Avalanche Hazard Reduction
By Burlington Northern Santa Fe Railway
In Glacier National Park and Flathead National Forest, Montana
Draft Environmental Impact Statement

Waterton-Glacier International Peace Park, National Park Service
U.S. Department of the Interior

Flathead National Forest, National Forest Service
U.S. Department of Agriculture

Montana State Department of Transportation

October 2006

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National Park Service-Waterton Glacier International
Peace Park
United States Forest Service-Flathead National Forest
Montana Department of Transportation

Flathead and Glacier Counties, Montana
September 2006

ABSTRACT

The purpose of this *Draft Environmental Impact Statement* is to analyze a proposal by Burlington Northern Santa Fe Railway (BNSF) to use explosive avalanche hazard reduction in Glacier National Park between railroad mileposts 1159 and 1164 for the protection of BNSF property, personnel, freight, and Amtrak passengers. Glacier National Park, Flathead National Forest, and Montana Department of Transportation are cooperating agencies on this draft environmental impact statement (DEIS). This DEIS presents four alternatives addressing explosive and non-explosive avalanche hazard reduction actions on Glacier National Park lands, Flathead National Forest lands, and within the adjacent BNSF and US Highway 2 transportation corridor. Alternative A: No Action is the *status quo* alternative that addresses the consequences of continuation of the current conditions. Alternative B is the Preferred Alternative and the Environmentally Preferred Alternative and recommends that BNSF construct less than one mile of snowsheds with no explosive use permitted. Alternative C permits limited explosive use to reduce avalanche hazard for up to 10 years upon a commitment from BNSF to construct recommended snowsheds. Alternative D is the BNSF proposal to use explosives (including military artillery) indefinitely in the park for avalanche hazard reduction and includes the extension of two snowsheds.

This *Avalanche Hazard Reduction, John F. Stevens Canyon, Montana Draft Environmental Impact Statement* has been prepared in accordance with the National Environmental Policy Act and analyzes the natural, cultural and socioeconomic consequences of each alternative. Our practice is to make comments, including names, home addresses, home phone numbers, and email addresses of respondents, available for public review. Individual respondents may request that we withhold their names and/or home addresses, etc., but if you wish us to consider withholding this information, you must state this prominently at the beginning of your comments. In addition, you must present a rationale for withholding this information. This rationale must demonstrate that disclosure would constitute a clearly unwarranted invasion of privacy. Unsupported assertions will not meet this burden. In the absence of exceptional, verified circumstances, this information will be released. We will always make submissions from organizations or businesses, and from individuals identifying themselves as

representatives of or officials of organizations or businesses, available for public inspection in their entirety.

If you wish to comment on the draft environmental impact statement, you may post comments online at http://parkplanning.nps.gov/ or mail comments to Superintendent Glacier National Park, Attn: Avalanche Hazard DEIS, P.O. Box 128, West Glacier, Montana 59936. This DEIS will be on public review for 60 days.

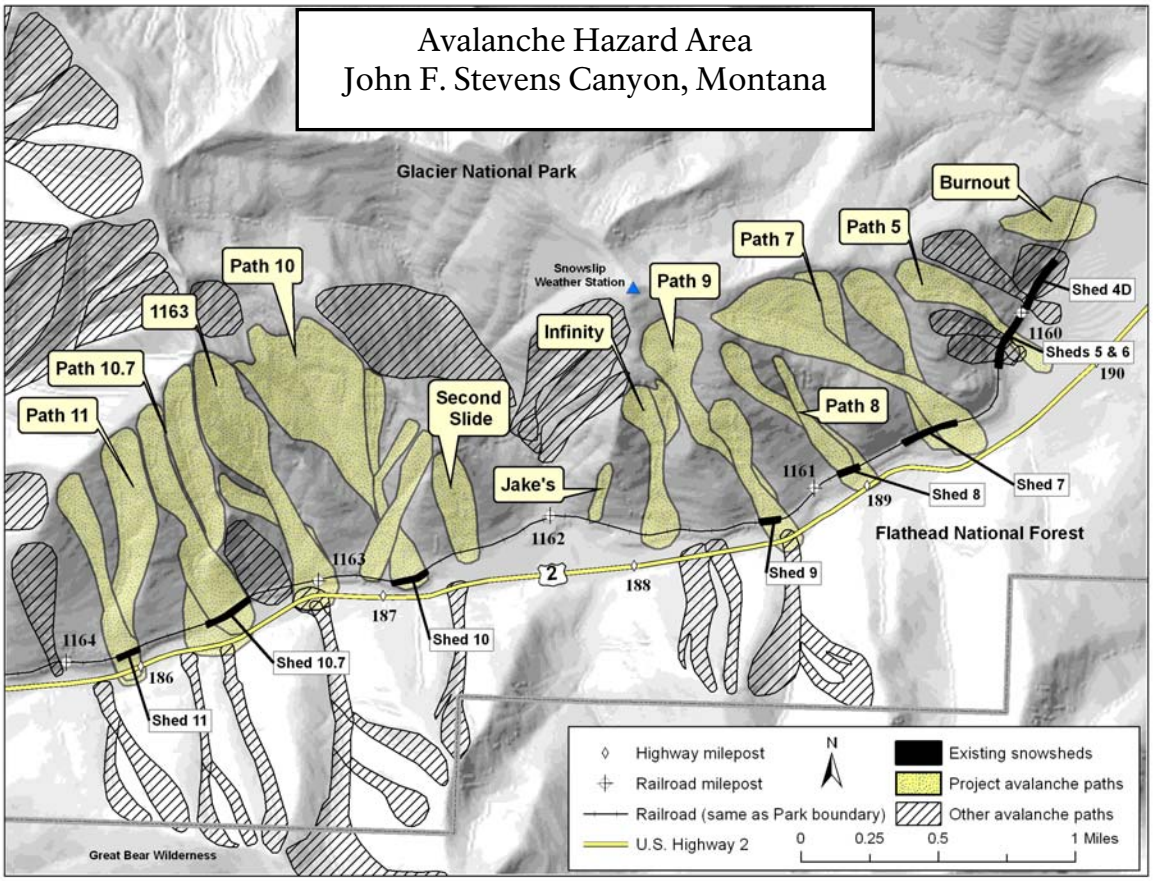
Cover Photo by Dave Panebaker
1979 Avalanche Cycle

