Four Corners Fire

April 5 & 6, 2000

Entrapment Investigation Report

WISCONSIN
DEPT. OF NATURAL RESOURCES

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Preface

Fire fighting, whether wild land or structural, is a profession that involves inherent risks. It requires physical and mental skills, sound judgment, along with the ability to make swift and difficult decisions in adverse conditions. During the Four-Corners fire on April 5th and 6th 2000, there were a series of judgments, decisions, events and actions as well as uncharacteristic weather and fire behavior that when combined led to the entrapment of three individuals. None of the people involved purposely made decisions that led to this entrapment.

An investigation team was assembled with the intent of finding factual evidence that would lead to an understanding of the circumstances that led to the entrapment. The team was assigned without any preconceived thoughts of why or what had happened. The intent of the investigation was to gather facts and analyze the incident in hopes of learning from the events and attempting to reduce the chance of reoccurrence. The report will be presented to the Forestry Division Administrator, Forestry Bureau Director and Forestry Bureau Protection Section Chief.

The investigation team wishes to express sincere gratitude to everyone that contributed to the investigation.

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

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July 5, 2000

TO: HEALTH AND SAFETY WORKING TEAM

FROM: ED FORRESTER

ENCLOSED IS THE REPORT ON OUR "ENTRAPMENT" INVESTIGATION.

THE BOTTOM LINE IS THAT NOTHING NEW WAS DISCOVERED , WE SIMPLY HAD A PROBLEM IMPLEMENTING THE PRESENT STATE OF KNOWLEDGE AND IN HUMAN COMMUNICATIONS.

SIGNIFICANT ACTIVITIES ARE UNDERWAY RELATED TO DEALING WITH FIRES IN THE PORTIONS OF THE STATE IN WHICH THE LOCALS HAVE THE PRIME RESPONSIBILITY. (COOPERATIVE AREAS) SINCE WE DOWNSIZED OUR EFFORTS THERE IN THE 70'S AND 80'S HAVING PROBLEMS SHOULD NOT BE A SURPRISE EITHER.

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Executive Summary

The Incident

The preceding summer and winter had been unusually warm and dry in Southwest Wisconsin and the Black River Falls Dispatch Group had been in full operation since the end of February. An intense low-pressure area had entered the state from the northwest that morning and winds were increasing dramatically as evening approached. By late that night they were gusting to 40 miles per hour.

At approximately 10:00 p.m., on April 5, 2000, Wisconsin Department of Natural Resources (WDNR) assistance was requested on a forest fire located in the extreme northeast corner of La Crosse County, Wisconsin, outside of the WDNR Organized Protection Area. It had been a busy day for area firefighters, already 10 other fires had been dealt with during the course of the day.

The nearest WDNR Forest Ranger responded and assumed command. The fire was approaching 100 acres upon arrival and burning in sandy soil oak with scattered clumps of red and jack pine and grassy openings. Substantial wind damage had occurred in the area two years before and much of the cured slash from clean-up operations was scattered throughout the fire area. The local fire department had already called for Mutual Aid and a large structural protection effort was underway for some time prior to the arrival of the WDNR units.

The Incident Commander (IC) found himself in the dark, in unfamiliar territory, with no good maps, poor radio and cell phone coverage, and with no spotter aircraft available due to high winds. While trying to size-up the fire, he was simultaneously working to organize the structural protection effort and set up a wildfire organization.

In the confusion, three firefighters and two tractor-plow units positioned to begin fire line construction were entrapped and overrun by the fire. One fire shelter was used and no serious injuries or equipment damage occurred.

The Investigation

Upon discovery that a possible entrapment situation had occurred, the Bureau of Forestry Law Enforcement Specialist was immediately sent to Black River Falls to investigate. After initial interviews to clarify the situation, an investigation team was formed with representatives from the Division of Forestry, WDNR Regions affected, and the US Forest Service. The following week the entire team met and formulated an investigative strategy. Incident reports were solicited from 15 individuals and 12 oral interviews were conducted. The following week, all personnel directly involved were interviewed at the actual site of the entrapment. A draft report was competed on April 26, 2000.

Causal Factors

Direct Causes

The Investigation Team determined that the direct causes of the entrapment on the Four Corners Fire were as follows:

Fire Behavior

Weather

- The high winds experienced at the time of the entrapment (sustained winds of 16 mph, with gusts to 34).
- Wind speeds peaked at midnight - at the same time the entrapment occurred.

Environmental Factors

Smoke

- The smoke became so thick that visibility was down to zero for periods of time. Personnel could not see the lights on nearby engines or dozers next to them.
- Safe movement of equipment became difficult and dangerous. There was a high possibility of running over firefighters in the smoke while trying to reposition tractors or engines.

Visibility

- Lack of daylight made it difficult to size-up the fire properly
- Hills near the entrapment site blocked the view of parts of the fire and gave a false impression of size and location on the fire.

Incident Management

Tactics

- Heavy Units were unloaded in an unsafe location too near the fire edge to allow time for proper deployment.
- Heavy Units were pulled straight in and could not back out easily for quick escape
- The tactical plan to plow against the grain of the fire, J hook and reverse direction to plow with the spread of the fire was poorly understood. This was based on a faulty size-up and fraught with unmitigated hazards.
- There was no anchor point. Line construction groups are intended to start at the origin or some other well-defined anchor point and plow down fire.

Safety Briefings/Major Concerns Addressed

- Safety Briefings were not held and LCES (Lookout, Communication, Escape route, Safety zone) considerations were not discussed with personnel involved.
- No feedback was requested or considered.

Instructions Given

- Instructions were unclear and not commonly understood.
- Personnel were unsure of what was meant by "J hook" and where it was to be done.

Control Mechanisms

10 Standard Fire Orders/18 Watch Out Situations

- Eight of the 10 Standard Fire Orders were compromised.
- Twelve of the 18 Watch Out Situations were present and not mitigated.

Involved Personnel Profiles

Attitudes

- A general attitude prevailed that it was critical to get units plowing on the fire as soon as possible - despite a lack of key information. A "hurry up" approach precluded proper size-up, orderly deployment, and adequate briefings.
- Operators felt a need to "protect their equipment" and may have stayed in place longer because they did not want it to burn.

Leadership

- The IC was distracted by structural concerns and directing all wildland suppression activities simultaneously.
- The Group Supervisor was too focused on implementation of the tactics and did not have time to adequately consider safety issues.
- A climate of mutual respect and teamwork between supervisors and line personnel did not exist. At least 4 veteran Forestry Technicians concurred that the situation was unsafe, yet only one was willing to repeatedly bring it to the attention of the supervisors.
- Personnel began to take independent actions. Fire Department units supporting group operations did not report to Group Supervisor.
- Riders were "lost" at times.
- The Leadership lost sight of the need to ensure that SAFETY was job one.

Contributory Causes

The following factors contributed to the entrapment on the Four Corners Fire.

Fire Behavior

- The pre-green fuels were drier than normal and there was a general underestimation of the fire behavior in hardwood and grass fuels near the entrapment site.
- There was abnormally hilly topography in the area and the entrapment site was in a saddle.
- There was a general lack of forecast information, extreme fire conditions, and a subconscious perception that fires are supposed to "lay down at night" and decrease in intensity.

Incident Management

- The fire occurred in a Cooperative Fire Protection Area. Personnel were unfamiliar with the area and lacked maps, photos, and other normally available resources.
- Resource allocation and deployment may have been slower than would have been the case had the fire been in an Intensive Fire Protection Area.

Control Mechanisms

- The span of control for the IC was too great given the complexity of the fire. His attention was diverted by constant radio traffic from both structural and wildland forces. The result was a lack of time for adequate size-up and briefings.
- It was not made clear to the fire department units supporting the left group that they were under the command of the left group supervisor.
- Hilly terrain and being in a co-op area adversely affected tactical (red) net, repeater (blue) net, and cell phone communications.
- Both the IC and Left Group Supervisor were monitoring both red net and firecom (fire department net). There was excessive talking on red net.
- A ten code (10-33) was used instead of plain text to convey "emergency traffic".
- Both the IC and the Group Supervisor failed to recognize that the "plan" was being overtaken by events. "Tunnel vision" occurred and there was a failure to step back and re-evaluate the plan in light of the changing situation.

Involved Personnel Profiles

- The Initial IC was qualified at the ICT3 level, by the time of the entrapment, the fire was transitioning into a Type 2 incident.
- Black River Falls Personnel involved had all been working from 38-41 days straight prior to this fire and had been on duty since 0900 that morning (entrapment occurred at around midnight).
- The Black River Falls Dispatcher had also been working for 38-41 days straight and was on duty without a fully qualified relief for a 24-hour period during the incident.
- All personnel involved were experienced firefighters, but a fire of this magnitude, at night, in co-op, in hilly topography, was new to most of them.
- Personnel involved in the entrapment stayed calm and acted decisively. They made effective use of their training and equipment. The use of a fire shelter by one of the technicians to shield himself from embers and heat was an excellent idea. The conduct of those involved in the entrapment was a **positive influence** on the outcome of the incident.

Equipment

- A lack of maps and aerial photos hampered fire planning.
- The unavailability of the patrol aircraft due to high winds and poor visibility hampered ground activities.
- All equipment was well maintained and, except for the pump on Pray Engine 1, worked properly. All personnel were properly equipped with protective clothing and equipment.

Incident Overview

Note: This overview is not intended to reflect an exact sequence of events. It is a composite based on several interviews and incident reports.

Background

The spring of 2000 fire season in the Black River Falls (BRF) Dispatch Group started early and was shaping up to be a record year. Rainfall had been below normal since mid-summer the year before and snowfall was well below average. Spring snow melt had come very early and by the 1st of April fire crews had been working continuously since February 28th.

On April 5, 2000, the Black River Falls Dispatch Area was experiencing a very active fire day. At noon a fire was in progress in the Fairchild Fire Response Unit (FRU) and by mid afternoon, several units were working on a series of Railroad fires. Over the course of the day 10 fires would be dealt with, not counting the Four Corners Fire and the Beaver Creek Fire that occurred later that night.

It had been 12 days since any significant rainfall had occurred. Weather observations taken at Black River Falls at 1300 hours recorded overcast skies, 58 degrees, 31% relative humidity, and SE winds at 14 mph gusting to 24 mph. Wind speeds continued to increase as the day went on. By approximately 2200 hours, when the report of a "large fire burning in Monroe County" was relayed from Monroe County via Jackson County to the Black River Falls Ranger (BRF Ranger), the wind was gusting to 44 mph and coming straight out of the West.

The BRF Ranger was in his engine searching for still another fire at the time. Shortly after the report, he was advised by the fire department on-scene that the fire he was currently enroute to was under control and he immediately broke away and responded to the new fire. Based on the initial description, on-going activity, and current weather conditions, the BRF Ranger ordered additional rangers and equipment enroute. He also requested that a patrol aircraft, the Basin Fire Management Officer (FMO) and the Black River Falls Dispatch Group Incident Management Team be dispatched.

Initial Activities

Upon arrival the BRF Ranger assumed command of the incident. He established a staging area at the Four Corners Restaurant and met with the Fire Department Officers already on scene. The Melrose Fire Department Chief requested that the BRF Ranger assume overall command at that time and efforts to organize the structural protection effort began. Structural Zones were established and Structure Branch Director was appointed.

Very little information was available relative to the location of the fire. No one knew where the origin was. The Incident Commander (IC) left the Four Corners Restaurant - now designated as the Incident Command Post (ICP) - with the Bangor Fire Chief to size up the fire.

It soon became apparent that the fire was not in Monroe County as originally reported but, rather, in the northwest corner of La Crosse County.

The State of Wisconsin is organized into three categories relative to forest fire protection:

- "Intensive Protection Areas", where the WDNR has primary forest fire protection responsibilities. Portions of Monroe and Jackson Counties fall in this category.

- "Extensive Protection Areas", where WDNR and Fire Departments both respond and share protection responsibility.

- "Cooperative Protection Areas", (commonly referred to as "co-op" areas) include the rest of the state. In these areas, local fire departments have primary forest fire protection responsibilities and the WDNR role is limited to training, grant administration, and support on large fires if requested by the local unit of government. The whole of La Crosse County is a "co-op" protection area.

The fact that the fire was in a "co-op" area presented a number of challenges:

- Since DNR Forest Rangers do not normally respond to forest fires in "co-op" areas, they are not as familiar with local road systems, landmarks, and forest fuels as they would be in their normal response areas.

- They also do not carry the maps, aerial photos, and other local resource information relative to "co-op" areas that they would normally have in their vehicles when responding in an Intensive or Extensive Protection Area.

- In addition, the DNR fire radio repeater system is not designed to provide reliable coverage outside of "Intensive" and "Extensive" fire protection areas.

The high winds and lack of daylight also created a significant concern over pilot safety and the earlier request for a patrol aircraft was turned down by the Regional FMO.

This left the IC in a position of trying to accurately locate the fire with only a statewide "gazetteer" - in total darkness, in unfamiliar country, with only a limited ability to contact his dispatch center and without the benefit of aircraft. To compound matters even further, there was considerable topography in the fire area that made it difficult to see large portions of the fire from the ground and affected the use of his cell phone. This topography did not appear on the gazetteer, which did not include any contour lines.

Normally, "co-op" areas are not heavily forested and most of the fuels are composed of grass and brush. Access is usually well developed, and local fire departments can be effective on wildfires with structural equipment. This was not the case in this particular area. The entire fire area was forested and was bisected by only one blacktop road. The fuels consisted primarily of sandy soil oak, mixed with scattered small jack and red pine stands, and grassy openings. The area had experienced extensive wind damage in recent years and much of the area had been salvaged, leaving clumps of slash behind. These fuels combined with high winds and topography resulted in a fire that was not typical of the average "co-op" fire.

