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FOR THE STATE OF WASHINGTON

QUINAULT INDIAN NATION, Petitioner, and FRIENDS OF GRAYS HARBOR, SIERRA CLUB, SURFRIDER FOUNDATION, GRAYS HARBOR AUDUBON, and CITIZENS FOR A CLEAN HARBOR, Petitioners, vs. CITY OF HOQUIAM, WASHINGTON STATE DEPARTMENT OF ECOLOGY and WESTWAY TERMINAL COMPANY, LLC, Respondents, and IMPERIUM TERMINAL SERVICES, LLC., Intervenor-Respondent.	SHB NO. 13-012*c* DIRECT TESTIMONY OF JOSEPH WARTMAN, PH.D.

1. Attached as Exhibit A are my expert opinions on the analysis of geologic hazards (notably seismic, soil liquefaction, and tsunami hazards) for the proposed Westway and Imperium Renewables crude-by-rail projects ("Projects") proposed at adjacent sites in Hoquiam

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Washington ("Sites").

2. Attached as Exhibit B is my curriculum vitae.

3. Attached as Exhibit C are figures supporting my expert opinions.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge. Executed this 9th day of September, 2013.

Joseph Wartman

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CERTIFICATE OF SERVICE

I certify under penalty of perjury under the laws of the state of Washington that on September 9, 2013, I caused the Direct Testimony of Joseph Wartman to be served in the above-captioned matter upon the parties herein via e-mail:

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EXHIBIT A

Expert Testimony of Professor Joseph Wartman, Ph.D.

I. Qualifications and Experience

I am currently an Associate Professor at the University of Washington, where I hold the H. R. Berg Endowed Professorship in the Department of Civil and Environmental Engineering. I am an Editor of American Society of Civil Engineers (ASCE) *Journal of Geotechnical and Geoenvironmental Engineering*, which is among the most respected scholarly journal in my field. I have been the recipient of several international and national research honors including, most recently, selection in 2011 for the U. S. National Academy of Engineering Frontiers of Engineering Program and the 2011 Prakash Foundation Research Award. I have authored or co-authored over 60 professional articles on the topics of geotechnical engineering, earthquake engineering, natural hazards, and sustainable geotechnics. I have participated in several field investigations of large-scale disasters including major earthquakes in Latin America (2001 M 8.4 Southern Peru; 2003 M 7.6 Tecoman, Mexico; 2007 M 8Pisco, Peru) and Asia (2011 M 9 Tōhoku, Japan), and Hurricane Katrina in New Orleans (2005).

Prior to my career in academia, I served in full-time engineering practice for 5 years, most recently as a licensed Professional Engineer and Project manager for Golder Associates in Oakland, California. Immediately prior to joining the University of Washington, I was an Associate Professor at Drexel University, where I served as a founding Co-Director of the *Engineering Cities* Initiative, a multi-disciplinary urban systems research center at Drexel.

I was awarded a B.C.E. degree from Villanova University in 1990, and later pursued graduate studies at the University of California, Berkeley, where I earned two master degrees (M.S. in Geotechnical Engineering, M.Eng. in Civil Engineering; both in 1996) and my Ph.D. (Civil Engineering, 1999)

At University of Washington and Drexel University, I have taught courses on geotechnical engineering, geologic hazards, engineering geology, and earthquake engineering.

Attached is my curriculum vitae.

II. Materials Considered in Preparing this Expert Report

I reviewed several project-specific documents when preparing this report, including the threshold determinations and Shoreline Substantial Development Permits for the projects, and attachments, the briefing on summary judgment, the declarations of Dennis Kyle and exhibits, and other geological information that was received through discovery. I additionally referenced a series of relevant professional and scholarly books, reports, and articles, which are cited in this report. These book and articles are recognized in the professional community and are considered reliable by other experts in my field. Additionally, I have relied upon my 20+ years of professional and research experience in the field of civil engineering (including field investigations of several major earthquakes) when formulating the opinions stated in this report.

III. Summary of Expert Opinions

My opinions on the analysis of geologic hazards for the proposed Westway and Imperium Renewables projects may be summarized as follows:

- At the project sites there exists a very high seismic hazard, a very high liquefaction hazard, and a high tsunami hazard.
- There is a very high likelihood of a significant seismic event at the project sites. There is a 14% chance of a Magnitude 8+ earthquake, and a 63% chance that a Magnitude 6+ earthquake will strike the region during a standard project design

life of 50 years[1]. The Grays Harbor area is known to be subject to periodic tsunamis.

- Detailed engineering analyses of these hazards and their consequences have not been undertaken for the projects; these hazards remain unmitigated. As a result, there was insufficient information available at the time of the decision to determine that there would not be a significant environmental impact or that there was sufficient mitigation.

- The permitting and engineering documents are insufficient to support assessment and mitigation of the seismic hazards.

- Because of the complex nature of the industrial facility and the storing of a large quantity of hazardous materials, the Projects are special facilities that require careful assessment and scrutiny to ensure the safety of the local community and environment.

- Without sufficient evaluation and mitigation of these hazards, a seismic event could cause the Projects' systems to fail and cause catastrophic environmental impacts. For example, seismic impacts could include the failure of the tanks, connectors, and/or containment systems, releasing oil into the environment. Tsunamis have been shown to cause critical failures to oil storage tanks, such as the ones proposed to be built by Westway and Imperium. Liquefaction is expected to cause substantial and permanent deformation of the ground surface, which is likely to damage to system components (including associated environmental containment structures).

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[1] For design purposes, standard building codes typically assume that facilities will remain functional for a limited 50 year time period or "life". In reality, facilities are in effect "permanent," and thus remain in place and functional for much longer time periods.

- Overall, it is also my opinion that multiple hazards at the site together with the severe consequences of failure combine in a manner that poses a high risk[2] to the local region.

- There is insufficient information available to quantify and mitigate these seismic impacts. Given the hazards of the Projects and the high seismic hazards of the Project Sites, the permitting agencies should have required a detailed analysis of these risks and mitigation prior to issuing the permit. This was necessary to determine whether or not it was even possible to adequately mitigate the risk and build the Projects safely. Detailed study is needed regarding risks and potential mitigation before deciding to place hazardous crude oil facilities in a tsunami zone.
- Methods of analysis have been developed to assist governments and project proponents to understand, quantify, and mitigate seismic risks. These procedures include tasks such as assessment of worst case scenarios. This has not occurred for the current project. Instead, it appears that the decision makers neglected to consider credible risks to the facility. The preparation of an Environmental Impact Statement (EIS) will serve many of the functions of proper risk planning, including consideration of worst case scenarios and peer review.
- The size and magnitude of a tsunami and earthquake can be substantially larger than those predicted by current models and design codes.
- The mitigation for Westway and Imperium is inadequate. Building code provisions, and warning and evacuation plans, are by themselves insufficient mitigation to prevent significant impacts from a tsunami, liquefaction, and a seismic event.

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[2] *Risk* is considered the product of the hazard (i.e., probability of hazard occurrence) multiplied by the consequences of the event

IV. Seismicity and Seismic Hazards at the Port of Grays Harbor

A megathrust earthquake on the Cascadia subduction zone is a primary geologic hazard that poses the greatest threat to the Grays Harbor region. The Cascadia subduction zone spans a 1,100 km (680 mile) coastal stretch between Vancouver Island, British Columbia and Cape Mendocino, California (Figure 1). The Juan de Fuca tectonic plate is subducting beneath the North American Plate at a rate of approximately 4 centimeters per year (Riddihough 1984). Satellite measurements show that the offshore portion of this megatrust is now "locked" along the entire length of the subduction zone (McCaffrey et al. 1984), and is thus progressively accumulating tectonic stress and strain that will be released during a large magnitude (i.e., Magnitude 8 to 9) earthquake at some time in the future. It is now well established that the Pacific Northwest has a long history (at least many thousands of years) of repeated "characteristic" Magnitude 8 to Magnitude 9 megathrust earthquakes along the Cascadia subduction zone (e.g. Atwater et al. 2005, Goldfinger et al. 2012). The last great megathrust earthquake, which occurred on January 26, 1700, was estimated to be in the range of Magnitude 8.7 to Magnitude 9.2 (Satake et al. 2003). This megathrust earthquake produced a tsunami that caused damage and loss of life as far away as Japan (Atwater et al. 2005).

Owing to its setting within the Cascadia subduction zone, the coastal region of the Pacific Northwest, including the Grays Harbor Area, is regarded as having a high level of seismic activity. For example, the United States Geologic Survey (USGS) estimated that there is a ~14% chance that a Great Cascadia subduction earthquake (Magnitude 8+) will strike the region in the next 50 years (50 years is regarded as the typical design life of a structure or facility in the U.S.) [Petersen et al. 2002]. The USGS considers this probability "quite high" (Petersen et al. 2002). Moreover, due the close proximity to the Cascadia's seismogenic zone (i.e. the zone along a fault where earthquakes initiate), extremely high levels of earthquake ground shaking are expected along the coast (Figure 2). The USGS seismic hazard maps indicate that earthquakes are expected to result in a peak ground acceleration in stiff soils of 0.67g in the Grays Harbor region. (This ground motion corresponds to the standard "return period" provisions of the International

Building Code. It corresponds to a motion having a 2% chance of being exceeded in a building design life of 50 years, which equates to a return period of about 2,500 years. See Figure 3). Ground shaking in weaker soils, such are those found at the Westway Terminal Expansion site, are expected to be even higher due to "site effects," which refers to a phenomenon whereby earthquake shaking is amplified in the presence of soft soils. To provide context for this acceleration value, 0.67g is roughly equivalent to a Modified Mercalli Earthquake Intensify scale of IV (Wald et al. , which is associated with "violent" shaking and characterized by "General panic. Damage slight to moderate (possibly heavy) in well-designed structures. Well-designed structures thrown out of plumb. Damage moderate to great in substantial buildings, with a possible partial collapse. Some buildings may be shifted off foundations. Walls can fall down or collapse.[3]"). By comparison, the commensurate building code ground motion in Seattle, which lies inland of the Cascadia subduction zone, is 0.49g or about 25% less than that expected in Grays Harbor (USGS)

In addition to having a high intensity (i.e., acceleration amplitude) of shaking, Cascadia earthquake ground motions at Grays Harbor are expected to be long in duration due to the subduction system rupture mechanism. A recent example of such long-duration shaking occurred during the 2011 Magnitude 9 Tōhoku, Japan subduction earthquake, which lasted more than one and a half minutes at many locations along the coast (Wartman et al. 2013).

Based on this, it is my opinion that the Westway and Imperium Project Sites have a very high seismic hazard (i.e., is subject to strong ground shaking). The chance (14%) that the facility will experience a large magnitude (Magnitude 8+) earthquake during a 50-year design life is "quite high" (Petersen et al. 2002).

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[3] See: http://earthquake.usgs.gov/learn/topics/mercalli.php

V. Soil Liquefaction Hazard

The Westway and Imperium Project Sites have an extremely high susceptibility to soil liquefaction. Soil liquefaction is a secondary geologic hazard[4] that is a major cause of damage during earthquakes (e.g. Seed et al. 2003). In a recent monograph, the Earthquake Engineering Research Institute (Idriss and Boulanger 2008) explains that liquefaction occurs in soft, saturated soil deposits because "loose sand tends to contract (densify) under cyclic loading imposed by earthquake shaking ... which results in a reduction on effective confining stress within the soil and an associated loss of strength and stiffness that contributes to deformations of the soil deposit." Soil liquefaction has been repeatedly observed in dozens of earthquakes over the past decades. Its effects are especially pronounced in subduction earthquakes due to the long duration of shaking. The effects of soil liquefaction vary based on several factors including geologic setting, soil layering, earthquake ground motion (intensity and duration), ground surface morphology (gradient and topography), and the local built environment, among others. As illustrated in Figure 4 to 6 (Seed et al. 2003), these effects have been observed to result in:

- Lateral spreading or displacement of the ground surface by translation- or flow-type movements
- Flow failures
- Translational movement
- Rotational failures
- Ground surface "spreading" and cracking
- Vertical settlement of the ground surface
- Slumping of embankments
- Loss of building foundation support (i.e., bearing capacity failure).

[4] The term "*secondary*" indicates that the liquefaction hazard is a consequence of the initiating "*primary*" seismic (or ground shaking) hazard. It is not intended to indicate a lesser significance of the hazard. This concept is explained further in Smith (2013).

These mechanisms may result in permanent deformation of the ground surface as shown in the figures. The devastating effects of liquefaction-induced ground deformation on the built environment is well documented and has included (Idriss and Boulanger, 2008): collapse of structures, uplift or "floating" of tanks and underground pipes, and lateral spread-induced failure of underground pilings leading to structural collapse.

Liquefaction hazards are typically mitigated using one of several "ground modification" construction techniques that density and/or artificially "cement" susceptible soils. These techniques include vibro methods, deep dynamic compaction, compaction grouting, deep soil mixing, and jet grouting (Idriss and Boulanger, 2008).

Owing to their marine setting, port facilities are commonly underlain by soft, saturated soil deposits, which are materials well recognized as having a high susceptibility to liquefaction. This is also true for the Westway and Imperium Terminal Expansion Project Sites.

There are three main questions that must be answered when assessing soil liquefaction (Idriss and Boulanger, 2008):

(1) Will liquefaction be triggered by the design ground motions?
(2) What will be the consequences for the structure or facility?
(3) What are the options for mitigating the potential consequences?

Geotechnical test borings at the Westway project site performed by Hart Crowser reveal a variable thickness of surface "crust" of unsaturated or relatively stiff soils over a deep deposit of soft, loose soils (intermixed silts and sands). This deeper loose soil stratum has Standard Test Penetration (SPT) "blow" count[5] values as low as 0 to 1. These extraordinarily low SPT values are well below the minimum threshold require to trigger soil liquefaction in an earthquake. Paradoxically, the stiffer shallow surface "crust" poses

[5] The SPT "blow" count is the number of strikes of a 140 pound hammer falling 30 inches to drive a "split spoon" soil sampler into a soil deposit. High blow counts (greater than ~30) indicate stiff soils, while low blow count values (less than ~10) indicate soft, weak soils.

an additional concern as such layers may slide (or "laterally spread") over the underlying liquefied ground, and in so doing impart significant bending stresses upon deep foundation systems, such as pilings. Overall, it is my opinion that soil liquefaction is the governing geotechnical concern at the project site.

As part of my evaluation, I reviewed available portions of the Geotechnical Investigation Report for the Westway Terminal Expansion (dated June 12, 2013) that was prepared by Hart Crowser and provided as part of the declaration of Dennis Kyle. This report confirms the liquefaction hazard at the site (Question 1 above); however, the provided documents were incomplete (e.g. Appendix D, Seismic Analysis was not included) and thus I was unable to assess how the last two questions (consequences and mitigation) were addressed. Nevertheless, it is known that in the presence of a topographic irregularity (e.g., an open or "free" face—or a quay or soil retaining wall), such as that which seems to exist along the southwest portion of the project site, even relatively flat ground may be subject to lateral spreading. I have personally observed such liquefaction effects and consequent damage at port facilities subjected to subduction earthquakes in both Latin America and Asia (2003 Tecoman, Mexico earthquake; 2007 Pisco, Peru earthquake; 2011 Tōhoku, Japan earthquake). From my review of the project documents, it does not appear that any significant liquefaction mitigation campaign has been planned for the Westway Project.

Based on my experience, I anticipate that liquefaction at the Westway Terminal Project Site would result in significant horizontal and vertical deformation of the ground surface. These ground deformations could cause significant damage to containment protection structures such as berms and/or walls and thus reduce or negate their ability to contain spills.

Based on the above, it is my opinion that a very significant liquefaction hazard exists at the project site for Westway. Additionally, it is my opinion that neither the project permit application nor the engineering documentation provided as part of the declaration of Dennis Kyle, provides enough information for me to make a detailed assessment of how the consequences were assessed.

I also reviewed the Report: Geotechnical Engineering Services Proposed Storage Tanks, Port of Grays Harbor, Washington for Seattle BioFuels, Inc. (June 13, 2006) that I understand was produced by Imperium as a Geotech report for its Project. The report indicates that substantial liquefaction settlement and lateral spreading will occur in the event of a design earthquake. Based upon this report and the location and soils at the Imperium site, it is my opinion that soil liquefaction is a significant concern for this Project Site and the consequences of such an event would be severe. The report indicates that the design recommendations are "not intended to withstand a major subduction zone earthquake, which may be technically impossible." This obviously suggests that any mitigation suggested by the report for the Imperium project will be insufficient to protect against the hazards posed by liquefaction in a major subduction event, which has a high probability of occurring during the project design life.

In sum, the risks posed to the Westway and Imperium projects from liquefaction are significant and would likely result in severe damage to the oil storage tanks, containment systems, and other equipment, resulting in the release of large quantities of oil into the environment.

VI. Tsunami Hazard

The Southern Washington Coast Tsunami Map indicates that the Westway and Imperium Projects are located within a tsunami inundation hazard zone (Figure 7; Washington State Department of Natural Resources, 2000; Washington State Department of Natural Resources, 2007). A tsunami is a great sea wave that is most often triggered by an offshore earthquake. Two well-known recent examples of tsunamis are those triggered by the 2004 Indian Ocean earthquake and the 2011 Tōhoku, Japan earthquake. Tsunamis are characterized by their high speeds, long wavelengths, and long periods. They are generally difficult to observe on the open sea, but become more pronounced (and damaging) when entering shallow waters such as those along the coast and in bays and harbors. Numerical modeling conducted as part of a Washington State Department of Natural Resources (2000) tsunami hazard assessment indicates that tsunami heights between 3 to 4 feet will occur in the city of Hoquiam under a typical "scenario" subduction earthquake. Another tsunami awareness document highlights the possibility of 10 foot waves in Hoquiam (Washington State Department of Natural Resources, 2007). These projected wave heights are based on large-scale and relatively coarse modeling; as such, it is my opinion that these estimates have a relatively high degree of uncertainty. While this implies that a tsunami wave height may be less than that projected, it is equally likely that the tsunami many exceed current estimates. Such was the case in the 2001 Tōhoku, Japan earthquake, where the actual tsunami wave heights greatly exceeded design projections Pidgeon (2012).

As we have witnessed over the past decade, tsunamis can be highly destructive. Their effects include overturning and displacement of structures, collapse of facilities as a result of debris impacts, and uplifting of buildings due to submersion. Tsunamis can significantly impact industrial faculties and have previously caused oil and gas spills at ports in Sumatra (Vab Dijk 2008), Turkey (Steinberg and Cruz 2004), and Japan (Cruz et al. 2011 and references therein). One such tsunami-induced industrial spill occurred after the 1964 Magnitude 7.6 Niigata, Japan earthquake. This tsunami caused fires in five oil storage tanks and oil spills in several hundred tanks along the coast (Cruz et al. 2011). The consequences of the spills were severe and included dispersion of oil through a harbor by the tsunami current and the inland transport and emplacement of contaminants within a residential area. Moreover, historical data has shown that Tsunamis can damage oil storage tanks located in their paths, including during earthquakes as early as 1964 in Alaska and recently on Sumatra Island during 2004 (Goto 2008). Goto also notes that large storm surges associated with Hurricane Katrina in 2005 caused oil storage tanks to lift and dislodge, causing the tanks to split and release oil. In sum, tsunamis have been shown to cause critical failures to oil storage tanks.

Tsunamis impose a variety of complex loads on structures including hydrostatic loads (i.e. water pressure), buoyancy or uplift loads, hydrodynamic loads from moving currents, surge loads, breaking wave loads, and impact loads from entrained or floating debris (Cruz et al. 2011). Current structural design codes focus on water loads from river flooding and storm waves, but do not address the complex loads imposed by tsunamis (Yeh et al. 2005). Indeed, an investigation by Naito et al. (2013) of tsunami-induced tank failures in the 2011 Tōhoku, Japan earthquake highlighted that "the gravity, wind, and seismic design requirements do not provide adequate protection against tsunami events." As such, analysis of tsunami hazards for industrial facilities requires a specialized assessment such as that documented by Cruz et al. (2011). This assessment concluded that even a modest tsunami could result in "Inundation ... (resulting) in salt water intrusion on low-lying equipment such as pumps and motors, electrical panels and electronic control equipment, particularly at and near the pump station and warehouse, as well as at the western half of the refinery where water depths are greater. Damage to electric and/or electronic control equipment could result in process upsets and possible accidental releases of hazardous materials. The inundation may also overcome the internal plant drainage system, possibly causing waste oil to be lifted by the floodwaters, which may spark." Tsunami mitigation options for industrial facilities are limited; as Cruz et al. (2011) have noted: "limiting industrial development in tsunami-prone areas is the most effective way to minimize the hazard associated with the tsunami impacts."

Due to the catastrophic effects from locating industrial facilities in tsunami zones and minimal mitigation possibilities, extensive study is needed before placing hazardous facilities in tsunami zones. Past events demonstrate that the Grays Harbor area is subject to periodic tsunamis, thus this hazard must be taken seriously.

In my review of the Westway and Imperium Project documents, I did not find any detailed consideration or engineering assessment of the tsunami hazards at the site; nor did I find any consideration or discussion of tsunami hazard mitigation measures.

Based on the above, it is my opinion that a tsunami hazard clearly exists at the Westway and Imperium Terminal Project Sites. It is difficult to reliably assess the severity of this hazard as the available modeling is relatively coarse (i.e., approximate) and thus associated with a degree of uncertainty. It is also my opinion that the tsunami hazard received no detailed engineering assessment as part of the project planning, and that the hazard remains unmitigated.

For the Westway site, the Declaration of Dennis Kyle, which relies on a study from 1998, suggests that wave height generated by a tsunami would be about 0.5 meters by the time it reached Hoquiam based upon the dissipation of waves after entering Grays Harbor. This study further notes that depending upon frequencies, rather than dissipating, waves could actually increase in magnitude by the time they reached Hoquiam. (Rogers 1998). After the 1998 study, lessons learned from the disasters at Sumatra and Fukushima confirm the study's prediction that waves could be significantly higher when they enter a harbor, not lower, because the magnitude of waves increases in closed bays. Regardless of the size of the waves, the 1998 study recognizes that even small waves can cause severe damage to boats and ships. If a small wave severely damaged a vessel or tanker during or after a transfer of crude oil from the storage tanks at Westway or Imperium, oil spills could result. Additionally, other vessels docked or moving in the channel would be at risk. For example, a vessel loaded with crude oil that takes three hours to move from Hoquiam out to the channel could be struck by a tsunami in the middle of the Harbor without any protection given that tsunamis can strike within 25 minutes of an earthquake (Washington Military Department 2012/2013). The effects could be amplified and result in severe oil spillage if an earthquake causes liquefaction or failure of the oil storage tanks followed by a tsunami that renders the containment system useless.

The Imperium Geotech report does not provide a detailed analysis regarding the environmental impacts from tsunamis and the possible mitigation but given the close proximity of the two project sites, my conclusions about the risks of tsunamis equally apply to the Imperium site.

VII. Seismic Risks Associated with Industrial Facilities

Million of gallons of crude oil will be stored at the proposed Westway and Imperium Project Sites. As noted in the prevision sections, the project sites have a high seismic hazard, a high liquefaction hazard, and a high tsunami hazard. Taken individually, these hazards each pose a significant risk to the facilities; however, when acting together (as they would be expected to in a seismic event), these hazards can combine and result in a large-scale cascading-type failure. Such "cascading" or chain-reaction-type events are a hallmark of large-scale engineering system failures initiated by earthquakes and other extreme events. Moreover, as these types of failures are the result of an extreme event, they occur at times when emergency response services are most taxed and least able to respond to a crisis. A well-known recent example of a cascading-type failure of an engineering system is the Fukushima nuclear disaster that was initiated by the 2011 Tōhoku, Japan Earthquake. At the Westway and Imperium Project Sites, the seismic hazard concerns are further amplified by the toxic nature of the impounded crude oil. Moreover, consequences of a failure at the facility would be severe in light of the economic and cultural importance of the state's coastal region, and the vulnerability of the local ecosystem. Additionally, the IAEA recognizes that risk of extreme events, which can cause cascading failures such as these, are becoming more significant over time as the effects of climate change are realized (2012).

In a recent review article, Pidgeon (2012) cites a series of safety-oriented practices to employ when addressing the possible failure of complex systems. Practices relevant to the Westway and Imperium Project evaluations include: (i) open communication and deference to expertise (at all levels) to help identify, address, and respond to potential failures, (ii) avoiding incomplete or inaccurate representation of problems, which can influence an organization's belief about what is and what is not regarded as a "hazard," (iii) failure to recognize limitations and uncertainty in codes and standards, even when it is possible that triggering events that may exceed established professional guidelines and/or legal remit. Antonioni et al. (2009) go beyond these general practices and offer a systematic procedure for assessing "*Na-tech*" risks—that is risks posed to *technical* systems by *natural* hazards. Their guidelines were established for chemical facilities, however, it is my opinion that they are also relevant in this project. Their procedure encompasses:

1. Characterization of the external event(s)
2. Identification of susceptible equipment
3. Identification of damage states and reference scenarios
4. Estimate of the damage probability
5. Consequence evaluation for the reference scenario
6. Identification of credible combinations of events
7. Frequency/probability calculation for each combination
8. Consequent calculation for each combination
9. Calculation of risk indexes

In my review of the project documents, I found no indication that these practice guidelines and procedures were considered or followed in the planning of the Westway and Imperium Projects.

Because of the complex nature of the industrial facilities and the storing of a large quantity of hazardous materials, I regard the Westway and Imperium Projects as special facilities that require careful assessment and scrutiny to ensure the safety of the local community and environment. Overall, it is also my opinion that multiple hazards at the sites together with the severe consequences of failure combine in a manner that poses a high risk to the local region.

VIII. Analysis of the Westway and Imperium Terminal Expansions

A comprehensive study is needed to evaluate the hazards, risks and appropriate mitigation discussed above before placing millions of gallons of crude oil in a seismic, tsunami, and liquefaction hazard zone. As explained above, the probability of a seismic, tsunami, and/or liquefaction event in the Westway or Imperium project area is high over a standard project design life (i.e., 50 years).. A scientific and in-depth study is needed to assess the seismic risks posed to the environment from the crude oil storage tanks and associated equipment at the Westway and Imperium Project Sites. Only after a study such as this is completed can scientifically-supportable conclusions about the environmental impacts and potential mitigation measures be made.

The information provided by the applicants is insufficient and ignores the lessons learned from the world's two recent subduction earthquakes. As a result, the permitting documents do not provide a sufficient analysis of or mitigation for the catastrophic risks posed by the location of crude oil tanks in a tsunami and liquefaction zone.

For the Westway Terminal Expansion, the applicant's environmental checklist did not reveal that the project was located in a tsunami zone. Westway did not include information about risks from tsunamis and seismic events during the permitting process but rather later in the Declaration of Dennis Kyle. As I discuss above, the Declaration and its accompanying report are inadequate and insufficient for assessing the environmental impacts and mitigation. For the Imperium Terminal Expansion, the information provided in the Geotechnical Report does not detail the specific effects of the geologic hazards on the facility and therefore is also insufficient for assessing its environmental impacts.

IX. Mitigation for the Westway and Imperium Terminal Expansions

The decision-makers should request additional information and study that information to conclude whether there will be significant environmental impacts and whether those impacts can be adequately mitigated at the project site. The main protections against spills at the Westway and Imperium Project Sites are containment berms/walls surrounding the storage tanks. In the event of liquefaction, tsunami, or seismic events, these containment systems are likely to be damaged, thus reducing or negating their ability to contain an oil spill after an earthquake. This would allow oil to enter the environment and the water.

The IAEA recognized the importance of considering common cause failure for multiple unit sites such as this (2012). For example, if liquefaction moves and ruptures one oil storage tank, it will likely move and rupture all of the oil storage tanks at the site, causing more than a single tank of crude to be released, rendering the containment berm for a single tank ineffective at containing liquid. In this scenario, a liquefaction event that was sufficient to move and rupture a storage tank could also move and crack the containment berm, making it unable to contain any oil.

Evacuation planning, warnings, and risk management cannot mitigate against risks posed by locating oil storage tanks in a tsunami zone. Warnings of an impending tsunami or an earthquake cannot prevent damage to an oil storage tank or allow for evacuation of a tank before damage occurs because tsunamis can strike within tens of minutes to hours after an earthquake.

Current applicable building codes, including the 2009 International Building Code (IBC) adopted for the Projects, do not provide adequate protection against tsunami events. Overall, it is my opinion that the hazards remain unmitigated.

X. References

Antonioni, G., Bonvicini, Spadoni, G., and Cozzani, V. (2009) "Development of a framework for the risk assessment of Na-Tech accidental events, Reliability Engineering and System Safety, 94, p. 1442–1450

Atwater, B.F., Musumi-Rokkaku, S., Satake, K., Tsuji, Y., Ueda, K., and Yamaguchi, D.K. 2005. The orphan tsunami of 1700; Japanese clues to a parent earthquake in North America: Report U.S. Geological Survey Professional Paper 1707, 133 phttp://pubs.usgs.gov/pp/pp1707/.

Cruz, A., Krausmann, E., and Franchello, G. (2011) Analysis of tsunami impact scenarios at an oil refinery, Natural Hazards, v. 58, p. 141–162.

Goldfinger, C., Nelson, C.H., Johnson, J.E., Morey, A.E., Guitérrez-Pastor, J., Karabanov, E., Eriksson, A.T., Gràcia, E., Dunhill, G., Patton, J., Enkin, R., Dallimore, A., and Vallier, T., 2012. Turbidite event history—Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: Report U.S. Geological Survey Professional Paper 1661-F,170 p http://pubs.usgs.gov/pp/pp1661f

Goto, Y. (2008) Tsunami Damage to Oil Storage Tanks, the 14th World Conference on Earthquake Engineering; Beijing, China.

Idriss, I. and Boulanger, R. (2008) Soil liquefaction during earthquakes, EERI, Oakland, Ca.

International Atomic Energy Agency (2012) Report on Protection against Extreme Earthquakes and Tsunamis in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant.

McCaffrey, R., Qamar, A.I., King, R.W., Wells, R., Khazaradze, G., Williams, C.A., Stevens, C.W., Vollick, J.J., and Zwick, P.C. 2007. Fault locking, block rotation and crustal deformation in the Pacific Northwest: Geophysical Journal International, v. 169, p. 1315-1340, doi: 10.1111/j.1365-246X.2007.03371.x.

Naito, C., Cox, D., Yu, Q., and Brooker, H. (2012) "Fuel Storage Container Performance during the 2011Tohoku, Japan, Tsunami," Journal of Performance of Constructed Facilities, Vol. 27, No. 4.

Petersen, M.D., Cramer, C.H., and Frankel, A.D. 2002. Simulations of seismic hazard for the Pacific Northwest of the United States from earthquakes associated with the Cascadia subduction zone: Pure and Applied Geophysics, v. 159, p. 2147-2168.

Pidgeon, N. (2012) "Complex Organizational Failures: Culture, High Reliability, and the Lessons from Fukushima," The Bridge, 42, No. 3.

Riddihough, R.P. 1984. Recent movements of the Juan de Fuca plate system: Journal of Geophysical Research, v. 89, p. 6980-6994.

Satake, K., Wang, K., and Atwater, B.F. 2003. Fault slip and seismic moment of the 1700 Cascadia earthquake inferred from Japanese tsunami descriptions: Journal of Geophysical Research, v. 108, p. 17, doi: 10.1029/2003JB002521.

Seed, R., Cetin, K., Moss, R., Kammerer, A., Wu, J., Pestana, J., Riemer, M., Sancio, R., Bray, J., Kayen, R., and Faris, A. (2003) Recent advances in soil liquefaction engineering: a unified and consistent framework, Keynote Presentation, 26th Annual ASCE Los Angeles Geotechnical Spring Seminar, Long Beach.

Smith (2013) Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge Press.

Steinberg L.J. and Cruz A.M. (2004) When natural and technological disasters collide: lessons from the Turkey earthquake of August 17, 1999. Nat Hazards Rev 5(

PIANC Working Group 53 (2009) Mitigation of Tsunami Disasters in Ports.

Van Dijk S (2008) Environmental impact assessment: tsunami Indonesia. United Nations, office for the coordination of humanitarian affaires, Banda Aceh, Aceh, Indonesia

Wald, D., Quitoriano, V., Heaton, V., and Kanamori, H. (1999), Relationships between Peal" Ground Acceleration, Peal" Ground Velocity, Modified Mercalli Intensity in California, Earthquake Spectra, 15, No. 3.

Wartman, J., Dunham, L., Tiwari, B., and Pradel, D. (2013) "Landslides in Eastern Honshu induced by the 2011 Tōhoku Earthquake," Bulletin of the Seismological Society of America, Vol. 103, No. 2B, pp. 1503-1521.
3):121–130

Yeh H, Robertson I, Preuss J (2005) Development of design guidelines for structures that serve as tsunami vertical evacuation sites. Washington State Department of Natural Resources, Washington Division of Geology and Earth Resources, open file report 2005-4.

FIGURES

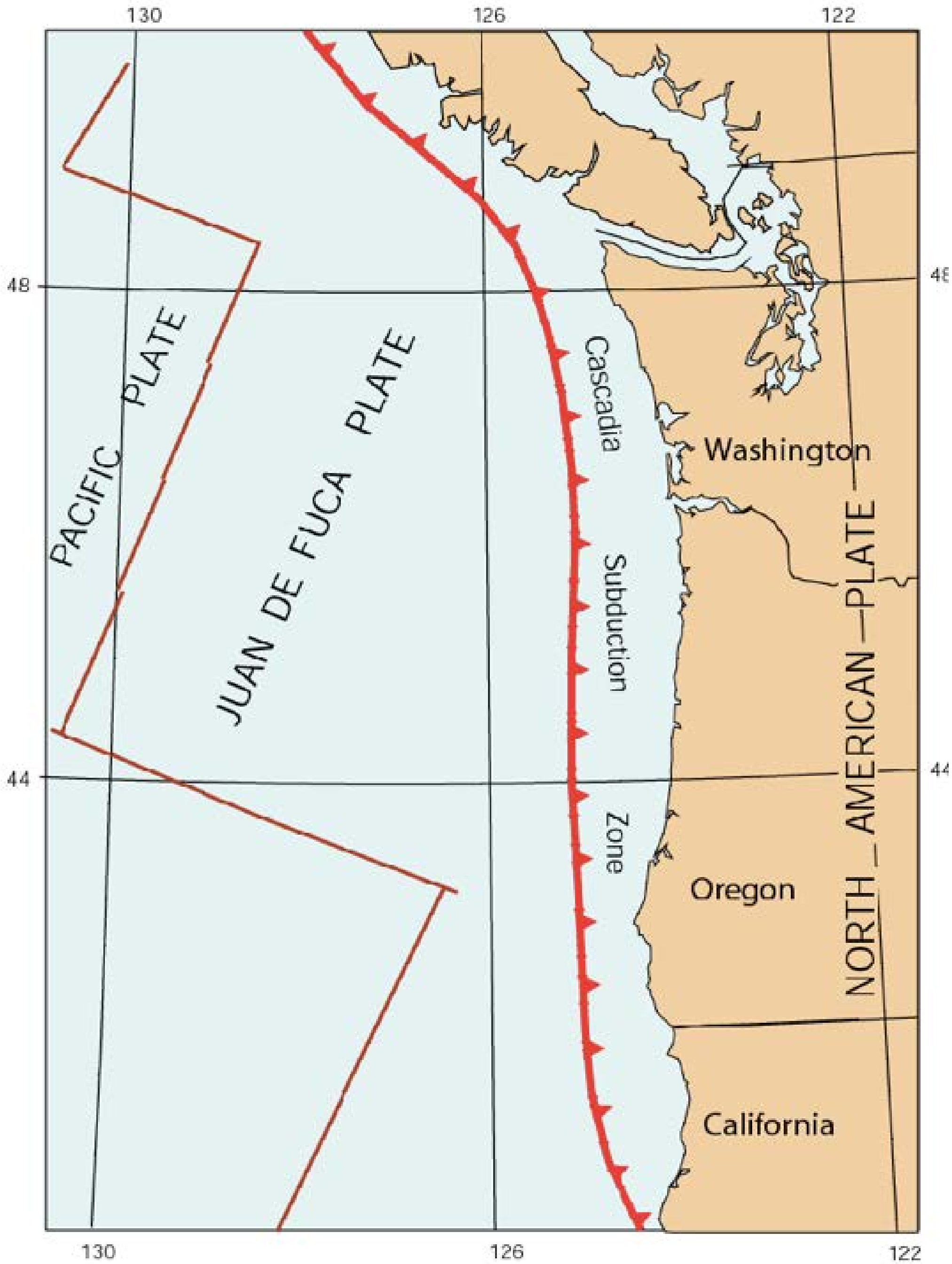


Figure 1 - Location of the Cascadia Subduction Zone (source: USGS)

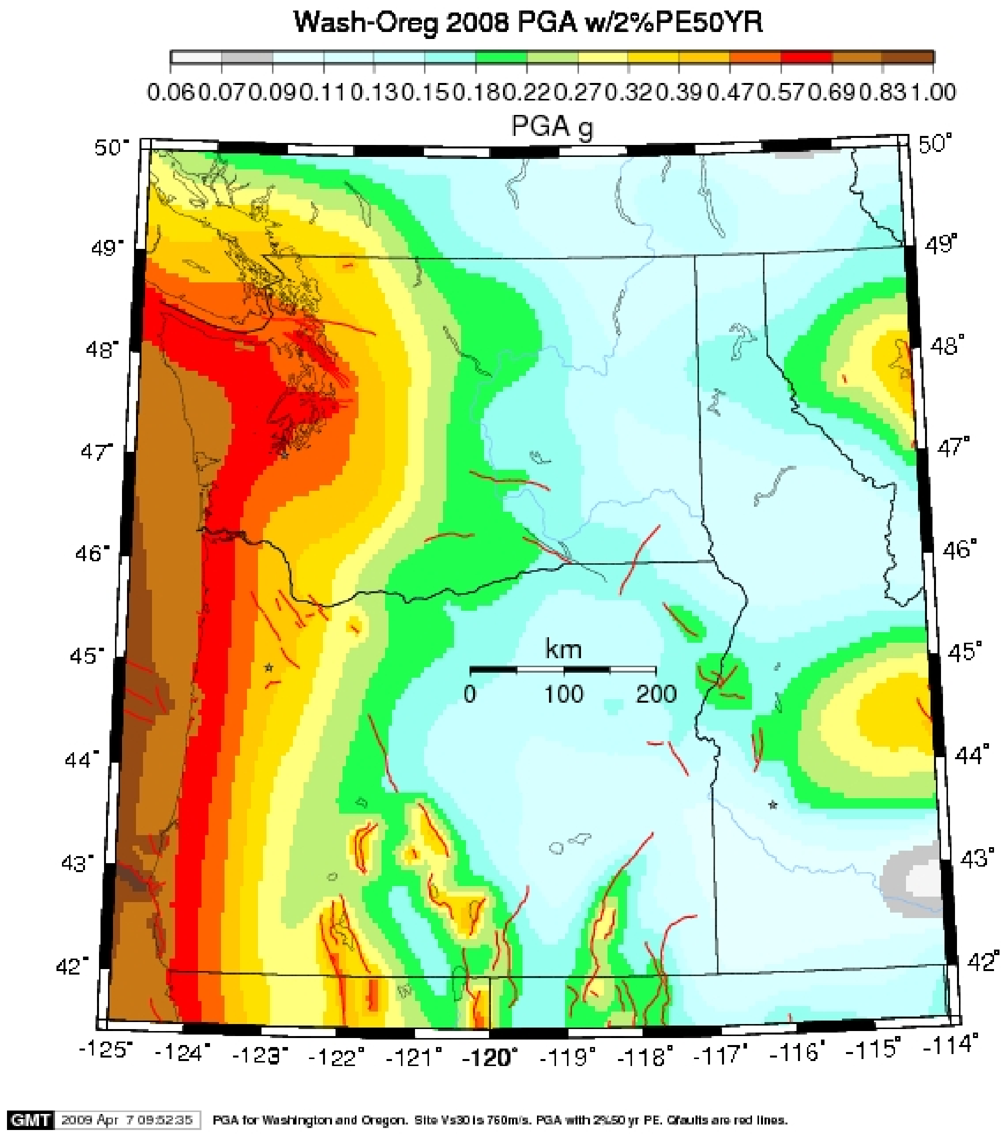


Figure 2 - Map showing Peak Ground Acceleration (PGA) Intensity for a ground motion having a 2% chance of being exceeded in 50 years (Source: USGS).

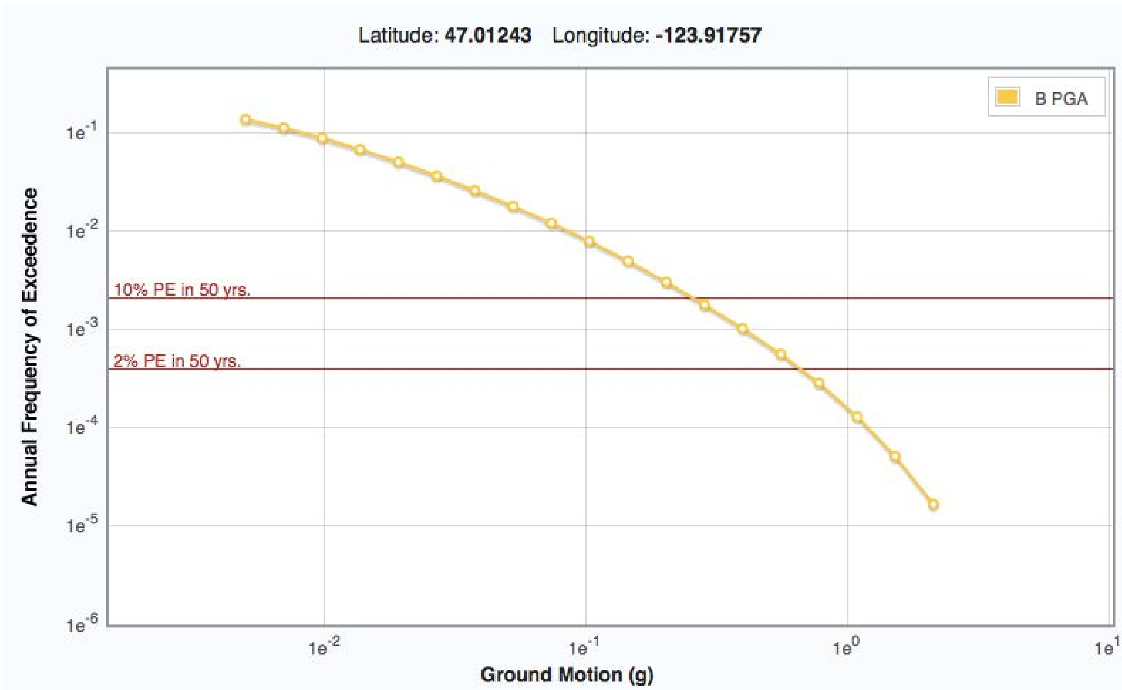


Figure 3 - Seismic hazard curve (yellow curve) for Projects showing expected Peak Ground Acceleration (PGA) as a function of return period. The 2%/50 year motion is denoted with the lower red line. Note that the hazard curve is for stiff "site class B" soils; ground shaking on softer soils, such as those found at the site, are likely to be larger.

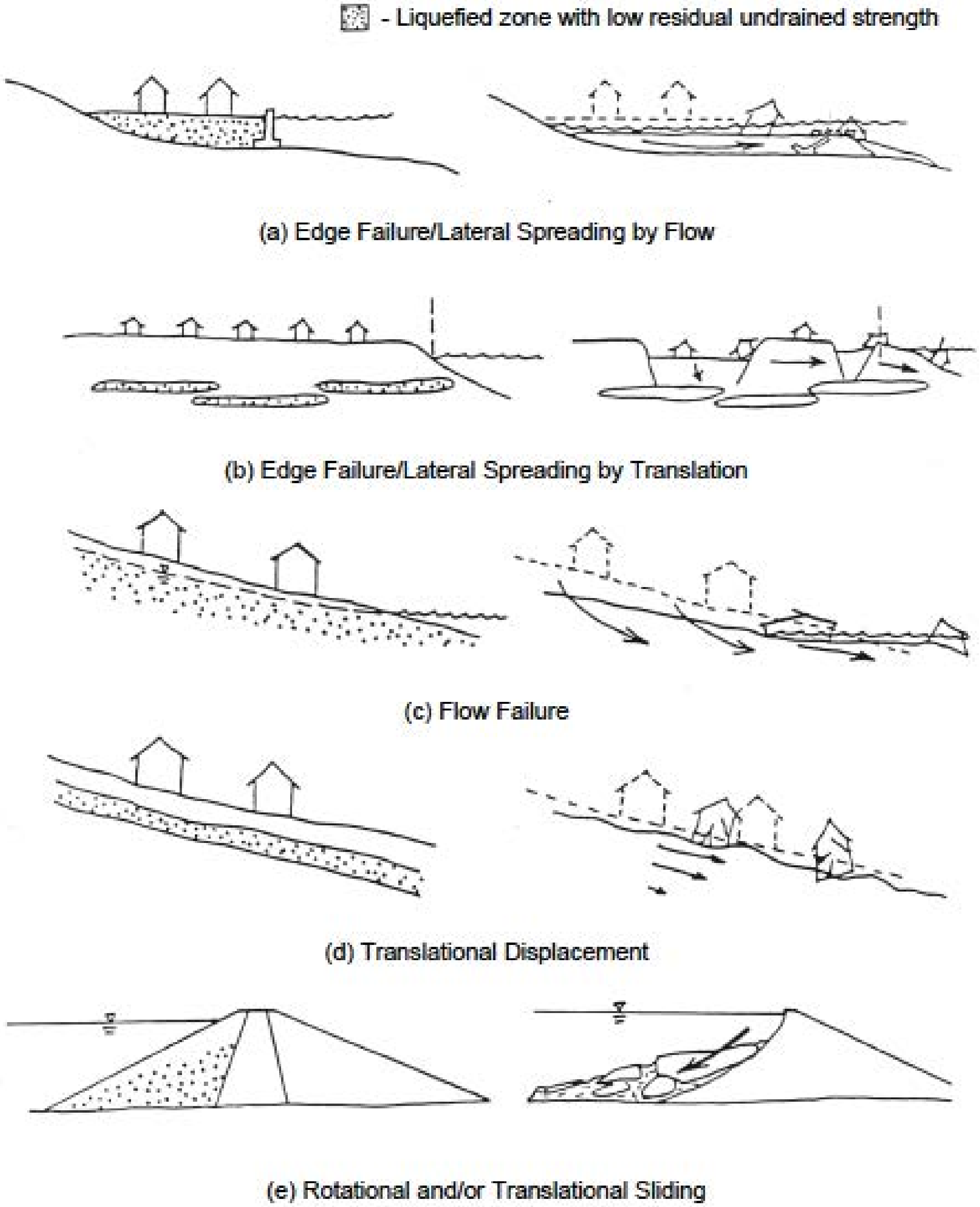


Fig. 44: Schematic Examples of Liquefaction-Induced Global Site Instability and/or "Large" Displacement Lateral Spreading

Figure 4: Examples of liquefaction-induced global site instability from (Seed et al. 2003, with original figure caption included)

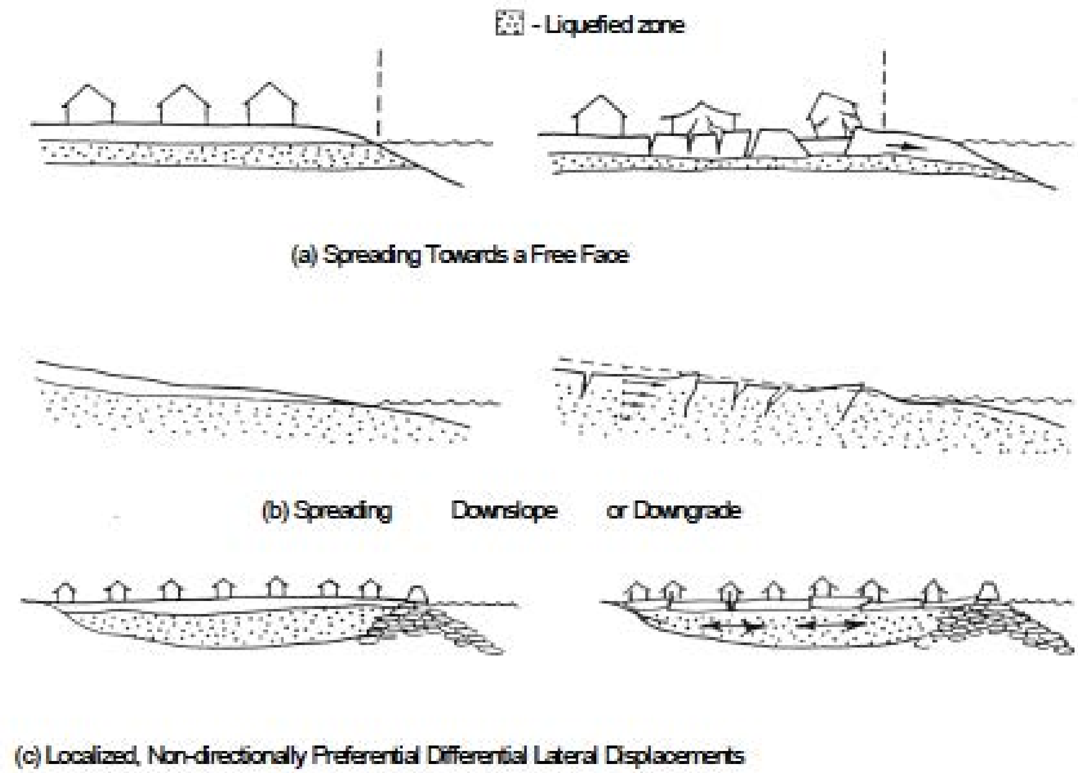


Fig. 49: Schematic Examples of Modes of "Limited" Liquefaction-Induced Lateral Translation

Figure 5 - Examples of liquefaction-induced lateral translation from (Seed et al. 2003, with original figure caption included)

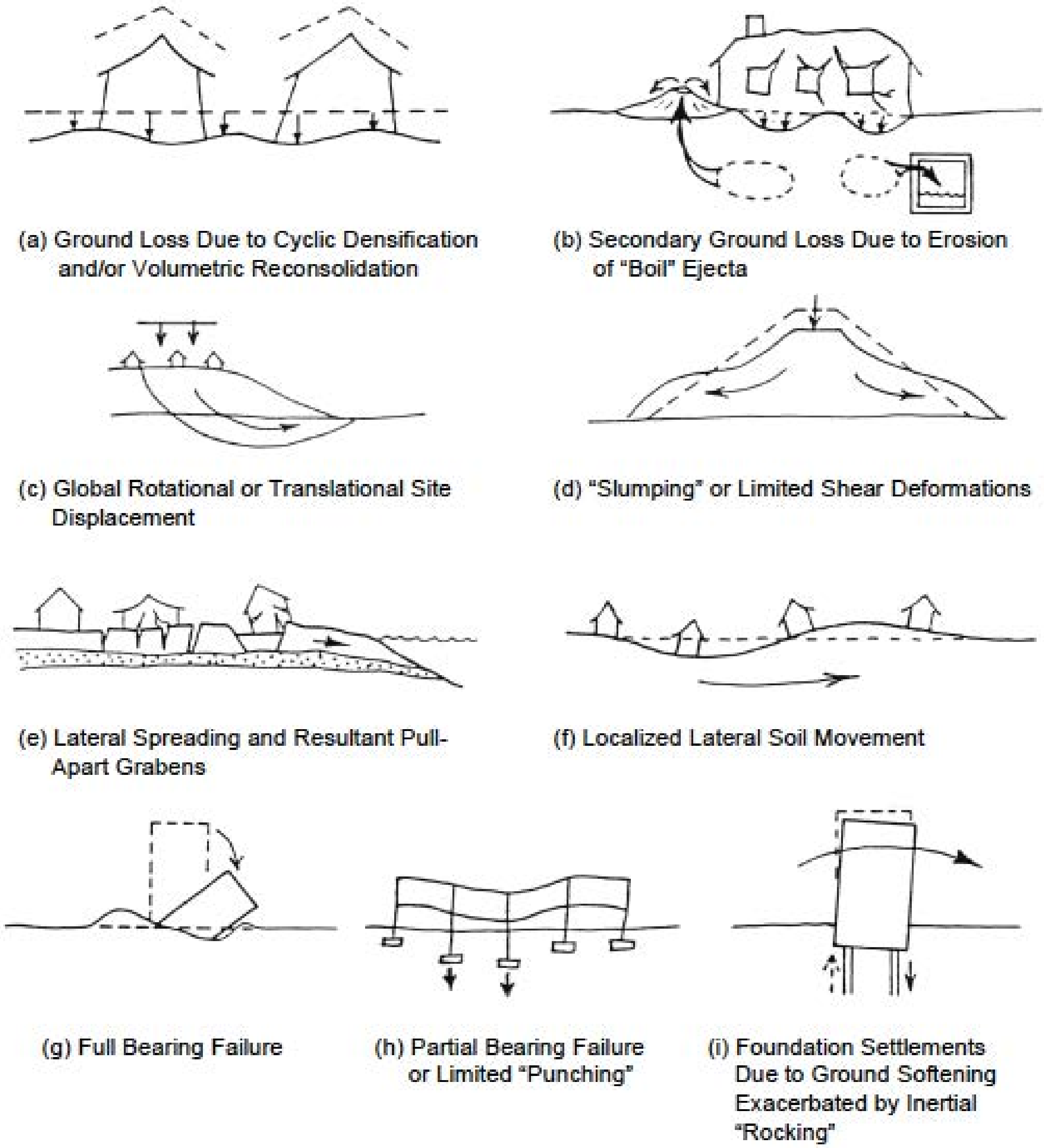
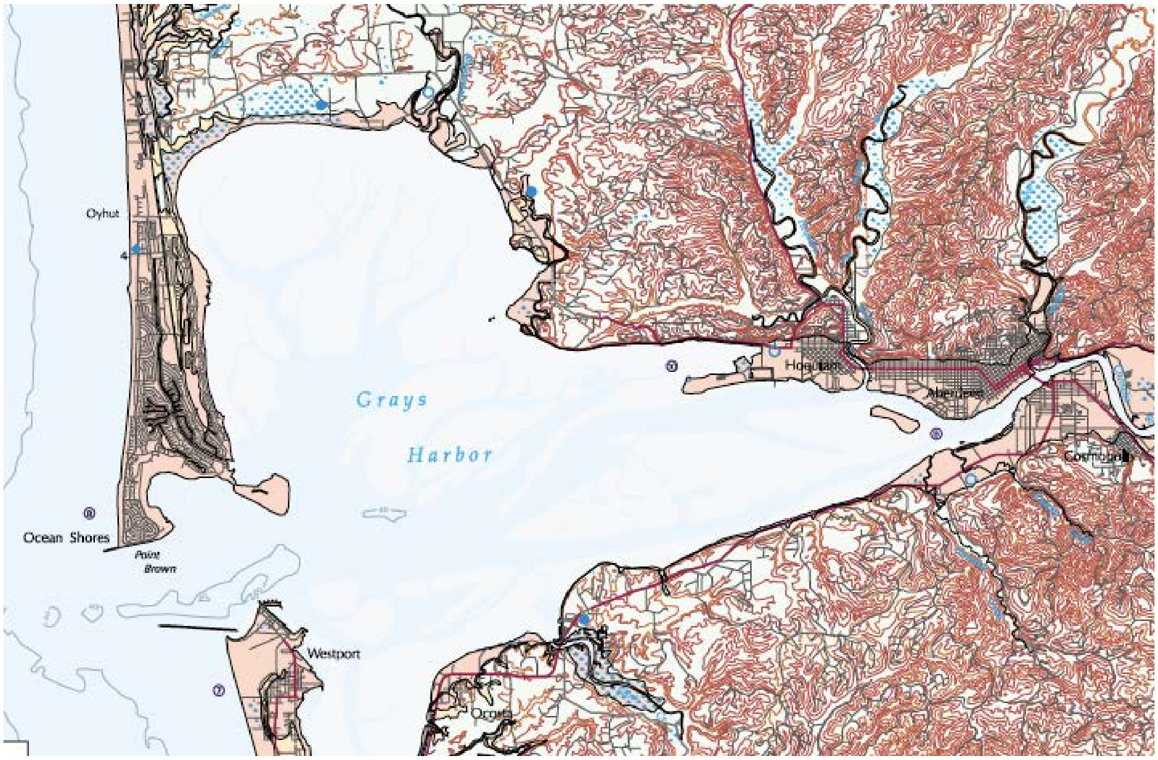


Fig. 50: Schematic Illustration of Selected Modes of Liquefaction-Induced Vertical Displacements

Figure 6 - Examples of liquefaction-induced vertical settlements (Seed et al. 2003, with original figure caption included)



EXPLANATION

Areas inundated by a moderately high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A).

Additional areas inundated by a high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A with asperity).

Areas not inundated by the modeled tsunami.

Figure 7 - Map showing location of tsunami inundation zones (from the Washington State Department of Natural Resources)

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Geotechnical Engineer of the Year, American Society of Civil Engineers, Philadelphia Section, 2007

John J. Gallen Memorial Award for Technical Advancements, Villanova University, 2005

National Science Foundation Faculty Early Career Development (CAREER) Award, 2002

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PUBLICATIONS

Journals

Pradel, D., J. Wartman, and B. Tiwari (2013) Impact of anthropogenic changes on liquefaction along the Tone River during the 2011Tohoku Earthquake, *Natural Hazards Review*, in press.

Wartman, J., Dunham, L., Tiwari, B., and Pradel, D. (2013) "Landslides in Eastern Honshu induced by the 2011 Tōhoku Earthquake," *Bulletin of the Seismological Society of America*, Vol. 103, No. 2B, pp. 1503-1521.

Urias, D., Gallagher, P., and Wartman, J. (2012) "Critical features and value in assessing a research experience for undergraduates: the case of Engineering Cities," *Journal of STEM Education: Innovations and Research,* Vol. 13, No. 1, pp. 30-42.

Strenk, P. and Wartman, J. (2011) "Uncertainty in Seismically Induced Slope Deformation Model Predictions," *Engineering Geology*, Vol. 122, pp. 61-72.

Andrejack, T. and Wartman, J. (2010) "Development and interpretation of a multi-axial tension test for geotextiles," *Geotextiles and Geomembranes*, Vol. 28, No. 6, pp. 559-569.

Rodríguez-Marek, A., Bay, J., Park, K., Montalva, G., Cortez-Suárez, A., Wartman, J., and R. Boroschek (2010) "Engineering analysis of ground motion records from the Mw 8.4 Southern Peru Earthquake," *Earthquake Spectra*, Vol. 26, No. 2, pp. 499–524.

Mavrouli, O., Corominas, J., and Wartman, J. (2009) "Methodology to evaluate rock slope stability under seismic conditions at Solá de Santa Coloma, Andorra," *Natural Hazards and Earth System Science*, Vol. 9, pp.1763-1773.

Grubb, D. G., Wartman, J., and Malasavage, N. E. (2008) "Aging of Crushed Glass-Dredged Material Blend Embankments," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 134, No. 11, pp. 1676-1684.

Seed, R., Bea, R., Abdelmalak, R., Athanasopoulos-Zekkos, A., Boutwell, G., Briaud, J.-L., Cheung, C., Cobos-Roa, D., L. Ehrensing, L., Govindasamy, A., Harder, L., Inkabi, K., Kammerer, A., Karadeniz, D., Kayen, R., Moss, R., Nicks, J., Pestana, J., Porter, J., Rhee, K., Riemer, M., Rogers, J., Storesund,., Vera-Grunauer, X., and Wartman, J. (2008) "New Orleans and Hurricane Katrina: I - Introduction, Overview, and the East Flank," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 134, No. 5, pp. 701-717.

Seed, R., Bea, R., Athanasopoulos- Zekkos, A., Boutwell, Bray, J. D., Cheung, C., Cobos-Roa, D., Harder, L., Pestana, J., Riemer, M., Rogers, J., Storesund, R., Vera-Grunauer, X., and Wartman, J. (2008) "New Orleans and Hurricane Katrina: II - The Central Region and the Lower Ninth Ward," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 134, No. 5, pp. 718-739.

Seed, R., Bea, R., Athanasopoulos- Zekkos, A., Boutwell, Bray, J. D., Cheung, C., Cobos-Roa, D., Harder, L., Moss, R., Pestana, J., Riemer, M., Rogers, J., Storesund, R., Vera-Grunauer, X., and Wartman, J. (2008) "New Orleans and Hurricane Katrina: III - The 17th Street Drainage Canal," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 134, No. 5, pp. 740-761.

Seed, R., Bea, R., Athanasopoulos- Zekkos, A., Boutwell, Bray, J. D., Cheung, C., Cobos-Roa, D., Cohen-Waeber, J., Collings, B., Harder, L., Keyen, R., Pestana, J., Riemer, M., Rogers, J., Storesund, R., Vera-Grunauer, X., and Wartman, J. (2008) "New Orleans and Hurricane Katrina: IV - The Orleans East Bank (Metro) Protected Basin," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 134, No. 5, pp. 762-779.

Malasavage, N. E., Gallagher, P. M., Grubb, D. G., Wartman, J., and Carnivale, M. (2007) "Modifying a Plastic Clay with Crushed Glass: Implications for Constructed Fills," *Soils and Foundations*, Vol. 47, No. 6, pp. 1017-1028.

Wartman, J., Natale, M., and Strenk, P. M., (2007) "Immediate and Time Dependent Compression of Tire Derived Aggregate," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 133, No. 3, pp. 245-256.

Strenk, P. M., Wartman, J., Grubb, D. Humphrey, D., and Natale, M. (2007) "Variability and Scale-Dependency of Tire Derived Aggregate," *Journal of Materials in Civil Engineering,* Vol. 19, No. 3, pp. 233-241.

Rodríguez-Marek, A., Alva Hurtado, J., Cox , B., Meneses, J., Montalva, G. A., Moreno, V., Olcese, M., Sancio, R., and Wartman, J. (2007) "Geotechnical Aspects of the 15 August 2007 Pisco, Peru Earthquake, *Revista Internacional de Desastres Naturales, Accidentes e Infraestructura Civil*, Vol. 7, No. 2-3, pp. 239-258 (in Spanish).

Keefer, D., Wartman, J., Navarro-Ochoa, C., Rodriguez-Marek, A., and Wieczorek, G. (2006). "Landslides Caused by the M 7.6 Tecomán, Mexico Earthquake of January 21, 2003," *Engineering Geology*, Vol. 86, nos. 2-3, pp.183-197.

Grubb, D., Gallagher, P., Wartman, J., Liu, Y., and Carnivale, M. S. (2006) "Laboratory Evaluation of Crushed Glass-Dredged Material Blends," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 132, No. 5, pp. 562-576.

Grubb, D., Davis, A., Sands, S., Carnivale, M. S., and Wartman, J. (2006) "Field Evaluation of Crushed Glass-Dredged Material Blends," *Journal of Geotechnical and Geoenvironmental Engineering,* Vol. 132, No. 5, pp. 577-590.

Wartman, J. (2006). "Geotechnical Physical Modeling for Education: A Learning Theory-Based Approach," *Journal of Professional Issues in Engineering Education and Practice*, Vol. 132, No. 4, pp. 288-296.

Wartman, J., Rondinel-Oviedo, E. A., Rodriguez-Marek, A. M. (2006). "Performance and Analysis of Mechanically Stabilized Earth (MSE) Walls in the Tecomán, Mexico Earthquake," *Journal of Performance of Constructed Facilities*, Vol. 20, No. 3, pp. 287-299.

Wartman, J., Rodriguez-Marek, A., Macari, E. J., Deaton, S., Ramírez-Reynaga, M., Navarro Ochoa, C., Callen, S., Repetto, P., and Ovando Shelley, E. (2005). "Geotechnical Aspects of the January 2003 Tecomán, Mexico Earthquake," *Earthquake Spectra*, Vol. 21, No. 2, pp. 493-538.

Wartman, J. and Riemer, M. (2005). "The Use of Fly Ash to Alter the Engineering Properties of a 'Model' Clay," *International Journal of Physical Modeling in Geotechnics*, Vol. 5, No. 2, pp. 17-29.

Wartman, J., Seed, R. and Bray, J. (2005). "Shaking table modeling of seismically induced deformation in slopes," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 131, No. 5, pp. 610-622.

Wartman, J., Grubb. D., and Nasim, A. (2004). "Select Engineering Characteristics of Crushed Glass," *Journal of Materials in Civil Engineering*, Vol. 16, No. 6, pp. 526-539.

Wartman, J., Rodriguez-Marek, A, Repetto, P. and Keefer, D. (2003). "Ground Failure. Southern Peru Earthquake of June 21, 2001 Reconnaissance Report," *Earthquake Spectra,* Vol. 19(A), No. 1, pp. 35-56.

Repetto, P., Wartman, J., and Rodriguez-Marek, A. (2003) "Mines: Geotechnical Aspects. Southern Peru Earthquake of June 21, 2001 Reconnaissance Report," *Earthquake Spectra,* Vol. 19(A), No. 1, pp. 57-72.

Rodriguez-Marek, A., Williams, J., Wartman, J., and Repetto, P. (2003). "Ground Motion and Site Response. Southern Peru Earthquake of June 21, 2001 Reconnaissance Report," *Earthquake Spectra,* Vol. 19(A), No. 1, pp. 11-34.

Wartman, J. Bray, J.D., Seed, R. B. (2003). "Inclined Plane Studies of the Newmark Sliding Block Procedure," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 129, No. 8, pp. 673-684.

Conference Publications

Pradel. D., Wartman, J., and Tiwari, B. (2013) "Failure of the Fujinuma Dams during the 2011 Tohoku Earthquake," *Proc., Geo-Congress 2013: Stability and Performance of Slopes and Embankments*, San Diego, March 3-7.

Wartman, J. and Malasavage, N. (2013) "Predicting Time-to-Failure in Slopes from Precursory Displacements: A Centrifuge Experiment," *Proc., Geo-Congress 2013: Stability and Performance of Slopes and Embankments*, San Diego, March 3-7.

Tiwari, B., Wartman, J., and Pradel, D. (2013) "Slope Stability Issues After Mw 9.0 Tohoku Earthquake," *Proc., Geo-Congress 2013: Stability and Performance of Slopes and Embankments*, San Diego, March 3-7.

Wood, C., Cox, B., Rodriguez-Marek, A., Assimaki, D., Wartman, J., and Pando, M. (2012) "Topographic Effects from Longwall Coal Mining Seismicity: Phase I Experimental Setup and Results, *Proc., Second International Conference on Performance-Based Design in Earthquake Geotechnical Engineering*, Taormina, Italy, May 28-30.

Tiwari, B., Pradel, D., and Wartman, J. (2012) "Performance of Slopes and Dams in the M_w 9.0 Tohoku, Japan Earthquake," *Proc., Second International Conference on Performance-Based Design in Earthquake Geotechnical Engineering*, Taormina, Italy, May 28-30.

Pradel, D., Wartman, J., and Tiwari, B. (2012) "Failure of Fujinuma Dam during the 2011 Tohoku Earthquake, " *Joint Proc., 9th International Conference on Urban Earthquake Engineering/ 4th Asia Conference on Earthquake Engineering*, Tokyo, March 6-8.

Strenk, P. and Wartman, J. (2011) "Comparison of dynamic response from Equivalent-Linear and Cyclic Non-Linear Models of Hysteretic Soil Behavior," *Proc., 2nd International FLAC/DEM Symposium*, Melbourne, February 14-16.

Ozkahriman, F. and Wartman, J. (2010) "Reliability of One-g Shaking Table Experiment," *Proc., 7th International Conference on Physical Modeling in Geotechnics*, Zurich, June 28-July 1.

Cox, B., Cothren, J., Barnes, J., Wartman, J., Meneses, J., Rodriguez-Marek, A. (2010) "Towards Quantifying Movement of a Massive Lateral Spread Using High-Resolution Satellite Image Processing," *Proc., 2010 US-CANADA joint conference on Earthquake Engineering*, Toronto, July 25-29.

Wartman, J. and Malasavage, N. (2010) "Were Topographic Effects Responsible for Building Collapses in the 2001 Southern Peru Earthquake?," *Proc. 7th International Conference on Urban Earthquake Engineering and 5th International Conference on Earthquake Engineering*, Tokyo, March 3-5.

Meneses, J. F., Franke, K. W., Cox, B. R., Rodriguez-Marek, A., and Wartman, J. (2009) "Performance-Based Evaluation of a Massive Liquefaction-Induced Lateral Spread in a Subduction Zone," *Proc., International Conference on Performance-Based Design in Earthquake Geotechnical Engineering*, Tokyo, June 15-18.

Strenk, P. M. and Wartman, J. (2008) "Validity of the Pseudostatic Surface Assumption for Evaluating Seismically-Induced Deformation in Slopes," *Proc., First International FLAC/DEM Symposium on Numerical Modeling*, Minneapolis, August 25-27

Mavrouli, O., Corominas, J., and Wartman, J. (2008) "The Seismic Effect on Rockfall Hazards," *Proc., Interdisciplinary Workshop on Rockfall Protection*, Morschach, Switzerland, June 23-25

Malasavage, N. and Wartman, J. (2008) "Spatial Analysis of Damage Distribution in the 2001 Southern Peru Earthquake," *Proc., Geotechnical Earthquake Engineering and Soil Dynamics IV*, Sacramento, Calif., May 18-22

Andrejack, T. L. and Wartman, J. (2008) "Development of a Multi-Axial Test for Geotextiles," *Proc., First Pan American Geosynthetics Conference & Exhibition*, Cancun, Mexico, March 2-5

Silva, W., Rodriguez-Marek, A., and Wartman, J. (2007) "Development of synthetic ground motions for the June 23rd 2001 Southern Peru Earthquake," *Proc., 13th PanAmerican Conference on Soil Mechanics and Geotechnical Engineering*, Isla de Margarita, Venezuela, July 15-19

Rondinel-Oviedo, E., Rodriguez-Marek, A., Wartman, J., Zegarra-Pellanne, J., and Repetto, P. (2007) "Geotechnical Aspects of the June 23rd 2001 (Mw=8.4) Southern Perú earthquake," *Proc., 13th PanAmerican Conference on Soil Mechanics and Geotechnical Engineering*, Isla de Margarita, Venezuela, July 15-19 (in Spanish)

Ozkahriman, F. Nasim, A. and Wartman, J. (2007) "Topographic Effects in a Centrifuge Model Experiment," *Proc., 4th Intl. Conf. on Earthquake Geotechnical Engineering*, Thessaloniki, Greece, June 25-28

Seed, R., Bea, R., Abdelmalak, R., Athanasopoulos, A., Boutwell, G., Bray, J., Briaud, J.-L., Cheung, C., Cohen-Waeber, J., Collins, B., Cobos-Roa, D., Farber, D., Hanenmann, M., Harder, L., Inkabi, K., Kammerer, A., Karadeniz, D., Kayen, R., Moss, R., Nicks, J., Nimala, S., Pestana, J., Porter, J., Rhee, K., Riemer, M., Roberts, K., Rogers, J., Storesund, Govindasamy, A., Vera-Grunauer, X., Wartman, J., Watkins, C., Wenk, E., Yim, S. (2007) "Investigation of Levee Performance in Hurricane Katrina: A Summary of Findings from the Independent Levee Investigation Team (ILIT)." *Proc., Engineering of Geo-Hazards*, ASCE Metropolitan Section Geotechnical Group Specialty Seminar, New York City, May 16-17

Ozkahriman, F. and Wartman, J. (2007) "Investigation of 1-G Similitude Laws by "Modeling-of-Models" Exercise," Advances in Measurement and Modeling of Soil Behavior, ASCE Geotechnical Special Publication 173, Part of *Proc., GeoDenver: New Peaks in Geotechnics,* Denver, February 18-21

Grubb, D., Wartman, J., Malasavage, N., and Mibroda, J. (2007) "Turning Mud into Suitable Fill: Amending OH, ML-MH, and CH Soils with Curbside-Collected Crushed Glass," Geoenvironmental Engineering, ASCE Geotechnical Special Publication 163, Part of *Proc., GeoDenver: New Peaks in Geotechnics,* Denver, February 18-21

Seed, R., Bea, R., Abdelmalak, R., Athanasopoulos, A., Boutwell, G., Bray, J., Briaud, J.-L., Cheung, C., Cohen-Waeber, J., Collins, B., Cobos-Roa, D., Farber, D., Hanenmann, M., Harder, L., Inkabi, K., Kammerer, A., Karadeniz, D., Kayen, R., Moss, R., Nicks, J., Nimala, S., Pestana, J., Porter, J., Rhee, K., Riemer, M., Roberts, K., Rogers, J., Storesund, Govindasamy, A., Vera-Grunauer, X., Wartman, J., Watkins, C., Wenk, E., Yim, S. (2007) "Investigation of the Performance of the New Orleans Regional Flood Protection Systems During Hurricane Katrina: Lessons Learned," Embankments, Dams, and Slopes, ASCE GSP 161, *Proc., GeoDenver: New Peaks in Geotechnics,* Denver, February 18-21

Seed, R., Bea, R., Athanasopoulos, A., Boutwell, G., Bray, Cheung, C., Collins, B., Cobos-Roa, D., Harder, L., Kayen, R., Pestana, J., Porter, J., Riemer, M., Rogers, J., Storesund, R., Vera-Grunauer, X., and Wartman, J. (2007) "Investigation of Levee Performance in Hurricane Katrina: The Inner Harbor Navigation Channel," Embankments, Dams, and Slopes, ASCE GSP 161, Part of *Proc., GeoDenver: New Peaks in Geotechnics,* Denver, February 18-21

Seed, R., Bea, R., Athanasopoulos, A., Boutwell, G., Bray, Cheung, C., Collins, B., Cobos-Roa, D., Cohen-Waeber, L., Harder, L., Kayen, R., Moss, R., Pestana, J., Porter, J., Riemer, M., Rogers, J., Storesund, R., Vera-Grunauer, X., and Wartman, J. (2007) "Investigation of Levee Performance in Hurricane Katrina: The New Orleans Drainage Canals," Embankments, Dams, and Slopes, ASCE GSP 161, Part of *Proc., GeoDenver: New Peaks in Geotechnics,* Denver, February 18-21

Cleveland, L. and Wartman, J. (2006) "Principles and Application of Digital Photogrammetry for Geotechnical Engineering," *Proc., GeoShanghai International Conference,* Shanghai, China, June 6-8

Nasim, A. S. M. and Wartman, J. (2006) "Fully Coupled Modeling of Seismic Compression," *Proc., Fourth International FLAC Symposium*, Madrid, May 29-31

Grubb, D. G., Carnivale, M. Wartman, J., and Gallagher, P. (2006) "Select Engineering Properties of Crushed Glass-Dredged Material (CG-DM) Blends," *Proc., ISSMGE: 5th International Congress on Environmental Geotechnics,* Cardiff, Wales, UK, June 26-30

Cortez-Flores, A., Rodriguez-Marek, A., and Wartman, J. (2005). "Failure Mechanisms Observed in Highway Infrastructure During the 2001 Southern Peru Earthquake." *Proc., Second Pan-American Congress on Integrated Transportation*, Tarija, Bolivia (In Spanish)

Wartman, J., Harmanos, D., and Ibanez, P. (2005) "Development of a Versatile Device for Measuring the Tensile Properties of Geosynthetics," in *Proc., 18th Geosynthetic Research Institute Conference*, Austin, Texas, January

Wartman, J., Grubb, D. G., and Strenk, P. (2004) "Engineering Properties of Crushed Glass-Soil Blends," *Geotechnical Engineering for Transportation Projects: Proceedings of Geo-Trans 2004*, July 27-31.

Wartman, J., Rodriguez-Marek, A., Keefer, D., Deaton, S., Repetto, P. and Macari, E. (2004) "Preliminary Geotechnical Engineering Observations of the Tecoman, Mexico Earthquake of January 21, 2003," *Proc. of Fifth Intl. Conf. on Case Histories in Geotechnical Engineering*, New York, April 13-17

Rodriguez-Marek, A., Wartman, J., Repetto, P. and Williams, J. (2004) "Observations of Site Amplification and Liquefaction in the June 23, 2001, Southern Peru Earthquake," *Proc. of Fifth Intl. Conf. on Case Histories in Geotechnical Engineering*, New York, April 13-17

Rodriguez-Marek, A. and Wartman, J. (2004) "Characteristics of Strong Ground Motion Recorded During the 2003 Tecomán, Mexico, Earthquake," *Proc., 11th Intl. Conf. on Soil Dyn. and Earthquake Engineering*, Berkeley, Calif., January 7-9

Wartman, J. and Reimer, M. F., (2002) "The Use of Fly Ash to Alter the Geotechnical Properties of Artificial "Model" Clay," *Proc., International Conference on Physical Modeling in Geotechnics*, St. John's, Canada, July 10-12

Wartman, J., Bray, J.D. and Seed, R. B. (2001) "Shaking Table Experiment of a Slope Subjected to Two Ground Motions," *Proc, Forth Intl. Conf. on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics*, San Diego, California, March 14-16

Wartman, J., Vahdani, S., and Liang, H. S. (2001) "Seismic Soil Structure Interaction Analyses for an Office Building in Oakland, California," *Proc, Forth Intl. Conf. on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics*, San Diego, California, March 14-16

Wartman, J., Seed, R. B., Bray, J. D., Riemer, M. F., and Rathje, E. M. (1999) "Laboratory Evaluation of the Newmark Method for Assessing Seismically-Induced Slope Deformations," *Proc., Second International Conference on Earthquake Geotechnical Engineering*, Lisbon, Portugal, June 21-25

Wartman, J., Riemer, M. F., Bray, J. D., and Seed, R. B. (1998) "Newmark Analyses of a Shaking Table Slope Stability Experiment," *Proc., Geotechnical Earthquake Engineering and Soil Dynamics III*, Seattle, August 3-6

Riemer, M. F., Gookin, W. B., Bray, J. D., and Wartman, J. (1998) "Using Reflected Shear Waves to Measure Small Strain Dynamic Properties," *Proc., Fifth Caltrans Seismic Research Workshop*, California Dept of Transportation, Sacramento, Calif., June 16-18

Wartman, J., Rathje, E. M., Bray, J. D., Riemer, M. F. and Seed, R. B. (1998) "Shaking Table-Based Evaluation of the Newmark Procedure for Estimating Seismically Induced Slope Deformations," *Proc., Fifth Caltrans Seismic Research Workshop*, California Dept of Transportation, Sacramento, Calif., June 16-18

Books

Wartman, J. and Malasavage, N. E. (2010) "Spatial Analysis for Identifying Urban Damage Patterns," Chapter in *Methods and Techniques in Urban Engineering*, I-Tech Publishing, ISBN 9789533070964

Porbaha, A., Shen, S.-L., Wartman, J . and Chai, J.-C., eds. (2006) *Ground Modification and Seismic Mitigation,* ASCE Press, Reston, Virginia, ISBN 0784408645

Aydilek, A. and Wartman, J., eds. (2005) *Recycled Material in Geotechnics*, ASCE Press, Reston, Virginia, ISBN 0784407568

Published Abstracts

Wartman, J. and Strenk, P. (2009) "Uncertainty in Earthquake-Induced Deformations: History of the Calabasas Landslide," The Next Generation of Research on Earthquake-induced Landslides: An International Conference in Commemoration of the 10th Anniversary of the Chi-Chi Earthquake, Taipei, Taiwan, September 21-24.

Wartman, J. (2009) "Earthquake-Induced Rockfall Hazard Assessment," National Science Foundation Engineering Education Programs Awardees Conference, Reston, VA, February 2-3.

Urias, D., Wartman, J., Gallagher, P., and Morrison, K. (2009) "Assessment of the Engineering Cities REU Program," National Science Foundation Engineering Education Programs Awardees Conference, Reston, VA, February 2-3.

Wartman, J., Cox, B., Meneses, J., Moreno, V., Olcese, M., Rodriguez-Marek, A, and Sancio, R. (2008) "Landslides Triggered by the 15 August 2007 M8.0 Pisco, Peru Earthquake," *Geophysical Research Abstracts*, Vol. 10, European Geophysical Union General Assembly, Vienna, April 13-18

Mavrouli, O., Wartman, J., and Corominas, J. (2008) "Assessment of Earthquake-Induced Rockfall Hazards," *Geophysical Research Abstracts*, Vol. 10, European Geophysical Union General Assembly, Vienna, April 13-18

Wartman, J., Rodriguez-Marek, A., Macari, E. J., Deaton, S., Ramírez-Reynaga, M., Navarro Ochoa, C., Callen, S., Repetto, P., and Ovando Shelley, E. (2006) "Ground Failure in the January 2003 Tecoman, Mexico, Earthquake," *Seismological Research Letters,* 77(2), pp. 321-322, Annual meeting, Seismological Society of America, San Francisco, April 18-22

Wartman, J., Bray, J. D., and Seed, R. B., (2001) "Inclined Plane Studies of Seismically Induced Displacements in Slopes," Extended Abstract with Presentation, *Proc., Tenth International Conference on Soil Dynamics and Earthquake Engineering*, Philadelphia

Vahdani, S., Povone, M., Benson, S., Osmun, D., Ehasz, J. and Wartman, J., (2001) "Static and Dynamic Stability and Soil Liquefaction Analyses of the 200-Meter-High Rockfill San Roque Dam, Extended Abstract with Presentation, *Proc., Tenth International Conference on Soil Dynamics and Earthquake Engineering*, Philadelphia

Rodriguez-Marek, A., Repetto, P., Wartman, J., Zegarra-Pellanne, J., (2001) "Preliminary Observations of The Geotechnical Aspects of the June 23, 2001 Southern Peru Earthquake," Extended Abstract with Presentation, *Proc., Tenth International Conference on Soil Dynamics and Earthquake Engineering*, Philadelphia

Grubb, D. and Wartman, J., (2001) "Geotechnical Evaluation of Glass Cullet for Transportation Applications," *Proc. of Beneficial Use of Recycled Materials in Transportation Applications,* Washington, D.C., June 1

Major Reports and other Publications

Tiwari, B., Pradel, D., and Wartman, J., (2011) "Landslides Triggered by the Tohoku Earthquake: Preliminary Observations, GeoStrata, Vol. 10, p 28-32

Schwartz, H., Corley, W., Desormeaux, E., Edge, B., Edwards, C., and Wartman, J. (2009) ASCE Post-Disaster Assessment Manual, American Society of Civil Engineers.

Seed, R., Bea, R., Abdelmalak, R., Athanasopoulos, A., Boutwell, G., Bray, J., Briaud, J.-L., Cheung, C., Cohen-Waeber, J., Collins, B., Cobos-Roa, D., Farber, D., Hanenmann, M., Harder, L., Inkabi, K., Kammerer, A., Karadeniz, D., Kayen, R., Moss, R., Nicks, J., Nimala, S., Pestana, J., Porter, J., Rhee, K., Riemer, M., Roberts, K., Rogers, J., Storesund, Govindasamy, A., Vera-Grunauer, X., Wartman, J., Watkins, C., Wenk, E., Yim, S. (2006) *"Investigation of the Performance of the New Orleans Flood Protection Systems in Hurricane Katrina on August 29, 2005, Volume I: Main Text and Executive Summary, Final Report July 31, 2006,"* Independent Levee Investigation Team, Center for Information Technology Research in the Interests of Society (CITRIS), University of California, Berkeley

Seed, R., Nicholson, P., Dalrymple, R., Battjes, J., Bea, R., Boutwell, G., Bray, J., Collins, B., Harder, L., Headland, J., Inamine, M., Kayen, R., Kuhr, R., Pestana, J., Silva-Tulla, F., Storesund, R., Tanaka, S., Wartman, J., Wolff, T., Wooten, L., Zimmie, T. (2005) *"Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005,"* Report No. UCB/CITRIS – 05/01, Center for Information Technology Research in the Interests of Society (CITRIS), University of California, Berkeley

Wartman, J., Seed, R. B., and Bray J.D. (2001) *"Physical Model Studies of Seismically Induced Deformations in Slopes,"* Geo-Engineering Report No. UCB/GT/01-01, Department of Civil and Environmental Engineering, University of California, Berkeley

Wartman, J., Seed, R. B., and Bray J.D., (2001) *"Physical Model Studies of Seismically Induced Deformations in Slopes: Experimental Data,"* Geo-Engineering Report No. UCB/GT/01-02, Department of Civil and Environmental Engineering, University of California, Berkeley

Travasarou, T., Bray, J., Wartman, J., Seed, R. and Riemer, M. (2001) *"Evaluation of Seismic Slope Displacement Procedures through Back-Analysis of Physical Models Tests,"* Geo-Engineering Report No. UCB/GT/01-04, Department of Civil and Environmental Engineering, University of California, Berkeley

INVITED LECTURES, PANEL DISCUSSIONS, and CONFERENCE PRESENTATIONS

Invited Lectures

California Institute of Technology, Jet Propulsion Laboratories, Earth Science Group Seminar, March 2012

University of California, Los Angeles, Civil and Environmental Engineering Seminar, March 2012

Assoc. of Engineering Geologists and Geo-Institute, Los Angeles Section, Monthly Meeting, March 2012

Oregon State University, Civil Engineering Seminar, November 2011

Gunma University (Japan), Civil Engineering Seminar, April 2011

Shannan and Wilson Professional Seminar, April 2011

Seattle Chapter of the Geo-Institute, Monthly Meeting, January 2011

Tufts University, Civil and Environmental Engineering Seminar, October 2010

Delaware Valley Geo-Institute Seminar, April 2010

Geotechnical Extreme Event Reconnaissance (GEER) Association Workshop, May 2009

Drexel University, Homeland Security, Philadelphia Student Chapter Seminar, January 2009

Columbia University, Civil Engineering and Engineering Mechanics Seminar, October 2008

Rensselaer Polytechnic Institute, NEES Centrifuge Research and Training Workshop, September 2008

Imperial College London, Geotechnics Seminar, June 2008

Universitat Politècnica de Catalunya, Civil Engineering Seminar, May 2008

Universitat Politècnica de Catalunya, Landslide Research Group Seminar, November 2007

Centre for Post-Graduate Training and Research in Earthquake Eng. (ROSE School), Seminar, May 2008

ETH Zurich, Engineering Geology Seminar, April 2008

Drexel University, Order of the Engineer Induction Ceremony, Lecture, May 2007

Delaware Valley Geo-Institute, Annual Student Meeting, Lecture, February 2007

University of Pennsylvania, Environmental Science Seminar, March 2007

Drexel University, Great Works Symposium, Lecture, May 2006

American Society of Highway Engineers, Earthquake Engineering Short Course, April 2006

American Society of Highway Engineers, Dinner Meeting, Lecture, April 2006

Clemson University, Civil Engineering Seminar, April 2006

Virginia Polytechnic Institute, Civil and Environmental Engineering Seminar, April 2006

University of Pennsylvania, Environmental Science Seminar, February 2006

American Water Resources Association, Philadelphia Section, Seminar, November 2005

Valley Geo-Institute and ASCE Philadelphia Section, Special Presentation, November 2005

Villanova University, Civil and Environmental Engineering Seminar, October 2005

University of Pennsylvania, Environmental Science Seminar, February 2005

University of Delaware, Dept. of Civil and Environmental Engineering Seminar, April 2003

Delaware Valley Geo-Institute, Monthly Meeting, Lecture, September 2003

Drexel University, Graduate Student Association, Seminar, May 2003

Columbia University, Civil Eng. and Engineering Mechanics Seminar, November 2002

University of Pennsylvania, Earth and Environmental Science Seminar, February 2002

National Science Foundation Workshop on Use of Physical Modeling for Eng. Education, 2002

URS Corporation, Plymouth Meeting, Pennsylvania, Seminar, November 2001

Delaware Valley Geo-Institute, Monthly Meeting, Lecture, October 2001

Delaware Valley Port Authority, Seminar, December 2001

Berkeley Geotechnical Society, Research Seminar, May 1999

Association of Engineering Geologists, San Francisco Section, Monthly Meeting, Lecture, March 1999

Conference Presentations

The 7th International Conference on Urban Earthquake Engineering and 5th International Conference on Earthquake Engineering, *"Were Topographic Effects Responsible for Building Collapses in the 2001 Southern Peru Earthquake?,"* Tokyo, 2010, (Invited Talk)

The Next Generation of Research on Earthquake-Induced Landslides: An International Conference in Commemoration of the 10th Anniversary of the Chi-Chi Earthquake, *"Uncertainty in Earthquake-Induced Deformations: History of the Calabasas Landslide,"* Taipei, 2009 (Invited Talk)

European Geophysical Union, Annual Meeting, *"Landslides triggered by the 5 August 2007 M_w8.0 Pisco, Peru earthquake,"* Vienna, 2008

Woman Engineers: Bridging the Past, Present, and Future, Society of Women Engineering Conference, *"Engineering for the Community,"* Philadelphia, 2006

Transportation Research Board, 85th Annual Meeting, *"Levee System Performance in Hurricane Katrina,"* Washington, D.C., 2006

Transportation Research Board, 84th Annual Meeting, *"Performance and Analysis of Mechanically Stabilized Earth (MSE) Walls in the Tecomán, Mexico Earthquake,"* Washington, D.C., 2006

GeoFronters/18th Geosynthetic Research Institute Conference *"Development of a Versatile Device for Measuring the Tensile Properties of Geosynthetics,"* Austin, Texas, 2005

Geotrans 2004, *"Engineering Properties of Crushed Glass-Soil Blends,"* Los Angeles, 2004

Eleventh International Conference on Soil Dyn. and Earthquake Engineering, *"Characteristics of Strong Ground Motion Recorded During the 2003 Tecomán, Mexico, Earthquake,"* Berkeley, Calif., 2004

International Conference on Physical Modeling in Geotechnics, *"The Use of Fly Ash to Alter the Geotechnical Properties of Artificial "Model" Clay,"* St. John's, Canada, 2002

Tenth International Conference on Soil Dynamics and Earthquake Engineering, *"Inclined Plane Studies of Seismically Induced Displacements in Slopes,"* Philadelphia, 2001

Tenth International Conference on Soil Dynamics and Earthquake Engineering," *Geotechnical Aspects of the June 23, 2001 Southern Peru Earthquake: Preliminary Observations,"* Philadelphia, 2001

Geotechnical Earthquake Engineering and Soil Dynamics. *Newmark Analyses of a Shaking Table Slope Stability Experiment,"* Seattle, 1998

Fifth Caltrans Seismic Research Workshop, California Dept of Transportation *"Shaking Table-Based Evaluation of the Newmark Procedure for Estimating Seismically Induced Slope Deformations,"* Sacramento, Calif., 1998

Panel Discussions

Transportation Research Board, 85th Annual Meeting, *"Katrina: Infrastructure Damage and Rehabilitation,"* January 23, 2006

Drexel University, Pennoni Honors College Special Meeting *"The Politics of Disaster,"* October 2005

PROFESSIONAL ACTIVITIES

Editor and Editorial Board Service

Editor, *Journal of Geotechnical and Geoenvironmental Engineering,* 2010-present
Member, Editorial Board, *Journal of Geotechnical and Geoenvironmental Engineering,* 2005-2010

Committee Service

Member, *ASCE Geo-Institute International Activities Council,* 2013-present
Chair, Technical Program, Geocongress 2013, 2011-2013
Member, NEES Education, Outreach, and Training subcommittee, 2011-present
Member, ASCE Task Committee on Engineering Review Procedures, 2008-2009
Member, *International Advisory Committee*, GeoShanghai 2010, 2008-2010
Member, *Scientific Committee*, First International FLAC/DEM symposium on Numerical Modeling, 2008
Chair, *ASCE Geo-Institute Committee on Embankments, Dams and Slopes*, 2007-2011
Member, *ASCE Inter-Institute Committee on Levees*, 2007-present
Member, *Site Operations Comm.*, George E. Brown Network for Earthquake Eng. Simulation, 2007-2009
Member, *Advisory Committee*, Civil and Environmental Eng. Dept., Villanova University, 2007-2010
Member, *Technical Committee*, GeoShanghai International Conference, 2005-2006
Member, *Managing Board*, ASCE Delaware Valley Geo-Institute, 2001-2004
Member, *ASCE Geo-Institute Committee on Embankments*, Dams and Slopes, 2002-2006
Member, *ASCE Geo-Institute Committee on Earthquake Engineering and Soil Dynamics*, 2004-2011
Member, *Research Committee*, U.S. University Council of Geotechnical Engineering, 2004-2006
Member, *Scientific Committee*, 11th Intl. Conf. on Soil Dyn. and Earthquake Engineering, 2004
Member, *NEHRU Graduate Fellowship Committee*, Earthquake Engineering Research Institute, 2003

Organization and Chairmanship of Professional Meetings

Member, Student Activities Committee, Geotechnical Earthquake Engineering and Soil Dynamics IV, 2008

Co-organizer and Co-Moderator, *Sessions of the Geotechnical Aspects of Hurricane Katrina*, Geo-Denver Conference, 2007

Organizer, Moderator and Presenter, *Workshop on the Application of Advanced Technologies for Post-Earthquake Geotechnical Engineering Reconnaissance*, Geo-Congress, Atlanta, 2006

Organizer and Chair, *Sessions on the Mitigation of Seismically Induced Ground Failure,* GeoShanghai International Conference, Shanghai, 2006

Chair, *Session on Dynamic Characterization and Modeling of Soils*, 11th Intl. Conf. on Soil Dyn. and Earthquake Engineering, Berkeley, 2004

Official Discusser, *Session on Recent Seismic Events*, 5th Intl. Conf. on Case Histories in Geotechnical Engineering, New York, 2004

Co-Organizer and Co-Chair, *Session on Beneficial Reuse of Recycled Materials in Transportation and Geotechnical Applications*, ASCE National Conference, Baltimore, 2004

Co-Organizer and Summary Presenter, *Session on Recycled Materials in Transportation Geotechnics*, Geo-Trans, 2004

Co-Organizer and Moderator, *Symposium to Honor the Research Achievements of Robert Koerner*, Philadelphia, 2004

Member, Local Organizing Committee, *10th Intl. Conf. on Soil Dyn. and Earthquake Engineering*, Philadelphia, 2002

Chair, Session on Soil-Structure Interaction, *10th Intl. Conf. on Soil Dyn. and Earthquake Engineering*, Philadelphia, 2002

Moderator, *Session on Environmental Geotechnique*, 4th Intl. Conf. on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, San Diego, 2001

Invited Participation in Workshops

Cyberinsfrastructure Summer Institute for Geoscientists, San Diego, 2009
Geotechnical Extreme Event Reconnaissance, Richmond, California, 2009
Workshop on Project "Big Risk," Barcelona, Spain, 2009
NEES Centrifuge Research and Training Workshop, Troy, New York, 2008
Reforming Civil and Environmental Education, Istanbul, 2007
NEES Centrifuge Research and Training Workshop, Davis, California, 2004
National Science Foundation CAREER Awardees Workshop, Arlington, Virginia, 2004
National Science Foundation Workshop on Use of Physical Modeling for Eng. Edu., St. Johns, Canada, 2002
Workshop on Seismic Response of Reinforced Soil Structures, New York, 2002
Geo-Institute/ISSMGE International Research Workshop, Istanbul, 2001
Army Research office Centrifuge Modeling Workshop, Vicksburg, Mississippi, 2001

Professional Reviews

Journals

- *Journal of Geotechnical and Geoenvironmental Engineering*
- *Engineering Geology*
- *Geotechnique*
- *Canadian Geotechnical Journal*
- *Soil Dynamics and Earthquake Engineering*
- *Earthquake Spectra*
- *Geotechnical Testing Journal*
- *GeoRisk*

- *Geosynthetics International*
- *Journal of Environmental Engineering*
- *Journal of Materials in Civil Engineering*
- *Journal of Professional Issues in Engineering Education and Practice*

Conferences

- GeoFlorida-2010, 2009
- International Foundation Congress and Equipment Expo, 2009
- 11th Multidisciplinary Conf. on Sinkholes and the Eng. and Env. Impacts, 2008
- First International FLAC/DEM symposium on Numerical Modeling, 2008
- Geotechnical Engineering and Soil Dynamics, 2008
- GeoShanghai International Conference, 2006
- ASCE Geo-Institute Geo-Frontiers Conference, 2005
- ASCE Geo-Institute Geo-Trans Conference, 2004
- 11th Intl. Conf. on Soil Dyn. and Earthquake Engineering, 2004
- International Conf. on Physical Modeling in Geotechnics, 2002
- 10th Intl. Conf. on Soil Dyn. and Earthquake Engineering, 2002

Books

- Wiley Publishing
- American Geophysical Union

Proposals

- National Science Foundation
- United States Geologic Survey
- Qatar National Research Fund

GRANTS AWARDED

As Principal Investigator

Regional-Scale Statistical Modeling of the Northridge Earthquake Landslide Database, United States Geological Survey, PI: J. Wartman, $165,205, 2010-2012

NEESR-CR: Seismically Induced Rock-Slope Failure: Mechanisms and Prediction, National Science Foundation, PI: J. Wartman with co-PI Mary MacLaughlin, $934,112, 2010-2012

Collaborative Research: The M8.0 Pisco Peru Earthquake - A Benchmark Ground Failure Event for Remote Sensing and Data Archiving, National Science Foundation, $119,297, 2009-2010

IREE: Research and Educational Collaboration with the Polytechnic University of Catalonia, National Science Foundation, $52,000, 2007-2008

Tarrtown Bridge Scrap Tire Embankment, APEX Environmental, Inc., Pennsylvania Dept. of Transportation Partnership, $87,581, 2003-2005

Collaborative Research: Investigation of Site Effects, Seismic Compression, and Liquefaction in the June 23, 2001 Southern Peru Earthquake, National Science Foundation, $131,474, 2002-2005

Development of a Multiaxial Geosynthetics and Fibrous Material Test Device, National Science Foundation, PI: J. Wartman with co-PIs F. Ko, Y. G. Hsuan, R. M. Koerner, $202,731, 2002- 2005

CAREER: Physical Modeling for Geotechnical Engineering Research and Education, National Science Foundation, $375,000, 2002-2007

Laboratory Evaluation of REU Site: Engineering Cities, National Science Foundation, PI: J. Wartman with co-PI P. Gallagher, $394,905, 2006-2008

Evaluation of Analytical Procedures for Estimating Seismically Induced Permanent Deformations in Slopes, United States Geological Survey, $64,276, 2006-2007

Tire Derived Aggregate: Hybrid Experimental/Computational Simulations, Pennsylvania Dept. of Transportation, $61,148, 2006-2007

Evaluation of Analytical Procedures for Estimating Seismically Induced Permanent Deformations in Slopes, United States Geological Survey, $64,090, 2004-2005

Development of Innovative Construction Materials, APEX Environmental, Inc./Army Corps of Engineers Partnership, PI: J. Wartman with co-PI P. Gallagher, $71,205, 2003-2006

Geotechnical Earthquake Engineering Reconnaissance of the January 21, 2003, Colima, Mexico Earthquake, National Science Foundation, PI: J. Wartman with co-PI A. Rodriguez-Marek (Washington State Univ.), $29,850, 2003-2004

Modeling and Analyses of the Select Engineering-Related Properties of Glass Cullet, Pennsylvania Dept of Transportation with matching funds from D. M. Stoltzfus Co. and Todd Heller Recycling Co., $8,700, 2001

As Co-Principal or Senior Investigator

A Platform for Proactive Risk-based Slope Asset Management (2013/2014), PI: K. Cunningham, with co-PIs J. Wartman, and M. Olsen, $200,000, 2013-2014

A Platform for Proactive Risk-based Slope Asset Management (2012/2013), PI: A. Metzger with co-PIs J. Wartman, P. Arduino, and M. Olsen, $200,000, 2012-2013

NEESR-CR: Topographic Effects in Strong Ground Motion - From Physical and Numerical Modeling to Design, PI: A. Rodriguez-Marek, with Co- and Senior Investigators D. Assimaki, B. Cox, M. Pando and J. Wartman, $1,200,000, 2009-2011

MRI: Acquisition of a High Resolution X-ray Tomography Unit, National Science Foundation, PI: Antonios Zavaliangos with co-PIs Joseph Wartman, Haviva M. Goldman, Surya R. Kalidindi, Wei Sun, $349,267, 2005-2006

Geotechnical Earthquake Engineering Reconnaissance of the June 23, 2001 Arequipa Earthquake, National Science Foundation, PI: A. Rodriguez-Marek (Washington State Univ.) with co-PIs Joseph Wartman and P. Repetto (URS Corp.), $29,671, 2001-2002

Equipment and Software Grants (As Principal Investigator)

Google Earth Pro Licensing, Google, $12,000 (Software), 2007

GIS for Civil Engineering Education at Drexel University, International Federation of Surveyors and ESRI, Inc., $211,120 (Software and GIS library), 2003

INTERVIEWS PUBLISHED IN THE POPULAR PRESS

"City Adrift: New Orleans Before & After Katrina," Louisiana State University Press, 2007
"Texas City's levees contain faults cited in New Orleans," *Houston Chronicle*, July 23, 2006
"Shaky ground," *Prism Magazine*, April 2006
"Investigators gain access to levee for soil test," *New York Times*, February 1, 2006
"Evidence points to man-made disaster," *New Orleans Times Picayune*, December 8, 2005
"Floodwall anchors and soil gain new focus as suspects," *New York Times*, October 27, 2005
"Engineers point to flaws in flood walls' design as probable cause of collapse," *NY Times*, Oct. 24, 2005
"Tilt!" *Discover Magazine*, July 2005
"Latin America's tallest 'sails' through Mexico quake," *Engineering News Record*, February 3, 2003

PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

American Society of Civil Engineers (ASCE), Geo-Institute (GI)
Earthquake Engineering Research Institute (EERI)
American Geophysical Union (AGU)
Seismological Society of America (SSA)
Geological Society of America (GSA)