

**APPENDIX F**  
**SEARCH AND RECOVERY ASSUMPTIONS**

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## **APPENDIX F. SEARCH AND RECOVERY ASSUMPTIONS**

### **F.1 PURPOSE OF THIS APPENDIX**

The characteristics (*e.g.*, launch vehicle, trajectory, and payload) and frequency of missions conducted at the Poker Flat Research Range (PFRR) are highly dependent upon the scientific objectives of the sponsoring researcher and the National Aeronautics and Space Administration's (NASA's) scientific priorities. Therefore, it is not possible to assess every possible mission scenario that could be proposed for PFRR in the next 10 years.

Accordingly, certain assumptions were made regarding the types of rocket, payload, and recovery operations that would most likely occur; these were based primarily upon past experience, interviews with key personnel, and best professional judgment.

It is important to recognize that recovery efforts would only be undertaken if a post-launch (or post-report in the case of an existing stage or payload) search flight resulted in the positive identification of hardware associated with the NASA Sounding Rockets Program (SRP). In the case of newly launched hardware, recent searches have resulted in the identification of approximately half of the known items. This success rate is expected to increase as location devices are improved; however, the reader should not assume that all downrange flight hardware would be found in every case. Therefore, the most reliable (and conservative) product of these assumptions is an estimated quantification of fuel usage (and resulting air emissions) of recovery-related vehicles. Estimates of flight times (and fuel usage) associated with both search and recovery would be considered conservative in that greater emissions would occur compared to recovery efforts alone. However, when other resource areas, including the wilderness values of special use lands, are considered, these scenarios may underestimate impacts in that not all hardware would be removed. Therefore, within certain resource sections of the *Final Environmental Impact Statement for the NASA Sounding Rockets Program at Poker Flat Research Range (PFRR EIS)*, ranges of potential impacts are presented for the reader's consideration.

### **F.2 GENERAL ASSUMPTIONS**

For all searches, it is assumed that the search plane would be a two-person, fixed-wing aircraft that would depart from Fairbanks International Airport. Flights to and from the search area would be about 610 meters (2,000 feet) above ground level (AGL) at a speed of approximately 225 kilometers (120 knots) per hour. Once the search area is reached, the plane would fly between approximately 61 meters (200 feet) and 150 meters (500 feet) AGL and slow to allow for searching. Searches are assumed to last an average of 2 hours or as long as a single tank of fuel would allow. If a payload is not located on the first search operation, a maximum of 2 days would be spent searching for it. For this analysis, it is assumed that payload search operations would take 2 days and spent stage search operations would take 1 day.

For recovery operations, helicopters are assumed to depart from Fairbanks. Flights to the recovery area would be about 460 meters (1,500 feet) AGL at a speed of approximately 225 kilometers (120 knots) per hour. Once the recovery area is reached, it is assumed that the

helicopter would spend approximately 30 minutes hovering at the recovery site and 2 hours of downtime while the payload or spent stage was rigged for transport away from the site. While transporting a payload or spent stage, it was assumed that the helicopter would fly about 60 to 150 meters (200 to 500 feet) AGL at an average speed of about 65 kilometers (35 knots) per hour. For recovery operations within 50 kilometers (30 miles) of the PFRR launch site, it was assumed that the recovered object would be flown back to the PFRR launch site underneath the helicopter. For distances beyond 50 kilometers (30 miles), it was assumed that the recovered object would be transported to a nearby airstrip (assumed to be within 30 kilometers [20 miles] of the recovery site), where the object would be left for pickup by a fixed-wing transport plane. Objects returned by transport plane to Fairbanks would be trucked from Fairbanks to the PFRR launch site.

In general, spent stages and payloads would not be recovered during the winter months (October through April). Only in special cases, such as recovery of a payload for scientific reasons or response to an off-nominal flight, would a payload or a spent stage be recovered in the winter. In the event of a winter recovery, two helicopters (for safety reasons) would be used to support the recovery.