EXECUTIVE SUMMARY

INTRODUCTION

Burlington Northern Santa Fe Railway (BNSF) has requested a special use permit from Glacier National Park (GNP) to use explosive avalanche hazard reduction in the park for the protection of BNSF employees, Amtrak train passengers, freight, and equipment along the southern boundary of GNP through John F. Stevens Canyon. Additionally, BNSF wants to reduce avalanche caused interstate commerce delays along the route. Historically the railroad constructed snowsheds in this area to protect trains. Eight of the original nine snowsheds remain, but do not provide adequate protection.

Explosive use for avalanche hazard reduction would be an unprecedented action in GNP, and the park has many serious concerns about impacts to park values, including winter wildlife habitat, threatened and endangered species, natural sound, and recommended wilderness. However, the park concurs that there are avalanche hazard safety issues in this area and agreed to consider and analyze BNSF's proposal as well as a range of alternatives. This draft Environmental Impact Statement (EIS) was prepared to analyze the impacts of the proposal and alternatives. The Flathead National Forest (FNF) and Montana Department of Transportation (MDT) are cooperating agencies on this environmental impact statement.



On January 28, 2004, during an avalanche cycle, the railroad through John F. Stevens Canyon was blocked by several avalanches for 29 hours. The avalanches originated in starting zones within GNP. During this storm an empty, 119-car freight train was hit by an avalanche and derailed. While it was stopped, it was hit by another avalanche from an adjacent path that derailed more cars. A third avalanche just missed cleanup crews and a fourth slide hit a truck traveling along US Highway 2 below the railroad. BNSF requested an emergency special use permit to perform immediate explosive avalanche control within the canyon. The park, after much consideration, issued a 3-day emergency permit for this activity. The snow stabilized and explosive use was not necessary. BNSF was informed that future explosive avalanche hazard reduction would require the preparation of an Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA). BNSF requested another special use permit for emergency explosive use in February 2006 during the EIS preparation period. The park issued a 3-day emergency permit and a helicopter was used to deliver 10 explosive charges. Very little avalanche activity was triggered and the operation was cancelled once the Avalanche Safety Director determined that the snowpack had stabilized naturally.

After the January 2004 incident, BNSF contracted Chugach Adventure Guides to analyze the avalanche hazard in the canyon. Their report *Avalanche Risk Analysis John Stevens Canyon, Essex, Montana* (Hamre and Overcast 2004; Appendix A) identifies the avalanche potential for 14 avalanche paths along the railroad. Avalanche paths are dynamic in nature, widening and narrowing with vegetation removal or growth. Seven avalanche paths are partially protected by existing snowsheds because the avalanche paths have widened and the snowsheds are too short. These seven snowsheds could be extended to provide adequate coverage through avalanche zones. Five of the avalanche paths in the analysis do not have snowsheds and two of the paths were not determined to be a hazard to railroad traffic due to the low frequency of avalanche occurrence. The report defines avalanche hazard reduction alternatives including explosive avalanche hazard reduction and snowshed construction. The report states that the snowshed construction alternative would decrease avalanche risk most effectively providing 24-hour protection of the tracks.

