Fire and Emergency New Zealand Wildfire Investigation Report

District Fire Name:	Canterbury
Fire Name:	Worsley Road Port Hills
Fire Date:	14 February 2024
Time Reported:	14:12:59
FENZ CAD:	F3914792
Sponsor:	Dave Stackhouse

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Cover photo taken by: Emma Maguire

1. Terminology

Aerial Fuels	All live and dead vegetation located in the forest canopy or above the surface fuels, including tree branches and crowns, snags, moss and high brush.
Aspect	The direction a slope is facing, i.e. its exposure in relation to the sun.
Available Fuels	Those fuels which burn during a passage of a flaming front under specific burning and fuel conditions.
Burning Period	That part of each 24-hour period when fires will spread most rapidly. Typically, this is from about mid-morning to about sundown, or late afternoon.
Combustion	The rapid oxidation of combustible materials that produces heat energy.
Continuity of Fuels	The proximity of fuels to each other that governs the fire's capability to sustain itself. This applies to aerial fuels and surface fuels.
Control Line	An inclusive term for all constructed or natural fire barriers and treated fire edges used to control a fire.
Crown Fire	A crown fire is a fire that has ascended from the ground into usually forest canopy and is advancing from crown to crown in advance of the fire on the ground
Direct Attack	A method of suppression that treats the fire as a whole, or all its burning edge, by wetting, cooling, smothering or by chemically quenching it or mechanically separating it from unburned fuel.
Diurnal	Daily, especially pertaining to cyclic actions which are completed within 24 hours and which recur every 24 hours.
Duff	A mat of partially decomposed organic matter immediately above the mineral soil, consisting primarily of fallen foliage, herbaceous vegetation and decaying wood (twigs and small limbs).
Elevation	The height of the terrain above mean sea level, usually expressed in feet.
Extreme Fire Behaviour	Implies a level of wildfire behaviour characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rates of spread; prolific crowning and/or spotting; presence of fire whirls; a strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment, behaving erratically and sometimes dangerously.
Fine Fuels	Fuels that are less than ¼ inch in diameter such as grass, leaves, draped pine needles, fern, tree moss and some kinds of slash which, when dry, ignite readily and are consumed rapidly. (Also known as Flash Fuels).
Fire Pattern Indicators	As a fire progresses, it will leave visible marks of its passage on combustible and non-combustible objects in its path. These markings are called fire pattern indicators.

Fire Perimeter	The entire outer edge or boundary of a fire.
Flanks of a Fire	The parts of a fire's perimeter that are roughly parallel to the main direction of spread.
Fuel Moisture Content.	The amount of water in a fuel, expressed as a percentage of the oven dry weight of that fuel
Ground Fire	All combustible materials lying beneath the ground surface including deep duff, roots, rotten buried logs, peat and other woody fuels.
Head of a Fire	The most rapidly spreading portion of a fire's perimeter, usually to the leeward or upslope.
Heavy Fuels	Fuels of large diameter such as snags, logs and large limb wood that ignite and are consumed much more slowly than flash fuels (also known as Coarse Fuels).
Hot Spotting	Checking the spread of fire at points of more rapid spread, or special threat. It is usually the initial step in prompt control with emphasis on first priorities.
Humidity	The measure of water vapour content in the air.
Indirect Attack	A method of suppression in which the control line is mostly located along natural firebreaks, favourable breaks in topography, or at considerable distance from the fire and all intervening fuel is backfired or burned out. The strip to be backfired is wider than in the parallel method and usually allows a choice of the time when burnout or backfiring will be done.
Ladder Fuels	Fuel that can carry a fire burning in low-growing vegetation to taller vegetation. Examples of ladder fuels include tall grasses, low-lying tree branches and shrubs and trees under the canopy of a large tree. This includes both living and dead fuels.
Long-Range Spotting	Large glowing firebrands are carried high into the convection column and then fall out downwind beyond the main fire-starting new fires. Such spotting can easily occur ¼ mile or more from the firebrands' source.
Mop Up	Extinguishing residual fire to make sure it doesn't continue to spread outside of an established containment area. Mop up includes actions like breaking apart smouldering debris, ensuring embers are completely extinguished, or moving burned debris so it cannot roll downhill and ignite previously unburned fuels.
Precipitation	The collective name for moisture in either liquid or solid form large enough to pull from the atmosphere and reach the earth's surface.
Rate of Spread	The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire; or as rate of forward-spread of the fire front; or as rate of increase in area, depending on the intended use of the information. Usually it's (forward) rate of spread is expressed in chains or acres per hour.

