National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

APR 2 9 2019

RECORD OF ENVIRONMENTAL CONSIDERATION

The National Environmental Policy Act (NEPA) Record of Environmental Consideration (REC) for the Psyche Mission

1.0 Introduction

The National Environmental Policy Act of 1969 as amended (42 U.S.C. 4321, et seq.), requires federal agencies to consider potential environmental impacts during program and project decision-making. NASA must comply with the Council on Environmental Quality (CEQ) regulations for implementing the Procedural Provisions of NEPA [40 CFR Parts 1500-1508], NASA's NEPA regulations [14 CFR, Part 1216, Subpart 1216.3], as well as NASA's NEPA policy [NPR 8580.1]. NASA has also prepared an Environmental Assessment (EA) (Ref: Environmental Assessment (Final) for Launch of NASA Routine Payloads, November 2011) to assess the environmental impacts of missions launched with spacecraft that are considered routine payloads from existing launch facilities.

Spacecraft defined as routine payloads utilize materials, quantities of materials, launch vehicles, launch sites, and operational characteristics that are consistent with normal spacecraft preparation and flight activities at Cape Canaveral Air Force Station (CCAFS) and the Kennedy Space Center (KSC), among others. The environmental impacts of launching routine payloads from these sites falls within the range of routine, ongoing, and previously documented impacts that have been determined not to be significant.

NASA program and projects are responsible for complying with NEPA. The Psyche mission is managed by the Planetary Missions Program Office at NASA Marshall Space Flight Center (MSFC) and the mission has been awarded to NASA's FFRDC, the Jet Propulsion Laboratory (JPL), who will design and construct the payload. As such, the attached Environmental and Facility Checklists were completed by the JPL NEPA Manager and reviewed by the Program Executive at NASA Headquarters. The checklists along with criteria defined in NASA's Routine Payload EA were then used to evaluate whether the subject Psyche mission qualifies for designation as a NASA Routine Payload.

This REC serves to document NASA review and determination under NEPA for the Psyche mission.

2.0 Mission Description

NASA's planned Psyche mission seeks to understand a previously unexplored component of the early building blocks of planets – iron cores.

The Psyche mission will explore one of the most intriguing targets in the main asteroid belt between Mars and Jupiter – a giant metal asteroid, known as 16 Psyche, about three times farther away from the Sun than is the Earth. The asteroid measures about 130 miles (210 kilometers) in diameter and, unlike most that are rocky or icy bodies, is thought to be comprised mostly of metallic iron and nickel, similar to Earth's core. Because Earth's core cannot be measured directly, Psyche offers a unique window into the violent history of collisions and accretion that created terrestrial planets.

The Psyche spacecraft is targeted to launch in summer 2022 and travel to the asteroid using solar-electric (low-thrust) propulsion, arriving in 2026, following a Mars flyby and gravity-assist in 2023. After arrival, the mission plan calls for 21 months spent at the asteroid, mapping it and studying properties.

The Psyche spacecraft will carry a multispectral imager, a gamma ray and neutron spectrometer (GNRS), and a magnetometer; conduct radio science; and include a Deep Space Optical Communication (DSOC) technology demonstration. The multispectral imager consists of a pair of identical cameras designed to acquire geologic, compositional, and topographic data. The gamma ray and neutron spectrometer will detect, measure, and map Psyche's elemental composition. The magnetometer is designed to detect and measure the remnant magnetic field of the asteroid. The Psyche mission will use the X-band radio telecommunications system to measure Psyche's gravity field to high precision. When combined with topography derived from onboard imagery, this will provide information on the interior structure of Psyche. The Psyche mission also will test a sophisticated new laser communication technology that encodes data in photons (rather than radio waves) to communicate between a probe in deep space and Earth.

During the nominal mission, the spacecraft would perform science operations from four staging orbits that become successively closer. The stages are Orbit A for characterization (41 orbits), Orbit B for topographic studies (162 orbits), Orbit C for gravity science (369 orbits), and Orbit D for elemental mapping (585 orbits). Additional information on the spacecraft and planned mission is available at www.nasa.gov/psyche.

3.0 Compliance Documentation and Conclusion

The Psyche mission has been reviewed in accordance with the NASA Routine Payload (NRP) criteria established in the "Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles," dated November 2011 and Finding of No Significant Impact (FONSI) dated November 22, 2011. The Psyche mission will not carry any pathogenic organisms or return samples to Earth.

The GNRS on the Psyche mission would utilize a 0.1 microcurie (3.7 kBq) Cesium 137 calibration source. The total A2 mission multiple would be $1x10^{-8}$ which is less the Envelope Payload Characteristic value of 10. The Radioactive Materials On-Board Report is attached.