The following is a direct quote from the narrative supplied by the Fairchild Ranger, who was assigned to the left flank of the fire:

"*Fuels along the left flank consisted of heavy slash for most of the distance. Burning intensities were extreme. Wind gusts pushed hard on the left flank at times and breakouts were a concern all night. Some breakouts were experienced and potential for many more existed. The 40-50 mile per hour winds made the fire a panoramic vision that I had never experienced before. I was in awe at all the extreme colors of reds, oranges, purples, and bright whites of pine crowns when they went up. You could literally look out over a 200-acre area and see it all burning at one time - what a sight! Flame lengths were sometimes 50-60 feet.*"

The fact that the fire was determined to be in a "co-op" area also presented some difficult challenges for the Dispatch Group Fire Management Officer (FMO) and the West Central Regional Fire Management Officer (Regional FMO). While trying to assess resource priorities relative to the Four Corners Fire, a second major incident (the Beaver Creek fire) had broken out and was building up in another adjacent "co-op" area (this one involving a portion of state-owned land as well). All this at a time when the same weather conditions prevailed over both the Black River Falls Dispatch Group and the neighboring Wisconsin Rapids (WIR) Dispatch Group for which they had primary protection responsibility.

Fortunately, they had recognized the potential development of such a situation based on earlier weather forecasts and had pre-positioned additional rangers and equipment from other regions in both the BRF and WIR Dispatch Groups earlier that same day.

All of these resources would find themselves deployed to the Four Corners Fire.

Suppression Strategy

Having completed a hasty road reconnaissance of the fire, the IC's first action was to establish a Line Construction Group on the right flank - since that was where the majority of the structures appeared to be. The Tomah Ranger was contacted by cell phone and designated Right Group Supervisor. He was directed to lead the Pray 2 (PRY 2), Black River Falls 1 (BRF 1) and Black River Falls 2 (BRF 2) heavy units north from County Highway A to the origin and begin to plow east along the right flank of the fire.

The IC then drove northeast on Sommers Road and crossed through the fire to a point just north of the left flank. There he noticed a chained off driveway leading to the east and what appeared to be a gravel pit on the west side of the road slightly further to the northeast. The left flank of the fire was south of the junction of Sommers Road and the driveway at the time and was burning on both sides of Sommers Road.

Note: The IC stated in follow-up interviews that he had driven through the north edge of the fire in his type 7 engine a number of times without any difficulty during his size-up efforts.

The IC estimated flame lengths west of Sommers Road at 6 to 8 feet or less. He was only able to see approximately 50 yards of fire along the flank to the west and felt he was near the origin or something else that was inhibiting fire spread in that area.

Note: It turned out later, with the benefit of daylight, that the IC's vision was blocked by a ridge to his west that he could not discern in the dark.

The IC developed a plan to bring a Left Flank Line Construction Group in to that location and plow back to the west (up wind) against the grain and J-hook the origin. The group would then reverse direction and commence plowing to the east (down wind) along the left flank. At about this point the IC encountered a fire department unit and told them he would be sending in tractors and to make sure they had a full tank because they would be supporting the Line Construction Group by controlling any slop-overs along Sommers Road.

The IC then drove back to the ICP/Staging area and met the FMO and the Structural Branch Director to compare maps and brief them on actions taken. A short discussion was held between the IC and FMO relative to what was being done on the right flank and the proposed plan for the left flank. The IC's narrative states that the FMO "showed some concern and I told him that the Fire Department would be watching the groups back door so they would not get flanked. The FMO agreed and I assembled a group with Ladysmith East Ranger as Left Group Supervisor (LG Supv), and heavy units Ladysmith 1 (LAD 1) and Pray 1 (PRY 1)." Tomah 1 heavy unit was also part of the initial group. Black River Falls 3 (BRF 3), Tomah 2 (TMH 2), and Fairchild 1 (FAR 1) heavy units were also assigned to the left group a short time later.

Note: Ladysmith East Ranger, his rider, and Ladysmith 1 were part of the resources pre-positioned from the Northern Region earlier that day.

Note: Pray 1 and his rider had not met each other until earlier that day.

Note: The fire department units in place back on Sommers Road, near the left flank, were not formally assigned to the Left Group.

The Entrapment

Once assembled at the staging area, the IC led the LG Supv, PRY 1 and rider, LAD 1, and TMH 1 back down Sommers Road in a southwesterly direction. FAR 1, TMH 2 and BRF 3 followed minutes behind. The IC, LG Supv, PRY 1 and LAD 1 stopped at the "gravel pit" along the west side of Sommers Road and PRY 1 pulled in head first to unload.

Upon exiting his engine PRY 1 operator noticed that the parking area was not actually a gravel pit and the ground was covered with matted grass. In the darkness, he had not been able to see the difference in his headlights. Since the fire had advanced to within 50-75 yards of his location he began to plow a safety furrow around the parking area. While he was doing so, LAD 1 also pulled in headfirst alongside. Prior to unloading, LAD 1 operator contacted the LG Supv on the radio and said that he felt "this was a bad place to be". LG Supv acknowledged the transmission, but was in the midst of a briefing with the IC, while monitoring both red net and firecom, and was distracted. LAD 1 unloaded his tractor and began to use his blade to widen the furrows being put in by PRY 1. In the process of plowing, both noticed that several slash piles were inside the parking area - which now appeared to actually be a landing created during the salvage work. PRY 1 pushed away some of the slash that was immediately adjacent to the heavy units and as they continued to work they discovered that a number of 12-16" oak stumps were also scattered amongst the slash making plowing and dozing very difficult.

It was now very near midnight and wind was still gusting at around 35 miles per hour.

Both PRY 1 and LAD 1 were concerned about their location. While the surface fire moving toward them through the grass south of their location (on northwest side of Sommers Road) did not appear "unusually dangerous" it was clear to them that it would burn up to and around them. The fire across the road on the southeast side of Sommers Road was moving into a small stand of sapling-sized red pine and beginning to torch out. Their view directly to the west was blocked by a hill, which no one was able to see in the darkness.

At some point, the two Forestry Technicians on BRF 3 and TMH 1 walked down the road from further up Sommers Road where they were parked to confer. All agreed that "this was a bad place to be". A short time later, the small stand of pine across the road torched out completely.

Following the briefing between the IC and LG Supv, the IC left to return to the ICP. As the IC prepared to leave, he told LG Supv to "pull out if it gets too hot". LG Supv and his rider drove southwest along Sommers Road to the location where PRY 1 and LAD 1 were unloaded. LG Supv was met by LAD 1 who reiterated his earlier comment that "this was not the place to be". LG Supv agreed and instructed both PRY 1 and LAD 1 to load up and pull out of the area. LG Supv and his rider then climbed into their type 7 engine and drove northeast along Sommers Road to clear the way for PRY 1 and LAD 1 to drive out. The LG Supv was concerned about the potential for a vehicle accident in the heavy smoke and darkness. BRF 3, FAR 1, TMH 1, and TMH 2, backed up their units northeast along Sommers Road to clear the area.

About this time the rider on PRY 1 ran up to the operator of PRY 1 who was on his tractor and told him that the fire had crossed the furrow. PRY tractor 1 immediately tried to push the burning material back across the plow line and in the process got high centered on a stump. Seeing that PRY tractor 1 was hung up, the LAD 1 operator started the pump on LAD engine 1 and began to use the hose in an attempt to control the fire inside the furrows. PRY 1 operator attempted to do the same with PRY engine 1 but was unable to get the pump to run properly and retreated to his tractor. He started the tractor pump, wet down the slash near him, set up his shower system and placed his fire shelter on the dash in front of him.

Note: WDNR tractor-plow units are equipped with a shower system built into the rollover protection cage and fed by two water tanks containing a total of 150 gallons. The system is designed to offer protection for the operator in the event of an unexpected flare-up next to the tractor and there is no time to exit the tractor and deploy the fire shelter on the ground. It operates off the tractor pump and is activated by throwing a single valve located beside the operator. It provides about 10-12 minutes of spray from several nozzles located around the operators' position.

The fire department units that had been standing by near their location became concerned at that point and pulled out to the northeast along Sommers Road.

In the meantime, LAD 1 operator found that the one inch hose line from his engine was not effective. He stated later that "warm water was blowing directly back into my face!" At that point he also retreated to his tractor. PRY 1 rider appeared out of the smoke and darkness and crawled up on the machine beside him.

Both LAD 1 and PRY 1 operators said in later interviews, that they still felt at that point that it would have been possible (though difficult) to exit the area by walking northeast along Sommers Road out of the fire or southeast into the black. They both felt, however, that the safer option was to ride out the fire on their tractors. By doing so, they felt they would also be in a better position to protect their equipment as the fire went through. They had rejected the idea of trying to drive out of the area because of the time it would have taken to back out and turn around the engines. The fact that one of the tractors was stuck would have left all three to ride on a single tractor in very heavy smoke and darkness.

The operator on PRY 1 tractor, being stuck and unable to move, was positioned facing the on-coming fire and the high winds were blowing ash, embers and smoke directly into his face. Radiant heat was also increasing. He decided to use his fire shelter from his tractor seat as a shield from the embers and heat. PRY 1 operator stated later that "I found the breathing was much easier behind the shelter and felt confident that I could stay there until the fire passed." The LAD 1 tractor was down wind of PRY 1 tractor and facing away from the fire.

The smoke was so thick at that point, that the two technicians could not see the lights on PRY engine 1 from their tractors. At times, they could not even see each others tractor which were parked less than ten feet apart.

As the fire passed, LAD 1 advised LG Supv that they were all OK. LAD 1 had heard the LG Supv trying to reach them by radio earlier asking if they were all right, but had been unable to respond while working to protect their units.

Aftermath

PRY 1 and LAD 1 operators were checked by EMT's at the ICP and released and sent home for rest. The LAD 1 operator expressed some concern over the smoke and grit in his eyes and was transported to a local hospital by the Basin Supervisor, where his eyes were flushed. He was released and driven to his motel by the Basin Supervisor to get some rest.

The radiant heat had cracked the windshield on LAD engine 1. PRY engine 1 was downwind of LAD 1 and suffered no damage. The inside left rear dual tire on LAD engine 1 and the trailer tires on the upwind side were scorched. The pump on LAD engine 1 was still running and the hose was still lying charged on the ground. LAD tractor 1 hooked a chain to PRY tractor 1 and pulled it off the stump.

Meanwhile, the LG Supv was able to establish contact with the IC and relay what had happened. The IC responded to the entrapment location and told them to assess the damage to the equipment and that they were being released. Both units were checked over and found to be road worthy

The IC formed a replacement Left Line Construction Group that began plowing from the origin and completed the line without incident.

Shortly after, Command was passed to the FMO and BRF Ranger assumed the role of Line Branch Director.

The Four Corners Fire was declared controlled the next day after burning 678 acres.

Investigation

When it was first learned that there may have been either a burn over or entrapment incident on the Four-Corners Fire, an investigator was immediately sent to the Black River Falls dispatch center for initial interviews. Upon clarification of events through initial interviews an investigation team was formed. The team structure and charter is as follows:

Four Corners Fire - April 05 & 06, 2000
Entrapment Investigation
LaCrosse County

The designated Investigation Team membership will consist of Rick Bucklew, Division of Forestry Suppression and Law Enforcement Specialist WIDNR; Steve Courtney, WC Regional FMO WIDNR; Ken Sloan, NO Regional FMO WIDNR; Steve Holdsambeck, Nicolet/Chequamegon National Forest FMO USFS and Additional representatives and assistants may be delegated if deemed necessary. This Team will conduct a joint investigation of the incident where equipment and personnel on the Four Corners Fire found themselves in a compromising situation. The Team shall:

1. Identify facts that are associated with the circumstances that surrounded the incident.
2. Accurately and objectively record these findings.
3. Analyze these findings and identify factors that lead to the incident.
4. Make recommendations for changes that may prevent similar future incidents.
5. Develop a factual and objective report of the investigation and submit findings to the Forestry Division Administrator and other appropriate personnel as soon as possible.

These actions shall commence immediately and reach conclusion as soon as possible.

The team solicited over 15 written incident reports and orally interviewed over 12 other individuals that were in some way involved with the fire. On April 17th the team met in Black River Falls and over the course of the next three days held interviews with key personnel involved with the Four-Corners Fire. The interviews with personnel directly involved with actions that led to the entrapment and/or involved in the entrapment were held at the site of the incident. This enabled the investigation team to clearly understand valuable information shared by involved personnel. Each on site interviewee was asked the same set of predisposed questions (see attached) in an effort to recognize thoughts on the same subject matter. Follow up questions prompted by answers given to predisposed questions may have varied. The team spent considerable time over the three weeks that followed the fire analyzing and reviewing their findings. Once an outline of these findings was in draft, each team member took specific assignments with a goal of finalizing a report as soon as possible. The finalized "draft" was completed on April 26th of 2000.

The team was thoroughly impressed by the level of professionalism displayed by all that were interviewed or had a helping hand in conducting this investigation. It must be noted that the level of honesty and integrity of these individuals should be commended. Their positive attitudes were tremendous help to the team. There was a genuine interest in finding out what had happened and why it had happened. At no time did anyone attempt to hide information or mislead the investigation. There was a sincere concern for their fellow fire fighters and a desire to learn from the incident in hopes of not repeating similar mistakes. Any findings regarding this incident as a result of this or any other analysis should receive proper review and response. Again, thanks to all that helped this investigation throughout its entirety.

Findings

This section presents the Investigation Team's findings, which are supported by interviews, witness statements and physical evidence. The Investigation Team used the Entrapment Investigation Element Matrix, developed by the National Wildfire Coordinating Group. Following these elements the team assessed and marked in parentheses how categories contributed to the entrapment: significantly contributed, influenced, or did not contribute. All elements were addressed.

Fire Behavior:

Fuels (influenced)

- Fuels were drier than normal. A dry fall of 1999 was followed by limited snowfall during the winter months. Snow cover left around the end of February and precipitation was below normal up to the time of the incident.
- 1000-hour fuel moisture at Black River Falls was 19%. 10-hour fuel moisture at the time of the incident was 8.4%.
- The area was "hardwood country" and the fuels around the entrapment site were deceptively light and/or underestimated.
- Fire occurred during springtime pre-green conditions.