In addition to snowshed construction in the previous century, BNSF has been proactive in implementing avalanche reduction measures that have not required federal, state or local permits. BNSF has instituted an avalanche awareness program including forecasting, non-explosive stability testing, weather data collection, employee avalanche awareness and rescue training. However, BNSF has determined that these safety measures are insufficient and the costs of delayed railroad traffic during periods of high snow instability would be too great to incur. They have requested a special use permit from GNP for a permanent explosive avalanche hazard reduction program including the use of military artillery. According to BNSF, this is necessary to protect increasing train numbers and intercontinental freight lines. This request is analyzed as Alternative D in this document.

Issues and Concerns

Public scoping began with a scoping letter sent to a mailing list compiled by GNP and FNF staff on May 17, 2005. Public open houses were held in Essex, Montana on May 25, 2005 and in Kalispell, Montana on May 26, 2005. The public scoping process ended on July 22, 2005 and GNP received 954 written comments concerning the BNSF request for explosive use. Concerns and issues raised by the public meetings and comments are listed below.

Wilderness

Weather station installation under Alternatives B, C, and D would be on recommended wilderness lands in GNP. The explosive use in Alternatives C and D would occur in starting zones within GNP recommended wilderness resulting in recreational closures, impacts on natural soundscape, and possible removal of the area from wilderness area recommendation if a continuous explosive program were permitted. Placing fixed structures in recommended wilderness would be against National Park Service (NPS) policy.

Threatened and Endangered Species and other Wildlife

Winter wildlife observations in the project area were conducted during 2005 and 2006. Federally listed threatened and endangered species (gray wolves, grizzly bears, bull trout Canada Lynx, and bald eagles) were observed and have been known to occur in the project area. A number of state listed species also occur in the project area. In addition, this area serves as winter range for ungulate species.

Avalanche Risk to Human Safety and Trains

Avalanche caused fatalities, train derailments, and equipment damage have contributed to BNSF's request for explosive use. The railroad has implemented non-explosive measures to protect their equipment, employees and freight. Hamre and Overcast (2004) recommend several alternatives including snowshed construction and explosive use to reduce the risk of avalanche caused incidents by 80-90%. These alternatives form the basis for some of the alternatives discussed in this document.

US Highway 2

MDT raised concerns about BNSF shooting explosives from the US Highway 2 corridor and impacts on highway traffic from avalanche hazard reduction activities and snowshed construction.

Use of Explosives in Glacier National Park

Most of the public scoping comments expressed concern about the appropriateness of explosive use, especially military artillery, in GNP. Concerns about the compatibility of explosive use with park values, wilderness, and federal law were raised. Impacts on wildlife, threatened and endangered species, vegetation, water quality, air quality, natural sound, visitor experience, and recreation were also raised.

Wildlife Crossings

Public comments raised the issue of incorporating wildlife crossings into BNSF snowshed designs.

Public Use and Experience

The public raised concerns about explosive noise, visitor safety, unexploded ordnance and restrictions on public use of the area. The public lands between Marias Pass and Essex, Montana are popular for backcountry skiing, snowshoeing, and snowmobiling. Commercial and private recreational trips may be affected by road and trail closures in some alternatives.

Scenic Resources

The US Highway 2 corridor is managed as part of the Northern Continental Divide Scenic Loop. Both sides of US Highway 2 are surrounded by steep mountainous terrain that contributes significantly to the beauty of the area. Explosive use could affect rock outcrops or vegetation along the corridor. Fixed explosive equipment such as blaster boxes or Avalhex

systems may be visible from the roadway. New snowsheds and snowshed extensions may change views from the highway and the railroad as people travel through the area.

Socioeconomics

BNSF Railroad has expressed concern about the economic ramifications of delaying train traffic for long periods during periods of high avalanche danger as well as the high costs of snowsheds. Other economic concerns of the railroad are the cost of equipment loss, derailments, spill cleanup, and time sensitive commodities transported on the railroad.

Issues and Concerns Dismissed from Further Analysis

The following issues and concerns were raised during the scoping and EIS preparation process, but were determined to be beyond the scope of the EIS.

- Naturally occurring avalanche threat to US Highway 2
- Explosive avalanche hazard mitigation in national forests and other national parks
- Fire suppression in John F. Stevens Canyon
- Avalanche hazard mitigation on other railroads
- Global and regional climate change

ALTERNATIVES

Avalanche hazard reduction methods considered in this document include explosive technology, snowshed construction, weather data collection, avalanche forecasting, stability testing, avalanche detection technology, railroad delays and restrictions.

Alternative A: No Action

There would be no BNSF action permitted by the NPS. No explosive use would be permitted in Glacier National Park. BNSF would maintain eight existing snowsheds. No new avalanche hazard reduction structures would be built on park or forest lands. Avalanche signal wire would continue to be maintained for avalanche detection on the railroad. The Avalanche Safety Director (ASD) would use avalanche forecasting and weather data collection to make recommendations to BNSF concerning delays or restrictions on the railroad.