Regarding the use of Class IV lasers, the DSOC Project anticipates receiving a Letter of Determination from the Federal Aviation Administration (FAA) stating that the uplink laser is in compliance with Federal Aviation Administration (FAA) requirements for nominal ocular hazard distance. The uplink laser also would be registered with the United States Air Force (USAF) Strategic Command Laser Clearinghouse (LCH), from which the DSOC project anticipates receiving a waiver because it does not exceed the Department of Defense irradiance threshold. The downlink laser from DSOC would have a nominal ocular hazard distance of approximately 50 meters from the laser aperture. The JPL Laser Safety Officer does not anticipate the need for a USAF LCH waiver for the DSOC downlink laser to be operated aboard the Psyche spacecraft.

The completed JPL facility checklist confirms that design and construction of the spacecraft is not expected to require any facility construction activity and will conform with environmental permits and environmental management system plans and commitments. The Psyche mission launch vehicle will be either an Atlas V or Falcon, and launch site either Kennedy Space Center (KSC) or Cape Canaveral Air Force Station (CCAFS). These candidate launch vehicle/launch site combinations fall within the scope of the EA.

Based upon the analyses, NASA has determined that the Psyche mission fits within the envelope payload characteristics described by the 2011 NRP Checklist and therefore, qualifies as a Routine Payload. Any impacts from the mission are anticipated to be minor and transient.

The program is responsible for reviewing any significant changes in the scope of the payload or activities conducted as part of the Psyche mission to ensure they fall within the NASA Routine Payload criteria. If an aspect of the mission falls outside the scope of this REC, additional environmental review and/or documentation will be completed.

4/29/19

Thomas H. Zurbuchen
Associate Administrator
Science Mission Directorate, NASA HQ

Enclosures:
Environmental Evaluation and Request for Categorization of the Psyche Mission as a NASA Routine Payload
Radioactive Materials On-Board Report - Psyche
NASA Routine Payload Environmental Assessment Checklist
JPL Facility Environmental Evaluation Checklist – Psyche
JPL Facility Environmental Evaluation Checklist - DSOC

March 28, 2019

Environmental Evaluation and Request for Categorization of the Psyche Mission as a NASA Routine Payload

The proposed Psyche mission has been reviewed in accordance with the Routine Payload criteria established by the "*Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles,*" and Finding of No Significant Impact (FONSI) dated November 2011 (2011 NRP EA). This review indicates that the Psyche spacecraft fits within the envelope payload characteristics described by the 2011 NRP EA checklist. Therefore, it is requested that NASA designate the Psyche mission as a NASA Routine Payload. Supporting documentation and NASA Routine Payload Checklist are attached for your review.

Signed:

J. Mark Phillips, Manager
Launch Approval Engineering Office

4/1/2019
Date

Signed:

Deputy PM for
Henry W. Stone, Manager
Psyche Project

3/28/2019
Date

Description of Proposed Mission:

Psyche is both the name of an asteroid orbiting the Sun between Mars and Jupiter (officially referred to as (16) Psyche) — and the name of a proposed Discovery mission to visit that asteroid. The Psyche spacecraft would launch from Kennedy Space Center (KSC) or Cape Canaveral Air Force Station (CCAFS), Florida (FL) aboard an Atlas V or Falcon launch vehicle and travel to the asteroid using solar-electric (low-thrust) propulsion (SEP). Following a Mars flyby and gravity-assist in 2023, it would arrive at Psyche in 2026. After arrival, the mission would spend 21 months mapping the asteroid and studying its properties. At the end of its mission, the spacecraft would remain in orbit around the asteroid.

The Planetary Missions Program Office at NASA Marshall Space Flight Center (MSFC) would provide Program Management for Psyche. NASA Jet Propulsion Laboratory (JPL) would provide Project Management; Mission Assurance; Systems Engineering; X-band Telecommunications Subsystem; Psyche Compute Element; Low-power Distribution Assembly; Flight Software; Assembly, Test, and Launch Operations (ATLO); and mission operations. The spacecraft SEP chassis would be managed by a JPL subcontract with SSL (a Division of Maxar), which would also provide the attitude control, propulsion, thermal control, structure and harness subsystems.