Weather (significantly contributed)

- Black River Falls Weather Station had 10 minute 20 foot wind speeds of 15 to 25 mph with gusts above 40 mph. Humidities were in the 50% range.
- All personnel involved had received a weather forecast earlier in the day.

Topography (influenced)

- The fire was in unusual hilly terrain for most WI Forest Protection areas.
- The incident occurred in a "Saddle"

Predicted Vs Observed (influenced)

- Preconceived notion that fires at night are supposed to lay down and burn with less intensity than what actually occurred.
- No spot forecast requested prior to the entrapment.
- Fire behavior observed near the entrapment site ranged from 20+ foot flame lengths in a nearby pine plantation that crowned to 6 to 12 feet in the hardwood, 1 to 2 feet in the entrapment location.
- Short range spotting was observed.
- Once resources were committed fire spread overtook firefighters quickly.
- Burning index for the E and Q fuel model reached into the extreme category during the fire.

Environmental Factors:

Smoke (significant contributor)

- Smoke became very thick with visibility down to zero at some moments. Personnel failed to see lights on nearby engines or dozers next to them.
- Safe movement with equipment and on foot was difficult and dangerous. There was a high possibility of firefighters being run into or over by repositioning tractor plows.

Temperature (did not contribute)

- Temperatures around 50 degrees at the time of the incident were not felt to be a factor.

Visibility (significant contributor)

- Nighttime hours added difficulty in the ability to fully size up the fire adequately.
- Hills near the entrapment site blocked the view of parts of the fire and gave a false impression of the size and parts of the fire.

Slope (did not contribute)

- Although some slope (about 8%) was present up to the entrapment site, the Team felt it did not contribute to the entrapment. Topography, mentioned earlier, did influence fire behavior.

Incident Management:

Incident Objectives (did not contribute)

- The Initial Attack IC had objectives in mind: safety, flank attack and structure protection. Objectives may have been set but not written down. The team felt it was the tactical implementation of the objectives that was the significant contributor to the entrapment.

Strategy (did not contribute)

- Overall strategy, flank attack with line construction groups, was sound. The tactical implementation of the strategy was the significant contributor to the entrapment.

Tactics (significant contributor)

- There was a rush to produce without discussing with the personnel involved the overall plan and the best way to implement it.
- Initial Attack IC should have been more concerned with disengaging from the tactical implementation and more clearly articulating the objectives, strategy and plan to all involved.
- Fire was not adequately sized up.
- Initial Attack IC wanted to implement "Against the Grain" plowing from entrapment site.

- Lack of an anchor point. Uncontrolled line west of the entrapment site overtook the units.
- Instructions were to "J hook", for the anchor point, but what to J hook was unclear.
- Tactic did not begin at the origin.
- Proper briefings with personnel did not occur.
- Location to unload was poor. Stumps, slash and small area covered with fine fuel. The area was described to personnel as a "gravel pit". Equipment Operators felt a need to plow a furrow around their equipment to protect it.
- Heavy Units pulled in forward and could not back out easily for quick escape.

Safety Briefing/Major Concerns addressed (significant contributor)

- Not conducted with all personnel.
- No feedback was requested or listened to.

Instructions Given (significant contributor)

- Instructions were unclear.
- Personnel had different ideas on what was to be done.
- Personnel was unsure what was meant by "J hook" or where to "J hook".

Other (influenced)

- Fire was in a Cooperative Forest Protection Area.
- Personnel were unfamiliar with the area
- Personnel were unsure exactly whose fire this was.

Control Mechanisms:

Span of Control (influenced)

- Initial Attack IC was trying to manage both Fire Depts. for structure protection and DNR units. This overloaded the IC and prevented good size up.
- Two Fire Dept. brush trucks were sent into the entrapment location. Assignments for these units varied from protecting the DNR units to supporting line construction. It was not clear who these units were assigned too. These units left when the fire approached the entrapment location and crossed the safety furrows.

Communications (influenced)

- Hilly terrain may have blocked some red net traffic.
- Blue repeater net was not always reliable because not in normal protection area and hills.
- Cell phone reception was in and out.
- Line Group Supervisor trying to monitor both firecom and red net. Although red was priority constant traffic from both nets added to confusion.
- Excessive talking on red net tied up communication. IC, Line Group Supervisors and tractor plows were all using red net.

- Plain text was not used to convey critical information. (10-33 instead of "emergency traffic")

On-Going Evaluations (influenced)

- Line Group Supervisor and IC failed to recognize that the "plan" was being overtaken by events.
- A tunnel vision effect occurred where the IC and Line Group Supervisor failed to step back and reevaluate the "plan" and actions that were being taken.

18 Watchout Situations (significantly contributed)

- Personnel involved identified 12 of 18 that were present and not mitigated.
- Fire was not scouted or sized up.
- In country not seen in daylight.
- Safety Zones and Escape Routes were not identified.
- Unfamiliar with weather and local factors influencing fire behavior.
- Personnel were uninformed on strategy, tactics and hazards.
- No safe anchor point.
- Attempting frontal assault. IC and Line Group Supervisor felt that they were deploying on the left flank. A slight wind change with unsecured line to the west changed this to a head fire at the time of the entrapment. Fire indicators showed direct fire spread toward the entrapment site.
- Unburned fuel between the fire and entrapment site where they were to unload.
- Wind increased and changed direction for a period of time.
- Frequent spot fires were occurring.
- Escape to Safety Zones was difficult due to terrain, fuels and location to unload.

10 Standard Orders (significantly contributed)

- Personnel identified 8 of 10 orders that were compromised.
- The fire was fought aggressively but not with safety first.
- Failure to recognize current weather with tactic deployed.
- Did not ensure instructions were given and understood.
- Current information on fire status was not obtained or known.
- Personnel did not always feel that they were in communication with supervisors.
- Safety zones and escape routes were not identified.
- General feeling that control was not retained at all times
- General feeling that supervisors were not always calm.

Involved Personnel Profiles

Training/Quals/Physical Fitness (influenced)

- This fire developed into a type 2 Wisconsin fire. Initial Attack IC at the time of the incident was ICT3 qualified. The Initial Attack IC recognized after the entrapment that the fire was becoming to involved. The FMO was on scene at the field ICP just prior to the entrapment and was in the process of taking over as IC.

Operational Period Length/Fatigue (influenced)

- Personnel involved had started work that morning about 9:00 a.m.
- Black River Falls personnel had recorded work time for 38 to 41 days straight prior to this fire. This is not unusual for WI firefighters. Specifically the Dispatcher is committed to all fires within the dispatch group and is generally the first one in and last one out.

Attitudes (significantly contributed)

- Aggressive, "must contain the fire" attitude.
- Operators felt that they should protect their equipment and may have stayed longer because they didn't want the equipment to burn.

Leadership (significantly contributed)

- Everyone followed the IC and Line Group Supervisor into the entrapment area before fully assessing the situation. Personnel began to independently take actions.
- Riders were "lost" at times.
- Leadership lost sight of safety as job one.

Experience Levels (influenced)

- All personnel had significant fire experience, but most had little experience with a fire of this magnitude and under these circumstances (night, coop area, size, etc.)
- Once recognized as being over run, personnel involved kept their cool, stayed reasonably calm and used some good judgment in staying with equipment where they felt secure. Using the fire shelter to shield smoke, embers and heat was a **good** thing.

Equipment

Availability (influenced)

- Maps for the area were hard to come by for DNR resources.
- Air Photos were not readily available early on.
- Initial Attack IC did request aircraft. Do to high winds was told that it would not be available.
- Significant amounts of equipment DNR and Fire Depts were on scene.

Performance/nonperformance (influenced)

- Equipment performed as expected and daily checks were completed.
- Pump on Pray type 4 engine kept shutting down.
- Lights on LAD Tractor Plow went out.
- Shower systems were not used primarily because operators wanted to save their water and didn't feel they needed to use it during the entrapment.

Clothing and PPE (influenced)

- All personnel were wearing the required personal protective equipment.

Used for intended purpose (did not contribute)

- Use of the fire shelter was appropriate. It is felt by the team that this investigation should not deter personnel from using the shelter in the future.

ENTRAPMENT INVESTIGATION ELEMENT MATRIX

	Did Not Contribute	Influenced	Significant Contribution
FIRE BEHAVIOR			
Fuels		X	
Weather			X
Topography		X	
Predicted vs. Observed		X	
ENVIRONMENTAL FACTORS			
Smoke			X
Temperature	X		
Visibility			X
Slope	X		
INCIDENT MANAGEMENT			
Incident Objectives	X		
Strategy	X		
Tactics			X
Safety Briefings/ Major Concerns Addressed			X
Instructions Given			X
Other		X	
CONTROL MECHANISMS			
Span of Control		X	
Communications		X	
Ongoing Evaluations		X	
"10 Standard Fire Orders/18 Watch Out Situations"			X
INVOLVED PERSONNEL PROFILES			
Training/Quals Physical Fitness		X	
Operational Period Length/Fatigue		X	
Attitudes			X
Leadership			X
Experience Levels		X	
EQUIPMENT			
Availability		X	
Performance Non-Performance		X	
Clothing and Equipment		X	
Used for Intended Purpose	X		

Causal Factors

Direct Causes

The Investigation Team determined that the direct causes of the entrapment on the Four Corners Fire were as follows:

Fire Behavior

Weather

- High winds were experienced at the time of the entrapment (sustained winds of 16 mph, with gusts to 34).
- Wind speeds peaked at midnight - at the same time the entrapment occurred.

Environmental Factors

Smoke

- The smoke became so thick that visibility was down to zero for periods of time. Personnel could not see the lights on nearby engines or dozers next to them.
- Safe movement of equipment became difficult and dangerous. There was a high possibility of running over firefighters in the smoke while trying to reposition tractors or engines.

Visibility

- Lack of daylight made it difficult to size-up the fire properly
- Hills near the entrapment site blocked the view of parts of the fire and gave a false impression of size and location on the fire.

Incident Management

Tactics

- Heavy Units were unloaded in an unsafe location too near the fire edge to allow time for proper deployment.
- Heavy Units were pulled straight in and could not back out easily for quick escape
- The tactical plan to plow against the grain of the fire, J hook and reverse direction to plow with the spread of the fire was poorly understood. This was based on a faulty size-up and fraught with unmitigated hazards.
- There was no anchor point. Line construction groups are intended to start at the origin or some other well-defined anchor point and plow down fire.

Safety Briefings/Major Concerns Addressed

- Safety Briefings were not held and LCES considerations were not discussed with personnel involved.
- No feedback was requested or considered.

Instructions Given

- Instructions were unclear and not commonly understood.
- Personnel were unsure of what was meant by "J hook" and where it was to be done.

Control Mechanisms

10 Standard Fire Orders/18 Watch Out Situations

- Eight of the 10 Standard Fire Orders were compromised.
- Twelve of the 18 Watch Out Situations were present and not mitigated.

Involved Personnel Profiles

Attitudes

- A general attitude prevailed that it was critical to get units plowing on the fire as soon as possible - despite a lack of key information. A "hurry up" approach precluded proper size-up, orderly deployment, and adequate briefings.
- Operators felt a need to "protect their equipment" and may have stayed in place longer because they did not want it to burn.

Leadership

- The IC was distracted by structural concerns and directing all wildland suppression activities simultaneously
- The Group Supervisor was too focused on implementation of the tactics and did not have time to adequately consider safety issues.
- A climate of mutual respect and teamwork between supervisors and line personnel did not exist. At least 4 veteran Forestry Technicians concurred that the situation was unsafe, yet only one was willing to repeatedly bring it to the attention of the supervisors.
- Personnel began to take independent actions. Fire Department units supporting group operations did not report to Group Supervisor.
- Riders were "lost" at times.
- The Leadership lost sight of the need to ensure that SAFETY was job one.

Contributory Causes

The following factors contributed to the entrapment on the Four Corners Fire.

Fire Behavior

- The pre-green fuels were drier than normal and there was a general underestimation of the fire behavior in hardwood and grass fuels near the entrapment site.
- There was abnormally hilly topography in the area and the entrapment site was in a saddle.

- There was a general lack of forecast information, extreme fire conditions, and a subconscious perception that fires are supposed to "lay down at night" and decrease in intensity.

Incident Management

- The fire occurred in a Cooperative Fire Protection Area. Personnel were unfamiliar with the area and lacked maps, photos, and other normally available resources.
- Resource allocation and deployment may have been slower than would have been the case had the fire been in an Intensive Fire Protection Area.

Control Mechanisms

- The span of control for the IC was too great given the complexity of the fire. His attention was diverted by constant radio traffic from both structural and wildland forces. The result was a lack of time for adequate size-up and briefings.
- It was not made clear to the fire department units supporting the left group that they were under the command of the left group supervisor.
- Hilly terrain and being in a co-op area adversely affected tactical (red) net, repeater (blue) net, and cell phone communications.
- Both the IC and Left Group Supervisor were monitoring both red net and firecom (fire department net). There was excessive talking on red net.
- A ten code (10-33) was used instead of plain text to convey "emergency traffic".
- Both the IC and the Group Supervisor failed to recognize that the "plan" was being overtaken by events. "Tunnel vision" occurred and there was a failure to step back and re-evaluate the plan in light of the changing situation.

Involved Personnel Profiles

- The Initial IC was qualified at the ICT3 level, by the time of the entrapment, the fire was transitioning into a Type 2 incident.
- Black River Falls Personnel involved had all been working from 38-41 days straight prior to this fire and had been on duty since 0900 that morning (entrapment occurred at around midnight).
- The Black River Falls Dispatcher had also been working for 38-41 days straight and had been on duty without a fully qualified relief for a 24-hour period during the incident.
- All personnel involved were experienced firefighters but a fire of this magnitude, at night, in co-op, in hilly topography, was new to most of them.
- Personnel involved in the entrapment stayed calm and acted decisively. They made effective use of their training and equipment. The use of a fire shelter by one of the technicians to shield himself from embers and heat was an excellent idea. The conduct of those involved in the entrapment was a **positive influence** on the outcome of the incident.

