FPInnovations
Wildfire Operations

FPInnovations

Assessing fuel treatment effectiveness:

A case study of the Nohomin Creek wildfire encroachment on the community of Stryen 9

BRITISH COLUMBIA
BC Wildfire Service

Greg Baxter, Senior Researcher

Steve Hvenegaard, Senior Researcher

Andrew Stack, Researcher

www.wildfire.fpinnovations.ca
Wildfiregroup@fpinnovations.ca

January 2024

On July 14, 2022, the Nohomin Creek wildfire (K70580) started approximately 1.7 kilometres northwest of Lytton, British Columbia, on the west side of the Fraser River. In the first burning day, the fire spread seven kilometres north, up the Fraser River valley, through mixed agricultural land and ponderosa pine forests resulting in structural losses in a residential area south of the Stein River. Late in the day, the wildfire jumped the Stein River and entered fuel treatments on the north side of the river.

Fire behaviour in the fuel treatment south of the community of Stryen 9 was moderated from an intermittent crown fire to a creeping surface fire, such that there was no damage to the community hall, which was the most vulnerable structure, despite unrelenting winds into the late evening.

Project number: 301015438
Report number: WFTR 2024 N.3

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of the Province of British Columbia through the Ministry of Forests.

FPInnovations wishes to acknowledge the traditional territory of the Lytton First Nations People, the current and original stewards of the lands upon which this research took place.

REVIEWERS
Andrew Stack

AUTHOR CONTACT INFORMATION
Greg Baxter
Researcher, Fire Operations
greg.baxter@fpinnovations.ca

APPROVER CONTACT INFORMATION
Kelsey Winter
Manager, Wildfire Operations
kelsey.winter@fpinnovations.ca

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

On July 14, 2022, the Nohomin Creek wildfire ignited and spread towards the Lytton First Nation community of Stryen 9, which had fuel treatments created in the area over the previous few years. The fire moved into this community from the south through the treated areas; these treated areas are the focus of this case study. The fire had the greatest impact on values at risk in the first burning period (from ignition which was approximately 1215 h, until 2100 h). This case study focusses on this timeframe because this is when the wildfire challenged the fuel treatments near the community.

This case study is noteworthy because there were minimal fire suppression or structure protection activities around the fuel treatment and adjacent subdivision while the fire moved through the area. This allowed an assessment of how the treatment independently impacted fire behaviour without the influence of suppression resources.

The Nohomin Creek wildfire case study forms a component of a larger research initiative to assess the effectiveness of fuel treatments in moderating fire behaviour and/or improving the potential for successful suppression operations. More specifically, this case study addresses the following key questions developed by fuels management specialists within British Columbia Wildfire Service (BCWS):

1. Was there a change in fire behaviour resulting from the wildfire moving into the fuel treatment area?
2. What factors contributed to a change in fire behaviour?
3. Was there a change in suppression strategy and tactics based on the presence of the fuel treatment or a change in fire behaviour? Did the fuel treatment provide a strategic or tactical advantage in suppression operations?

In the initial stages of this larger research initiative, ongoing consultation with BCWS helped refine the data collection and analysis processes to develop a framework for a national fuel treatment evaluation protocol that can be applied by a larger group of researchers and wildfire specialists.

FPInnovations has collaborated with personnel from BCWS and British Columbia Ministry of Forests to collect data from multiple sources, including:

- BCWS records (incident action plans, fire progression maps, weather forecasts, notes)
- field observations in areas of wildfire-fuel treatment encounters
- eyewitness accounts
- photographs from suppression personnel
- fuel treatment maps and prescriptions from fuels management specialists

2 SITE DESCRIPTION

The Nohomin Creek wildfire started 1.7 km northwest of Lytton, British Columbia, and spread northward through undulating benchlands along the western bank of the Fraser River (Figure 1). The fire was primarily wind driven and grew along the valley bottom through agricultural land, orchards, and residential areas, eventually crossing the Stein River and entering the residential area of Stryen 9 during the evening of July 14, 2022.

The residential area of Stryen 9, which consists of 13 residential structures and one community building, is located 7 km north of Lytton on a bench of land above the Fraser River, at the base of the 800 m peak of Stein Mountain (Figure 2). The Stein River intersects the valley bottom 500 m south of Stryen 9 and is one of the most impactful features along the Fraser valley due to the daily west winds descending from the Stein River valley.

Figure 1. Fire spread in the Fraser Valley on July 14, 2022. Photograph courtesy of the BCWS.

The community is nestled within a ponderosa pine forest (C-7 fuel type). There is a gravel road passing through the community with structures on both sides. The east side of the community abuts several hay fields.

Figure 2. Fire spread across the Stein River and toward the residential area of Stryen 9 (photo centre) Credit: Steve Hvenegaard.

3 FIRE CHRONOLOGY

- 1215 h on July 14, 2022, a member of the public reported a 0.5 ha wildfire burning on private land in the community of Lytton 27 IR, approximately 5 km south of the Stryen 9.
- An airtanker group arrived on scene at 1517 h.
- Aerial photography from the attending airtanker group shows dense smoke being produced on the north bank of the Stein River as early as 1945 h, indicating the fire had crossed the river and entered the fuel treatment unit (Figure 3).
- By 2005 h, a visible spot fire confirmed the fire had crossed the Stein River. Although an exact time cannot be determined with the supplied photos, the fire was confirmed to have exited the community of Stryen 9 to the north by 2038 h.

Figure 3. Nohomin Creek wildfire chronology: Looking west towards Lytton 27 IR, arrival of the birddog at 1517 h (top left) while approaching the community of Lytton 27 IR from the east. Dense smoke on the north shore of the Stein River (orange arrow) at 1945 h suggesting the fire had spotted over the river (top right). Confirmation of spot fire on the north bank of the Stein River at 2005 h (orange arrow, bottom left). The community of Stryen 9 at 2308 h after the wildfire had passed (bottom right). Photographs courtesy of BCWS.