The proposed Psyche payload would also include the following JPL-managed instruments:

- Dual fluxgate magnetometers would be supplied by the University of California, Los Angeles (UCLA), in a gradiometer configuration, to characterize the magnetic field of the asteroid. It would be composed of two identical high-sensitivity magnetic field sensors located at the middle and outer end of a 2-meter (m) (6-foot) boom. The Massachusetts Institute of Technology (MIT) would lead the magnetometer investigation. As such, the magnetometer team would be based at the MIT and at UCLA.
- Redundant Multispectral Imagers (MI) would be managed by Arizona State University (ASU) under its contract with NASA and built by Malin Space Science Systems under a subcontract with ASU. The MI would provide high-resolution images using filters to discriminate between Psyche's metallic and silicate constituents. They would also be used to optically navigate to the asteroid. The instrument would consist of a pair of identical cameras designed to acquire geologic, compositional, and topographic data. The purpose of the second camera would be to provide redundancy for the mission-critical optical navigation.
- Gamma Ray and Neutron Spectrometer (GRNS), to be supplied by the Applied Physics Laboratory (APL) at Johns Hopkins University (JHU), would detect, measure, and map Psyche's elemental composition, determine elemental composition, particularly the concentrations of iron, nickel, silicon, and potassium. The GRNS instrument would utilize a 0.1 microcurie (3.7 kBq) Cesium-137 (Cs-137) calibration source. The instrument would be mounted on a 2-m (6-foot) boom to distance the sensors from background radiation created by energetic particles interacting with the spacecraft and to provide an unobstructed field of view.
- The spacecraft's X-Band telecommunication system would serve two purposes. First, it would provide the primary means by which the spacecraft communicates with Earth (commands and telemetry). Second, it would serve as the science instrument for the X-band Gravity Science Investigation that would measure Psyche's gravity field to high precision. When combined with topography derived from onboard imagery, this would provide information on the interior structure of Psyche. The Gravity Science Investigation team would be based at MIT and JPL.
- Psyche would also accommodate and test a Deep Space Optical Communications (DSOC) instrument as a technology demonstration, as described in the Discovery Announcement of Opportunity (AO). DSOC would be a sophisticated new laser communication technology that would encode data in photons (rather than radio waves) to communicate between a probe in deep space and Earth. Using light instead of radio would allow the spacecraft to communicate more data in a given amount of time. The DSOC hardware would be provided as Government furnished equipment (GFE) by NASA to the Psyche project. The DSOC Project Team would be at JPL. The DSOC project would be solely responsible for additional optical ground stations

required for its operation. DSOC would not be required for Psyche to accomplish its Mission Level 1 requirements.

Statement of Purpose and Need:

NASA published a new Strategic Plan in 2018, which includes four strategic themes: Discover, explore, develop, and enable. These themes correspond to NASA's missions of scientific discovery of the Earth, of other worlds, and of the cosmos as a whole; missions of exploration in our solar system with humans and robotic probes that expand the frontiers of human experience; and missions of development that advance new technologies in aeronautics and space systems that allow American industry to create and expand a nascent space marketplace to serve the needs of space exploration, both here on Earth and in near-Earth environments. In addition, the Agency has a number of activities in support areas that enable our missions.

NASA's Strategic Goal 1 is to expand human knowledge though new scientific discoveries. Under Strategic Objective 1.1: Understand the Sun, Earth, Solar System, and Universe, NASA would conduct scientific studies of the Earth and Sun from space, return data and samples from other bodies in the solar system, peer out into the vast reaches of the universe, and play a catalyzing role in lunar robotic exploration by supporting innovative approaches to advancing science. These efforts are guided by National priorities and recommendations from the National Academies' decadal surveys and implemented through a balanced portfolio of programs. Missions for NASA's Discovery program lie outside the bounds of a decadal strategic plan, so the most recent decadal study report, *Visions and Voyages for Planetary Science in the Decade 2013-2022*, makes no recommendations on specific Discovery flight missions. However, the committee emphasized that the Discovery program has made important and fundamental contributions to planetary exploration and can continue to do so in the coming decade.

NASA's Science Mission Directorate (SMD) conducts scientific exploration enabled by the use of space observatories and space probes that view the Earth from space, observe and visit other bodies in the solar system, and peer out into our Galaxy and beyond. The Space Science program portfolio comprises the following areas: flight mission development, research, applications development, and technology development. These areas are responsible for conducting and sponsoring research, collecting and disseminating new observations, developing new technologies and predictive capabilities, and demonstrating innovative and practical uses of the program's data and results for societal benefit. In addition, NASA develops partnerships with other national and international organizations to enhance economic security and environmental stewardship to benefit society.

The Planetary Science Research Program supports investigations to help ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere. The Planetary Science Research portfolio contains specific Program Elements aimed at addressing these strategic objectives.

