National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

May 14, 2018

Reply to Attn of: 434

RECORD OF ENVIRONMENTAL CONSIDERATION

Lucy National Environmental Policy Act Compliance

1.0 Introduction

The National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321, et seq.), requires Federal agencies to consider the project's environmental impacts in its decision making process. To comply with NEPA and associated regulations (the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA [40 CFR Parts 1500-1508] and NASA policy and procedures [14 CFR, Part 1216, Subpart 1216.3]), NASA prepared the "Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles," November 2011. The 2011 NASA Routine Payload Environmental Assessment (NRPEA) assessed the environmental impacts of missions launched with spacecraft that are considered routine payloads from existing launch facilities at Cape Canaveral Air Force Station (CCAFS), Florida; Vandenberg Air Force Base (VAFB), California; the United States Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS) in the Republic of the Marshall Islands; NASA's Wallops Flight Facility (WFF), Virginia; and the Kodiak Launch Complex (KLC), Alaska.

Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles, launch sites, and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at VAFB, CCAFS, USAKA/RTS, WFF, KLC, and Kennedy Space Center (KSC). The environmental impacts of launching routine payloads from these sites fall within the range of routine, ongoing, and previously documented impacts that have been determined not to be significant. Spacecraft within the scope of this environmental assessment (EA) meet specific criteria ensuring that the spacecraft, its operation, and decommissioning, do not present any new or substantial environmental or safety concerns.

To determine the applicability of a routine payload classification for a mission, it is evaluated against the criteria defined in the EA using the routine payload checklist (RPC).

2.0 Mission Description

Jupiter's swarms of Trojan asteroids may be remnants of the primordial material that formed the outer planets, and serve as time capsules from the birth of our solar system more than 4 billion years ago. The Trojans orbit in two loose groups that orbit the Sun, with one group always ahead of Jupiter in its path, the other always behind. At these two Lagrange points the bodies are stabilized by the Sun and Jupiter in a gravitational balancing act. These primitive bodies hold vital clues to deciphering the history of the solar system, and perhaps even the origins of life and organic material on Earth.

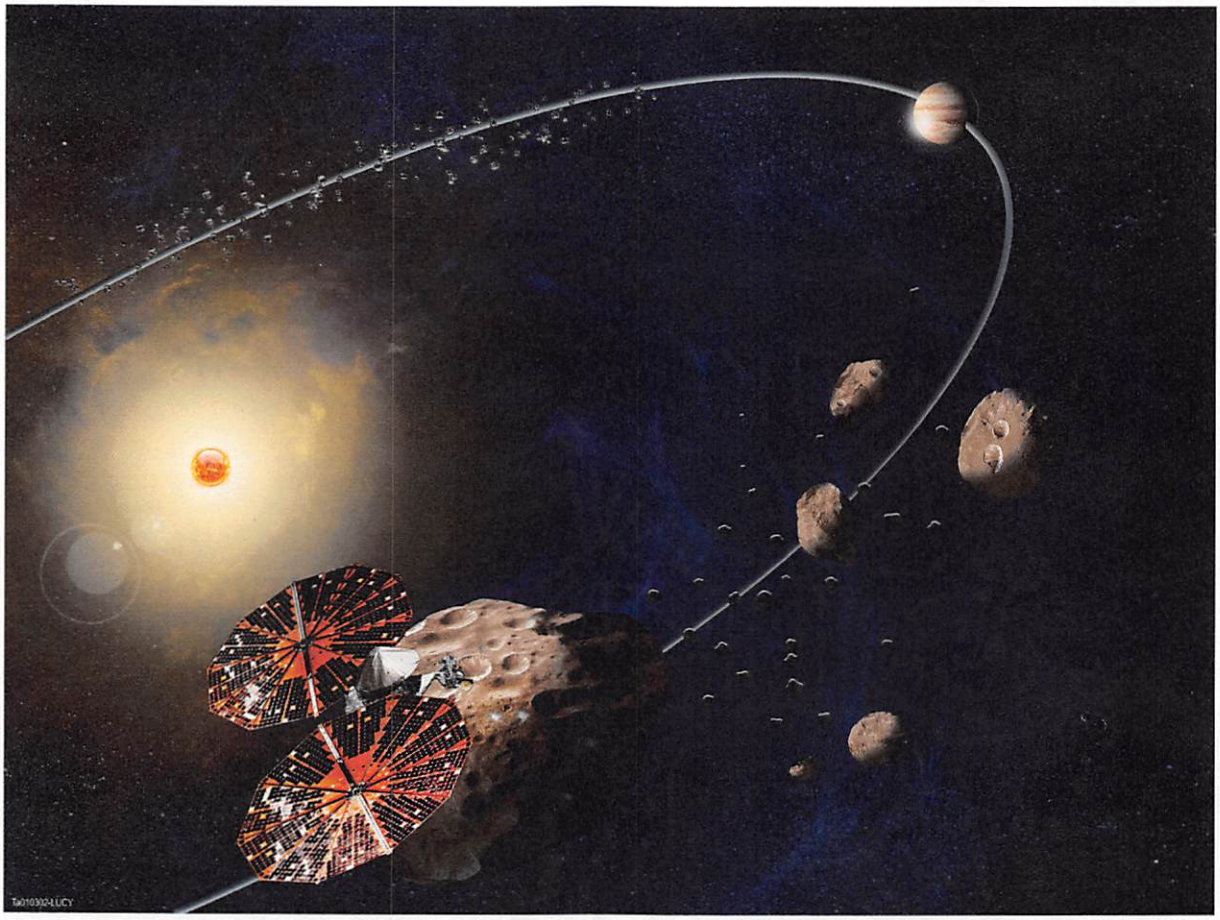
Lucy will be the first space mission to study the Trojans. The mission takes its name from the fossilized human ancestor (called "Lucy" by her discoverers) whose skeleton provided unique insight into humanity's evolution. Likewise, the Lucy mission will revolutionize our knowledge of planetary origins and the formation of the solar system.

