Peer Review Report
of
Balls Canyon Near-Miss
June 27th, 2006
Humboldt-Toiyabe National Forest

Contents:

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I. PEER REVIEW - INTENT & PURPOSE

"Effective risk management depends crucially on establishing a reporting culture." ~ James Reason

Successful implementation of a doctrinal approach to fire management requires an organization that is committed to improving decision making and impulsively seeks to expose, learn and adjust to inevitable human fallibility. It is essential our employees share this commitment and feel free to report errors and mistakes. Our organization, with a proper *preoccupation with failure*, must then embrace these errors, analyze the upstream systems that enable the errors, and adjust the system to ensure that normal human error will not result in an unacceptable loss.

After Action Reviews, when implemented correctly, have enormous value at the local and small group level. Successful After Action Reviews result in the disclosure of errors in an open and non-critical atmosphere. The group immediately learns and adjusts to mitigate these errors. However, due to the confidentiality of After Action Reviews, managers (responsible for designing the system, procedures and training) cannot analyze the errors and thus cannot effect changes to make the larger system more resilient to human error. At the opposite end of the spectrum of *reviews*, is the formal investigation. Due to many factors, people subjected to investigations are often reluctant to disclose mistakes. Thus, like After Action Reviews, *organizational* learning opportunities are missed because managers are not learning from human error. Managers may see an error and its consequences, but never understand the human factors involved in <u>why</u> the error occurred. Moreover, due to the cost and complexity of formal investigations, they are a tool best suited to catastrophic events where either litigation is likely or there could be a need for significant policy changes.

Bridging the gap between After Action Reviews and Investigations are Peer Reviews. Peer reviews are based on a "Just Culture". Just Culture is an organizational ethic where employees are encouraged to report errors and mistakes because of an ethical recognition that other employees and managers must learn (and then make adjustments to compensate) from normal human error. Rewards and punishments are based on the employee's values and how he or she acted on their values. If an employee's values are consistent with the organization's values (with the value of human life being <u>the</u> core value) then their errors and mistakes should be treated as normal and ethical human error. Traditional organizational reaction to errors often includes punishment for normal, or "honest," human error. This inevitably results in the suppression of error reporting and the collapse of a reporting culture.

The process used in this review encouraged honest and frank disclosure of mistakes. The peers involved were assured that the only outcome will be a report intended to facilitate organizational learning. This Peer Review was fashioned after an After Action Review. The questions asked to the peers involved in this very close call were intentionally similar to, but in greater depth than, After Action Review questions.

To facilitate organizational learning the narrative was written as a story. Storytelling is widely recognized as the most effective tool for teaching human - environmental interactions. (Reference *Sources of Power*, by Gary Klein © 1998 Massachusetts Institute of Technology)

The questions asked to peers in this incident were designed to ascertain each interviewee's perspective. The Peer Review team then combined these perspectives to develop a picture of the event, internal and external influences, and the decisions and behaviors involved.

The following questions were asked:

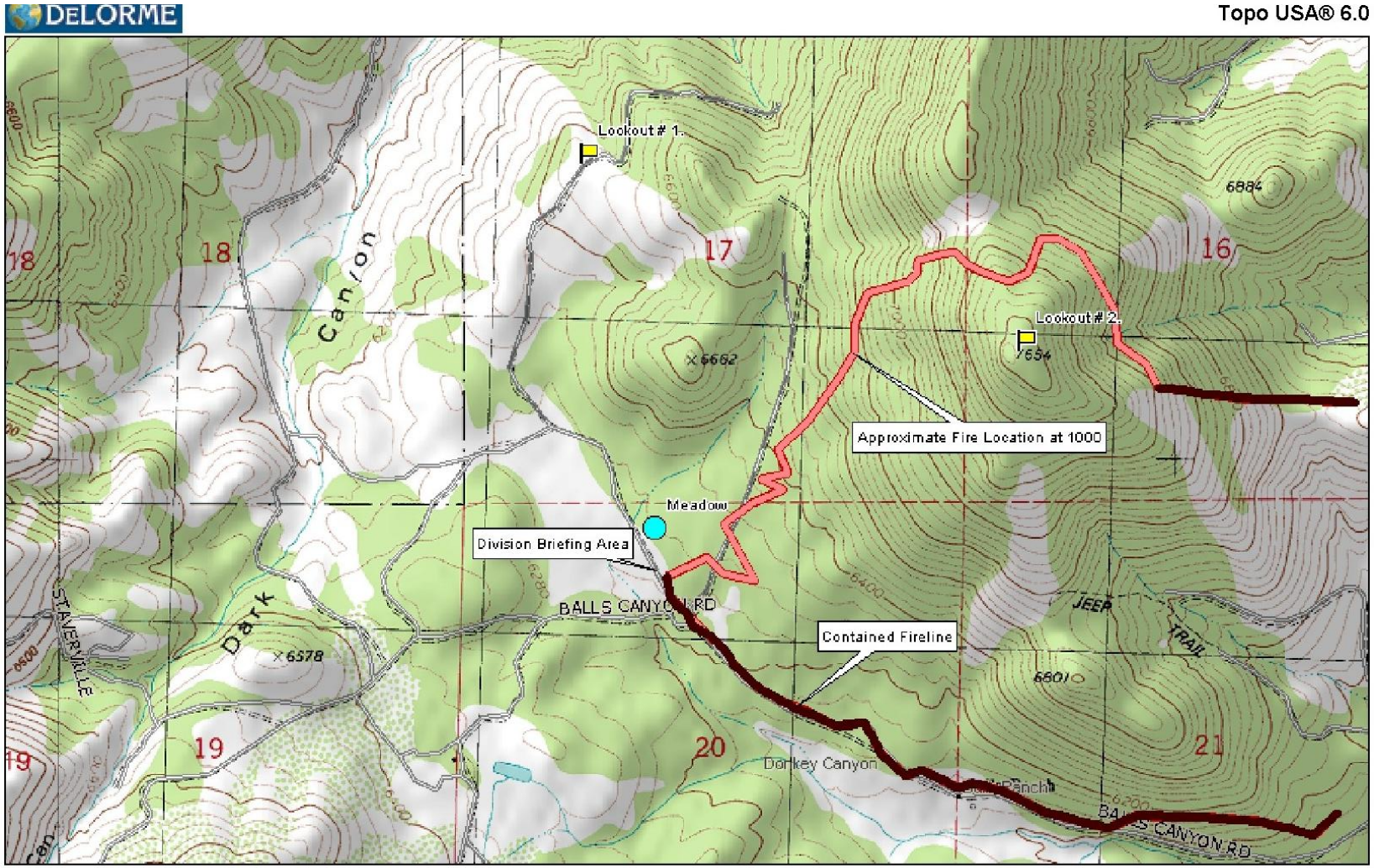
1. What was planned?
    a. What was your leader's intent?
    b. What information were you provided?
    c. What did you feel was missing?
    d. Why couldn't you get it?
2. What was the situation?
    a. What did you see?
    b. What were you aware you couldn't see?
3. What did you do?
    a. Why did you do it?
    b. What didn't you do?
    c. Why didn't you do it?
4. What did you learn?
    a. What might you do differently the next time?
    b. What can we learn as an organization?
    c. What might we do differently?