As part of the Planetary Science Division within SMD, the purpose of NASA's Discovery Program is to offer the scientific community the opportunity to assemble a team and design exciting, focused investigations that complement NASA's larger planetary science explorations. The main objective of the Discovery Program is to enhance human understanding of the Solar System by exploring the planets, their moons, and small bodies such as comets and asteroids.

The Psyche mission would contribute to the above-mentioned goals by exploring a highly improbable metal world, the Psyche asteroid. The Psyche mission would also enable NASA to demonstrate Deep Space Optical Communication (DSOC) at locations in the solar system of interest to NASA (e.g., Mars).

The Psyche mission would seek to understand a previously unexplored component of the early building blocks of planets: iron cores. Psyche would:

- Determine whether (16) Psyche is a core, or if it is unmelted material.
- Determine the relative ages of (16) Psyche's surface regions.
- Determine whether small metal bodies incorporate the same light elements as are expected in the Earth's high-pressure core (silicon, potassium, sulfur, carbon and oxygen).

- Determine whether the asteroid (16) Psyche was formed under more oxidizing or more reducing conditions than Earth's core.
- Characterize (16) Psyche's topography.

Special Considerations:

The following special considerations are applicable to the Psyche project:

• Class 4 Lasers:

The Psyche and DSOC Projects are both in the formulation phase, and the DSOC Project has not yet competed all of the necessary interagency approvals for the ground uplink at the Optical Communication Telescope Laboratory (OCTL) at the Table Mountain Facility (TMF). The DSOC Project anticipates receiving a Letter of Determination from the Federal Aviation Administration (FAA) stating that the uplink laser is in compliance with FAA requirements for nominal ocular hazard distance. The uplink laser also would be registered with the United States Air Force (USAF) Strategic Command Laser Clearinghouse (LCH), from which the DSOC project anticipates receiving a waiver because it does not exceed the Department of Defense irradiance threshold. The downlink laser from DSOC would have a nominal ocular hazard distance of approximately 50 meters from the laser aperture. The JPL Laser Safety Officer does not anticipate the need for a USAF LCH waiver for the DSOC downlink laser to be operated aboard the Psyche spacecraft.

• Cs-137 Calibration Source:

The GRNS instrument would utilize a 0.1 microcurie (3.7 kBq) calibration source. The total A2 mission multiple would be $1x10^{-8}$, which is less the Envelope Payload Characteristic value of 10. The Radioactive Materials On-Board Report is attached.

JPL Facility Requirements:

The Psyche Project and DSOC Project have coordinated with the JPL Environmental Affairs Program Office (EAPO) to ensure Project activities at JPL are within the limits and requirements described by JPL facility permits and environmental documentation. Changes to Project facility needs or requirements would be coordinated with the EAPO to ensure compliance with all pertinent permits and environmental documentation.

The proposed task would include the use of an enclosed laser system in building 161-106. The laser system is operating under a current JPL pre-Occupational Safety Review (pre-OSR). All personnel involved have been trained in Personal Protective Equipment (PPE), safety measures, hazard communication, etc. Thus, the proposed task, conducted according to the requirements of the pre-OSR and safety pre-test reviews, would not pose a substantial threat to worker health and safety.

JPL would receive the flight GRNS instrument in December 2020, which would include a very small 0.1 microcurie (3.7 kBq) Cs-137 calibration source. The JPL Systems Safety Office will work with the Occupational Safety Program Office (OSPO) to receive the Cs-137 source to ensure compliance with JPL's radioactive materials license, and for completion and approval of the Use Authorization (UA) form. All onsite operations involving the radioactive source will be reviewed and approved by both offices.

Radioactive Materials On-Board Report - NPR 8715.3

Radioactive Materials On-Board Report - PSYCHE

1 Isotope	2 Date Arrived On-Board	3 Number of Sources	4 Activity per Source at Arrival (Curies)	5 Isotope Half-Life (years)[1]	6 Activity as of Mission Start (Curies)	7 A2 Limit For Isotope (Curies)	8 Current A2 Multiple for Each Isotope Source	9 Remarks
Cesium-137		1	1.00E-07	3.00E+01	1.00E-07	1.00E+01	1.00E-08	
Total Activity:					1.00E-07			
Mission A2 Multiple (sum of all lines)							**1.00E-08**	

NOTES: This report is best available information as of 09/04/2018. Confirmed changes in radioactive material on-board will be reported via an updated form.
Column 4 activity is individual source activity (Curies) at launch
Column 6 activity is total activity (Curies) at launch for the line item
Column 8 is A2 Multiple at launch for the line item