Lucy will launch in October 2021 and, with boosts from Earth's gravity, will complete a 12-year journey to seven different asteroids — a Main Belt asteroid and six Trojans, the last two members of a "two-for-the-price-of-one" binary system. Lucy's complex path will take it to both clusters of Trojans and give us our first close-up view of all three major types of bodies in the swarms (so called C-, P-, and D-types).

The dark-red P- and D-type Trojans resemble those found in the Kuiper Belt of icy bodies that extends beyond the orbit of Neptune. The C-types are found mostly in the outer parts of the Main Belt of asteroids, between Mars and Jupiter. All of the Trojans are thought to be abundant in dark carbon compounds. Below an insulating blanket of dust, they are probably rich in water and other volatile substances.

No other space mission in history has been launched to as many different destinations in independent orbits around our sun. Lucy will show us, for the first time, the diversity of the primordial bodies that built the planets. Lucy's discoveries will open new insights into the origins of our Earth and ourselves.

Lucy is a Discovery class mission led by a principal investigator from the Southwest Research Institute in Boulder, Colorado, who, with a team of scientists and engineers, will address key science questions about the solar system. NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, will provide overall mission management, systems engineering, and safety and mission assurance. Lockheed Martin Space Systems in Denver will build the spacecraft. Instruments will be provided by GSFC, the Johns Hopkins Applied Physics Laboratory (JHU/APL) in Laurel, Maryland, and Arizona State University. Discovery missions are overseen by the Planetary Missions Program Office at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama, for NASA's Planetary Science Division.



3.0 NASA Routine Payload Determination

The components utilized in the Lucy spacecraft are made of materials normally encountered in the space industry. The Lucy mission will not utilize radioactive sources, will not carry any pathogenic organisms, and will not return samples to Earth.

The Lucy mission has been evaluated against the 2011 NRPEA, using the RPC (see enclosed evaluation recommendation package). A positive response was indicated on the checklist for Question C.1 "Would the candidate spacecraft be launched on a vehicle and launch site combination other than those indicated in Table C-1 on Page 2?" The Atlas V 401/411 and Falcon Heavy are the possible launch vehicles and all would launch from CCAFS/KSC: LC41, LC40, or LC39A. The Falcon Heavy and LC39A are not listed in Table C.1 of the NRPEA.

The NRPEA allows for the inclusion of launch vehicles and launch sites for which separate NEPA documentation has been prepared. KSC prepared an environmental assessment for launch complexes 39A and 39B which includes the Falcon Heavy as one of the launch vehicles (Final Environmental Assessment for Multi-Use of Launch Complexes 39A and 39B John F. Kennedy Space Center, FL., November 2013). With FAA as the lead agency and

NASA as a cooperating agency, SpaceX has also committed to preparing an EA for the Falcon program.

The Lucy mission does not present any unique or unusual circumstances that could result in new or substantial environmental impacts. Based on the foregoing and the analyses set forth in the 2011 NRPEA, NASA/GSFC has determined that the environmental impacts associated with the Lucy mission will not individually or cumulatively have a significant impact on the quality of the human environment and that a routine payload classification for the mission is applicable. No additional NEPA action or documentation is required at this time. Once launch vehicle selection has occurred, the mission will be reviewed to ensure that a routine payload classification is still valid.