**F.3 STAGE RECOVERY WITHIN 2 KILOMETERS (1.2 MILES) OF THE PFRR LAUNCH SITE (TARGETING TALOS [1ST STAGE BLACK BRANT XII], TERRIER [1ST STAGE TERRIER-IMPROVED ORION], OR TERRIER [1ST STAGE BLACK BRANT X])**

On its way to search for a more distant spent stage or payload, a two-person search plane would briefly search the immediate area near the PFRR launch site for the spent stage in question. After the spent stage was located, the search plane would mark the location using global positioning system (GPS) coordinates and take pictures of the site for the recovery crew and continue on to its primary search destination.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel back to the PFRR launch site at 65 kilometers per hour (35 knots). The spent stage would be dropped off and the helicopter would return to its base of operations.

In some cases for recoveries close-in to the PFRR launch site, it may be possible to recover the spent stages using an off-road vehicle (*e.g.*, snow machine) without causing any environmental damage in the area. However, to be conservative in terms of estimating the environmental impacts in the *PFRR EIS*, all recovery operations in this area are assumed to be accomplished with a helicopter. **Table F-1** shows a summary of transportation time and fuel usage for this recovery operation.

**Table F–1. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the State Lands Above the PFRR Launch Site**

	Helicopter Used for Stage Recovery <sup>a</sup>
Travel time	4 hours
Fuel used	450 liters

a. It is assumed that a more robust helicopter would be needed to handle these stages due to their weight.

**Note:** To convert liters to gallons, multiply by 0.26417.

**F.4 STAGE RECOVERY WITHIN 20 KILOMETERS (12 MILES) OF THE PFRR LAUNCH SITE (TARGETING TAURUS [2ND STAGE BLACK BRANT XII])**

A two-person search plane would depart from Fairbanks International Airport and travel toward the recovery site. Once on site, it would circle around searching for the spent stage in question. After the spent stage was located, the search plane would mark the location using GPS coordinates and take pictures of the site for the helicopter crew and return to Fairbanks.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel back to the PFRR launch site at 65 kilometers (35 knots) per hour. The spent stage would be dropped off and the helicopter would return to its base of operations. **Table F–2** shows a summary of transportation times and fuel usage for this recovery operation.

**Table F–2. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the State Lands Above the PFRR Launch Site**

	Fixed-Wing Search Plane	Helicopter Used for Stage Recovery <sup>a</sup>
Travel time	4 hours	5 hours
Fuel used	75 liters	640 liters

a. It is assumed that a more robust helicopter would be needed to handle these stages due to their weight.

**Note:** To convert liters to gallons, multiply by 0.26417.

**F.5 STAGE RECOVERY WITHIN WHITE MOUNTAINS NATIONAL RECREATION AREA (APPROXIMATELY 50 KILOMETERS [30 MILES] FROM THE PFRR LAUNCH SITE) (TARGETING IMPROVED ORION [IO] AND PAYLOAD FROM SINGLE STAGE VEHICLE [30.XXX])**

A two-person search plane would depart from Fairbanks International Airport and travel toward the recovery site. Once on site, it would circle around searching for the spent stage in question. After the spent stage was located, the search plane would mark the location using GPS coordinates and take pictures of the site for the helicopter crew and return to Fairbanks.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel back to the PFRR launch site at 65 kilometers (35 knots) per hour. The spent stage would be dropped off and the helicopter would return to its base of operations. **Table F-3** shows a summary of transportation times and fuel usage for this recovery operation.

