NF and employee's qualifications are fully documented.

Level of Awareness and Understanding of Prescribed Fire Planning and Implementation Procedures and Guidance of the Personnel Involved

All staff within the Fuels organization both at the Forest and District levels demonstrated verbally, in writing, and in actions a high level of knowledge and awareness of policy, planning, and implementation procedures. There is strong evidence of leadership and support for building the program, developing expertise, confidence and high expectations for performance, and demonstrated success leading to employee pride in program accomplishments. In describing the culture of the Williams District prescribed burn program, employees spoke of building "pride and confidence" in the work they were completing and treating fuels to achieve desired fire effects are more important than just burning to blacken acres for accomplishment sake. There is an ethic of work accomplishment in an open and transparent process while taking advantage of every burn day opportunity. The program is centered on fuels treatment adjacent to communities, working on a landscape scale, and balancing initial entry treatments with needed maintenance burning. There is an emphasis on increasing skills and qualifications throughout the organization. It is clear that the Forest has placed focus on building relationships in the community and through that relationship building; strong positive community support for continued fuels treatment efforts exists.

Positive actions to meet policy and procedural directions were evident at each level of the organization, including:

- A high level of engagement by Agency Administrators; Delegations of Authority are in place, demonstrated confidence in the fire organization's ability to carry out treatments is evident, and periodic communication during implementation consistently occurs.
- Consistent engagement and communication by the Williams District Ranger with the Burn Boss during implementation of the project.
- Involvement by the Forest Fire Staff while serving as Agency Administrator and signing the Burn Go/No Go checklist.
- Having all written requirements/elements for burn plan documentation in place, and field documentation during implementation of the burn was completed.
- Availability of incident qualification records and completion of maintenance of qualification records.
- Field level briefings with prescribed burn personnel were completed, thorough, and documented.

Factors Contributing to the Escape and the Wildfire Declaration:

Factor	Description	Contributed To:
Wind direction switch	Northeast winds were desirable for successful completion of the burn unit. Ignition operations were based on continuing northeast winds. The wind switched direction to southwest sometime between 0930- 1100 from forecasted and observed direction prior to this time. The wind changing direction triggered a decision to change ignition operations to prevent established fire from reaching the east control line without a black buffer to protect it. The spots that ultimately lead to the escape occurred on the east side of the burn unit. The east side of the burn presented greater difficulty for holding due to more	**Escape of prescribed fire:** • Shifting wind direction pushed fire toward and lofted firebrands into fuels outside the burn unit. Potential spotting distance under this situation was .3 miles. • Spot fires developed from embers reaching non-target fuels and subsequent fire growth eventually exceeded controllability.

	complex terrain and changing fuel types outside the burn unit. Had winds continued out of the northeast ignition crews would have been igniting the east line with the wind at their backs.	
Exceeding relative humidity parameter in prescription in combination with changing wind direction	Minimum relative humidity stated in the Burn Plan prescription was 12%. Ignition was started with an actual relative humidity of 17% and a forecasted minimum relative humidity of 7%. Ignition continued after observed weather indicated the relative humidity had dropped to 8%. It is not known if this factor without the change in wind direction would have caused escape of the prescribed fire. This did not occur on the southern burn unit under these relative humidity conditions.	**Escape of prescribed fire:** • Low relative humidity contributed to spot fire propagation and growth. • Probability of ignition was in excess of 60% at the time spot fires began to appear and would have continued to increase through the day.
Fuel Type differences inside and outside the planned burn unit	The Twin Prescribed Burn Plan did not address the major fuel change north of the unit which was thinned in 2006. The burn plan states that the adjacent fuels are similar to fuels located within the burn units. It does briefly mention that along the northern edge of the project area at the base of Bill Williams Mountain there is a higher fuel loading.	**Wildfire declaration:** • The adjacent fuel loading northeast of the north unit is a very significant change. • It can be classified as a Fuel Model 11 and therefore increasing the resistance to control.
Contingency resource identification in the burn plan	The contingency resources for this burn plan were calculated for a Fuel Model 9. This is the Fuel Model stated in the burn plan as the Fuel Model within the unit and as the adjacent Fuel Model. The Fuel Model in the thinning unit that the prescribed fire spotted into can be classified as a Fuel Model 11.	**Wildfire declaration:** • Resources on site were adequate to meet the calculated production rate, inside the burn units but the resource mix was not adequate for the complex terrain and different fuel type outside of the burn unit.

