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

June 8, 2009

Reply to Attn of: 427

MEMORANDUM FOR THE RECORD

The National Environmental Policy Act (NEPA) Compliance for Landsat Data Continuity Mission (LDCM) is below:

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 (CEQ) 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 (ELVs) 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 LDCM is the successor mission to Landsat 7. As the first U.S. satellites designed for observing land surfaces, the Landsat satellites have provided the longest continuous record of Earth's surface as seen from space. Landsat gave the world the first unabridged perspective of human-induced large-scale environmental changes such as the rapid expansion of desert cities

like Dubai and Las Vegas, the deforestation of the Amazon rainforest, and the disappearance of the Aral Sea. Landsat-related research has led to the implementation of many socially beneficial applications, such as improved water management techniques, crop insurance fraud reduction, natural disaster relief planning, continental-scale carbon estimates, and extensive cartographic advances.

Landsat satellites have continuously acquired multispectral images of the global land surface since the launch of Landsat 1 in 1972. The Landsat data archive constitutes the longest moderate-resolution record of the global land surface as viewed from space. Because of Landsat's long history and unparalleled data record, data continuity with prior Landsat missions is paramount. LDCM will collect and archive data consistent with its predecessor Landsat satellites to allow comparisons for regional and global change detection.

The LDCM mission objective is to extend the ability to detect and quantitatively characterize changes on the global land surface at a scale where natural and man-made causes of change can be detected and differentiated. The LDCM space and ground systems consist of the following segments:

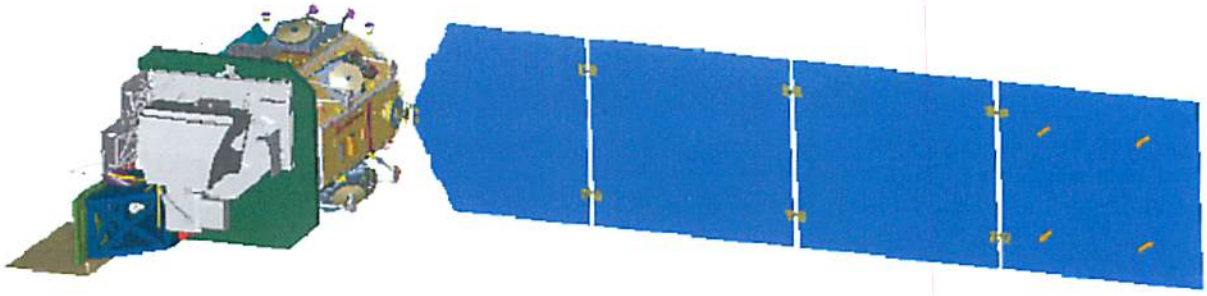
- Space Segment (SS) (spacecraft bus and instrument payloads)
- Launch Support Segment (launch vehicle interfaces/integration)
- Flight Operations Segment (FOS) (mission operations center and communications)
- Data Processing and Archiving Segment (DPAS) (science data processing and archive)

The SS consists of the imaging sensor and the spacecraft platform. The LDCM observatory is anticipated to launch aboard an Atlas V Model 401 launch vehicle from VAFB in December 2012. The observatory will operate in a 716 Km orbit with a 16-day repeat cycle and a 10:00 a.m. (+/- 15 minutes) mean local time for the descending node. Imaging sensor and ancillary data (combined as mission data) will be collected, stored onboard and subsequently downlinked to ground stations within the LDCM Ground Network (LGN) via an X-band communications link. Additionally, a real-time X-band downlink capability will transmit mission (imaging sensor and ancillary) data to the LGN and international cooperators equipped to receive this data. The observatory will also receive and execute commands and transmit real-time housekeeping telemetry via an S-band link to the LGN. This link will also include stored housekeeping telemetry. The ground support equipment provides the functionality to perform ground-based integration and testing of the observatory prior to launch.

The instrument payloads on the LDCM observatory are the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). The OLI is a reflective-band multi-channel Earth-imaging instrument that provides imagery to detect and quantitatively characterize changes on the global land surface at a scale where natural and man-made causes of change can be

detected and differentiated. The OLI has eight multi-spectral bands ranging in wavelength from 433 nm to 1390 nm with spatial resolutions of 30 meters, and one panchromatic visible band with a spatial resolution of 15 meters.

The TIRS is a thermal imaging instrument with two spectral bands that are complementary to the reflective bands sensed by OLI for detecting and quantitatively characterizing land surface change, continuing the record of Earth monitoring in the thermal portion of the electromagnetic spectrum currently sensed by Landsats 5 and 7. The TIRS spectral bands are at 10.8 and 12 micrometers and have a maximum ground sampling distance, both in-track and cross track, of 120m.