4 FIRE ENVIRONMENT

The fuels surrounding the residential area of Stryen 9 are a mix of ponderosa pine and Douglas-fir overstory with pinegrass, woody debris, and needle litter as the predominant surface fuels. This fuel environment aligns with the C-7 (Ponderosa pine/Douglas-fir) Fire Behaviour Prediction (FBP) System fuel type (Forestry Canada Fire Danger Group, 1992).

The biogeoclimatic ecological classification (BEC) assigned to this area is PPXh2 (Ponderosa Pine, very dry hot) (Meidinger and Pohar, 1991) and the natural disturbance type for this area is NDT4 (frequent, stand maintaining fires). This fire regime has been disrupted with several decades of successful fire suppression and few fires have occurred causing a buildup of forest fuels through ingrowth of understory and deposition of woody debris and litter.

A fuel reduction treatment surrounding the Stryen 9 residential area was viewed as critical to mitigating the threat of catastrophic wildfire. Fuel treatment work was prescribed to surround this community's values, which included hydro and water supply infrastructure, homes, and a community hall.

4.1 Fuel Treatments

Extensive wildfire risk reduction initiatives have been applied near the Stryen 9 residential area (part of the community of Lytton First Nation) in the form of forest fuel reduction treatments. Fuel treatment work conducted near the Stryen 9 residential area (shown in Appendix A) consisted of a Community Resilience Investment (CRI) treatment west of the hydro line and the Lytton First Nation Polygon 30C, which was anchored to the Stein River and the east side of the hydro right-of-way (ROW). The fuel treatment work west of the hydro line was completed in 2018, and Polygon 30C was completed in 2021. All fuel treatment work was done by hand. The predominant wind direction in the valley is from south to north so the area south of the community was prioritized for treatment.

The fuel treatment defined as Polygon 30C (Figure 4) was planned and developed to alter the forest fuel conditions, that in the event of a wildfire, the levels of fire behaviour, the likelihood of crown fire initiation, fire intensity and rate of spread will be reduced to a level that the wildfire will be less aggressive and destructive in areas proximal to the community. (Landscope Consulting Corporation, 2020)

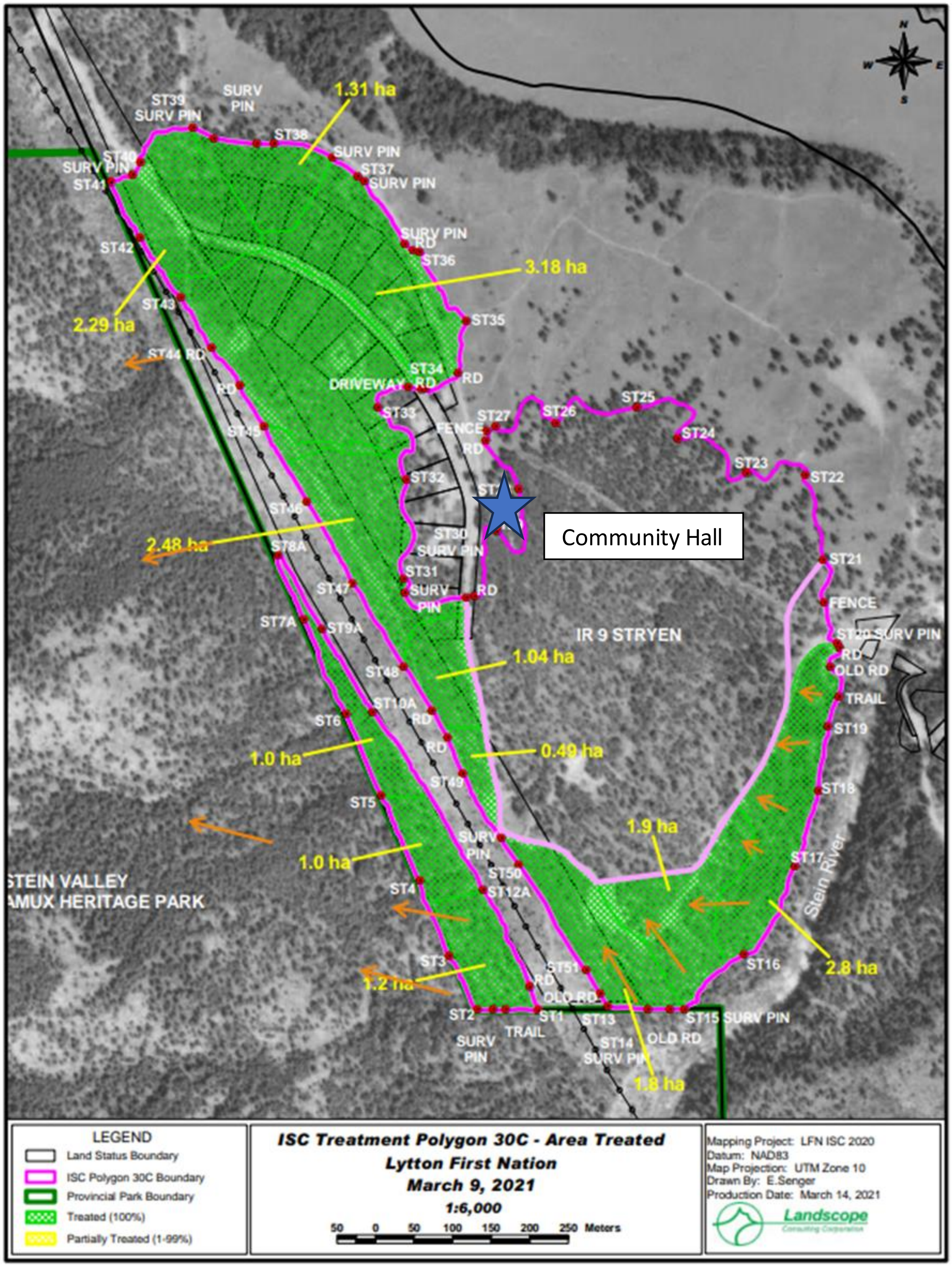


Figure 4. Fuel treatment Polygon 30C (purple boundary) surrounding the Stryen 9 residential area. The orange arrows indicate the direction of fire spread.