David F. Mitchell
Director of Flight Projects

5/9/18
Date

C. J. Scolese
Christopher J. Scolese
Director

14 May 2018
Date

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
Flight Project Environmental Checklist

Enclosure

NA SA Goddard Space Flight Center
RECORD OF ENVIRONMENTAL CONSIDERATION (REC)

PROJECT NAME: Lucy

1. **Description of proposed action:** The first space mission to study Jupiter's swarms of Trojan asteroids.

   Date and/or Duration of project:

2. **It has been determined that the above action:**

☒ a. Is adequately covered in an existing EA or EIS.
   Title: NASA Routine Payload Environmental Assessment
   Date: November 2011

☐ b. Qualifies for Categorical Exclusion and has no extraordinary circumstances that would suggest a need for an environmental assessment.
   Categorical Exclusion: _____

☐ c. Has no significant environmental impacts as indicated by the results of an environmental checklist and/or detailed environmental analysis.

☐ d. Is exempt from NEPA requirements under the provisions of: _____

☐ e. Will require the preparation of an Environmental Assessment.

☐ f. Will require the preparation of an Environmental Impact Statement.

☐ g. Is addressed under EO12114.
   - ☐ Is exempt from EO12114 requirements under the provisions of: _____
   - ☐ Action not included under EO12114: _____
   - ☐ Qualifies for an EO12114 categorical exclusion: _____
   - ☐ Is adequately covered in existing documentation: _____
   - ☐ Requires an environmental summary document: _____
   - ☐ Requires EO documentation IAW 2-4. (a) i, ii, iii: _____

☐ h. Is not federalized sufficiently to qualify as a major federal action.
☐ i. Other: _____

4/10/18
Michael Donnelly Date
Lucy Project Manager, Code 434

Beth Montgomery 4/9/18
Beth Montgomery Date
GSFC NEPA Manager, Code 250

NASA Routine Payload Evaluation and Determination Process and Checklist

After a proposed spacecraft mission is sufficiently well formulated (usually the Phase B design study), the Sponsoring Entity, in coordination with the local Environmental Management Office (EMO), will prepare an environmental evaluation. An environmental evaluation is a preliminary review that determines what aspects of the proposal are of potential environmental concern. The environmental evaluation also assists in determining the appropriate level of National Environmental Policy Act (NEPA) documentation (i.e., environmental assessment [EA], or environmental impact statement [IEIS]) for the proposal. The local EMO uses a comprehensive checklist to provide a level of rigor to this early evaluation of the proposal, helping to ensure that pertinent considerations are not overlooked. Local EMO review of the Routine Payload Checklist (RPC, below) forms the basis for evaluating the applicability of a NASA Routine Payload (NRP) spacecraft classification for a proposed mission.

The local EMO uses the completed RPC (and required attachments) to evaluate the proposed mission against the NRP EA criteria. If the EMO evaluation of the RPC indicates that a NRP categorization may be appropriate, the Sponsoring Entity documents this in an Evaluation Recommendation Package (ERP). The ERP is then processed for review and approval in accordance with established National Aeronautics and Space Administration (NASA) procedures and guidelines. If approved, the ERP would be attached to a Record of Environmental Consideration (REC).

The Sponsoring Entity can then proceed with the proposal while monitoring the project activities, for changes or circumstances during implementation that could affect classification of the proposed mission as a NRP spacecraft. If a NRP spacecraft categorization is determined to be inappropriate, the local EMO will initiate plans for preparation of additional NEPA documentation.

NASA Routine Payload Checklist

Project Name: Lucy		Date of Launch: October 16, 2021
Project Contact: Michael Donnelly	Phone Number: 301-286-4004	Mailstop: 434
Project Start Date: January 4, 2017	Project Location: GSFC	

Project Description:
Lucy is the first reconnaissance of the Jupiter Trojans. Two swarms of Jupiter Trojans exist, in the regions leading and trailing Jupiter in its orbit around the Sun. Lucy will perform an exhaustive landmark investigation that will visit six of these primitive objects.

