DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE SOUNDING ROCKETS PROGRAM AT POKER FLAT RESEARCH RANGE

VOLUME 1

EXECUTIVE SUMMARY AND CHAPTERS 1 THROUGH 9

Sounding Rockets Program Office
National Aeronautics and Space Administration
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ABSTRACT

This *Draft Environmental Impact Statement for the Sounding Rockets Program at Poker Flat Research Range (PFRR EIS)* has been prepared by the National Aeronautics and Space Administration (NASA) in accordance with the National Environmental Policy Act, as amended, to assist in the decisionmaking process for its Sounding Rockets Program (SRP) at Poker Flat Research Range (PFRR), Alaska.

The proposed action addressed in this *PFRR EIS* is the NASA SRP's continued use of PFRR. Sounding rockets launched from PFRR support the advancement of scientific knowledge of the Sun–Earth connection, the upper atmosphere, and global climate change. Since the late 1960s, NASA, other government agencies, and educational institutions have conducted suborbital rocket launches from PFRR; however, changes in the uses and designations of downrange lands have led to a greater focus on the location and recovery of hardware related to sounding rocket, including spent stages and payloads from past and future launches. Accordingly, this *PFRR EIS* focuses on alternative means for NASA to continue its operations at PFRR within an increasingly sensitive environmental context.

This *PFRR EIS* presents a description of SRP at PFRR; an overview of the affected environment at the launch site and within the flight corridor; and the potential environmental consequences associated with five alternatives under consideration, including the No Action Alternative.

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EXECUTIVE SUMMARY

This *Draft Environmental Impact Statement for the Sounding Rockets Program at Poker Flat Research Range (PFRR EIS)* has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended **(42 U.S.C. 4321 *et seq.*)**; the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA **(40 CFR 1500** through **1508)**; and the National Aeronautics and Space Administration's (NASA's) NEPA policy and procedures **(14 CFR 1216.3)**. The purpose of this Draft Environmental Impact Statement (EIS) is to assist in the decisionmaking process concerning the NASA Sounding Rockets Program's (SRP's) continued use of the Poker Flat Research Range (PFRR), a facility owned by the University of Alaska (UAF) east of Fairbanks, Alaska. The U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), and UAF have served as cooperating agencies in the preparation of this *PFRR EIS* as they have either legal jurisdiction or special expertise regarding the alternatives under consideration.

ES. 1. BACKGROUND

Since the late 1960s, NASA, other government agencies, and educational institutions have conducted suborbital rocket launches from PFRR. While PFRR is owned and managed by the Geophysical Institute of UAF, NASA SRP has exclusively funded and managed the support contract with PFRR for more than 25 years. NASA recently reviewed its 2000 *Final Supplemental Environmental Impact Statement for Sounding Rocket Program (SRP SEIS)* and determined that the overall environmental analysis in the 2000 *SRP SEIS* remains sufficient to support NASA's broad programmatic decision to continue the SRP; however, potential changes in both PFRR operations and the environmental context of the launch corridor north of PFRR warrant preparation of additional PFRR-specific environmental analysis. This *PFRR EIS* tiers from the 2000 *SRP SEIS*.

ES. 2. PURPOSE AND NEED FOR ACTION

NASA's purpose for action is to enable the continued safe and cost-effective sounding rocket-based scientific investigations at PFRR. Sounding rockets launched from PFRR support the advancement of scientific knowledge of the Sun–Earth connection, the upper atmosphere, and global climate change.

The proposed action is needed to ensure that NASA and the global science community have a launch capability based in the United States to conduct experiments to aid in the understanding of the phenomena affecting the past, present, and future of the Earth and the Sun–Earth connection. Sounding rockets permit the only means to study the lower atmosphere (40–80 kilometers [25–50 miles]) and the middle ionosphere (80–150 kilometers [50–93 miles]) with direct measurements, and the only means to explore the upper ionosphere (150–1,500 kilometers [93–930 miles]) with vertical trajectories on relatively slowly moving platforms. These are essential regions of the Earth's environment and must be measured to understand how the Earth and space interact.

The northern location of PFRR is strategic for launching NASA sounding rockets for scientific research in auroral space physics and earth science. PFRR is the only high-latitude, auroral-zone rocket launching facility in the United States where a sounding rocket can readily study the aurora borealis and the Sun–Earth connection.

ES. 3. ALTERNATIVES EVALUATED

This *PFRR EIS* evaluates five alternatives, including the No Action Alternative.

Elements Common to All Alternatives

Under all five alternatives, NASA would continue to fund UAF's PFRR and conduct scientific investigations using sounding rockets. NASA forecasts that an average of about four launches per year would be conducted at PFRR, but could range up to eight launches per year. This launch rate is typical of past years, but, because of the very nature of scientific research and discovery, it is not possible to predict accurately what future needs might be. New discoveries or scientific needs might require more or fewer launches to accomplish NASA's scientific goals.

