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LIGO HANFORD OBSERVATORY

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Date: June 15, 1999
Refer to: LIGO-L990188-00-W

Thomas W. Ferns, HRA-EIS Document Manager
U.S. Department of Energy, Richland Operations Office
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Dear Mr. Ferns:

The LIGO Laboratory is pleased to provide these comments to the U.S. Department of Energy in response to the revised draft report DOE/EIS-0222D, entitled "Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan." These comments regard proposed land-use designations for the land on which LIGO is located and adjacent lands. These are part of a large land area in the category "All Other Areas." The LIGO Laboratory is concerned that this plan does not adequately represent the extreme sensitivity of the LIGO facilities to noise and vibration created by other activities on the Hanford site, even though such activities may be at large distances from the Observatory. The Laboratory is particularly concerned that several of the proposed planning alternatives indicate that mining activities would be allowable uses for land adjacent to the LIGO site without a discussion of the nature and physical extent of potential impacts on LIGO operations. It is proposed that language in the draft be changed to more accurately reflect the extreme sensitivity of LIGO to noise and vibration created by activities at great distances and that clarifying information on the nature and extent of this sensitivity be included in appendices to the plan. Good communications between NSF and DOE will be essential in managing land use at Hanford over the lifetime of the proposed land use plan. In furtherance of this goal, one effective mechanism is for NSF to become a cooperating agency in completion of the plan and in procedures to advise on and approve future special permits affecting land use.

LIGO Hanford Observatory is a state-of-the-art scientific facility, operated for the U.S. National Science Foundation (NSF), that is part of an emerging international network of gravitational-wave detectors. LIGO represents the largest investment ever made by the NSF in major research equipment. LIGO uses high-precision laser beams to detect the extremely small motions of mirrors caused by gravitational waves created in deep space. Seismic noise (i.e., natural vibrations of the earth) and noise induced by man-made vibrations can hide or mimic the effect of a gravitational wave. Successful detection of the gravitational waves requires that the Hanford Observatory work in unison with its sister facility in Livingston, Louisiana. Thus, a significant increase in the levels of seismic noise and vibration at either of the LIGO observatories could render all of LIGO inoperable for gravitational-wave observations for as long as these increased levels of vibration persist. For this reason, the observatories were located in places with exceptionally low levels of

seismic noise and vibration. Following the evaluation of 18 proposed LIGO sites throughout the continental United States, the Hanford site was chosen for LIGO in a national competition, based in part on the low levels of seismic noise and vibration known to exist at this site and the likelihood that these levels would remain low in the foreseeable future.

The LIGO Laboratory prepared a memo (LIGO-L960853) detailing the sensitivity of LIGO to seismic effects of various land uses. This memo was made available at the LIGO Hanford Observatory office to provide guidance to planning agencies that request such information. It is encouraging that information concerning the sensitivity of LIGO to vibration has been included in the current draft plan. The revised draft also addresses impacts of activities such as mining in other regards. These are positive developments. The LIGO Laboratory remains concerned that a lack of detail in presentation of this information may mislead readers in the future to underestimate the potential for an activity, like mining, to render LIGO inoperable. For example, reasonable proposers of an activity might assume that operation of mining equipment at a distance of a mile would not seriously impact LIGO when, in fact, such activities at distances of 10 to 25 miles could significantly disrupt LIGO operations. Significant expenditures of money and schedule might thus be spent on planning for a proposed activity with little guidance from the DOE plan that a severe conflict may be expected.

The LIGO Laboratory proposes that the memo (LIGO-L960853) be appended to the final DOE report and that references to this appendix appear wherever there is discussion of locating Conservation zones that include mining adjacent to LIGO (including in the Tables). It is proposed to modify the sentence in Section ES5.5.1 "Cumulative Impacts to Land Use," in paragraph 4, "Operation of LIGO conflicts with Conservation mining designations because of the facility's sensitivity to vibrations." A sentence that more accurately describes the extent of conflict is, "Operation of LIGO conflicts with Conservation mining designations because of the facility's sensitivity to vibrations, even when the source of those vibrations is many miles distant from LIGO facilities."

It is important that the DOE land use plan be written as clearly as possible to minimize dependence many years hence on the memories of individuals who participated in the preparation of the document. Also the nature of conflicting activities can significantly change over the long time span envisioned by this plan. Finally, vibration is only one of a number of possible mechanisms by which adjacent land uses could conflict with LIGO operations. NSF's representation on the Site Planning Advisory Board would allow NSF to play a positive role in articulating its concerns while also providing helpful guidance on potential mitigation measures to those who might propose conflicting activities in future.

Respectfully,

Frederick J. Raab

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Head, LIGO Hanford Observatory

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Laser Interferometer Gravitational Wave Observatory (LIGO) Project

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Refer to: LIGO-L960853-01-M

Date: December 2, 1996

Subject: Information on the seismic effects of various land uses.

This letter summarizes information about possible impacts on the Laser Interferometer Gravitational-wave Observatory (LIGO) caused by activities on the surrounding land. The discussion below highlights criteria concerning man-made sources of vibration that were among the criteria used to choose the Hanford site over other proposed sites in the continental United States.