Approved: Dep PM for Date: Nov 15, 2018

Psyche Project Manager, Henry Stone

[1] - Isotope Half-Life Reference: IAEA Safety Standards, Specific Safety Guide No. SSG-26, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)

Psyche Mission NRP Categorization Request, Final

Evaluation Checklist for Applicability of the NASA Routine Payload Environmental Assessment (NRP EA)

PROJECT NAME: Psyche Mission **LAUNCH DATE:** NET August 2022

PROJECT CONTACT: Robert A. Mase **PHONE:** 818-354-8990 **E-MAIL:** robert.a.mase@jpl.nasa.gov

PROPOSED ACTION DESCRIPTION: Psyche would launch a single spacecraft from KSC, FL, CCAFS, FL, or VAFB, CA, aboard an Atlas V or Falcon 9 launch vehicle. Psyche would travel to the asteroid using solar-electric propulsion. It would also carry the Deep Space Optical Communications (DSOC) technology demonstration and a 0.1 microcurie Cesium 137 calibration source on GRNS.

Note: "YES" responses require explanation in the comment field at the end of each section, and may require the conduct of additional studies or preparation of additional NEPA compliance documentation.	YES	NO
A. Sample Return:		
Would the candidate mission return a sample from an extraterrestrial body?	☐	☑
Comment:		
B.		
Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?	☐	☑
Comment: The Gamma Ray Neutron Spectrometer would carry a 0.1 microcurie Cesium 137 calibration source. The total A2 mission multiple would be 1 x 10-8, which is well below the value of 10 in the EPC and within the signature authority of the NASA Nuclear Flight Safety Assurance Manager. See attached Radioactive Materials On Board Report.		
C. Launch Site and Launch Vehicles:		
1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those listed in Table 1 of this checklist?	☐	☑
2. Would launch of the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?	☐	☑
Comment:		
D.		
Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities? (If YES, provide a brief description below of the construction or modification required, including whether ground disturbance and/or excavation would occur)	☐	☑
Comment:		
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 Envelope Payload Characteristics (EPCs) in Table 2 of this checklist?	☐	☑
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 (EPCs)?	☐	☑
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 the *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles* dated November 2011?	☐	☑
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)?	☑	☐

Evaluation Checklist for Applicability of the NASA Routine Payload Environmental Assessment (NRP EA)

PROJECT NAME: Psyche Mission **LAUNCH DATE:** NET August 2022

PROJECT CONTACT: Robert A. Mase **PHONE:** 818-354-8990 **E-MAIL:** robert.a.mase@jpl.nasa.gov

PROPOSED ACTION DESCRIPTION: Psyche would launch a single spacecraft from KSC, FL, CCAFS, FL, or VAFB, CA, aboard an Atlas V or Falcon 9 launch vehicle. Psyche would travel to the asteroid using solar-electric propulsion. It would also carry the Deep Space Optical Communications (DSOC) technology demonstration and a 0.1 microcurie Cesium 137 calibration source on GRNS.

Note: "YES" responses require explanation in the comment field at the end of each section, and may require the conduct of additional studies or preparation of additional NEPA compliance documentation.	YES	NO
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]?	☐	☑
Comment: Psyche would carry DSOC as a technology demonstration. DSOC would utilize a Class 3b or 4 laser in both the flight and ground terminals. The ground terminal would be at NASA's Table Mountain Facility. FAA and DoD Laser Clearinghouse documentation would be obtained prior to PDR.		
F. Other Environmental Issues:		
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 Envelope Payload Characteristics (EPCs) have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?	☐	☑
Comment:		
G. Applicability of the NASA Routine Payload Environmental Assessment (NRP EA):		

Pending approval by NASA, the NASA Routine Payload Environmental Assessment (NRP EA) ☑ does ☐ does not provide adequate coverage for the proposed action as currently described.

Additional considerations, if any:

Individual Completing Checklist: Janis Graham

Launch Approval Engineer, Psyche

Date of Completion: 10/31/2018

Concurred by NMO NEPA Manager:

Date: 11-15-2018

[1] 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.

Data Tables from NASA "Final Environmental Assessment For Launch Of Nasa Routine Payloads On Expendable Launch Vehicles", November 2011

Table 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)	N/A	Pad 0	LP-1
Atlas V Family	LC-41	SLC-3	N/A	N/A	N/A
Delta II Family	LC-17	SLC-2	N/A	N/A	N/A
Delta IV Family	LC-37	SLC-6	N/A	N/A	N/A
Falcon 1/1e	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-3[b]
Minotaur I	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur IV	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Pegasus XL	CCAFS skidstrip, KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	N/A
Taurus	LC-46 and/or LC-20	SLC-576E	N/A	Pad 0	LP-1
Taurus II/Antares[c]	NA	NA	N/A	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 and LP-3 are currently under design

[b] 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.