Relative Humidity	The ratio of the amount of moisture in the air to the amount which the air could hold at the same temperature and pressure if it were saturated; usually expressed in percent.
Smouldering	Behaviour of a fire burning without flame and barely spreading.
Spot Fire	Fire set outside the perimeter of the main fire by flying (or rolling) sparks or embers.
Spotting	Behaviour of a fire producing sparks or embers that are carried by convection columns and/or the wind and which start new fires beyond the zone of direct ignition by the main fire.
Surface Fire	A fire that burns surface litter, debris and small vegetation.
Surface Fuels	All materials lying on, or immediately above, the ground including needles or leaves, duff, grass, small dead wood, downed logs, stumps, large limbs, low brush and reproduction.
Thermal Belt	An area of a mountainous slope that typically experiences the least variation in diurnal temperatures, has the highest average temperatures, and thus, the lowest average relative humidity.
Topography	The configuration of the earth's surface, including its relief and the position of its natural and manmade features.
Vertical Arrangement	The relative heights of fuels above the ground and their vertical continuity, which influences fire reaching various levels or strata (Surface fuels vs Aerial fuels and their relationships to one another).
Wildfire	1. An unplanned wildland fire requiring suppression action, or other action according to agency policy, as contrasted with a prescribed fire burning within prepared lines enclosing a designated area, under prescribed conditions. 2. A free burning wildfire unaffected by fire suppression measures.

2. Lead Fire Investigator

Name: John Foley - Senior Specialist Fire Investigator

I am a Fire Investigator for Fire and Emergency New Zealand (Fire and Emergency).

I have served with Fire and Emergency (previously New Zealand Fire Service) and the Marlborough Rural Fire Authority since 1987.

I was appointed as a Fire and Emergency New Zealand Inspector under Section 166 of the Fire and Emergency New Zealand Act 2017 on July 2017.

I have completed and passed the following National Rural Fire Authority training courses.

- Wildfire Investigation Level 1
- Wildfire Investigation Level 2
- Wildfire Unit Standards in fire suppression, fire behaviour, managing emergency events.

I have attended the following courses in Australia.

- Arson Fire Management Course Melbourne 2012
- Origin and Course refresher Course Melbourne 2015
- Bushfire Arson Investigator Course Melbourne 2019
- Motor Vehicle Fire and Origin Course Fire Rescue Australia New South Wales 2021

I have completed online training modules via the CFITTrainer website operated by the (IAAI) in the US.

As a fire investigator for Fire and Emergency, I am required to respond to significant fires in accordance with our national commanders' instructions with the principal objectives being to coordinate, supervise, or undertake, investigations into major or serious fires including fatal fires, by determining the point of origin of a fire and from this, establishing the cause of the fire.

Additional Investigators

Graeme Still – Wildfire Specialist
Craig Chambers – Community Risk Manager

3. Fire Investigation Terms of Reference

Sponsor

David Stackhouse – District Manager/Commander, Canterbury District

Lead Investigator

Craig Chambers CRM Mid-South Canterbury (Fire Investigation Lead – Port Hills Fire 2024) (Worsley Rd Fire F3914792).

Incident background

On the 14 February 2024 a fire was reported to FIRECOM via 111 at 1412hrs as a vegetation fire on Worsley's Track. The fire quickly progressed to a long duration incident involving multiple air and ground assets to extinguish the fire.

Several properties were at risk with multiple evacuations being carried out by emergency services and a state of emergency was declared by both Christchurch City and Selwyn District Councils.

This fire presented significant political and public interest due to its visibility and risk to the Christchurch communities and the location was similar to the Port Hills fire in 2017.

Objective

As the Incident Commander I require an in-depth fire investigation to establish the point of origin and potential cause of the ignition.

If in the hypothesis of establishing cause and origin the fire cause is deemed suspicious work with the New Zealand Police to assist them in any potential criminal investigation and provision of evidence.

Scope

1. Form an investigation team to complete the task set.
2. All cost for the investigation sits in BU7842 with the Incident Commander being kept abreast of any major financial needs other than normal BAU.
3. Analysis of Communications Centre's information on call and communications logs for potential witness canvassing.
4. Provide any other information arising from the investigation that may be of benefit for operational practices, in our future operations in relation to establishing the area and point of origins or anything relevant to the investigation efficiency.
5. Analysis of any other information that has relevance to this investigation.
6. Work with any other agencies that may have an interest in or may be of assistance in the objective set above.
7. Produce a completed report for the report sponsor outlining all relevant findings to me within a suitable time frame as discussed.
8. Provide the New Zealand Police with any evidence gathered during the investigation if required.

David Stackhouse – District Manager/Commander, Canterbury District

4. Executive Summary

14/02/2024

Incident Report Time: 14:12:59

Location: Worsley Road Port Hills Christchurch

Area Burnt: 474 hectares.

