EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

October 15, 2010

The Honorable Bart Gordon
Chairman, House Committee on Science and Technology
United States House of Representatives
2321 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Ralph M. Hall
Ranking Member, House Committee on Science and Technology
United States House of Representatives
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Gordon and Ranking Member Hall:

This letter relates to Section 804 of the National Aeronautics and Space Administration (NASA) Authorization Act of 2008, which directs the Director of the Office of Science and Technology Policy (OSTP) to "(1) develop a policy for notifying Federal agencies and relevant emergency response institutions of an impending near-Earth object threat, if near-term public safety is at risk; and (2) recommend a Federal agency or agencies to be responsible for –

(A) protecting the United States from a near-Earth object that is expected to collide with Earth; and
(B) implementing a deflection campaign, in consultation with international bodies, should one be necessary."

Current and Prospective Near-Earth Object (NEO) Detection Activities

As you are aware, NEOs are asteroids or comets whose orbits bring them within a set distance of the Earth,[1] with a portion of these objects traveling sufficiently close to make an eventual collision a possibility. No NEO large enough to present a hazard is known to be on a collision course with the Earth, and the probability of an impact by such a NEO is extremely low. Nevertheless, incidents of this nature have occurred in Earth's geologic past, and our immediate neighborhood of the Solar System is continually showered by very small, non-hazardous objects. Indeed, a steady stream of these objects enters the Earth's atmosphere on a daily basis, consisting mostly of dust-sized particles and estimated to total some 50 to 150 tons each day. Thus, however remote it may be, the possibility of a future collision involving a more hazardous object should not be ignored.

[1] In general terms, this distance is equivalent to about one-third the average distance of the Earth from the Sun.

Any strategy for addressing the potential hazard of a future NEO impact depends in the first instance on the detection, precision tracking, and characterization of potentially hazardous space objects. However, there are several challenges involved in first finding NEOs that are coming toward the Earth, and then determining whether a collision is likely. Such a determination is contingent upon factors such as the distance, size, orbit, and reflectivity of these objects, as well as the number and capabilities of the telescopes that are involved in the search. This is further complicated by the prospect that the orbits of known objects can be changed by gravitational or solar radiation perturbations, or even collisions with other objects, meaning that periodic monitoring of known NEOs must also be conducted.

Against this backdrop, Congress has provided direction to NASA to pursue enhanced NEO detection activities in various pieces of legislation, including most recently in the 2005 NASA Authorization Act (in a section labeled The George E. Brown, Jr. Near-Earth Object Survey Act), wherein NASA is directed to detect, track, catalogue, and characterize 90 percent of all NEOs with a diameter of 140 meters or greater by 2020. Earlier Congressional direction in 1998 tasked NASA with locating at least 90 percent of all NEOs with a diameter of one kilometer or greater (i.e., those judged by many experts to have the potential to threaten civilization) within ten years.

In pursuit of these Congressionally-directed goals, NASA currently sponsors various activities relating to the search for NEOs, including the international Minor Planet Center (MPC), located at the Harvard-Smithsonian Center for Astrophysics and operating under the auspices of the International Astronomical Union, for the collection and correlation of NEO orbit data; research at two radio telescope facilities to help provide precision tracking and characterization of NEOs; surveys conducted by ground-based optical telescopes; and NASA's NEO Program Office at the Jet Propulsion Laboratory (JPL) for the overall coordination of these efforts and assessments of NEO orbits and impact probabilities. There are also cooperative projects among NASA, the National Science Foundation (NSF, which has a key role within the United States for ground-based astronomical assets), and the U.S. Air Force (USAF), as well as non-government academic and space research organizations. Within this latter category, an important international collaboration exists with the University of Pisa's NEO Dynamic Site in Italy, which performs high-precision orbit determination and trajectory prediction in parallel with NASA's NEO Program Office, allowing analyses from these two organizations to be independently compared and cross-checked.

