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

April 3, 2007

Reply to Attn of: 410

MEMORANDUM FOR THE RECORD

National Environmental Policy Act (NEPA) Compliance for Aeronomy of Ice in the Mesosphere (AIM)

1.0 Introduction

The NEPA of 1969, as amended (42 U.S.C. 4321, *et seq.*), requires Federal agencies to consider the environmental impacts of a project in their 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 has prepared an Environmental Assessment (EA) for routine payloads launched on Expendable Launch Vehicles from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB) (Ref: *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida, and Vandenberg Air Force Base, California*, June 2002). The EA assesses the environmental impacts of missions launched from CCAFS and VAFB with spacecraft that are considered routine payloads.

Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles and operational characteristics that are consistent with normal and routine spacecraft preparation and flight activities at VAFB, CCAFS, and the Kennedy Space Center. The environmental impacts of launching routine payloads from VAFB and CCAFS fall within the range of routine, ongoing and previously documented impacts that have been determined not to be significant. Spacecraft covered by this 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 launched from VAFB and CCAFS and coverage under the NASA routine payload EA, the mission is evaluated against the criteria defined in the EA using the Routine Payload Checklist (RPC).

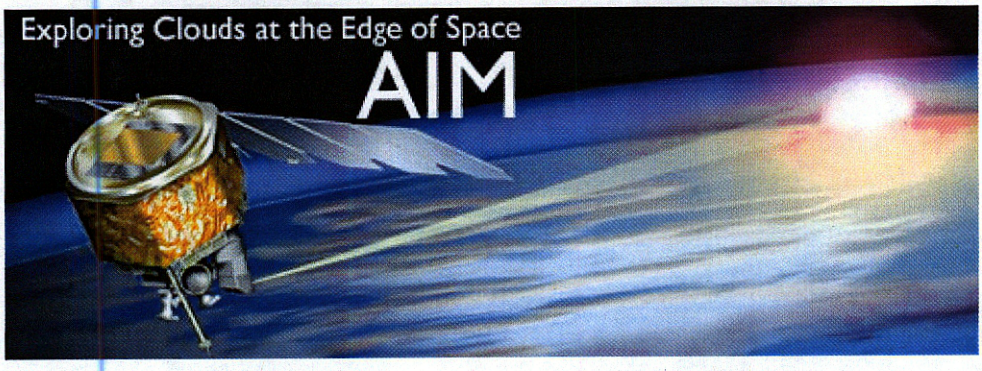
2.0 Mission Description

The AIM experiment is a NASA space mission designed to study the highest clouds in the Earth's atmosphere – clouds at the edge of space. The brightest of these clouds are

made of frozen water, or ice crystals, just like some of the clouds that appear in the sky every day. Unlike more common clouds that form up to six or seven miles above the surface of the Earth, these clouds are 50 miles high in a layer of the atmosphere called the mesosphere. Also, unlike normal clouds, these clouds can only be seen near twilight, when the sun is just below the horizon and the sky is dark. For this reason, they are often called "Noctilucent Clouds," or NLCs, because the word noctilucent means "night-shining." Scientists also call these clouds "Polar Mesospheric Clouds," or PMCs for short, because they usually form only at high latitudes in the north and south polar regions. In recent years, however, several people have reported seeing NLCs at lower latitudes. In the continental United States, NLCs have been reported at latitudes as low as 40°N, in Utah and Colorado. Also, NLCs seem to be getting brighter over time. Scientists do not understand why this is happening, and would like to find out. In particular, they wish to determine if these changes are caused by natural variations in the Earth's atmosphere, or if they are influenced by human activities.

The AIM mission will explore these PMCs to find out why they form and why they are changing. By measuring PMCs and the thermal, chemical and dynamic environment in which they form, AIM will quantify the connection between these clouds and the meteorology of the polar mesosphere. Results from this mission will provide the basis for study of long-term variability in the mesospheric climate and its relationship to global change.

The measurements can only be obtained by a complement of instruments on an orbiting spacecraft because of the need for global coverage and because extinction and foreground emissions compromise optical sensing from the ground.