GPS Co-ordinates:

☒ Specific Origin Area 9(2)a

☐ Point of Origin

☐ Other (Explain)

Property Owner: Privately Owned

Incident Injuries: Nil

Type: Nil **Number:** Nil

4.1. Incident Information

Lead Investigator: John Foley

Additional Investigators: Graeme Still, Craig Chambers.

Supporting/Other Agencies: Police

Classification of Fire Cause: Undetermined

Ignition Source: Undetermined

The following ignition sources were considered during this investigation:

- Electric fences
- Campfires
- Lightning
- Smoking
- Debris burning
- Incendiary devices / accelerants
- Equipment use
- Children
- Miscellaneous
  - Power lines
  - Glass / Bottles refraction / Magnification
  - Firearms use
  - Spontaneous combustion
  - Vehicle exhaust

While closing the gate that prevents unauthorised vehicle access to the upper section of Worsley Road, Witness 3 noticed a fire on the hill behind them.

It was approximately 600 m above them on the east side of Worsley Road, they called out to a couple that were close by to phone 111 and report the fire. The first 111 call was recorded at 14:12:59hrs.

Witness 3 went back up the hill to investigate the fire, on arriving at the scene they made a 111 call. The fire was relatively small at this point but growing quickly. Another person turned up to assist but within a short time they realised their own safety was at risk so walked out onto Worsley Road.

By the time the first arriving fire appliance arrived at 14:28hrs the fire had spread to the western side of Worsley Road.

The closest remote automatic weather station (RAWS) is situated at Early Valley approximately 3km's southwest of the fire origin. The temperature at 14:00hrs was 25.3°, Relative Humidity was 38% with an easterly blowing at 33 km/h. Weather conditions, slope and continuous available fuels enabled the fire to spread quickly, eventually burning 474 ha. Initial reports of area burned were calculated at 650 ha, this was recalculated using satellite imagery.

Multiple owners have been impacted by fire, ranging in property, equipment, infrastructure, and vegetation loss. Individual areas burnt range in less than a hectare to hundreds of hectares. Fuel types varied from high producing exotic grasslands, broadleaved indigenous hardwoods, gorse/broom, areas of harvested forest, exotic forest, to manuka and kanuka.

Investigators are aware there are additional areas burnt and vegetation types lost but at the time of writing the report the information requested had not been received.

The investigation has identified when and where the fire started but not how the fire started.

5. Process of Investigation

On Wednesday 14 February 2024 a team of three wildfire investigators were brought together to investigate the origin and cause of the fire.

Investigator Craig Chambers was first to arrive at the Safe Forward Point at 07:05hrs on 15 February.

Graeme Still and John Foley arrived on site on 15 February at 09:40hrs. A team briefing took place to form an action plan for the day. Craig advised he had been up to the general origin area and taped it off to prevent anyone entering the area.

During the team briefing, Craig suggested John take the Lead Investigators role due to the high public interest and John's position in Fire and Emergency New Zealand (Fire and Emergency). This was agreed upon by the investigation team.

Investigators decided to meet with the first and second callers (Witness 1 and Witness 2) to see what they had seen and what lead up to making the 111 calls.

After speaking with the witnesses, investigators drove Witness 1 up to the area of the fire to get them to show them what they had seen and where they were at the time.

Witness 1 parked their vehicle in the cul-de-sac near the end of the sealed road not far from where Worsley Road transitions onto a gravel 4x4 track. They walked approximately 680 m up the hill when they passed a vehicle parked on the right side of the road. There was a male by the vehicle who walked into the scrub opposite the vehicle. After walking another 400 m it was getting too hot, so they turned around and walked back down the hill.

On their way down they passed the same male back at the vehicle. Carrying on down the track the vehicle eventually came down behind them, the driver was closing the gate when he called out call 111 there's a fire back up the hill.

From their location Witness 1 was not able to see anything, walking back up the track they could see the fire. They made the first 111 call at 14:12:59hrs.

The person (Witness 3) that called out went back up the hill to see what was on fire, once at the fire they made a 111 call.

Witness 3 tried to extinguish the fire and moved logs away from the fires edge. While on site another person turned up (Witness 4) who also tried to extinguish the fire.

Witness 3 and 4 decided the fire was growing too quickly for them and left the area.

While standing on the Worsely Road they noticed the fire had spotted onto the western side of the road.

Leaving the area, they returned to the cul-de-sac and waited for the Brigade.

Fig. 1 *- Satellite Map, yellow line across road location of access gate, yellow circle general area fire was noticed, and yellow rectangle cul-de-sac.*

A request for photos and video of the fire in the early stages was put out through the Fire and Emergency Communications Team. A large amount of information was received. CCTV footage was obtained through police, the recording showed at 14:09:47 the first signs of smoke were visible. Viewing the CCTV footage, it appears it may even be one minute before but as the footage was recorded 1.6 km away the more you zoom in the grainier the image becomes.

