

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

VOLUME I

**EXECUTIVE SUMMARY
AND
CHAPTERS 1 THROUGH 9**

**Sounding Rockets Program Office
National Aeronautics and Space Administration
Wallops Island, VA 23337**

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ABSTRACT

This *Final 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 rockets, 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

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EXECUTIVE SUMMARY

This *Final 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 Final 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 warranted preparation of additional PFRR-specific environmental analysis. As such, this *PFRR EIS* tiers from the 2000 *SRP SEIS*. Additionally, as the alternatives considered in this EIS would require independent actions (authorizations) on the part of BLM and USFWS, this EIS has been prepared to fulfill their respective NEPA obligations, as well as NASA's.

ES. 2. PURPOSE AND NEED FOR ACTION

NASA Purpose

NASA's purpose for action is to ensure 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.

BLM and USFWS Purpose

The purpose of BLM's action is to respond to authorization requests submitted by UAF (on NASA's behalf) for use of public lands under the authority granted to the U.S. Department of the Interior by the Federal Land Policy and Management Act (FLPMA). If approved, the authorization would allow rocket impacts and recovery of rocket hardware from the White Mountains National Recreation Area and Steese National Conservation Area in interior Alaska.

Similar to BLM, the purpose of the USFWS's action is to: (1) respond to UAF's request for use of public lands; and (2) assist NASA in modification of the PFRR program to allow for an effective Recovery Program for rocket hardware, both of which support the authorities granted to USFWS by the National Wildlife Refuge System Administration Act of 1966, as amended (NWRSA). If approved, the authorization would allow rocket impacts and recovery of rocket hardware from non-wilderness areas within Arctic and Yukon Flats National Wildlife Refuges (NWRs).

NASA Need

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.

BLM and USFWS Need

The two Federal cooperating agencies' proposed actions are needed because the Secretary of the Interior delegated the authorities granted in the FLPMA and NWRSA to BLM and USFWS, respectively, to authorize the use of public lands in accordance with their guiding policies for management.

ES. 3. ALTERNATIVES EVALUATED

This *PFRR EIS* evaluates five alternatives, including the No Action Alternative. To better inform the BLM and USFWS decisionmaking process, each alternative includes two possible authorization scenarios (both issuance and non-issuance) that could result in response to UAF's request for impacting within the lands under their jurisdiction. The primary difference between each alternative (under either scenario) is the level of effort taken to locate and remove sounding-rocket-related items from downrange lands. Additionally, two alternatives employ restrictions on future launch trajectories.

Elements Common to All Alternatives

Federal Landowner Issuance of Authorizations for Future Impacts

This scenario assumes that both BLM and USFWS would issue all required authorizations to UAF for continued launch-related impacts on their respective lands. Under all five alternatives, NASA would continue to fund UAF's PFRR and conduct scientific investigations using sounding rockets. The sounding rocket configuration employed for each mission would be dependent on specific scientific objectives, and could include any of the single- or multi-stage vehicles in the SRP's "stable" of 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. 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. NASA would continue to not conduct launches with a planned impact site within the Mollie Beattie Wilderness Area within Arctic NWR.

Non-Issuance of BLM Authorizations for Future Impacts

Under this scenario, BLM would not authorize future use of the White Mountains National Recreation Area or Steese National Conservation Area to UAF for stage/payload impact; however, recovery of existing items could continue. This restriction would essentially require NASA to ensure that the 3-sigma dispersion of its stages or payloads could not overlap either of the BLM-managed lands.

It is assumed under this scenario that USFWS would authorize use of its lands. Therefore, this scenario would restrict the use of the shortest- and longest-range rockets employed by the NASA SRP. It is expected that the single-stage Orion and the four-stage Black Brant (BB) XII rockets could no longer be launched as it is common for each to have planned impacts within or adjacent to the White Mountains National Recreation Area. It should be noted that the loss of the ability to launch the BBXII class rockets would severely limit NASA SRP's ability to enable larger, longer-duration missions from PFRR that are most frequently specified by its participating researchers in recent years. The use of two-stage rockets, notably the Terrier-Improved Orion and BBIX, could continue. Additionally, the three-stage BBX missions, with planned stage impact points well north and south of the BLM lands, could continue. An average of four launches per year would be expected. The above described consideration to avoid planning launch impacts within Mollie Beattie Wilderness Area would also apply to this scenario.