[c] The Taurus II LV was renamed Antares after publication of the *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles* in November 2011.

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 2. Summary of Envelope Payload Characteristics (EPCs) 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, monomethylhydrazine 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 (Ni-H_2) battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe use of lasers (see Section 4.1.2.1, Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles, November 2011)
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.

Facility Environmental Evaluation Checklist

This checklist is to be completed by the EAPO in coordination with the JPL program/project manager who proposes on-site activities. This checklist will become part of the environmental impact assessment. No work is to be conducted until this form and any environmental impact assessment has been completed and approved by NASA.

Title of Proposed Action: Psyche	**EAPO ID#** 19EIA14

Description of Proposed Action:
The Psyche project, within NASAs Discovery Program, proposes to send a spacecraft to visit the main-belt metal asteroid (16) Psyche. This small-body rendezvous mission would not include any sample return, combustion-based propulsion systems, or any significant amount of radioactive material. The spacecraft would use Xenon-based electric propulsion and Nitrogen cold gas for attitude control. The Gamma Ray Spectrometer science instrument on the spacecraft would use a very small amount (0.1 microCurie) of CS-137 as a calibration source. The Psyche mission would also include the DSOC (Deep Space Optical Communications) technology demonstration that would employ lasers in the near-infrared region of the electromagnetic spectrum to demonstrate the capability to deliver information rates 10 times faster than conventional deep space telecom systems. As currently envisioned, JPL's Table Mountain facility would be used for DSOC uplink and Caltech's Hale Telescope at Palomar Observatory would be used for DSOC downlink.

Start Date and Duration: 2017 (Launch 2022)	**Today's Date:** Nov 7, 2018
Name of Prog/Project Manager: Robert Mase (Deputy PM)	**Phone:** 818-354-8990
Facility Location: ☑ JPL Oak Grove ☐ GDSCC ☐ TMF	**Proposed Action Bldg/Room:** TBD

Environmental Impacts *(Check appropriate box and provide sufficient details for assessment. Explain any "Yes" and "Maybe" responses in the Assessment field on page 3.)*	Yes	No	May be
A. **Geologic**			
1. Would the proposed action induce erosion (Water/Wind) either on- or off-site?	☐	☑	☐
2. Would the proposed action affect surface stability?	☐	☑	☐
3. Would the proposed action affect agricultural lands?	☐	☑	☐
B. **Water**	Yes	No	May be
1. Would the proposed action affect a natural body of water?	☐	☑	☐
2. Would the proposed action alter storm water flow?	☐	☑	☐
3. Would the proposed action result in a >10% change of facility potable water use (>250GPM)?	☐	☑	☐
4. Would the proposed action impact chemical quality (pH, dissolved solids, organics, etc.) of wastewater or stormwater?	☐	☑	☐
5. Would the proposed action impact physical quality (temperature, suspended solids, etc.) of wastewater or stormwater?	☐	☑	☐
6. Would the proposed action require a modification to the existing stormwater permit?	☐	☑	☐
7. Would the proposed action require a modification to the existing industrial wastewater permit?	☐	☑	☐
C. **Air**	Yes	No	May be
1. Would the proposed action generate objectionable odors?	☐	☑	☐
2. Would the proposed action release toxic substances?	☐	☑	☐
3. Would the proposed action release particulates?	☐	☑	☐
4. Would the proposed action be classified as either a New Source Emission or a major modification to an existing source (SCAQMD Regulation XIII)?	☐	☑	☐
D. **Natural Resources**	Yes	No	May be
1. Would the proposed action affect an undisturbed natural area?	☐	☑	☐
2. Would the proposed action affect game animals and fish?	☐	☑	☐