The timing of the video is crucial to assist with the ignition time when the fire became a flaming ignition source. The visibility of the smoke is approximately three minutes before the 111 call was recorded.

External Scene Examination:

Craig Chambers had earlier taped off access into the general origin area located on the east side of Worsley Road. He identified key direction indicators of angle of char on the pine trees indicating the head fire run, leaf freeze which identified the wind direction at that point in time, which also supported the head fire run direction. Staining on rocks and signs of protection identified the areas of lateral burning as did grass stem fall supported areas of backing fire.

The predominant fuels outside of the general origin area were grasses, scrub, and pine trees. Being February, all fuels were available to burn. Once the fire was established it quickly spread across the hill country burning all available fuels.

Looking from the road towards the general origin area, investigators agreed with Craigs initial analysis of the indicators providing direction of travel.

Investigators followed a well-worn track that would later be identified by 9(2)a as the track they regularly use to access the property.

Fig. 2 *- Approximate general origin area marked in yellow, blue dot location investigators parked.*

General Origin Area - Internal Scene Examination:

After looking externally at the head fire runs and identifying areas of transition into flanking fire, investigators began their internal investigation in the area identified as the general origin area. This began on the edge of Worsely Road and encompassed the area to the east (Fig. 2.).

Directional indicators of white ash, angle of char, protection, staining, and leaf freeze provided a clear picture of the fire path of travel.

Two areas of interest were identified. The first location was approximately 45 m inside the general origin area, down slope below a rocky area (Area 1).

The second location (Area 2) was approximately 50 m to the north of Area 1.

Area 1

Two head fire runs were identified in Area 1, these burnt in a southwest to west direction out through a line of pine trees eventually spotting across Worsely Road.

Directional indicators were flagged to identify the fires direction at a given point.

- Red flags identify head fire direction of travel.
- Yellow flags identify lateral (sideways) direction of travel.
- Blue flags identify where the fire has backed away from the origin.

Reducing the area down to a specific origin area of approximately 5 m x 5 m, a closer examination was made.