**Table F-3. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the White Mountains NRA**

	Fixed-Wing Search Plane	Helicopter Used for Stage Recovery
Travel time	4 hours	5 hours
Fuel used	75 liters	190 liters

**Note:** To convert liters to gallons, multiply by 0.26417.

**Key:** NRA=National Recreation Area.

**F.6 PAYLOAD OR STAGE RECOVERY IN THE YUKON FLATS NWR (APPROXIMATELY 200 KILOMETERS [120 MILES] FROM THE PFRR LAUNCH SITE) (TARGETING IMPROVED ORION [IO] AND PAYLOAD FROM MK 12 T-TIO CONFIGURATION)**

A two-person search plane would depart from Fairbanks International Airport and travel toward the recovery site. Once on site, it would circle around searching for the spent stage or payload in question. After the spent stage or payload was located, the search plane would mark the location using GPS coordinates and take pictures of the site for the helicopter crew and return to Fairbanks.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel to a nearby landing strip at 65 kilometers (35 knots) per hour. The spent stage or payload would be dropped near the landing strip for pickup by a fixed-wing plane, and the helicopter would refuel before returning to its base of operations.

At the landing strip, the spent stage or payload would be loaded onto a chartered fixed-wing transport plane and transported back to Fairbanks, where it would be loaded onto a flatbed truck and transported to the PFRR launch site. **Tables F-4** (for spent stages) and **F-5** (for payloads) show a summary of transportation times and fuel usage for this recovery operation.

**Table F–4. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the Yukon Flats NWR**

	<b>Fixed-Wing Search Plane</b>	<b>Helicopter Used for Stage or Payload Recovery<sup>a</sup></b>	<b>Fixed-Wing Transport Plane (from Venetie to Fairbanks)</b>	<b>Flatbed Truck (round trip from Fairbanks to the PFRR launch site)</b>
Travel time	5 hours	6 hours	4 hours	1 hour
Fuel used	130 liters	1,600 liters	450 liters	20 liters

a. It is assumed that a more robust helicopter would be needed to recover these stages because the helicopter would carry extra fuel.

**Note:** To convert liters to gallons, multiply by 0.26417.

**Key:** NWR=National Wildlife Refuge.

**Table F–5. Transportation Times and Fuel Used During Search and Recovery Operations (Payloads) to the Yukon Flats NWR**

	<b>Fixed-Wing Search Plane<sup>a</sup></b>	<b>Helicopter Used for Stage or Payload Recovery<sup>b</sup></b>	<b>Fixed-Wing Transport Plane (from Venetie to Fairbanks)</b>	<b>Flatbed Truck (round trip from Fairbanks to the PFRR launch site)</b>
Travel time	10 hours	6 hours	4 hours	1 hour
Fuel used	260 liters	1,600 liters	450 liters	20 liters

a. Search time and fuel used is doubled assuming a 2-day search for payloads.

b. It is assumed that a more robust helicopter would be needed to recover these stages because the helicopter would carry extra fuel.

**Note:** To convert liters to gallons, multiply by 0.26417.

**Key:** NWR=National Wildlife Refuge.

**F.7 PAYLOAD OR STAGE RECOVERY IN THE VENETIE RESERVATION (APPROXIMATELY 305 KILOMETERS [190 MILES] FROM THE PFRR LAUNCH SITE) (TARGETING PAYLOAD AND IMPROVED-ORION [2ND STAGE FROM MK 70 T-IO CONFIGURATION] OR BLACK BRANT VC MOTOR [2ND STAGE FROM BLACK BRANT X])**

A two-person search plane would depart from Fairbanks International Airport and travel toward the recovery site. Once on site, it would circle around searching for the spent stage or payload in question. After the spent stage or payload was located, the search plane would mark the location using GPS coordinates and take pictures of the site for the helicopter crew and return to Fairbanks.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel to a nearby landing strip at 65 kilometers (35 knots) per hour. The spent stage or payload would be dropped near the

landing strip for pickup by a fixed-wing plane, and the helicopter would refuel before returning to its base of operations.

At the landing strip, the spent stage or payload would be loaded onto a chartered fixed-wing transport plane and transported back to Fairbanks, where it would be loaded onto a flatbed truck and transported to the PFRR launch site. **Tables F-6** (for spent stages) and **F-7** (for payloads) show a summary of transportation times and fuel usage for this recovery operation.