Alternative B: Glacier National Park, Flathead National Forest, and Montana Department of Transportation would recommend that BNSF construct or modify snowsheds (*Preferred Alternative*)

Under Alternative B, GNP, FNF, and MDT would recommend that BNSF build snowsheds in paths without adequate protection. The recommendation for snowshed construction is based on the report *Avalanche Risk Analysis John Stevens Canyon, Essex, Montana* (Hamre and Overcast 2004). Five new snowsheds, approximately 3,540 feet, would be constructed. Seven avalanche paths have grown wider than the area protected by existing snowsheds. Seven existing snowsheds would be extended a total of 1,500 feet for full avalanche path protection. The total amount of snowshed construction of new and extended snowsheds would be approximately 5,040 feet. Avalanche forecasting, non-explosive stability testing, and railroad restrictions would reduce avalanche hazard during snowshed construction. No explosive use would be permitted in Alternative B. Glacier National Park would grant a

permit for emergency explosive use in the event that human lives and or resources are at risk and all other options have been exercised by BNSF.

Alternative C: Glacier National Park, Flathead National Forest, and Montana Department of Transportation would recommend that BNSF construct or modify snowsheds. Glacier National Park would issue BNSF a 10-year special use permit for explosive avalanche hazard reduction during snowshed construction.

Under Alternative C, GNP, FNF, and MDT would recommend that BNSF build snowsheds in paths without avalanche protection. Five new snowsheds, approximately 3,540 feet, would be constructed. Seven existing snowsheds would be extended approximately 1,500 feet. A total of 5,040 feet of snowsheds would be constructed if the recommendations were followed from the report *Avalanche Risk Analysis John Stevens Canyon, Essex, Montana* (Hamre and Overcast 2004). Upon receipt of a BNSF commitment to construct snowsheds, GNP would issue a special use permit for up to ten years permitting explosive use in the park and along the US Highway 2 corridor while snowsheds are being constructed. The permit period would be decreased depending on the number of snowsheds to which BNSF commits. The permitted explosive delivery methods would be handcharges, Avalauncher, helicopter delivery, Avalhex type systems, and/or blaster boxes. RECCO tracking devices would be required on all explosive charges so that unexploded charges could be found quickly. Military artillery would not be permitted due to incompatibility with park values, shrapnel left in start zones, large noise footprint from the propellant explosion at the gun and ammunition detonation in the start zone, and the possibility for unexploded ordnance. The Avalhex type systems and/or blaster boxes would be temporarily installed in high elevation start zones. Infrasonic avalanche detection systems or geophone systems would be permitted within GNP or FNF lands.

Explosive use would depend on defined avalanche hazard conditions (Table 2-1). Past weather data from the past 29 years, shows that avalanche cycle conditions occur on average one to two times per year. Five cycles is the highest number of cycles recorded in one year and this has only occurred once in the 29-year record. Appendix C describes targeted start zones and estimated use of explosives.

BNSF would fund an extensive resource-monitoring program for up to 15 years to determine the impact of explosive use on wildlife, water, soils, vegetation, natural avalanche processes, and natural sound. An interagency technical team would develop monitoring thresholds, which would guide annual permitting and explosive use conditions. The annual permitting and explosive use amounts would be subject to change if impact threshold conditions were exceeded.

Alternative D: Glacier National Park would issue BNSF a special use permit for a permanent explosive avalanche hazard reduction program. (*BNSF Proposal*)

This alternative is the proposal developed and preferred by BNSF with some additions by GNP. A permanent program of explosive avalanche hazard reduction would occur in GNP and involve the use of FNF lands and the US Highway 2 right-of-way. Explosive delivery methods would include military artillery, blaster boxes, Avalhex type systems, helicopter delivery, Avalauncher, and handcharges. BNSF would limit explosive use to three events per year with NPS approval required if storm events exceed this. Up to four asphalt pads and up

to 700 feet of access road would be constructed off the US Highway 2 ROW. The asphalt pads would be used for artillery placement and firing.

BNSF would build extensions on Shed 7 (100 feet) and Shed 9 (150 feet). Shed 7 has the most avalanche hazard and Shed 9 starting zones are difficult to see or reach even with military artillery.

Actions Common to All Action Alternatives

Avalanche forecasting, non-explosive stability testing, and weather data collection are currently being conducted by the BNSF Avalanche Safety Director and are expected to continue in the future. Avalanche forecasting and hazard analysis would continue under all alternatives. A snow depth gage would be installed in the Park at elevation 5,600 feet on the ridge between Shed 7 and Shed 9. A weather station would be installed at milepost 189.8 in the Highway ROW off US Highway 2. The snow depth gage and weather station would provide data for avalanche forecasting. BNSF would delay train travel through the canyon when avalanche danger is high, when avalanche debris crosses the tracks, or explosives are used. Amtrak passengers would be delayed or rerouted around the canyon during periods of avalanche danger. Traffic on US Highway 2 would be delayed during explosive use. Avalanche detection technology such as infrasonic or geophone systems may be installed on FNF or GNP lands.