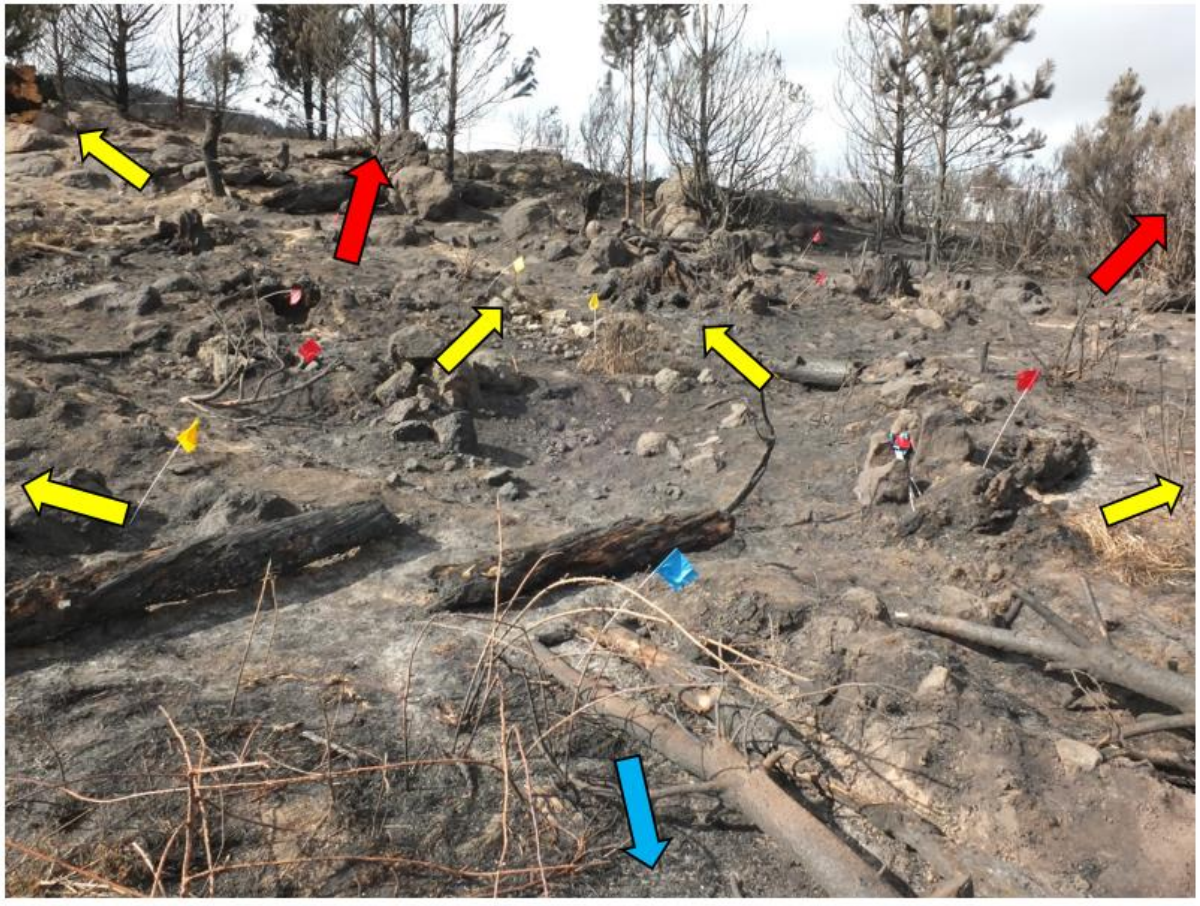

Fig. 3 *- Area 1 - identified fire travel in the specific origin area.*

The owner of the property 9(2)a advised there had been no activity or equipment used on the day of the fire and was unable to assist with what may have started the fire.

Based on the majority of the directional indicators the fire has spread outwards from this location, using the directional indicators, witnesses statements, and photographs provided of the fire in the

early stages investigators have determined Area 1 as the location the fire started and spread eventually burning over 400 ha.

Area 2

Following directional indicators across the general origin area a second area was identified, investigators examined the area to determine whether this was the fires origin or had burned sometime after the fire had started.

9(2)a

Fig. 4 *- Cropped photo of SO98218.JPG – Area 2*

Burn patterns indicate the fire has spread into the area on the southern end but out from all other directions. Two head fire runs were identified burning away from the location in a westerly direction.

The fire had burnt extremely hot indicating a high fuel loading.

Through witness statements and early photographs it has been established the area was burnt sometime later and had a pile of logging slash and scrub that had been stacked from a previous logging operation.

A photograph was provided of the early stages of the fire identifying Area 2 was not alight but Area 1 was.

Fig. 5 *- Area 2 sits within the yellow oval, the dry fuel can be seen stacked up. Photo taken after the fire has started.*

Fig. 6 *- Area 1 in yellow circle and Area 2 in yellow oval.*

6. Fire Spread and Behaviour

6.1. Weather Factors

In the hour before the fire was reported the Early Valley RAWS recorded low relative humidity, hot temperatures, and was windy.

The combination of dry weather, low moisture content within the fine to medium fuels and a continuous available fuel load assisted in the ignition and spread of the fire.

The availability of fuels came about through a combination of prolonged periods of dryness which increased the natural drying of the fine and the medium fuel component. The larger diameter fuels were not completely consumed in the fire due to their moisture content compared to the fine to medium fuels.

Fire Behaviour:

Fire behaviour is determined by the surrounding conditions, influences and modifying forces of topography, fuel, and weather.

The area contained variable fuel types that were continuous across the hills. Once the fire started and began to spread it was always going to be difficult to contain. Wind and slope assisted in the rapid rate of spread.

Contributing factors for the fire to spread were:

- Weather – Low relative humidity, hot temperatures and wind all contributed to extreme fire behaviour.

- Topography – Having a north/northwest aspect the hills were exposed to the sun causing preheating of the fine fuels reducing the amount of energy required to ignite them.

  The northerly aspect also contributed to the drying of the fuel being exposed to the hot nor ’westerly wind over the summer months.

  Slope has a similar affect as wind contributing to the rapid increase in the rate of spread increasing head fire intensity.

- High available fuel load - in grass, scrub, and forest fuels.

Rate of Spread

Calculating the initial rate of spread has been estimated by working backwards.

We have established a known point where the fire was at 14:22hrs and the time the fire was visible plus the distance from the ignition area to the known point being approximately 45 m enabled the investigation to estimate the fire began to flame and spread between 14:02hrs and 14:05hrs before becoming visible at 14:10hrs. The initial rate for spread has been calculated at 45.5 m in the first 11 minutes.