Search and recovery of future launched items would be limited to USFWS, tribal, and state lands. Recovery efforts on BLM lands would be limited to items remaining from past launches.

Non-Issuance of USFWS Authorizations for Future Impacts

Under this scenario, USFWS would not authorize future use of the Arctic and/or Yukon Flats NWRs to UAF for stage/payload impact; however, recovery of existing items could continue. This restriction would have the same effect of requiring 3-sigma dispersions to avoid the USFWS lands. It is expected that USFWS adoption of this scenario would preclude NASA from launching all of its multi-stage rockets. Given that only the single-stage Orion (which typically impacts on BLM-managed lands and has limited scientific utility compared to the SRP's higher-performance vehicles) could be launched from PFRR, it is expected that NASA would discontinue funding PFRR altogether.

The actions that would occur at the launch site following the discontinuation of the NASA SRP at PFRR cannot be precisely defined at the current time; however, several general assumptions can be made:

- NASA would remove the majority of “personal property” and technical equipment from the launch site and transport it to Wallops Flight Facility for program uses elsewhere. These items would include the rocket launchers, radar and telemetry dishes, ground support equipment (*e.g.*, rocket dollies, slings), computer systems, and associated radar/telemetry electronics.
- Ownership of existing NASA-owned buildings and structures (*e.g.*, payload assembly building, launch support facility) would most likely be transferred to UAF.
- Depending on the alternative in this *PFRR EIS*, NASA would fund a limited Recovery Program for the removal of existing items from within downrange lands. Given that program funds would be eliminated or redirected to other agency priorities, the limited Recovery Program would be discontinued approximately 10 years following program withdrawal from PFRR.

Due to the discontinuation of NASA funding at PFRR, it is also likely that UAF would shut down the range if USFWS authorizations were not granted.

No Action Alternative

Council on Environmental Quality regulations for implementing NEPA require that an agency “include the alternative of no action” as one of the alternatives it considers in an EIS (40 CFR 1502.14[d]). The No Action Alternative serves as a baseline against which the impacts of the proposed action are compared. In the case of this *PFRR EIS*, NASA's funding the operation of PFRR is an action that has occurred on a regular (*i.e.*, annual or semi-annual) basis since the late 1960s. Accordingly, NASA has adopted the “status quo” interpretation of “no action” in defining its No Action Alternative; this would mean that PFRR would continue to operate as it has in the recent past.

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 greater recovery-related environmental impacts.

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, feasibility concerns, or a combination of the four. 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, tracking all future stages and payloads, and use of heavy mechanized equipment for recovery.

ES. 4. NASA'S PREFERRED ALTERNATIVE

In consideration of both public input offered during scoping and review of the *Draft PFRR EIS* and the results of the environmental analysis in Chapter 4 of this *Final PFRR EIS*, NASA has identified Alternative 1, Continue NASA SRP Activities and Flights at PFRR within Existing Flight Zones, with Environmental Screening for Recovery of New and Existing NASA Stages and Payloads (Environmentally Responsible Search and Recovery Alternative), as its Preferred Alternative.

ES. 5. ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

This section summarizes the potential impacts on resources under the five *PFRR EIS* alternatives assuming both issuance and non-issuance of BLM and USFWS authorizations for stage/payload impacts on their lands. Given that the potential effects of the "all Federal authorizations issued" scenario most sharply contrast with the effects of the non-issuance of USFWS authorizations scenario, this section focuses on these two scenarios. Detailed descriptions and in-depth discussions of impacts on resources under all scenarios (including non-issuance of BLM authorizations) 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.

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.

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).

Air Quality

Emissions 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. Emissions 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 emissions from search and recovery operations, followed by Alternatives 1 and 3. Alternatives 2 and 4 would result in the greatest possible emissions due to additional search and recovery operations. However, in absolute terms, search and recovery-related emissions for all alternatives would be regional in scope and adverse, but minor and medium-term in duration.

Emissions from non-winter launches would not be expected to be measurably different from those described above under any of the five alternatives. If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, emissions within the region of influence (ROI) from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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 greenhouse gas emissions 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. If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, greenhouse gas emissions from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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, even more so, under Alternatives 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 and Scenic 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 and Scenic Rivers are anticipated to be localized, negligible, and short-term. Potential effects of other Wild and Scenic 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. If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on water resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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, 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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on geology and soil resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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 in intensity. 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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts within the ROI from noise related to PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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 and Scenic 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.