With respect to the Congressional direction to identify 90 percent of the objects that are one kilometer or greater in diameter, NASA advises that it is now closing in on that objective after twelve years of conducting surveys (updates are provided on the NEO Program website at http://neo.jpl.nasa.gov). As of October 1, 2010, search teams have discovered 903 of these objects (out of an estimated total population of 1,050 NEOs that are one kilometer or larger in diameter) and have determined that only 149 of these objects are in orbits that could ever pose a collision hazard with the Earth -- with none presenting a threat of impact on Earth within the next century. NASA anticipates reaching the 90 percent detection goal for this category of NEOs by the end of 2010.

More generally, this twelve-year search effort has increased the total number of known NEOs from 499 to 7,319, of which 1,142 are thought to be traveling in potentially hazardous orbits (including the 149 objects larger than one kilometer in diameter mentioned above and 993 objects smaller than one kilometer). While this represents genuine and notable progress (see Figure 1),

NASA notes that a large number of the NEOs predicted to exist still remain undiscovered, and many of these could present a potential future hazard to the Earth. To help illustrate this point using the data provided above, 6,416 of the NEOs detected thus far are smaller than one kilometer in diameter, including the 993 objects in this category that are traveling in potentially hazardous

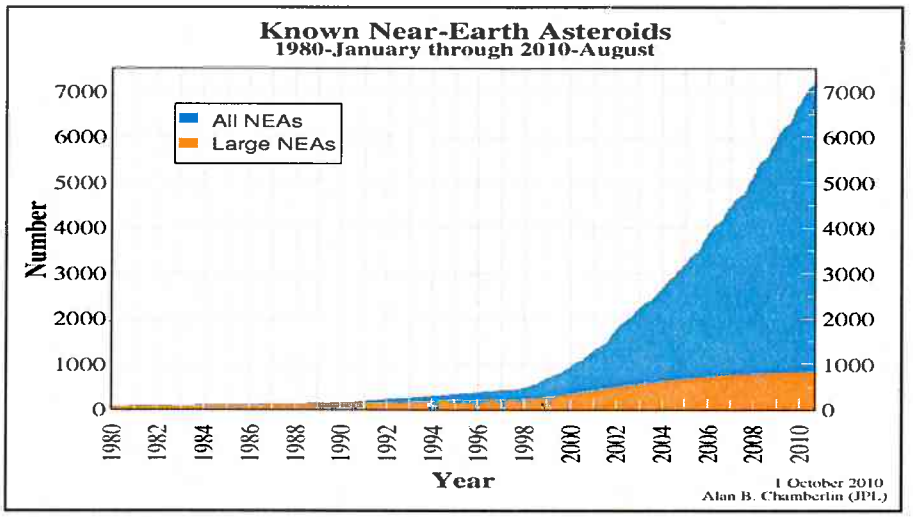

Figure 1. Cumulative history of all NEA discoveries

orbits. However, the latest estimates for the total population of NEOs below one kilometer in size indicate that these 6,416 known objects represent less than five percent of the total number of NEOs projected in this size category (see Figure 2 for a depiction of the status of detection efforts for various size categories). Thus, based upon simple probability, it seems quite likely that there are more than 993 objects of this smaller size traveling in orbits potentially hazardous to the Earth.