**Table F-6. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the Venetie Reservation**

	Fixed-Wing Search Plane	Helicopter Used for Stage or Payload Recovery <sup>a</sup>	Fixed-Wing Transport Plane (from Venetie to Fairbanks)	Flatbed Truck (round trip from Fairbanks to the PFRR launch site)
Travel time	6 hours	7 hours	5 hours	1 hour
Fuel used	150 liters	2,000 liters	680 liters	20 liters

a. It is assumed that a more robust helicopter would be needed to recover these stages because the helicopter would carry extra fuel.

**Note:** To convert liters to gallons, multiply by 0.26417.

**Table F-7. Transportation Times and Fuel Used During Search and Recovery Operations (Payloads) to the Venetie Reservation**

	Fixed-Wing Search Plane <sup>a</sup>	Helicopter Used for Stage or Payload Recovery <sup>b</sup>	Fixed-Wing Transport Plane (from Venetie to Fairbanks)	Flatbed Truck (round trip from Fairbanks to the PFRR launch site)
Travel time	12 hours	7 hours	5 hours	1 hour
Fuel used	320 liters	2,000 liters	680 liters	20 liters

a. Search time and fuel used is doubled assuming a 2-day search for payloads.

b. It is assumed that a more robust helicopter would be needed to recover these stages because the helicopter would carry extra fuel.

**Note:** To convert liters to gallons, multiply by 0.26417.

**F.8 STAGE RECOVERY IN THE WIND RIVER AREA (APPROXIMATELY 370 KILOMETERS [230 MILES] FROM THE PFRR LAUNCH SITE) (TARGETING BLACK BRANT VC MOTOR [BLACK BRANT XII 3RD STAGE])**

A two-person search plane would depart from Fairbanks International Airport and travel toward the recovery site. Once on site, it would circle around searching for the spent stage or payload in question for as long as a single tank of fuel would allow. After the spent stage or payload was located, the search plane would mark the location using GPS coordinates and take pictures of the site for the helicopter crew and return to Fairbanks.

At a later date, the recovery helicopter would depart from Fairbanks and travel to the location marked by the search plane. The helicopter crew would then land and begin rigging the spent

stage for transport back to the PFRR launch site. During this time, the helicopter would be turned off so no fuel is burned. After the rigging has been completed, the helicopter would recover the spent stage to be transported and would travel to a nearby landing strip at 65 kilometers (35 knots) per hour. The spent stage or payload would be dropped near the landing strip for pickup by a fixed-wing plane, and the helicopter would refuel before returning to its base of operations.

At the landing strip, the spent stage or payload would be loaded onto a chartered fixed-wing transport plane and transported back to Fairbanks, where it would be loaded onto a flatbed truck and transported to the PFRR launch site. **Table F-8** shows a summary of transportation times and fuel usage for this recovery operation.

**Table F-8. Transportation Times and Fuel Used During Search and Recovery Operations (Spent Stages) to the Wind River Area**

	Fixed-Wing Search Plane	Helicopter Used for Stage or Payload Recovery <sup>a</sup>	Fixed-Wing Transport Plane (from Venetie to Fairbanks)	Flatbed Truck (round trip from Fairbanks to the PFRR launch site)
Travel time	7 hours	8 hours	5 hours	1 hour
Fuel used	190 liters	2,300 liters	830 liters	20 liters

a. It is assumed that a more robust helicopter would be needed to recover these stages because the helicopter would carry extra fuel.

**Note:** To convert liters to gallons, multiply by 0.26417.

**F.9 ANNUAL ESTIMATES OF TRANSPORTATION REQUIREMENTS ASSOCIATED WITH THE RECOVERY OF PAYLOADS AND SPENT STAGES UNDER THE DIFFERENT ALTERNATIVES**

**Table F-9** shows the number of attempted recoveries of new and existing spent stages and payloads that are projected to be recovered each year under the different alternatives being considered in the *PFRR EIS*. These numbers assume an average of four new launches per year.