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, under these alternatives, no specific provisions would reduce the likelihood of planning an impact within a designated Wild and Scenic River corridor. 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.

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 (*i.e.*, Wild and Scenic River corridors). 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.

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 if launches were conducted during these months. 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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on visual resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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 search and 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 in intensity.

The restricted trajectories provided under Alternatives 3 and 4 could lessen the potential impacts on wildlife within Wild and Scenic River corridors, where the probability of a stage or payload impact is already extremely low. 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. There are no Endangered Species Act 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 (threatened) and the polar bear (threatened) have the potential to occur year-round within the ROI and could be affected by descending payloads or spent stages. The bowhead whale (endangered), bearded seal (threatened), and yellow-billed loon (candidate) are primarily 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.

Due to the presence of federally listed species within the launch corridor, NASA consulted with the USFWS and the National Oceanic and Atmospheric Administration National Marine Fisheries Service regarding potential effects of its operations at PFRR on listed, proposed, and candidate species under their respective jurisdictions. Both resource agencies concurred with NASA's determinations.

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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on ecological resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

Land Use and Recreation

The most recent USFWS- and BLM-issued permits for rocket impact and recovery 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 be 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 machiners 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 and 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, early coordination with downrange landowners would be required to reduce potential impacts to the greatest extent practicable.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on land use and recreation within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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.

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 through 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 a payload or spent stage 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.

In accordance with Section 106 of the National Historic Preservation Act, NASA consulted with the Alaska State Historic Preservation Office (SHPO), Alaska Natives, and interested parties regarding the potential effects of the alternatives on cultural resources. The Alaska SHPO concurred with NASA's determination that there would be no historic properties affected.

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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on cultural resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on subsistence resources within the ROI from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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 700 years and 1 chance in 450 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, with these alternatives having the same risks as shown above for Alternatives 1 and 2, respectively.

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 recovery activities would occur during the summer under either launch scenario.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts within the ROI from PFRR-related transportation would no longer be generated beyond the limited 10-year Recovery Program.

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 estimates it would remove from downrange lands. Under the No Action Alternative, approximately

4,600 kilograms (10,000 pounds) of recoverable spent stages and payloads would be deposited in downrange lands, 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 an annual 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 a 900-kilogram (2,000-pound) net increase in materials, annually, 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 (Wild and Scenic River corridors). 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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts within the ROI from waste generated as a result of PFRR routine operations, rocket launches, and search and recovery operations would be avoided beyond the limited 10-year Recovery Program.

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 some instances, 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 11 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 greater for non-winter launches due to higher population densities within downrange lands. Additionally, 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.

If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, potential adverse impacts on public and worker health and safety from PFRR routine operations, rocket launches, and search and recovery operations would no longer be generated beyond the limited 10-year Recovery Program.

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, respectively. Non-winter launches would not change the socioeconomic impacts projected for the different alternatives under consideration. If UAF shuts down PFRR as a result of USFWS no longer granting authorizations, the economic benefits from the NASA SRP within the ROI would no longer be generated beyond the limited 10-year Recovery Program.

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 within or adjacent to downrange lands and 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 than 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 a net deposition of approximately 125,000 kilograms (276,000 pounds) of material from NASA activities and a net deposition of approximately 55,000 kilograms (121,000 pounds) from non-NASA activities. The net deposition from both NASA and non-NASA activities is approximately 180,000 kilograms (397,000 pounds) of items within the flight corridor, with the majority of it being inert steel and aluminum. Approximately 45 percent of all items (approximately 65 percent by weight) are estimated to remain 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. Non-issuance of USFWS authorizations would present the least potential for adverse cumulative effects from waste given that no future launches would occur. However, recovery of historic items would discontinue 10 years following program withdrawal from PFRR.

ES. 6. MITIGATION MEASURES

All of the alternatives evaluated in detail in this EIS have the potential to produce impacts on one or more resource areas. However, 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. Therefore, NASA has included mitigation measures addressing these resource areas as integral components of Alternatives 1 through 4. These measures are described in Chapter 4, Section 4.18, and Appendix E.