RECOMMENDATIONS

- **Compliance with policy and direction –** ensure that prescribed burn planning complies with required policy elements for burn plans such as Burn Prescription, and Contingency Plan, ensure that implementation follows the approved Burn Plan, and ensure that operational changes such as changes to firing patterns and prescription parameters during the burn are formally documented with proper notifications.

- **Burn Plan development**- Improve specificity and clarity of the burn plans.
    - Consider more than one burn plan for a project area such as this.

- Consider completing only one complexity analysis for each burn plan.
- Improve decision support analysis to include fire behavior modeling for adjacent fuels, fire intensity, rate of spread, and resistance to control, and consider the information as part of contingency planning.
- Specify the minimum required implementation organization (including contingency resources) to meet the capabilities by position, equipment, and the supplies needed for all phases of the prescribed fire until declared out (instead of by line production rate only) [per Interagency Prescribed Fire Planning and Implementation Procedures Guide (NWCG 2008)].
- Ensure that onsite contingency resources are not assigned to critical operations, inhibiting their ability to respond to meet the intent of the contingency plan.

- **Pre-burn preparations** - During pre-burn preparations complete detailed reconnaissance and establish increased awareness of the surrounding area.

- **Prescription Parameters:**
  - Check with the National Weather Service (NWS) the day of ignition to verify the forecast from the night before.
  - Include in the comment section of spot weather forecast requests the importance of any critical weather element (such as wind direction for the Twin Prescribed Fire), to allow the NWS to specifically explore that element in detail.

- **Position Qualifications** - Ensure position qualifications, position task book requirements, and documentation are complete and meet requirements for each prescribed burn assignment

- **Staff Integration** - Increase communications between Silviculture and Fuels Managers. Ensure that knowledge of planned and implemented silvicultural actions is gained by fire and fuels specialists so that substantial fuel modifications do not unexpectedly impact fire management operations.

COMMENDATIONS

General - The Review Team could not have completed assigned task without significant support from Kaibab NF and Williams Ranger District personnel. The Team wishes to thank all individuals who assisted for their significant support.

Line Officer Involvement - It is very apparent that all Line Officers on the Forest are very involved in all aspects of the fire and fuels management program. This is not always the case and is not an easy situation to balance in light of all issues that face line officers. The Forest Supervisor, Williams District Ranger, and individuals in "Acting" positions are to be commended for sustaining a high level of involvement.

Prescribed Burning Program - The prescribed burning program on the Kaibab NF is significant in scope, scale, and accomplishments. Landscape scale treatment programs are difficult to plan and implement. The amount of coordination and detailed planning required is significant. This Forest and District have completed this work and are in the process of implementing a landscape scale fuel and vegetation management program. All individuals involved in this program are to be commended for undertaking such an endeavor and the strong record of accomplishments to date.

Public Communication and Involvement – It is very apparent that the Forest and District have worked very proactively to communicate with and engage the local public in all aspects of this program and individual projects. Very strong positive support exists for the program and was evident

at public meetings and throughout the town. Comments made regarding this program are positive and supportive. All personnel involved in these efforts should be commended for their proactive, successful, enthusiastic, and persistent efforts – they could serve as an example for other administrative units.

Decision Making and Leadership – Decision making during the prescribed fire implementation, when considering the declaration to a wildfire, and during the transition to the wildfire were proactive, definitive, and effective. This signifies strong decision making capability, strong leadership capability, confidence in knowledge of tactical responses, and strong situational awareness. Personnel involved in the decision making in leadership and line officer positions during these phases of this operation should be commended for exhibiting this level of decisiveness and leadership.

Project Level Panning – Project level planning appears to be thorough, based on best available information, and effective in meeting needs. Personnel involved in this area should be commended for their competency and effectiveness.

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GLOSSARY OF ACRONYMS AND TERMS

Command - The act of directing, and/or controlling resources by virtue of explicit legal, agency, or delegated authority.

CRWB (Crew Boss) - A person in supervisory charge of usually 16 to 21 firefighters and responsible for their performance, safety, and welfare.

Escaped Prescribed Fire – a prescribed fire that has exceeded or is expected to exceed prescription parameters or otherwise meets the criteria for conversion to wildfire. Criteria is specified in "Interagency Prescribed Fire – Planning and Implementation Procedures Reference Guide".

ENGB (Engine Boss) – A person in supervisory charge of usually 2-6 firefighters and responsible for their performance, safety, and welfare.

FIRB (Firing Boss) –The Firing Boss reports to the Prescribed Fire Burn Boss and is responsible for supervising and directing ground and/or aerial ignition operations according to established standards in the Prescribed Fire Plan.

FEMO (Fire Effects Monitor) - The Fire Effects Monitor is responsible for collecting the onsite weather, fire behavior, and fire effects information needed to assess whether the fire is achieving established resource management objectives.

FFT1 (Fire Fighter)– A working leader of a small group (usually not more than seven members), who is responsible for their performance, safety, and welfare.

FOBS (Field Observer) – This position is responsible for collecting and reporting situation information for an incident.

Helibase - The main location within the general incident area for parking, fueling, maintenance, and loading of helicopters.

HECM (Helicopter Crew Member) - An individual assigned to an agency or call-when-needed helicopter to support helicopter operations.

HEB2 (Helibase Manager Type 2) - This position is responsible for controlling helicopter take-offs and landings at a helibase, managing helibase assigned helicopters, supplies, fire retardant mixing and loading.

HEB1 (Helibase Manager Type 1) – This position is responsible for controlling helicopter take-offs and landings at a helibase, managing helibase assigned helicopters, supplies, fire retardant mixing and loading.

Incident - An occurrence either human-caused or natural phenomenon, that requires action or support by emergency service personnel to prevent or minimize loss of life or damage to property and/or natural resources.

ICT1/ICT2/ICT4/ICT5 (Incident Commander) - The Incident Commander position is responsible for overall management of the incident. The Incident Commander reports to the Agency Administrator for the agency having incident jurisdiction.

MOP-UP – Extinguishing or removing burning material near control lines, felling snags, and trenching logs to prevent rolling after an area has burned, to make a fire safe, or to reduce residual smoke.

PSD (Plastic Sphere Dispenser) - Device installed, but jettisonable, in a helicopter, which injects glycol into a plastic sphere containing potassium permanganate, which is then expelled from the machine and aircraft. This produces an exothermic reaction resulting in ignition of fuels on the ground for prescribed or
wildland fire applications.

PLDO (Plastic Sphere Dispenser Operator) - Is responsible for the preparation, operation, maintenance, and care of the dispenser. The PLDO reports to the Firing Boss (FIRB).

Prescribed Fire—is a wildland fire originating from a planned ignition to meet specific objectives identified in a written, approved, prescribed fire plan for which NEPA requirements (where applicable) have been met prior to ignition (see planned ignition).

RXB1 (Prescribed Fire Burn Boss – Type 1) – Person responsible for supervising a prescribed fire from ignition through mopup. See definition for "Type" below.

RXB2 (Prescribed Fire Burn Boss – Type 2) - Person responsible for supervising a prescribed fire from ignition through mopup. See definition for "Type" below.

RXB3 (Prescribed Fire Burn Boss – Type 3) – Person responsible for supervising a prescribed fire from ignition through mop up. See definition for "Type" below.

RXM1 (Prescribed Fire Manager – Type 1) – Person responsible for implementing and coordinating assigned prescribed fire activities. See definition for "Type" below.

Safety Officer Type 2 – Person responsible for monitoring and assessing hazardous and unsafe situations and developing measures for assuring personnel safety.

Strike Team - Specified combinations of the same kind and type of resources, with common communications, and a leader.

STCR (Strike Team Leader Crews) – This position is responsible for supervising a strike team of crews and report to the Holding Boss.

STEN (Strike Team Leader Engines) - This position is responsible for supervising a strike team of engines and report to the Holding Boss.

SOPL (Strategic Operational Planner) - Primary task of this position is to coordinate the development of the course of action for a wildfire (unplanned ignition).

Task Force - Any combination of single resources assembled for a particular tactical need, with common communications and a leader. A Task Force may be pre-established and sent to an incident, or formed at an incident.

TFLD (Task Force Leader) - The Incident Command position responsible for supervising a task force. This position reports to the Holding Boss.

Type (1/2/3) - Refers to resource capability. Resource typing provides managers with additional information in selecting the best resource for the task.

Wildland Urban Interface (WUI) – The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.