Similarly, past scientific research has mandated that most launches be conducted during the winter months, with most of the launches occurring at night or in darkness. While this is the expected mode of future operations, new scientific needs might raise the desirability of other launch periods. If such needs were to arise, additional analysis of the range safety requirements, as well as potential mitigation factors to reduce environmental impacts, would be required.

No Action Alternative

Under this alternative, no significant efforts would be taken to recover spent stages unless desired for programmatic reasons, and payloads would only be recovered if required by the scientists. Thus, recovery efforts and impacts would primarily be focused on retrieval activities associated with recovery of parachuted payloads.

Alternative 1 (Environmentally Responsible Search and Recovery)

Under Alternative 1, NASA and UAF would employ enhanced efforts to locate new and existing spent stages and payloads within the PFRR flight corridor. Attempts would be made to recover all newly expended stages and payloads predicted to land on Federal, state, or private lands. Spent stages and payloads that are located would be recovered if it is determined that the recovery operation can be performed safely while causing minimal environmental damage. As such, some items or parts thereof could be left in the field if the landowners agree that attempted recovery could cause more damage to the environment than leaving it in place. A key component of this alternative is the development of a formal rocket hardware Recovery Plan.

For past SRP operations at PFRR, most spent rocket stages and payloads have not been recovered. Consistent with the philosophy that would be employed for new rocket motors and payloads, hardware that is located from past operations would be recovered if it could be done safely and in an environmentally responsible manner.

Alternative 2 (Maximum Cleanup Search and Recovery)

Alternative 2 is the same as Alternative 1, except maximum practicable effort would be exerted to fully recover newly expended and existing spent stages and payloads from PFRR if it is determined that they can be recovered safely, even if the efforts result in longer-term recovery-related environmental impacts. The key difference under this alternative compared to Alternative 1 is that NASA would also implement a policy that follows the mantra of "Leave No Trace Behind." Such a cleanup effort might require the use of larger equipment in remote areas, resulting in more short- and long-term disruption, but it is possible that the long-term benefits of removing outwardly visible hardware could outweigh those associated with a more intensive recovery effort.

Alternative 3 (Environmentally Responsible Search and Recovery with Restricted Trajectories)

Alternative 3 is the same as Alternative 1, except trajectories of future sounding rocket missions would be restricted such that planned impacts would not be permitted within designated Wild and Scenic River corridors. The restriction would be an extension of the existing prohibition on having planned impacts within Mollie Beattie Wilderness Area and would become a program requirement that must be met during mission planning. The restriction on planned impacts within Mollie Beattie Wilderness Area would remain in effect.

Alternative 4 (Maximum Cleanup Search and Recovery with Restricted Trajectories)

Alternative 4 would be the same as Alternative 2, except that like Alternative 3, NASA would restrict the flight trajectories of future PFRR missions such that planned impacts would not be located within Wild and Scenic River corridors or Mollie Beattie Wilderness Area.

Alternatives Considered but Dismissed from Detailed Study

NASA also considered additional alternatives but did not evaluate them in detail due to their inability to meet its purpose and need, largely due to an inability to achieve scientific goals, safety concerns, exorbitant cost, or a combination of the three. These alternatives included discontinuing operations at PFRR, relocating operations to other high-latitude launch sites, both foreign and domestic, use of other scientific platforms, installing recovery systems on all future missions, assigning numerical risk criteria to sensitive environmental features, launching easterly into Canada, and tracking all future stages and payloads.

ES. 4. ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

This section summarizes the potential impacts on resources under the five *PFRR EIS* alternatives. Detailed descriptions and in-depth discussions of impacts on resources are provided in Chapter 4, "Environmental Consequences."

Project-related environmental impacts are described by their type, context, intensity, and duration for each affected resource area. The levels of impacts and their specific definitions vary based on the resource that is evaluated. **Table ES–1** provides a general overview of how

potential impacts are evaluated in this EIS. Specific considerations that are only applicable to a resource area are described within its respective section in Chapter 4.

Table ES–1. Evaluation Criteria for Analyzing Environmental Impacts

Type of Impact	
Adverse	The impact would result in some level of environmental degradation.
Beneficial	The impact would result in some level of environmental improvement.
Context of Impact	
Local	The impact would not extend beyond the immediate vicinity of the action causing the effect.
Regional	The impact would occur over a larger geographic scale, such as an ecoregion.
Global	The impact would occur at the global level.
Intensity of Impact (how much)	
Major	Substantial impact on or change in a resource area that is easily defined, noticeable, and/or calculable but may not be measurable, or exceeds a threshold level that may threaten the integrity of one or more resource components.
Moderate	Noticeable change in a resource occurs, but the integrity of the resource remains intact.
Minor	The impact is at the lowest levels of detection (barely measurable and with no perceptible consequences) or would result in only a minor change in a resource.
Negligible	Impact is at the lowest level of measurement or is so low as to be immeasurable and has no perceptible consequences.
Duration of Impact (how long)	
Long-Term	The impact would likely persist for a period greater than the medium-term impact and, depending on the specific resource and project type, would likely extend beyond the life of the project.
Medium-Term	The impact would only occur for specific, relatively brief periods during the project life, interrupted by periods of no impacts (for example, during recovery operations).
Short-Term	The impact would extend for short periods much less than the overall project life (for example, during launch operations).