Environmental Consequences of Alternatives

Impact Topics

The affected environment for each impact topic is described in Chapter 3. The environmental consequences of each alternative are discussed in Chapter 4. The impact topics are avalanche processes, water quality, aquatic species, geology and soils, vegetation, wildlife, threatened and endangered species and species of concern, natural sound, air quality, historic structures, buildings, and landscapes, socioeconomics, human health and safety, wilderness, visual resources, visitor use and experience.

Environmental Consequences of Actions Common to All Alternatives

There is potential for an avalanche caused derailment and hazardous material spill under each alternative. Alternatives A and B (during snowshed construction) would have the greatest potential for avalanche caused derailment of freight or hazardous materials if train delays were not implemented in a timely manner according to elevated avalanche hazard. Snowshed construction under Alternatives B and C would protect avalanche paths and the potential for avalanche caused derailments or hazardous material spills would be nearly nonexistent once snowsheds are completed. The environmental impact of a derailment or hazardous material spill would run a range of effect depending on the substance. The range of adverse impact would be negligible to major, short-term to long-term, site-specific to regional on water resources, aquatic resources, soils, vegetation, wildlife, threatened and endangered species, air quality, socioeconomics, health and safety, wilderness, visual resources, and public use and experience. BNSF would bear all costs associated with a hazardous material spill and cleanup operations.

BNSF avalanche forecasting, non-explosive stability testing, and weather data collection would not have any impact on park or forest resources. Snow depth sensor, avalanche detection system, and weather station installation would include a negligible amount of

vegetation and soil disturbance. Camouflage paint would decrease the visibility of the instrumentation and there would be negligible impacts on visual resources. Installation of fixed structures in recommended wilderness for purposes unrelated to wilderness preservation is against the Wilderness Act and NPS policy, would be a nonconforming use requiring approval.

Environmental Consequences of Alternative A

Alternative A would have no effect on avalanche processes, water resources, aquatic resources, wildlife, threatened and endangered species, natural sound, historic resources, wilderness, visual resources, and public use and experience. Averaged over time, impacts on BNSF socioeconomics would be minor, adverse, and long-term. Most economic impacts from Alternative A result from an average of 7.1 hours of delay time per year from avalanche caused incidents over the past 28 years. Seven avalanche cycles have disrupted train traffic in the past 28 years and each incident has delayed rail traffic an average of 39.6 hours. Delays, rerouting Amtrak traffic, and equipment damage have resulted in minor, adverse, long-term and BNSF-specific economic impacts. If an avalanche caused derailment and consequent cleanup were to occur, costs could greatly increase depending on the substance and difficulty of removal. There would be no impact on US Highway 2 with Alternative A as there would be no explosive use closures delaying or rerouting motorists or freight vehicles. Only natural avalanche hazard would affect the highway with hazard closure procedures.

The greatest impact from Alternative A would be on public health and safety if timely delays or restrictions were not implemented during periods of high avalanche danger and injury or death occurred from an avalanche. The impact on health and safety could be major, adverse, long-term, and site-specific in the event of fatalities. Avalanche forecasting, avalanche safety awareness, and recommended delays or restrictions could eliminate most avalanche risk if continued. In the event of a hazardous material spill, the range of impacts on avalanche processes, water resources, aquatic species, soils, vegetation, air quality, natural sound, socioeconomics, and public use and experience would run the range of negligible to major, adverse, site-specific to regional, and short-term to long-term depending on the substance spilled. The estimated annual cost to BNSF would be $1, 039,000-$1,978,000. BNSF would be responsible for all costs associated with this alternative.

Environmental Consequences of Alternative B (*Preferred Alternative*)

Snowshed construction would disturb soil in already disturbed areas around the railroad. Natural avalanche processes would continue to occur without artificial triggering. Avalanche hazard would continue to occur, causing BNSF to use avalanche forecasting and hazard analysis to impose delays and restrictions while snowsheds are built. Once snowsheds are completed, the railroad would be fully protected and restrictions or delays are not expected to be necessary.

Snowshed construction in Alternative B would have a negligible, beneficial, site-specific, long-term impact on natural avalanche processes, as the natural slope over the railroad would be restored by the snowshed. Water resources would have minor, adverse, site-specific impacts from naturally occurring avalanche debris periodically damming Bear Creek and snowshed construction introducing sediment into the watershed. The decrease in derailment potential from snowshed construction would be a minor, beneficial, long-term, localized impact on aquatic resources. Construction activities are expected to have a minor to moderate, adverse, long-term, site-specific impact on geology, vegetation, wildlife,

threatened and endangered species, air quality, natural sound, wilderness, and public use and experience.

Snowsheds cost from $20,000 to $25,000 a linear foot, according to BNSF, and would have a moderate, adverse, long-term impact on BNSF economics. BNSF would be responsible for all costs associated with snowshed construction under this alternative. While it seems that this impact would be great financially, the benefits of removing the avalanche caused spill potential and eliminating railroad delays would have moderate, long-term, beneficial impacts on BNSF economics. The annual cost of this alternative would be approximately $5,409,000 amortized over a 50-year period. If a local company were to do the work, a minor, beneficial impact to the local economy could occur. There would be an interim period during snowshed construction where public health and safety would rely on avalanche risk being reduced by avalanche forecasting, avalanche safety awareness, and timely delay or restriction implementation. The greatest impact from Alternative B would be on public health and safety if timely delays or restrictions were not implemented during periods of high avalanche danger and injury or death occurred from an avalanche. The impact on health and safety could be as great as major, adverse, long-term, and site-specific with a fatality during snowshed construction. Avalanche forecasting, avalanche safety awareness, and recommended delays or restrictions could eliminate most avalanche risk if continued. Once snowsheds are constructed, the residual risk of avalanche caused incidents would be the lowest when compared with Alternative A and D. Alternative C has the same residual avalanche risk once snowsheds are constructed. There would be no impact on US Highway 2 with Alternative B as there would be no explosive use closures delaying or rerouting motorists or freight vehicles. Only natural avalanche hazard would affect the highway with hazard closure procedures.

The extension of existing snowsheds by 1,500 feet would have a moderate, adverse, long-term, site-specific impact on historic snowsheds and the historic railroad through the canyon. This area is the only known place in the United States where a series of historic, wooden snowsheds still protect a railroad from avalanches. The snowsheds as well as the railroad are eligible for the National Register of Historic Places. A total of 5,040 feet of new snowshed in the canyon would have a moderate, adverse, long-term, site-specific impact on visual resources, as the snowsheds would be readily visible from the wilderness areas as well as in the transportation corridor. This increase in snowsheds coverage would have a minor, beneficial, long-term, site-specific impact on natural sound and wilderness values as train noise would be decreased as trains pass through the snowshed. Impacts on wildlife would be minor to moderate, adverse, site-specific, and long-term if snowsheds impede wildlife movements within avalanche paths or fragment habitat. Wildlife crossings, if incorporated in the snowshed design, could reduce this impact.

Alternative B would have the same potential as Alternative A for an avalanche caused hazardous material spill during the time that snowsheds are constructed. If train delays or restrictions were not implemented in a timely manner, these two alternatives have the greatest potential for an avalanche caused, hazardous material spill. In the event of a hazardous material spill, the range of impacts on avalanche processes, water resources, aquatic species, soils, vegetation, air quality, natural sound, socioeconomics, and public use and experience would run the range of negligible to major, adverse, site-specific to regional, and short-term to long-term depending on the substance spilled. Once snowsheds are built, the potential for an avalanche caused hazardous material spill would be less than Alternative A and D. The estimated annual cost to BNSF would be $1,019,000-$5,739,000.

Environmental Consequences of Alternative C

Alternative C includes the same snowshed construction recommendation as Alternative B; however, there is a provision for GNP to permit temporary explosive avalanche control during the construction period. The permit would last up to 10 years to allow BNSF to reduce avalanche risk by means other than delays or restrictions. The explosive use methods allowed would be hand charges, Avalauncher, helicopter delivery, or Avalhex or blaster box systems. RECCO technology would reduce the potential for impacts to resources from unexploded charges. BNSF would have a choice of explosive use methods to choose from, so the impacts may change depending on their choice of a combination of explosive methods or single explosive method. The impacts from snowshed construction would be the same as those listed above in Alternative B.

The nature of explosive avalanche hazard reduction involves changing natural avalanche processes by increasing the frequency and decreasing the magnitude of natural avalanche events. Explosive avalanche hazard reduction would have a major, adverse, site-specific, long-term impact on natural avalanche processes. Explosive charges would leave residue in start zones that would have a minor, adverse, site-specific, long-term impact on water quality and aquatic species. Changes in natural avalanche processes would have an impact on soil erosion or vegetation caused by changes in natural avalanche disturbance levels.

Sporadic disturbance from explosive use would have a range of impacts on wildlife and threatened or endangered species. Direct impacts include mortality or injury from an explosion or triggered avalanche, physiological changes, flight response, deafness, seismic disturbance, and/or behavioral changes. Indirect impacts include vegetation changes, food or prey availability changes, decrease in reproductive success, habitat fragmentation, loss of habitat connectivity, and changes to critical habitat for threatened or endangered species. The impacts on wildlife are expected to have a range of impacts depending on species and amount of explosive use. There are significant impacts on wildlife associated with explosive use. Resource impacts are expected to return to pre-explosive use conditions after an up to 10-year explosive use program. A 15-year resource-monitoring program would be instituted. The monitored resources would be wildlife, water quality, vegetation, avalanche processes, and natural sound. A five-year post-explosive monitoring would examine the lasting impacts of explosive use and any deviation from pre-program conditions.

Explosive use would introduce a major, adverse, short-term, site-specific impact on natural sound. The natural quiet of wilderness would be interrupted by short bursts of loud explosions. There would be fixed structures for 10 years in wilderness resulting in a moderate, localized, adverse, long-term impact on wilderness values. There would be a safety closure of the immediate project area as well as a closure of US Highway 2 affecting recreational access during periods of high avalanche hazard and explosive use. Both US Highway 2 and the project area closures would have a minor to moderate impact on public use and experience for people using the area. There would be an impact on US Highway 2 with Alternative C as there would be delays or closures, during explosive use times, delaying or rerouting motorists or freight vehicles. This impact would cause irregular delays for up to 10 years. After snowshed construction, there would be no impact on US Highway 2 except during times when natural avalanche hazards threaten the road.

Avalanche forecasting, avalanche safety awareness, and recommended delays or restrictions along with explosive use could eliminate most avalanche risk if continued. Once snowsheds are constructed, the residual risk of avalanche caused incidents would be the lowest when

compared with Alternative A and D. Alternatives B and C have the same residual avalanche risk once snowsheds are constructed. Human health and safety impacts during snowshed construction would be dependent on the Avalanche Safety Director and human fallibility during forecasting and avalanche hazard assessment. There is always a residual risk due to uncertainty of explosive mitigation effectiveness, especially considering wet snow avalanche events, which historically predominate in the analysis area. Impacts on human health and safety run the range of impact intensity, duration, and magnitude depending on timely delays, explosive mitigation, and exposure reduction.

Timely delays for avalanche hazard, explosive mitigation, and exposure reduction would prevent a hazardous material spill. In the event of a hazardous material spill, the range of impacts on avalanche processes, water resources, aquatic species, soils, vegetation, air quality, natural sound, socioeconomics, and public use and experience would run the range of negligible to major, adverse, site-specific to regional, and short-term to long-term depending on the substance spilled. Once snowsheds are built, the potential for an avalanche caused hazardous material spill would be less than Alternative A and D.

This alternative would be the most expensive alternative as the snowshed cost is $20,000 to $25,000 a linear foot and the explosive program (including the resource monitoring program) would cost an additional $2,543,500. The estimated annual cost of this alternative would be $8,139,200 with snowshed amortization over 50 years and a 10-year explosive period. BNSF would be responsible for all costs associated with snowshed construction, resource monitoring, and agency operational administration. While it seems that this impact would be great financially, the benefits of removing the avalanche caused spill potential and eliminating railroad delays would have moderate, long-term, beneficial impacts on BNSF economics. Train delay costs under this alternative would be less than in Alternative A or B, where natural snow stabilization processes would take longer. The socioeconomic impacts of this alternative would be minor to moderate, adverse, BNSF-specific, and long-term. The estimated annual cost to BNSF would be $2,034,000- $8,139,200.

Environmental Consequences of Alternative D

Compared to the other alternatives (after snowshed completion under Alternative B and C), Alternative D would have a relatively high residual risk that would continue indefinitely with a continuous program of explosive use. There is always a residual risk due to uncertainty of explosive mitigation effectiveness, especially considering wet snow avalanche events, which historically predominate in the analysis area. The impact on human health and safety would range from negligible to major, adverse or beneficial, site-specific, and short-term or long-term depending on accidental death or injury due to avalanche caused incidents that were not accurately predicted. Another cause of injury or death could be unexploded ordnance. Area closures would be used to mitigate this safety issue.

A continuous program of explosive use would have a major adverse impact on natural avalanche processes, changing frequency and magnitude of natural slides. Vegetation and soils would have minor to moderate, adverse, long-term, site-specific impacts from altered avalanche processes. Water resources would have a minor, adverse, site-specific impact from explosive use residue from long-term explosive use. Continuous explosive use would introduce a major, adverse, long-term, site-specific impact on natural sound. Artillery use would increase the sound footprint as two explosions occur, the propellant detonation near the gun in the valley bottom and the detonation explosion in the starting zone.

The natural quiet of wilderness would be interrupted by short bursts of loud explosive sound. Fixed structures in the starting zones would have a major adverse impact on wilderness and the continuous program of explosive use would impact the recommended wilderness status for designation. Shrapnel from military ordnance would be present in recommended wilderness starting zones and would be very difficult to remove. There would be a safety closure of the immediate project area as well as a closure of US Highway 2 affecting recreational access during periods of high avalanche hazard and explosive use. Both US Highway 2 and the project area closures would have a minor to moderate impact on public use and experience for people using the area. The possibility of unexploded ordnance in the project area would necessitate a year-round closure of the area. There would be an impact on US Highway 2 with Alternative D as there would be annual explosive use closures delaying or rerouting motorists or freight vehicles.