3. Would the proposed action affect threatened or endangered species?	☐	☑	☐
4. Would the proposed action affect nesting birds?	☐	☑	☐
5. Would the proposed action affect a critical habitat?	☐	☑	☐
6. Would the proposed action affect protected trees (e.g.: oak)?	☐	☑	☐
E. Land Use	**Yes**	**No**	**May be**
1. Would the proposed action affect floodplains/wetlands?	☐	☑	☐
2. Would the proposed action affect off-site land use?	☐	☑	☐
3. Would the proposed action affect on-site land use?	☐	☑	☐
4. Would the proposed action affect aesthetics?	☐	☑	☐
F. Cultural Resources	**Yes**	**No**	**May be**
1. Would the proposed action affect NRHP-Listed Properties?	☐	☑	☐
2. Would the proposed action affect properties eligible or potentially eligible for the NRHP?	☐	☑	☐
3. Would the proposed action affect known historic landmarks?	☐	☑	☐
4. Would the proposed action affect known and/or potential archeological areas?	☐	☑	☐
G. Socio-Economic/Environmental Justice	**Yes**	**No**	**May be**
1. Would the proposed action affect regional employment?	☐	☑	☐
2. Would the proposed action disproportionally affect low income or minority populations?	☐	☑	☐
H. Noise	**Yes**	**No**	**May be**
1. Would the proposed action expose people to severe noise levels (>80dBA)?	☐	☑	☐
2. Would the proposed action increase existing community noise contours?	☐	☑	☐
I. Health and Safety	**Yes**	**No**	**May be**
1. Would the proposed action generate ionizing or non-ionizing radiation?	☐	☐	☑
2. Would the proposed action use pesticides, insecticides, herbicides, fungicides, or rodenticides?	☐	☑	☐
3. Would the proposed action require entry into a confined space?	☐	☑	☐
4. Would the proposed action include the use, acquisition, or storage of toxic or hazardous substances?	☐	☐	☑
5. Would the proposed action generate medical, hazardous, toxic, or radiological waste?	☐	☐	☑
J. CERCLA	**Yes**	**No**	**May be**
1. Would the proposed action affect existing CERCLA infrastructure (e.g.: wells)?	☐	☑	☐
2. Would the proposed action be located in an area of known future CERCLA activity?	☐	☑	☐
3. Would the proposed action result in exposure or disturbance of contaminated soil or groundwater?	☐	☑	☐
K. Activity/Systems	**Yes**	**No**	**May be**
1. Would the proposed action reduce parking?	☐	☑	☐
2. Would the proposed action affect access to utility or infrastructure support systems?	☐	☑	☐
3. Would the proposed action affect roadway transportation systems?	☐	☑	☐
4. Would the proposed action increase hazards to motor vehicles or pedestrians?	☐	☑	☐
5. Would the proposed action require the acquisition or storage of solid waste storage containers?	☐	☑	☐

Assessment:
I. Health and Safety# 1 - In the development of the DSOC flight terminal, non-ionizing radiation would be generated in JPL building 161-112. The proposed activity has been assessed by the JPL LSO and documented in preOSR 17-3370-002. JPL has established processes and procedures in place to comply with DSOC laser operations safety requirements. JPL Occupational Safety Program Office (OSPO) has begun coordination with the DSOC project to prepare for outdoor laser safety compliance, which would include FAA, Laser Clearinghouse, NASA Laser Safety Review Board (LSRB) and JPL Use Authorization requirements. Given that the coordination at this time is preliminary and subject to change, any laser communication operations would not be conducted until the relevant requirements have been fulfilled.

JPL would receive the flight Gamma Ray Spectrometer instrument in December 2020, which includes a very small (0.1microCurie (3700 dps)) CS-137 calibration source. The JPL Systems Safety Office will work with the Occupational Safety Program Office (OSPO) to receive the CS-137 source to ensure compliance with JPL's radiological license, and for completion and approval of the Use Authorization (UA) form. All onsite operations involving the radioactive source will be reviewed and approved by both offices.

Signature of Program/Project Manager: [signature] Date: Nov 7, 2018

Environmental Analysis Determination

Title of Proposed Action: Psyche (including DSOC)

Description of Proposed Action:
The Psyche project, within NASAs Discovery Program, proposes to send a spacecraft to visit the main-belt metal asteroid (16) Psyche. This small-body rendezvous mission would not include any sample return, combustion-based propulsion systems, or any significant amount of radioactive material. The spacecraft would use Xenon-based electric propulsion and Nitrogen cold gas for attitude control. The Gamma Ray Spectrometer science instrument on the spacecraft would use a very small amount (0.1 microCurie) of CS-137 as a calibration source. The Psyche mission would also include the DSOC (Deep Space Optical Communications) technology demonstration that would employ lasers in the near-infrared region of the electromagnetic spectrum to demonstrate the capability to deliver information rates 10 times faster than conventional deep space telecom systems. As currently envisioned, JPL's Table Mountain facility would be used for DSOC uplink and Caltech's Hale Telescope at Palomar Observatory would be used for DSOC downlink.