Equipment

- A lack of maps and aerial photos hampered fire planning.
- The unavailability of the patrol aircraft due to high winds and poor visibility hampered ground activities.
- All equipment was well maintained and, except for the pump on Pray Engine 1, worked properly. All personnel were properly equipped with protective clothing and equipment.

Follow up Recommendations

In general, no "missing pieces" were found at the root of this incident. Rather, it was felt there is a need to "get back to basics" in our training efforts. We need to "practice what we preach" - not just on fires - but all the time. After considerable discussion, the following recommendations are made by the investigation team in hopes of minimizing the chances of the reoccurrence of a similar incident.

Each dispatch group should develop specific action items designed to address each of the recommendations below.

Systems review

Incidents of this nature do not occur in a vacuum. Fire fighting is a team sport. Teams understand the role, contributions, and expectations of each member - including themselves. In the spirit exhibited by the people actually involved in this incident, the team recommends the following:

1. A copy of this report be provided to each station and a formal discussion of its findings be held in each dispatch group as part of their next annual 16 hour in-service training. We need to learn from this event. The next lesson may be a lot more expensive.

2. A Fire review be conducted by 07/01/00 to assure a complete evaluation of any other issues involved beyond the scope of this investigation. This review should include local Fire Departments, other officials etc. that were involved in the incident.

3. There was no safety officer assigned to this incident. Freeing up people with enough of a fire background to effectively function as a Safety Officer has been a tough nut to crack. They are all committed to suppression. Somehow, this problem must be solved.

Training

Knowing *how* to do the correct thing in a given situation and do it correctly every time, is only part of the challenge fire fighters face. Equally important is the need to be able to decide *what* to do, based on limited information and under tremendous stress. We do under stress what we do in training. To make that training more effective, the team recommends the following:

4. Development of a standard ***Initial Attack Incident Commander Check List*** to help ensure specific critical actions are addressed and to help anticipate changing overall

incident complexity. Create systems and policies to ensure it's use and make it part of training exercises.

5. Emphasize the use of the ***Lookouts, Communications, Escape routes, and Safety zones (LCES) mitigation chart*** to identify and analyze alternatives when considering non-traditional tactical applications (e.g. plowing against the grain, frontal assault, use of line construction groups, etc). Specifically discuss its use in post fire and training debriefings.

6. Make constant awareness and consideration of the ***10 Standard Fire Orders & 18 Watch Out Situations*** a part of training exercises. Develop training scenarios that require a specific activity to be aborted when appropriate - build an understanding that the Orders and Watch Outs mean you fix it - or *stop*!

7. Train personnel to expect a quality briefing process in everything they do. Develop scenarios which require feedback and two-way communication at all levels to make specific tactics successful. ***Practice listening skills***.

8. Reinforce the **"basics"** in ALL training (backing in vehicles for quick escape, doing an adequate size-up *first*, use of plain text, good radio discipline, getting and giving a good briefing, discussing safety issues, etc).

9. Use simulation and hands-on in-service training to practice night fire fighting skills - including the use of aircraft.

Fatigue and Stress Levels

There is a need to manage fatigue and stress. Ways need to be found to increase the "depth of the bench" so that front line people have an opportunity to get away from it completely when they need to. Fire fighters cannot work safely for 24 hours straight. The team recommends the following:

10. The dispatchers are the first one in and the last one out every day. Every Fire Response Unit does not have a fire everyday - but almost every dispatcher does. As the fire gets bigger, FMO's and other support people leave them alone to go to the fire. Efforts need to be made to address the need for fully qualified back-up support for dispatchers - as is currently required for equipment operators.

11. The use of pre-positioned resources on the Four Corners Fire was very effective. Initial attack was strengthened and people were available to staff "day two" without over-committing local staff. Such statewide mobility needs to be expanded to include dispatchers, FMO's, and front line fire personnel specifically to spell folks during extended seasons.

Equipment

Existing equipment worked well during this incident. A number of upgrades currently underway will make it work even better:

12. The strobe lights currently under consideration to increase visibility for tractor plows in thick smoke and darkness would have been valuable addition on this fire - both to keep track of equipment and to enhance fire fighter safety.

13. The availability of GPS hand held receivers in all engines along with corresponding software at the dispatch centers to convert Latitude/Longitude to legal descriptions would help personnel better pin down their locations as well as keep track of each other, particularly at night.

14. Ways to make the 10 Standard Fire Orders and 18 Watch Out Situations more visible to personnel need to be explored (Stickers on tractor and truck dashboards, tattoos, etc).

15. All indications are that the fire shelter provided great benefit to the tractor plow operator when it was used as a shield. The current project to adapt the use of "fire curtains" on tractor-plows makes good sense and should be continued.

Coop Fire Areas

The level of WDNR commitment to the Four Corners Fire sets a new precedent for a co-op fire. The team recommends:

16. An initiative be undertaken to evaluate current co-op fire policies relative to DNR roles, obligations, and staffing relative to fire in Cooperative areas.

17. Develop ways to ensure that maps, photos, and other critical information is available to fire control personnel responding to unfamiliar situations in cooperative areas.

WEATHER AND FIRE BEHAVIOR REPORT

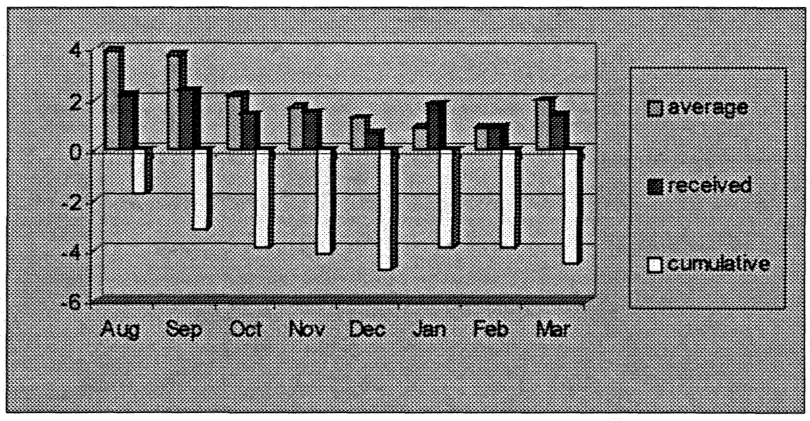
WEATHER CONDITIONS PRIOR TO THE FOUR CORNERS FIRE

The 1999 late summer, fall and early winter in southwest Wisconsin was characterized as unusually warm and dry. Fire danger conditions persisted long into the winter with significant activity into December.

The winter offered little relief from the drought. The month December was 6.8 degrees above average with a record high of 53 degrees on the 29th and receiving only 51% of normal precipitation. January was a slight reprieve as the area received almost an inch above average precipitation, however the average temperatures were 3.9 degrees above average. February saw near normal precipitation but the month was a record 10.5 degrees above average. This unusually warm weather led to a completely snow free condition by the 23rd.

By the end of February the Black River Falls Fire Response unit was in full operation and had responded to numerous wildland fires. March weather was consistent with the pattern experiencing only 70% of normal precipitation and a record 9 7 degrees above average temperature.

The following chart shows the precipitation deficit situation at La Crosse; approximately 20 miles southwest of the Four Corners fire.



WEATHER CONDITIONS DURING THE FOUR CORNERS FIRE

April 5th saw an intense low-pressure system enter the state from the northwest. The passage of the front over the Four Corners area was indicated by dry south-southeasterly winds in the morning and early afternoon. By 5:00 PM, the winds had increased in speed, temperature humidity and changed to southerly. By 8:00 PM, the highest temperature of the day, the winds were gusty and predominately westerly. Unfortunately, no onsite weather observations were taken during the fire.

One weather station was used to model the weather and fire behavior during the Four Corners Fire. This station is approximately 17 miles north-northwest of the incident and is maintained by the Wisconsin Department of Natural Resources, Black River Falls Service Center. This station was not inspected as a part of the entrapment investigation due to time constraints. However, the state has an outstanding fire weather program and there is little reason to believe this station is not maintained to national standards.

The following table displays the pertinent station data beginning at 8:00 PM April 5th, 2000. During site inspections of the entrapment area, the temperature, wind speed and wind direction were noted and then compared to the readings at this station. The difference in weather conditions noted on site and the conditions logged at the station at the same time were insignificant. It is presumed, therefore, the fire weather conditions on the Four Corners Fire would have been very similar to the conditions shown here.

	Black River Falls DNR Fire Weather Station				
local time	wd speed	wd dir	peak wd	RH	Temp F
2000	16	W	18	36	64
2100	15	W	33	35	59
2200	24	W	40	44	53
2300	15	W	35	48	52
0	16	W	34	52	49
100	17	W	33	54	46
200	17	W	35	58	45
300	18	W	33	57	44
400	18	W	32	60	42
500	17	W	27	62	42
600	14	W	25	63	42

The National Weather Service maintains an uncommissioned (i.e., unofficial) weather station at the La Crosse Regional Airport. This station is about 22 miles southwest of the Four Corners Fire site. For comparison, the data recorded during the Four Corners fire is displayed below The disparity in the temperature and dew point data between the Black River Falls and the Airport site (only ~ 40 miles apart) is reasonably explained by the difference inherent in an airport compared to a "field" location. The difference in wind speeds between the two stations, however, is quite significant and should warrant further investigation.

La Crosse Regional Airport (this station is uncommissioned)					
local time	wd speed	wd dir	peak wd	RH	Temp F
2000	29	WNW	53	27	63
2100	26	NW	50	31	59
2200	29	NW	48	41	54
2300	26	NW	47	44	52
0	31	WNW	51	47	50
100	28	WNW	46	50	48
200	32	WNW	44	50	46
300	21	NW	44	57	45
400	22	NW	41	53	45
500	23	NW	38	53	43
600	20	NW	38	57	43

FIRE BEHAVIOR DURING THE FOUR CORNERS FIRE.

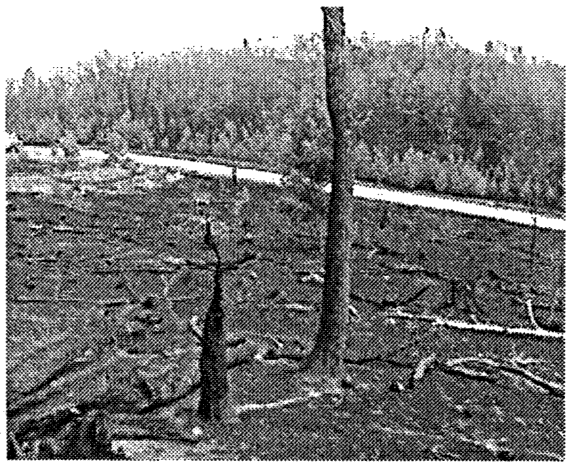
PROCESS

To reconstruct the fire behavior experienced on the Four Corners Fire, the team interviewed five eyewitnesses, viewed a television news footage video of the fire, studied pre, and post-fire aerial photography, and conducted a thorough ground reconnaissance of the fire area. This information was used along with the weather station records to model the behavior using the USDA Forest Service's BEHAVE version's 4.4 and 4.1 software and Remsoft Corporation's BEHAVE by Remsoft version 97.2 software.

FUELS

Droughty, deep sands, typical of edaphic conditions that support moderate densities of scrub oak and jack pine timber characterize almost the entire fire area. Nonetheless, the fuels in the area consumed by the fire were diverse and fairly difficult to model. Much of the area had experienced a moderate to severe blow-down event in 1998 and as a result had moderate accumulations of well-cured fuels (mostly hardwood) at the time of the fire. A large portion of the blow-down, however, had been salvaged over the last two years and thus had generally light fuels dotted by slash piles and crisscrossed by logging and skid roads. Fire Behavior Prediction System Models 9, 1, and 12 in that order of preponderance were used to model the overall spread of the fire.

The general topography is characterized as gently rolling. Topographic influences on the fire behavior are insignificant overall. Of note, is the fact that the entrapment site is situated at the apex of a saddle, along a slight ridge. The slope approaching the entrapment area is a modest 7-9%. However, the crest of the ridge rises approximately 150 feet above the saddle both to the northwest and the east. (See Topographic Maps, pages A1-10/11)



THE PICTURES ABOVE ARE OF THE ENTRAPMENT SITE. THE PICTURES ARE TAKEN FROM A SPOT APPROXIMATELY 150' SOUTHWEST OF THE ENTRAPMENT SITE. THE ENGINE IN THE MIDDLE GROUND IS PARKED AT THE CREST OF THE SADDLE.

Fine dead fuel moisture would have been at approximately 8% when the fire began and reached approximately 12% by the time the fire was contained early the next morning. The Black River Falls fire weather station predicted the ten-hour time lag fuels to have been at 7 to 10% and thousand hour time lag fuels at 19%. Based upon the observed fuel consumption the moisture level in the smaller fuels could certainly have been correct. It appears likely however, the larger fuels were significantly drier than 19%.

FIRE BEHAVIOR BY PERIOD (*ALL TIMES, RATES & DISTANCES ARE APPROXIMATE*):

9:00 – 10:00 PM

The fire began at approximately 9:00 PM. and initially spread down a gentle slope through a mixed pine and all aged hardwood stands. The younger jack pines near the origin area occasionally torched producing 15 to 30 foot flames, but overall the fire would have been characterized as a wind driven surface fire with flame lengths of about 3 to5 feet and a surface spread rate of 15 to 30 chains per hour. The abundant oak leaves in the front of the fire would rapidly ignite, and in the turbulence of the fire been caught up in the gusty winds causing profuse short range spotting. This spotting negated the fuel break value of the numerous roads in the area and would moderately have increased the rate of spread above the rate of which the BEHAVE model predicts. By 10:00PM the fire would have spread 1200 to 1500 feet from the origin.