**Table F-9. Annual Projected Recovery of Spent Stages and Payloads**

	No Action Alternative	Alternatives 1 and 3	Alternatives 2 and 4
Payloads	1	2	4
Spent Stages	0	11	16

Payload recoveries are assumed to be from the Venetie Reservation and Yukon Flats National Wildlife Refuge and spent stage recoveries are assumed to be from the various locations discussed above. Using these projected recoveries, the airplane, helicopter, and truck transport times were estimated for each alternative, along with the fuel that would be burned under each alternative, as shown in **Tables F-10** and **F-11**.

**Table F–10. Annual Projected Airplane, Helicopter, and Truck Transport Times (hours)**

	No Action Alternative	Alternatives 1 and 3	Alternatives 2 and 4
Airplane Transit Time	6	30	47
Airplane Search Time	4	28	44
Helicopter Transit Time	3	25	37
Helicopter Down Time	2	26	40
Helicopter Hovering Time	0.5	7	10
Helicopter Recovery Time	0.5	6	9
Airplane Transport Time	2	14	21
Truck Transport Time	1	5	8

**Table F–11. Annual Projected Airplane, Helicopter, and Truck Fuel Usage (liters)**

	No Action Alternative	Alternatives 1 and 3	Alternatives 2 and 4
Airplane	1,000	6,700	10,000
Helicopter	2,000	17,000	25,000
Truck	20	120	180
<b>Total</b>	<b>3,000</b>	<b>23,000</b>	<b>35,000</b>

**Note:** To convert liters to gallons, multiply by 0.26417.

Assuming an average of four launches per year, the following recovery actions would take place. **Table F–12** shows the number and location of recoveries of new and existing spent stages and payloads that are projected to be recovered each year under the different alternatives being considered in the *PFRR EIS*.

**Table F-12. Summary of Recovery Operations Based on an Average of Four Launches per Year**

	Assumes 2 BBXII and 2 T-IO			Assumes 1 BBX and 3 T-IO			
	No Action Alternative	Alternatives 1 and 3	Alternatives 2 and 4	No BLM Authorization Scenario with Alternatives 1 and 3 Recovery	No BLM Authorization Scenario with Alternatives 2 and 4 Recovery	No USFWS Authorization Scenario with Alternatives 1 and 3 Recovery	No USFWS Authorization Scenario with Alternatives 2 and 4 Recovery
New Payloads Recovered	1 from Venetie Reservation	1 from Yukon Flats NWR 1 from Venetie Reservation	Same as Alternatives 1 and 3	2 from Yukon Flats NWR 1 from Venetie Reservation	2 from Yukon Flats NWR 1 from Venetie Reservation	No new launches; therefore, no recovery operations	No new launches; therefore, no recovery operations
Existing Payloads Recovered	0 based on past history	0 based on past history	1 from Yukon Flats NWR 1 from Venetie Reservation	Same as Alternatives 1 and 3	Same as Alternatives 2 and 4	Same as Alternatives 1 and 3	Same as Alternatives 2 and 4
Newly Spent Stages Recovered	0 based on past history	1 from Wind River 1 from Venetie Reservation 2 from Yukon Flats NWR 2 from White Mountains NRA	1 from Wind River 1 from Venetie Reservation 2 from Yukon Flats NWR 2 from White Mountains NRA 2 from ADNR land	1 from Venetie Reservation 3 from Yukon Flats NWR	1 from Venetie Reservation 3 from Yukon Flats NWR 2 from ADNR land	No new launches; therefore, no recovery operations	No new launches; therefore, no recovery operations
Existing Spent Stages Recovered	0 based on past history	1 from Wind River 1 from Yukon Flats NWR 1 from White Mountains NRA 2 from ADNR land	1 from Wind River 1 from Venetie Reservation 2 from Yukon Flats NWR 2 from White Mountains NRA 2 from ADNR land	Same as Alternatives 1 and 3	Same as Alternatives 2 and 4	Same as Alternatives 1 and 3	Same as Alternatives 2 and 4