NASA will launch the AIM satellite on a Pegasus XL from VAFB. It will orbit the Earth for a two year mission. The satellite will have three instruments that provide information about PMCs and their environment. One instrument, called Cloud Imaging and Particle Size Experiment, will take the highest resolution pictures of the clouds ever recorded to determine when and where they form, and what they look like.

Another instrument, called the Solar Occultation for Ice Experiment, will measure the temperature of the mesosphere and how much water vapor is present; to determine what combination of these is necessary to freeze the water into ice crystals that form PMCs.

This instrument will also measure the amounts of other gases to tell scientists more about the chemistry and movement of air in the mesosphere that might lead to cloud formation or evaporation.

The third instrument, called the Cosmic Dust Experiment, measures how much meteoric dust enters the Earth's atmosphere. This is important because scientists want to assess the importance of dust influx in controlling the formation of PMCs.

The components utilized in the AIM spacecraft are made of materials normally encountered in the space industry. AIM will not use any lasers or radioactive materials and will not carry any pathogenic organisms. The AIM mission will not pose any substantial hazards or environmental concerns.

The AIM mission will meet the requirements of NASA Policy for Limiting Orbital Debris Generation (NPD 8710.3) and NASA Safety Standard, Guidelines and Assessment Procedures for Limiting Orbital Debris (NSS 1740.14).

3.0 NASA Routine Payload Determination

The AIM mission has been evaluated against the NASA routine payload EA for launches from CCAFS and VAFB, using the RPC (see enclosed Evaluation Recommendation Package). The evaluation indicates that the mission meets the criteria for a routine payload. The mission does not present any unique or unusual circumstances that could result in new or substantial environmental impacts. Based on this review, it is determined that the AIM mission qualifies as a routine payload and falls within the scope of the reference routine payload EA. No additional NEPA action or documentation is required.

Edward J. Weiler
Director

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: Aeronomy of Ice in the Mesosphere (AIM)

2. Description/location of proposed action: Mission to understand why polar mesospheric clouds form and why they vary

   Date and/or Duration of project: Launch 04/2007

3. It has been determined that the above action:

__X__ a. Is adequately covered in an existing EA or EIS.
   Title: *Final Environmental Assessment for Launch of NASA Routine Payloads on ELVs from CCAFS, Florida and VAFB, California*
   Date: June 2002

___ b. Qualifies for Categorical Exclusion and has no special circumstances which would suggest a need for and Environmental Assessment.
   Categorical Exclusion:

___ c. Is exempt from NEPA requirements under the provisions of:

___ d. Is covered under EO 12114, not NEPA.

___ e. Has no significant environmental impacts as indicated by the results of an environmental checklist and/or detailed environmental analysis.
   (Attach checklist or analysis as applicable)

___ f. Will require the preparation of an Environmental Assessment.

___ g. Will require the preparation of an Environmental Impact Statement.

___ h. Is not federalized sufficiently to qualify as a major federal action.

Beth Montgomery — NEPA Program Manager, Code 250 — 3/1/07
Beth Montgomery — Date

Chris Savinell — Project Manager, Code 410 — 3/2/07
Chris Savinell — Date

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: **Aeronomy of Ice in the Mesosphere** DATE OF LAUNCH: April, 2007

PROJECT CONTACT: Chris Savinell PHONE NUMBER: 6-1339 MAILSTOP: Code 410

PI Institution-Hampton University

PROJECT START DATE: July, 2002 PROJECT LOCATION: PM Institution – LASP/Univ. of Colorado