Treatment Unit A (TUA) is the focus of this discussion because it was most influential in moderating fire behaviour as the wildfire approached the community. The fuel management prescription (FMP) for Polygon 30C prescribed overstory thinning to retain the majority of larger diameter ponderosa pine and Douglas-fir stems, with more aggressive removal of smaller stems in the understory. Understory pruning was also conducted with intensive cleaning of surface fuels to reduce woody debris loadings to a target range of 0.1 to 0.4 kg/m^2.

The contrast in stand density can be seen in the pre-treatment (Figure 5) and post-fire (Figure 6) photographs. The post-fire photo is not, however, a good indicator of post-treatment surface fuel loading since a large portion of litter and woody debris would have been consumed by the fire. A 360-degree panorama of this area shows the extensive stand-thinning at the south end of TUA. Any surface litter shown in this panorama is post-fire needle cast.

Figure 5. Pre-treatment stand structure in polygon 30C at WTA Plot 30C-12. Photograph courtesy of Landscope Consulting Corporation.

Figure 6. Post-burn view of the fuel treatment south of the community hall.

4.2 Fire Weather

The BCWS Splintlum weather station is approximately 7.5 km north of the wildfire-fuel treatment encounter (Figure 7). The station is on the opposite side of the Fraser River and approximately 200 m higher in elevation than Stryen 9. Hourly weather and Fire Weather Index (FWI) System values (Van Wagner, 1987) recorded at the Splintlum station are shown in Table 1. The Duff Moisture Code (DMC), Drought Code (DC), and Buildup Index (BUI) for July 14, 2022, were 74, 568, and 111, respectively.

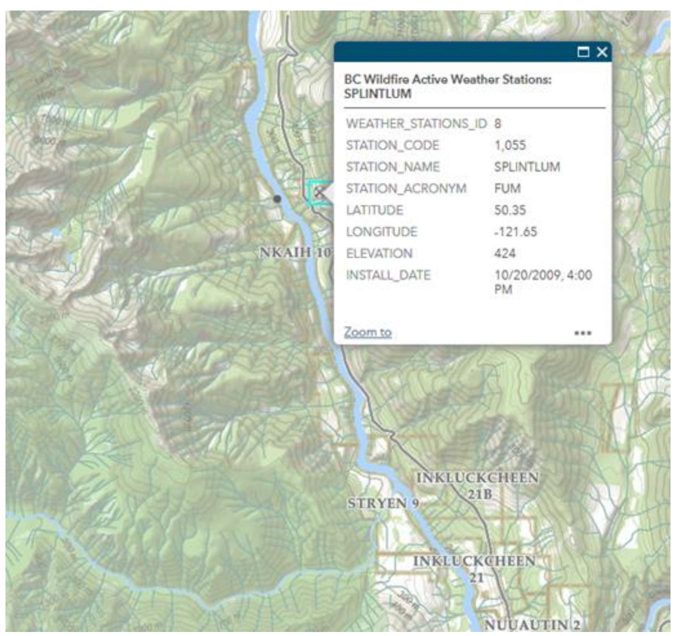


Figure 7. Location of the Splintlum fire weather station relative to the surrounding First Nation communities.

Wind was consistent throughout the burning day with speeds between 15 and 20 km/h from the south-southwest; this direction is typical for the valley as can be seen in the Initial Spread Index (ISI) roses in Figure 8.

Fuel treatments in British Columbia are designed with the objective of reducing the potential for crown fire initiation and limiting surface fire intensity to a level that will allow for safe and effective suppression under 90th percentile conditions (British Columbia Wildfire Service, 2023). The 90th percentile fire hazard for the Splintlum weather station is an ISI of 16.5 and a BUI of 219. During peak fire activity on July 14, 2022, the Splintlum weather station reported an ISI of 19.9 and a BUI of 111, indicating the fuel treatment would have been pushed to its operational limits during the time of the incursion. These values can be compared to hourly weather observations and FWI values presented in Table 1 for the first day of the fire.