The LIGO Observatory in Hanford, Washington is a state-of-the-art facility, operated for the U. S. National Science Foundation, that is part of an emerging international network of gravitational-wave detectors. LIGO uses high-precision laser beams to detect the extremely small motions of mirrors caused by gravitational waves created in deep space. Seismic noise (i.e., natural vibrations of the earth) and noise induced by man-made vibrations can hide or mimic the effect of a gravitational wave. Successful detection of the gravitational waves requires that the Hanford Observatory work in unison with its sister facility in Livingston, Louisiana. Thus, a significant increase in the levels of seismic noise and vibration at either of the LIGO observatories could render all of LIGO inoperable for gravitational-wave observations for as long as these increased levels of vibration persist. For this reason, the observatories were located in places with exceptionally low levels of seismic noise and vibration. Following the evaluation of 18 proposed LIGO sites throughout the continental United States, the Hanford site was chosen for LIGO in a national competition, based in part on the low levels of seismic noise and vibration known to exist at this site and the likelihood that these levels would remain low in the foreseeable future.

The site-evaluation committee rated each site according to criteria that reflected LIGO's needs. To evaluate sites on the basis of man-made sources of vibration, an international set of guidelines[1] developed for seismic observatories was used. The guidelines list recommended minimum distances to the nearest source of man-made vibration due to different categories of sources. These recommendations were used to obtain "preferred" and "acceptable" minimum distances to these sources. The sites were then graded according to these criteria. Sample criteria, useful for land-planning purposes are listed below:

1. Reciprocating power-plant machinery, rock crushers and heavy machinery should be located at least 10 miles from the site, with a preferred distance of at least 25 miles.

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1. Manual of Seismological Observatory Practice, P. L. Gilmore, ed., World Data Center A for Solid Earth Geophysics, U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, Environmental Data and Information Service, Boulder, CO, 80303; Table 2.1.

2. Railways that operate frequently should be at least 6 miles from the site, with a preferred distance of at least 12 miles.

3. Non-reciprocating power-plant machinery and balanced industrial machinery should be located at least 4 miles from the site, with a preferred distance of at least 10 miles.

4. Vehicular traffic should be located at least 0.6 miles from the site, with a preferred distance of at least 3 miles.

Using these criteria, the only serious seismic noise disturbance identified at the Hanford site was vehicular traffic. The Hanford site was given an acceptable rating because the potential disruption due to traffic would be confined to morning and evening rush hours. This was considered to be the only negative vibration-related impact at the site. With assurances from the United States Department of Energy that no significant development was likely within this zone[2], the Hanford site was given a high rating. In selecting the Hanford site for LIGO, the National Science Foundation recognized the anticipated conditions at the site.

We have recently received a final report concerning vibration measurements done for the LIGO site by the Pacific Northwest National Laboratory. Part of the mission of these measurements was to identify possible impacts on observatory operations caused by man-made vibration. The data obtained from this study confirm that the site-evaluation criteria for man-made vibration sources are applicable to the Hanford site.

The effect of traffic was determined with the help of video surveillance equipment and seismometers. Traffic on Route 10 past the LIGO site was observed to cause increased noise at the corner station of the observatory complex. We can say with certainty that large increases in traffic on this road would be disruptive to operations, especially if the weight of vehicles should increase significantly (as would happen if truck traffic increased on this road) or if the quality of the road surface were significantly degraded. We were less sensitive to traffic on Route 240 and Route 4 South, because they were farther from the observatory complex. However, large increases in truck traffic or degradation of the surfaces of these roads could also have negative impacts.

Measurements were also done during a time when there was construction activity near the site. By moving the seismometers we were able to identify how vibrations from construction equipment would lessen with distance away from the site. We found that vibrations from such activities within approximately 8 to 9 miles of the site could cause significant disruptions for as long as such activity persisted.

Similar activities can be expected to be similarly disruptive unless they are situated sufficiently far away. Practical examples of extremely disruptive operations, similar to category (1) above, would be gravel or basalt mining operations, metal-stamping mills and any kind of construction activity that involved backhoes, bulldozers, heavy digging machinery, etc. Continuous operations of this type would render LIGO inoperable if they were located too closely. The equipment in nuclear reactors at Hanford would likely fall into category (3), as would many modern facilities such as biotechnology or semiconductor fabrication plants. Metal or plastics manufacturing using low-impact methods (i.e., no stamping operations) should also fit into this category. The

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2. Option to Site A: Laser Interferometer Gravitatinal-Wave Observatory (LIGO), U. S. Department of Energy, Richland Operations Office, March 1, 1991; Section 3.7

operation of facilities like this within the category (3) range would not be deleterious to LIGO, but construction work on these facilities might cause severe disruption. Mechanized farming operations should be in category (4), with activities that disturb the ground (such as plowing) likely to be more disruptive than use of harvesting equipment. With these guidelines, LIGO should be able to respond to any inquiry and to evaluate proposed uses and to identify adverse impacts on LIGO operations.

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