PROJECT DESCRIPTION: Study Polar Mesospheric Clouds

A. SAMPLE RETURN:	YES	NO
1. Would the candidate mission return a sample from an extraterrestrial body?		X
B. RADIOACTIVE SOURCES:	YES	NO
1. Would the candidate spacecraft carry radioactive materials?		X
2. If Yes, would the amount of radioactive sources require launch approval at the NASA Associate Administrator level or higher according to NPG 8715.3 (NASA Safety Manual)?		
Provide a copy of the Radioactive Materials Report as per NPG 8715.3 Section 5.5.2.		
C. LAUNCH AND LAUNCH VEHICLES:	YES	NO
1. Would the candidate spacecraft be launched using a launch vehicle/launch complex combination other than those indicated in Table 1 below?		X
2. Would the proposed mission cause the annual launch rate for a particular launch vehicle to exceed the launch rate approved or permitted for the affected launch site?		X
Comments:		
D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?		X
2. If Yes, has the facility to be modified been listed as eligible or listed as historically significant?		
Provide a brief description of the construction or modification required:		
E. HEALTH AND SAFETY:	YES	NO
1. Would the candidate spacecraft utilize any hazardous propellants, batteries, ordnance, radio frequency transmitter power, or other subsystem components in quantities or levels exceeding the Envelope Payload characteristics (EPCs) in Table 2 below?		X
2. 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 (EP)?		X
3. Would the candidate mission release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?		X
4. Would launch of the candidate spacecraft suggest the potential for any substantial impact on public health and safety?		X
5. Would the candidate spacecraft utilize a laser system that does not meet the requirements for safe operation (ANSI Z136.1-2000 and ANSI Z136.6-2000)? For Class III-B and IV laser operations, provide a copy of the hazard evaluation and written safety precautions (NPG 8715.3).		X
6. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health?		X
Comments:		

NASA Routine Payload Checklist (2 of 2)

PROJECT NAME: **Aeronomy of Ice in the Mesosphere** DATE OF LAUNCH: April, 2007

PROJECT CONTACT: Chris Savinell PHONE NUMBER: 6-1339 MAILSTOP: Code 410

PI Institution-Hampton University

PROJECT START DATE: July, 2002 PROJECT LOCATION: PM Institution – LASP/Univ. of Colorado

PROJECT DESCRIPTION: Study Polar Mesospheric Clouds

F. OTHER ENVIRONMENTAL ISSUES:	YES	NO
1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?		X
2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?		X
Comments:		

Table 1: Launch Vehicles and Launch Pads

Launch Vehicle	Eastern Range (CCAFS Launch Complexes)	Western Range (VAFB Space Launch Complexes)
Atlas IIA & AS	LC-36	SLC-3
Atlas IIIA & B	LC-36	SLC-3
Atlas V Family	LC-41	SLC-3
Delta II Family	LC-17	SLC-2
Delta III	LC-17	N/A
Delta IV Family	LC-37	SLC-6
Athena I & II	LC-46 or -20	California Spaceport
Taurus	LC-46 0r -20	SLC-576E
Titan II	N/A	SLC-4W
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB airfield

Table 2: Summary of Envelope Spacecraft Subsystems and Envelope Payload Characteristics (EPC)

Structure	**Unlimited:** aluminum and titanium **Limited:**
Propulsion	none
Communications	One 5 W (RF) S band transmitter
Power	Solar cells; 23 A-Hr (Ni-H_2) battery
Science instruments	3 instruments, all passive: SOFIE (Solar Occultation for Ice Experiment) CIPS (Cloud Imaging and Particle Size) CDE (Cosmic Dust Experiment)
Other	none

NEPA Environmental Checklist

1. Project/Program

Aeronomy of Ice in the Mesosphere (AIM)

2. Points of Contact

Principal Investigator: Dr. James Russell III Hampton U Telephone: (757) 728-6893
Project Manager: Mike McGrath LASP Telephone: (303) 492-8482
GSFC Mission Manager: Chris Savinell Code 410 Telephone: (301) 286-1339
S/C Manager: Dave Oberg Orbital Sciences Telephone: (703) 948-8236
CIPS/CDE Instrument Manager: Mark Lankton LASP Telephone: (303) 492-7915
SOFIE Instrument Manager: Lorin Zollinger SDL Telephone: (435) 797-4609

3. Schedule

Formulation Process (Phase A/B): May 2001 to March, 2004
Implementation Process (Phase C/D): March 2004 to April 2007
Launch Date: April 25, 2007
Other Milestone Dates: PDR – January 2004, CDR – November 2004, Obser. I&T – November-2005

4. Current status

In process of completing Observatory environmental testing, and preparing for PSR on February 26, 2007