	Yes	No
A. Sample Return:		
1. Would the candidate mission return a sample from an extraterrestrial body?	☐	☒
B. Radioactive Materials:	Yes	No
1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?	☐	☒
Provide a copy of the Radioactive Materials On Board Report as per NPR 8715.3 with the ERP submittal.	Attachment	
C. Launch and Launch Vehicles:	Yes	No
1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those indicated in Table C-1 on Page 2?	☒	☐
2. Would the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?	☐	☒

Comments:
AtlasV 401/411 or Falcon Heavy are the possible launch vehicles all from CCAFS: LC41, LC40, or LC39A. The Falcon Heavy and LC39A are not in Table C-1 below.

	Yes	No
D. Facilities:		
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?	☐	☒

Provide a brief description of the construction or modification required, including whether ground disturbance and/or excavation would occur.

	Yes	No
E. Health and Safety:		
1. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellant, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the EPC's in Table C-2 below?	☐	☒
2. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA Standard 8719.14?	☐	☒
3. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload Characteristics?	☐	☒
4. Would the candidate mission, under nominal conditions, release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?	☐	☒
5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?	☐	☒
6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operation (ANSI Z136.1-2007 and ANSI Z136.6-2005)?	☐	☒
7. Would the candidate spacecraft contain, by design (e.g., a scientific payload) pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety Level 1 (BSL 1)[1]?	☐	☒

Comments:

The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices including the use of mechanical pipetting devices, no eating, drinking, or smoking in the laboratory, and required hand-washing after working with agents or leaving a lab where agents are stored. Personal protective equipment such as gloves and eye protection is also recommended when working with biological agents.

NASA Routine Payload Checklist (continuation)

Project Name: Lucy		Date of Launch October 16, 2021
Project Contact: Michael Donnelly	Phone Number: 301-286-4004	Mailstop: 434
Project Start Date: January 4, 2017	Project Location: GSFC	

Project Description:
Lucy is the first reconnaissance of the Jupiter Trojans. Two swarms of Jupiter Trojans exist, in the regions leading and trailing Jupiter in its orbit around the Sun. Lucy will perform an exhaustive landmark investigation that will visit six of these primitive objects.

F. Other Environmental Issues:	Yes	No
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?	☐	☒
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?	☐	☒
3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?	☐	☒

Comments:

Table C-1. Launch Vehicles and Launch Sites

Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Athena I, IIc, III[a]	LC-46	CA Spaceport (SLC-8)	NA	Pad 0	LP-1[a]
Atlas V Family	LC-41	SLC-3	NA	NA	NA
Delta II Family	LC-17	SLC-2	NA	NA	NA
Delta IV Family	LC-37	SLC-6	NA	NA	NA
Falcon I/Ie	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-1
Minotaur I	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur IV[c]	LC-20 and/or LC-46	SLC-8	NA	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	NA	Pad 0	NA
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	NA
Taurus	LC-20 and/or LC-46	SLC-576E	NA	Pad 0	LP-1
Taurus II	NA	NA	NA	Pad 0	LP-3[b]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance.					

a
Athena III is currently under design.
b
LP-3 is currently under design.
c
While not explicitly listed in this table, the Minotaur IV includes all configurations of this launch vehicle, including the Minotaur IV+, which is a Minotaur IV with a Star 48V 4th stage.

Key: CA = California; CCAFS = Cape Canaveral Air Force Station; KSC = Kennedy Space Center; LC = Launch Complex; LP = Launch Pad; MARS = Mid-Atlantic Regional Spaceport; SLC = Space Launch Complex; SLF = Shuttle Landing Facility; USAKA/RTS = United States Army Kwajalein Atoll/Reagan Test Site; VAFB = Vandenberg Air Force Base; WFF = Wallops Flight Facility.

Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Structure	• Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion[a]	• Liquid propellant(s); 3,200 kg (7,055 lb) combined hydrazine, monomethyhydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (RF) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (NiH_2) battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe lasers (see Section 4.1.2.1)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered outside of the scope of this environmental assessment

a
Propellant limits are subject to range safety requirements.

Key: kg=kilograms; lb=pounds.

GSFC Flight Project Environmental Checklist

1. Project/Program	Date:
Discovery Program, Lucy Project	July 11, 2017

2. Schedule

PDR/CDR:	Launch Date:
9/2018, 10/2019	October 16, 2021

3. Current Status

Lucy Project competitively selected January 4, 2017
Entered Phase B on June 14, 2017
Phase C begins January 1, 2019

4. Project Description

a. Purpose:
Lucy is the first reconnaissance of the Jupiter Trojans. Two swarms of Jupiter Trojans exist, in the regions around the L4 and L5 Lagrange points, leading and trailing Jupiter in its orbit around the Sun. Lucy will perform an exhaustive landmark investigation that will visit six of these primitive objects, covering both the L4 and L5 swarms.