The ground system consists of the FOS and the DPAS. The FOS is the portion of the ground system that includes the Collection Activity Planning Element (CAPE), the Mission Operations Element (MOE), and the LGN element. The CAPE develops a set of image collection and imaging sensor(s) calibration activities to be performed by the observatory. The MOE converts the CAPE input to specific imaging sensor and observatory activities, plans, deconflicts, and schedules these activities, commands and controls the observatory, and monitors the health and status of the observatory and ground operating systems. The CAPE and MOE hardware and software systems reside in the LDCM mission operations center located at the NASA/Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. The LGN includes the ground stations that will communicate with the observatory for commanding and monitoring, and will receive mission data from the observatory. The LGN will route mission data and observatory housekeeping telemetry to the DPAS.

DPAS is the portion of the ground system that ingests, processes, and archives all LDCM mission data. The storage and archive element performs ingest and long-term archiving. The image processing element processes all data to create LDCM data products, and performs image assessment. This includes the generation of worldwide reference system-2 scenes, including scene overlap regions. The LDCM independent calibration/validation team interacts with the image assessment capability to assess data quality and update calibration parameters. A capability to receive and fulfill user requests for LDCM image collections and data products is provided by the DPAS user portal element. The DPAS will be located at the US Geological Survey (USGS) Center for Earth Resources Observation and Science (EROS) in Sioux Falls, South Dakota.

LDCM is being developed and operated through a final implementation agreement established in April 2007 between NASA and USGS. The lead NASA center for LDCM is the GSFC. The lead USGS center for LDCM is the EROS center. The responsibilities for the LDCM

implementation are largely divided between mission segment areas; NASA is responsible for the development of the SS, launch support segment, and the MOE. USGS is responsible for the development of the ground system, excluding development of the MOE. The USGS is also responsible for LDCM mission operations after completion of the on-orbit checkout period. NASA will serve as the system integrator for the entire LDCM and lead the mission systems engineering and mission assurance efforts through the on-orbit checkout period. After on-orbit checkout, primary responsibility for the LDCM mission and its operation transfers from NASA to USGS. After handover, NASA will continue to participate in science data processing and calibration/validation activities.

3.0 NASA Routine Payload Determination

The components utilized in the LDCM spacecraft are made of materials normally encountered in the space industry. LDCM will not use any radioactive materials or lasers. LDCM will not carry any pathogenic organisms, nor will LDCM return samples to Earth. The LDCM mission will not pose any substantial hazards or environmental concerns.

The LDCM 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 LDCM mission qualifies as a routine payload and falls within the scope of the reference Routine Payload EA.

At this point no additional NEPA action or documentation is required. However, NASA is in the process of updating the NASA Routine Payload EA. Once the Agency issues the final updated EA, NASA will review the potential environmental impacts of the proposed LDCM mission in the context of the new analysis and information contained in the updated EA. If NASA determines that there are substantial new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, NASA will formally reopen the NEPA process for this mission.

for George W. Morrow
Director of Flight Projects

Robert Strain
Director

Enclosure

EVALUATION RECOMMENDATION PACKAGE

Record of Environmental Consideration
Routine Payload Checklist
NEPA Environmental Checklist

Enclosure

RECORD OF ENVIRONMENTAL CONSIDERATION

1. Project Name: Landsat Data Continuity Mission (LDCM)

2. Description/location of proposed action: Mission to continue the Landsat series of multispectral earth observations from the traditional 705 km polar orbit.

   Date and/or Duration of project: Launch 12/2012

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 — 5/27/09
Beth Montgomery — Date

William Ochs — Project Manager, Code 427 — 5-28-09
William Ochs — Date

GSFC Routine Payload Checklist

PROJECT NAME: LANDSAT DATA CONTINUITY MISSION (LDCM)		DATE OF LAUNCH: DECEMBER 2012
PROJECT CONTACT: WILLIAM R. OCHS	PHONE NUMBER: 6-7277	MAILSTOP: 427
PROJECT START DATE: ~2000	PROJECT LOCATION: GSFC BUILDING 16W	

PROJECT DESCRIPTION:
Continue Landsat series of multispectral earth observations from the traditional 705 km polar orbit. 5-year design life. 10 years of fuel.

A. SAMPLE RETURN:	YES	NO
1. Would the candidate mission return a sample from an extraterrestrial body?	☐	☒
B. RADIOACTIVE SOURCES:	**YES**	**NO**
1. Would the candidate spacecraft carry radioactive materials?	☐	☒
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?	☐	☒
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?	☐	☒

Comments:

D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?	☐	☒
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 (EPC's) in Table 2 below?	☐	☒
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)?	☐	☒
3. Would the candidate mission release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?	☐	☒
4. Would launch of the candidate spacecraft suggest the potential for any substantial impact on public health and safety?	☐	☒
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).		
6. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health?	☐	☒
Comments:		
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?	☐	☒
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, magnesium, carbon resin composites, and titanium **Limited:** beryllium [50 kg (110 lb)]
Propulsion	Mono- and bipropellant fuel; 1000 kg (2200 lb) (hydrazine); 1000 kg (2200 lb) (monomethyhydrazine) Bipropellant oxidizer; 1200 kg (2640 lb) (nitrogen tetroxide) Ion-electric fuel; 500 kg (1100 lb) (Xenon) SRM; 600 kg (1320 lb) (AP)-based solid propellant
Communications	Various 10-100 W (RF) transmitters
Power	Solar cells; 150 A-Hr (Ni-H_2) battery; 300 A-Hr (LiSOC) battery; 150 A-Hr (NiCd) battery
Science instruments	10 kW radar ANSI safe lasers (Section 4.1.2.1.3)
Other	Class C EEDs for mechanical systems deployment Radioisotopes limited to quantities that are approved for launch by NASA Nuclear Flight Safety Assurance Manager Propulsion system exhaust and inert gas venting