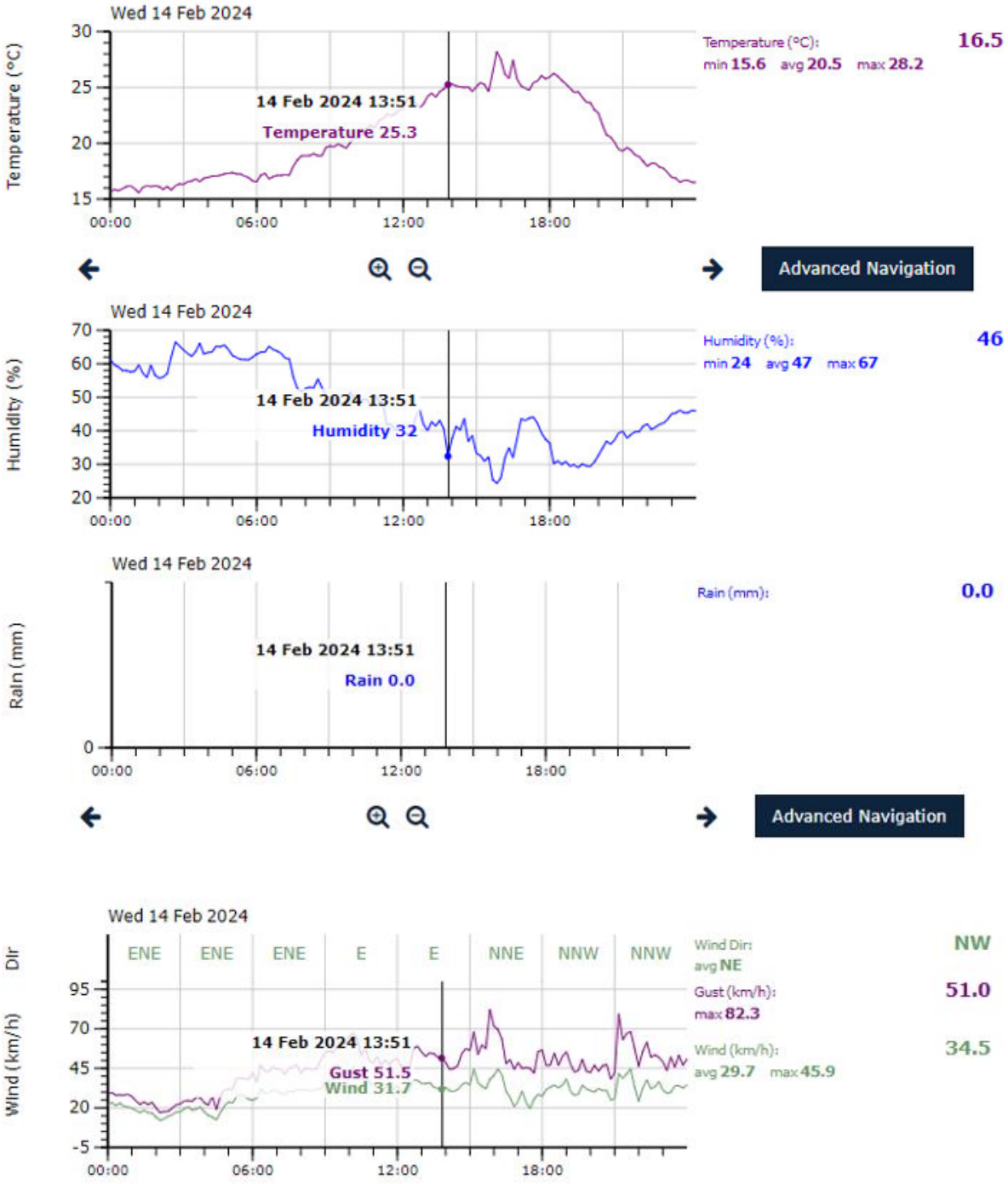

Fig. 7 *– Early Valley RAWS data.*

Date	Time 24hrs	Station	Temperature °C	RH %
14/02/2024 Approximate time of ignition	13:51	Early Valley	25.3	32
	14:08	Early Valley	25.0	41
15/02/2024	15:01	NC Portable	26.3	38
	15:03	Early Valley	24.8	41
16/02/2024	15:35	NC Portable	18.4	59
	15:35	Early Valley	18.3	65

Fig. 8 *- combined Temperature and Relative Humidity (RH) data from Early Valley and North Canterbury Portable RAWS which was position on Worsley Road on 15 February.*

6.2. Fuel Factors

Moisture content of fine fuels plays a significant part in their availability to not only ignite but to sustain ignition. The fuel's ability to increase and decrease its moisture content is influenced by the daily rise and fall of relative humidity (RH).

- Low RH in the mid-day period will lead to a low fine fuel moisture content in mid-afternoon.
- Low RH indicates an increase in the potential for ignition of fine fuels.
- RH affects the flammability of fuels because water vapour is continuously exchanging between the atmosphere and dead fine fuels. Dead fuels give up moisture to a dry atmosphere and absorb moisture from a humid atmosphere.

The available fine fuel loading was continuous in all directions from outside the specific origin area. Fuels were predominately a mix of grass, scrub, and pine trees.