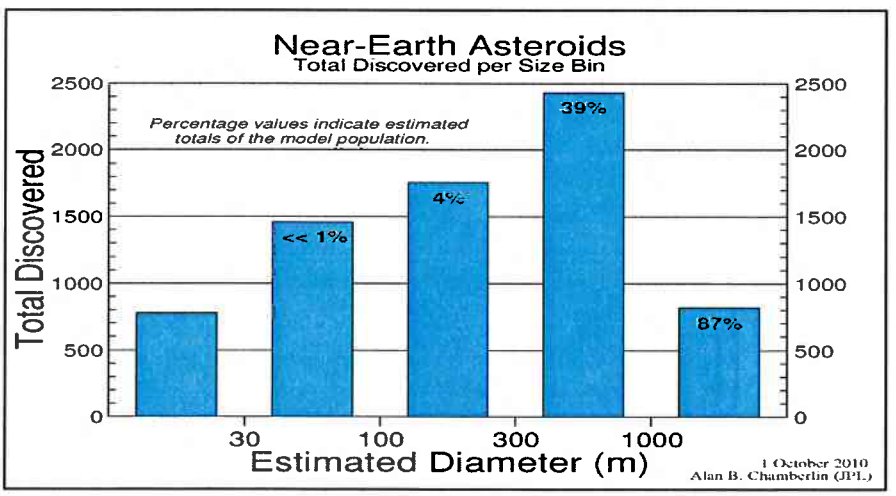

Figure 2. NEA discoveries and estimated completeness for five size categories

In light of such considerations and consistent with its Congressional direction, NASA has continued to pursue additional capabilities for a NEO surveillance program able to detect, track, catalogue, and characterize NEOs down to 140 meters in diameter. In particular, NASA has been seeking to leverage partnerships with various dual-use facilities and spacecraft to further the goal of NEO detection and characterization. For example, NASA has supported the enhancement of the

capabilities of the MPC to enable it to process all NEO observations received from worldwide facilities and disseminate the resulting orbit information without fees via the Internet. With these enhancements, the MPC should be able to accommodate the anticipated significant increase in NEO observation data from world-wide "next generation" search efforts. In addition, NASA has partnered with the USAF Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) program to utilize this system for detection of NEOs that are a few hundred meters in diameter. Although Pan-STARRS has experienced some delays in final development, it is expected to begin regular NEO survey operations soon. As noted earlier, NASA also continues to support interplanetary radar capabilities for precision tracking and characterization of NEOs at its Goldstone Solar System Radar facility in California (part of NASA's Deep Space Network for communication with interplanetary spacecraft) and now also at the NSF's Arecibo radio telescope in Puerto Rico.

In a recent development along these lines, NASA has expanded the utility of its Wide-field Infrared Survey Explorer (WISE) satellite, which was launched in December 2009 for the primary purpose of scanning the sky in infrared frequencies, to help support NEO detection and characterization activities. Under a project known as NEO-WISE, modifications of the ground data processing functions of WISE have enabled automated searches for NEOs using already-collected WISE images. These efforts have resulted in the observation of tens of thousands of asteroids (most of which orbit the Sun in the Main Asteroid Belt, which is located between Mars and Jupiter) and hundreds of known NEOs, as well as the discovery of 119 new NEOs. Nineteen of these newly identified objects are considered potentially hazardous, and seven are greater than one kilometer in diameter. WISE has reached the expected end of its on-board supply of coolant, and NEO-WISE mission operations will conclude by the end of January 2011.

At the same time, NASA is exploring whether other planned wide-field space surveillance systems being developed by U.S. Government (USG) agencies can be utilized in support of NEO detection and tracking efforts. Two planned ground-based facilities of particular interest are the USAF's next generation Space Surveillance Telescope (SST), which is being developed by the Defense Advanced Research Projects Agency and is in the final stages of development, and the proposed Large Synoptic Survey Telescope (LSST), which currently is aiming to begin operations by the end of the decade if approved by NSF and the U.S. Department of Energy, and if funded by Congress. Both systems could provide significant contributions to the search for NEOs, although adapting them for this purpose might require some modifications, and involved agencies likely would need to reach agreements on how the NEO survey mission would be balanced against the primary missions of these systems. Other options include a possible observing spacecraft tailored to the search for NEOs and operating in a solar orbit interior to that of Earth. Recent analyses both by NASA and a National Research Council (NRC)[2] study team suggest that such a spacecraft could significantly accelerate the detection of NEOs 100 meters or larger in diameter, and NASA's experience with space-based telescopes such as Spitzer, Kepler, and WISE indicate that existing technologies should be sufficient for this purpose. Nonetheless, it should be noted that a project of this nature would likely be much more costly than Earth-based telescopes. No plans are in place to

[2] *Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies*, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, National Research Council (NRC), 2010. This report was produced by the NRC at the direction of Congress (in the Consolidated Appropriations Act of 2008).

pursue such a mission, though evaluations of the costs and benefits of this approach relative to other capabilities (such as the SST and LSST) will continue as NEO survey activities progress.