GODDARD SPACE FLIGHT CENTER
ENVIRONMENTAL CHECKLIST
FOR FLIGHT PROJECTS

1. PROJECT/PROGRAM
Landsat Data Continuity Mission (LDCM)

2. POINTS OF CONTACT

Name:	Code:	Phone No.:
William R. Ochs	427	301 286-7277

3. SCHEDULE

PDR/CDR:	Launch Date:
July 2009 / March 2010	December 2012

4. CURRENT STATUS

Phase B proceeding to Confirmation Review in November 2009

5. PROJECT DESCRIPTION

a. Purpose: Continue Landsat series of multispectral earth observations from the traditional Landsat 705 km polar orbit. 5-year design life. 10 years of fuel.

b. Spacecraft: Being built by General Dynamics Advanced Information Systems, procured through RSDO catalog.

c. Instruments: (1) Operational Land Imager (OLI): a multispectral imager being built by Ball Aerospace & Technologies Corp. (2) Thermal InfraRed Sensor (TIRS): a two-band thermal imager being built in-house at GSFC.

d. Launch Vehicle: Atlas V Model 401

e. Launch Site: Vandenberg, CA

f. NASA's Involvement/Responsibility: Project management; systems engineering; oversight of bus, OLI, and Mission Operations Element (MOE) contracts; science and cal/val; coordination with USGS partner developing ground system and performing mission operations.

g. Participants/Locations: NASA/GSFC. Partner - USGS/EROS in Sioux Falls, SD responsible for ground system development and mission operations.

h. End of Mission, Re-entry:
Baseline controlled re-entry.

6. Is there anything controversial about the mission?

No.

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

No.

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

Similar GD spacecraft have recent flight history on GLAST, GEOEye, and SWIFT. Atlas V is Category III certified, so there must be environmental documentation.

9. Is the mission (s/c and LV) compliant with NASA policy and guidelines for orbital debris (NPD 8710.3 and NSS 1740.14)? Explain non -compliances.

Yes (the updated versions of these documents, NPR 8715.6 and NASA-STD-8719.14). Baseline controlled re-entry. The NPR and STD are applicable documents in our contracts.

10. Has an Air Force Form 813 been completed? *(Please attach copy)*	☐ YES ☒ NO

11. During any phase, does the mission/project 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	Ionizing Radiation Devices/Sources
C √	Explosives
D √	Hazardous Materials/Substances/Chemicals
E	Lasers (Class, Earth Pointing)
F	Disease Producing Pathogenic Microorganisms
G	Discharges of any Substances into Air, Water, or Soil
H	Hazardous Wastes
I √	High Noise Levels
J	Sample Return to Earth
K √	Radio Frequency Communications
L	Construction/Modification/Demolition of a Facility
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/near Areas of Cultural Significance
Q	Impact on Local Social or Economic Conditions (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	Require any Environmental Permit

Additional Information

Fuel: Mono-propellant for station keeping and de-orbit. Explosives: Pyros on L/V clamp band. Hazardous Chemicals: Hydrazine RF Comm.: X-band and S-band. High Noise Levels: Rocket launch will be rather loud.

12. What Safety hazards are associated with the mission?

Nothing special.

13. Summary of subsystem components

Structural Materials	Aluminum, GFRP, Invar
Propulsion	Mono-prop. Hydrazine. 453 kg max load of hydrazine and pressurant. Tank Shell Material: Ti-6Al-4V.
Communications	Fixed full-earth coverage X-band antennas. S-band omnis.
Power	Single wing paddle solar array. Capacity: 4747 W BOL, cell technology: Triple junction GaInP2/GaAs/Ge. Battery: 125 Ah NiH_2
Science Instruments	Operational Land Imager (OLI) Thermal InfraRed Sensor (TIRS)
Hazardous Components (radioactive materials, lasers, chemicals, etc.)	None.
Other (include dimensions and weight of s/c)	Observatory stowed dimensions in neighborhood of 4 m tall x 3m diameter. Mass: Bus (dry) 1544 kg. Propellant and pressurant max load: 460 kg. OLI Payload 450 kg. TIRS payload 200 kg. Total

	launch mass (w/ max fuel load): 2650 kg
PROJECT MANAGER NAME: William R. Ochs	DATE
PROJECT MANAGER SIGNATURE	5-28-09