It has been determined that the above action (choose one):

☑	Qualifies for one or more Categorical Exclusions pursuant to 14 CFR 1216.304(d) and the current NASA Policy Requirement (NPR) which suggests no need for an Environmental Assessment (EA) or Environmental Impact Statement (EIS). List applicable Categorical Exclusion(s): (3)(i) Research, development, and testing in compliance with all applicable Federal, Federally recognized Indian tribe, State, and/or local law or requirements and Executive Orders.
☐	Is exempt from NEPA requirements under the provisions of the (cite superseding law):
☐	Is adequately covered in the following Environmental Assessment (EA) or Environmental Impact Statement (EIS): and dated:
☐	Has no environmental impact as indicated by the result of an existing environmental checklist or analysis (attach checklist or analysis).

Prepared by: Faustino Chirino (JPL EAPO) **Signature:** Faustino Chirino **Date:** Nov 7, 2018

Approved by: Steve Slaten (Environmental and Facilities Manager, NASA Management Office, JPL) **Signature:** [signature] **Date:** 11-08-2018

Facility Environmental Evaluation Checklist

This checklist is to be completed by the EAPO in coordination with the JPL program/project manager who proposes on-site activities. This checklist will become part of the environmental impact assessment. No work is to be conducted until this form and any environmental impact assessment has been completed and approved by NASA.

Title of Proposed Action: DSOC (Deep Space Optical Communication)	**EAPO ID#** 18NEPA14

Description of Proposed Action:
NASA's Deep Space Optical Communication (DSOC) as a technology demonstration project that would use laser communication technology to encode data in photons, rather than radio waves, which could enable future missions to return more data to Earth. As currently envisioned, JPL's Optical Communication Telescope Laboratory (OCTL) at the Table Mountain Observatory would be utilized for uplink to the DSOC flight terminal, and Caltech's Hale Telescope at Palomar Observatory would be used for downlink.

Start Date and Duration: 2017 (Launch 2022)	**Today's Date:** Dec 7, 2017
Name of Prog/Project Manager: William Klipstein	**Phone:** (818) 354-2245
Facility Location: ☑ JPL Oak Grove ☐ GDSCC ☑ TMF	**Proposed Action Bldg/Room:** TBD

Environmental Impacts *(Check appropriate box and provide sufficient details for assessment. Explain any "Yes" and "Maybe" responses in the Assessment field on page 3.)*	Yes	No	May be
A. Geologic			
1. Would the proposed action induce erosion (Water/Wind) either on- or off-site?	☐	☑	☐
2. Would the proposed action affect surface stability?	☐	☑	☐
3. Would the proposed action affect agricultural lands?	☐	☑	☐
B. Water	Yes	No	May be
1. Would the proposed action affect a natural body of water?	☐	☑	☐
2. Would the proposed action alter storm water flow?	☐	☑	☐
3. Would the proposed action result in a >10% change of facility potable water use (>250GPM)?	☐	☑	☐
4. Would the proposed action impact chemical quality (pH, dissolved solids, organics, etc.) of wastewater or stormwater?	☐	☑	☐
5. Would the proposed action impact physical quality (temperature, suspended solids, etc.) of wastewater or stormwater?	☐	☑	☐
6. Would the proposed action require a modification to the existing stormwater permit?	☐	☑	☐
7. Would the proposed action require a modification to the existing industrial wastewater permit?	☐	☑	☐
C. Air	Yes	No	May be
1. Would the proposed action generate objectionable odors?	☐	☑	☐
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Assessment:

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Signature of Program/Project Manager: [signature] **Date:** 6 Dec 2017

Environmental Analysis Determination

Title of Proposed Action: DSOC (Deep Space Optical Communication)

Description of Proposed Action:

NASA's Deep Space Optical Communication (DSOC) as a technology demonstration project that would use laser communication technology to encode data in photons, rather than radio waves, which could enable future missions to return more data to Earth. As currently envisioned, JPL's Optical Communication Telescope Laboratory (OCTL) at the Table Mountain Observatory would be utilized for uplink to the DSOC flight terminal, and Caltech's Hale Telescope at Palomar Observatory would be used for downlink.

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☐	Is exempt from NEPA requirements under the provisions of the (cite superseding law):
☐	Is adequately covered in the following Environmental Assessment (EA) or Environmental Impact Statement (EIS): and dated:
☐	Has no environmental impact as indicated by the result of an existing environmental checklist or analysis (attach checklist or analysis).

Prepared by: Faustino Chirino (JPL EAPO) **Signature:** Faustino Chirino **Date:** Dec 7, 2017

Approved by: Steve Slaten (Environmental and Facilities Manager, NASA Management Office, JPL) **Signature:** SSlaten **Date:** 12-7-17

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