10:00 – 12:00 AM

The fire continued to spread, in a tight elliptical pattern, due east in the mixed slash, pine, and hardwood stands with spread rates of 30 to 40 chains per hour. Eyewitness reported general flame lengths of 4 to 6 feet, though the flames were much higher in areas of slash piles or unsalvaged blow-down. Young pine trees frequently torched producing flame lengths of 30 to 40 feet and showers of sparks. Fuel barriers such as Sand Creek and Summers Road were easily spotted over such that they essentially had no effect on the fire spread. Blow-down areas that had been salvaged had a one to two years re-growth of cured light grass. Where continuous these areas were supporting fire spread rates 60 to 80 chains per hour and flames nearly level with the ground extending 4 to 6 feet long. Over the past two hours the head of the fire would have spread an additional 6000 feet.

At approximately 11:40 PM, the men eventually involved in the entrapment park their equipment in an old log landing approximately 450 feet from the northern flank of the fire. The men unloaded their dozers, and began preparation to create fire breaks alongside this northern edge of the fire. For at least a brief period the wind direction is consistently westerly, giving the appearance of a straight-line edge to the northern flank.

If northwesterly wind influences existed at this point they would be moderated *in this particular location* by the presence of a modest ridgeline which begins about 500 feet to the northwest of the log landing and extends about a half a mile to the east (See photos, page A1-4 and topographic maps, pages A1-10/11).

At 11:53 PM a picture is taken immediately across Sommers Road from what will become the entrapment site (See picture, page A1-8). This picture was taken because the photographer was impressed by the fire behavior exhibited by a small tightly spaced stand of 11-13 year old red pines beginning to torch out along the flank of the fire (the same pine stand mentioned previously). This picture saliently displays the fire behavior potential of young confers on droughty soils, in a spring time drought, in high winds.

12:00 AM – 12:30 AM

Very soon after the 11:53 PM photograph is taken (perhaps just a couple of minutes) there is a brief wind shift from predominately westerly to southwesterly winds. The entire uncontained north flank of the fire gained head fire characteristics. The men working in the vicinity of the entrapment site were showered by a hail of embers and enveloped by exceedingly dense smoke.

Within five minutes, the stand of red pine in the 11:53PM photograph was completely consumed - generating 30-60' flame lengths. In spite of the fact that this, otherwise impressive sight, was immediately across the road from the entrapment area, the men on site were in such dense smoke that the event was completely obscured and unnoticed.

> *Smoke, while not directly affecting fire behavior, is a significant issue to the men now facing a head fire at the entrapment site. The reasons the smoke was so dense are several. First, smoke at night has a far greater impact on visibility than an equivalent density of smoke in daylight conditions - simply because of less available light. Moreover, steam and smoke significantly reduce the effectiveness of headlights and flashlights*
>
> *Secondly, by midnight on the fire the effects of solar convection have essentially subsided. Thus, the only convective lift affecting an air parcel at the surface of the fire is that which is generated by the heat of combustion. In a very stable, nighttime atmosphere this heat is insufficient to cause appreciable lift.*
>
> *Thirdly, high speed surface wind carries smoke long distances over the ground. As a result, the smoke at the rear of the fire accumulates with smoke from the smoldering fires in the middle of the fire area and further accumulates with the smoke at the flaming front. Related to high speed surface winds is the fact that these winds disturb and transport much of the ash and other debris generated by combustion. Thus, the men facing the head of the Four Corners fire had to contend not only with heavy smoke concentrations but also with smoke containing an unusually high component of ash and wind-borne debris.*

> *And finally, light fuels rapidly absorb moisture from the surrounding air. By midnight on the Four Corners Fire, the relative humidity is already above 50%. Consequently, leaves and dead grass absorbing this moisture are burning less and less efficiently. The less efficient the combustion process the greater the proportion of particulate matter produced and greater proportion of steam contained within a given volume of smoke.*

Within ten minutes the fire had reached the entrapment site traveling approximately 60' per minute (55 chains per hour). Fire behavior calculations are consistent with witness accounts describing flame lengths of 4 to 6' in the grass, 15 to 25' in slash piles and profuse spotting 20 to 50' feet ahead of the front.

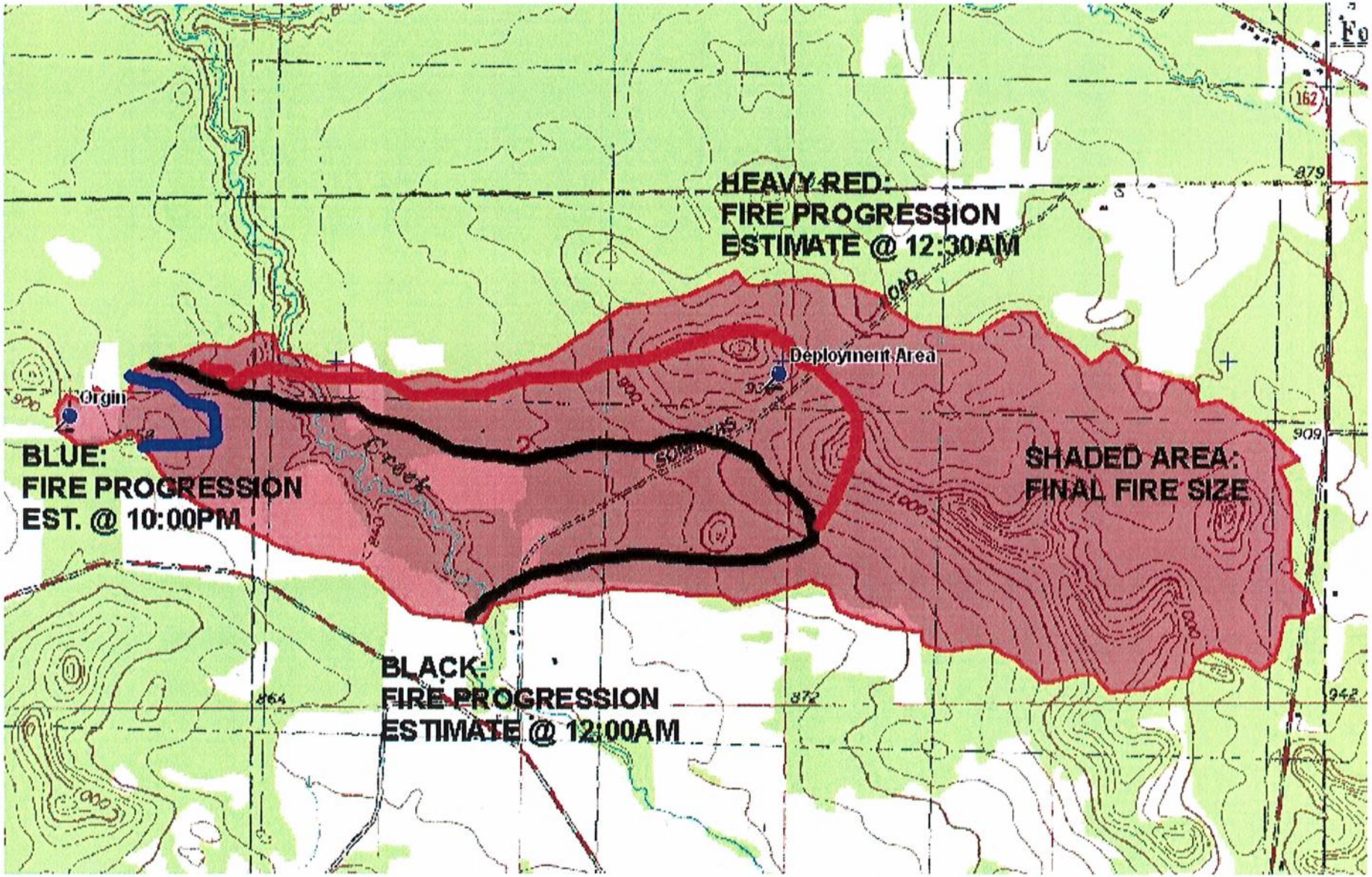
Within 30 minutes the fire had burned through the entrapment site and up to the immediately adjacent ridgeline. During the time period, the fire would have spread an additional 1100 feet.

As mentioned previously the location where the men parked (the entrapment site) is located in a saddle along a ridgeline and immediately adjacent to a small (about two-acre) stand of young red pine. In reconstructing the fire behavior, considerable discussion and analysis surrounded the effect these features had on fire behavior as the fire approached the entrapment site. It was concluded that the fire behavior near, and at, the entrapment site was *not significantly influenced by the slope, a wind funneling effect in the saddle nor the convection produced by the adjacent young red pine stand.* The topographic consequence of this particular site on winds is likely much less material to the entrapment scenario than the fact that the topography blocked their view of fire extent and activity to the west. With respect to the convection or "draw" created by the young red pine stand, the convective force produced by this relatively small crown fire would have been altogether overcome by the power of the strong gusty winds.

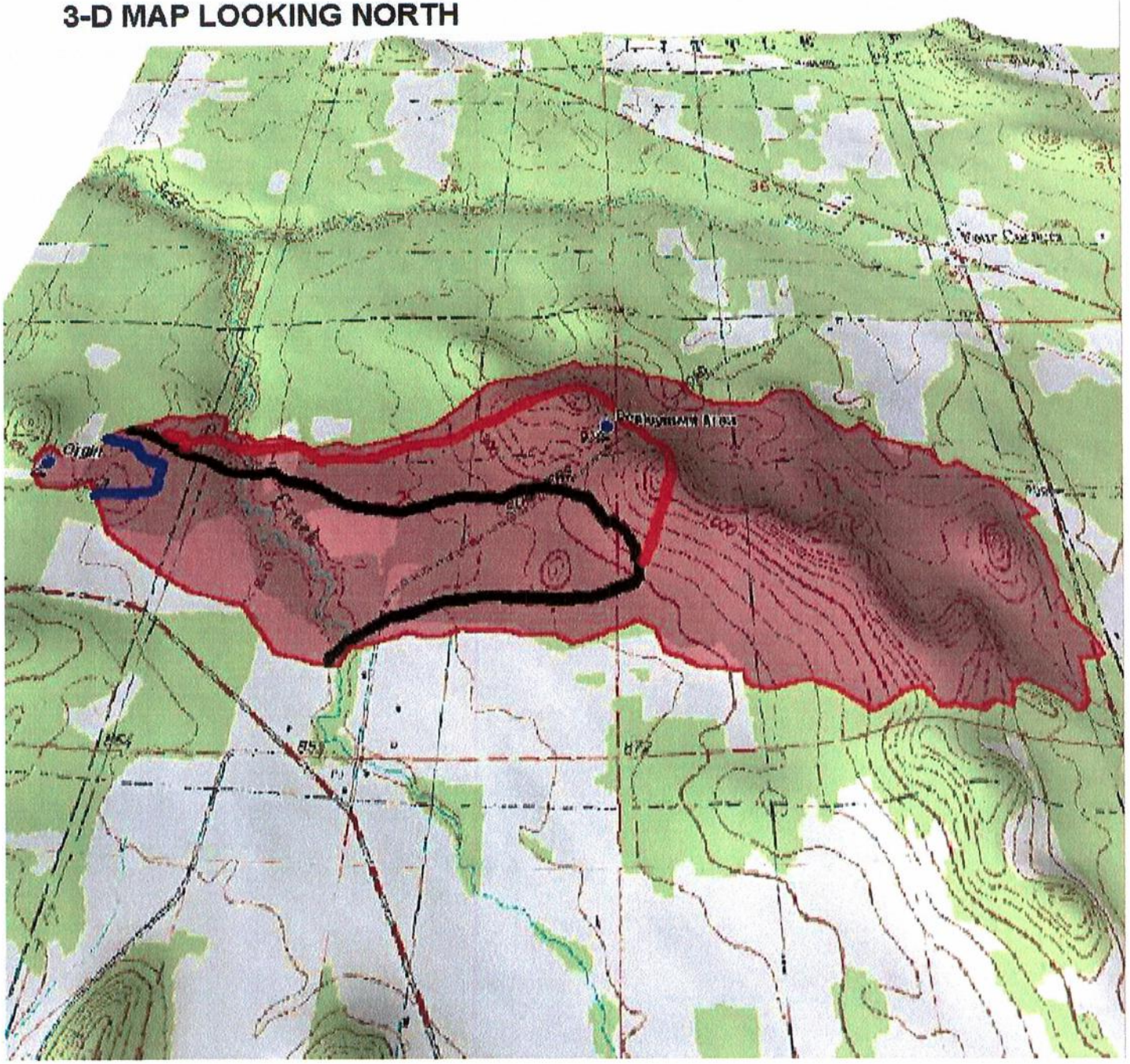
12:30 AM – 2:30 AM

The winds returned to predominantly west winds for the duration of the fire. The acutely elliptical spread pattern indicates there was little variability in wind direction. As the fire neared highway 162 (see fire map, page A1-9), the spread and intensity gradually diminished due to greater wind shelter from standing trees, and the gradually increasing relative humidity During this period the head of the fire can be characterized by flame lengths of 4-6' and spread rates of 30-40 chains per hour. Occasional torching of young pines, blow-down trees and slash pile accumulations produced significantly greater fire intensities. Over the two hour period the head of the fire spread an additional 4000 feet. Abundant fire engines aligned along highway 162 provided sufficient capability to catch and suppress the spotting over the highway The fire would be effectively stopped at highway 162 and fully contained soon thereafter.