Future international collaboration may also help enhance efforts to discover and characterize NEOs. For example, NASA is sponsoring a science team to work with the Canadian Space Agency (CSA) on collection and processing of data from the CSA's Near Earth Object Surveillance Satellite, which is scheduled for launch in 2011, and a potential bilateral partnership also is being discussed with respect to Germany's planned Asteroid Finder mission. More broadly, NASA, the Department of State (DOS), and other USG agencies are actively engaged in the NEO Working Group of the Scientific and Technical Subcommittee of the United Nations (UN) Committee on the Peaceful Uses of Outer Space (COPUOS), which is promoting more involvement by other nations in dealing with the threat of potentially hazardous NEOs.

Finally, I wish to underscore that various Administration policy and budgetary decisions this year have addressed the subject of NEOs in some form and are expected to buttress ongoing detection and tracking activities going forward. For example, the President's FY2011 budget request for NASA calls for more than a 3.5-fold increase from the enacted FY2010 level (from $5.8 million to $20.3 million) for NEO detection activities. Further, the President's new National Space Policy specifically directs NASA to "pursue capabilities, in cooperation with other departments, agencies, and commercial partners, to detect, track, catalog, and characterize near-Earth objects to reduce the risk of harm to humans from an unexpected impact on our planet and to identify potentially resource-rich planetary objects." This guidance reinforces NASA's roles and responsibilities in this arena and makes clear that cooperation with other organizations will be a key aspect going forward. Finally, the President's new plan for NASA's human space flight activities establishes a goal of conducting a human mission to an asteroid by 2025 – an effort that relates to NEO detection and possible mitigation activities in several ways. Among other things, NEO detection and tracking efforts should provide more candidates for human and robotic exploration programs, allowing NASA to choose a more optimal trajectory and target for this mission. Moreover, the opportunity to comprehensively survey an entire object through both human and precursor robotic missions (and relate carefully collected samples to that object) will represent a scientific milestone in human exploration and could also reveal important information about asteroid composition and structure. The planning, required capabilities, and ultimate execution of such a mission also would parallel most aspects of a potential robotic asteroid deflection mission, providing valuable experience in asteroid rendezvous techniques. As such, considerations relating to potential asteroid mitigation or deflection activities are envisioned as part of the overall mission planning and objectives for this effort.

Notification Procedures for a Potential NEO Threat

OSTP has been working closely with several departments and agencies to determine the plans, mechanisms, and procedures that should be used for notifying local, state, and Federal authorities and emergency response institutions in the unlikely event of an impending NEO threat to the United States. As will be described in more detail below, the essence of the planned notification approach is to utilize existing communications resources and mechanisms resident at the Federal Emergency Management Agency (FEMA) in the Department of Homeland Security (DHS) for this purpose, once an initiating notice has been received from NASA regarding a potential NEO threat. Such domestic notification efforts would be supported by the diplomatic

mechanisms of DOS for international communications as needed. These notification procedures have been exercised and implemented regularly over the last few years, particularly for re-entering human-made space objects (with a prominent recent example being the successful *Burnt Frost* Joint Task Force effort to engage and destroy the non-functioning "USA-193" spacecraft in February 2008). FEMA considers these procedures to be well-understood and applicable to the emergency notifications needed for a potential NEO threat.