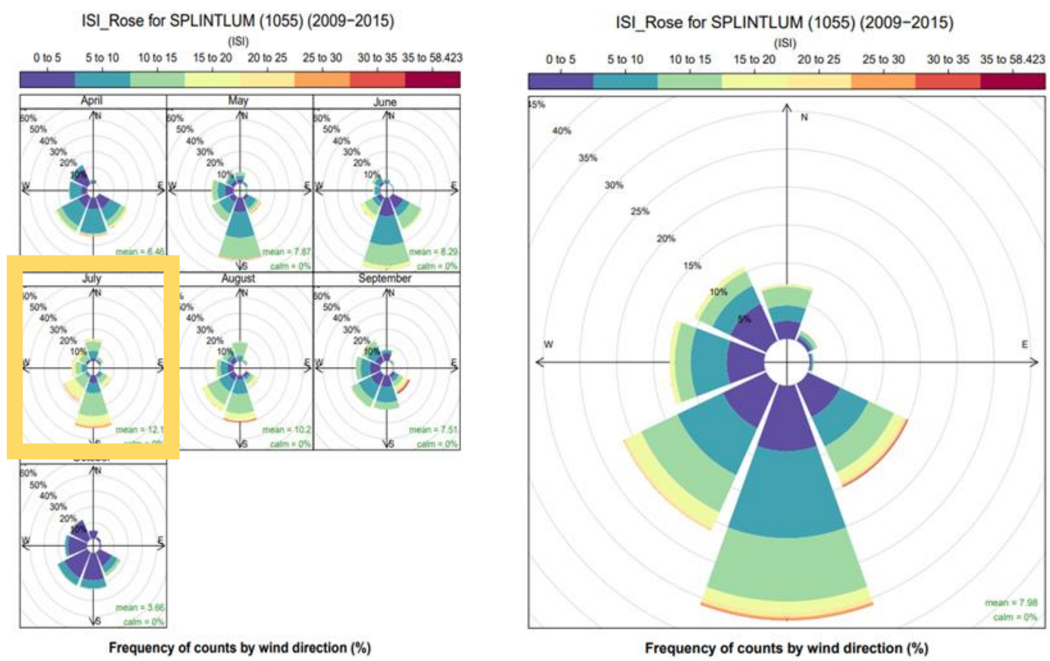


Figure 8. Initial Spread Index (ISI) roses for the Splintlum weather station. The greatest proportion of spreading days occurs from the south (right). Proportion of spread days in July are dominated by the south, followed by the southwest (left, yellow box).

Table 1. Weather and FWI values recorded at BCWS Splintlum weather station on July 14, 2022.

Time	Weather Values				FWI Values		
	Temperature (ºC)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)	FFMC	ISI	FWI
1100	25	34	9.4	223	89.9	6.8	24.9
1200	26.3	28	8.8	189	90.5	7.1	25.7
1300	28	26	12.2	192	91.1	9.3	31.4
1400	29.8	22	14.6	162	91.9	11.7	36.8
1500	29.8	22	15.5	149	92.5	13.4	40.1
1600	29.9	21	15.4	153	93.1	14.4	42.0
1700	29.8	20	19.7	148	93.6	19.2	50.3
1800	28.4	22	19.6	138	93.7	19.7	51.1
1900	27.7	23	19.7	121	93.9	19.9	51.6
2000	27	23	14.9	126	93.9	15.8	44.5
2100	25.9	24	16.2	133	93.9	16.9	46.6
2200	24.4	29	5.9	255	93.9	9.9	32.9

4.3 Topography

The community of Stryen 9 is located along the western banks of the Fraser River, nestled in the heart of British Columbia's southern interior mountains (Figure 9). Approximately 7 km northwest of Lytton, Stryen 9 rests atop the stepped, relatively flat paleo-floodplains at the base of the valley, approximately 50 m above the Fraser River (Figure 10, Figure 11, and Figure 12). Most of the structures within the community are located on these flat plateaus and benches, which are periodically broken up by water drainages and draws originating from the east-aspect slopes of Stein Mountain, immediately to the west.

The transition from flat plateaus to the east-aspect slopes of Stein Mountain is roughly marked by an electrical right-of-way that runs north-south, parallel to the community's edge. From this boundary, the terrain rises approximately 200 m at an average slope of 40% but ranges from less than 10% to greater than 70%. Cross-slope terrain is broken up by numerous chutes and box canyons, as well as exposed rock faces that break up fuel continuity. The southern boundary of the study area is marked by the Stein River, which flows out of the Stein Valley Nlaka'pamux Heritage Park from the west and into the Fraser River. The confluence of the Stein River and Fraser River valleys creates complex terrain and wind interactions, affecting both local winds and regional valley channeling.

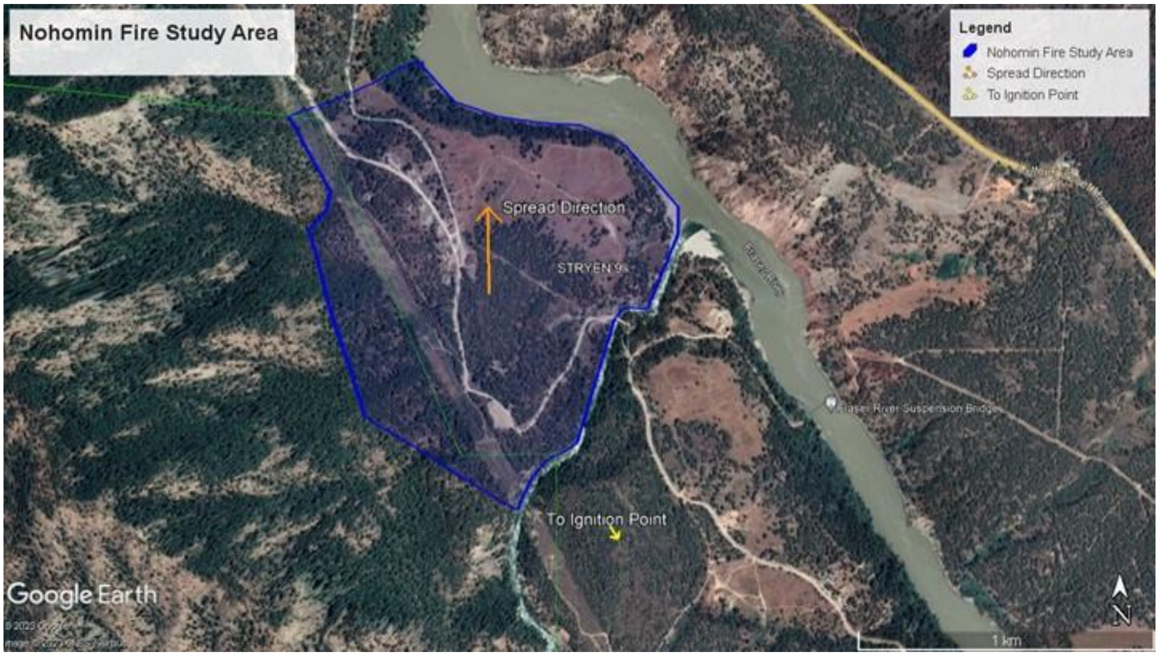


Figure 9. The Nohomin Creek wildfire study area (blue polygon) surrounding the community of Stryen 9 and fire spread direction (orange arrow) at the time of contact with the community fuel treatment. The direction to the ignition point is indicated by the yellow arrow at the bottom of the image.