II. STORY OF THE INCIDENT

On June 27 2006 the Ball's canyon fire was managed by a Sierra Front, Type 2 Incident Management team. In the past three days, the fire had grown to just over a thousand acres in size and was divided into three divisions. The fire was burning in sagebrush, oak brush ponderosa and Jeffery pine fuels typical of the eastern slopes of the Sierra Mountains at the 6000 to 7000 foot elevation. Fire behavior over the past three days was characterized as smoldering and creeping at night with minimal fire activity until mid-afternoon. From mid to late afternoon for the two previous days, fire activity increased significantly with frequent torching and short duration crown runs. Late in the afternoon of June 26, two strike teams of California Division of Forestry (CDF) engines and two strike teams of CDF crews arrived at the ICP, checked-in, and were instructed to report to ICP the next morning for a 0600 briefing.

On June 27, following the morning briefing at ICP, Division A Supervisor (DIVS) met with his resources at the meadow near the Southwest corner of Division A at about 1000. {SEE MAP 1.} Division A resources consisted of two CDF strike teams of five Type-3 engines, two CDF strike teams of two Type 1 (inmate) hand crews and a field observer. Two dozers arrived on the division shortly after 1000. DIVS and the field observer had witnessed the previous day's fire activity but this was the first shift on the fire for all of the strike teams. DIVS has a trainee Division Supervisor with him throughout the day.

Map 1. Fire and Crew location at 1000



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The night shift from the evening of the 26th had completed direct line along the southern flank of the fire near the Ball's Canyon road. The initial plan for the June 27th day shift on Division A was to resume direct line construction where the night shift left off; up hill from the meadow and eventually connecting with crews from Division to their east building direct line up to approximately the location of Lookout #2. If the fire activity prevented direct attack, the fall-back option was use existing roads connecting up to Lookout #1, and backfire off these roads burning out several hundred acres.

The crews were briefed on the predicted weather and fire behavior for the day. These forecasts predicted temperatures in the low 90's, humidity in the low teens, light diurnal winds and a red flag warning for thunderstorms producing strong gusty winds by mid-afternoon. A map of the incident was included in the Incident Action Plan. As is typical, the map displayed an *estimate* of the fire's location. Aircraft were not available for mapping or for observation on the 26th or the 27th.

After the briefing, the hand crews began direct line construction, supported by hose-lays, as planned. The Division Supervisor stationed himself with Lookout #1. The location at Lookout #1 afforded the Division Supervisor with a good location to oversee the operations and was also a location where he could reliably reach the Command-Net repeater. The winds at the time were calm and a weak inversion lay over the fire.

After about an hour, the strike teams building direct line encountered significant amounts of unburned islands and enough fingering such that the plan to build direct line would take too long. Fire behavior at the time ranged from smoldering to creeping. The fall back plan seemed overly cautious and it would also force a major adjustment to the plans of the adjacent division. In discussion with DIVS, Strike Team Leader Crew #2 (STCR #2) devised a new plan. The new plan was to use dozers to construct an indirect line to the north, around a hill (elevation point 6662), and reconnect the line, where practical, into the fire's edge. After completing the indirect dozer line, the plan was for the crews to burn out from the dozer line when weather conditions were favorable. This new plan would minimize the amount of line to be constructed and acres burned. Importantly, the plan would enable Division A to connect their line with the adjacent division on schedule. DIVS approved the new plan. STCR #2 took charge of scouting a line location and leading the dozer. There was no dozer boss assigned to this division.

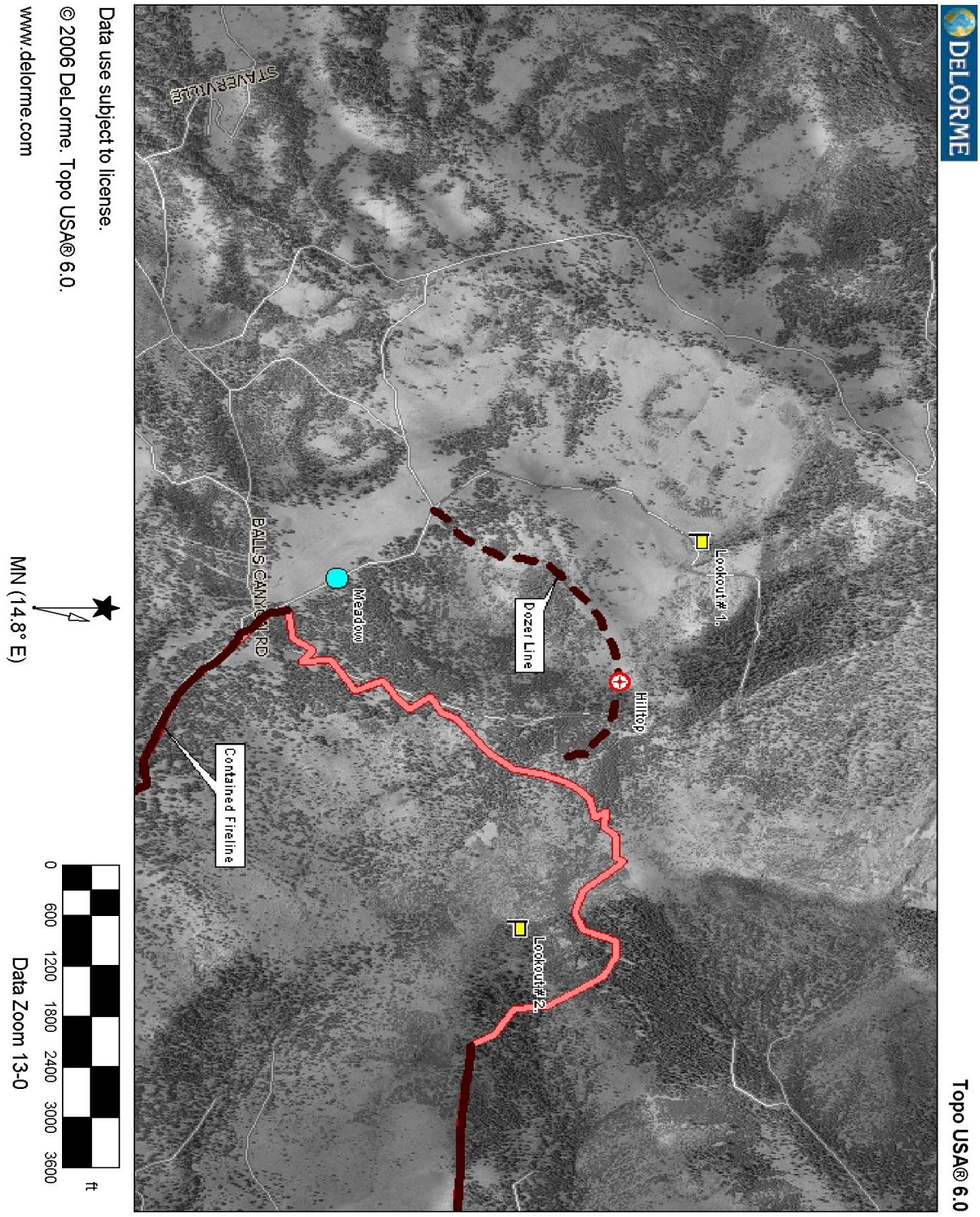
Based on the radio conversation between DIVS and STCR #2, it seemed to most listeners on Division A, that STCR #2 was taking charge of all resources building the indirect portion of the fire line. DIVS also believed STCR #2 was in charge and had become a temporary Task Force Leader of a dozer and both strike teams of crews. For the rest of the afternoon, most all radio communication from DIVS was directed to STCR #2.