Potential impacts on resource areas are presented in a comparative format such that the reader can best understand how each compares to the next. A *relative comparison* is provided, and compares the impacts from one alternative to the others. Additionally, an *absolute description* of the impact, consistent with the findings in Chapter 4, is provided so that the reader can understand how each alternative affects the resource area in "the bigger picture." For example, even if one alternative may result in greater impacts on a resource than another alternative, if those greater impacts do not represent a substantial overall difference (*i.e.*, both are still considered minor) in potential effects, it may not need to be a key driver in NASA's final decision.

For all resource areas, a general discussion of potential impacts occurring from non-winter launches is presented. Although non-winter launches have not occurred within recent years, and are not expected to occur, the potential for their proposal cannot be completely discounted. Therefore, a high-level assessment of potential effects and necessary considerations is provided as a means to identify relevant issues that would need to be addressed should the need for such an operation arise. Given only the cursory level of assessment of potential effects in this EIS,

any future proposals for non-winter launches would require more-focused, mission-specific NEPA analysis, as appropriate.

Air Quality

Air quality impacts from PFRR routine operations (*e.g.*, facility heating, employee transportation) would be equal for all alternatives, regional in scope, and adverse, but minor and long-term in duration. Impacts from rocket launches would also be the same for all alternatives and global in scope, adverse, and minor and short-term in duration. The No Action Alternative would have the least air quality impacts from search and recovery operations, followed by Alternatives 1 and 3. Alternatives 2 and 4 would result in the greatest possible impacts. However, in absolute terms, search and recovery-related impacts for all alternatives would be regional in scope and adverse, but minor and medium-term in duration. Impacts from non-winter launches would not be expected to be measurably different from those described above under any of the five alternatives.

Global Atmosphere

For all alternatives, emissions from rocket launches would be equal and confined to the lower layers of the atmosphere. It is expected that there may be a very small, temporary, local stratospheric ozone reduction effect in the wake of upper-stage rockets, but no globally noticeable effects (minor, long-term impacts).

The No Action Alternative would have the least air quality impacts from search and recovery operations, followed by Alternatives 1 and 3. Alternatives 2 and 4 would result in the greatest possible impacts because additional search and recovery activities would be undertaken. However, in absolute terms, search and recovery-related greenhouse gas emissions and resulting impacts on climate change would be global, adverse, minor, and long-term. Impacts from non-winter launches would not be expected to be measurably different from those described above under any of the five alternatives.

Water Resources

For all alternatives, it is expected that the potential adverse impacts from launches and reentry of flight hardware on surface water quality would be equal. As compared to the No Action Alternative, additional recovery-related surface disturbance would occur under Alternatives 1 and 3 and 2 and 4, potentially increasing the likelihood for sediment-laden runoff to enter surface waters. The risk of spills from recovery equipment would also increase; however, the additional adverse impacts on surface water or groundwater resources beyond the localized, negligible, and short-term effects of the No Action Alternative would be minor. For all alternatives, impacts on groundwater or perennial spring water quality or recharge are also anticipated to be negligible.

The restricted trajectories proposed by Alternatives 3 and 4 would be the least impactful on designated Wild Rivers in that they could lessen the already low probabilities that spent stages or payloads would land within them. Alternatives 1 and 2, respectively, would have the next greatest impacts, as they would entail the removal of items if located. Impacts would be greatest

for the No Action Alternative, as no flight hardware would be removed unless required for scientific evaluation. However, for all alternatives, adverse effects on the physical and chemical integrity of designated Wild Rivers are anticipated to be localized, negligible, and short-term. Potential effects of other Wild River values, particularly recreation and wilderness experience, are discussed under Land Use and Recreation.

Compared to winter conditions, interaction of flight hardware with surface water or groundwater resources would be more immediate in the case of a non-winter launch. However, the principles and patterns of possible water resource impacts would follow similar trends and ultimate endpoints.

Geology and Soils

For all alternatives, impacts from launch and reentry of flight hardware are expected to be the same. Under winter snow, ice cover, and frozen soil conditions, no soil erosion impacts or degradation of permafrost is expected. No impacts on PFRR launch site or launch corridor soil chemistry are anticipated from the corrosion of metal items. Based on the relatively low number of flights, small payload quantities, relatively small ground area that would be affected, and low levels and decomposition rates of perchlorate in the soil, adverse impacts on soil chemistry would be short-term, negligible, and localized. Negligible adverse impacts on soil chemistry are anticipated, and adverse impacts on soil erosion would be minor in magnitude and medium-term in duration.