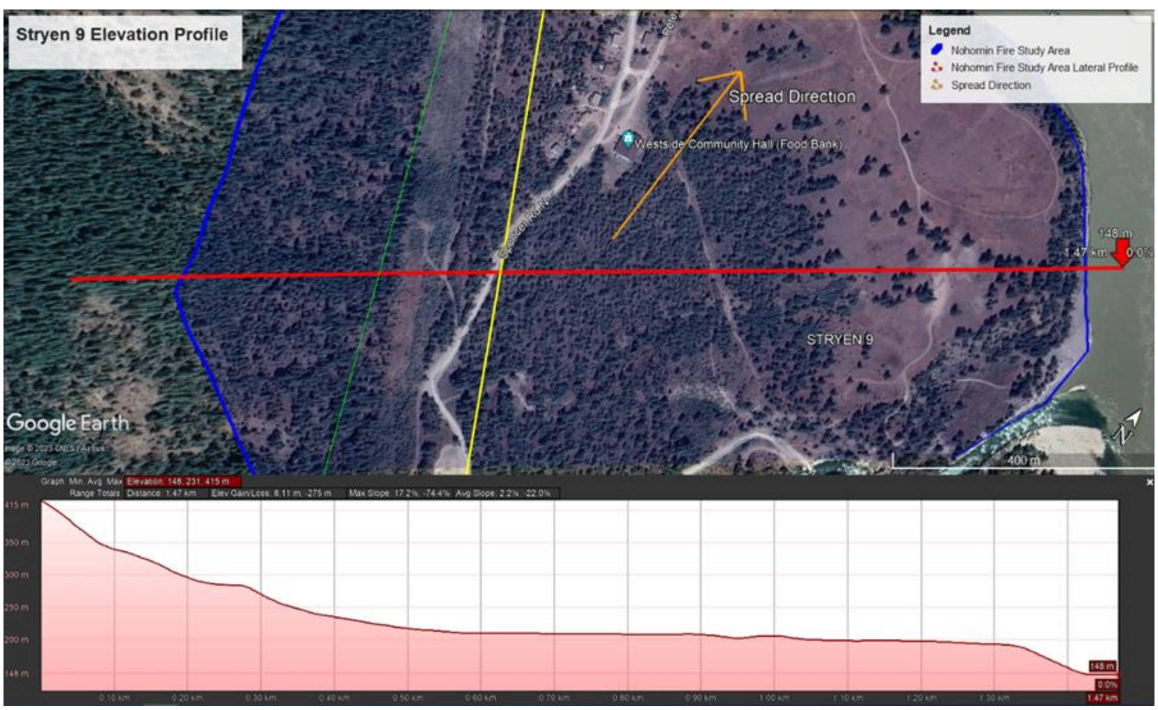


Figure 10. The lateral elevation profile of Stryen 9 showing the nearly-level topography of the community.

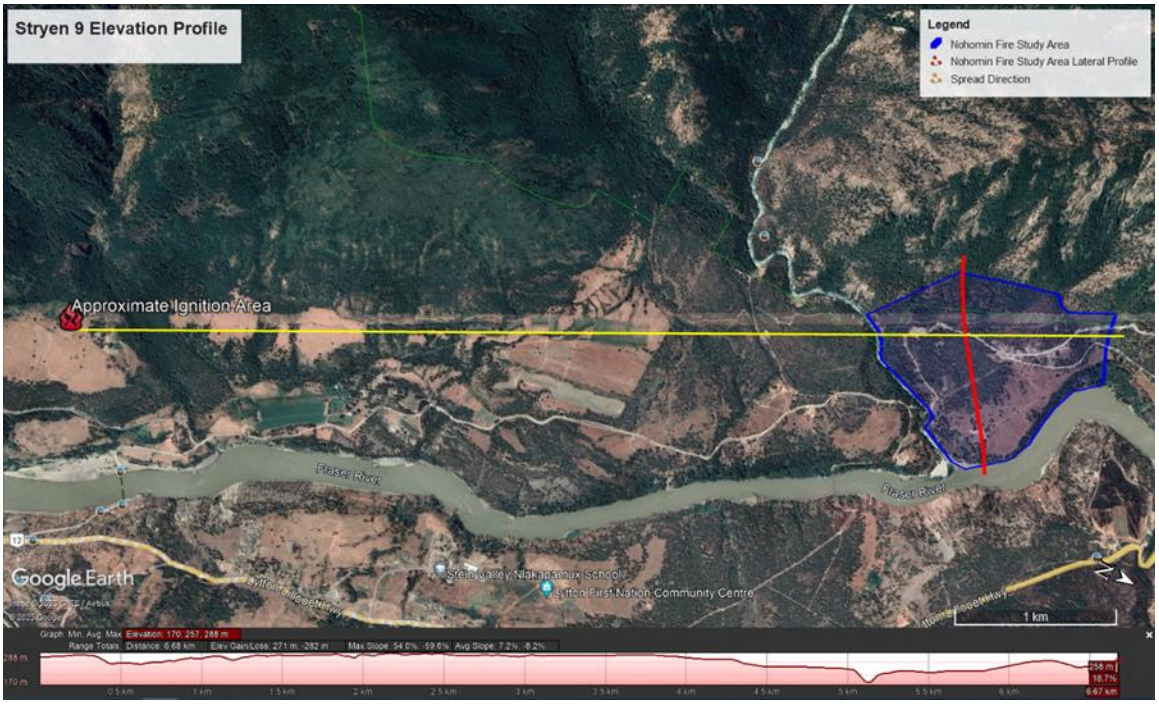


Figure 11. The elevation profile (top image) from point of origin north northwest towards the community of Stryen 9 (left to right). The topographical low at approximately 5 km indicates the Stein River. The elevation profiles have been adjusted to show no vertical exaggeration.