Supported by the two strike teams of hand crews, a half mile of dozer line was constructed to a hilltop by 1300 {See Aerial Photo #1}. STCR #2 contacted the Division Supervisor and reported that they made excellent progress to the hilltop. From his vantage at Lookout #1 DIVS could see the dozer at the hilltop. With the approval of DIVS, the plan at this point was to construct a safety zone at the hilltop (or other suitable location nearby) and continue indirect dozer line construction to the fire's edge. The line from the hilltop to the fire's edge and from the hilltop back to the south would be

supported by four-wheel-drive engines. While DIVS could see the hilltop, he couldn't see how far it was from the hilltop to the fire's edge.

At approximately 1315, the STCR #2 instructed the dozer operator to construct a "safety island" on the hilltop and then he scouted a location for the dozer to construct line to the fire's edge. The line scouted between the hilltop and the black was approximately 500 yards long. The last 200 feet or so of the scouted line would be constructed by hand as it was determined too steep for the dozer. The dozer line to be constructed from the hilltop crossed a saddle and then crossed the top of a small drain on a 30% slope. This was an area of closed canopy 30-50 foot high ponderosa pine. STCR #2 posted a lookout at the hilltop then contacted the Engine Strike Team Leaders requesting they send four-wheel-drive engines up to his location to support the dozer line with hose lays. The engine strike team leaders (still near the southern portion of Division A) split up their strike teams (as they were mixed between 2WD and 4WD) and sent four 4WD engines towards the dozer line to support STCR #2.

Aerial Photo #1 Shows Dozer Line Construction at 1400

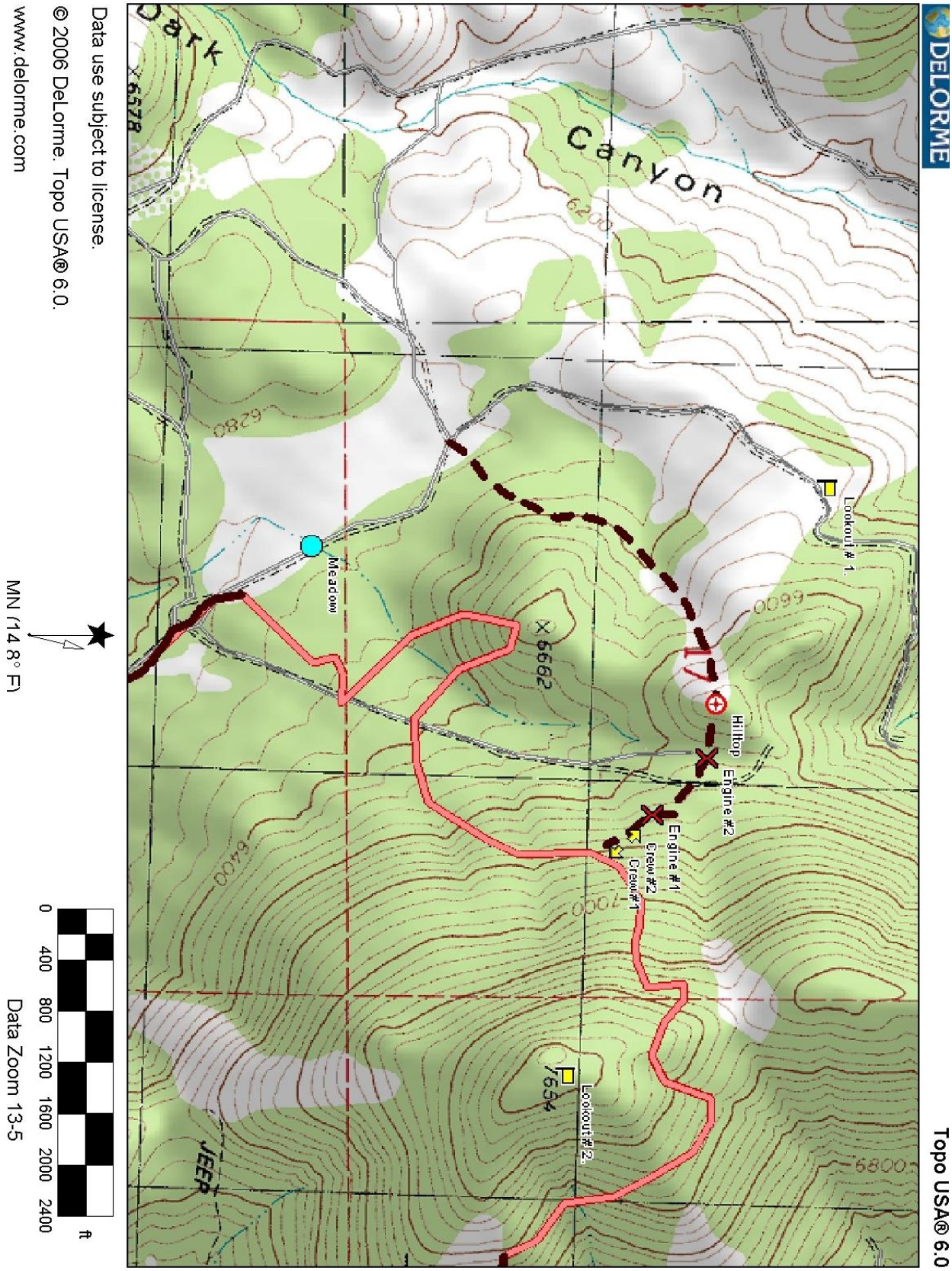


After construction of the final portion of dozer line, the dozer left to return to the meadow. The weak inversion that had been over the fire most of the morning had now dissipated. There were widely scattered thunderstorms building in the area but none of them were close enough to be a wind threat to the fire. Near the end of the dozer line, STCRs #1 and #2 discussed their options and agreed to split up. STCR #1 planed to take his crews and complete the indirect hand line construction from the end of the dozer line to the fire's edge; anchor to the black; then begin building direct line up hill to the east eventually connecting with crews building direct line in the adjacent division to their east. STCR #1 and #2 discussed safety zone options for STCR #1. While there were large areas of unburned fuel within the fire perimeter, they could see there were also sufficient patches of good black to serve as adequate safety zones within the fire area. STCR #2 planed to use his crews to improve the dozer line and work with the engines on a hose line from the hilltop to the fire's edge. The fire behavior at this time was still minimal.