Under Alternatives 1 and 3, the additional efforts to recover flight hardware could result in isolated soil disturbances from activities such as hand-digging around a landing site; however, all recovery efforts would be conducted in an environmentally sensitive manner, thereby mitigating the impact to a level that is essentially equivalent to the No Action Alternative. Although Alternatives 2 and 4 would entail the greatest recovery efforts and could result in potentially the greatest soil disturbances, the extent of impacts beyond those effects expected for the other alternatives would be minor.

Compared to winter conditions, interaction of flight hardware with soil resources would be more immediate because there would not be as much snow and ice on the surface to cushion the impact of spent stages or payloads. However, the principles and patterns of possible soil-related impacts would follow the same trends and ultimate endpoints. Indirect impacts could result from the increased likelihood of a wildfire starting as a result of a spent stage igniting such a fire. Under such circumstances, before a summer launch was conducted, additional precautions would be necessary to minimize the risks associated with igniting such a fire, including notifying appropriate fire patrol personnel.

Noise

For all alternatives, the continued launch of sounding rockets would be equal to and consistent with existing sources of noises at PFRR. In absolute terms, the noise impact from routine PFRR activities, employee vehicles, and delivery vehicles under all alternatives would be regional,

adverse, long-term, and minor. The noise impact from rocket launches and spent-stage reentry and impact would be regional, adverse, short-term, and minor in intensity.

Search and recovery-related noise would be the least under the No Action Alternative and would be considered adverse, regional in scope, medium-term, and minor. Estimates of noise levels on the ground under search and recovery aircraft would be similar for all alternatives. Sound levels generated from disassembly of rocket motors during recovery would likely be above background levels within the downrange lands; however, in either scenario, the sound generated would be short-term (*i.e.*, generally less than an hour per motor), infrequent, and depending on specific conditions, confined to a limited distance from the source. Accordingly, the noise impact from search and recovery operations under Alternatives 2 and 4 would be the greatest of the alternatives and considered regional in scope, adverse, medium-term in duration, and moderate in intensity.

The type, intensity, and duration of noise impacts would be the same for a non-winter launch; however, the likelihood of a receptor (*e.g.*, recreational user, wildlife species) hearing the sound of a rocket flight, reentry, and post-flight search would be greater. Potential impacts on these resources are discussed under Land Use and Recreation and Ecological Resources.

Visual Resources

Under all alternatives, no measurable changes would be made to the appearance of the PFRR launch site; therefore, no impacts on visual resources would be expected. The impact on visual resources from the launching of sounding rockets would be the same for all alternatives and would be minor and short-term.

The intensity of an alternative's impact from land-impacting flight hardware would be dependent upon where the impact site is located and how often users of the downrange lands see it. For example, it is expected that an item landing in a regularly used Wild River corridor could result in greater adverse impacts on visual resources than an item that is partially buried in a remote bog. The duration of impacts on visual resources would vary depending on how long the stages and payloads were left unrecovered.

The restricted trajectories proposed under Alternatives 3 and 4 could result in lower probabilities that future rocket launches from PFRR would impact in these areas. Since these areas may attract a greater number of visitors due to their designations, avoidance of these areas could result in fewer search and recovery actions within the areas and less potential adverse impacts on visual resources. Coupled with the commitment to search and recovery of located items, it is expected that Alternatives 3 and 4 would have the least long-term adverse effects on visual resources. However, the presence of search and recovery aircraft would result in a short-term, minor adverse effect. Additionally, under Alternative 4, a more aggressive cleanup policy could result in localized ground scars or ruts, which could degrade the natural appearance of an area.

Recovery of additional payloads and spent stages under Alternatives 1 and 2 would reduce the probability of a visitor or user of the lands encountering such materials, thereby reducing the long-term visual impact. However, no specific provisions would reduce the likelihood of

planning an impact within a designated Wild River. Similar to Alternatives 3 and 4, the presence of search and recovery aircraft would result in a short-term, minor adverse effect. In general, few payloads (and even fewer stages) would be recovered under the No Action Alternative. Accordingly, adverse impacts on visual resources would be the greatest under the No Action Alternative and would most likely be long-term and could range from minor to moderate, depending on location.

No change in BLM Visual Resource Management classification would be anticipated for the lands within the PFRR launch corridor under any of the five alternatives.

As more human activities would occur within the PFRR launch corridor during non-winter months, the potential for someone to observe a rocket overflight would be greater. Also, due to the absence of frozen ground and ice during the summer in areas of lower elevation, there is the potential that spent stages would bury themselves in shallow bogs and sloughs (particularly in the wetland areas of the Yukon Flats), thereby lessening the likelihood of a land user encountering such materials. Additionally, there is the potential that a land user would observe a post-launch fixed-wing search operation within the PFRR launch corridor due to the larger user base during the non-winter months.