The sporadic disturbance from explosive use would have a range of impacts on wildlife and threatened or endangered species. Direct impacts include mortality or injury from an explosion or triggered avalanche, physiological changes, flight response, deafness, seismic disturbance, and/or behavioral changes. Indirect impacts include vegetation changes, food or prey availability changes, decrease in reproductive success, habitat fragmentation, loss of habitat connectivity, and changes to critical habitat for threatened or endangered species. The continuous use of explosives could drive populations of animals from the winter range, effectively changing the ecosystem. There is a slight chance that unexploded ordnance could spontaneously detonate possibly injuring or killing wildlife close to the blast. The impacts on wildlife are expected to have a range of impacts depending on species and amount of explosive use. There are significant impacts on wildlife associated with explosive use. Wildlife impacts are expected to continue indefinitely under a continuous explosive use program.

Extension of Sheds 7 and 9 would add 250 feet of new snowshed to the area and these would be difficult to distinguish from the existing snowsheds. Extensions on Sheds 7 and 9 would have a moderate impact on historic snowsheds and the railroad landscape. Mitigation would be required to reduce the adverse, long-term impacts affecting National Register eligibility. There would be substantially less visibility of new snowsheds under Alternative D than there would be under Alternative B and C. The impacts of Alternative D on visual resources would be negligible.

Although Alternative D is substantially less expensive than Alternatives B and C, which include snowshed construction, the impacts to natural resources in the project area are greater and would be permanent. BNSF would be responsible for all costs of an indefinite explosive use program and agency operational administration. The economic impacts to BNSF of Alternative D are minor, adverse, and long-term.

Alternative D would have potential for an avalanche caused hazardous material spill if human error occurs in avalanche hazard assessment. Timely delays for avalanche hazard, explosive mitigation, and exposure reduction would prevent a hazardous material spill. This alternative is the least expensive method of reducing the potential of avalanche caused derailments or spills. In the event of a hazardous material spill, the range of impacts on avalanche processes, water resources, aquatic species, soils, vegetation, air quality, natural sound, socioeconomics, and public use and experience would run the range of negligible to major, adverse, site-specific to regional, and short-term to long-term depending on the substance spilled. The estimated annual costs to BNSF would be $1,304,000- $2,287,400.

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LIST OF ABBREVIATIONS AND ACRONYMS

AGL	Above-ground level
AHI	Avalanche Hazard Index
ANFO	Explosive mixture of ammonium nitrate and fuel oil
ASD	Avalanche Safety Director
BA	Biological Assessment
BEPA	Bald Eagle Protection Act
BIMS	Bear Information Management System
BMP	Best Management Practice
BNSF	Burlington-Northern Santa Fe Railway
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DPS	Distinct Population Segment (wolves)
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FE	Endangered under federal Endangered Species Act
Forest, FNF	Flathead National Forest
FT	Threatened under federal Endangered Species Act
GMP	Glacier National Park's General Management Plan
HA	EPA Health Advisory standards
HCP	Habitat Conservation Plan
IGBG	Interagency Grizzly Bear Guidelines
ITP	Incidental Take Permit
MDT	Montana Department of Transportation
MP	Railway mileposts
MS	Management Situation (grizzly bears)
MSC	Montana Special Concern Species
MT	Montana
NCDE	Northern Continental Divide Ecosystem
NEPA	National Environmental Policy Act
NFS	National Forest System
NIOSH	National Institute of Occupational Safety and Health
NOI	Notice of Intent
NPS	National Park Service
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromic hydrocarbon (water quality)
Park, GNP	Glacier National Park
PDO	Pacific Decadal Oscillation
pers. comm.	Personal communication
PIF	Partners in Flight
PM_{10}	fine particulate matter (air quality)
RDX	Cyclotrimethylene trinitramine
RECCO	Reflector system used to retrieve items under snow

ROS	Rain-on-snow weather event
ROW	Right-of-way
RP	Highway reference posts
SHPO	State Historic Preservation Office
SNOTEL	Snowpack Telemetry Systems
SP	Soluble phosphorous
SRP	Soluble reactive phosphorous
SWE	Snow water equivalents
TKN	Total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TNT	2,4,6-trinitrotoluene
TP	Total phosphorous
USDA	United States Department of Agriculture
USDOI	United States Department of Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Trans Mercator coordinate system
Vpd	Visitors per day
WAA	Wildlife analysis area
WEPP	Water Erosion Prediction Project
WF	West Fork
WORF	Wildlife observation reporting form

Measurement units

C	degrees Celsius
cfs	cubic feet per second
dB	decibel
F	degrees Fahrenheit
ft	feet
kg	kilogram
km	kilometer
lb/day	pounds per day
m	meters
m/s	meters per second
mg/L	milligrams per liter
MHz	Megahertz
mi	miles
mm	millimeter
ppb	parts per billion

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