Fire Weather Indices:

The closest Fire and Emergency RAWS to the fire site is Early Valley situated approximately 3 km to the southwest of the general origin area.

The Build Up Index (BUI) recorded at Early Valley was 33.4. A BUI of >40 indicates high levels of fuel available for combustion.

BUI is a numerical rating of the total amount of fuel available for combustion that combines the Duff Moisture Code (DMC) and the Drought Code (DC).

Forest	Scrub	Grass	FFMC	DMC	DC	ISI	BUI	FWI	TEMP	RH	DIR	WSP	RN24	GC%
V	E	E	88.9	18.7	387.5	21.3	33.4	30.9	24.2	40	87	34.9	0	80

Fig. 9 - *Early Valley FWI figures observed 14 February 2024 12:00hrs NZST.*

To provide some context around the FWI figures, temperature, relative humidity, rainfall, wind speed and direction are the only actual figures recorded at 12:00 NZST (13:00hrs NZDT). The additional figures are modelling projections for fire behaviour later in the day.

The grass curing percentage set at Early Valley is an estimate of the general area not a specific location within.

There were several indices showing as elevated:

Fine Fuel Moisture Code (FFMC) of 88.9: means if an ignition source was applied to the fine fuels they would readily ignite.

Drought Code (DC) of 387.5: the Drought Code is a numeric rating of the average moisture content of deep compact, organic layers. The code is a useful indicator of seasonal drought effects on forest fuels, and the amount of smouldering in deep duff layers and large logs that would occur during a fire.

- A DC of 300 indicates mop up will be difficult and prolonged.

Initial Spread Index (ISI) 21.3: an Initial Spread Index (ISI) of 8-15 indicates rapid spread of fire. An ISI of 16+ indicates an extremely fast-moving fire. ISI is a numerical rating of the expected rate of fire spread. It combines the effects of wind and FFMC on the rate of spread without the influence of variable quantities of fuel.

An (ISI) in the 30s indicated an extremely fast spreading fire. Observing the fire pattern indicators left behind by the fire that is exactly what has occurred - a high intensity, fast moving fire.

Wind speed: 34.9km/h, Gusting over 50km/h

Relative humidity (RH) reading of 40: Relative Humidity is the amount of moisture in the air compared with the amount of moisture the air can hold. When the air is saturated, RH is 100%, extremely dry air can have a reading of zero percent.

At 13:51hrs there was a drop in RH down to 32%. This would have assisted with any smouldering fire to become a flaming fire over time.

Relative humidity %

- Below 60% contributes to fire development.
- Below 30% contributes to rapid fire development.
- Below 15% contributes to extremely rapid-fire development.

Fire Weather Index (FWI) 30.9: the fire demonstrated extreme head fire intensity and crews would have had difficulty trying to control it. FWI figures are recorded at 12:00 NZST and modelled for fire behaviour mid-afternoon.

Using the FWI figures from Early Valley may not provide a true reflection of the conditions on Worsely Road. Regardless of their accuracy, the fine fuel on the day was receptive not only to an ignition but was able to sustain ignition spreading out to other available fuels becoming a slope, fuel, and wind-driven fire.

6.4. Fire and Char Patterns

The fire contained many indicators that allowed investigators to identify direction of travel, areas of lateral and back burning. Angle of char could clearly be seen on pole type fuels (trees) and in the foliage crowns (scrub fuels).

Several rocks exhibited spalling which is generally associated with the advancing fire and appears on the side of the rock exposed to the heat. Signs of protection were seen around rocks and fuels

shielding the unexposed side of the fuel from heat damage. Staining, white ash and sooting on rocks was also visible.

Curling could be seen on leaves; this occurs when green leaves curl inward towards the heat source. Leaf freeze was seen in the pine needles which is a good indication of the direction of any breeze or wind at the time. This may not always identify the direction of travel of the fire.

No one indicator should be used in isolation to identify the fires direction of travel. Investigators used as many as possible of the available fire pattern indicators to identify the ignition area.

6.5. Witness Observations

Key witnesses have provided information regarding location, timings and what they saw in the early stages of the fire's development.

Directional indicators on site coupled with witness information has assisted investigators to form their final hypothesis determining where and when the fire started.

7. Visual and Physical Evidence

Area 1:

Investigators flagged fire directional indicators enabling them to reduce the size of the general origin area down to a specific origin area.

Within the specific origin area is the ignition area, an ignition source was not identified.

Fig. 10 - *Identification of the specific origin area and fire spread.*

8. Elimination of Possible Causes

Before a conclusion of causation could be established a thorough process of elimination was carried out. The following ignition sources were considered during the investigation:

- Electric Fences
- Campfires
- Lightning
- Smoking
- Debris burning
- Incendiary devices / accelerants
- Equipment use
- Children
- Miscellaneous
    - Power lines
    - Glass / Bottles refraction / Magnification
    - Firearms use
    - Spontaneous combustion

Cigarettes:
Research shows for a cigarette to 'likely' cause a fire the RH requires to be around 0-18%. An RH of 18-22% tends to make ignition marginal and unlikely, an RH of >22% no fire starts.