Ecological Resources

Under all alternatives, there would be no impacts on vegetation at the launch site because the surrounding area is cleared and maintained free of vegetation. Upon landing of flight hardware, impacts on vegetation would be restricted to the area immediately surrounding the item(s) and would diminish rapidly as distance from the impact point increases. Therefore, potential adverse effects on vegetation and habitat under all alternatives from launch and impact of flight hardware would be equal and local in scope, short-term in duration, and negligible in intensity. Any adverse impacts from launch operations on wildlife (*e.g.*, direct strike, startle) would be similar for all alternatives and would be local, short-term, and negligible due to the time of year that launches typically occur (winter months), the low density of species within the launch corridor, and the infrequency of launches during a launch season (average of four per year).

Impacts on vegetation from recovery operations would be the least under the No Action Alternative. The additional recovery efforts under Alternatives 1–4 would add to the areal extent of disturbance to vegetation, although the types of disturbance would be the same as those described under the No Action Alternative. Because of the low number of recovery efforts annually, the small and isolated area of vegetation affected by recovery of a spent stage or payload, and the natural regeneration of vegetation after disturbance, adverse impacts on vegetation would also be negligible under Alternatives 1–4.

It is expected that recovery-related impacts (*e.g.*, startle) on wildlife species would be the least under the No Action Alternative. The additional recovery efforts under Alternatives 1 and 2 would increase the potential for disturbance of terrestrial wildlife and birds; however, any adverse impacts would be localized to the vicinity of search and recovery activities, would be short-term in duration, and would be minor.

The restricted trajectories provided under Alternatives 3 and 4 could lessen the potential impacts on wildlife within these areas. However, any adverse impacts on wildlife are already considered to be negligible, so any decrease in impacts is not expected to be substantial.

None of the five alternatives would adversely affect essential fish habitat, target species, or subsistence species. Due to the presence of federally listed species within the launch corridor, NASA is consulting with USFWS and the National Oceanic and Atmospheric Administration Fisheries Service regarding potential effects of its operations at PFRR on listed, proposed, and candidate species under their respective jurisdictions. There are no listed, proposed, or candidate species known to live in the vicinity of the PFRR launch site or under the launch corridor until it approaches the coast of the Beaufort Sea. The ringed seal (proposed threatened) and the polar bear (threatened) have the potential to occur year-round within the region of influence (ROI) and could be affected by descending payloads or spent stages. The bowhead whale (endangered), bearded seal (proposed endangered), and yellow-billed loon (candidate) are summer residents and would be absent during the winter season, when launches are proposed to occur and payloads and spent stages are expected to impact sea ice covering the Beaufort Sea. Spectacled and Steller's eiders (threatened) are accidental in occurrence and uncommon within the ROI. They would also most likely be present during the summer months, if they were present at all.

In the event of a non-winter launch, more vegetation would be exposed due to a lack of snow cover; therefore, impacts would be greater. Additionally, the risk of unintentional wildfire from hot reentering flight hardware would increase markedly. Spent stages and payloads would have greater potential to land in proximity to wildlife than during winter because of the greater number of species present, potentially causing short-term behavioral response such as flight. Responses to search and recovery activities would be negligible, since these activities would normally occur during summer under any launch scenario. The likelihood of direct impacts on fish of importance for subsistence or commerce fisheries is expected to be minimal. The potential impacts on federally listed species would need to be revisited, as more species would be located within the PFRR launch corridor during non-winter months.

Land Use and Recreation

The most recent USFWS- and BLM-issued permits for rocket landing and recovery within the Yukon Flats and Arctic National Wildlife Refuges (NWRs) require the recovery of flight hardware. Therefore, the No Action Alternative, which would direct recovery of payloads solely for scientific need, would not be fully consistent with the terms and conditions of the use permits, and would likely not by authorized by the land management agencies.

The No Action Alternative would not limit the ability for users to visit or take part in recreational activities within downrange lands; however, it would result in the greatest deposition of flight hardware in downrange lands. In the case that recreational users of the downrange lands were to discover a piece of flight hardware, it could negatively affect their experience, particularly those persons intending to have a wilderness experience. Others may find it a positive experience to discover a spent stage or payload. It is expected that those persons engaged in hiking and rafting would be the most sensitive to finding sounding rocket hardware, with hunters, trappers, and snow machines the most tolerant. The impact would be on a person-by-person basis and would

be influenced by the perception of the individual. Accordingly, impacts could be beneficial or adverse, localized, minor in intensity, and short-term to long-term in duration, depending on how long the known payloads and spent stages remain within the launch corridor.

Recovery of payloads and new and existing spent stages under Alternative 1 would further assist UAF in complying with the requirements of the special use permits and memoranda of agreement with BLM, USFWS, and landowners within the ROI. Additionally, it would reduce the probability that a recreational user would encounter flight hardware. However, as compared to the No Action Alternative, initial search activities could have negligible, short-term impacts on persons participating in recreational activities in areas within the PFRR launch corridor. Given the relative infrequency of flights and the very low probability that a low-flying/landing recovery action would be necessary within the most highly used river corridors within the downrange lands, adverse effects are anticipated to be localized, minor in intensity, and short-term in duration. It is expected that in most cases, the long-term impacts of leaving a piece of flight hardware within the downrange lands would be greater than the short-term disturbances (*e.g.*, noise, aircraft overflight) associated with recovery.