FEMA Emergency Notification Procedures. For FEMA to initiate its notification process, it must itself first receive notice of a potential NEO threat from NASA, which will have coordinated the NEO threat information from other organizations within the NEO detection community. This initial notice must be given to the FEMA Operations Center (FOC), the Joint Space Operations Center (JSpOC)[3] within the U.S, Department of Defense (DOD), DOS, appropriate organizations in the Executive Office of the President (EOP), and other relevant Federal officials and organizations, and would include information regarding the predicted time and location of the potential NEO impact, along with an assessment of the uncertainty regarding that prediction. NASA already has instituted communications procedures aimed at this purpose, including direction with regard to public release of such information. These NASA procedures would be set in motion only after the necessary observations, analyses, and characterization efforts had taken place within the NEO community to determine that a space object indeed represented a sufficiently credible threat. Depending upon the perceived level of risk and urgency, such activities could well unfold over the course of many years after initial detection of an object and often would entail various combinations of increased monitoring, cross-checks of any potentially hazardous trajectories as needed, and accelerated orbit-determination efforts in cases where a potential hazard is considered nearer term in nature.

Following this precipitating notice, FEMA would implement its standard emergency notification and response procedures for a space object re-entry incident. FOC watch officers first would coordinate with FEMA leadership to determine what other notifications might be required and in what time frame. In the case of notices received several months or more before a potentially threatening impact, DHS/FEMA would work closely with NASA, DOD, DOS, and other relevant agencies in assessing the potential threat and considering next steps (as well as possible responses), while providing updates to my office and other involved organizations within the EOP as these discussions and analyses progress. For a more imminent threat (but where the impact location was not yet identified), FOC staff would quickly execute FEMA's communications checklist for space object re-entry events, including early-warning conference calls to FEMA response coordination and emergency operations centers as well as state homeland security advisors. NASA and the JSpOC would provide continued updates to the FOC on the projected trajectory and impact location for the NEO throughout this process. Similar information would be communicated at appropriate levels to DOD, DOS, involved EOP offices, and as needed to other agencies.

Once sufficiently accurate trajectory information became available to conclude that the NEO would likely impact in an area that would affect either the United States or its territories,

[3] The JSpOC is operated under the U.S. Strategic Command (USSTRATCOM), one of ten U.S. unified commands under the U.S. Department of Defense. Among other functions, the JSpOC helps conduct USSTRATCOM's mission to (1) detect, track, and identify all human-made objects in low-Earth orbit and (2) support the operational employment of worldwide joint space forces.

FEMA would notify the affected states and territories through the National Warning System (NAWAS), a comprehensive communications system used to convey alerts regarding a broad range of potential incidents to U.S. Federal, state and local governments, as well as potentially involved military and civilian populations. A pre-scripted message for this type of event has been prepared by FEMA with placeholders for information about the size, composition, and possible hazards related to the NEO or other entering space object. Utilizing the NAWAS, the FOC would provide periodic updates regarding the projected impact area as this information became more precisely defined.

In addition to these broad NAWAS transmissions, formal alerts would be provided to the DHS National Operations Center and FEMA's interagency partners for emergency response activities as appropriate and based upon approvals from DHS/FEMA leadership. These agencies would provide support consistent with their statutory authorities and the provisions of the National Response Framework. Further, the National Response Coordination Center (NRCC) in FEMA Headquarters would be activated in accordance with current procedures, as would the applicable Regional Response Coordination Centers (RRCC), located in each of FEMA's ten designated regions. Similar to the responsibilities of the NRCC at the national level, the RRCCs would alert required regional emergency support functions and also would relay information to state and local emergency operations centers as needed. Such communications would be supported using the emergency notification capabilities of the FOC.

DOS International Notification Procedures. In addition to the domestic notification process described above, it will be important to facilitate international notifications to those nations within the projected impact area in an effort to minimize the potential loss of life and property. The United States currently is the world leader in NEO detection activities and will have a vital role to play in such communications, irrespective of whether the direct risk to the United States or its territories is considered low.