There are several other variables required to assist with an ignition, ash content which impacts on the exterior temperature of the tip, shrinkage of the tobacco during burning, exposure time between fuel and cigarette, fuel bed composition and dead fuel moisture content.

Fine dead fuel moisture (FDFM) of ground fuels is required to be less than 14%.

Steensland, Paul; Cigarettes as a Wildland Fire Cause

Countryman, Clive; **Ignition of Grass Fuels By Cigarettes**; Research Forester (R), USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Riverside, California.

Investigators did not observe any discarded cigarette butts in the area.

The property owner stated they are not a smoker.

Electric Fences:
There were no fences observed in the vicinity of the general origin area.

Firearms/tracer ammunition:
Investigators did not observe any discarded ammunition cases in the general origin area.

Incendiary devices / accelerant:
After a thorough inspection investigators did not observe any signs of accelerant, or any incendiary devices having been used.

Spontaneous combustion:
Investigators have ruled out spontaneous combustion as we did not observe any piles of decaying organic matter or "bird's nests" from any logging operations to support this hypothesis within the specific origin area.

Burning debris:
Burning debris has been ruled out. Although there were rows of stacked trees these had been there some time and the fire has not come from those locations.

Fire directional indicators support the fire burning into the debris setting it alight.

Deliberately Lit:
The property owner has stated they did not light any fire on the property.

Electrical:
There were no low or high voltage power lines crossing the property.

Equipment use:
The property owner has been unable to identify any activity that would have generated enough heat to cause an ignition. There had been no equipment use such as chainsaws, scrub cutters petrol or electric.

Lightning:

Lightning was considered a possible ignition source which may have caused a smouldering ignition. A request for lightning data from the 1 February to 16 February was made to MetService. Within a 50Km radius of the fire over the 16-day period there had been 98 Strikes to the ground or cloud to cloud.

None were within proximity of Worsely Road. Lightning has been ruled out as a competent ignition source.

Police Support: Police have supported the investigation with obtaining statements, photographs, aerial mapping and securing CCTV footage that has also supported investigators to identify the location the fire started but not how it started.

9. Fire Classification, Origin and Cause

The Fire Classification for this incident has been classified as:

☐ **Accidental Fire Cause Classification**
Accidental fires involve all those for which the proven cause does not involve an intentional human act to ignite or spread fire into an area where the fire should not be.

☐ **Natural Fire Cause Classification**
Natural fire causes involve fires caused without direct human intervention or action, such as fires resulting from lightning, earthquake, wind, and flood.

☐ **Incendiary Fire Cause Classification**
An incendiary fire is a fire that is deliberately set with the intent to cause a fire to occur in an area where the fire should not be.

☒ **Undetermined Fire Cause Classification**
Whenever the cause cannot be proven to an acceptable level of certainty, the proper classification is undetermined.

Origin and Cause

After completing the elimination process investigators have formed their final hypothesis.

They have identified when the fire became a flaming ignition and the ignition area.

The location was approximately 50 m within the property boundary and not near the edge of Worsely Road.

The ignition area was identified using fire directional indicators, witness statements, photographs, and CCTV footage.

9(2)a [redacted]

Within approximately 20 minutes of being in the area a fire has ignited and was only noticed 9(2)a [redacted] when they were locking the access gate further down the hill. Other witnesses had walked up and down Worsely Road prior to the fire being reported and not seen or smelt smoke.

To the best of the investigators knowledge there have been no other person/s identified as being on the block of land prior to the fire being reported. There were serval witnesses that were on the Worsely Road track, but none have identified anyone in this location 9(2)a [redacted]

The property owner has been unable to assist with what caused the fire, they have stated they are not a smoker and no equipment had been used to cause an ignition.

Police inquires have been unable to identify any information in relation to the ignition source.

Investigators have established when and where the fire started but not how the fire started.

Investigators believe whatever caused the ignition was not hot enough to create a flame, so the fire smouldered for some time before flaming ignition occurred.

With a high RH it is possible the fire may have smouldered in the dry fine fuels for some time until the RH dropped around 13:51hrs allowing the smouldering fire to begin flaming slowly spreading until it got large enough to be influenced by the topography, fuels, and weather.

Based on current information the cause of the fire is undetermined.

If new information is identified at a later stage, it may change the findings of this report.

Report completed by:

Fire Investigator: John Foley

Signature: 9(2)a [redacted]