Land use and recreation impacts from launches under Alternative 2 would be essentially the same as Alternative 1. Recovery of the additional payloads and new and existing spent stages would further assist UAF in complying with the requirements of the special use permits and memoranda of agreement with the landowners within the ROI. However, under this alternative, it is possible that some outward signs of more invasive recovery operations could be exhibited, affecting the wilderness character of the lands. Additionally, more recovery flights could result in more recreational users observing aircraft overhead.

Impacts on land use and recreation under Alternatives 3 and 4 would be identical to those identified under Alternatives 1 and 2, respectively, with the exception of NASA's restricting trajectories on future launches such that designated Wild or Scenic River segments would not be allowed to have predicted impact points for stages or payloads within them. These restricted trajectories could reduce the probability that spent stages or payloads would land within these areas and therefore reduce the need to recover spent stages or payloads from these areas.

For non-winter launches, it is expected that impacts on land use and recreation would be greater due to the larger user base in downrange lands. It is possible that more visitors would voluntarily suspend or relocate their planned activities upon reading posted launch notices; the potential duration of this could vary from days up to several weeks if optimum science conditions are not met until the end of the launch window. It is also possible that downrange "clear" zones would need to be established to ensure public safety, thereby restricting public access to these areas. However, in the event that such an operation would be proposed, substantial early coordination with downrange landowners would be required to reduce potential impacts to the greatest extent practicable.

Cultural Resources

For all alternatives, under the anticipated launch schedule of an average of four launches annually, there is an extremely low probability of impacting or damaging a specific site of cultural or religious importance. Launches during the winter would likely reduce the potential impact if a landing was to occur on a cultural resource, as snow and ice and frozen ground would reduce surface and subsurface damage. To date, no impacts on cultural resources have been documented through the existing SRP launch and limited recovery program. NASA would continue to coordinate with agencies and Alaska Natives according to Section 106 of the National Historic Preservation Act, NASA regulations, and other pertinent laws and regulations, as appropriate.

Due to its limited recovery activities, the No Action Alternative would be expected to have the least recovery-related chance of impacting an area of cultural significance. Because there would be a greater number of recovery activities under Alternatives 1 and 4 compared to the No Action Alternative, there would be a greater possibility of disturbing a historic property. In relative terms, Alternatives 2 and 4, which would entail the greatest recovery effort, could present the highest risk of resource damage. However, given the low probability of landing on or adjacent to such a resource (and then becoming a recovery site), it is expected that impacts from recovery would also be negligible for all alternatives.

For non-winter launches, the impact point could experience greater effect if the ground were thawed than during the winter, when the ground is frozen. If the impact point were to be on or very near a cultural resource, and if that resource were a historic property, this could have a greater effect than during the winter. However, the likelihood of a rocket impacting a historic property is extremely low; thus, it is unlikely that summer launches would adversely impact historic properties.

Subsistence Resources

Under all alternatives, the chances of a direct impact on subsistence resources within the PFRR launch corridor due to a payload or spent stage striking an individual animal are negligible. Therefore, adverse effects on subsistence activities would also be negligible to minor and short-term.

The potential for recovery-related impacts on subsistence users would be the least under the No Action Alternative. The villages of Arctic Village, Beaver, Fort Yukon, Stevens Village, and Venetie have subsistence use areas within or in close proximity to the predicted impact areas for spent stages and payloads that would be removed under Alternatives 1 and 2. Noise from low-flying aircraft would have the potential to startle wildlife and could cause the wildlife to leave the area in which search and recovery operations are taking place. However, these startle effects and departures from the area are expected to be temporary and limited to the relatively short periods that these aircraft would be within earshot of or visible to wildlife. Once any disturbance from the low-flying aircraft has ceased, it is expected that wildlife would return to their normal habits and locations. Any adverse impacts on subsistence resources or the harvest of subsistence resources are expected to be localized, minor, and short-term in duration under Alternative 1.

Although Alternative 2 has the potential for the greatest disturbance to wildlife and subsistence hunting, these activities would continue to be relatively minor and infrequent across the affected areas since they would be spread over great distances. The restricted trajectories proposed under Alternatives 3 and 4 would not be expected to have measurable differences in potential impact on subsistence resources or uses and would therefore be equivalent to Alternatives 1 and 2.

For non-winter launches, greater potential impacts on subsistence activities would be expected due to the larger presence of subsistence resources in downrange lands and waters. As discussed under Ecological Resources, direct impacts on fish and game resources would be minor. However, as discussed under Health and Safety, requirements to maintain public safety could result in areas being avoided (either voluntarily or mandatorily) by subsistence users who would otherwise be hunting or fishing.

It should be noted that the impacts would be launch-specific and highly dependent upon the month it would occur. For example, a launch planned in late spring or early summer could affect subsistence hunters targeting waterfowl on the Yukon Flats, whereas a mid-summer launch would require consideration of traditional fishing camps along the many rivers within the ROI. Consultation with Alaska Natives and downrange landowners would be necessary for NASA and PFRR to assess the potential effects of a specific non-winter launch and appropriately mitigate its potential effects.