Figure 12. Valley bottom looking north towards the community of Stryen 9. The south aspect slope of the Stein River valley, part of Stein Mountain, can be seen in the upper left of the photo.

5 DISCUSSION

5.1 Analysis of Fire Behaviour

The fire behaviour of the Nohomin Creek wildfire was a combination of vigorous surface fire with intermittent crowning. The angle of the smoke column observed from aerial photos suggests a wind-dominated column and wind-driven growth for much of the burning period (Figure 13). During peak burning, at 1600 h, the intensity increased such that the fire became column-dominated and continuous crowning occurred. Intermittent periods of continuous crowning are noted by completely consumed canopies, seen in both the aerial photographs as well as in the post-fire analysis of crown consumption.

Figure 13. Winds from the western valley mixing with the dominant southern winds, driving the fire north (Left). The fire transitioned to column-dominated during an increase in burning intensity at approximately 1600 h (Right). Photographs courtesy of the BCWS.

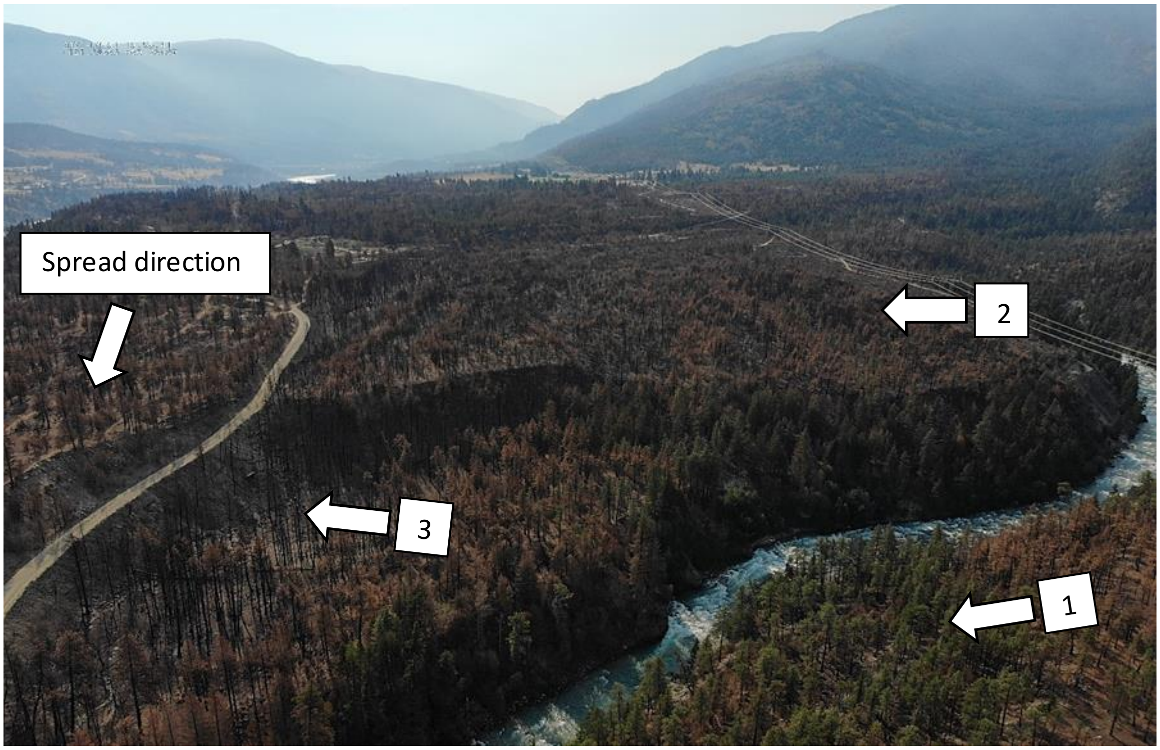


Figure 14. Aerial imagery looking south at contrasts in fire intensity observed on opposites sides of the Stein River: (1) indicates surface fire, (2) intermittent crowning, and (3) continuous crowning.

Figure 15. Looking northeast at the fuel treatment area between the Stein River and the gravel road bordering Stryen 9.

Reviewing the post-fire aerial imagery (Figure 14), the fire achieved peak burning intensity before jumping the Stein River (arrow 3), as indicated by the charred tree stems with no remaining needles. Upon crossing the Stein River (Figure 15), the fire entered a treated fuel area where it burned up a short, terraced slope and into a gravel road, spotting over the fuel-free areas in rapid succession (Figure 16).

Two major landscape features appear to have influenced fire behaviour as the wildfire interacted with the fuel treatments surrounding Stryen 9. First, down-valley west winds generated in the Stein valley would have altered the fire spread direction such that the fuel treatment was encroached by flanking fire. Second, the roadways would have interrupted fire spread and reduced the potential for the fire to build in intensity.