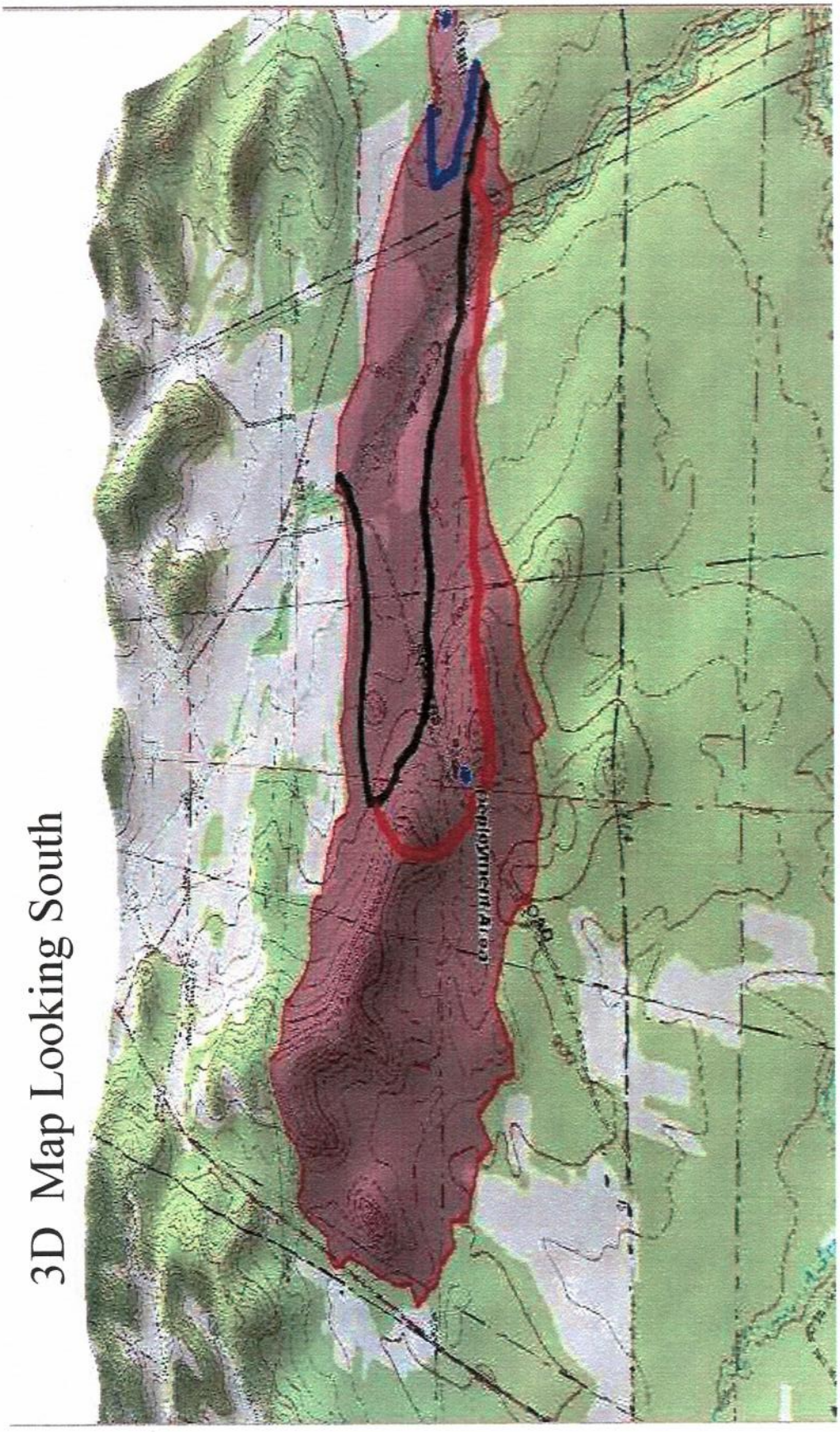
Photo take of the small stand of red pine directly across Sommers Road from the entrapment site as it began to torch out.


HEAVY RED:
FIRE PROGRESSION
ESTIMATE @ 12:30AM
Deployment Area
Origin
BLUE:
FIRE PROGRESSION
EST. @ 10:00PM
SHADED AREA:
FINAL FIRE SIZE
BLACK:
FIRE PROGRESSION
ESTIMATE @ 12:00AM

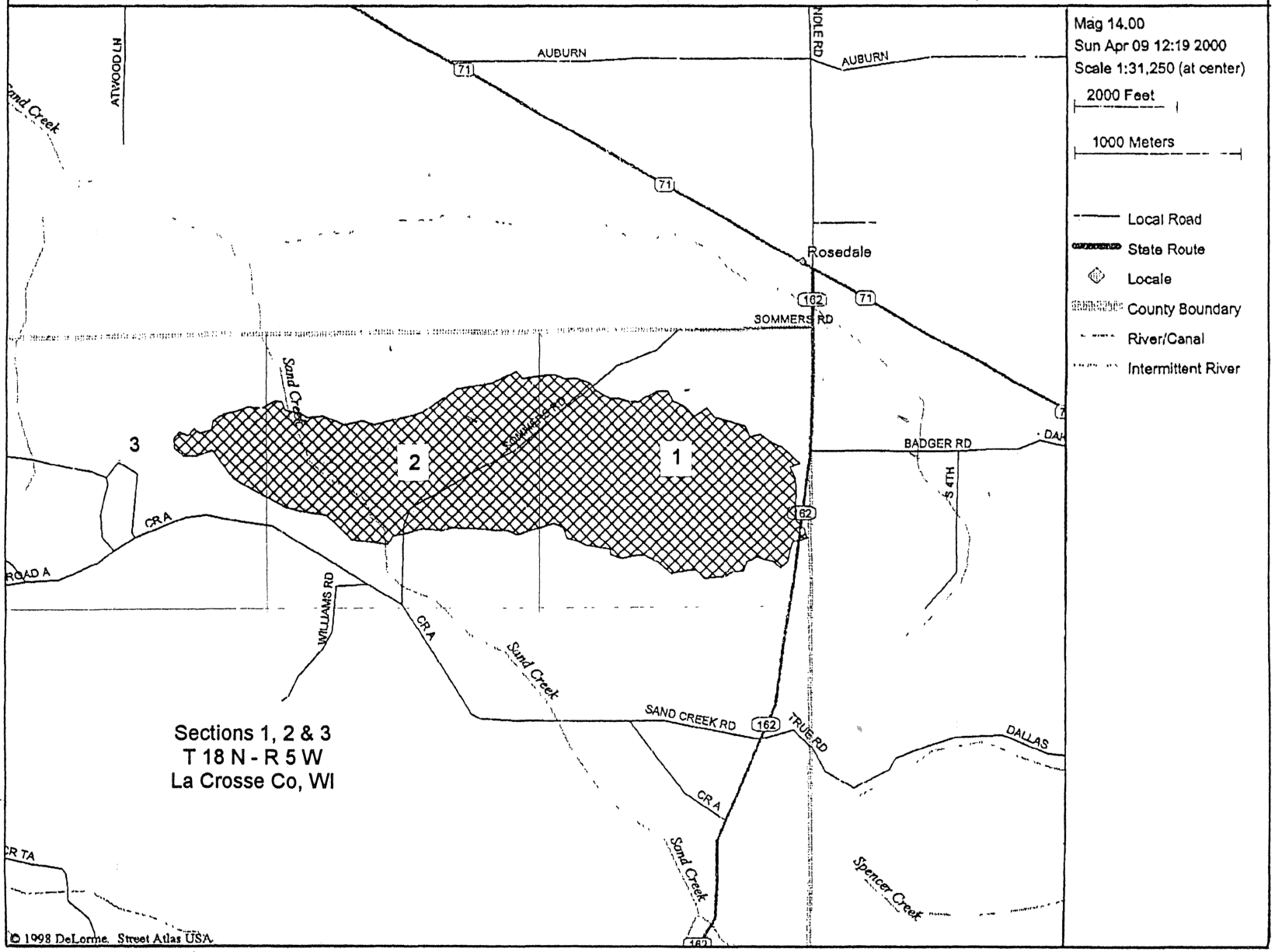
3-D MAP LOOKING NORTH

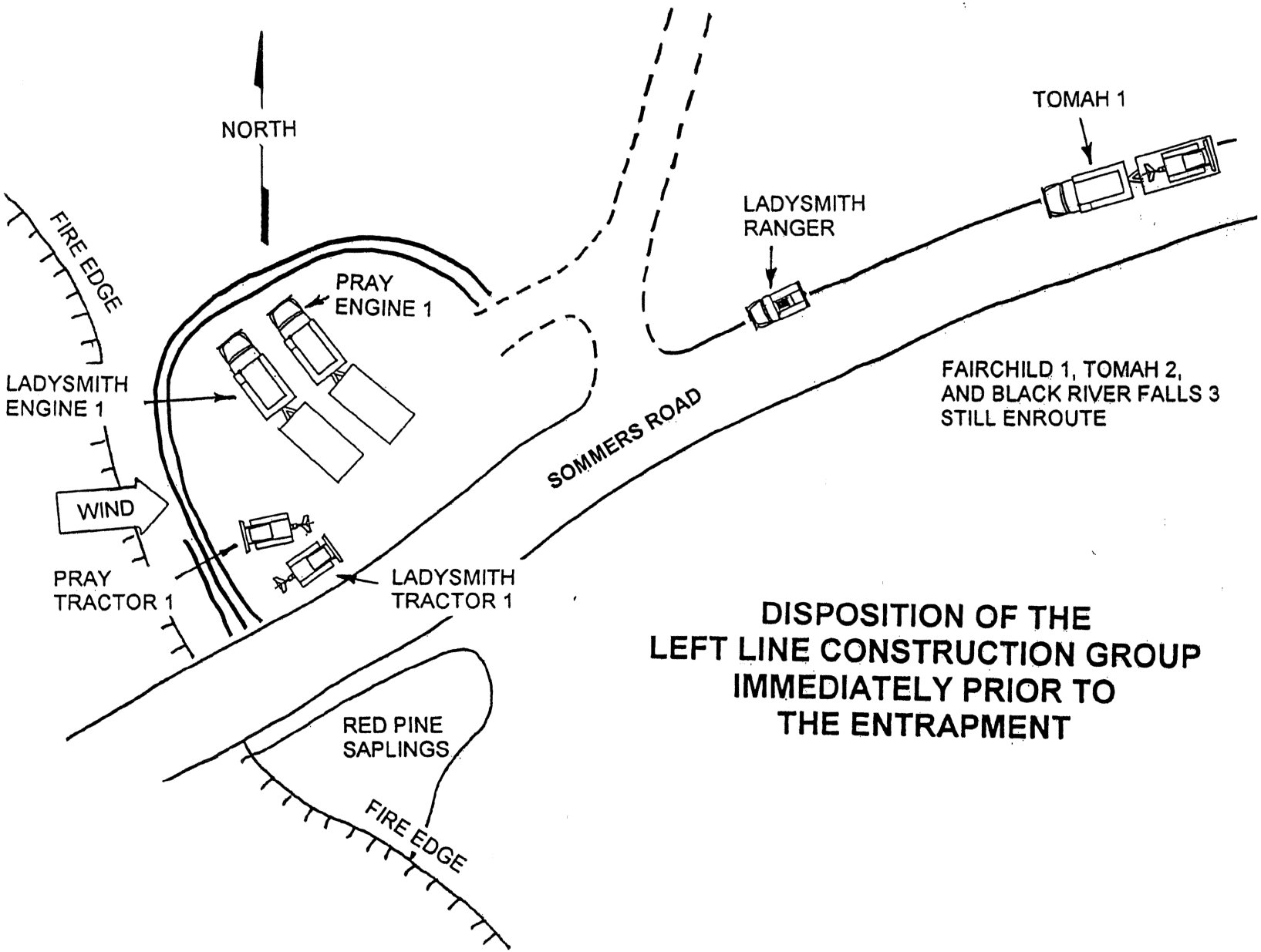


3D Map Looking South



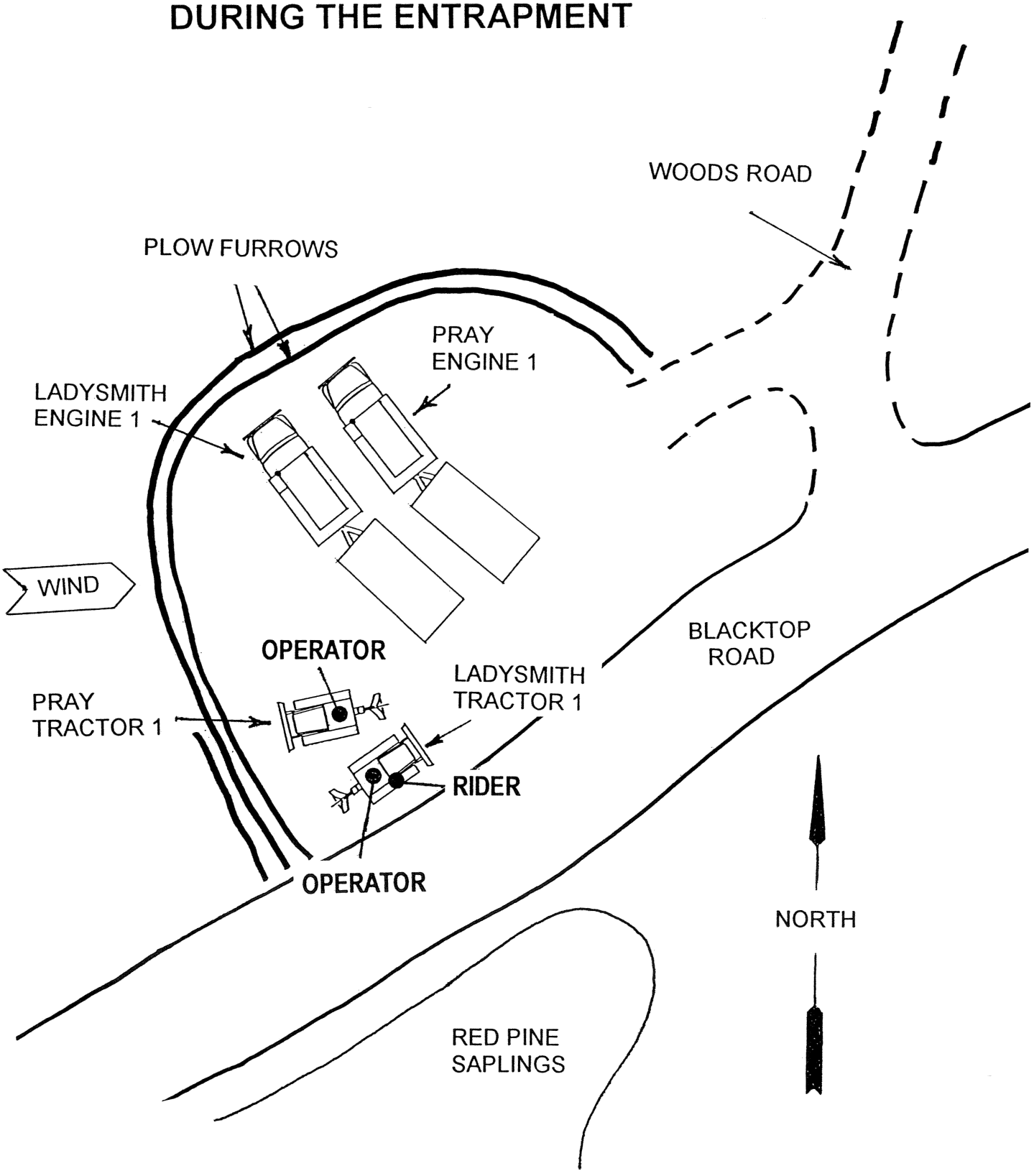
Four Corners Fire / 678 Acres





DISPOSITION OF THE LEFT LINE CONSTRUCTION GROUP IMMEDIATELY PRIOR TO THE ENTRAPMENT

LOCATION OF PERSONNEL AND UNITS DURING THE ENTRAPMENT



4 Corners Fire Entrapment
Personnel and Units Involved

Type 7 Engines

Black River Falls Ranger	Incident Commander
Ladysmith Ranger Casual (Rider)	Left Group Supervisor