5. Project Description

a. Purpose/Need: Objective of the AIM mission is to understand why polar mesospheric clouds (PMCs) form and why they vary. AIM will study the microphysics of polar mesospheric clouds as well as the environment in which they form.

b. Spacecraft/Instruments:

Spacecraft: OSC provided 3-Axis stabilized spacecraft;
Instruments : (CIPS) Cloud Imaging and Particle Size
(SOFIE): Solar Occultation For Ice Experiment
(CDE): Cosmic Dust Experiment

c. Launch Vehicle: Pegasus XL
d. Launch Site: VAFB , VAFB Airfield
e. Alternatives (to or for the mission): None

f. NASA's Involvement/Responsibility: AIM is a PI Mode mission sponsored by NASA Headquarters, the Science Mission Directorate (SMD), and is managed by the Explorers Program Office/ Goddard Space Flight Center.

g. Participants/Locations: PI Institution – Hampton University
Major Partners – LASP/University of Colorado
- Orbital Sciences Corporation/Dulles VA
- Space Dynamics Lab/ Utah State University
-GATS, Inc, Newport News, VA

h. Mission Life: 24 month primary mission,

i. End of mission, Re-entry: April, 2009; TBD

6. Is there anything controversial about the mission?

No

7. Is there anything unique, unusual, exotic about the mission, spacecraft, and instruments?

No

8. Is there any environmental documentation for spacecraft, launch vehicle (NEPA or EO12114)?

MSPSP covers this .

9. Is the mission compliant with NASA policy and guidelines for Orbital Debris? (NPD 8710.3 and NSS 1740.14)

Yes. AIM Observatory is fully assembled and calculations show the total debris casualty area is below the 8 square meters reentry footprint requirement. The Total Casualty Area is 2.6 m^2) for the Observatory and 3.4 m^2 for the Launch Vehicle.

10. Has an Air Force Form 813 been completed? (Please attach copy)

Yes

11. Does the mission include or involve:

Check all that apply. If uncertain indicate with a "?"
For all that apply provide an explanation. Use the additional space below if needed.

a. Fuels
b. Radioactive Material
c. Explosives
d. Chemicals
e. Hazardous Materials/Substances
f. Lasers (Class, Earth Pointing)
g. Disease Producing Pathogenic Microorganisms
h. Construction/Modification of a Facility
i. Discharges of any substances into air, water, or soil
j. Generation/Use/Storage/Disposal of Toxic or Hazardous Substances
k. Generation of Hazardous Wastes

l. Generation of High Noise Levels marman clamp explosive bolts
m. Sample Return to Earth
n. Generation of Ionizing or Nonionizing Radiation
o. Impact on Local Social or Economic Conditions
p. Removal of Vegetation or Destruction of Habitat
q. Impact/Affect on Minority or Low Income Populations
r. Affect Any Threatened or Endangered Species
s. Affect Areas of Historical or Cultural Significance
t. New or Foreign Launch Vehicle
u. Other Issues of Potential Environmental Impact

12. What hazards are associated with the mission?

Chris Scolese — 3/1/07

GSFC Mission Manager, Code 410 — **Date**

Explanations

Summary of AIM Subsystems

Structural Materials	Aluminum; Aluminum Alloy; limited titanium and stainless steel fasteners and fittings;
Propulsion	None on board spacecraft.
Communications	5 W S-Band Transceiver
Power	GaAs solar cells, 23 A-hr NiH2 battery
Science instruments	(CIPS) Cloud Imaging and Particle Size (SOFIE): Solar Occultation For Ice Experiment (CDE): Cosmic Dust Experiment
Other (include dimensions and weight of s/c)	Height 55", Diameter 44", Weight 205 Kg.