Post-fire aerial photography of Stryen 9 shows significantly more green canopies in the fuel treated zones immediately south of the community centre, suggesting fire activity was reduced to a surface fire when compared to the elevated severity and intermittent crowning immediately to the east. Aerial photography taken during the incursion into the community suggests that the community was not hit directly by the head of the fire (Figure 17), but rather a flank fire of low to moderate surface intensity.

Figure 16. Aerial photo looking northward towards the community of Stryen 9 showing the mixed severity of the fire delineated by the border of green canopies (image centre). The network of gravel pathways, surface fuel reduction, overstory thinning, and indirect passage of the fire maintained the fire on the forest floor such that buildings in the community were undamaged.

Figure 17. At 2038 h, following the initial fire passage, the flanking fire can be seen interacting with the fuel reduction treatment surrounding Stryen 9. Photograph courtesy of the BCWS.

Fire behaviour predictions were calculated using the 1700 h data from the Splintlum weather station on July 14, 2022 (Table 2). The post-fire aerial imagery (Figure 16) shows the contrast in treated (left half, green canopies) and untreated (right half, orange/black canopies) stands. As predicted, the untreated ponderosa pine fuels show scorched canopies (orange needles) and approximately 1/5 of the crown removed (black stems with no needles).

Table 2. Predicted fire behaviour at 1700 h in standard C-7 fuels.

Parameter	Value
FFMC	93.6
BUI	111
Wind Speed	19 km/h
Crown Fraction Burned	17 %
Head Fire Equilibrium Rate of Spread	9.11 m/min
Head Fire Type	Intermittent Crowning
Head Fire Intensity Class	5
Critical Surface Intensity	6740 kW/m
Head Fire Energy Output	7730 kW/m
Flank Fire Intensity	1636 kW/m
Flank Fire Type	Surface
Flank Fire Intensity Class	3

The fuel treatment area retained a significantly higher proportion of green canopies, indicating a reduced fire intensity when the fire passed through. Regardless of whether it was inside or outside the fuel treatment areas, needle litter and duff were consumed, as noted during the post-burn field assessment; the duff layer was only 2 to 4 centimetres deep. As suggested by the visible delineation between green and orange canopies in the middle of Figure 16, the fuel treatment area experienced reduced surface fire behaviour such that the needles in the canopy of the treated area were undamaged by the surface fire beneath.

What remains unclear is whether a direct impact of the fire's head on the fuel treatment would have yielded the same results as the "glancing blow" that Stryen 9 experienced. The calculated head fire energy output for the untreated conditions is 7730 kW/m, which corresponds to an Intensity Class 5 fire, where direct engagement from ground suppression is deemed ineffective (and unsafe). This also exceeds the critical surface intensity of 6740 kW/m, where the fire would have sufficient energy to climb into the forest crown in a typical C-7 stand. By contrast, flanking fire intensity was calculated to be 1636 Kw/m, an Intensity Class of 3, which is insufficient to exceed the critical surface intensity to initiate crown involvement. This kept the fire on the surface and significantly reduced its capability to jump even small fuel free zones, such as a quad path.

5.2 Fire Management Approach

The Nohomin Creek wildfire created logistical fire management issues due to timing and location. Being situated just to the west of Lytton and across the Fraser River, there are three ways to access the community and the fire area without flying: ferry transportation, a walking bridge, or an hour-plus drive via Lillooet. At the time of ignition there were only two access routes: the gravel road from Lillooet and the walking bridge (the ferry was shut down on this date). The drive from Lillooet via the Texas Creek road is slow; the road follows the Fraser River and is narrow and winding. Thus, only helitankers and airtankers could action the fire quickly, and ground resources were delayed from arriving and taking immediate action. This situation provided an opportunity to document fire behaviour within a fuel treatment that was not substantially impacted by timely fire management activities. This fire did not burn over several days and then move into fuel treatments; it ignited, spread quickly, and within the first burn period encountered a fuel treatment without having fire management efforts significantly impact how, and where, the fire spread.

Initial fire response focused on advising the public of the fire situation and initiating a door-to-door notice of evacuation. Few suppression activities took place on the first day. Aerial attack did complete several retardant drops as documented in the photographs, and timestamps show these drops occurred before 1600 h along the east side of the fire. No aerial drops occurred around the Stryen 9 fuel treatment.

6 CONCLUSION

The Nohomin Creek wildfire (K70580) was as close an example of a wildfire encountering an established fuel treatment with little to no influence from fire fighting resources that we may have the opportunity to document. Because there were fewer variables involved, FPInnovations was able to document the change in fire behaviour that occurred primarily as a result of the changes made to stand structure and surface fuel loading in the fuel treatment.

To review, the fire spread in grass fuels, through agricultural land and the into C-7 fuels. It grew quickly and escaped any chance of containment by locals or the BCWS. Fire behaviour fluctuated from areas of aggressive surface fire to intermittent crown fire until it moved into the fuel treatment. The Nohomin Creek wildfire was a wind-driven fire that increased in intensity to a column-driven fire later in the day.

The fire crossed the Stein River, moved up out of this small valley, and then encountered a gravel road and the existing fuel treatment on the south side of the community. There was a notable difference in burn severity from the south side of the Stein River to the north side. The river acted as a barrier to fire spread, and the continued fire spread on the north side would have been likely due to firebrand transfer and spot fire development in the fuel treatment areas on the north side of the river. The fire then moved into the treatment area and was restricted to lower intensity surface fire with some isolated candling.

Firsthand observations from responding fire personnel attested to the reduced fire behaviour within the treated area compared to the fire behaviour in untreated stands. There was agreement amongst fire personnel that the reduced intensity levels were unlikely to cause impact to structures. In fact, no structures were lost in Stryen 9 due to the wildfire.