Heavy Units (Left Flank Line Construction Group)

*Forestry Technician *Casual (Rider)	*Pray 1
*Forestry Technician	*Ladysmith 1
Forestry Technician	BR Falls 3
Forestry Technician	Fairchild 1
Forestry Technician	Tomah 1
Forestry Technician	Tomah 2

* Personnel and units actually entrapped

Questions - 4 corner fire incident

1. What unit were you staffing? Was anyone else assigned to your unit?

2. How many years of experience do you have? How long have you operated your unit? What are your fire qualifications?

3 How long had you been working that day prior to this fire?, How many days in a row had you worked prior to this fire?

4. How many fires similar to this one have your been on? Night fires?

5 What was your specific assignment? Who briefed you? Was your assignment clear to you?

6. Did you scout the fire? Did you know where the origin was? Did you know what part of the fire you were on?

7 What was your anchor point?

8. Do you know who your supervisor was?

9 Do you know who the IC was?

10. Was there a sense of order on the fire line, were orders clear, understood and carried out? Was input on decisions solicited? Was there confidence in the decisions being made?

11. Did the IC or your supervisor discuss LCES considerations, predicted weather, and predicted fire behavior with you?

12. What weather conditions and fire behavior did you observe?

13 Were lookouts posted? Could you see the fire? Were you aware of fire behavior and direction of spread? Could you communicate with the lookouts?

14. What was your escape route?

15 Where was your safety zone?

16. Did you feel at any time, that your escape route was compromised to the point where you could not exit the area safely?

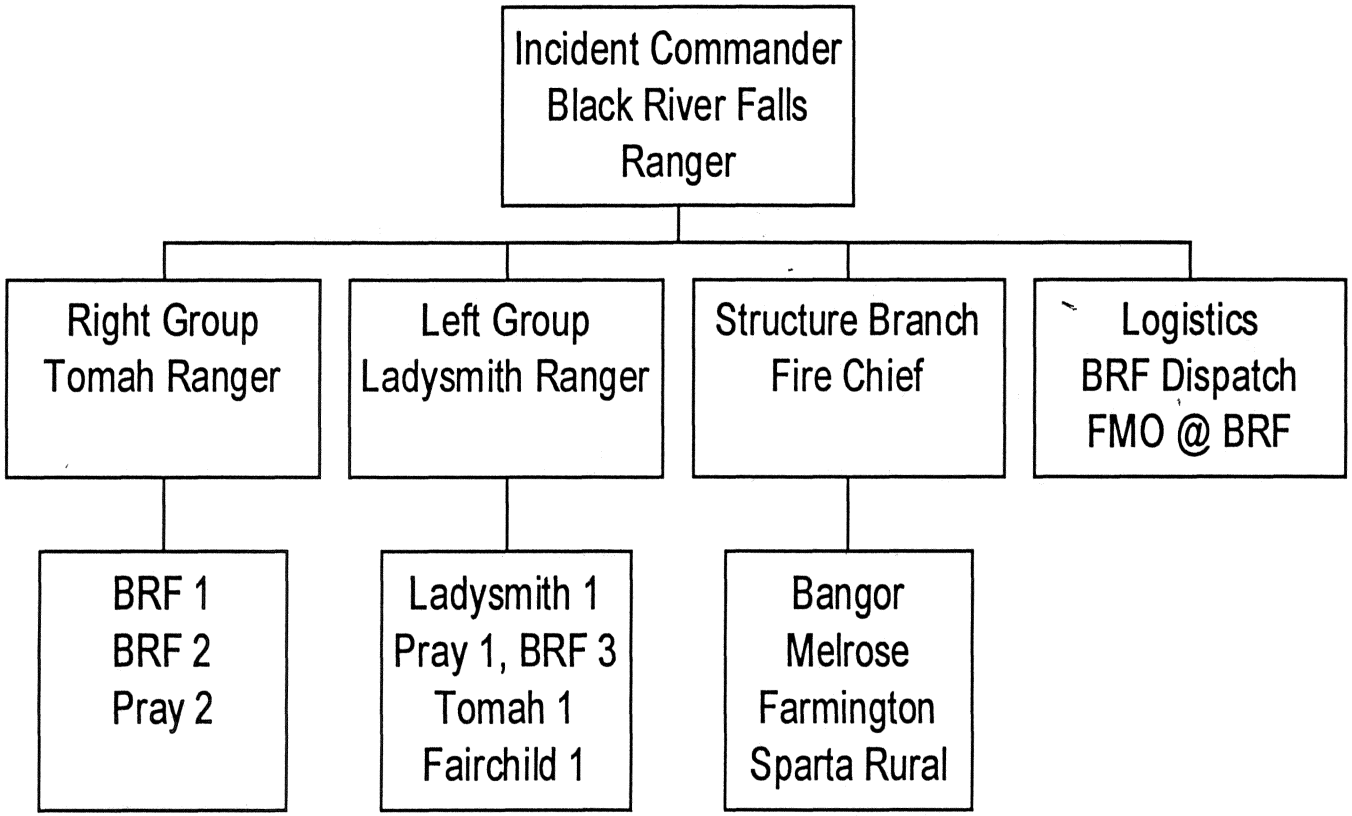
17 Did you observe any unsafe behavior? Were any of the Standard Orders and Watchout situations compromised?

18. Did your equipment function properly? Pumps, shower system, etc?

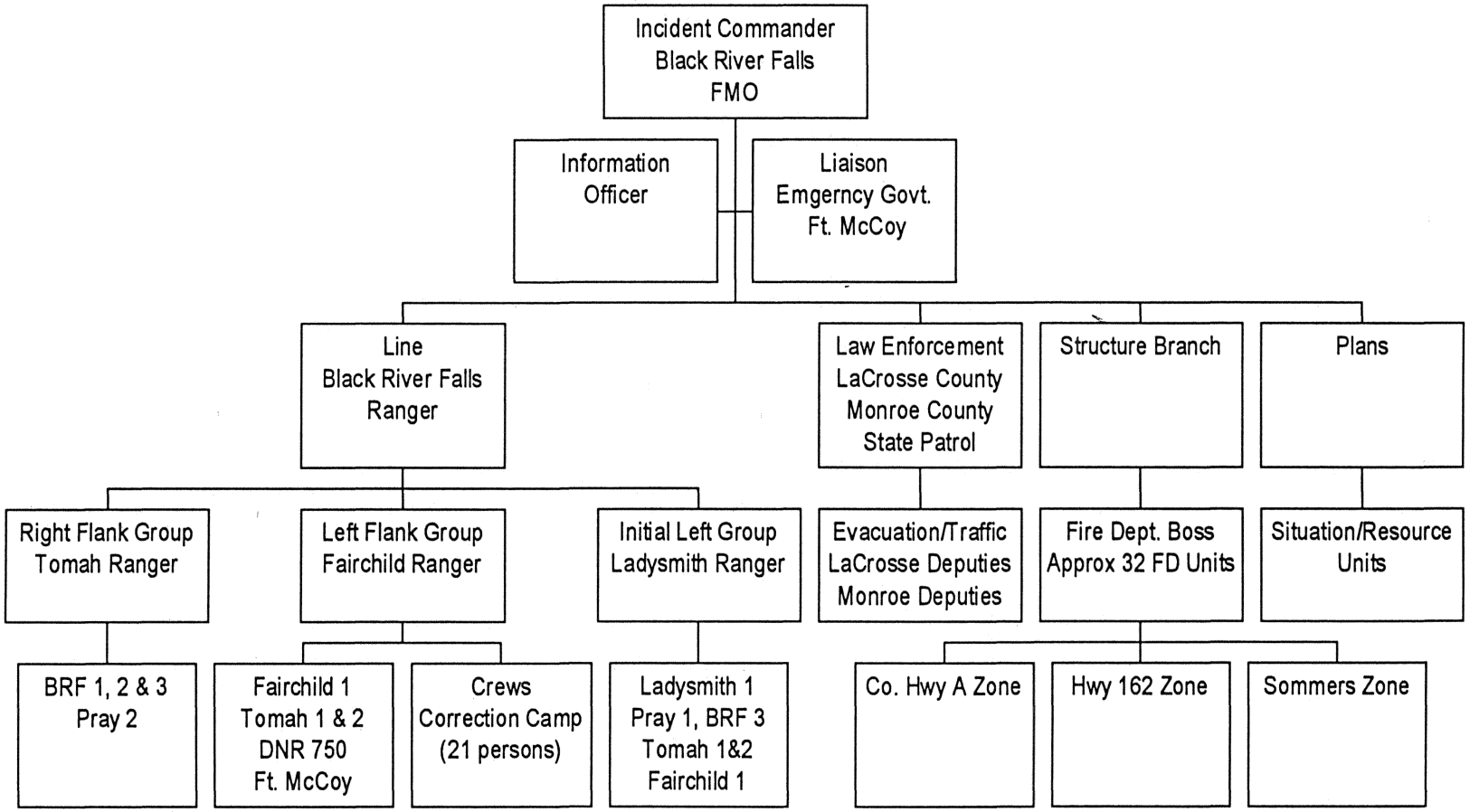
19 Tell us, step by step, what your specific actions were just prior to, during, and following time the fire moved through your area.

20. Were there any other factors not yet addressed that you feel had an impact on the conduct of this fire.

Initial Four Corners Incident
4-5-00
Approximately 2300 hrs.



Four Corners Fire
April 5-6, 2000



Glossary

Against the grain: Plowing or otherwise constructing fire line along the flank of a fire in the opposite direction of the fire spread; towards the origin of the fire and into the wind.

Dispatch Group: A group of five to ten Fire Response Units reporting to a single dispatch center and managed by a Dispatch Group Fire Management Officer.

Dispatch Group FMO: A Fire Management Officer charged with directing fire control activities in a dispatch group. Generally acts as Incident Commander on large fires.

Engine: A one-ton (Type 7) or 3 ton (Type 4) fire suppression truck equipped with a pump, hose reel(s), radio, and fire fighting hand tools

Entrapment: A situation where personnel are unexpectedly caught in a fire behavior-related, life threatening position where planned escape routes or safety zones are absent, inadequate or have been compromised.

Fire Response Unit: A 200,000 to 300,000 acre initial attack area assigned to a single Ranger Station. Staffed by a Forest Ranger and one to three Forestry Technicians.

Fire review: A formal review of all aspects of a particular forest fire

Firecom: A common radio frequency designated for use by structural fire units

Flank attack: A fire fighting strategy wherein fire fighters and/or fire plows build fire breaks as close as possible to the edge of the fire starting at the origin or some other anchor point and working along the flank of the fire in the same direction as the fire spread. Also known as "direct attack"

Flank: That portion of the fire edge where flames are moving across the wind. A flank begins at the "origin" of the fire where flames are backing into the wind and extend to the "head" of the fire where flames are moving directly with the wind. When standing at the origin and looking downwind, the portion of the fire edge to the left is designated the LEFT FLANK and that portion to the right is designated the RIGHT FLANK.

Forest Ranger: Foresters with a primary fire control responsibility for a Fire Response Unit in the WDNR. They operate Type 7 initial attack engines and direct operations on larger fires.

Forestry Technician: Highly skilled firefighters who operate tractor plow units and Type 4 engines in the WDNR fire control organization.

Furrow: A mineral soil trench, approximately 5 feet wide, created by a fire plow pulled by a tractor-plow unit.

Heavy Unit: The primary fire control unit used by the WDNR. It consists of a 3-ton, Type 4 engine pulling a tractor-plow unit loaded on a tilt-bed trailer. When fully configured, it is identified by the station it is assigned to along with a number - for example: TOMAH HEAVY UNIT 1. When the engine unhooks from the trailer and operates independently, it then is referred to as TOMAH ENGINE 1, while the tractor-plow unit is referred to as TOMAH TRACTOR 1 after it is unloaded and plowing.

J-hook: Refers to the practice of building fire line a short distance up one flank, doubling back to the origin and then proceeding to build fire line along the other flank. The purpose is to prevent the fire from backing up from the origin, crossing over the fire line and coming up behind personnel and equipment building fire line. It is generally done when not enough resources are available early in the fire to build line along both flanks simultaneously.

Line Construction Group: A group of personnel and tractor-plows charged with constructing fire line from the origin or other anchor point along a flank towards the head of the fire. They are referred to as the LEFT or RIGHT group depending on which flank they are working.