Examples

Summary of CONTOUR Subsystems

Structural Materials	aluminum; aluminum/magnesium alloy; graphite-epoxy composites
Propulsion	monopropellant; 75 kg (165 lb) hydrazine STAR 30 SRM; 466 kg (1025 lb) AP-based solid propellant
Communications	15 W X-band transmitter
Power	GaAs solar cells, 9 A-hr NiCd battery
Science instruments	(CRISP) imager/spectrograph (CFI) Imager (NGIMS) mass spectrometer (CIDA) dust analyzer
Other	two Class C EEDs used to deploy instrument covers

EED Electro Explosive Device

Summary of MESSENGER Subsystems

Structural Materials	graphite-cyanate-ester composite; selected aluminum and/or magnesium alloy and/or titanium housings	
Propulsion	mono- and bipropellant; 361 kg (794 lb) hydrazine; 236 kg (519 lb) nitrogen tetroxide	
Communications	11 W X-band transmitter	
Power	solar cells, 23 A-hr Ni-H_2 battery	
Science instruments	(MDIS) Imager (MAG) magnetometer (MASCS) UV/VIS/IR spectrometer (EPPS) energetic particle and plasma detector	(GRNS) Gamma-Ray and neutron detector (XRS) X-Ray detector (MLA) laser altimeter (RS) radio science (uses spacecraft telecom system)
Other	4 kg (8.8 lb) beryllium in MLA electronics housing; Class C EEDs used to deploy solar array, MAG boom, and instrument covers	

Orbital Debris Assessment of the Aeronomy of Ice in the Mesosphere (AIM) Spacecraft

Scott Hull, Orbital Debris Engineer
Code 592, Goddard Space Flight Center Greenbelt, MD

Executive Summary

An Orbital Debris Assessment has been performed in accordance with NASA Safety Standard NSS 1740.14 for the AIM spacecraft, which is expected to launch in 2006, reentering the atmosphere no later than 2018. This analysis was performed in conjunction with the mission Critical Design Review (CDR), and involved the use of both DAS 1.5.3 and ORSAT 5.5 software. The review comments from the Orbital Debris Program Office regarding the earlier PDR report have been addressed in this assessment report. The assessment indicates that all of the guidelines contained within NSS 1740.14 will be met by the current mission plan and spacecraft design. Of particular importance was the reentry survivability analysis, which indicated that two object types (five total pieces) of debris could survive reentry , producing a total debris casualty area of approximately 2.6 m^2. For the AIM inclination of 97 degrees, this equates to a worst case risk of less than 1 in 35,000 of injuring one person for an uncontrolled reentry. **The AIM spacecraft is compliant with respect to all guidelines, as summarized in the following table.**

Guideline Number	Description	Met	Not Met	Not Applicable	Comments
3-1	Operational Debris - LEO	X			No operational debris released during the mission
3-2	Operational Debris – GEO			X	AIM is not a GEO mission
4-1	Explosions – During Mission	X			NiMH battery design prevents explosion; no other sources of pressure or chemical reaction
4-2	Explosions - After Mission	X			Spacecraft is intended to be passivated upon completion of mission
4-3	Intentional Breakup - Long Term			X	No intentional breakup planned
4-4	Intentional Breakup - Short Term			X	No intentional breakup planned
4-5	Intentional Breakup - Reentry			X	No intentional breakup planned
5-1	Collisions – Large Debris	X			$P_{impact} \leq 0.00001$
5-2	Collisions – Small Debris			X	Passive disposal, no propulsion
6-1	Disposal – LEO	X			Option A, uncontrolled atmospheric reentry; orbit lifetime <10 years
6-2	Disposal – GEO			X	AIM is not a GEO mission
6-3	Disposal – 12-Hour Orbits			X	AIM is not a 12-hour orbit mission
6-4	Disposal – Reliability	X			Passive disposal, no operations necessary
7-1	Reentry Survivability	X			DCA = 2.61 m^2, Risk < 1 in 35,000

This updated assessment includes information from the Launch Services Program at Kennedy Space Center (KSC) for the AIM Pegasus XL launch vehicle (contact Eric Haddox, Mission Analysis Engineer). Sections 9 through 14 describe the launch vehicle. **The launch vehicle is compliant with respect to all guidelines, as summarized in the following table.**