While different circumstances would be required to know if this fuel treatment would have withstood a direct impact from the fire, it is clear this fuel treatment was effective in mitigating structural damage from the fire behaviour it did receive on this day.

7 REFERENCES

British Columbia Wildfire Service. (2023). 2023 Fuel Management Practices Guide. British Columbia Wildfire Service. 63 pp. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/prevention/fire-fuel-management/fuels-management/2023_fuelmanagementpracticesguide_final_2023-june-06.pdf

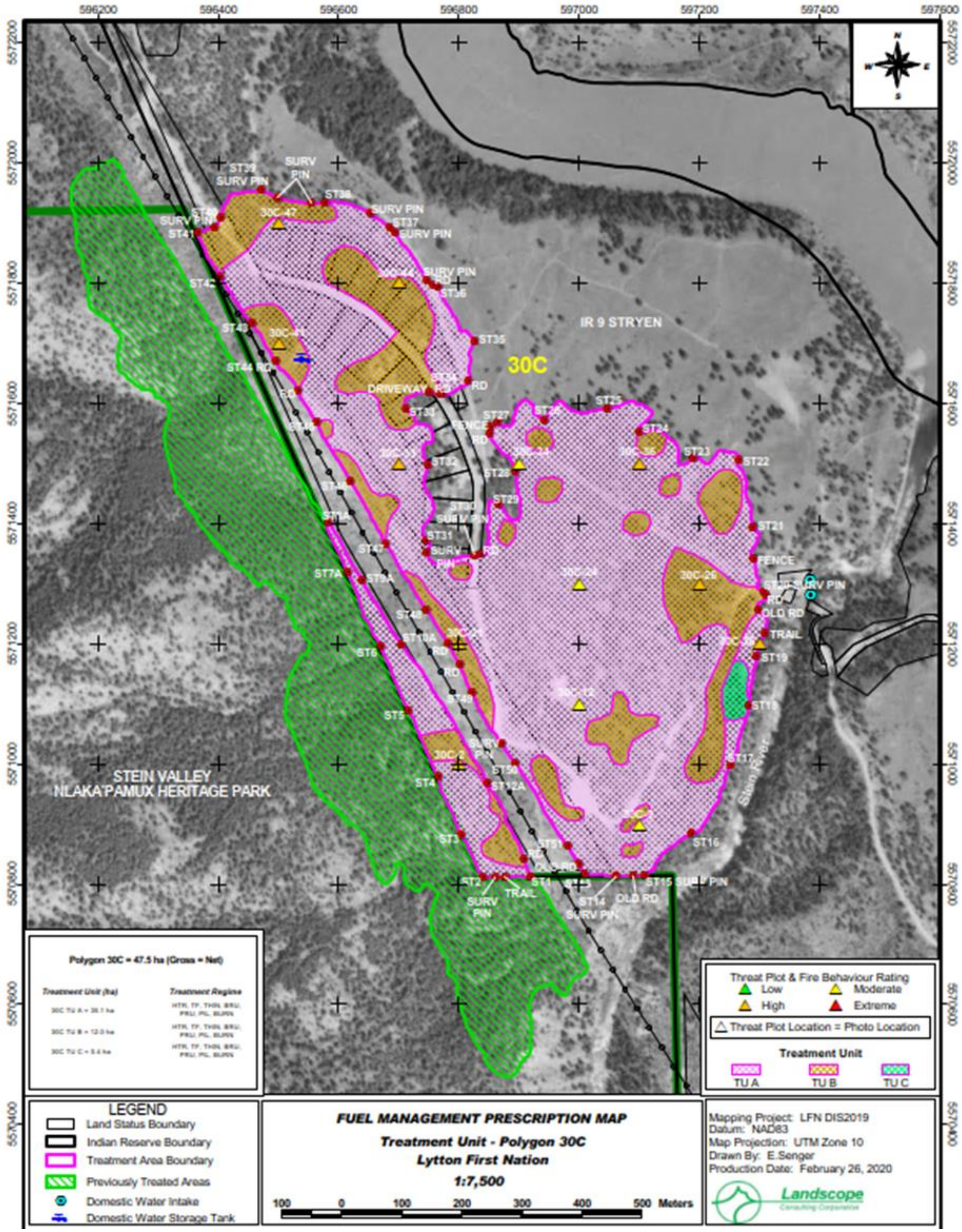
Forestry Canada Fire Danger Group. (1992). Development and structure of the Canadian Forest Fire Behavior Prediction System [Information Report ST-X-3]. Hull, QC: Forestry Canada. Retrieved from https://cfs.nrcan.gc.ca/publications?id=10068

Landscope Consulting Corporation (2020). Lytton First Nation Fuel Management Prescription – Polygon 30C.

Meidinger, D. & Pojar, J. (1991). Ecosystems of British Columbia. British Columbia Ministry of Forests. 330 pp. http://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/SRseries.htm

Van Wagner, C.E. (1987). Development and structure of the Canadian Forest Fire Weather Index System. Canadian Forest Service. Ottawa, Ontario. Forest Technology Report Number 35.

8 APPENDIX A: FUEL TREATMENT MAP



www.wildfire.fpinnovations.ca
Wildfiregroup@fpinnovations.ca

OUR OFFICES

POINTE-CLAIRE
570 Saint-Jean Blvd.
Pointe-Claire, QC
Canada H9R 3J9
(514) 630-4100

VANCOUVER
2665 East Mall
Vancouver, BC
Canada V6T 1Z4
(604) 224-3221

QUÉBEC
1055 rue du P.E.P.S.
Québec, QC
Canada G1V 4C7
(418) 659-2647

EDMONTON
11810 Kingsway Ave, NW.
Edmonton, AB
Canada
T5G 0X5