Line Construction Group Supervisor: The leader of a line construction group charged with directing the group resources and maintaining radio contact with the Line Branch Director.

Plow line: A fire break constructed by a tractor-plow. Also called fire line. See "furrow"

Ranger: See "Forest Ranger"

Red net: The term used by WDNR to denote the point-to-point tactical frequency used by fire line forces.

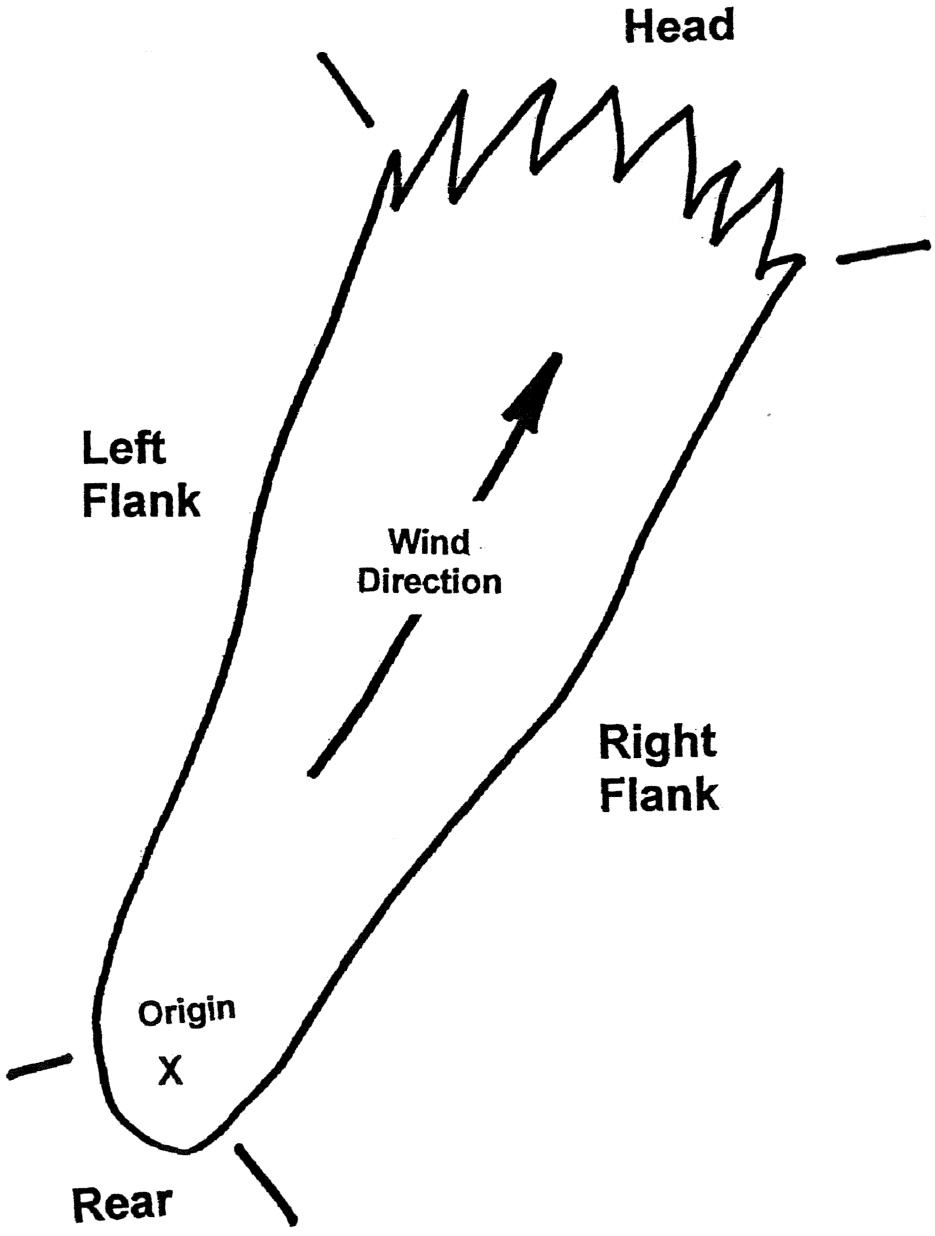
Regional FMO: A Fire Management Officer responsible for a Regional fire program incorporating a number of Dispatch Groups.

Repeater System: A radio system incorporating a series of relay towers used by Dispatch Centers to communicate over long distances.

Shower system: A series of nozzles built into the rollover protection cages of WDNR tractor-plow units which can deliver water from on-board water tanks to wet down the operator in the event of an unexpected flame-up too near the unit.

Tractor plow: The primary fire line building unit used by WDNR. Generally consists of a John Deere 450 bulldozer with a hydraulically operated fire plow mounted on the back and a dozer blade on the front. They are equipped with a radio, fire pump, hose and carry 150 gallons of water in tanks along each side of the operator.

PARTS OF A FIRE



LINE CONSTRUCTION GROUPS

Definition:

A line construction group is a unit formed to create holdable fireline across division boundaries. The group is responsible for burning out the line concurrently with construction – unless LCES or tactical considerations make it unnecessary. Post burnout, containment, and mop-up is the responsibility of divisions formed behind the line construction group.

When to use:

Project fires can have a rate of spread in excess of two miles per hour. Because of this it is necessary to build and hold a fire line as rapidly as possible.

The conventional methods of line construction involve establishing divisions and assigning resources to them. These resources then complete the line, burn it out, and mop it up. This method remains valid; however, it is slower than the technique of using a line construction group.

Line construction group formation is most appropriate on fast moving project fires in pine fuel types and/or where two or more divisions are needed on a given flank. They should only be employed when adequate resources are available to create divisions to hold constructed line behind the group.

A LCG is normally intended for use in direct attack situations where tractor plows can operate close to the fire. By operating close to the fire the group may go into the burn if a breakout behind them creates a safety hazard.

Resources assigned:

A line construction group may be composed of any combination of resources available and deemed adequate to maximize the rate of safe line construction. These resources should be led by a group supervisor on the line with them. Normally the group supervisor follows behind the tractors to make sure the line is properly burned out and holding, but he/she may move up front to locate line, assess stream crossings, etc., as needed.

In general application, a LCG would consist of a Group Supervisor, Three to five tractors and a person to burn out the line (which may be the group supervisor in some cases). A group may also be assigned crews, ATV's, fire engines, private dozers, or aircraft as necessary. Any private dozers assigned to a LCG should be equipped with a canopy and radio communications.

Other resources which will help the group maximize the rate of line construction include fixed wing and rotary wing aircraft. Fixed wing aircraft can be valuable to the safety of a group by watching for spot fires outside the line behind them. Helicopters can greatly support the group by attacking spot fires behind them or by cooling hot spots ahead of them.

It is strongly recommended that anyone assigned as a line construction group supervisor be highly experienced, assertive, have substantial knowledge of fire behavior, and be properly equipped with maps, compass and fusees.

Tactics:

Tactically a line construction group anchors its line at the origin or other defined anchor point and builds fire line toward the head of the fire. The group will continue line construction until it hits a natural barrier or the fire is contained within the lines.

Tractors assigned to assist a group after the initial assignment has left an anchor point should evaluate the line already put in. If two or more good furrows exist and the line has burned out and is holding, the operator should consider the alternatives. If the line appears at all questionable an additional furrow can be put in. If the line is in good condition, the operator should follow it with plow up at the best possible speed to catch up with the group. Obviously, if line skips or hot spots are found they should be furrowed before continuing.

Only a single line construction group should be employed at any one time on each flank. If a LCG encounters a natural barrier that prevents further progress, such as a river, a new group with additional resources can be formed to continue line construction on the down fire side. The original group should then be re-designated as a division or deployed as single resources as the tactical situation dictates. At any given time, the line construction group on each flank should be the unit actively constructing line closest to the head of the fire.

To reduce communication confusion, groups will be identified on the radio as "right group" or "left group". If new group is formed to continue line construction on the far side of a barrier, it should be temporarily identified as a task force using the supervisors' last name ("Task Force Sloan"). When the task force is in position and ready to begin line construction, it should be re-designated as "right group" or "left group" depending on the flank they are on. The original group will then be simultaneously re-designated as a division or use their single resource identifiers (Lake Tom Ranger, Lake Tom Tractor, etc.).

Safety considerations:

Equipment assigned to a group should stay within eyesight or close radio contact of one another for safety reasons. This would allow them to support each other in case of hanging up on a stump or a blow-up situation.

When a breakout occurs behind a group and resources return to furrow it, caution must be exercised. If you begin furrowing on the first flames you find across the line, you will have to plow across the head of an initiating fire and against the grain on the opposite flank. It is safer to continue along the original fire perimeter until you find the other side of the breakout and begin furrowing on its flank.

Relationship between a LCG and Divisions:

After the line construction group creates the line, follow-up containment and mop up are the responsibility of the divisions, which are created. Assignment of divisions to support the group can speed line construction and improve safety.

Frequently divisions will be established when the group is still within their boundaries. It is expected that the division and the group supervisors will coordinate their activities to be sure the line is created and held.

Should a serious breakout occur behind a group and the division is lightly equipped, portions of the group may have to return to assist in containing it. Once the breakout is contained the resources should be returned to the group as soon as possible.

INCIDENT ACTION PLAN SAFETY ANALYSIS	1 Incident Name	2 Date	3. Time

LCES* Analysis of Tactical Applications Lookouts, Communications, Escape routes, Safety zones												Other Risk Analysis						
Division/Group	Plowing against the grain	Snags and/or slash	Indirect fireline	Heavy pine fuel types	Frontal assault	Poor anchor points	Extreme conditions Spotting, crowning, fire whirls	Unburned areas	Communications		LCES MITIGATIONS	Hazardous Materials	Traffic	Evacuation	Structure Protection	Multi-Aircraft	Powerlines	LCES MITIGATIONS

Prepared by (Name and Position)

FIRE ORDERS

Fight fire aggressively but provide for safety first.
Initiate all action based in current and expected fire behavior.
Recognize current weather conditions and obtain forecasts.
Ensure instructions are given and understood.

Obtain current information on fire status.
Remain in communication with crew members, your supervisor, and adjoining forces.
Determine safety zones and escape routes.
Establish lookouts in potentially hazardous situations.
Retain control at all times.
Stay alert, keep calm, think clearly, act decisively.

WATCHOUT SITUATIONS

1. Fire not scouted and sized up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.
4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics and hazards.
6. Instructions and assignments not clear.
7. No communication link with crew members/supervisor.
8. Constructing fireline without safe anchor point.
9. Building fireline downhill with fire below.
10. Attempting frontal assault on fire.
11. Unburned fuel between you and the fire.
12. Cannot see main fire, not in contact with anyone who can.
13. On a hillside where rolling material can ignite fuel below.
14. Weather is getting hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across line.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near the fireline.

NEWS RELEASE

Wisconsin Department of Natural Resources
P.O. Box 7921, Madison, WI 53707-7921
Phone: 608/267-7404 TDD: 608/267-6897

FOR RELEASE: April 7, 2000
CONTACT: Steve Courtney, Fire management officer (715) 421-7851

SUBJECT: Follow-up to Four Corners Fire

Eau Claire, Wis. -- Forest fire control officials with the Department of Natural Resources announced today that a routine investigation was being opened into a "burn over" incident that occurred during the 600-acre Four Corners Fire on April 5-6 in Monroe County

A "burn over" is when a fire overtakes fire fighters and they have to shelter themselves in place while the fire burns through. Two heavy fire-fighting units, each consisting of a bulldozer with a rear-mounted plow and a truck to pull the trailered bulldozer-plow unit and an operator for each unit, were surrounded by flames from the fast moving fire.

Neither operator was injured and equipment damage was limited to scorched tires, melted reflectors and a cracked windshield. After the flames had passed, the operators drove themselves out of the incident location and reported to the fire command post. One operator was examined by medical personnel at the command post and released immediately, the other was transported to a local hospital where he was examined and released within a few hours. The equipment was examined and put back into action later in the day

The Four Corners Fire, located near the intersection of highways 162 and 71 in Monroe County, was initially reported at 9 p.m. on April 5 Between 1 a.m. and 3 a.m. the operators and equipment were dispatched to what was believed to be the left flank of the fire to establish fire lines. Upon arriving and unloading their equipment, it became apparent to the operators that the deployment was, in fact, near the head of the advancing fire.

The operators plowed a wide firebreak around the area where their trucks and trailers were parked. Thick smoke prevented escape by vehicle. In addition to the fire break, the operators used water from a tank carried on the trucks to wet down the area within the fire break. At the approach of the flames, one of the operators opened and used his personal fire shelter as a shield against blowing embers. The other sheltered behind one of the trailer-truck units.

Conditions at the scene of the fire were difficult to assess early in the blaze. High winds, heavy smoke and night-time darkness hampered firefighters. Hilly terrain blocked radio signals and made communications difficult. Deployment of heavy equipment to the flanks of the fire to establish fire-containing lines is the standard mode of attack on a fire of this type. The fire was located in an area of the state for which local fire departments have primary responsibility for fire suppression. Multiple fire departments responded to the blaze. DNR crews were called by local authorities to assist and were working in unfamiliar territory

Anytime a personal fire shelter is used or in the case of a burn-over, Department of Natural Resources fire operations procedures call for an investigation into the chain of events and the circumstances leading up to the event. The investigation is conducted to provide knowledge that will avoid similar situations in the future.

The investigation is being conducted separately from the standard investigation into the cause of the blaze and is expected to be available in about two weeks.

Investigators will attempt to determine if basic operating procedures for deployment of equipment were followed including: the availability of a look-out to warn operators of approaching danger or a change in fire behavior; the adequacy of communications between command and field equipment operators; the planning of an escape route should the fire change unexpectedly; and, has a safety zone been established.

As a precaution against rapidly advancing flames or changes in fire behavior, the bulldozers the operators were using are equipped with water showers. Although the operators did not use the showers, the safety equipment is designed to provide a curtain of water around the vehicle cabin sufficient to protect the operator until the danger passes.