Transportation

Under all alternatives, the estimated number of traffic fatalities associated with truck transports would be minor, with a risk of about 1 chance in 500 years that a traffic fatality would occur. The impact on traffic volume of truck transports related to launch and search and recovery operations would be negligible.

The risk of an air transport incident under the No Action Alternative is estimated to be the least of the alternatives, with a risk of about 1 chance in 4,800 years that a fatal accident would occur. Alternatives 1 and 2 would result in greater risk, at 1 chance in 770 years and 1 chance in 480 years, respectively, due to more flight time during recovery operations. These probabilities are very low and would be considered negligible and minor impacts, respectively. The restricted trajectories proposed under Alternatives 3 and 4 would not change the potential transportation impacts as compared to Alternatives 1 and 2.

For a non-winter launch, the transportation impacts should remain the same as those projected for launch operations in the winter because the truck transports and aircraft operations associated with search and recovery activities would occur during the summer under either launch scenario.

Waste Management

Under all alternatives, future launch activity would remain at a level similar to what has occurred at PFRR in the past 10 years. The continuation of launch operations would require the use of small quantities of potentially hazardous materials, some of which would unavoidably land within downrange properties. These materials typically include small pyrotechnic devices,

rechargeable batteries, compressed gases, lead-containing solder and balance weights, chemical tracers, and (for some older rocket motors) asbestos-containing insulation. In comparison to the structural materials (*e.g.*, hardened steel, aluminum) of sounding rocket hardware, these potentially hazardous components make up a very small portion of the total mass of a spent stage or payload.

A key difference among the alternatives is the amount of material that NASA would remove from downrange lands. Under the No Action Alternative, an estimated average of 2,800 kilograms (6,200 pounds) of recoverable spent stages and payloads would be deposited in lands outside the Poker Flat North and South Special Use Areas annually. Of this material, between approximately 2,200 kilograms (4,850 pounds) and 3,400 kilograms (7,500 pounds) would be expected to land within the Alaska Department of Natural Resources (ADNR) Poker Flat North and South Special Use Areas, thus resulting in a net deposition of between 1,200 kilograms (2,650 pounds) and 2,400 kilograms (5,300 pounds) elsewhere, a ***moderate to major long-term adverse impact.***

Under Alternative 1, approximately 900 to 2,300 kilograms (2,000 to 5,100 pounds) of material would be deposited in downrange lands annually under this alternative. Excluding the materials within the designated ADNR Poker Flat North and South lands, other downrange lands could realize a net reduction of 500 kilograms (1,100 pounds) up to and 900 kilograms (1,980 pounds) increase in materials, which would correspond to either a minor beneficial to minor adverse long-term impact of regional scope.

Under Alternative 2, up to a 900-kilogram (2,000-pound) overall reduction in waste could occur, however up to 400 kilograms (880 pounds) of material could be deposited in downrange lands annually under this alternative. Excluding the items within the designated ADNR Poker Flat North and South lands, other downrange lands could realize a net reduction of 1,200 kilograms (2,650 pounds) up to a 100-kilogram (220-pound) increase in materials, which would correspond to either a moderate beneficial to minor adverse long-term impact of regional scope.

The restricted trajectories proposed under Alternatives 3 and 4 would not change the potential quantities of wastes deposited in downrange lands as compared to those described for Alternative 1 and 2. They could, however, reduce the potential for such materials to land within the avoided areas. No change in hazardous material and waste use or generation or its impact on the environment is anticipated in the event of a summer launch.

Health and Safety

Under all alternatives, public and worker health and safety impacts associated with the launch of NASA sounding rockets from PFRR would be equal, short-term, and negligible. Health risks to workers and recovery personnel occur principally during the short period around the launch when the rocket is being prepared and when the search and recovery activities take place. Continued adherence to the NASA safety rules should ensure that the risk to the PFRR workers and visitors would remain very low with future missions. The public is protected from the impacts of sounding rockets and their components through the safety policies and practices of the NASA SRP. All NASA SRP missions are required to prepare both Ground and Flight Safety

Plans to minimize risk to human life and property. A Flight Safety Risk Assessment is also prepared for each mission. Both impact and overflight criteria are considered in the Flight Safety Plans and, while risk cannot be entirely eliminated, it is reduced to an acceptable margin. The criteria that are imposed are a combination of NASA criteria from NASA's *Range Safety Manual* that is common across the U.S. Government rocket launch ranges, and additional criteria or guidelines adopted by UAF and PFRR. In most cases, these criteria are acceptance criteria, and nominally less restrictive risk estimates may be approved on a case-by-case basis with recognition of the conservatism built into the risk calculations.

