

# Wisconsin Ground Water Association Newsletter



## President's Message

The WGWA 2006 Fall Field Trip to Door County was a resounding success for those who attended. We express gratitude to Boyd Possin for his tireless efforts in planning for the enjoyable and educational trip.

The 2007 WGWA Spring Conference has been set for February 23 in the Wisconsin Dells. A call for student and professional papers will be issued shortly, if not before this article is published. Attendance at the Conference is free to presenters with prize money involved for student presenters (do you have something to share from your summer internship?).

Be sure to vote for next year's officers and Looking forward to seeing everyone in February!

*Becky Caudill, WGWA President*

## WGWA Board Announces Spring Conference and Call for Papers

The WGWA Board has selected the date and time for the WGWA Spring Conference.

Location: Great Wolf Lodge, Wisconsin Dells  
Date: Friday, February 23, 2007  
Time: 7:30 Registration  
8:00–4:30 Presentations  
4:30–5:00 Awards

The price and registration form will be provided in a future WGWA notes, but as before conference will include lunch, which will be a buffet. There will also likely be a special room rate for those who wish to take advantage of the hotel's water facilities for a late winter family get-away.

Papers for presentation are being requested at this time. Presentations of course should be related in some way to groundwater, and should minimize commercial appeals.

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The newsletter is published four times per year. If you have any suggestions or submissions, please contact us at: Wisconsin Ground Water Association, c/o Lee Trotta, 18905 #D Wilderness Court, Brookfield, WI 53045. Email: [wgwainfo@wgwa.org](mailto:wgwainfo@wgwa.org); Web site: <http://www.wgwa.org>. The deadline for submissions to the 1st quarter of 2007 newsletter is February 15, 2007.

## Conferences, Meetings, and Courses

### Ground Water-Related Conferences and Meetings

2006 NGWA Ground Water Expo, Las Vegas, NV, December 5-8, 2006

2007 Wisconsin Ground Water Conference, Wisconsin Water Well Association, January 10-11, 2007

WGWA Spring Conference, Wisconsin Dells, February 2007 [date to be announced]

4th Conference on Hydrogeology, Ecology, Monitoring, and Management of GW in Karst Terrains, AGWSE, Safety Harbor, FL, February 27-28, 2007

AWRA - Wisconsin Section 2007 Meeting, Wisconsin Dells, WI, March 1-2, 2007

Federation of Environmental Technologists Environment 07 Conference, Milwaukee, WI March 12-14, 2007

2007 NGWA Ground Water and Environmental Law Conference, Dublin, OH, July 24-25, 2007

### Ground Water-Related Courses in Midwest

Principles of Ground Water: Flow, Transportation, and Remediation, NGWA, Dublin, OH, March 21-23, 2007

Model Calibration & Predictive Uncertainty Analysis Using PEST, SSPA, Minneapolis, MN, April 16-18, 2007, Advanced Session April 19, 2007

Assessing Ground Water Movement and Contaminant Migration Through Aquitards, Midwest Geosciences Group, Fermilab, Illinois May 8, 9, and 10, 2007

Analysis and Design of Aquifer Tests Including Slug Tests and Fracture Flow, NGWA, Dublin, OH, June 18-20, 2007

### EPA Ground Water-Related On-Line Courses (free, see [www.clu-in.org](http://www.clu-in.org))

ITRC An Overview of Direct-push Well Technology for Long-term Groundwater Monitoring, Dec 7, 2006

ITRC Risk Assessment and Risk Management: Determination and Application of Risk-Based Values, Dec 12, 2006

### Newsletter Advertising Rates

2.5" x 3.5" (business card)  
\$20/issue    \$60/annual

3.5" x 5" (quarter page)  
\$35/issue    \$100/annual

5" x 7" (half page)  
\$65/issue    \$175/annual

7" x 10" (full page)  
\$125/issue    \$320/annual

**REMINDER**

**It is time to  
Renew  
Your  
Membership**

# Earthquakes and Groundwater

By Troy Thompson

*Editor's Note: This article is the second in a series of four that review the role that groundwater can play in various geological hazards and catastrophic events that have occurred, and may occur again.*

The passive link between groundwater and earthquakes is not new and is well documented. The Chinese noticed centuries ago that water levels in wells can vary in association with earthquake activity, and used this behaviour with some success to anticipate earthquakes. More recent research in the United States has attempted to use monitoring of groundwater levels in wells to help predict earthquake activity (Moyle, 1980). In addition, it is known that earthquakes such as the 2004 Indonesian quake can cause measurable changes groundwater levels in places thousands of miles from the epicenter (USGS, 2005). The 1983 Borah Peak earthquake in southeastern Idaho caused groundwater located near its epicenter to erupt as much as 25 feet into the air (CGER, 1992). It has been suggested that an earthquake could similarly cause groundwater to rise towards the ground surface and flood the proposed Yucca Mountain radioactive waste repository, although this potential threat is not generally accepted as likely as the repository would be located approximately 1,000 feet above the water table.

However, within the past 50 year researchers have noted that groundwater can play a direct role in earthquake occurrence and earthquake related damage. Research on earthquake mechanisms indicates that groundwater likely plays a significant role in many earthquakes, including most if not all large earthquakes. Furthermore, groundwater can magnify the damaging effects of groundwater. This article briefly surveys the role of groundwater in earthquake disasters.

## **Fault Slip and Earthquake Generation**

Most people are familiar with the standard model of fault-related earthquake generation: two bodies of rock lock against each other along a fault as the result of frictional resistance until opposing shear stresses on either side of the fault build to the point where they overcome the frictional resistance resulting in a sudden slip along the fault and an earthquake. However, following the recognition of thin-skinned thrust zones exhibiting movements over tens of miles, it became apparent that this model of fault slip was incomplete. Calculations of slip along a thrust fault based on dry frictional conditions showed that such faulting should not occur as only a

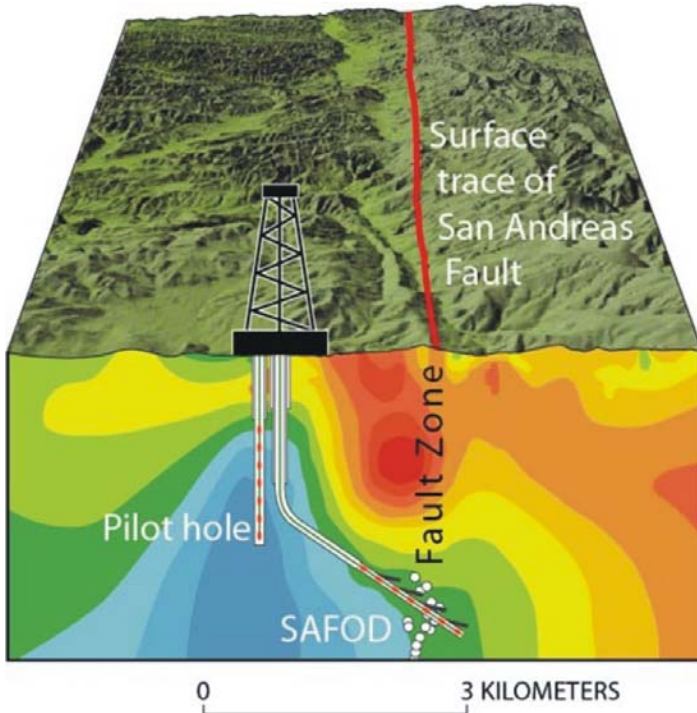
maximum of 6 miles of slip offset could be accommodated before the crush strength of the upper plate rocks would be exceeded.

In a classic paper, Hubbert and Rubey (1959) showed how the presence of water could resolve this problem. They calculated that high fluid pressure along the fault plane could sufficiently reduce the effective normal stress on the fault plane to overcome frictional resistance to lateral sliding. The reduction in effective normal stress is potentially so great that one geologist has joked that the problem is not getting thrust faults moving, but getting them to stop.

This explanation has subsequently been extended to explain how slip occurs on other faults, such as the San Andreas fault (Preuss, 1998). The potential role of fluids in controlling the behavior of the San Andreas fault has been of particular interest given the threats posed by this fault, as well as some apparently paradoxical conditions associated with the fault. The amount of shear stress causing movement along the fault is considerably less than it should be given the magnitude of the compressional stresses exerted on the fault. Furthermore, frictional heating along the fault should lead to higher geothermal temperatures along the fault than have been observed. It has been proposed that presence of fluids along the fault zone could in effect lubricate the fault reducing its strength and associated frictional heating.

Two different models of the source and role of these fluids have been proposed (Preuss, 1998). One model, called the Byerlee-Sleep and Blanpied model, or "closed box" model, proposes that local crustal fluids, such as groundwater, are drawn into the fault zone due to fault rupture, become trapped by mineralization, become overpressured by stress buildup, and then facilitate the occurrence of the next rupture. The other model, called the Rice model, proposes that fluids from the mantle are forced up under pressure and focused into the fault zone. Preliminary analyses of gases along the fault zone indicate the Rice model is at least partially correct. To test hypotheses concerning the role of fluids in slip on the fault, a project called the San Andreas Fault Observatory at Depth (SAFOD) was started in 2005 to drill deep into the fault zone, collect samples, and place instruments at depth to monitor fault behavior (Earthscope, 2006).

*(Continued on page 4)*



*Planned drilling scheme for the San Andreas Fault Observatory at Depth Source: Lovett, 2006*

*(Continued from page 3)*

The role of fluids in the slip of subduction zones and the generation of earthquakes, such as the 2004 Sumatra earthquake, are also being examined (NSF, 2006). Potential effects include overpressuring along the fault and effects on rock mechanics due to fluid alteration of minerals.

Research is also focusing on the complex interactions between fluids, magma, and faulting in volcanic zones

(Templeton and Dreger, 2004).

The role of fluids in earthquake generation has led to the recognition that human activities have had effects on seismic activity, at least at small scales (University of Texas, 2001). Minor seismicity has been recorded in connection with the impounding of water behind dams and fluid injections from wells at various places around the world. However, it is unlikely these types of activities would lead to a damaging earthquake as such earthquakes occur at depths that are unlikely to be affected by the hydrodynamic stresses created by these activities.

### **Groundwater and Earthquake Effects**

Groundwater can also play a significant role in how earthquakes affect the ground surface when an earthquake occurs. The most well known effect is liquefaction. During the shaking cause by an earthquake, certain types of fluid saturated sediments can lose their structure and become liquefied. This phenomena led to increased structural damage in the Marina district of San Francisco during the 1989 earthquake. However, this fact seems to have had little effect on local property values. Various projects are underway in different earthquake-prone areas, such as the Los Angeles Basin (Hillhouse, et. al., 2002), to map areas susceptible to groundwater related earthquake damage.

Increased earthquake damage has also been observed in areas without liquefaction, but with shallow groundwater, such as during the 1994 Park Ridge earthquake in California (USGS, 1996).

In spite of all the research to-date, there still remains a lot to learn about the relationship between groundwater and earthquakes.

*(Continued on page 5)*



*Liquefaction effects from the 1933 Long Beach earthquake. Source: Hillhouse, et. al., 2002.*

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# REMINDER

**It is time to  
Renew  
Your  
Membership**

## WGWA 2006 Field Trip – Door County

*By Troy Thompson*

This year's Fall Field Trip went beyond those of before. Not only did it have some very interesting stops, as well as manage to avoid most of the rain, but it may be the first field trip to have a central theme. The central theme was the karst geology and hydrogeology of Door County. Undoubtedly everyone that participated came away with a greater appreciation of the complexities and problems of this type of geology.

The trip's success was in big part due to the generous voluntary efforts of several people, including some who are not WGWA members. A big thanks is owed to Bill \_\_\_\_ and Brian \_\_\_\_ of the Door County \_\_\_\_ who volunteered to develop the trip itinerary and recruit speakers for various stops. Brian then acted as a tour guide for the entire trip. Other trip stop speakers included \_\_\_\_\_. In addition, Ken Bradbury of the Wisconsin Geological and Natural History Survey generously agreed to drive up to Door County to give an after dinner presentation on his recent research in Door County even though he had return to Madison early the next morning for a personal commitment.

Base camp was the Alpine Resort in Egg Harbor: a Bavarian-themed resort that is one of the oldest resorts in Door County. The resort provided a convenient starting and stopping place for each day's activities, good meals, and a pleasant setting for discussions over a drink.

Brian \_\_\_\_ provided a unified overview of the karst features and challenges of Door County. Stops included first hand looks at enlarged, surface-exposed, fracture systems [see photo], sinkholes [see photo], caves [see photo], and the carbonate stratigraphy of the Door Peninsula. Trip participants learned the second longest documented cave is located in Door county. Brian also explained and showed how presence of these features combined with various types of land uses, such as farming, cherry orchard pesticide usage, and private waste disposal systems, have created one of the most difficult water quality challenges in the State. Sites were located at a variety of places from Peninsula State Park to Sturgeon Bay

Stops also included points of interest with non-hydrogeological aspects. Friday included a stop at the Ridges Sanctuary near Baileys Harbor. There the group was given a presentation of the U.S. Fish and Wildlife's

efforts to save the endangered Hines Emerald Dragonfly, which is dependent on specific types of groundwater discharges and is only known to exist in a few places in the United States, including the Ridges Sanctuary. The Ridges Sanctuary is one of most unique ecological places in North America. It formed on a series of relict beach ridges and has an amazing variety of micro-ecosystems. It is also home to several rare species of plants [see photo] and insects, including some that occur no where else. In addition, it is fed by groundwater discharges that help create the special conditions that support unusual species such as the dragonfly. The stop included a guided tour of the sanctuary by naturalists.

Another stop included a visit and special tour of the Sturgeon Bay Coast Guard Station. Field trip participants received an interesting look at the operations and equipment of an active Station. Other stops included the opening stop at the Fish Creek Harbor for a presentation on beach water quality issues, a look at the Sturgeon Bay ship channel, and one gift shop for a bathroom break and coffee (plus some quick shopping by a few trip participants). The final stop was at Cave Point County Park, which showed how the geology of the Peninsula has combined with its water resources to create some of its spectacular scenery [see photo].

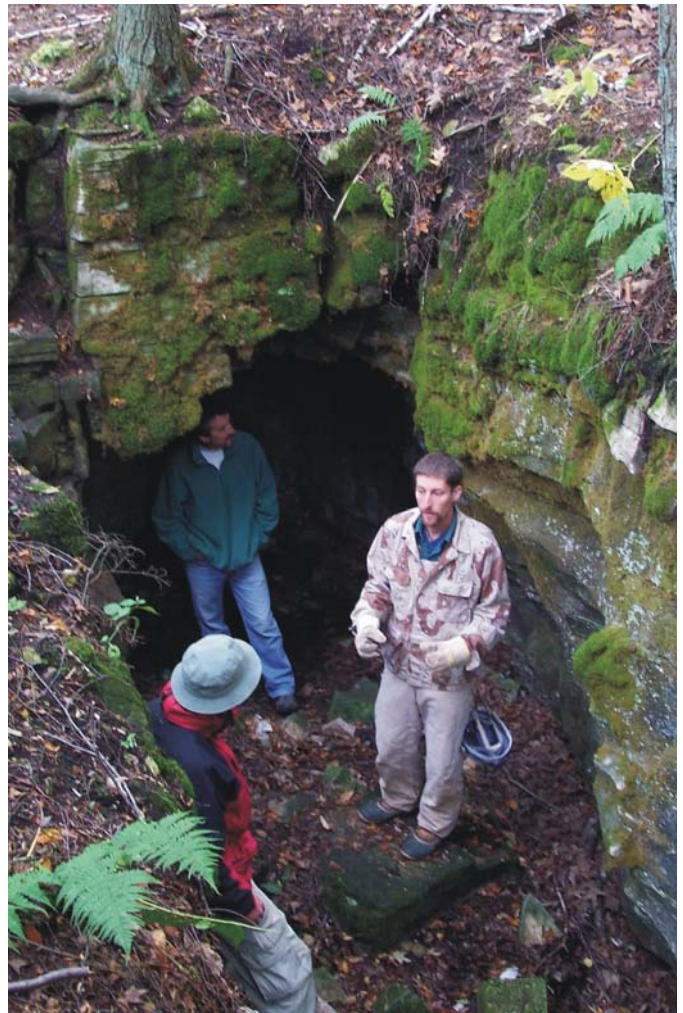


*Network of bedrock fractures exposed in forest near Bailey's Harbor.*

*Continued on page 7*



*Brian standing in a sinkhole located in a cornfield.*



*Entrance to one of several caves in Door County.*



*Carnivorous Pitcher Plant at the Ridges Sanctuary.*



*Geology plus water equals great scenery at Cave Point County Park*

## TREASURERS REPORT DECEMBER 2006

BALANCE FORWARD		\$10,250.60
INCOME		
Field Trip Fee		\$1,645.00
Member Dues		\$5,285.00
Services		<u>\$155.00</u>
	TOTAL INCOME	\$7,085.00
EXPENSES		
Certificate of Deposit		\$5,000.00
Charity		\$1,500.00
Dining		\$1,110.65
Education		\$10.00
Housing		\$500.00
Licenses and Permits		\$10.00
Postage and Delivery		\$279.62
Reimbursement of Overpay		\$115.00
Rent Paid		\$150.00
Travel, Bus		\$827.81
Utilities, Bus:	Telephone, Bus	\$499.65
	TOTAL EXPENSES	\$9,923.13
TOTAL INCOME—EXPENSES		-\$2,838.13
TOTAL		\$7,412.47



# WGWA Board Meeting Minutes

Wednesday, November 7, 2006

Persons present: Boyd Possin, Janis Kesy, Corey Pagles, Becky Caudill, Troy Thompson, Ken Wade, Mike Raimonde, Joan Viney, Dave Nemetz, and Lee Trotta

I. Call to order about 5:30 pm.

II. Minutes from last meeting – August 16, minutes posted to website. Any comments on the minutes please send to Janis by November 15.

III. Treasurers Report – \$5,000 was moved into a CD. Balance in checking account \$ 7,363.07. Field trip income was \$1645. Field trip expenses were bus-\$827.81, hotel - \$500 deposit to hold rooms (should receive reimbursement), dinner -\$1110.65. Field trip loss of \$293.43.

IV. Membership Report – Currently 208 members. No change in membership

V. Old Business

Logo Contest – Received one Logo entry. Joan will make some changes to the logo submitted and distribute to board for feedback.

VI. New Business

Elections – 2007 officers open positions: President-Elect – candidate for position Mike Raimonde. Secretary – candidate for position Troy Gawronski. Election ballots will be sent out by November 27. One At Large Board Member Position comes open in 2007. Becky asked Cory if he would continue in the position for 2007-2009 and he agreed. Board approved appointment of Cory Pagels as an at large board member.

Fall Field Trip – Small attendance for trip – 18 people. Trip was very good and everything went very well. Ken Bradbury's talk on Friday evening was very good. Field trip leaders from Door County Soil and Conservation Department did a great job! Trip was very relevant, educational and entertaining. Boyd will send a Thank You to the two men from Door County Soil and Conservation. Will include membership to WGWA. Future changes to field trip? Announce earlier, find ways to promote the trip, look at demographics/location, considered co-participating with another organization such as AIPG.

Newsletter Advertising – Geosciences Midwest has contacted Troy about advertising in the WGWA newsletter. Now that the newsletter is electronic how do we want to handle the advertising rates? Discussed various options settled on ½ banner (1/4 page) charge \$50, whole banner (1/2 page) charge \$100. A link can be created or they can provide a link to add to the banner. No charge for link if they are a WGWA corporate member.

Spring Conference 2007 – Tentative date Friday, February 23. Becky has contacted the Kalahari. They are able to accommodate us for February 23. Room rate Thursday night \$99, room rate Friday night \$199. Send out a call for papers before Thanksgiving. Three people have volunteered to help with the conference: Lori Rosemore (Ayres), Paula Richardson (NRT), Eric Kovatch (NRT).

Contracting membership duties – Decision made not to retain a service too expensive. Becky offered to help Lee with the membership renewals.

Received email from Wisconsin Crop Producers. They would like WGWA to join their organization and have a booth at their conference in January. Board is to think about it and make a decision.

Boyd made motion to adjourn meeting. Janis seconded motion.

## The 2006 Board, Committee, and Area Coordinators

### **President (2006)**

Rebecca Caudill  
Natural Resource Technology, Inc.  
Phone: 262.522.1215; Fax: 262.523.9001  
rcaudill@naturalrt.com

### **President-Elect (2006)**

Boyd Possin (2007 President)  
Phone: 920.606.0323; Fax: 419.858.8471  
boydpossin@earthlink.net

### **Secretary (2005-2006)**

Janis S. Kesy, P.G., Senior Technical Consultant  
Foth & Van Dyke and Associates, Inc.  
Phone: 920.496-6819; Fax: 920.497.8516  
JKesy@foth.com

### **Treasurer/Membership (2006-2007)**

Lee Trotta  
Brookfield, WI 53045  
Phone: 262.641.9341  
lctrotta53072@yahoo.com

### **Past President (2005 President)**

Dave Nemetz  
Liesch Environmental Services, Inc.  
Phone: 608.223.1532 Fax: 608.223.1534  
dnemetz@madison.liesch.com

### **At-Large Board Members**

Corey Pagels (2004-2006)  
Leggette, Brashears & Graham, Inc.  
Phone: 608.833-5555; Fax: 608.833.5551  
pagels@lbgmad.com

Kenneth Wade (2005-2007)  
Wisconsin DOT  
Phone: 262.548.6733 (Tu, W)  
Phone: 608.767.3111 (M, Th, F)  
kenneth.wade@dot.state.wi.us

Michael Raimonde (2006-2008)  
Metcalf & Eddy, Inc.  
Phone: 262-909-8316  
mike.raimonde@m-e.com

### **Committee Chairpersons**

#### **Newsletter**

Troy Thompson, Editor  
T N & Associates, Inc.  
Phone: 414.217.1541  
troyrt@earthlink.net

#### **Ground Water Sand Model Reservations**

Lori Rosemore  
Ayres Associates  
Phone: 715.834.3161; Fax: 715.831.7500  
rosemorel@AyresAssociates.com

Kathi D. Ried, P.G.  
CH2M HILL  
135 S. 84th Street, Suite 325  
Milwaukee, WI 53214  
Phone: 414.847.0464; Fax: 414.454.8818  
Kathi.Ried@CH2M.com

#### **Web Site**

Joan Viney  
Phone: 608.279.9598  
jviney@tds.net

#### **Education Committee**

Paula Richardson  
Natural Resource Technology, Inc.  
Phone: 262.522.1221; Fax: 262.523.9001  
prichardson@naturalrt.com

#### **Area Coordinators**

*We are looking for coordinators in many of the following areas. If you are interested, please contact Rebecca Caudill.*

#### **Western Area**

(LaCrosse, Black River Falls, Eau Claire, Chipewewa Falls, surrounding area)  
Position Open.

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**Southern Area**

(Madison and surrounding area)

John Tweddale

BT<sup>2</sup>

Phone: 608-224-2830 and 608-224-2839

jtwweddale@bt2inc.com

**North Central Area**

(Stevens Point, Wisconsin Rapids, Wausau, Rhineland, surrounding area)

Tod Roush

Maxim Technologies

Phone: 715.845.4100; Fax: 715.842.0381

ttroush@maximusa.com

**Northeast Area**

(Green Bay, Appleton, Oshkosh, Fond du Lac, surrounding area)

Position Open.

**Southeast Area**

(Milwaukee, Sheboygan, Racine, Kenosha, surrounding area)

Michael Raimonde

Metcalf & Eddy, Inc.

Phone: 262.909.8316

mike.raimonde@m-e.com





**Join the Wisconsin Ground Water Association Today!**

**WISCONSIN GROUND WATER  
ASSOCIATION MEMBERSHIP  
APPLICATION/RENEWAL FORM**

Please take a few moments and become a member of, or renew your membership in, WGWA. Annual dues are \$15 for students, \$30 for individuals, and \$25 per person for corporate memberships of six or more. Dues are payable to "WGWA." Complete the following form and send, with check, to:

**Wisconsin Ground Water Association**  
c/o Lee Trotta  
18905 #D Wilderness Court  
Brookfield, WI 53045

**Individual Membership:**      Regular Member: \_\_\_\$30      Student Member: \_\_\_\$15  
Name: \_\_\_\_\_ Title: \_\_\_\_\_  
Firm/Agency: \_\_\_\_\_  
Mailing Address: \_\_\_\_\_  
City, State, ZIP Code: \_\_\_\_\_  
Telephone Number: \_\_\_\_\_ Fax: \_\_\_\_\_  
E-Mail: \_\_\_\_\_

Are you interested in participating in any WGWA Committees?

\_\_\_ Newsletter \_\_\_ Membership \_\_\_ Web Site \_\_\_ Legislation \_\_\_ Program & Education  
\_\_\_ Please check if you don't have e-mail access and need to receive the *WGWA Newsletter* via regular mail.

**Corporate Membership Discount (six or more individuals):**      \_\_\_\$25/individual  
Firm: \_\_\_\_\_  
Mailing Address: \_\_\_\_\_  
City, State, ZIP Code: \_\_\_\_\_  
Telephone Number: \_\_\_\_\_ Fax: \_\_\_\_\_  
Corporate Individuals (include each individual's e-mail address, if available. Attached additional page if necessary):

	Name	Title	E-Mail
1.)	_____	_____	_____
2.)	_____	_____	_____
3.)	_____	_____	_____
4.)	_____	_____	_____
5.)	_____	_____	_____
6.)	_____	_____	_____

\_\_\_ Check here if you don't have e-mail, and need to receive the *WGWA Newsletter* via regular mail.