Guideline Number	Description	Met	Not Met	Not Applicable	Comments
3-1	Operational Debris - LEO	X			No operational debris released during the mission
3-2	Operational Debris – GEO			X	AIM is not a GEO mission
4-1	Explosions – During Mission	X			KSC is working with OSC to obtain data needed to accurately assess explosion risk.
4-2	Explosions - After Mission	X			
4-3	Intentional Breakup - Long Term			X	No intentional breakup planned
4-4	Intentional Breakup - Short Term			X	No intentional breakup planned
4-5	Intentional Breakup - Reentry			X	No intentional breakup planned
5-1	Collisions – Large Debris	X			
5-2	Collisions – Small Debris			X	Passive disposal, no propulsion
6-1	Disposal – LEO	X			Nominal mission compliant; dispersed mission potentially non-compliant due to large in-flight performance variations.
6-2	Disposal – GEO			X	AIM is not a GEO mission
6-3	Disposal – 12-Hour Orbits			X	AIM is not a 12-hour orbit mission
6-4	Disposal – Reliability	X			Passive disposal, no operations necessary
7-1	Reentry Survivability	X			

REQUEST FOR ENVIRONMENTAL IMPACT ANALYSIS

Report Control Symbol RCS: 06-012

INSTURCTIONS: *Section I to be completed by Proponent: Sections II and III to be completed by Environmental Planning Function. Continue on separate sheets as necessary. Reference appropriate item number(s).*

SECTION I - PROPONENT INFORMATION

1. TO *(Environmental Planning Function)*	2. FROM *(Proponent organization and functional address symbol)*	2a. TELEPHONE NO.
30 CES/CEVPP	NASA/ELVIS	(805) 605-1012

3. TITLE OF PROPOSED ACTION
Preparation and Launch of the AIM Spacecraft

4. PURPOSE AND NEED FOR ACTION *(Identify decisions to be made and need date)*
See Attached

5. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES *(DOPAA) (Provide sufficient details for evaluation of the total action.)*
See Attached

6. PROPONENT APPROVAL *(Name and Grade)*	6a. SIGNATURE	6b. DATE
Ed Apalategui NASA/ELVIS Environmental Engineer	Edward F. Apalategui	20051103

SECTION II - PRELIMINARY ENVIRONMENTAL SURVEY. *(Check appropriate box and describe potential environmental effects including cumulative effects.) (+ = positive effect; 0 = no effective; - = adverse effect; U = unknown effect)*	+	0	-	U
7. AIR INSTALLATION COMPATIBLE USE ZONE/LAND USE *(Noise, accident potential, encroachment, etc.)*	☐	☑	☐	☐
8. AIR QUALITY *(Emissions, attainment status, state implementation plan, etc.)*	☐	☑	☐	☐
9. WATER RESOURCES *(Quality, quantity, source, etc.)*	☐	☑	☐	☐
10. SAFETY AND OCCUPATIONAL HEALTH *(Asbestos/radiation/chemical exposure, explosives safety quantity-distance, etc.)*	☐	☑	☐	☐
11. HAZARDOUS MATERIALS/WASTE *(Use/storage/generation, solid waste, etc.)*	☐	☑	☐	☐
12. BIOLOGICAL RESOURCES *(Wetlands/floodplains, flora, fauna, etc.)*	☐	☑	☐	☐
13. CULTURAL RESOURCES *(Native American burial sites, archaeological, historical, etc.)*	☐	☑	☐	☐
14. GEOLOGY AND SOILS *(Topography, minerals, geothermal, Installation Restoration Program, seismicity, etc.)*	☐	☑	☐	☐
15. SOCIOECONOMIC *(Employment/population projections, school and local fiscal impacts, etc.)*	☐	☑	☐	☐
16. OTHER *(Potential impacts not addressed above.)*	☐	☐	☐	☐

SECTION III - ENVIRONMENTAL ANALYSIS DETERMINATION

17. ☑ PROPOSED ACTION QUALIFIES FOR CATAGORICAL EXCLUSION (CATEX) OR A2.3.11
☐ PROPOSED ACTION DOES NOT QUALIFY FOR A CATEX; FURTHER ENVIRONMENTAL ANAYLYSIS IS REQUIRED.

18. REMARKS
none

19. ENVIRONMENTAL PLANNING FUNCTION CERTIFICATION *(Name and Grade)*	19a. SIGNATURE	19b. DATE
TARA WISKOWSKI, GS-11	Tara Wiskowski	9 Nov 05