At approximately 1400, the four 4WD engines arrived at the hilltop. Engine #1 then drove approximately 400 yards down the dozer line and began to deploy hose lines. Engine #2 drove down the dozer line 50 to 100 yards, turned around, and also began to deploy hose. Two engines remained at the hilltop. The crew of STCR #1 was still constructing line to connect the end of the dozer line to the fire edge. The Crew of STCR #2 was widening the dozer line and assisting the engines.

At approximately 1420 STCR #2 was at the end of dozer line and discussing operations with STCR #1. STCR #1 could see across the saddle to the hilltop and noticed two engines on the hilltop. STCR #1 pointed them out to STCR #2. They were both somewhat surprised to see the engines there and even more surprised moments later to see engine crew members laying hose line up to their location near the end of the dozer line. The STCRs assumed that all engines were at or near the hilltop and that the engine crews had laid 500 yards of hose from at or near the hilltop location. There had been no communications between the Engine Captains and STCR #1 or STCR #2. STCR #2 reported excellent progress to DIVS. STCR #2 then requested the dozer to return to the hilltop as he planned to use the dozer to increase the width of the line in the closed canopy ponderosa by several blade widths. Up until this time fire behavior was characterized as very low, creeping, to 1 foot flame lengths.

Map 2. Fire and Crew locations at 1430-1440. Two additional engines were located at the hilltop.



At about 1430 the Field Observer reported to STCR #2 that the fire activity was increasing significantly. A type one helicopter, which had been down for maintenance most of the afternoon was now actively dropping on flare-ups below the dozer line and on a small finger of fire making a run to a ridge point about 600 yards southwest of their location.

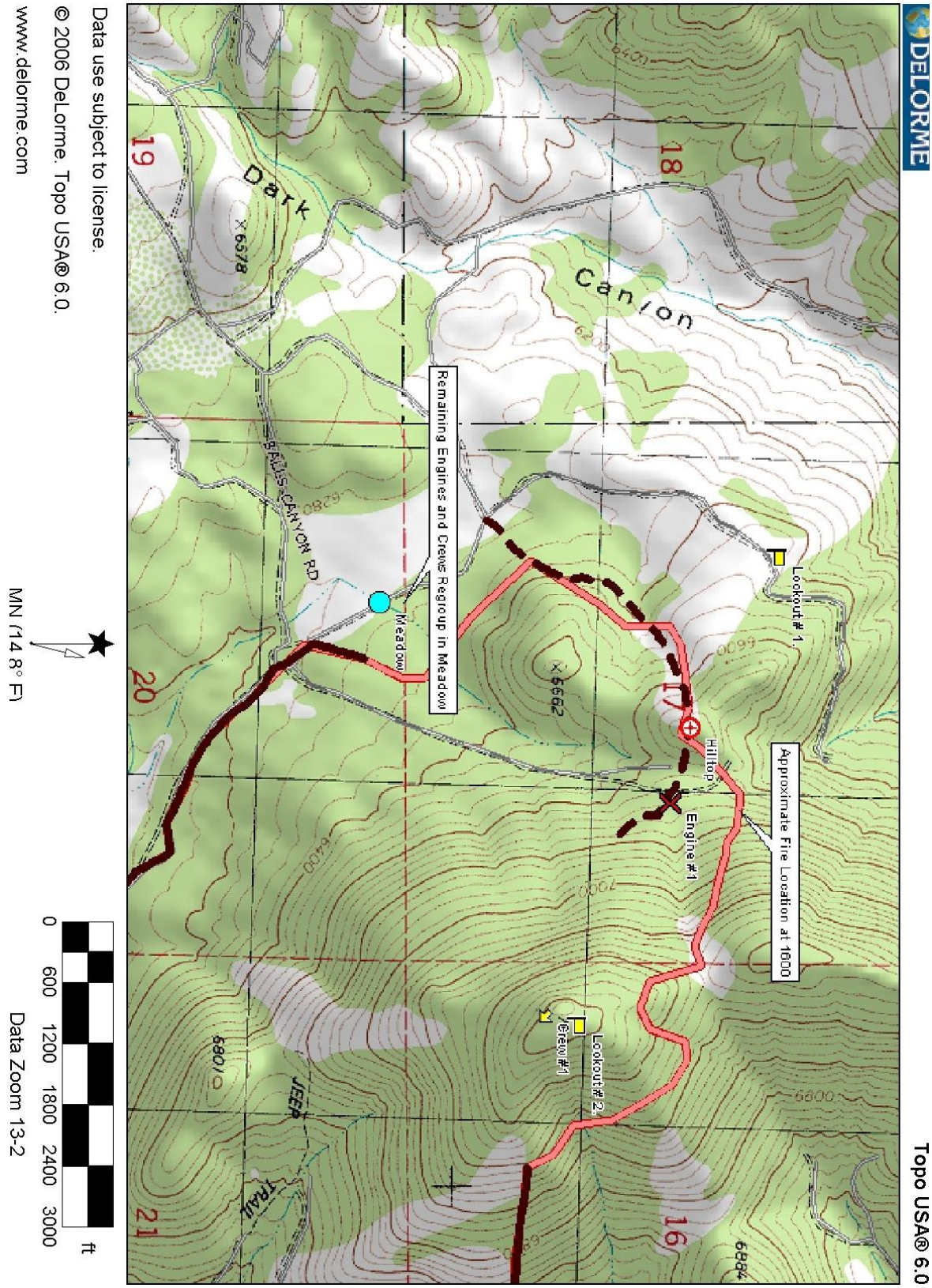
About 10 minutes later STCR #2, still at the end of the dozer line, also noticed an increase in fire behavior. About 10 minutes after that he felt a slight up-canyon wind. Within moments, group torching below the dozer line became frequent and a large column formed over the drain directly about 500 yards below their location. The Division Supervisor called STCR #2 and ordered him to disengage and have all personnel go to the safety zone. STCR #2 did not hear this radio transmission as he was already busy ordering all personnel to disengage and retreat to their safety zones. STCR #1 and his crews retreated into black just east of their location. STCR #2 ordered his own crews to go back the way they came, "back to the safety island!" While STCR #2 was walking briskly west, retreating along the doze line, he came upon Engine #1. STCR #2 was surprised to see the engine so far down the dozer line. He noticed that the engine crew was busy rolling up their hose. STCR #2 ordered the engine captain to drop their hoses, and immediately back out of their location and get up to the hilltop safety island.

STCR #2 continued past Engine #1 and ensured he had accounted for all his hand crew members. When he came upon Engine #2, he climbed onto the back of Engine #2 and rode with them back up to the hilltop. Engine #1 meanwhile, disconnected their hose lines and began backing towards the hilltop.

While backing, Engine #1 drove slightly off the dozer line and became stuck. The engine captain believed he did not have time to get the engine un-suck but believed he did have time to burn out around the engine before leaving. He directed his crew members to burnout around the Engine. At the same time the Type one helicopter began dropping on the main fire below the engine but could not completely suppress the emerging crown fire. With the support of the helicopter the captain believed he had additional time before he and the crew had to escape to the hilltop safety area. Once the firing was completed the captain directed his crew into the cab of the engine as the heat, embers and smoke from the fire below was a concern. The captain then used a hose to wet the crowns around the engine and cool the surrounding area. While in the engine, the crew members opened three fire shelters. The crew members pressed the fire shelters against the windshield and side windows to shield themselves from the radiant heat.

STCR #2 and others now at the hilltop became aware that Engine #1, with crew was still on the dozer line, in closed canopy ponderosa pine, at the top of a drainage with a building fire below them. STCR #2 and others noticed that the crew of Engine #1 appeared to be trying to burn out around the engine and they could see a stream of water from Engine #1 shooting into the tree crowns. Several attempts to radio the engine were unsuccessful. A CDF heavy equipment operator with a light 4WD flatbed service truck was also at the hilltop. After a brief discussion with STCR #2 and the engine captain from Engine #2, the heavy equipment operator and the engine captain from Engine #2 drove down the dozer line to Engine #1 in the service truck. When they got to Engine #1 they ordered all the crew members to abandon their efforts to protect the engine and jump on to the back of the truck. The crew of Engine #1 jumped onto the truck and were driven back out to the safety of the hilltop.

Map 3. Fire Location After Engine Burn Over



STCR #1 led his crew to into a previously burned area (as planned) to escape the crowning fire below them. However even though the area they had chosen was safe, the crews were taking a lot of smoke and sought a safe path to another location with better air. STCR #1 made contact with an Interagency Hot Shot crew from the Division just east of their location. The IHC crew boss then assisted STCR #1, leading them to a safe and less smoky area.

The Division Supervisor and STCR #2 ordered all resources at the hilltop safety zone to the meadow. With at least 8 water drops from the helicopter, and later, several air taker drops, Engine #1 was spared any damage. By 1600 all Division A resources retreated to the meadow except STCR #1 and his crew who eventually walked out to the meadow several hours later.

III. REASONS "THE STORY" UNFOLDED THE WAY IT DID.

Formal Accident Investigations look at Equipment Factors, Human Factors and Environmental Factors and from those draw contributing and causal factors. Similarly, the Peer Review team looked at these factors but focus of the review is on how the participants perceived each of these contributing to the near-miss. With an outsider's view, the Peer Review team evaluated and summarized these perspectives and observations.

Equipment Factors no one involved in the incident related any significance to equipment factors as contributing to the incident. The DIVS believed that he needed to remain at the lookout point in part because he wanted to remain radio contact with the command repeater. However, unbeknownst to him, there was good communications with the repeater all along the upper dozer line. Thus radio communications were not an equipment issue they were a human factors issue.

Human Factors played a very strong role in this near-miss. All of the resources involved were competent and appropriately trained but command and control in the area of the upper dozer line fell apart. Importantly, the lessons learned here apply to hundreds if not thousand of similar fire situations yearly in this country. It is not uncommon for the initial plans to change, for leadership roles to change and for strike teams to be dissembled and reconfigured to meet objectives of the new plans. Likewise it is not uncommon for firefighters and fireline supervisors to assume people are functioning in roles without specifically assigning them to be in that role.

STCR #2 is an individual with a strong, commanding personality and stature. He has run inmate crews for over twenty years and has over thirty years of a wildland and structure fire experience. All agree he was never formally assigned to be the "leader" of STCR #1 or to be the leader of the engines sent to work with him along the upper dozer line. Nevertheless, STCR #1 and the DIVS both assumed STCR #2 was in charge of all resources on the upper portion of the dozer line. One reason for this misconception may be because he was serving as line scout and effectively deciding where all the people behind him were going to go. A second reason may be because over the course of the morning and late afternoon virtually all radio traffic between the

DIVS and the resources on the line were handled by and directed to STCR #2. This was true also of communications from the FOBS and the resources on the line. For example, the warning at 1430 that fire behavior was beginning to increase was relayed from the FOBS directly to STCR #2. STCR #2 however felt sure he was only in charge of his crew and for a while the dozer operator. It wasn't until quite a while after the incident that STCR #2 learned that the DIVS thought he was in command of all the resources on the upper dozer line. In his words, STCR #2 said that in hindsight he should have made more of an effort to make the organization clear so that the DIVS, STCR #1 and the engines all knew who was in charge.

STCR #2 uses the words "Safety Island" as interchangeable with "Safety Zone". At the time of this incident, no one questioned the term safety island even though the term came up frequently in conversations with STCR #2. Fortunately use of improper terminology did not play a significant role in this incident. However had the fire's run been slightly more to the west, proper use of terminology would have been a major focus of a review or an accident investigation. At the hilltop, STCR #2 ordered the dozer operator to construct a safety island and then he left the dozer operator to scout the line across the saddle. The dozer operator, a private contractor, constructed what could best be described as a *large deployment area*; far short of an acceptable safety zone. It is not known if the dozer operator failed to construct a true safety zone because he was unsupervised or because he was constructing an *island* instead of a zone. In hindsight, STCR #2 felt he needed to supervise safety zone construction and understood that the term island could have been confusing.

Engine #1 was sent by his supervisor in the meadow to work with STCR #2. Based on how he made sense of his instructions and the situation, he believed he was an independent resource assigned to support another independent resource. A key decision that played a factor in the event was that the Engine Captain never established radio contact with STCR #2 when he reached the upper portion of the dozer line. Instead, he talked with people briefly at the hilltop and then, independently determined the tactics he would use to support the planned operation. While this decision may seem inappropriate, within the context of the situation this was not necessarily unreasonable. The engine captain knew within 15 to 30 minutes he could have a face to face with STCR #2 and then he could communicate more effectively than by radio.

A second key decision that played a factor in the event was Engine Captain #1's decision to drive forward (not back) down the dozer line. The direct consequence of this decision was that the engine got stuck at the worst possible time. The Captain didn't know at the time he left the hilltop that there was or wasn't a turn-a-round area along the dozer line but he reported that, based on the fire behavior at the time, he felt there was plenty of time to eventually get the engine turned around properly.

A third key decision was when ordered by the STCR #2 to drop the hoses and leave the area the Engine Captain initially agreed with the order but when the engine became stuck, the Engine Captain independently evaluated the situation and determined he had time to backfire and wet down around the engine before walking out with his crew. In the Engine Captain's view, a supervisory person didn't order him to leave - it was a co-worker. At the time,

the Engine Captain felt he was still working for his assigned Strike Team Leader back at the meadow. When the engine got stuck the captain was still in charge of his resource, unable to communicate with his supervisor and so he took the responsibility to make the decision to delay retreat in hopes of saving the engine. Within the CDF Engine Captains hold the same title (i.e., "captain") as Strike Team Leaders of crews. Lacking direction from any higher authority the Engine Captain did not feel compelled to obey the orders of another Captain.

With the helicopter dropping below the engine, the Engine Captain reasoned he had additional time to help protect his engine. The Review team believes this was a very risky decision. From the Captain's perspective in the saddle the decision to defend the engine may have seemed reasonable but from the greater vantage point of the hilltop, the safety risks to the crew were too great. Had the helicopter become unavailable, the crews escape route could have been made impassible and the engine would have almost certainly burned.

From this experience the Engine Captain #1 says he learned to ask more questions and make sure he knows the complete picture. He also feels he learned that an assigned supervisor needs to be directly involved in determining tactics. And finally, he stated learned he should always back down single path fire lines.

DIVS believed he needed to remain at his lookout point on the afternoon of the 27th to assure good communications with Operations. DIVS also believed he had competent leadership on the ground with STCR #2 in charge of the upper dozer line serving as a Taskforce Leader. And finally he knew the lookout point afforded him an excellent view of the operations throughout his division. These three factors worked to convince DIVS that he did not need to personally inspect the dozer line operation.

There were frequent conversations by radio between STCR #2 and DIVS. These conversations reinforced to DIVS that STCR #2 was in charge and had a good plan. In STCR #2's mind, these conversations never changed his understanding that he was in charge *only of his hand crews* and that the DIVS was in charge of the rest of the resources in his area.

When STCR #2 reported to the DIVS in the morning that going direct would not work and he had a good option to build indirect line along an existing road (instead of the original fall back option of using the Balls Canyon road as the indirect line) DIVS felt confident in the assessment he was given and confident in SCTR #2's ability to choose a good line location. It seemed to be a good option in both the minds of the DIVS and STCR #2 because it would involve burning far less acreage than the original fall back line and there would also be no need to adjust the adjacent division's plan. Later when STCR #2 reported he was building a safety island and then a direct line through the timber directly to the black, DIVS approved this again because he had full confidence in the experience and skill of STCR #2.

Importantly the length of the line from the safety island to the black was never clarified in the radio conversations. STCR #2 believed he conveyed correct information about the length though he does not remember stating it would be about 500 yards. DIVS's understanding from the conversations was that the line through the timber was "just a little" segment. From the radio conversations DIVS envisioned a constructed safety *zone* and perhaps fifty to a hundred yards of dozer line through timber which then connected to solid black. Ironically DIVS had an excellent view from the lookout point of almost

entire division except this one segment of line through the timber. In hindsight (after seeing the line after the fact) the DIVS said he would never have approved a line through dense timber, that long, and in that location, because from his experience it would not be a defensible line and would be a dangerous line to try and hold with a backfiring operation. Reflecting on the incident, the DIVS said that he learned that in spite of full confidence in the resources beneath him, he would be more careful in reviewing decisions and would be more direct in assigning roles in a changing organization. In the future, DIVS said he will not assume resources under him are organizing correctly or are estimating fire behavior potential correctly.

Environmental Factors played a significant role in the near-miss. As described in the Fire Behavior Analyst's Report and as witnessed by virtually everyone on the incident, fire behavior changed very rapidly from benign to explosive. Most people on the upper dozer line were completely surprised by how fast this change occurred. The fire behavior report however states this was clearly predictable and there were no unusual events such as unexpected down drafts, unrecognized dryness, etc that caused the rapid change in fire behavior (see Appendix A). In fact, the forecasted red flag wind conditions never materialized that day. Had the winds been as severe as forecasted, the fire behavior would have been significantly more extreme.

The DIVS, FOBS, and the Division Supervisor trainee all reported that the fire behavior on June 27th was reasonably consistent with their expectations. These people were assigned to the fire the day before and knew that torching, group torching and small crown runs began in the early afternoon triggered by intense solar heating, surface instability and very low afternoon relative humidity. In contrast on the upper dozer line, STCR #1, STCR #2 and all of the Engines were all on their first shift of that fire. None had seen the fire behavior the day before and all of them were non-local resources.

The written fire behavior forecast may have played some role in people underestimating the fire behavior. The fire behavior forecast clearly says "See Attached Weather Forecast" (and every firefighter is trained to read or listen to the weather forecast) but the written fire behavior forecast did not caution fire fighters specifically on the red flag conditions nor did the written forecast advise firefighters to expect group torching or minor crown runs in the absence of any wind.

The fire behavior forecast may have contributed but was not deficient as they are, by design, predicated on the day's operational plans. In this case the operational plan was to build direct fire line. A plan to build indirect line might have resulted in additional warnings in the written fire behavior forecast. Moreover, the FBAN reported he cautioned operational personnel on both the red flag and *normal afternoon torching* in his morning shift briefing. Also DIVS stated that he briefed his forces on expected fire behavior at the 1000 meadow briefing that morning based on what he had seen the day before. Almost all the firefighters involved in this near-miss reported that they learned to be more cautious and respectful of fire's potential to change extremely rapidly.

IV. Lessons Learned Evaluated Relative to principle based decision making

The Review Team analyzed the lessons learned by the firefighters involved in this incident and evaluated them relative to the six categories of principles found in the document, **Foundational Doctrine Guiding Fire Suppression in the USDA Forest Service.** This evaluation serves as this Report's Lessons Learned Analysis and is intended to further the doctrine's understanding and application in wildland fire management.

1. The Operational Environment

The firefighters involved in Division A were actively mitigating the risks they believed were present. In hindsight however, virtually everyone on the Dozer line seriously underestimated the fire behavior. A key lesson from this incident is that highly trained and very experienced firefighters can dangerously underestimate fire behavior. Substantial risks are mitigated through a strong and stable organizational structure. A second key lesson learned from this incident is that strong and very experienced fire organizations can become destabilized when operational roles are changed and not explicitly discussed.

2. Mission

The Mission of Division A appeared to be entirely valid and appropriate. No lessons learned.

3. Leadership and Accountability

Strong leadership attitudes and actions were exhibited by DIVS and STCR #2. On the morning of June 27 DIVS's "leader's intent" was clearly understood and accepted by all resources. As the afternoon progressed additional leadership roles were given to STCR #2 without STCR #2 knowing or accepting them. It is a valuable lesson for the greater wildland fire community to learn that a clear chain of command needs to be expressed and then must be reinforced as operation plans change and as crews or strike teams are reconfigured. Also, assumptions were made by several leaders involved in Division A that resulted in a lack of accountability. A key lesson learned by the firefighters involved in Division A is that Leadership decisions (such as assigning engines to an adjacent strike team or ordering the construction of a safety zone) require affirmative follow-up to ensure the actions are meeting Leader's Intent.

4. Roles and Relationships

There is no indication that roles and relationships as described in the doctrine document (dealing with external relationships) can provide a Lesson Learned from this incident.

5. Operations

The crew and engine leaders on Division A were empowered to make operational decisions. These leaders were creative and decisive in exercising responsibility to complete the mission. However, since they underestimated the potential fire behavior, they choose a strategy that could not succeed and tactics that would eventually place firefighters in situation of

unacceptable risk. A critical lesson learned from this incident is that while leadership empowerment is essential for a safe and effective fireline operation, it can lead to confusion over leadership roles if changes are not clearly communicated. Also, leaders involved in selecting suppression tactics need to ensure they all share a common understanding of potential and expected fire behavior.

6. Risk Management

The leadership involved in Division A was actively trying to implement LCES. They had three lookouts; adequate communications, identified escape routes and safety zones. All of these risk mitigations were discussed frequently throughout the incident. However, fire behavior assumptions and assumptions on changing leadership roles aligned to make a substantial hazard to firefighters. A critical lessoned learned from this incident is that fire behavior assumptions and organizational assumptions also create risks that must be resolved or appropriately mitigated.

Summary and Recommendation:

The Review team believes the mistakes that occurred on this incident likely occur on hundreds if not thousands of wildland fires annually. In fact had the engine backed out successfully at 1430, all of the faint signals of errors and mistakes would likely have been overlooked, the incident would have been viewed as a successful operation *and behaviors reinforced*. It is critical we, as an organization, learn how subtle errors can lead to potentially catastrophic outcomes. The Review team recommends this report be distributed widely and posted on the Lessons Learned website. This report can also be used as an effective learning tool to create sand table exercises based on this scenario.

The review team sincerely thanks and appreciates people involved in Ball's Canyon for their honest and frank responses and willingness to share their experiences for the good of the greater wildland fire community.

Appendix A. Fire Behavior Analyst's Report

Fire Behavior on the Ball's Canyon Fire
During the Fire Shelter Deployment Event on Division A

Wm. T. "Sandy" Munns, FBAN

The Ball's Canyon fire had been burning since 6/25/06, spreading west over and around a ridge north of Ball's Canyon. At approximately 1445 hrs on 6/27/06, fire intensity and rate of spread changed rapidly. Based on the new fire conditions, the Division 'A' Supervisor called for a disengagement of all resources in the division and ordered everyone to their designated safety zones, utilizing identified escape routes. The following discusses the factors and probable causes of the observed rapid change in fire behavior.

Topography:
Fire had been burning on a southwest-to-west aspect slope on the north side of Ball's Canyon, extending from approximately the Staverville Rd (6200') to the 7800' peak, and had been burning across the 45% slope into the wind, in a northwest-to-north direction. At the location of the event, there is a south-facing drainage with a 15% slope ending in a small saddle running east-west between a knoll (6800') to the west and the mountain to the east.

Fuels:
The area of the event contained an open stand of mature timber with small, dense patches of immature trees (dog-hair pines). This was intermixed with juniper, mountain mahogany, short sagebrush and perennial grasses. There was a consistent layer of needle cast and litter under the trees (FBPS Fuel Model 8). The sagebrush and grasses were generally in the open (FBPS Fuel Model 5). Calculated 1 hr fuel moisture at the time of the event was 5%. 10 hr fuel moistures are estimated at 6% (RAWS data), 100 hr FM was approximately 8% (WFAS calculated value 6-10%), while 1000hr fuel moisture was <10%. Live fuel moistures averaged <175% (measured at Doyle and Ravendale, CA, 6/19/06) for sagebrush, and Pinyon pine at 97% (Markleeville, CA, 6/19/06). For calculations an estimated live fuel moisture of 150% was used, since this was two weeks later than the sampling date, and was on a south aspect location.

Weather:
The region had seen several days of warm, dry weather, with mostly clear skies and no precipitation. On the day of the event, the National Weather Service had issued a Spot Weather Forecast for the fire area at 1026 hrs. Predicted conditions for 7000ft elevation were: max temperature 84-86deg F, min RH 15-18%, winds upslope 3-7mph except gusty near thunderstorms. Additionally, they had issued a Red Flag Warning from 1300 through 2200 hrs for thunderstorms, with associated strong outflows and dry lightning.

During the day, a FOBS in Div A had been monitoring weather with a belt weather kit. At 1430 hrs the FOBS (with DIVS, DIVS(T), and SOF) was on an open, exposed area 1/4 mile to the northwest, with a good view of the event location. He recorded observations of 87deg, 30% RH, eye level winds 3-5mph from the NW, approximately 30% cloud cover and thunderstorm cells were actively developing in the vicinity of the fire area.

Fixed RAWS units in the area (Dog Valley, Galena, Stampede, Doyle and Desert Springs) al recorded RH values much lower than observed on site, leaving the observed value as suspect. Observed winds were consistent with regional RAWS data, which recorded a light prevailing flow from the north.

Fire Behavior:
According to observations by the FOBS and DIVS, the fire had been burning with low intensity, described as smoldering and creeping spread, and short flame lengths. BEHAVE calculations show ROS approximately 1/2 chain/hr and flame lengths <1 ft, consistent with observed fire behavior. The visible smoke column was moving southerly. At approximately 1445 hrs, the FOBS and DIVS observed a rapid (less than 2 minutes) increase in fire activity, with several distinct smoke columns along the fire line, and in the drainage. They could not see the fire itself. They stated the smoke columns were well defined and vertical. As the fire intensified, they saw a further increase in fire intensity, with frequent torching of small groups of trees. The fire spread rapidly uphill in the south-facing drainage toward the saddle, then turned and moved uphill on the main slope. Flame lengths were estimated at 75-100' from torching trees, and ROS was undetermined, but estimated at approximately 20 chains/hr on the steep slope. Spotting from torching trees was a likely element in fire spread, as well as radiant heat due increased fireline intensity. Fire jumped the dozer line on the hill.

Conclusion:
Fire was burning in surface fuels with consistent and predictable fire behavior. The prevailing N-NW wind was holding any significant advance of the fire line toward the north. When winds changed, the fire spread to the north changed quickly. After discussion with National Weather Service IMET Jim Wallman of the Reno office, it was agreed the solar heating of the area created upslope winds, which became dominant over the prevailing winds. Wind speed is estimated at 3-5mph upslope, or about 1 mph at eye level under the trees. Wind moved upslope in the south facing drainage, then moved upslope on the main, west aspect slope. This slope-driven air flow caused an increase in fire intensity and rate of spread. As fire moved into the dense patches of immature timber, they torched, causing spotting and the large flame lengths. The primary carrier of fire was the sun-heated sagebrush and the shaded timber litter.

BEHAVE calculations also show a dramatic sharp increase in flame length and rate of spread for fuel model 5 (brush) when fuel moistures drop below 4%. This may also have been a contributing factor, since RAWS stations in the area show RH values lower than measured on-site observations. Additionally, a significant drop below 20% was noted after 1200 hrs, with minimum RH vales being reached around the time of the event.

Appendix B. Fire Behavior Forecast for 6/27/06

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BEHAVIOR FORECAST

Forecast #2 **Incident:** Ball's Canyon Fire **Prediction for:** DAY Operational Period 06/27/06

Issued: 06/26/06, 2100 hrs

Weather: See attached.

Review Your Pocket Cards:
Burning Index (BI): Yesterday (actual): 122 Today (forecasted): 121
Energy Release Component (ERC): Yesterday (actual): 93Today (forecasted): 88

Fire Behavior:

General:
Conditions will be similar to yesterday, with a greater chance of wetting rain from afternoon thunderstorms. Poor overnight RH recovery in the thermal belt and morning solar heating will make fire active fairly early in the morning. Very dry conditions exist throughout the entire fuel complex. A stationary, high-pressure ridge is producing cells that don't move. Downdrafts from nearby cells will create erratic gusty winds. Active burning is causing torching trees by noon with spotting from them up to 0.1 miles.

Division A and M:
Inversion should lift around 0900 hrs. Firing operations will be effective after this time. Firing should be complete by 1300-1400 hrs when thunderstorm cells begin to develop around the area. Gusty winds should hit around 1500 hrs, possibly sooner. Watch for spotting over the line when trees torch.

Air Operations: A weak inversion in the morning will hold smoke and limit visibility, but should break by 1000 hrs. Afternoon thunderstorm activity will have strong downdrafts. Avoid air operations during the period of gusty winds.

Safety: Remember the Standard Fire Order: *"Base all actions on current and expected fire behavior."*
The fire environment is not static! Conditions change throughout the day. Forecasting is useful, and assists in knowing what to expect --- to a point--- but you must also monitor conditions constantly. If conditions change significantly, reevaluate your actions and adjust to the current conditions. Take weather obs and note fire intensity and rate of spread continuously.

NOTE to Division Supervisors: Assign someone in each division to monitor weather HOURLY and turn in to FBAN at base camp. Thanks
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Appendix C. Spot Weather Forecast for 6/27/06

BALLS CANYON FIRE (WILDFIRE) (Requested: 1001 PDT 6/27/06)

Forecast complete at 1026 PDT 6/27/06

Requested by: FBAN TNF Phone:(775) 224-3473 Contact:

Location: Legal: Lat/Lon:39 39 43/120 04 58 Quad:EVANS CANYON CA
Calculated: (39°39'42"N 120°4'58"W) (EVANS CANYON CA)

Elevation:5560-7000 Drainage:BALLS CANYON Aspect:E Size:1000

Fuel Type:unknown (Partially Sheltered)

Observations:

Place Elev Time Wind Temp Wetbulb RH Dewpt Remarks

Requested Parameters Remarks

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.XX Clouds / Weather
.XX Temperature
.XX Relative Humidity
.XX 20 Foot Wind
... Smoke Dispersion
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FORECAST:

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IF CONDITIONS BECOME UNREPRESENTATIVE,
CONTACT THE NATIONAL WEATHER SERVICE.
...RED FLAG WARNING IN EFFECT FROM 1 PM THROUGH 10 PM THIS AFTERNOON
AND EVENING FOR THUNDERSTORMS WITH STRONG OUTFLOWS AND ISOLATED DRY
LIGHTNING...

DISCUSSION...HIGH PRESSURE WILL REMAIN OVER THE FIRE FOR ONE MORE
DAY BEFORE MOVING OFF TO THE EAST TONIGHT. TEMPERATURES WILL REMAIN
VERY WARM WITH A VERY UNSTABLE ATMOSPHERE. WHILE GENERAL WINDS WILL
BE LIGHT...OUTFLOWS FROM THUNDERSTORMS WILL BE CAPABLE OF WIND GUSTS
AROUND 50 MPH AND ERRATIC WIND SHIFTS. UNLIKE PREVIOUS NIGHTS...
ISOLATED THUNDERSTORMS WILL BE POSSIBLE THROUGH THE NIGHT AS THE
PATTERN TRANSITIONS TO WETTER AND COOLER ON WEDNESDAY.

FOR TODAY
   WEATHER.............PARTLY CLOUDY WITH AREAS OF SMOKE. BECOMING
                       MOSTLY CLOUDY AFTER 1300 WITH SCATTERED
                       SHOWERS AND THUNDERSTORMS.
   TEMPERATURE.........MAX 90-92 AT 5500 FT
                       MAX 84-86 AT 7000 FT
   HUMIDITY............MIN 12-15% AT 5500 FT
                       MIN 15-18% AT 7000 FT
   WIND...20 FOOT.....UPSLOPE 3-7 MPH EXCEPT ERRATIC AND GUSTY
                       NEAR THUNDERSTORMS.

FOR TONIGHT
   WEATHER.............MOSTLY CLOUDY. SCATTERED SHOWERS AND
                       THUNDERSTORMS THROUGH 2100 THEN ISOLATED
                       THROUGH THE NIGHT.
   TEMPERATURE.........MIN 60-63
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HUMIDITY.....MAX 35-40%
WIND...20 FOOT.....NORTHWEST 6-12 MPH BECOMING DOWNSLOPE 2-4 MPH AFTER 2200. WINDS ERRATIC AND GUSTY DURING AND UP TO TWO HOURS AFTER STORMS.

OUTLOOK FOR WEDNESDAY
WEATHER.....MOSTLY CLOUDY WITH SHOWERS AND THUNDERSTORMS BECOMING NUMEROUS.
TEMPERATURE.....MAX 80-84
HUMIDITY.....MIN 19-22%
WIND...20 FOOT.....UPSLOPE 3-7 MPH BECOMING SOUTHWEST 7-12 MPH IN THE AFTERNOON.