Accordingly, DOS has examined the types of detailed international notification procedures that would be appropriate for a potential NEO threat, based upon recent experience with the re-entry of other space objects. DOS anticipates that it first would provide notifications bilaterally through diplomatic channels to potentially affected nations, as well as to member nations in multilateral forums such as the COPUOS and to the UN Office for Outer Space Affairs. Depending upon the circumstances, notifications also could be transmitted through U.S. Missions to the UN Secretary General, the UN Security Council and other applicable UN organizations, the North Atlantic Treaty Organization, and other current or future regional security organizations for land masses and maritime areas potentially at risk. It may also prove useful for USG delegations to brief the COPUOS, the UN Office for Outer Space Affairs, and key member state missions to the UN (when COPUOS is not in session) regarding the details of the projected NEO threat.

As necessary and appropriate, updated notifications would follow regarding the latest assessments of the NEO threat and the status of any response plans to all governments with whom the United States has diplomatic relations (as well as appropriate multilateral organizations). With refined updates and perhaps one day in advance of the predicted impact, final international notifications would be transmitted vis-à-vis the projected impact location and response planning, while DOD notices would be sent to airmen and mariners regarding maritime and airspace restrictions in the area of potential impact.

Emergency Response Procedures for a Potential NEO Threat

FEMA Emergency Response Procedures. FEMA has reported that its emergency response procedures concerning the potential aftermath of a NEO incident are closely coupled to its notification process and would be executed as needed once those notifications have taken place. As mentioned above, the planned approach entails implementation of the standard emergency response procedures and plans for a space object re-entry incident. These procedures can be summarized as follows:

- Activating the NRCC at an appropriate level depending upon the amount of time before a possible impact and the projected damage from an impact.
- Activating RRCCs at appropriate levels depending upon the amount of time before a possible impact, the projected damage, and the anticipated location. As the situation evolves and these projections become more precise, the RRCCs could be allowed to return to normal operations if the NEO in question is either small or expected to impact the Earth in a manner that would cause little damage.
- Placing applicable national Incident Management Assistance Teams (IMAT) on alert status and pertinent Urban Search and Rescue (US&R) Task Forces on advisory status.

For reference, the primary mission of a FEMA IMAT is to rapidly deploy to an incident or incident-threatened venue, provide leadership in the identification and provision of Federal assistance, coordinate inter-jurisdictional responses in support of the affected locale, and support the initial establishment of a unified command structure. FEMA's US&R Response System is a framework for structuring local emergency services personnel into integrated disaster response task forces. Currently 28 of these task forces exist for deployment (along with the necessary tools and equipment) to assist state and local governments in rescuing victims of structural collapse incidents or to assist in other search and rescue missions.

DOS International Response Procedures. In the event of a NEO incident causing significant damage outside of the United States, DOS typically would transmit technical and mitigation strategy assessments to its diplomatic posts after the event, and also would brief the UN and all relevant international organizations with appropriate support from USG technical agencies. Further, subject to the necessary approvals from involved agencies, DOS would convey any U.S. offers of NEO-related disaster relief and assistance to countries requesting aid, including possible participation in humanitarian and disaster-relief response teams.

USG Roles and Responsibilities for Potential Future NEO Mitigation/Deflection Activities

OSTP also has been consulting relevant departments and agencies on the subject of appropriate agency roles and responsibilities for protecting the United States from a potential future NEO threat and implementing a deflection campaign, if such is deemed necessary and appropriate. As described above, an essential first step in preparing for any future NEO mitigation and/or deflection activity is to continue to enhance our capabilities and efforts for detecting these objects. The goal of these efforts should be not only to identify potential NEO hazards, but also to provide as much advance warning of a threat as possible in order to enable more options for mitigation. NASA has been functioning as the lead for this detection effort within the USG, and

this responsibility has been reaffirmed by the new National Space Policy as well as statutory direction.