Based on the assumed recovery of 1 payload per year under the No Action Alternative and normal injury and fatality rates for similar types of activities in Alaska, no annual fatal injury flight accidents, no occupational injuries during ground recovery operations, and no fatalities during ground recovery activities would be expected. Projected impacts of search and recovery of the assumed 2 payloads and 10 stages under Alternative 1 are about a factor of 6.4 to 9 times higher than the No Action Alternative, but are still small, with no lost work day injuries or fatalities expected during a year's recovery operations. Projected impacts from search and recovery of the assumed 4 payloads and 16 stages under Alternative 2 are the highest at a factor of 11 to 19 times higher than the No Action Alternative, but again are still small, with no lost work day injuries or fatalities expected. Alternatives 3 and 4 would be expected to have the same potential impacts as Alternatives 1 and 2, respectively.

The potential safety risks would be higher for non-winter launches due to higher population densities and greater potential for unintended impacts due to accidents, including fires started by incompletely burned stages. Burning solid propellant and hot rocket motors could produce fires in areas of impact. This would be especially true where impacts occurred in dry areas during the summer months. The potential worker risks would be unchanged or slightly less for summer launches because workers would not be subject to the below freezing temperatures present at PFRR during the winter months. Before scheduling a summer launch, additional landowner consultation and safety analyses would need to be performed to ensure that such launches could be conducted safely in accordance with NASA, UAF, and landowner guidelines.

Socioeconomics and Environmental Justice

For all alternatives, normal operations at PFRR are estimated to result in direct employment of approximately 17 full-time equivalents annually. Direct employment at PFRR is expected to generate indirect employment of approximately 11 jobs, for a total impact of 28 jobs within the ROI attributable to PFRR activities. Normal operations at PFRR are estimated to generate approximately $1.9 million of direct economic activity annually. Approximately $1.4 million of the value added would be in the form of earnings to PFRR employees, which in turn would generate an estimated $640,000 of indirect earnings within the ROI, resulting in minor, medium-term, beneficial socioeconomic impacts.

Search and recovery activities under the No Action Alternative would be the least of the alternatives and would result in negligible, though beneficial, socioeconomic impacts over the medium-term. Additionally, the No Action Alternative is not expected to create any additional indirect employment opportunities. Under Alternatives 1 and 2, recovery activities are expected

to result in minor, medium-term, beneficial effects, with the generation of 3 and 4 full-time jobs, respectively, with the annual value added to the local economy estimated to be approximately $166,000 and $282,000, respectively. The restricted trajectories proposed under Alternatives 3 and 4 would not change the potential socioeconomic impacts associated with Alternatives 1 and 2. Non-winter launches would not change the socioeconomic impacts projected for the different alternatives under consideration.

Regarding environmental justice, the analyses presented for each alternative have shown that the intensity of the risks to public health and safety from NASA SRP normal operations, off-normal flights, and transportation are estimated to be negligible to minor. In addition, continued SRP operations at PFRR, including search and recovery activities, are not expected to adversely affect subsistence resources or users within the PFRR launch corridor. Therefore, continued NASA SRP operations at PFRR are not expected to result in disproportionately high and adverse impacts on minority or low-income populations under any of the alternatives under consideration in this EIS.

Cumulative Effects

NASA considered a number of past, present, and reasonably foreseeable future actions that could occur on downrange lands and would contribute cumulatively to impacts on the same resource areas affected by PFRR launch and recovery. With the exception of waste, the cumulative effects analysis in this EIS indicates that the NASA SRP's operations at PFRR under any of the five alternatives would be much smaller in scope and environmental impact that other activities occurring within the ROI; therefore, its contribution to adverse cumulative effects would be minor.

Regarding cumulative waste, more than 40 years of PFRR operation with limited focus on recovery of flight hardware from both NASA and non-NASA launches has resulted in net deposition of approximately 181,000 kilograms (399,000 pounds) of items within the flight corridor (inland and ocean areas combined), with the majority of it being inert steel and aluminum. Approximately 45 percent of all items (approximately 64 percent by weight) are estimated to be located within the ADNR Poker Flat North and South Special Use Areas, which are specially designated for rocket and payload impacts.

Within other downrange lands, the No Action Alternative would result in a continued cumulative increase in the deposition of flight hardware, resulting in a major, long-term, adverse impact. Accordingly, NASA has incorporated mitigation of this long-term adverse impact in Alternatives 1–4 by establishing a formal Recovery Program such that over time, the quantity of flight hardware would be reduced in downrange lands. Alternatives 1 and 3 would have lesser cumulative effects than the No Action Alternative; while Alternatives 2 and 4 would likely result in the most waste removed from downrange lands over time, and would likely contribute the least to long-term adverse cumulative effects.

ES. 5. MITIGATION MEASURES

All of the alternatives evaluated in detail in this EIS have the potential to produce impacts to one or more resource areas. Based on analysis in Chapter 4 of this EIS, only the No Action Alternative could potentially result in significant impacts on Land Use and Waste Management. NASA has included mitigation measures as integral components of Alternatives 1 though 4. These measures are described in detail in Chapter 2, Section 2.1.7.2, Chapter 4, Section 4.18, and in Appendix E.