**Key:** ADNR=Alaska Department of Natural Resources; BB=Black Brant; BLM=U.S. Bureau of Land Management; NRA=National Recreation Area; NWR=National Wildlife Refuge; T-IO=Terrier-Improved Orion; USFWS=U.S. Fish and Wildlife Service.

**F.10 NON-ISSUANCE OF U.S. BUREAU OF LAND MANAGEMENT AUTHORIZATION FOR FUTURE IMPACTS**

If the U.S. Bureau of Land Management (BLM) does not authorize future use of the White Mountains National Recreation Area (NRA) and Steese National Conservation Area (NCA) to the University of Alaska Fairbanks (UAF) for stage/payload impact, NASA would be required to ensure that the 3-sigma dispersion of its stages or payloads could not overlap either of the BLM-managed lands. Search and recovery of historic items could continue within the BLM lands; however, search and recovery of future launched items would be limited to U.S. Fish and Wildlife Service (USFWS), Tribal, and state lands.

Under this scenario, NASA would still perform an average of four launches per year and would perform recovery operations for existing and newly spent payloads and stages as shown under the No BLM Authorization Scenarios with Alternatives 1 through 4 in Table F-12. These launches would be limited to multi-stage rockets such as the Terrier Improved-Orion (T-IO) or Black Brant X (BBX).

These changes to the number of projected recovery operations under this No BLM Authorization Scenario would change the annual projected fuel usage for search and recovery activities as follows: (1) the No Action Alternative requirement under this scenario would not change, (2) up to 24,000 liters (6,300 gallons) would be required for Alternatives 1 and 3 under this scenario, and (3) up to 36,000 liters (9,500 gallons) would be required for Alternatives 2 and 4 under this scenario. When compared to the totals from Table F-11, Alternatives 1 through 4, under this scenario, would use approximately the same amount of fuel, and there would be about the same amount of search and recovery activity.

**F.11 NON-ISSUANCE OF U.S. FISH AND WILDLIFE SERVICE AUTHORIZATION FOR FUTURE IMPACTS**

If USFWS does not authorize future use of the Arctic and Yukon Flats NWRs by UAF for stage/payload impact, NASA would be required to ensure that the 3-sigma dispersion of its stages or payloads could not overlap USFWS lands. Denial of USFWS authorization would preclude NASA from launching all of its multi-stage rockets, and as a result, it is expected that NASA would discontinue funding PFRR altogether. Search and recovery activities associated with future launches would not be needed, and search and recovery activities associated with past launches would be expected to continue for a period of up to 10 years after the USFWS authorization was denied.

Under this scenario, NASA would perform recovery operations for existing payloads and stages as shown under the No USFWS Authorization Scenarios with Alternatives 1 through 4 in Table F-12 for a period of 10 years.

These changes to the number of projected recovery operations under this No USFWS Authorization Scenario would change the annual projected fuel usage for search and recovery activities as follows: (1) the No Action Alternative requirement related to search for new payloads would change due to the cessation of future launches; as a result, no search and recovery activities would take place under this scenario; (2) up to 7,000 liters (1,800 gallons)

would be required for Alternatives 1 and 3 under this scenario; and (3) up to 18,000 liters (4,800 gallons) would be required for Alternatives 2 and 4 under this scenario. When compared to the totals from Table F-11, the No Action Alternative, under this scenario, would not require any fuel; Alternatives 1 and 3, under this scenario, would use approximately 70 percent less fuel; and Alternatives 2 and 4, under this scenario, would use approximately 50 percent less fuel. There would be similar reductions in the amount of search and recovery activity.

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