As you are aware, however, roles and responsibilities for potential NEO mitigation and deflection actions in the future have been less defined to date. Moreover, the USG's assessment of potential mitigation/deflection options is at an early stage of development and not yet ready for implementation, particularly in light of the wide range of possible scenarios and challenges involved. The NRC's recent report on this subject offers helpful insights into the options for NEO mitigation or deflection that appear to be technically viable for many of these scenarios. However, significantly more analysis and simulation are needed to understand aspects such as the feasibility and effectiveness of different mitigation and deflection approaches; the technological capabilities that would be required for such efforts; relative costs and benefits; and corresponding operational concepts and plans. As part of the technology assessment, it would be particularly instructive to conduct an initial "gap" assessment of the capabilities required for potential mitigation/deflection activities relative to those technologies that are either current or soon forthcoming in this area, with the goal of better understanding our potential mitigation posture.

Accordingly, I recommend that NASA take the lead in conducting these foundational analysis and simulation activities as a key preparatory step, with NASA's role at this early stage revolving primarily around the options analysis and an assessment of the technologies that may be applicable to NEO mitigation/deflection (along with preliminary research and development activities concerning such technologies and capabilities, where appropriate). This activity will need to be conducted in close coordination with DOD, DHS/FEMA, and other relevant departments and agencies, with these organizations providing necessary analytical (and other) support in their respective areas of expertise. For example, it will be important for DOD to support the evaluation of any protection options involving military capabilities and resources, as well as the development of a concept of operations for certain mission scenarios. Similarly, DHS/FEMA, in coordination with DOD, NASA, DOS, and other relevant organizations, should conduct a senior-level interagency simulation exercise to explore how the USG and the international community might respond to an impending NEO threat under a variety of scenarios. DHS/FEMA also will play a key role in the continued development and review of pre- and post-impact response plans as capabilities evolve. This recommended incident simulation could build on the lessons learned from a staff-level NEO response exercise that was hosted by the USAF in December 2008 and involved subject matter experts from a range of USG agencies.

As additional elements of this effort, it also is recommended that involved agencies conduct outreach with relevant private-sector stakeholders and organizations in order to leverage work already performed on NEO mitigation and deflection issues. Along the same lines, it will be important to engage other nations and multilateral forums as appropriate to explore potential opportunities for international cooperation in this arena. It bears noting that some multilateral efforts to consider NEO issues are already underway, albeit at an early stage of effort. For example, since 2007 the NEO Working Group of the COPUOS has been seeking to develop a proposed framework for promoting detection of NEOs and considering possible international procedures for handling potential NEO threats. This working group is comprised of governmental experts and ultimately intends to provide formal recommendations on these issues to the COPUOS. Over the last three years the United States also has convened several technical workshops with European Union space experts on space situational awareness topics and

challenges, including the detection of NEOs. Similarly, the International Space Exploration Coordination Group (ISECG), comprised of fourteen space agencies from across the globe, is actively coordinating and compiling plans, capabilities, priorities, and potential mission timelines for human and robotic space exploration, including NEO destinations. Thus the ISECG represents another forum that could be leveraged for multi-lateral planning and information sharing on NEO-related topics.

In my view, this recommended framework is an appropriate and effective way forward with regard to NEO protection issues at this stage. It is important to note, however, that this approach will be subject to further review as more information about NEO mitigation and deflection costs, approaches, and requirements comes to light. This in turn could lead to different philosophies on agency roles and responsibilities in this arena as we continue to consider the most effective way to address these potential threats. It also would be constructive to explore what resources may be needed to support these assessment activities going forward.

Continuing to improve our nation's capabilities and plans both for detecting NEOs and preparing for potential NEO-related threats in the future is a priority for OSTP, and my staff will continue to monitor progress and developments in this arena as we go forward. I appreciate your interest and support regarding this activity, and I look forward to any further dialogue my office may have with you or other members of the Committee on this subject.

Sincerely,

John P. Holdren

John P. Holdren
Director