b. Spacecraft:
LM providing spacecraft and I&T including the instruments. Heritage is from Juno, OSIRIS-REx and InSight

c. Instruments:
Lucy LOng Range Reconnaissance Imager (L'LORRI): High resolution visible imager; JHU/Applied Physics Laboratory, MD
Lucy Thermal Spectrometer Instrument (L'TES): Thermal IR Spectrometer; ASU/Tempe, AZ
L'Ralph: Panchromatic and color visible imager and IR spectroscopic mapper; GSFC/Greenbelt, MD and SwRI/San Antonio, TX

d. Launch Vehicle:
ULA ATLAS-V 411/401 or SpaceX Falcon Heavy

e. Launch Site:
CCAFB

f. NASAs Involvement/Responsibility: (include other NASA Centers)
GSFC = Project Management, Systems Engineering, Safety and Mission Assurance, L'Ralph instrument
MSFC = Program Office
KSC = LV

g. Participants/Locations:
Southwest Research Institute (SwRI), Boulder, CO; GSFC, Greenbelt, MD; Lockheed Martin, Littleton, CO; Applied Physics Laboratory, Columbia, MD; Arizona State University, Tempe, AZ; KinetX, Simi Valley, CA

h. End-of-Mission Plan: Planned Re-entry (controlled/uncontrolled?)
End of Mission 5/2033. No re-entry. Left in a 5AU orbit

5. Is there anything controversial or unique about the mission, spacecraft or instruments? If yes, Explain. Yes ☐ No ☒

6. Is the mission compliant with NASA requirements for limiting orbital debris (NPR 8715.6, and NASA Standard 8719.14? Explain non-compliances. Yes ☒ No ☐

7. During any phase, does the mission/project include or involve: Check yes for all that apply. If uncertain, check the corresponding box. For all that apply, provide an explanation	Yes	No	Uncertain
A. Fuels	☒	☐	☐
B. Ionizing Radiation Devices/Sources	☐	☒	☐
C. Explosives	☐	☒	☒
D. Hazardous Materials/Substances/Chemicals	☐	☒	☐
E. Lasers (Class, Earth Pointing)	☐	☒	☐
F. Disease Producing Pathogenic Microorganisms/Biological Agents	☐	☒	☐
G. Discharges/Venting of any Substances into Air, Water, or Soil	☐	☒	☐
H. Hazardous Waste Generation	☐	☒	☐
I. High Noise Levels	☐	☒	☐
J. Sample Return to Earth	☐	☒	☐
K. Radio Frequency Communications	☒	☐	☐
L. Construction/Modification/Demolition of a Facility/Lab (onsite - offsite)	☐	☒	☐
M. Land Disturbance, Tree Clearing, Removal of Vegetation	☐	☒	☐
N. Impact on Threatened or Endangered Species	☐	☒	☐
O. Impact/Destruction of Sensitive Wildlife Habitat	☐	☒	☐
P. Impact on Cultural Resources	☐	☒	☐
Q. Impact on Local Social or Economic Conditions (Increase in Traffic, Employment, etc.)	☐	☒	☐
R. Impact on Minority or Low Income Populations	☐	☒	☐
S. New or Foreign Launch Vehicle	☐	☐	☒
T. Other Issues of Potential Environmental Impact	☐	☒	☐
U. Environmental Permits	☐	☒	☐

Additional Information:

8. What Safety Hazards are associated with the mission?

Normal launch from CCAFB. Bi-propellant on Spacecraft

9. Summary of Subsystem Components

Propulsion (Include fuel type, amount, tank size, materials, dimensions	Oxidizer (~300Kg), Titanium, cylinder: ~30"(h)x23"(diameter) and Hydrazine(~400Kg), Titanium, ~30"(h)x23"(diameter)
Communications	X-Band, 25 watts
Structural Materials	graphite/polycynate (M55J/PC) facesheet/aluminum core sandwich construction
Power	Solar, Li-Ion battery (~400 watts)
Science Instruments	See above
Hazardous components (radioactive materials, lasers, chemicals, etc.)	N/A
Other (include dimensions and weight of s/c)	2.83m x 3.52m (launch configuration) 13.57m x 7m (post-launch configuration) Launch mass = 1486kg

GSFC Flight Project Environmental Checklist

Project Manager Printed Name:	Signature Field		
Michael Donnelly			
Project Name:	**Date:**	**Phone Number:**	**Org Code:**
Lucy	4/10/18	301-286-4004	434

Comments: