

State of Florida

Department of Environmental Protection
Colleen M. Castille, *Secretary*

REPORT TO THE 2006 FLORIDA LEGISLATURE
AS REQUIRED BY CHAPTER 2005-111, LAWS OF FLORIDA
REGARDING ACTIVITIES RELATING TO THE
SINKHOLE DATABASE

Prepared by the Department of Environmental Protection in
consultation with the Department of Financial Services

REFERENCE

GB
609.2
.R46
2006

TABLE OF CONTENTS

LEGISLATIVE REQUIREMENTS	1
BACKGROUND	2
HISTORY OF SINKHOLE DATA IN FLORIDA.....	2
SINKHOLE INVESTIGATIONS.....	6
USE AND LIMITATIONS OF CURRENT DEP SINKHOLE DATABASE	6
INFORMATION NEEDS	7
DEPARTMENT OF FINANCIAL SERVICES.....	7
DEPARTMENT OF ENVIRONMENTAL PROTECTION.....	7
RECOMMENDATIONS.....	8
SINKHOLE ACTIVITY / INSURANCE DAMAGE RESEARCH ENTITY.....	9
ACTION PLAN AND LEGISLATION.....	9
SELECTED REFERENCES	10

LIST OF APPENDICES

Appendix 1. DEP Open File Report 72	
Appendix 2. DEP Sinkhole Web Page	
Appendix 3. Frequently Asked Questions	
Appendix 4. DEP Special Publication No. 57	
Appendix 5. Process Flow Charts	
Appendix 6. Sinkhole Reporting Form	
Appendix 7. Combined List of Department of Financial Services and Department of Environmental Protection Information Needs	
Appendix 8. Agency participants	

**REPORT TO THE 2006 FLORIDA LEGISLATURE
AS REQUIRED BY CHAPTER 2005-111, LAWS OF FLORIDA
REGARDING ACTIVITIES RELATING TO THE
SINKHOLE DATABASE**

LEGISLATIVE REQUIREMENTS

Committee Substitute for SB 1486 was passed by the Florida Legislature and signed into Law by Governor Jeb Bush on June 1st, 2005. It was subsequently codified as Chapter 2005-111 Laws of Florida, which creates 627.7065, F.S. Section (5) states:

The Department of Environmental Protection, in consultation with the Department of Financial Services, shall present a report of activities relating to the sinkhole database, including recommendations regarding the database and similar matters, to the Governor, the Speaker of the House of Representatives, the President of the Senate and the Chief Financial Officer by December 31, 2005. The report may consider the need for the Legislature to create an entity to study the increase in sinkhole activity in the state and other similar issues relating to sinkhole damage, including recommendations and costs for staffing the entity. The report may include other information, as appropriate.

Within (1) of that Section the Legislature recognizes "...that the Florida Geological Survey of the Department of Environmental Protection has created a partial database of sinkholes identified in Florida, although the database is not reflective of all sinkholes or insurance claims for sinkhole damage. " They further acknowledge that "...creating a complete electronic database of sinkhole activity would serve an important purpose in protecting the public and in studying property claim activities in the insurance industry." Section (2) instructs the Department of Financial Services to "... consult with the Florida Geological Survey and the Department of Environmental Protection to implement a statewide automated database of sinkholes and related activity identified in the state."

BACKGROUND

HISTORY OF SINKHOLE DATA IN FLORIDA

Sinkholes have been occurring in Florida for millions of years. With the population explosion Florida has experienced, more and more people inhabit sinkhole-prone areas. The Department of Environmental Protection (DEP) has for many years collected data on both pre-historical (ancient) and modern-day sinkholes. This information was collected as supporting background data for various applied geoscience projects and natural resource inventories for the State. It was not collected to compile detailed, statistical information on sinkhole occurrences from a geographic or chronologic perspective. The basic intent was to supplement the subsurface geologic sample repository and surface topographic / geomorphologic data maintained by the DEP to better understand the unique relationship between karst¹ and the state's ground-water resources and aquifer systems. Inclusion of insurance industry claims information would create a more thorough repository necessary to further explore insurance issues related to sinkholes in Florida.

In recent years, reports of sinkholes and claims filed under homeowners insurance have increased dramatically. It is in part due to increased population, increased ground-water withdrawals and recent drought conditions. With the more insurance claims, various methods of investigating the sinkhole claims, both scientific and fraudulent, have developed thereby highlighting the need for guidelines delimiting technical expertise and the requirement to apply scientifically-accepted methodologies as outlined in the DEP/Florida Geological Survey Special Publication 57².

After the occurrence of the famous 1981 "Winter Park Sinkhole," the 1982 Florida Legislature created the Florida Sinkhole Research Institute (FSRI) at the University of Central Florida. Data from the Department of Natural Resources was transferred to the FSRI where it was modernized into a digital database. FSRI was intended to coordinate the activities of Florida universities, state and federal geological and planning agencies, state-water management hydrogeologists, private geotechnical firms, public safety officials, the insurance industry, the construction industry and the news media in a common effort to develop and disseminate useful information for dealing with sinkhole and subsidence related problems. With no Geology Department or Geosciences capability, UCF hired an outside professional to run the FSRI. At that time, all the sinkhole database files of the DEP were transferred to the FSRI for maintenance and development. The FSRI began transferring the data into a dBase III® database to allow

¹ An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams and caverns.

² See page 4 for more information about this report.

easier searching and querying. During the early 1990's the FSRI was disbanded. The database was subsequently returned to DEP, which continued to maintain this information and to publish selected portions. In 1994, the DEP Open File Report No. 58 was published titled the *Florida Sinkhole Index*. The data was prepared in a MS Excel spreadsheet form and made available to interested persons via the DEP internet website.

The 1992 Florida Legislature mandated that a study of sinkhole insurance issues be conducted. This included specific requests "...to evaluate the minimum standards for evaluating claims for sinkhole damage..." and investigate "...the need for an on-going research resource to conduct analysis and maintain current data and information on sinkhole issues within this state." The study was completed by the FSU Center for Insurance Research, under the direction of the Florida Department of Insurance. The final report was submitted in December 1992. Chapter V of the report, titled: *Examination of the Establishment of Minimum Standards for the Evaluation of Sinkhole Claims* involves claims standards. It was decided that a listing of standards used by professional geologists (PG) and professional engineers (PE with geotechnical expertise) was needed to determine how a site should be assessed and if karst is present. Chapter VI of the report, titled: *Need for an Ongoing Research Resource* included discussions and proposals to create a sinkhole research center based on input from the University of Florida, the University of South Florida and the DEP. The chapter concluded that the DEP should function as a clearinghouse for dissemination of data to the public and play a central role in the development and maintenance of a sinkhole database. It was further recommended the DEP continue to work with the universities to coordinate research of sinkhole occurrences and formation. A continued funding source was identified as a key to any continuation of such a state-wide program. These two chapters were reproduced by the DEP in Open File Report No. 72³ in response to interest from governmental agencies, the public and the professional community. The intent of the reproduction and publication of these two chapters was to make it easier for the public to obtain the results of the *Sinkhole Standards Summit* which was organized by the authors and attended by geologic experts from throughout the state. Their resulting consensus is presented in Chapter V of the report⁴.

Currently sinkholes are reported to the DEP on a non-mandated basis. The DEP receives sinkhole reports from sources including homeowners, police, elected officials and interested citizens. While limited, this information has helped identify regional patterns in sinkhole occurrences. Insurance companies and engineering/geological consulting firms generally do not report sinkhole occurrences to the DEP, therefore leaving an incomplete picture of the overall sinkhole frequency in Florida.

³ Appendix 1

⁴ Appendix 1

With the inception of the DFS data reporting requirements (627.7065, F.S.), any sinkhole claims processed by insurance companies must be incorporated into a state-wide sinkhole database. This new database would provide a more complete picture of the frequency, distribution and size of newly-formed sinkholes. The information reported to the DEP, in the years prior to the proposed creation of the sinkhole database, was compiled in various forms maintained by the DEP in paper copy files for staff research use and for access by interested individuals both public and private.

Additional reports and maps utilizing this information were subsequently published by DEP. These include: Special Publication No. 29, *Karst in Florida*, and Map Series No. 110, *Sinkhole Type, Development and Distribution in Florida*. Numerous other professional papers and educational outreach products pertaining to Florida sinkholes and the understanding of karst landscapes have been produced by DEP during the last 15 years⁵. In addition, as a public service, DEP has been on-call to the State Warning Point and county emergency coordinators when sinkholes are reported. DEP has made available sinkhole data forms to county representatives and available on the web site to facilitate data submittal. DEP has also placed several other informational and educational resources on the DEP web site regarding sinkhole occurrences⁶.

The 2004 Florida Legislative session requested an assessment of insurance coverage in response to sinkhole damage (Chapter 627.7077 F.S.). This study was conducted by the FSU College of Business, Department of Risk Management and Insurance, in consultation with the State Board of Administration and the DEP. The study included a feasibility and cost-benefit analysis of creating a Florida Sinkhole Insurance Facility. As defined in the statute, selected potential functions of the facility include: "Providing uniform standards for use by insurers in evaluating sinkhole loss claims," "Providing training, communication, and other educational services to the public, engineers, the construction industry, insurance professionals, or others" and "Maintaining a public database of all confirmed sinkholes and paid sinkhole loss claims..."

To assist the FSU group preparing the report DEP organized *Sinkhole Summit II* to solicit input from the geoscience and geotechnical community relating to proper and consistent assessment of subsidence features to determine if they are indeed sinkholes. A second workshop was held to solicit input from the geotechnical engineering community regarding design and engineering options available to remediate impacted facilities. The results of the second summit are now published as DEP/Florida Geological Survey Special Publication No. 57 titled: *Geological and Geotechnical Investigation Procedures for Evaluation of the Causes of Subsidence Damage in Florida*⁷.

⁵ See reference list

⁶ Appendix 2 and 3

⁷ Appendix 4

The final report submitted to the Legislature in April 2005, titled *Insurance Study of Sinkholes* reviewed numerous other states' programs and demonstrated how such entities are organized in similar situations. The report also looked at various funding options and federal tax implications. The emphasis was on a facility that dealt with finances, rate levels and claims oversight. Several non-insurance related services were considered fundamental to such a facility. These were listed as: training, communication and education services for impacted parties; establishing uniform evaluation and remediation standards for potential sinkhole claims; providing consulting services for insurers; and developing a public database of sinkhole claims and exposures. The report discusses options and makes recommendations in each of these topical areas.

Chapter 2005-111, Laws of Florida, which creates 627.7065, F.S., requires that "The Department of Financial Services... shall consult with the Florida Geological Survey and the Department of Environmental Protection to implement a statewide automated database of sinkholes and related activity identified in the state." During the summer and early fall of 2005, staff from the DEP and DFS met and developed the requirements for an 'automated database' or automated solution for recording Florida sinkhole event information. To create a useable and comprehensive automated database, information would have to be sufficient to allow for future analysis of sinkhole insurance related topics as outlined in the 2004 legislative report by FSU and DEP. In addition, an easy to use interface would be created to allow input of required information that would capture relevant data for insurance and scientific evaluation. DFS will begin developing an automated solution, and both DFS and DEP will work together to develop solutions to capture the necessary insurance and scientific information.

The 2005 Legislative session requested that consideration is given to the need for an entity to study sinkhole activity and related issues as a part of this report. There are two basic, but related, topical areas of need with regard to sinkhole understanding and insurance industry needs and statistics. Both require consistent, accurate information that can be verified and sorted by various topical fields. However, some of the fundamental operations of these two functions are clearly different and have their own unique protocols and expertise. As described in the FSU report there are several options to carry-out these activities, including: creating, staffing and building a fully functional institute to entirely perform the duties; contracting out the workload to a private sector entity; utilizing an existing entity(s) to supplement their current workload with fewer new staff and less additional funding; or some combination of the above.

SINKHOLE INVESTIGATIONS

To help understand the issues surrounding sinkhole damage and claims, a brief description of the geological investigation process from the claim to the final determination is provided below.

1. A homeowner may file a sinkhole damage claim if they observe damage to their home that they believe may be caused by sinkhole development.
2. The claim is investigated by a geological or geotechnical firm charged with determining the cause of the damage. Frequently, there is not an obvious sinkhole that caused the damage and the investigators have to conduct a subsurface investigation to determine the actual cause of the damage. The techniques utilized by firms vary⁸ and may include drilling, ground penetrating radar or other investigative methods. Some investigations are conducted using a single investigative technique while others are done with multiple techniques. The differences in procedures involved in sinkhole investigations provided much of the impetus for holding the *Sinkhole Summit II*.
3. At the conclusion of the investigation, the cause of the damage is determined. If sinkhole development is the cause, the insurance company deals with the homeowner on the claims issues. If the investigating company determines that a sinkhole is not to blame for the damage and the claim is denied, a homeowner may hire a company to conduct another investigation. If the second investigation determines that a sinkhole is the cause of the damage, the case often ends up in court with the firms presenting scientific data supporting either result. The courts then decide if the claim is valid or not.⁹

USE AND LIMITATIONS OF CURRENT DEP SINKHOLE DATABASE

In recent years, the DEP sinkhole database has been made accessible on the DEP website¹⁰. A general sinkhole report form has been developed by DEP to facilitate submittals and to standardize the information collection¹¹. This information was developed by DEP staff to support the needs from a geoscience perspective. Due to staffing limitations, the information submitted is not verified nor are the sites inspected. The DEP data repository is a voluntary submittal effort by all involved. This database represents only a very small subset of the total known modern sinkhole occurrences with the majority of the data focusing on geographic areas of high population density as well as other predispositions. Due to these facts, the existing DEP sinkhole database

⁸ Discussed in Florida Geological Survey Special Publication 57

⁹ Appendix 5A summarizes the Claim Process

¹⁰ http://www.dep.state.fl.us/geology/gisdatamaps/sinkhole_database.htm

¹¹ Copy of form attached as Appendix 6,
www.dep.state.fl.us/geology/forms/sinkholereport/sinkreportform.htm

has value to general geologic processes understanding, however, it is not useful for insurance industry statistical assessment. Therefore it is not recommended that existing data be incorporated into the new sinkhole database. It is estimated that DEP sinkhole information represents less than 10% of sinkholes reported to the insurance industry. In addition, no known database of insurance claims due to sinkholes exists.

At the public/private, local and state level, large gaps exist within the flow of information regarding the financial and scientific aspects of sinkholes¹².

INFORMATION NEEDS

DEPARTMENT OF FINANCIAL SERVICES

It is recommended that DFS collect sinkhole event information to be used for the insurance consumer, industry and scientific and regulatory purposes. The data would allow for more accurate assessments of loss probability and frequency as a result of sinkhole events within Florida and would provide concerned citizens with a comprehensive understanding of sinkhole activity in their communities¹³.

The data elements needed by DFS for a state-wide sinkhole database include street location reference including the county, address, city, state, zip and geographic/GPS position including latitude and longitude with degrees, minutes and decimal seconds, including the datum used to collect the GPS position. Insurance claim data should include the date the claim was reported, whether or not a sinkhole was validated, the type of policy insuring the property, policy limits for the insured structure, valuation of damage to the insured structure and an indication as to whether the structure was deemed a total loss. It is also recommended that a PG firm or geotechnical engineering firm with PG expertise perform the initial investigation of the sinkhole activity, specifically as it relates to identifying the exact nature and location of the activity, to provide consistency in the way the data is reported.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

DEP and DFS¹⁴ recommend that specific information regarding sinkhole occurrences from all available sources should be collected to facilitate analysis of sinkhole-prone areas. Other environmental benefits would exist, such as improving understanding the dynamics of karst and its relation to local ground-water quality. Environmental information needs generally pertain to the fundamental size, shape and locations of

¹² The disconnection between these databases is illustrated in the process charts in Appendix 5A and 5B

¹³ The entire list of data element needs for both the DEP and DFS is included in Appendix 7

¹⁴ Appendix 8 lists agency personnel involved

reported sinkholes¹⁵. The data for the sinkhole database needs to be gathered from multiple sources, however, DEP and DFS agree that sinkhole investigations and the data submitted should be accomplished by a PG firm or geotechnical/engineering firm with PG expertise to perform the initial investigation of the geologic data.

RECOMMENDATIONS

Corrective measures are needed to address the issues described herein. These measures comprise the following recommendations:

Create the sinkhole database to allow DFS to collect and manage sinkhole information, including information needs described above¹⁶; transmit scientific data electronically to DEP; and receive into DEP's newly refined sinkhole database the electronic feed of scientific information from DFS.

Analyze for a to-be-determined period of time the information collected for the sinkhole database to determine if there is a need for a sinkhole research entity.

Per 627.7065 F.S., DEP and DFS will develop a data collection agreement and information requirements from which a sinkhole database will be created¹⁷. The sinkhole database developed shall conform to DFS and DEP locational and metadata standards as well as those relevant to the Facility Identification Template for States (FITS, version 2). The developed application shall include search capabilities necessary to address issues pertaining to sinkhole field studies, prediction and sinkhole insurance claims activity.

The DFS will develop and maintain a database to collect information from insurance companies and other reporting groups or agencies. DEP shall maintain a database that will accept the electronic feed of information from the DFS¹⁸. The data collected for the sinkhole database will contain personal financial information (i.e., insurance policy number). As a result specific legislation is needed to determine which data fields will be available in the public domain and available for public and private use. Once these issues are addressed, appropriate components of the DEP's database will be available via the Internet.

¹⁵ The entire list of data element needs for both the DEP and DFS is included in Appendix 7

¹⁶ Appendix 7 indicates the minimum number of topical field elements needed to design the requested database and allow for statistical insurance and geologic data analysis.

¹⁷ Appendix 7

¹⁸ Appendix 7

Data collection will be needed from insurance companies (i.e., geological or geotechnical reports submitted to and compiled by the insurance agencies) and PG firms or geotechnical firms with PG or relevant PE expertise in sinkhole investigations. Insurance company submittals to DFS shall include insurance data and scientific information, which would be included as a geologic and geotechnical report attached as an appendix.

SINKHOLE ACTIVITY/INSURANCE DAMAGE RESEARCH ENTITY

The 2005 legislative language offered opportunity for this report to consider the need for a research entity to study sinkhole activity in the state. Should the need for such an entity be determined once the new information is analyzed, the two departments will work together to develop a plan for that entity.

ACTION PLAN AND LEGISLATION

It is proposed that as of July 1, 2006, DFS begin receiving and inputting reports from insurance companies (including data received from associated PG/PE firms) into the newly created sinkhole application. Once improvements are made to DEP's existing sinkhole database, DEP will begin receiving the DFS electronic information feed. The DFS would be responsible for the overall project, having taken into consideration the requirements of DEP's database.

Current authorities of the DEP encompass programmatic needs and therefore require no additional legislation until a full assessment of the database, data volume and flow, infrastructure, field inspection and scientific needs are completed. Upon completion of this assessment, a recommendation for a sinkhole research entity at the DEP may be put forth, which may require legislative action. DFS may request legislative action requiring insurers to provide DFS with data that will ensure the completeness and utility of the database.

SELECTED REFERENCES

Beck, B.F., 1984, **A Computer-Based Inventory of Recorded Recent Sinkholes in Florida:** Florida Sinkhole Research Institute, Report No. 84-85-1, 11 p.

Beck, B.F., and Sinclair, W.C., 1986, **Sinkholes in Florida: An Introduction:** Florida Sinkhole Research Institute, Report 85-86-4, 16 p.

Bond, P, 2002, **Florida's Hydrogeologic Environment:** Florida Geological Survey, Poster No. 5 revised.

Butler, A.M., Diskin, B.A., Eastman, K.L., Gatzlaff, D.H., Corbett, R.B., Lilly, C.C., and Maroney, P.F., 1992, **Insurance Study of Sinkholes:** Report submitted to the State of Florida, Department of Insurance, by the Florida State University, Center for Insurance Research, unpaginated.

DeHan, R. (compiler), 2003, **Significance of Caves in Watershed Management and Protection in Florida:** Workshop Proceedings, April 16-17, 2003, Ocala, Florida; Florida Geological Survey Special Publication No. 53, CD-ROM.

Florida Department of Financial Services, 2004, **Sinkholes in Florida; What Home Buyers Need to Know:** Information Flyer.

Florida Geological Survey, 1997, **Geologic and Geotechnical Assessment for the Evaluation of Sinkhole Claims:** Florida Geological Survey, Open File Report No. 72, 40 p.

Florida Geological Survey, 2005, **Sinkholes:** DEP web page, <http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm> (accessed December 15, 2005)

Florida Geological Survey, 2005, **Sinkhole Report Form:** DEP web page, <http://www.dep.state.fl.us/geology/forms/sinkholereport/sinkreportform.htm> (accessed December 15, 2005)

Florida Geological Survey, 2005, **GIS Map Data Layer - "Proximity to Karst Features"** see DEP web page, http://www.dep.state.fl.us/geology/programs/hydrogeology/geographic_info_sys.htm (accessed December 15, 2005)

Kindinger, J.L., and Flocks, J.G., 2000, **Geologic Controls on the Formation of Florida Sinkhole Lakes:** U.S. Geological Survey Open-File Report 00-294, 4 p.

SELECTED REFERENCES (continued)

Lane, E., 1986, **Karst in Florida**: Florida Geological Survey, Special Publication No. 29, 100 p.

Maroney, P.F., Cole, C.R., Corbett, R.B., Dumm, R.E., Eastman, K.L., Gatzlaff, K.M., and McCullough, K.A., 2005, **Final Report: Insurance Study of Sinkholes**: Report submitted to the Office of Insurance Regulation, under the Chief Financial Officer of the State of Florida, by the Florida State University, College of Business, Department of Risk Management and Insurance. CD-ROM.

Means, G.H., Chelette, H.E., and Thurman-Nowak, D.M., 2005, (in review) **Swallet / Stream-to-Sink Features, Lake City, Florida and Vicinity**: Florida Geological Survey, Open File Map Series No. 96. [The DEP/Florida Geological Survey is currently mapping swallets and stream to sink features throughout the state. This map is the first in a series anticipated to be completed during the coming year.]

Rupert, F. and Spencer, S., 2004, **Florida's Sinkholes**: Florida Geological Survey, Poster No. 11.

Scheidt, J., Lerche, I., and Paleologos, E., 2005, **Environmental and economic risks from sinkholes in west-central Florida**: *in*; Environmental Geosciences, v. 12, no. 3, p. 207-217.

Schmidt, W., 2001, **Sinkholes in Florida**: *In*; *Geotimes*, May, 2001, p.18.

Schmidt, W., 2005, **Geologic and Geotechnical Investigation Procedures for Evaluation of the Causes of Subsidence Damage in Florida**: Florida Geological Survey, Special Publication No. 57, 22 p.

Schmidt, W. and Scott, T.M., 1984, **Florida Karst - Its Relationship to Geologic Structure and Stratigraphy**: *in*; Beck, B., (ed.), Sinkholes: Their Geology, Engineering and Environmental Impact, Proceedings of the First Multidisciplinary Conference on Sinkholes, Orlando, FL, 10/15-17/1984, p. 11-16.

Sinclair, W.C. and Stewart, J.W., 1985, **Sinkhole Type, Development, and Distribution in Florida**: Florida Geological Survey, Map Series No. 110.

Spencer, S.M., and Lane, E., 1994 (periodically updated), **Florida Sinkhole Index**: Florida Geological Survey, Open File Report No. 58. Available on line http://www.dep.state.fl.us/geology/gisdatamaps/sinkhole_database.htm (accessed December 15, 2005)

SELECTED REFERENCES (continued)

Tihansky, A.B., 1999, **Sinkholes, West-Central Florida:** *in:* U.S. Geological Survey Circular 1182, p. 121-141.

Wetterhall, W.S., 1965, **Reconnaissance of Springs and Sinks in West-Central Florida:** Florida Geological Survey Report of Investigations No. 39, 42 p.

Wilson, W.L., 1991, **The New Picture of Sinkhole Development in Florida, Evaluating the Risks:** *in:* The Florida Specifier, v. 13, no. 2, p. 1-4.

Wilson, W.L., 1995, **Sinkhole and Buried Sinkhole Densities and New Sinkhole Frequencies in Karsts of Northwest Peninsular Florida:** *in:* Proceedings of the 5th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Gatlinburg, Tennessee, 4/3-5/1995, p. 79-91.

APPENDIX 1

Open File Report 72

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Virginia B. Wetherell, *Secretary*

DIVISION OF ADMINISTRATIVE & TECHNICAL SERVICES
Nevin G. Smith, *Director*

FLORIDA GEOLOGICAL SURVEY
Walter Schmidt, *State Geologist and Chief*

OPEN FILE REPORT NO. 72

GEOLOGIC AND GEOTECHNICAL
ASSESSMENT FOR THE EVALUATION
OF SINKHOLE CLAIMS

FLORIDA GEOLOGICAL SURVEY
TALLAHASSEE
1997

ISSN 1058-1391

July 1997

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

The 1992 Florida Legislature mandated that a study of sinkhole insurance issues be conducted. The study was completed by the Florida State University Center for Insurance Research, under the direction of the Florida Department of Insurance. The report, *Insurance Study of Sinkholes*, was submitted to the Department in December of 1992 and subsequently to the appropriate Legislative Committees.

Two chapters of that report are reproduced here in response to interest from governmental agencies, the public, and the professional community. Chapter V, deals with "Claims Standards." It was determined during the course of the study that a listing of typical standards used by Professional Geologists or Professional Geotechnical Engineers was needed to offer guidance regarding what a competent geological assessment of a site should consider to determine if karst processes are responsible for observed features. Chapter V is titled: "Examination of the Establishment of Minimum Standards for the Evaluation of Sinkhole Claims."

Chapter VI addresses the States need for an ongoing research resource to understand and characterize sinkhole occurrences and to create a central clearinghouse for the collection of sinkhole data and for its dissemination to the public.. The Chapter titled: "Need for an Ongoing Research Resource" includes input from four state university geology departments and the Florida Geological Survey.

The reproduction of these chapters here is intended to better make available the results of the "*Sinkhole Standards Summit*" which was organized by the authors and attended by geologic experts from throughout the state. Their resulting consensus is presented in Chapter V of the report.

Walter Schmidt, Ph.D., P.G.
State Geologist & Chief
Florida Geological Survey

FLORIDA GEOLOGICAL SURVEY
TALLAHASSEE

**V. EXAMINATION OF THE ESTABLISHMENT OF MINIMUM
STANDARDS FOR THE EVALUATION OF
SINKHOLE CLAIMS**

Clear Determination of Whether an Insured Event Has Occurred

Contract Definitions

The appropriate place to look for the specification of the insured event is the subject insurance contract. In this analysis, contracts covering dwellings, i.e., Homeowners and Dwelling (monoline fire) Forms have been the focus. Most insurance companies operating in Florida use contract wording identical or similar to the copyright wording of the Insurance Services Office, Inc. (ISO). The key wording is the following sentence, "Sinkhole Collapse means actual physical damage arising out of, or caused by, sudden settlement or collapse of the earth supporting such property and only when such settlement or collapse results from subterranean voids created by the action of water on limestone or similar rock formations." The "actual physical damage" must be to "covered property." Obvious problems arising from this seemingly simple and understandable wording include how the word "sudden" is to be interpreted/enforced, how evidence of the necessary "subterranean voids" is to be established, and whether land is part of the "covered property."

The threshold issue to be decided is what types of earth movement are to be included in the term sinkhole. The statute specifically defining sinkhole was enacted in 1981. There have been no cases interpreting it since that time. However, a case which pre-dated the statute, Zimmer v. Aetna,¹ was decided by

¹383 So.2d 999 (Fla. 5th D.C.A. 1980).

the Fifth District Court of Appeal in 1980. The Zimmer case construed the insurance policy definition of sinkhole discussed above. (The policy definition is almost identical to that contained in the rules developed by the Department pursuant to Section 627.351 F.S.)

Discussions with an individual who was involved in the original Florida sinkhole reinsurance facility and who participated in the drafting of the sinkhole definition incorporated in the original rules of the Department indicated an intent to cover those sinkholes which are sudden and overnight in nature and amount to an immediate catastrophe.² The Zimmer court indicated that the legislative purpose was not to limit losses to those of a "sudden, overnight nature, the type that amounts to an immediate catastrophe." The court indicated the legislative intent was to cover insurable sinkhole loss and that the Legislature did not intend to limit sinkhole loss to damage caused by "sudden settlement."

The Zimmer court reasoned that inclusion of the word settlement clearly reflected the legislative purpose not to limit losses to those of a sudden and overnight nature. The court rejected the argument that coverage was limited to sinkholes which instantaneously appear when the ceiling over a large void in the subterranean layer falls because it is no longer able to support the load above. Clearly, instantaneous sinkholes were intended to be covered and have always been covered. Problems

²Telephone conversation of A. Butler with H. Parks.

arise, however, in those situations where damages are the result of a continuous or slow settlement rather than instantaneous collapse. It is in these situations where determination of the cause of loss becomes difficult.

Apparently, as a result of Zimmer, sinkholes which gradually manifest themselves have been covered (cover subsidence) as well as those which appear instantaneously (cover collapse). The Zimmer court found no statistics as to the number of each kind of sinkhole. The court also wrote that "sinkhole losses did not prove to be burdensome to the insurance industry." The court referred to the April 26, 1973 Insurance Commissioner's order which stated that during the first three years of the plan for equitable apportionment of losses between insurers, there had not been a single loss.

The situation where no losses exist has changed. Specific statutory language outlining what earth movement perils are to be covered would aid in clarifying what types of loss the Legislature intended be covered.

CURRENT ADJUSTMENT METHODS

In order to determine the approach taken by insurers in investigating and settling sinkhole claims, ten companies were contacted and asked to explain the steps taken to adjust these claims. The companies included Aetna, Allstate, GEICO, Hartford, Liberty Mutual, Nationwide, Prudential, State Farm, Travelers, and USAA. Although there were some differences in the details of the claims adjustment process between companies, all followed

essentially the same basic approach. This approach consisted of the following steps:

1. Upon receipt of a claim for sinkhole damage, the initial response of the insurers is to send one of their company adjusters to the site. While these adjusters are trained in the settlement of property claims, they are not specially trained in handling sinkhole claims. As a result, their role is primarily to determine if there is any obvious cause of the damage other than sinkhole. (Some examples of such other causes are excavations being done by the insured, something buried in the yard, etc.) It was stressed by all of the companies that a denial of a claim based on a visual inspection by the company adjuster is very rare. Similarly, unless there is an obvious sinkhole, it is unlikely that the company adjuster will immediately declare the loss to be covered. Several companies estimated that a decision based on this initial investigation occurs in less than one percent (1%) of all reported sinkhole claims.
2. Assuming that the cause of the damage is unclear, the companies contact a geotechnical engineering firm to investigate the loss. The engineers/geologists usually begin with a shallow boring since it is the least expensive of the techniques. If the results of the shallow boring are not conclusive, then a deep boring is

used. (In some cases, ground penetrating radar (GPR) is used to determine the "best" places for conducting the deep borings. One company indicated that it uses GPR on any claim on the west coast of Florida.) The geotechnical engineering firm submits its report and its opinion to the company, which then makes its final decision based on the findings of the engineers/geologists.

3. Upon a determination that a loss is caused by a sinkhole, an engineering firm is used to determine the best approach for repairing the damage.

All companies indicated that the benefit of the doubt is given to the policyholder--that is, any damage reported as being caused by a sinkhole is assumed to have resulted from a sinkhole unless there is an obvious alternative cause, or unless a qualified engineer/geologist states that it was not.

Use of Professional Expertise

The selection of "experts" by insurers in the detection of sinkholes is a function of their quality, their promptness in the submission of their findings, and the clarity of the reports they prepare. One aspect of their professional quality which is important to insurers is these persons' capability as courtroom witnesses. More than one claims person commented that this is an important issue.

Circumstances Dictating Use

The principal circumstance dictating the use of an expert in the adjustment of a sinkhole claim is the lack of a clear determination that a sinkhole has or has not occurred. Normally, there is damage to property which could have been caused by a sinkhole but which could also have some other cause. These include soil dryness, water tables, improper foundation design or materials, excavation by burrowing animals, water pressure, soil erosion, earthquake, organic matter in the soil, and others.

Where there is reasonable doubt, the rule seems to be that some professional expertise is desirable. The best outcome of this process is that there is a determination of the "probable" cause at the lowest possible cost. This "lowest possible cost," sometimes expressed alternately as a "reasonable" cost, is a difficult concept in practice; the insured and the insurance company may have vastly differing notions regarding what is "reasonable." Since the insurance companies are incurring the adjustment costs, an insurance company may decide to pay a questionable claim and forego the investigation because the cost of an exact determination of cause would exceed the payout.

SINKHOLE SUMMIT

On August 28, 1992, a "Sinkhole Standards Summit" (the Summit) was convened with eminent geologists and engineers from the state of Florida. It was intended to bring some certainty and consensus to the issue of minimum standards to be employed in the determination of the whether a sinkhole has caused damage to

a structure. Thus, the main question which was addressed was "How do you determine the cause of the damage?" Dr. Walt Schmidt, Director of the Florida Geological Survey, was the moderator of this discussion.

The invited participants in the Sinkhole Standards Summit were:

Dr. Barry Beck
Former Director of the Florida Sinkhole Research Institute
Orlando, FL

Dr. John Garlanger
Ardaman and Associates
Orlando, FL

Mr. Tony Gilboy
Southwest Florida Water Management District
Brooksville, FL

Mr. Jack Harrington
Brown Testing Laboratories, Inc.
Tampa, FL

Mr. Craig Hutcheson
United States Geological Survey
Tampa, FL

Mr. Ed Lane
Florida Geological Survey
Tallahassee, FL

Dr. Bill Parker
Department of Geology
Florida State University
Tallahassee, FL

Dr. Anthony Randazzo
Department of Geology
University of Florida
Gainesville, FL

Dr. Tom Scott
Florida Geological Survey
Tallahassee, FL

Mr. William Sinclair
Environmental Consulting and Technology, Inc.
Tampa, FL

Dr. Mark Stewart, Chairperson
Department of Geology
University of South Florida
Tampa, FL

Mr. Bill Wilson
Subsurface Evaluations, Inc.
Winter Springs, FL

Dr. Walter Schmidt, Director
Florida Geological Survey
Tallahassee, FL

Mr. Bob Goehring
PSI/Jammal & Associates Division
Winter Park, FL

*These invitees were unable to attend.

Also in attendance were staff members of the Department of Insurance and the Florida Legislature, and Larry Brown of Brown Testing Laboratories, Tampa, Florida.

A major complaint which had been voiced by the homeowners in Dunedin was the inconsistency across geological and engineering firms in the identification of the cause of damage to their homes. From the day-long discussion among these professionals the following consensus was achieved:

1. Ideally, three professionals are needed to provide input to the insurance companies regarding the cause of loss: a structural engineer, a professional geotechnical engineer, and a professional geologist. The structural engineer would be employed initially to give advice regarding the structural soundness of the

building when constructed. The professional geologist would offer observations and interpretations regarding the earth and the actual cause of the damage (given poor construction has been ruled out by the structural engineer). Finally, the geotechnical engineer would supply input regarding the design of the foundation. The use of three professionals would be in the ideal (i.e., assuming no constraints with regard to money). Realistically, it was agreed that, at a minimum, a qualified individual must write the report. This individual must be a licensed professional engineer or a licensed professional geologist with documented experience with foundation subsidence.

2. Standardizing the sinkhole identification process so that each investigation is identical was deemed to be impossible and unnecessary by these engineers and geologists. A three-tier process was generally accepted as being necessary (see Table V-1). A checklist of points to consider was also recommended. If a process on this checklist was not undertaken, the recognition that this process was not undertaken should be noted in the report and the justification for this decision noted.

Table V-1

APPROACHING A SETTLEMENT INVESTIGATION FROM A THEORETICAL STANDPOINT

PHASE 1--PRE-SITE ASSESSMENT

REQUEST: (CLIENT)	Complaint; concern; need for solution
INFO FROM CLIENT: (PROJECT ENGINEER/ PROJECT GEOLOGIST)	Nature of Problem; his perception of problem; where; what; when; how serious background
PREL. SEARCH: (PROJECT ENGINEER/ PROJECT GEOLOGIST)	Review published information--maps, quads, SCS, office experience--ask share, talk to senior people
THEORIES: (COMBINED)	Most probable; process of elimination; most likely what is and what is not; what do you suspect

PHASE 2--ON-SITE ASSESSMENT

SITE DATA: (PROJECT ENGINEER/ GEOLOGIST)	Visit site - observe conditions in, out, around, photos History - nearby conditions, vegetation site grading, cut/fill, utilities, wells, buried structures, new construction coinciding with reported complaint, type/mode of failure, pattern, trends, normal, unique, unusual, minor, expansive, materials, additions, construction, design, settlement of ground?
REFINE THEORIES: (PROJECT OR SENIOR ENGINEERS)	Form some thoughts - foundation/settlement related, shallow/deep, influence from construction, etc.

PHASE 3--DETAILED SITE ASSESSMENT

DESIGN SCOPE OF EXPLORATIONS: (PROJECT ENGINEER/ GEOLOGIST)	Additional site visits, borings, pits, details, get plans, take measurements, soil tests, KEEP UP WITH FINDINGS!
RECONCILE: (COMBINED)	Does data support refined theory, is it or is it not a clear case - do others agree/disagree?
REDEFINE SCOPE: (COMBINED)	If not a clear case - regroup and redefine scope
EVALUATION: (PROJECT ENGINEER/ PROJECT GEOLOGIST)	If clear case - proceed with evaluation
SOLUTION AND RECOMMENDATIONS: (PROJECT OR SENIOR ENGINEERS/GEOLOGISTS)	Make recommendations, monitor, further studies, corrective works/alternatives, provide concepts of procedures depending

3. It was agreed among the geologists and engineers that a sinkhole research institute should be created which would provide a clearinghouse for seminars, conferences, lectures, and the general exchange of ideas. This would facilitate the standardization of the sinkhole identification process and important dissemination of information to practicing professionals. This institute must be cross-disciplinary, given the nature of and issues related to sinkholes.
4. It was agreed that, often insurance adjusters are not familiar with adjustment of claims, and that some sort of training should be given the adjusters assigned to adjust a reported sinkhole claim. Brochures could be created and seminars conducted by the aforementioned sinkhole research center. (See Appendix V-A for an example of a claims handling guide used by the Illinois Mine Subsidence Insurance Fund to adjust mine subsidence claims.)

PHASE 1: PRE-SITE ASSESSMENT. This stage involves collection of background information (either over the phone, if possible, or in person). The following questions should be answered.

- a) When the engineering or geological firm receives the request to investigate the home, is the damage life threatening or catastrophic?

- b) Is there a well being drilled on the property or nearby?
 - c) How old is the house?
 - d) Does the family have a swimming pool and does it leak?
 - e) Is there any excavation nearby?
 - f) Are you the original owner of the home?
 - g) Has there been any change in the vegetation coverage?
 - h) Have you had any changes in the color of your water?
 - i) Have you had sedimentation in your water?
 - j) What landscaping was done?
 - k) In relation to a well, have there been any significant changes in the pumping of the well recently?
 - l) What is the location of the pipes, drainage sewer lines, and septic tanks?
 - m) Has there been any recent flooding?
 - n) Have the public utilities been involved with this problem?
-

PHASE 2: ON-SITE ASSESSMENT

- a) Get to know the background geological literature for the area.
- b) Draw an accurate site map to scale, to map the ground cracks and the pattern of the cracks.

- c) Take photos and do sketches of the site.
- d) Look at the angled dip on the fractures. In the initial stages of sinkhole collapse there is a hemispherical cavity that is perhaps coming up to the surface. If there is a dip on the cracks away from the center of the circle, that is suggestive evidence of a sinkhole.
- e) If the homeowner has indicated that wells have been drilled nearby, get a completion report on any wells drilled.
- f) Observe downspouts and any drainage systems.
- g) Examine the alignment of trees. If the trees have been cut off at the ground and covered, the trunks rot and form a cavity in the ground.
- h) Look for paint in the cracks (as a clue to their age).
- i) Look for any change in site conditions.
- j) Locate the sewer pipe and the septic tank. Many sinkholes can develop above a sewer line if the line does not have the proper joint.
- k) Collect all of the above information and refine your hypothesis. If, from the above investigation, the cause of damage can be identified, further investigation may not be warranted.

PHASE 3 - DETAILED SITE INVESTIGATION

- a) If there is some minor cracking around the foundation, look at the footings to see if there is buried garbage.
- b) Do a shallow investigation (up to ten feet) using test pits, hand augers, a level survey of the floor, and ground penetrating radar.
- c) Use piezometers to take readings and draw a water table map. The water table will depress over the center of the subsidence and this test is relatively inexpensive.
- d) Put crack-monitoring devices on the walls. Mark all cracks.
- e) If deep penetrating borings are to be used, one must first determine where to do the borings. At a minimum two borings must be done; one in an unaffected area, in order to provide a reference point, and one in what is expected to be the center of the damage.
- f) Sometimes it is desirable to drill on a neighbor's land. Document if there are problems drilling on a neighbor's land. If there is, a different means of diagnosis will have to be utilized.
- g) After much discussion regarding what the objective of deep penetrating borings is, an inability to determine the actual location of the cavity was

deemed to be insufficient evidence of the lack of a sinkhole because a cover subsidence sinkhole can ravel laterally. Furthermore, one could locate a cavity and not have found a sinkhole because cavities can have many causes, only one of which may be a sinkhole as defined in the insurance policy. Thus, no minimum number of deep penetrating borings was recommended. However, a complete justification of the decision of why borings were or were not used was recommended.

- h) To completely analyze the sediment samples, the following measurements are recommended:
- i) moisture content;
 - ii) if it is clay, measurement of Atterburg limits;
 - iii) measurement of uncombined compressive strength;
 - iv) if the cause of the damage is hypothesized to be decaying organic soils, measurement of the percent of organic soils;
 - v) measurement of the engineering performance and behavior of the materials, e.g., the movement or deformation of the materials under the types of stresses that are present at that particular site;
 - vi) identification of the mineralogy;

- vii) measurement of density of the soil.³
 - i) Use an extensometer, i.e., put a pipe in the ground down to the bedrock and put a gauge on the pipe; observe how the ground moves relative to that pipe. This is very expensive, about \$11,000.
6. The participants recommended that an abridged report in layman's terms be made available to the homeowners. Currently, the standard procedure for denial of a claim by many insurance companies is notification of the homeowner of the basic conclusion of the investigation, with a recommendation to the homeowner to read his or her insurance policy.
7. If the report does not address the structural adequacy of the building, that should be noted through a specific statement of that fact. Otherwise, a comment on the structural adequacy of the building should be addressed in the report.
8. Some of the damage which masquerades as sinkhole damage, but is really caused by faulty construction, could be avoided by stricter building codes. Furthermore, damage from sinkholes could be limited through stricter building codes. Rarely are commercial buildings damaged by sinkholes, and it was suggested at the Summit that this was due to the fact that

³These measurements should be done according to some standard such as in conformance with the American Society of Testing Materials (ASTM).

commercial buildings are designed and engineered to much stricter standards. It was noted that the Southern Building Code Congress International, Inc. has promulgated a "deemed to comply" standard which would reduce the number of false sinkhole claims and possibly stabilize homes which are affected by sinkholes. Conformance with this "deemed to comply" standard would also mitigate damage caused by other perils such as windstorm damage from hurricanes. The preface and purpose of the "deemed to comply" standard can be found in Appendix V-B.

9. Soil tests are not required in all counties which are likely to have shrink/swell clay.⁴ Requirement of soil tests in these counties would reduce the incidence of damage to homes which masquerades as sinkhole damage. If shrink/swell clay is present on the footprint of the building, more expensive foundation design can be used to secure the home against damage by shrink/swell clay. A post-tension slab foundation can be poured at a cost of about \$2,000-\$3,000. In some instances, the seller of the lot will adjust the purchase price of the lot for the increased cost of the foundation.

⁴Shrink/swell clay is also known locally as pipe clay or Fuller's Earth, and in technical scientific terms is often a mixture of polygorskite and other clays such as illite or chlorite. Any mixture of clay minerals that can absorb large amounts of water can be called a shrink/swell clay.

10. A recommended decision process suggested by one participant and described through a flowchart and the form used by one participating geotechnical firm can be found in Appendix V-C.

Prompt and Fair Settlement of the Claim

The second component of "minimum standards" is prompt and fair settlement of the claim, given clear determination that an insured event has occurred. It has been asserted by homeowners in the Dunedin area that the techniques currently employed to repair homes damaged by a sinkhole do not work; after the repair, the homes continue to crack. This is the reason for their request that damage in amounts greater than fifty percent (50%) of the pre-damage value of the home be compensated through a cash settlement and that no effort be made to fundamentally repair the home.

In an effort to establish the validity of the homeowners' claim that the current sinkhole repair techniques are not effective, a phone survey of residents in the Dunedin area, who had experienced sinkhole damage and received some compensation for this damage from insurance companies, was undertaken. Identification of these homeowners came from the aforementioned mail survey done by the Florida Department of Insurance (DOI).

Out of the 8,500 surveys mailed by the DOI, 140 responded that they had suffered sinkhole damage. Of these 140 homeowners, 41 said they had received some payment to repair damage from their insurance company. Attempts were made to contact these 41

people, and 32 were successfully contacted. The results of this phone survey follow.

SINKHOLE GROUTING SURVEY SUMMARY

- 1) It is our understanding that you have had the damage to your property diagnosed as being caused by a sinkhole. Is this true?⁵

24 Yes 8 No

- 2) Was your house repaired by an engineering firm?⁶

18 Yes 6 No

- 3) How much did the repairs cost?⁷

Range \$7,800 - \$88,000

Average \$49,500

(sixteen replied/two did not know)

- 4) What repairs were made to your house?

Grouting only 8

Grouting with pilings 8

Pilings only 2

⁵Two homeowners' insurers diagnosed the property damage as being caused by clay shrinkage, yet settled with the insureds for \$130,000 and \$51,000.

⁶Several homeowners whose houses were diagnosed as being damaged by sinkholes settled with their insurers for the replacement cost of their houses and elected not to have repairs made.

⁷One homeowner's insurer paid for grouting and cosmetic repairs to the house (\$25,000 total) although the insurer diagnosed the property damage as being caused by clay shrinkage. The same homeowner also reported subsequent damage.

5) Have you had subsequent damage?

Yes 7

No 9

Under review 1

Do not know 1

6) Have you had subsequent damage?

<u>Grouting Only</u>			<u>Grouting W/ Pilings</u>		<u>Pilings Only</u>		
<u>Yes</u>	<u>No</u>	<u>Under Review</u>	<u>Yes</u>	<u>No</u>	<u>Yes</u>	<u>No</u>	<u>Do Not Know</u>
3	4	1	4	4	1	0	1

7) Do you currently have a homeowners insurance policy?

Yes 30

No 2

8) Have you had problems getting insurance?

Yes 11

No 21

9) What kind of coverage do you have?

Homeowners 23

Contents/Liability only 5

Forced-placed coverage 1

Dwelling excluding sinkhole
with contents/liability 1

None 2

10) How much do you pay for your homeowners insurance?

Homeowners	range	<u>\$135 - \$520</u>	average	<u>\$254</u>
C/L only	range	<u>\$261 - \$1,000</u>	average	<u>\$665</u>
Forced-placed coverage			average	<u>\$500</u>
Dwelling excluding sinkhole with C/L			average	<u>\$800</u>

*Summary statistics are based on 32 completed surveys from a sample of 41.

This survey admittedly had a very small sample. Thus results are not conclusive, but they do give "ballpark" findings. From this survey, approximately forty-four percent (44%) of the homeowners who had some kind of repair done to their homes had subsequent damage. As far as which particular technique was more effective (i.e., grouting only, grouting with pilings, or pilings only), casual observation of these numbers reveals that subsequent damage problems are evenly distributed across the techniques.

The reasons for this subsequent damage could be any of the four following reasons:

1. the initial diagnosis of the cause was incorrect;
2. the application of the technique was done incorrectly;
3. even though the diagnosis may be correct and the technique may have been performed correctly, the technique is ineffective; or,
4. the technique could have been effective and a separate cause of damage has subsequently developed.

From this small survey, we have no ability to judge which of the above reasons might explain why subsequent damage occurred.

SUMMARY

The current practice of insurers is consistent with the adjustment of other types of loss. However, one unique feature of the adjustment of sinkhole claims is that there is a great deal of reliance upon and deference to the opinions of the professional geologist or engineer utilized in the examination of the site. The result of the Sinkhole Summit indicated that there is no uniform set of criteria that can be universally applied to the investigation of sinkhole claims. Rather, the determination of the cause of loss is very site specific and requires an evaluation by highly trained individuals who possess great expertise. It was recommended that a list of guidelines be compiled. This list of guidelines relies heavily on the professional judgment of the geotechnical expert in its application. If the expert decides not to pursue an item on this checklist, the rationale should be noted in the report. Specific minimum guideline recommendations included a description of pre-site, on-site, and detailed site assessment issues which should be addressed (see pp. V-11 to V-17). Furthermore, it was highly recommended that

1. soil tests be required in areas of the state with a known presence of shrink/swell clay;

2. building codes be improved to conform with the Southern Building Code Congress International (SBCCI) "deemed to comply" standard and be enforced; and
3. the results of the geotechnical investigation be given to the homeowners in layman's terms.

Because of the unique nature of sinkhole losses and the necessity for an ad hoc evaluation of losses, as well as an expert's evaluation of what testing standards are appropriate in a given instance, a procedure which would centralize evaluation and utilize highly trained, highly competent professionals who would uniformly approach the problem seems desirable.

With regard to the effectiveness of the current efforts to repair damage, the results of a phone survey of thirty-two homeowners who had sinkhole damage repaired through the use of one of the three methods described indicated approximately forty-four percent (44%) experienced subsequent damage. The findings of this small sample survey suggest that current repair methods are somewhat unreliable. Further specialized investigation of this expensive repair process is required to explain why subsequent damages occurred.

VI. NEED FOR AN ONGOING RESEARCH RESOURCE

INTRODUCTION

The ability to explain and predict geologic phenomena is clearly enhanced by the availability of accurate data collected on a long-term basis. The issue with respect to sinkhole-related information is not, therefore, if it would be useful. Rather, the appropriate question is whether such data is or could be generated from current sources, or if the establishment of an ongoing research resource is needed. This question is not a new one, having been addressed nearly ten years ago prior to the formation of the Florida Sinkhole Research Institute (FSRI). Much of the discussion at that time is relevant today and is summarized below, along with a brief history of the FSRI. In addition, the current need for the proposed research resource is addressed. This section concludes with a discussion of three proposals for the establishment of a new sinkhole research center.

HISTORICAL DEVELOPMENT

The rapid growth in population and the development of previously rural land in Florida from the 1960's to the present time has resulted in a corresponding increase in property damage from sinkholes. The increase in population not only makes it more likely that sinkhole activity will be reported, but also may affect the incidence of sinkholes through its impact on the groundwater supply. At the same time, the construction of both residential and commercial buildings to service the needs of the

expanding population base makes it more probable that a sinkhole will actually result in property damage.

In 1981, the damage and resulting insurance problems associated with the 320-foot diameter Winter Park sinkhole led then-Insurance Commissioner Bill Gunter to recommend the establishment of a Sinkhole Research Institute. Proposals for the Institute were solicited by the University System Chancellor's Office, with five universities expressing an initial interest (Florida Atlantic University, Florida State University, the University of Central Florida, the University of Florida, and the University of South Florida). The University of Central Florida was eventually selected to house the Institute because of its proximity to both significant sinkhole activity and to geotechnical engineering firms that were considered to be the most active in sinkhole-related work.¹ The operating guidelines for the Institute were developed by an Advisory Board made up of representatives of a variety of groups concerned with sinkhole problems.² The Florida Sinkhole Research Institute was

¹The source of this information is a draft of the Proposal for the Establishment of Institutes or Centers, submitted by the University of Central Florida (April 20, 1982). This document is found at Appendix VI-A.

²The initial Advisory Board was appointed by Commissioner Gunter and included representatives of: all five participating universities and the Board of Regents; the insurance and construction industries; title companies, mortgage bankers, and real estate brokers; private geotechnical engineers, geophysicists, and land surveyors; the U.S. Geological Survey and state water management district hydrologists; Florida Departments of Insurance and Treasurer, of Natural Resources, and of Transportation; county planning, zoning and public safety commissions; and municipal officials.

officially founded in 1982 at the University of Central Florida by a cooperative agreement between the Institute Advisory Board and UCF President Trevor Colbourn. At that time, all sinkhole data files of the Florida Geological Survey (FGS) were transferred to the FSRI for use in their program.

The purposes of the Florida Sinkhole Research Institute, as stated in their literature, are summarized as follows:

1. to centralize and coordinate technical data and information on sinkholes in Florida;
2. to conduct research into the causes, mechanisms, location, engineering, and repair of sinkholes; and
3. to provide public information and education about the sinkhole hazard in Florida.

The initial funding of \$150,000 for the FSRI was provided by contributions from insurance companies doing business in the state of Florida. Apart from the use of the facilities at the University of Central Florida, the primary source of subsequent funding was external research grants. Because of an inability to generate additional funds from either private or public sources, the Institute was phased out of existence over the course of the past year. The staff was released in August, 1991, and the FSRI was officially disbanded with the expiration of the Director's contract in August of 1992. Portions of the data collected by the Institute have been deposited in part with the Florida Geological Survey and in part with the Southwest Florida Water Management District.

THE NEED FOR AN ONGOING RESEARCH RESOURCE

In order to determine whether an ongoing sinkhole research resource is considered to be necessary, the following parties were asked to assess both the need for such a facility and (if interested) their own capability in housing the research center: the Florida Geological Survey, Florida State University, the University of Central Florida, the University of Florida, and the University of South Florida (the request and responses are found at Appendix VI-B). In general, these entities were selected because they met the criteria of being academic institutions with established geology departments, and the letters were addressed to the chairperson of the geology department. The exception is the University of Central Florida, which has no geology department but was included because of its former association with the Florida Sinkhole Research Institute. (The letter in that case was sent to the former Director of the FSRI.)

In addition to surveying the universities and the Florida Geological Survey, the rationale for the establishment of the FSRI was reviewed. It is clear that at the time it was formed, there was a perceived need for the Institute. Although it encountered funding difficulties which resulted in its limited success and eventual termination, this does not necessarily mean that the need for the facility was not real.

The respondents were unanimous in their belief that an ongoing research resource is needed. A variety of reasons were

offered which, together with the rationale for the FSRI, can be categorized and summarized as follows:

1. IDENTIFICATION AND EXPLANATION OF SINKHOLE ACTIVITY:

Each of the respondents emphasized the importance of a systematic database (collected continuously over a long period of time) in identifying areas of sinkhole activity and in developing an understanding of the processes and trends responsible for the development of sinkholes. The need for an ongoing (i.e., long-term) research center as opposed to a short-run effort was cited in light of the fact that (1) the formation of sinkholes results from long-term processes that must be studied over time, and (2) the development of new technologies over time may lead to additional information that can be integrated into the existing body of knowledge to form a more complete understanding of these processes. It is also argued that the identification and explanation of sinkhole activity will provide a better assessment of risk that is needed for establishing appropriate insurance rates, setting building construction and design standards, and planning land use.

2. PREDICTION OF FUTURE SINKHOLE ACTIVITY: In addition to identifying and explaining the formation of existing sinkholes, the continuous collection of data and the mapping of indicators of future sinkhole locations

should prove useful in identifying specific areas of potential sinkhole development and in predicting the effects of changes in land and/or water use. These predictions would also have important implications for insurance rating, construction standards, and land-use planning.

3. CENTRALIZATION AND COORDINATION OF TECHNICAL DATA: The point was made in the UCF proposal for establishing the FSRI that the number and variety of agents and businesses involved in sinkhole-related activities slowed the process of compiling, analyzing, and disseminating information. The research center is needed, therefore, to act as a liaison between these groups and to coordinate their activities.
4. DISSEMINATION OF INFORMATION TO THE PUBLIC: Several of the respondents indicated that the research resource is needed to provide information to the public and to interested researchers. The potential for using the center as a means of educating the public about the sinkhole hazard in Florida is a common theme.

In general, the observations of the surveyed entities regarding the need for the research center correspond to the opinions expressed by the geologists and geotechnical engineers who met on the Florida State University campus in August. There is a definite consensus among this group that such a facility is needed.

PROPOSALS FOR THE ONGOING RESEARCH RESOURCE

The universities mentioned above, along with the Florida Geological Survey, were also asked (1) to indicate whether or not they would be interested in serving as the research resource center, and (2) if so, to evaluate their own ability and attributes, the quality and adequacy of their facilities, and the expected costs of doing so. The Chairman of the Geology Department at Florida State University indicated that, in his opinion, the "rational" choice for the research center would be the Florida Geological Survey. (His reasons are incorporated into the assessment of the FGS given below.) The University of Florida, the University of South Florida, and the Florida Geological Survey provided brief proposals and cost estimates, the details of which are outlined below.

1. THE UNIVERSITY OF FLORIDA (UF): The University of Florida proposal cited its strong programs in geology, civil engineering, and environmental engineering, as well as the presence of faculty involved in sinkhole research. The Department of Geology has some experience in operating research institutes, as it already administers a Board of Regents Type IV Institute for Environmental Studies. UF claims a record of success in supplementing state funds with private funding, and is close in proximity to the geographic areas where sinkholes are most prevalent.

Costs are expected to depend on the desired scope and breadth of the program. The funding required for a "modest but effective" program are estimated as follows:

Personnel: Summer salary for director of the center = \$ 20,000
Part-time secretary (for one year) = \$ 10,000
Student research assistant
(1/2 time for one year) = \$ 6,000

Other Needs: Equipment, supplies, and space needs
could be developed as the research
center grows.

Total Cost: = \$ 36,000

2. THE FLORIDA GEOLOGICAL SURVEY (FGS): The FGS cites two main reasons why it should be selected to house the sinkhole research resource center. The FGS is the only governmental agency with a statutory mandate to maintain and interpret geologic data from throughout the state. And secondly, its history in collecting sinkhole data, all of which was turned over to the FSRI at the time of its creation, suggests the FGS has the experience and expertise to do the job. Long-term continuity and staff expertise are also stressed. The staff of the FGS includes fifteen Florida licensed professional geologists with 185 collective years of experience and an established administrative support staff.

The sinkhole research center would be incorporated into the FGS's current facilities, which include: a research library; laboratories; computer capabilities; a core and well cuttings repository; a geophysical

wireline log library; and a geologic descriptions record file. In addition, the FGS shares a variety of equipment with the Florida State University Geology Department.

The FGS emphasizes that it has worked with all universities throughout the state of Florida and, where appropriate, will continue to do so. This gives it access to expertise and resources from a variety of sources while maintaining a central repository for the research.

The funding estimates for the FGS are summarized below:

<u>Personnel:</u>	One Professional Geologist Supervisor*	= \$ 52,600
	Two Geologists*	= \$ 60,000
	One Secretary*	= \$ 17,500

(*Includes salary & state benefits package)

<u>Other Needs:</u>	Expenses for these Positions (field expenses, auto maintenance, printing, and standard state budget package)	= \$ 43,000
---------------------	--	-------------

	OCO (one field vehicle) (standard state budget package)	= \$ 31,750
--	--	-------------

<u>Total Cost:</u>		= \$204,850
--------------------	--	-------------

3. THE UNIVERSITY OF SOUTH FLORIDA (USF): While this proposal indicates that a stand-alone resource center at the University of South Florida is a viable alternative, it suggests that a better arrangement would involve a sharing of responsibilities between the Florida Geological Survey and USF. The center, as it is

envisioned in this proposal, would be active in two major areas--service and research. The service component, which consists of the use of the center for collecting and disseminating sinkhole information, would be the responsibility of the FGS. The University of South Florida would then (subject to approval) oversee a program of applied sinkhole research, using the technical information gathered by the resource center.

The rationale for this arrangement is one of experience and expertise. Currently, there is a pressing need for sinkhole-related information on the part of homeowners, insurers, agencies, and local governments. Given its statutory mandate and long history of collecting and maintaining such data, USF feels the FGS is the logical choice for doing so under the proposed research facility. While this service function could be carried out at the university level, the primary activities of a university are teaching and research. It therefore makes more sense (USF argues) to divide the duties among the FGS and USF according to their areas of expertise.

The USF proposal also stresses the need for ongoing funding from the state, as opposed to the reliance on outside funding which contributed to the demise of the Florida Sinkhole Research Institute.

Personnel and funding requirements are estimated as follows:

SERVICE-RELATED REQUIREMENTS

Personnel: One Administrator
One or two Professional Staff Members
One Administrative Assistant

Other Needs: Vehicle and Travel Budget

Total Cost: = \$150,000 to \$200,000

RESEARCH-RELATED REQUIREMENTS

Personnel: One Part-Time Research Director
One Part-Time Fiscal/Administrative Assistant

Other Needs: None specified

Total Cost: = \$60,000 to \$120,000

SUMMARY

There is general agreement among the geologists, engineers, and academic institutions surveyed that there is a need for an ongoing facility to collect and disseminate sinkhole information and to conduct research on the formation and occurrence of sinkholes. The increase in sinkhole activity and the resulting difficulties it has created for homeowners, insurers, agencies, and local governments has highlighted the importance of identifying, explaining, and predicting sinkhole occurrences and related phenomena. It has also led to a broad-based interest in the information that would be collected by such a resource center. At the same time, the demise of the Florida Sinkhole Research Institute has already resulted in the decentralization

of the existing sinkhole database and a lack of coordination among the activities of these interested parties.

There is a consensus among the responses and proposals submitted to the research team that the Florida Geological Survey should play a central role in the development and maintenance of a sinkhole database. In addition to its own proposal, the responses from both Florida State University and the University of South Florida indicate that the FGS should be used as the central clearinghouse for the collection of sinkhole data and for its dissemination to the public. It has considerable experience in fulfilling this role, as well as established facilities and personnel in both the geological and administrative support staff areas.

The role of the FGS relative to that of the universities in overseeing sinkhole research activities is not as well-defined. Each of the proposals outlines the research expertise and resources of the respondents, all of which should be utilized when appropriate. As the central repository for the data, the FGS must continue to work with the universities (and the reinsurance facility, if established) to coordinate the research into sinkhole occurrences and formation.

Finally, the respondents agree that the demise of the Florida Sinkhole Research Institute was due in large part to a lack of continuing funding. The former director of the FSRI indicated that he had requested \$200,000 as the annual budget for the center. This amount corresponds roughly to the totals

specified in the current proposals (approximately \$205,000 for the FGS proposal and a range of \$210,000 to \$320,000 for the USF proposal). The research center must, it is agreed, be able to survive on this budget without relying on externally-generated funding.

APPENDIX 2

Department of Environmental Protection Sinkhole Web Page



- Programs
 - FGS Home
 - Coastal
 - Data
 - Acquisition
 - Education
 - Hydrogeology
 - Investigations
 - Oil and Gas

- Information
 - About Us
 - Contacts
 - Data & Maps
 - Events
 - Forms
 - Geologic Topics
 - Links
 - Newsletters
 - Publications
 - Rules
 - Statutes

Geology Topics

Sinkholes

- » [Download Sinkhole Database](#)
- » [Sinkhole type, Development and Distribution in Florida Map \(Map Series 110\)](#)
- » [Florida's Sinkholes \(Poster No. 11\) Contact Carol Armstrong to purchase this 24" by 36" poster. Poster was created in 2004.](#)
- » [Sinkhole Report Form](#)
- » [Sinkhole Frequently Asked Questions](#)

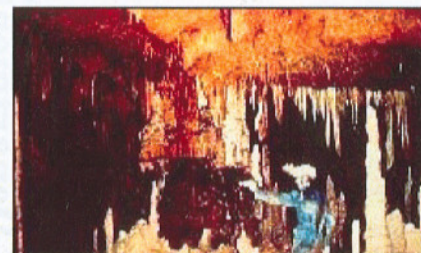
Sinkholes are a common feature of Florida's landscape. They are only one of many kinds of karst landforms, which include caves, disappearing streams, springs, and underground drainage systems, all of which occur in Florida. Karst is a generic term which refers to the characteristic terrain produced by erosional processes associated with the chemical weathering and dissolution of limestone or dolomite, the two most common carbonate rocks in Florida. Dissolution of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris.



Limestones in Florida are porous, allowing the acidic water to percolate through their strata, dissolving some limestone and carrying it away in solution. Over eons of time, this persistent erosional process has created extensive underground voids and drainage systems in much of the carbonate rocks throughout the state. Collapse of overlying sediments into the underground cavities produces sinkholes.

When groundwater discharges from an underground drainage system, it is a spring, such as Wakulla Springs, Silver Springs, or Rainbow Springs. Sinkholes can occur in the beds of streams, sometimes taking all of the stream's flow, creating a disappearing stream. Dry caves are parts of karst drainage systems that are above the water table, such as Marianna Caverns.

Suggested reading: Lane, Ed, 1986, Karst in Florida: Florida Geological Survey Special Publication 29, 100 p.



Last updated: November 14, 2005



APPENDIX 3

Florida Department of Environmental Protection

Sinkhole Frequently Asked Questions



Programs

- » [FGS Home](#)
- » [Coastal](#)
- » [Data](#)
- » [Acquisition](#)
- » [Education](#)
- » [Hydrogeology](#)
- » [Investigations](#)
- » [Oil and Gas](#)

Information

- » [About Us](#)
- » [Contacts](#)
- » [Data & Maps](#)
- » [Events](#)
- » [Forms](#)
- » [Geologic Topics](#)
- » [Links](#)
- » [Newsletters](#)
- » [Publications](#)
- » [Rules](#)
- » [Statutes](#)



Florida Geological Survey - Frequently Asked Questions

- » [Sinkhole Questions](#)
- » [Miscellaneous Questions](#)
- » [Contacts and links for additional information and assistance](#)
- » [Florida County Emergency Management websites](#)
- » [Florida Municipal Emergency Management Agencies - scroll to bottom of page](#)

Sinkhole Questions

1. [Why do sinkholes form?](#)
2. [My yard is settling---do I have a sinkhole?](#)
3. [I think I do have a sinkhole in my yard. What should I do?](#)
4. [How long does it take for the sinkhole to stop growing?](#)
5. [How do I fill in a sinkhole?](#)
6. [A sinkhole just opened in the middle of my street ---who should I call?](#)
7. [A sinkhole opened in my next door neighbor's yard...should I be concerned?](#)
8. [Will watering our lawn lower the water table level and thus, cause sinkholes to develop in our neighborhood?](#)
9. [Is there a government agency that will come and inspect my sinkhole?](#)
10. [Is there a government agency available to help fix a hole on my property?](#)
11. [Do I need a permit to fill a sinkhole?](#)
12. [What is the sinkhole risk factor associated with my area?](#)
13. [Is there any way to have my property evaluated as to the risk of a sinkhole forming?](#)
14. [I am buying a house with a repaired sinkhole under the foundation. Is this safe?](#)
15. [Is there a safe area of Florida in which to live with no chance of sinkholes?](#)

16. Is there a database showing all sinkholes in Florida?
17. Where can I find available sinkhole information for a specific area?
18. I am buying a new home and I want to know if there is a sinkhole disclosure law?
19. Is a new construction site tested for sinkholes?
20. I was denied homeowners insurance because there is a sinkhole within one half mile of my home. What can I do
21. My insurance company has informed us that the area where we are going to purchase property is listed as a sinkhole area. What does this mean? What can we do about it? Should we buy in that area?
22. Who may I call to obtain further information on insurance in Florida or to issue a complaint about my insurance company?
23. What happened to the Florida Sinkhole Research Institute (FSRI)

Sinkhole Questions Answered:

1. Why do sinkholes form? [back to top](#)

Sinkholes form in karst terrain principally from the collapse of surface sediments into underground cavities in the limestone bedrock. Slightly acidic ground water slowly dissolves cavities and caves in the limestone over a period of many years. When the cavity enlarges to the point that its ceiling can no longer support the weight of overlying sediments, the earth collapses into the cavity. In the less catastrophic, type of sinkhole, a bowl-shaped depression forms at the surface, usually over a considerable period of time. Well drilling data suggests that much of the underlying bedrock in Florida is riddled with cavities of differing size and depth. However, relatively few ever collapse and directly effect roads or dwellings.

Karst terrains develop in areas underlain by carbonate rocks such as limestone. They often have drainage systems that are reflected on the surface as sinkholes, springs, disappearing streams or even caves. The term karst, therefore, refers to the terrain and the term sinkhole is one of the types of drainage features reflected by that type of terrain.

In Florida you may see solution sinkholes, cover-subsidence sinkholes or cover-collapse sinkholes. The first of these three, solution sinkholes, usually occur where there is little or no sediment cover over the limestone. The rock is readily dissolved away at the ground surface or along joints or other openings. Cover subsidence sinkholes are located where thick permeable sediments cover the limestone. In this case the void in the rock is filled by sediments slumping downward from above. Eventually, the ground surface often shows a gentle circular depression. If a relatively thick layer of impermeable sediments covers the limestone there may not be a surface expression of a subsurface collapse. Cover-collapse sinkholes occur where sediments that overlie the void in the rock suddenly collapse due to triggering mechanisms such as heavy rainfall, drought, or mechanical loading.

Generally speaking karst terrains are not newsworthy items. Typically, it is only when a road or house happens to be located above developing karst features such as a sinkhole that headlines are made. Since much of Florida is karstic in nature, these same processes are continually taking place. As such, there is a certain degree of risk in living on karst.

However, most people accept the risk as one price to pay for living in the sunshine state.

2. **My yard is settling...do I have a sinkhole?** [back to top](#)

Maybe. But a number of other factors can cause sinking or settling. Expansive clay layers in the earth may shrink upon drying, buried organic material, poorly-compacted soil after excavation work, buried trash or logs and broken pipes all may cause depressions to form at the ground surface. If the settling is affecting a dwelling, further testing by a licensed engineer with professional geologist on staff or a professional geology firm may be in order. Property insurance may pay for testing, but in many cases insurance may not cover damage from settling due to causes other than sinkholes.

3. **I think I do have a sinkhole in my yard. What should I do?** [back to top](#)

Small sinkholes often require only filling with clean sand or soil. If the hole is under or very near a structure or swimming pool, your property owner's insurance may cover assessment and repair. Mark and secure the hole and keep children and pets away. If the hole is directly impacting a house, and sinking, sagging, or cracking walls are apparent, stay out of the dwelling. Call your property insurance adjuster and report it immediately. In some communities local government agencies may assist in evacuating the home, assessing damage and reporting the sinkhole. In many counties the local Emergency Management Offices (see contact list below) render assistance when a home is endangered. Personnel from your local Water Management District may also assist in sinkhole assessment, especially if the sinkhole potentially impacts local ground water. The sinkhole should be reported on the appropriate form and submitted to the Florida Geological Survey

4. **How long does it take for the sinkhole to stop growing?** [back to top](#)

When an underground cavity enlarges to the point that its ceiling can no longer support the weight of overlying sediments, the earth suddenly collapses into the cavity. A circular hole typically forms and grows over a period of minutes to hours. Slumping of the sediments along the sides of the sinkhole may take approximately a day's time to stop. Erosion of the edge of the sinkhole may continue for several days, and heavy rainfall can prolong the stabilization. In the less catastrophic cover subsidence type of sinkhole, a bowl-shaped depression forms at the surface, typically over longer periods of time (sometimes as long as years).

5. **How do I fill in a sinkhole?** [back to top](#)

Since anything buried in the earth potentially affects the groundwater, use only native earth materials or concrete for the fill. Broken limestone rip-rap or a concrete plug in the bottom of the sinkhole often helps create a stable foundation for the fill. Above that, add clayey sand to form a barrier that will help to prevent water from seeping downward through the hole and enlarging it further. Lastly, add sand and top soil, and landscape to surrounding conditions. Additional fill may be necessary over time, but most holes eventually stabilize.

6. **A sinkhole just opened in the middle of my street...who should I call?** [back to top](#)

The hole should be immediately cordoned off and clearly marked to protect traffic. Contact local law enforcement to report the hazard and call your city/county road department to initiate repair work. If the road is private, repair of the hole is usually the responsibility of the landowner or property owners' association.

7. **A sinkhole opened in my next door neighbor's yard....should I be concerned?** [back to top](#)

Although sinkholes in Florida tend to occur along linear fracture trends (aligned northwest to southeast and northeast to southwest), most are isolated events. The bedrock underlying the state is honeycombed with cavities of varying size, most of which will not collapse in our lifetimes. A quick inspection of your property for any sinking or soft areas might be prudent. Unless the sinkhole is very large, and extends to your property, there's likely to be little reason for concern.

8. **Will watering our lawn lower the water table level and thus, cause sinkholes to develop in our neighborhood?** [back to top](#)

Probable triggering mechanisms for sinkhole collapse may include drought, new construction, blasting, heavy ground loading, heavy rainfall, and heavy ground-water pumpage. Private lawn wells are typically not sufficient to impact the water table enough to cause sinkholes.

9. **Is there a government agency that will come and inspect my sinkhole?** [back to top](#)

There is currently no agency with responsibility and authority for sinkhole inspections in Florida. Often the Florida Geological Survey (FGS) receives calls from homeowners all over the state who have had the unfortunate experience of sinkhole. We do not have sufficient staff to visit all new sinkholes but do encourage the submittal of a sinkhole report. The Florida Geological Survey maintains a database of reported sinkholes which is available through the FGS web site. We will be happy to discuss your individual situation and make suggestions to you so that you will be informed as to how to handle the situation. In some parts of Florida, the local water management districts have staff available to check local sinkholes, particularly if they contain water. If a sinkhole is threatening your home, immediately contact your insurance company. In many counties staff from the local Emergency Management offices will advise homeowners on safety and evacuation of homes impacted by sinkholes.

10. **Is there a government agency available to help fix a hole on my property?** [back to top](#)

No. Sinkholes on private property are the responsibility of the property owner. In some cases the owner's property insurance may cover evaluation and repair of the sinkhole. Actual coverage may vary according to circumstances and insurance company policy.

11. **Do I need a permit to fill a sinkhole?** [back to top](#)

In general no permit is needed to fill a new sinkhole on private property unless it contains ground water. Sinkholes intersecting the underlying aquifers (those containing water) may require an Environmental Resources Permit before filling. This permit is available through your local Water Management District in southern Florida, or from the respective district offices of the Florida Department of Environmental Protection in northern Florida. District staff will assist in assessing the need for a permit and the permit approval process. As many sinkholes are direct conduits to our drinking water aquifers, some care in selection of fill material is advisable. Do not fill a sinkhole with trash, chemicals, or other materials that could contaminate ground water. Natural earth materials such as clean limestone rock, sand, and clayey sand are suitable.

12. **What is the sinkhole risk factor associated with my area?** [back to top](#)

Unfortunately there is no ready reference on sinkhole prediction or risk assessment. The insurance companies have tried developing some sort of risk prediction methodology, but since the underground cavities are largely undetectable without expensive ground-penetrating radar surveys, resistivity tests, or test drilling, no real progress towards this

goal has been made. About the most we can presently do is construct regional maps such as our, Sinkhole, Development and Distribution in Florida Map, showing zones of sinkhole occurrences based on the local geology and historical sinkhole activity.

13. **Is there any way to have my property evaluated as to the risk of a sinkhole forming?** [back to top](#)

Professional geologists and geotechnical engineering consultants with professional geologists on staff can perform a variety of tests to attempt to locate buried cavities which might form sinkholes. These tests include ground penetrating radar surveys, electrical resistivity tests, and borings. However, test results may be affected by the local geology and elevation of the water table, and are not always conclusive. And in many cases the cost of a detailed survey is beyond the typical homeowner's budget.

14. **I am buying a house with a repaired sinkhole under the foundation. Is this safe?** [back to top](#)

A number of engineering companies routinely repair sinkholes. Techniques vary from simple injection of grout into the hole to more advanced systems of engineered reinforced plugs, pins, and porous concrete. In general, if a repair has been certified by a licensed engineer, and completed to the satisfaction of the homeowner's insurance company, it is probably safe. However, as you are dealing with natural systems, there can be no guarantees that a repaired sinkhole will not cause future problems.

15. **Is there a safe area of Florida in which to live with no chance of sinkholes?** [back to top](#)

Technically no. Since the entire state is underlain by carbonate rocks, sinkholes could theoretically form anywhere. However, there are definite regions where sinkhole risk is considerably higher. In general, areas of the state where limestone is close to surface, or areas with deeper limestone but with a conducive configuration of water table elevation, stratigraphy, and aquifer characteristics have increased sinkhole activity. The Florida sinkhole location map (link button) shows the distribution of reported sinkholes statewide, and gives a rough idea where some of the increased risk areas may be located. However, these are only the reported sinkholes. There are countless more sinks statewide than are shown on this map. The sinkhole type and occurrence map (link) provides additional information on sinkholes statewide.

16. **Is there a database showing all sinkholes in Florida?** [back to top](#)

No. The Florida Geological Survey maintains a database of reported sinkholes. This represents only those sinkholes officially reported by observers. The reported sinkholes tend to cluster in populated areas where they are readily seen and commonly effect roads and dwellings. However, numerous sinkholes also occur in fields and forests, many of which go unseen and unreported. Also, the reported date only covers the period from 1954 to present. Many earlier sinkholes are unrecorded.

17. **Where can I find available sinkhole information for a specific area?** [back to top](#)

You can find this information in the [sinkhole database](#) located on this website. Click the Excel Spreadsheet link. The data is arranged by county. Find your county and search under the column that is titled address. It is here that you will have the best chance of finding the street locations. There are over 2000 reported sinkholes in the database.

18. **I am buying a new home and I want to know if there is a sinkhole disclosure law?** [back to top](#)

Most real estate seller's disclosure forms used in Florida today include a sinkhole disclosure statement. Sometimes it is overlooked. If it is in question, be sure to ask.

19. **Is a new construction site tested for sinkholes?** [back to top](#)

In most cases no. It is generally not required by building codes, and most building contractors do not provide testing on private home sites because of the additional expense. In some cases public building construction sites in sinkhole areas may be tested and reinforced as needed for safety and liability reasons.

20. **I was denied homeowners insurance because there is a sinkhole within one half mile of my home. What can I do?** [back to top](#)

Currently, an insurance company has the right to not issue an insurance policy on the basis of sinkholes in the "area." The definition of "area" remains subjective, and the issue will likely only be resolved through specific legislation, or by the general adoption of a standard by the insurance industry. Some companies have more liberal policies, and you may wish to shop around for other insurance that may be available.

21. **My insurance company has informed us that the area where we are going to purchase property is listed as a sinkhole area. What does this mean? What can we do about it? Should we buy in that area?** [back to top](#)

See question #20. Certainly the availability of insurance is a major factor to most homebuyers. Insurance companies may vary on their individual requirements and you should shop around for the best insurance policy that may be available to you. Unfortunately there is no ready reference on sinkhole prediction or risk assessment. This has made accurate risk determinations difficult and has hampered the formulation of either legislation or an industry standard on this issue. As a result many insurance companies rely heavily upon the regional maps showing zones of sinkhole occurrences based on the local geology and historical sinkhole activity. Any decision to purchase a particular property is of course a highly individual one, involving not only insurance availability, but also your own personal tolerance for risk and your desire to live in a particular area.

22. **Who may I call to obtain further information on insurance in Florida or to issue a complaint about my insurance company?** [back to top](#)

The Florida Department of Insurance has established a HELP LINE. The phone number is 1-800-342-2762.

23. **What happened to the Florida Sinkhole Research Institute (FSRI)?** [back to top](#)

The Florida legislature discontinued FSRI's funding in the early 1990's, and its database was transferred to the Florida Geological Survey(FGS). A brief history is outlined below.

Since its inception in 1907, the Florida Geological Survey has gathered data on Florida karst (sinkholes, caves, springs, etc.) This information is primarily used to more fully understand the unique relationship between karst and the state's groundwater resources and aquifer systems.

In 1982, the Florida Sinkhole Research Institute was created at the University of Central Florida in Orlando. At that time all FGS sinkhole data files were transferred to the FSRI. One of their programs was to compile and tabulate this information and convert it to a computer database. When the Florida legislature discontinued FSRI's funding in the

early 1990's, the FSRI nearly ceased operations entirely. After that the database was returned to the FGS and reformatted. Selected portions of the reformatted data were published in 1994 as FGS Open File Report 58, "FLORIDA SINKHOLE INDEX." The data is currently available in a MS Excel spreadsheet format via the FGS Internet web site. As for FSRI, they are still located at the University Of Central Florida (UCF) and their current director is Dr. Shiou-San Kuo. He can be reached at UCF's Department of Civil and Environmental Engineering at (407) 823-2280.

To better understand karst processes and the features associated with it, the FGS published Special Publication 29 (<http://fulltext.fcla.edu/cgi/t/text/text-idx?c=feol&idno=UF00000145&format=pd>) The author, Mr. Ed Lane, did an excellent job of explaining the various aspects of Florida Karst in an easy to understand manner for the non-scientific community, and as a tool for teachers to use in the classroom. Other FGS publications that discuss karst in Florida include QFR-58, mentioned above, and Map Series 110, at <http://www.dep.state.fl.us/geology/geologictopics/sinkholedevelopment.htm> which explains sinkhole types, their distribution and development.

The 1992 Florida Legislature mandated that a study of sinkhole insurance issues be conducted. The study was completed by the Florida State University Center for Insurance Research, under the direction of the Florida Department of Insurance. The report, Insurance Study of Sinkholes, was submitted to the Department in December of 1992 and subsequently to the appropriate Legislative Committees.

Two chapters of that report were reproduced by the Florida Geological Survey as Open File Report 72 (viewable online at: <http://fulltext.fcla.edu/cgi/t/text/text-idx?c=feol&idno=UF00003727&format=pdf>), in response to interest from governmental agencies, the public, and the professional community. Chapter V, deals with "Claims Standards." It was determined during the course of the study that a listing of typical standards used by Professional Geologists or Professional Geotechnical Engineers was needed to offer guidance regarding what a competent geological assessment of a site should consider to determine if karst processes are responsible for observed features. Chapter V is entitled "Examination of the Establishment of Minimum Standards for the Evaluation of Sinkhole Claims."

Chapter VI addresses the States need for an ongoing research resource to understand and characterize sinkhole occurrences and to create a central clearinghouse for the collection of sinkhole data and for its dissemination to the public. The Chapter entitled "Need for an Ongoing Research Resource" includes input from four state university geology departments and the Florida Geological Survey.

The intention of the reproduction of these chapters into an Open File Report was to make it easier for the public to obtain the results of the "Sinkhole Standards Summit" which was organized by the authors and attended by geologic experts from throughout the state. Their resulting consensus is presented in Chapter V of the report. This and all of the FGS publications are available at selected libraries throughout the state or from our library at the address shown below.

FGS staff are on call at all times to receive calls from the State Emergency Warning Point, which is part of the Department of Community Affairs. The Warning Point acts as a clearinghouse for emergency situations of all types including sinkhole activity throughout the Florida. Additionally, selected members of the FGS staff respond to a multitude of requests from the public, state and federal agencies, and consultants regarding sinkhole development or potential.

Miscellaneous Questions

1. How do I find information on jobs with the Florida Geological Survey or the State of Florida?
2. What publications or maps may I obtain from the Florida Geological Survey?

3. How may I order publications or maps from the Florida Geological Survey?
4. Where can I buy topographic maps for Florida?
5. What is the lowest point in Florida?
6. What is the highest point in Florida?
7. Can a geologist look at a rock or fossil I have found and identify it for me?
8. Can you test the soil from my garden or give me information on the soils in my area?

Miscellaneous Questions Answered

1. **How do I find information on jobs with the Florida Geological Survey or the State of Florida?**

All jobs with the State of Florida, including those with the Florida Geological Survey, are posted on the web. The statewide website for employment with the state is located at <http://www.myflorida.com/dms/hrm/myflorida/statejobsearch.html>

2. **What publications or maps may I obtain from the Florida Geological Survey?**

Go to the FGS [homepage](#) and click "List of Publications" you will find it on the right, in the Quick Links box. Read the directions on that page before opening the List of Publications.

3. **How may I order publications or maps from the Florida Geological Survey?**

Go to the FGS [homepage](#) and click "List of Publications" you will find it on the right, in the Quick Links box. After reaching the list of publications download page click on the blue box that says "Order Form & Ordering Instructions".

4. **Where can I buy topographic maps for Florida?**

These maps are available from the United States Geological Survey (USGS). Go to the USGS homepage at <http://www.usgs.gov/> and click "Publications" and then click "USGS Store".

5. **What is the lowest point in Florida?**

The lowest point that is exposed in Florida is sea level.

6. **What is the highest point in Florida?**

The highest point in Florida is 345 feet above sea level. It is located on a hilltop south of Lakewood in Walton County.

7. **Can a geologist look at a rock or fossil I have found and identify it for me?**

Yes, you may personally bring the specimen to our facility located in the Gunter Building at 903 West Tennessee Street, Tallahassee, Florida (here is a [map to the FGS](#)). Please contact us before you plan to visit because staff availability varies due to fieldwork. You may also send us a sample for examination by mail ([FGS address](#)). Again, please contact us by phone or e-mail so that we can refer you to the most appropriate staff member. You may then send the sample directly to the attention of the person who will work with it and arrange for its return.

8. **Can you test the soil from my garden or give me information on the soils in my area?**

Soils information is available from the United States Natural Resources Conservation Service at their web site

<http://www.nrcs.usda.gov/> If you need information specific to your area click "Find a Service Center".

Contacts and Links for Information and Assistance [back to top](#)

- » Alachua County Environmental Protection Department (352) 264-6800 <http://environment.alachua-county.org>
- » Florida Geological Survey (850) 488-9380 <http://www.dep.state.fl.us/geology/>
- » Northwest Florida Water Management District 850-539-5999 <http://www.state.fl.us/nwfwmd/>
- » Florida Department of Environmental Protection, Northwest District Office (850) 595-8300
<http://www.dep.state.fl.us/secretary/dist/nwdist.htm> (for sinkhole-related environmental resource permits in the panhandle)
- » St. Johns River Water Management District - (386) 329-4500 <http://sjr.state.fl.us>
- » Florida Department of Environmental Protection Northeast District Office (904) 807-3300
<http://www.dep.state.fl.us/secretary/dist/nedist.htm> (for sinkhole-related environmental resource permits in the northern peninsula).
- » South Florida Water Management District - (561) 686-8800 <http://www.sfwmd.gov>
- » Southwest Florida Water Management District - (352) 796-7211 <http://www.swfwmd.state.fl.us>
- » Suwannee River Water Management District - (904) 362-1001 <http://swrmd.state.fl.us>

903 W. Tennessee Street Tallahassee, Florida 32304 850-488-4191 (phone) 850-488-8086 (fax)
[Contact Us](#)

[DEP Home](#) | [About DEP](#) | [Contact Us](#) | [Search](#) | [Site Map](#)

Last updated: January 04, 2006

APPENDIX 4

Special Publication No. 57

Geological and Geotechnical Investigation Procedures For Evaluation of the Causes of Subsidence Damage In Florida



**Florida Geological Survey
Special Publication No. 57**

2005

Cover Photographs

Upper left – Winter Park Sinkhole, 1981

Upper right – Bartow, Florida, 1967

Lower left – Bartow, Florida, 1967

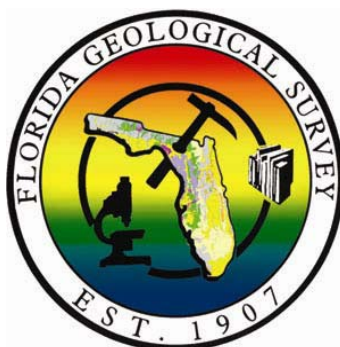
Lower right – Taylor County, 1967

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Colleen M. Castille, *Secretary*



DIVISION OF RESOURCE ASSESSMENT AND MANAGEMENT
Edwin J. Conklin, *Director*

FLORIDA GEOLOGICAL SURVEY
Walter Schmidt, *State Geologist and Chief*



SPECIAL PUBLICATION NO. 57

**Geological and Geotechnical Investigation Procedures
For Evaluation of the Causes of Subsidence Damage
In Florida**

Compiled by Walt Schmidt

Published by the
Florida Geological Survey
Tallahassee, Florida
2005

Florida Geological Survey

Tallahassee, 2005

ISSN 0085-0640

PREFACE



FLORIDA GEOLOGICAL SURVEY

Tallahassee, Florida
2005

The Florida Geological Survey (FGS), Division of Resource Assessment and Management, Department of Environmental Protection, is publishing as Special Report No. 57, *Geological and Geotechnical Investigation Procedures For Evaluation of the Causes of Subsidence Damage in Florida*.

This report is a consensus compilation from twenty six professionals who participated in Sinkhole Summit II, a meeting to discuss said issues. The meeting was initiated by the FGS to solicit input as the agency prepared input to assist the Florida State University, College of Business in preparing a report to the Florida Legislature in response to Chapter 627.7077 Florida Statutes. This report should assist the insurance industry, geologic and geotechnical consultants, government agencies, property owners, and the public, in providing a template for sinkhole investigations protocols.

Walter Schmidt, Ph.D.
State Geologist and Chief
Florida Geological Survey

CONTENTS

	Page
Background	1
Sinkhole Summit II, September 28, 2004	2
Introduction	3
Discussion	4
Current Florida Statutes Covering Sinkhole Insurance	5
Subsidence Investigation Protocols	7
Use of Professional Judgment	7
Professional Qualifications	7
Professional Practice	8
Initial Data Gathering	8
Geophysical Site Characterization	11
Floor Mapping	14
Subsurface Geotechnical Testing & Geological Interpretations	15
Laboratory Testing	19
Structural Inspection	20
Final Report	21
Retention of Samples and Data	22

Geological and Geotechnical Investigation Procedures For Evaluation of the Causes of Subsidence Damage In Florida

A Report Submitted to the Florida State University, College of Business, Department of Risk Management and Insurance, In Response to Requirements of Chapter 627.7077 Florida Statutes

Compiled and Prepared by

Walter Schmidt, P.G. #1

With contributions from the participants of *Sinkhole Summit II*, November 2004

Background

In 1992, the Florida Geological Survey (FGS) hosted a “*Sinkhole Summit*” in response to legislation that requested the Florida State University (FSU) Center for Insurance Research, under the direction of the Florida Department of Insurance to address numerous issues dealing with insurance coverage of sinkhole damages. One small part of that effort dealt with listing what competent professionals do to determine if karst processes are the likely or probable cause of observed damage. In addition, the legislation requested input on recommendations for a continuing research facility on sinkhole science. Our summit was a brainstorming and consensus building session among a cross-section of Professional Geologists, Geotechnical Engineers and other associated experts to compile such a listing and address the questions. A summary of those deliberations were included in the final legislative report, and those specific sections were reproduced by the FGS as Open File Report No. 72, titled: *Geologic and Geotechnical Assessment for the Evaluation of Sinkhole Claims* (available on line, see FGS web site - <http://www.dep.state.fl.us/geology/>), list of publications).

This past legislative session (2004) the Florida Legislature again requested an assessment of insurance coverage in response to sinkhole damage, and a study was requested to be done by the FSU College of Business, Department of Risk Management and Insurance, in consultation with the State Board of Administration and the Florida Geological Survey to provide recommendations on the feasibility of creating a “*Sinkhole Insurance Facility*,” and to recommend “*uniform standards*” for the insurance industry to evaluate sinkhole loss claims; to analyze the potential for the facility to provide training and educational services to the public, engineers, and others; and to maintain a public database for confirmed sinkholes and paid sinkhole loss claims (among numerous other things, see Chapter 627.7077 Florida Statutes). FSU is to provide their report to the Financial Services Commission and the presiding officers of the Legislature. To assist FSU in this regard, the FGS convened “*Sinkhole Summit II*” to essentially update the 1992 effort and to offer our professional guidance responding to these requests for analysis from the Legislature. Many technologies and the understanding of subsurface karst processes have advanced during the last twelve years since the first Summit, and a modern update is in order. The FGS has numerous licensed professional geological staff with a vast knowledge and experience base with which to compile such a summary. Nevertheless, our desire was to gather a group of experts in one place to discuss the currently accepted practices used by the professional geoscience community, and compile a listing of those technologies and activities a competent professional would utilize in an assessment of a site to determine if karst processes are present or responsible for observed features. On August 27, 2004, ASC

FLORIDA GEOLOGICAL SURVEY

Geosciences, Inc. convened a one-day specialty seminar in Tampa, Florida titled: “Sinkholes in Florida.” This meeting was a gathering of geologist’s, engineers, insurance and legal experts to discuss various aspects of sinkhole assessment, remediation and insurance claims in Florida. The FGS participated in this seminar, and announced at the meeting our desire for interested parties to contact the FGS regarding our solicitation for assistance in responding to FSU for the recently passed law, and the upcoming *Sinkhole Summit II*. We held the *Sinkhole Summit II* in the conference room of the FGS Headquarters at the Gunter Building in Tallahassee on September 28th, 2004. Twenty five professional geologists, geotechnical engineers, geoscience policy experts, and others representing private industry / consultants, regional, state and federal governmental agencies, academia, and agency insurance program experts participated either in person or through subsequent comments and editorial input. This report represents a compromise product from the FGS staff and the invited experts.

Sinkhole Summit II September 28, 2004

Prior to gathering in Tallahassee, State Geologist, Dr. Walt Schmidt prepared and distributed a tentative agenda and a draft outline of generalized standards, concepts, and subjects intended for more detailed discussion and expansion during the meeting. Several professionals within the FGS involved with karst processes and hydrogeology, and those from outside agencies or private organizations were asked to offer suggestions or submit other alternative outlines or existing documents they were aware of which deal with geoscience / geotechnical engineering aspects of sinkhole investigations. One such document was submitted by Dr. Sam Upchurch, with SDII Global Corp., Tampa, FL. Upon review of the initial outline prepared by Dr. Schmidt and the more detailed document submitted from SDII Global, all agreed the more detailed report submitted by Dr. Upchurch was a document which had already addressed most of the issues that we anticipated were in need of inclusion in a report the FGS was intending to compile. We agreed to go through this document section by section and review and edit as appropriate for our purposes. The SDII Global Corp. document is titled: *Summary of Suggested Investigation Procedures For Evaluation of the Causes of Subsidence Damage To Residences*, by Sam B. Upchurch, SDII Global Corporation, 4509 George Road, Tampa, FL 33634, September 7, 2004, 12 p.

Sinkhole Summit II participants either in person at the meeting or providing subsequent commentary:

Dr. Walt Schmidt, PG, FGS (Chief & Florida State Geologist), Chairman
Mr. Mike Bascom, PG, Coordinator DEP Springs Initiative
Mr. Richard Benson, PG, Technos Inc. (President)
Ms. Paulette Bond, PG, FGS
Dr. Rick Copeland, PG, FGS
Dr. Richard Corbett, FSU College of Business
Dr. Rodney DeHan, Groundwater Research Scientist, FGS
Mr. David Fisher, Sinkhole Ombudsman, Florida Dept. of Financial Services
Mr. Tony Gilboy, PG, Manager, Southwest Florida Water Management District
Mr. Tom Greenhalgh, PG, FGS
Dr. Tom Herbert, PG, Lampl-Herbert, Inc.

Dr. Tom Kwader, PG, URS Corp. (Vice President, Senior Consulting Hydrogeologist)
Ms. Kathy McDonald, PG, Subsurface Evaluations, Inc.
Dr. Pat Maroney, Esq., FSU College of Business
Dr. Tom Missimer, PG, Missimer Groundwater Science, Inc.
Mr. Sandy Nettles, PG, N.S. Nettles & Associates, Inc.
Dr. Tony Randazzo, PG, Geohazards, Inc. (past Chair & Professor Emeritus UF Geology Dept.)
Mr. D.S. Saxena, PE, ASC Geosciences, Inc. (President and Senior Consultant)
Dr. Tom Scott, PG, FGS, Assistant State Geologist for Geologic Investigations.
Dr. Doug Smith, PG, Geohazards, Inc. (Professor Emeritus, UF Geology Dept.)
Mr. Steve Spencer, PG, FGS (State Sinkhole Database oversight)
Dr. Mark Stewart, PG, Professor (past Chair) USF Geology Department
Ms. Ann Tihansky, Hydrologist, U.S. Geological Survey, Tampa
Dr. Sam Upchurch, PG, SDII Global Corp. (past Chair, USF Geology Dept.)
Mr. Mike Wilson, PE, Ardaman & Associates
Ms. Lynn Yuhr, PG, Technos Inc. (Vice President)
Also observing the discussion on September 28th was Ms. Kelly Kubiak an attorney with Gunn-Merlin, PA.

Introduction

As was the case in 1992, there are still inconsistencies across geological and geotechnical engineering firms in the identification and cause of subsidence features observed impacting structures. Hence the Legislative request for another analysis. Our group was in agreement with the findings of the first Sinkhole Summit, in that the most recent discussions, again found the following:

1. Ideally, at least *two topical areas of professional expertise may be needed* for a complete and comprehensive assessment of any subsidence feature to determine if a sinkhole is the likely reason for the observed damage and if the structure remains safe or is salvageable. These include: a Professional Geologist or a Professional Geotechnical Engineer qualified in Geology, and where appropriate, a Professional Structural Engineer could be warranted by circumstances.
2. A stringent “standardized cookbook” approach is not feasible, because there is too much variability of local geology. Professional judgment must be allowed using the various professional tools available and the expertise of the professional. These various technologies, however, must be utilized in a competent manner along with routine professional care in making reasonable interpretations. There can be a *generalized listing of the steps, processes and tools* a competent professional would utilize or consider in carrying out such an investigation. These “protocols” are included later in this report.
3. It was also agreed by the group that a *Florida Sinkhole Insurance Facility* (as named in the legislation), should include an educational outreach component to assist Insurance adjusters with these difficult decisions, and to provide continuing education for Professional Geologists and Engineers in these agreed upon “standards” or “protocols.” Leaflets, workshops and seminars could be conducted to continually update and inform

FLORIDA GEOLOGICAL SURVEY

the professional community and provide outreach to the public. Such a facility could also coordinate and support the geoscience and geotechnical research needed to respond to and answer the continuing questions involving sinkholes. There are still many unresolved scientific questions, such as; where do sinkholes occur and can they be predicted? What kind of processes both natural and human-induced triggers these events? What kind of frequency do we see and what is this related to? Can any correlation be developed between hydrologic conditions and sinkhole occurrences? What technologies or tools are available to begin to address these concerns? Are there correlations with whether a sinkhole claim is paid or not and how the site investigation was carried out? Our group pointed out, **any such facility needs a permanent funding appropriation to be able to maintain a long-term functioning program.**

4. It was further agreed by the group that a public database should be maintained and made available to all interested parties. This currently exists at the Florida Geological Survey; however, their program does not have the staff or funding to perform site specific ground truthing for quality control of the data. Nor is there any current law or requirements to submit this data to the FGS. The FGS currently receives voluntary cooperation from many interested agencies (including County Emergency Management agencies) and private sector entities, but only a small fraction of the total sinkhole inventory is captured. In fact, significant amounts of data are purposely not made available to the public database for various reasons. Participants of *Sinkhole Summit II* voiced the importance of insuring that geologic and geotechnical investigations reports must be submitted to the public database and made available to the geoscience / engineering community in order to increase our understanding of the causes of sinkhole occurrences. A standardized or uniform form should be developed that would be a mandatory submittal. The FGS currently has such a form available to be submitted electronically, however, as noted above there are no requirements to use it or even to submit any records at all. With a more complete and meaningful database, the professional community can develop more effective ways to recognize and assess sinkhole risks and advise policy makers, land-use planners, the construction industry, home owners, and insurers to minimize loss and conserve and protect Florida's natural resources.

Discussion

In recent years, reports developed by consultants retained for subsidence investigations by the insurance industry and by property owners or their representatives have become more and more comprehensive, largely because of their use as evidence in litigation. Several of Florida's largest property insurance companies have developed formal or implied guidelines for sinkhole investigations. SDII Global prepared a summary of these guidelines for consideration of the Sinkhole Summit II participants. This report utilized that document as a starting point for our discussions and consensus final report.

It is important that all consultants or other professionals who perform this service produce thorough, unbiased, scientifically credible, evaluations as to the cause(s) of the damage that has resulted in a sinkhole claim. These guidelines are intended to ensure that the procedures followed by any geological consultants investigating sinkhole claims in Florida are thorough and consistent. The protocols are intended to ensure that sufficient information is gathered to assist

in sinkhole claim evaluation and that standard methods that can withstand the evidentiary competence tests required for admission in state and federal court. It is the ultimate responsibility of the professional consultant to decide upon the steps necessary to complete an unbiased and scientifically competent investigation that is sufficient to detect sinkhole activity. Professional Engineers are licensed under Chapter 471 Florida Statutes, and Professional Geologists are licensed under Chapter 492 Florida Statutes. Both professions are regulated by Gubernatorial appointed Boards that oversee their respective profession, insure minimum competencies of their respective licensees and administer discipline.

The protocols provided herein are intended for the use of geological and geotechnical consultants to assist in standardizing subsidence claim investigations. These procedures are not intended to replace site-specific activities that reflect good professional geological practice and judgment. They are, however, offered as guidelines to assist in developing sufficient information to confirm the cause(s) of subsidence-related damage to a structure. These guidelines are listed in the sequence that typically should be followed, where possible.

Current Florida Statutes Covering Sinkhole Insurance

To eliminate some of the historical causes for confusion and poor understanding regarding the existing definitions and suggested sinkhole investigation standards currently found in the Florida Statutes, participants of *Sinkhole Summit II* recommend the following changes.

627.706 Sinkhole insurance.--

- (1) Every insurer authorized to transact property insurance in this state shall make available coverage for insurable sinkhole losses on any structure, including contents of personal property contained therein, to the extent provided in the form to which the sinkhole coverage attaches.
- (2) "Loss" means structural damage to the building. Contents coverage shall apply only if there is structural damage to the building.
- (3) "Sinkhole loss" means actual physical damage to the property covered arising out of or caused by ~~sudden~~ settlement or collapse of the earth supporting such property only when such settlement or collapse results from naturally occurring subterranean voids created by the action of water on a limestone or similar rock formations.
- (4) Every insurer authorized to transact property insurance in this state shall make a proper filing with the office for the purpose of extending the appropriate forms of property insurance to include coverage for insurable sinkhole losses.

History.--s. 2, ch. 81-280; s. 809(2nd), ch. 82-243; s. 79, ch. 82-386; s. 114, ch. 92-318; s. 8, ch. 2000-333; s. 1189, ch. 2003-261.

This proposed change reflects the lack of clarity of the term "sudden." Sinkholes may occur catastrophically and instantaneously, or on a sustained basis (imperceptibly over night, over weeks, a season, over years, or over dozens of years). Any and all can destroy a structure. Some observed features of a slow sinkhole may not be visible for some time after initial movement. The point is to identify a loss due to a sinkhole, the timing is generally not quantifiable, and the

FLORIDA GEOLOGICAL SURVEY

term sudden is not defined or generally applicable, as a result it has been defined as needed, causing constantly changing interpretations of the word. “Sudden” should either be deleted or replaced by “sudden and/or sustained.” The term “naturally occurring” is proposed to modify subterranean voids, to clarify the legislative intent to deal with sinkhole loss caused from continuing geologic processes that occur throughout Florida. It is intended to eliminate the heretofore included categories of collapse from anthropogenic causes such as but not limited to; subsurface construction debris compaction, water line or sewer line collapse or leaks, tree stumps decay, past mining activities, or poorly designed wells.

627.707 Minimum standards for investigation of sinkhole claims by insurers; nonrenewals.--

(1) Upon receipt of a claim for a sinkhole loss, an insurer must meet the following minimum standards in investigating a claim:

(a) Upon receipt of a claim for a sinkhole loss, the insurer must make an inspection of the insured's premises to determine if there has been physical damage to the structure which may constitute a sinkhole loss ~~might be the result of sinkhole activity~~.

(b) If, upon the investigation pursuant to paragraph (a), the insurer discovers damage to a structure which is consistent with a sinkhole loss activity or if the structure is located in close proximity to a structure in which sinkhole damage has been verified, then prior to denying a claim, the insurer must obtain a written certification from an individual qualified to determine the existence of a sinkhole loss activity, stating that the cause of the claim is not a sinkhole loss activity, and that the analysis conducted was of sufficient scope to eliminate a sinkhole activity as the cause of damage within a reasonable professional probability. The written certification must also specify the professional discipline and professional licensure or registration under which the analysis was conducted.

(c) If the insurer obtains, pursuant to paragraph (b), written certification that the cause of the claim was not a sinkhole activity, and if the policyholder has submitted the sinkhole claim without good faith grounds for submitting such claim, the policyholder shall reimburse the insurer for 50 percent of the cost of the analysis under paragraph (b); however, a policyholder is not required to reimburse an insurer more than \$2,500 with respect to any claim. A policyholder is required to pay reimbursement under this paragraph only if the insurer, prior to ordering the analysis under paragraph (b), informs the policyholder of the policyholder's potential liability for reimbursement and gives the policyholder the opportunity to withdraw the claim.

(2) No insurer shall nonrenew any policy of property insurance on the basis of filing of claims for partial loss caused by sinkhole damage or clay shrinkage as long as the total of such payments does not exceed the current policy limits of coverage for property damage, and provided the insured has repaired the structure in accordance with the engineering recommendations upon which any payment or policy proceeds were based.

History.--s. 1, ch. 92-146; s. 4, ch. 93-401.

These proposed modifications reflect the need to clarify a loss due to a sinkhole. Sinkholes are features that intersect the land surface, potentially impacting structures located and built on

near-surface, shallow geologic materials, including soils, sediments, rock, and fill. The depth of origin of the void caused by dissolution of limestone or other soluble geologic material varies with the local stratigraphy and hydrogeology. Solution action on subsurface limestones is present throughout all of Florida and can be found at most locations at depth. The term “sinkhole activity” has been used to suggest that subsurface, dissolution related features distant in terms of geographic vicinity or depth from the structure in question represent the process that has caused damage to the structure. This is not the case until the movement of geologic materials into the solution feature, void or cavern phenomena are near enough to the surface to cause a sinkhole loss. Instances of subsurface solution activity cannot be quantified with some threshold of depth, distance, and magnitude in order to qualify as a possible source of distress at the surface. This suggested statute wording change is to provide clarity and eliminate erroneous interpretations of distant, subsurface karst activity as reflecting a sinkhole loss at the land surface. The majority of participants in the *Sinkhole Summit II* feel this is an important point, and recommend this statute change be suggested to the Legislature.

Subsidence Investigation Protocols

[These procedures are not intended to be a sequential “cookbook” for the investigation of sinkholes. Listed here are various options / techniques available to the professional to chose. Appropriate decisions are site specific and based on circumstances, economics, time available, and other parameters.]

1. Use of Professional Judgment

- a. These guidelines are intended to standardize subsidence investigations initiated to determine the presence of a sinkhole loss as defined in the Florida Statutes.
- b. The professional investigator has the final responsibility for determining the specific procedures and amount of data necessary to complete the investigation in accordance with their professional license obligations and the requirements of §627.707 F.S.
- c. Modifications of these methods or procedures, reflecting appropriate professional judgment, should be documented and justified.
- d. These protocols are intended to be a comprehensive listing and brief discussion of those methods and procedures professionals have at their disposal to carry out such an investigation. Clearly site specific circumstances and economic capabilities of site owners must be reasonably weighed to determine what constitutes an adequate assessment to render a defensible interpretation. This is the call of the experienced professional carrying out the project. The goal is to minimize uncertainty in the final interpretation while maintaining a reasonable cost / benefit ratio.

2. Professional Qualifications

- a. Professional engineering and professional geology firms are required to hold

FLORIDA GEOLOGICAL SURVEY

Certificates of Authorization under Chapter 492 F.S. (geology) or Chapter 471 F.S. (engineering) to practice in the State of Florida. Similarly the individual professional consultant who performs subsidence investigations and who signs and seals work for geological or engineering firms, or practicing independently, must be licensed to practice as either a Professional Engineer qualified in geology, or a Professional Geologist in the State of Florida. Professionals doing work only for their parent company and others employed as teachers or instructors also must comply with these licensing requirements if such work is to be submitted to a government agency for public record.

- b. The professional consultant should be expected to provide evidence of training and experience in identifying subsidence caused by sinkholes, expansive clays, organic-rich soils, slope stability, and other processes that cause subsidence. Appropriate training and expertise in the various subspecialties listed in these protocols should also be identified.

3. Professional Practice

- a. At the conclusion of the investigation the professional will render an opinion within a reasonable degree of scientific or engineering probability as to the cause(s) of the damage in a professionally signed and sealed report.
- b. It is not sufficient to simply rule out a sinkhole loss. The most reasonable cause of damage must be presented with supporting data.
- c. ASTM or other published standard methods should be utilized wherever possible as appropriate based on professional judgment (i.e. standard geologic and geophysical field methods).

4. Initial Data Gathering

- a. Background Data Collection - To the extent possible, it is recommended that the following information be obtained in order to better design and execute a subsidence investigation.
 - i. Regional / local geomorphology, areal extent of nearby geologic features, depth to competent rock, and lithologic, stratigraphic, and hydrogeologic characteristics of strata likely to be present at the site,
 - ii. Site elevation, topography, and drainage features as observed on relevant USGS 1:24,000 topographic quadrangle maps of the vicinity, supplemented by smaller scale, more detailed of same if available,
 - iii. Soil conditions as reported in the county soil survey,
 - iv. Nearby historic sinkholes as available from the FGS sinkhole

SPECIAL PUBLICATION NO. 57

database, local agencies, and private vendors (many are accessible on-line),

- v. Historic aerial photographs that depict features that may represent sinkholes, wetlands, previous land uses, or other relevant features applicable to the site vicinity. It is important to keep in mind semi-circular depressions, wetlands, and other features observed on aerial photographs or other remotely sensed images may not always be sinkhole or karst features. Without ground truthing, these features must be treated as indicators, not proof of the existence of possible nearby sinkholes.
- vi. Relative elevations of the surficial, intermediate, and/or Floridan aquifer system potentiometric surfaces as represented in current water management district or U. S. Geological Survey (USGS) maps, and elevations of surface water bodies in the vicinity of the site. Significant rainfall events that preceded the sinkhole loss date should be noted.
- vii. Date of construction of the structure, notations of any additions, and other relevant information as obtained from the county property appraiser's web sites or owner (reference the source).

b. Preliminary Site Inspection

- i. An interview with the owner(s) or owner representative(s)
 - 1. Nature and extent of the damage to the structure,
 - 2. Timing of damage,
 - 3. Presence of additions to the building,
 - 4. Nature and timing of any previous repairs,
 - 5. Any known buried debris, removed tree stumps, old wells, etc., and
 - 6. Information concerning other sinkhole claims in the immediate neighborhood of the site,
- ii. Inspection of the grounds and immediate vicinity
 - 1. Suspicious land surface features,
 - 2. Overhanging trees and roots,
 - 3. Land slopes,

FLORIDA GEOLOGICAL SURVEY

4. Retaining walls,
 5. Water bodies, recent changes in hydrologic conditions (rainfall events, changes in potentiometric level, nearby pumping centers?) and,
 6. Utilities.
- iii. Detailed photographs of the structure from all sides and of the observed damage / distress, including a sketch map showing the locations of damage and photographs, and
 - iv. Access issues for subsequent geophysical and geotechnical evaluation activities.
- c. Organize the Results of the Preliminary Site Inspection in the form of field notes
- i. A sketch map drawn to scale and photographs showing locations of damage to the structure in sufficient detail and dated that they can be identified at a later time.
 - ii. Maximum widths of cracks (where measured and location information, or photo location details).
 - iii. Land slope, depressions, soil erosion, stressed vegetation, and water features.
 - iv. Evidence of past or present stress to neighboring structures, driveways, streets, and retaining walls. Document trees, fences, or retaining walls that lean down slope.
 - v. Locations of septic tank, pool, gutters and downspouts, drainage ways, buried utilities, on-site water wells, and other hydrologic features.
 - vi. Results of owner interview including past performance of the structure and history and timing of the damage.
 - vii. Information concerning
 1. Site flooding concerns or areas of historic flooding.
 2. Proximity to wellfields or other ground-water extraction facilities,
 3. New construction in the area (especially involving heavy equipment and/or blasting), and

4. Locations of nearby sinkholes or neighbors who have filed sinkhole claims, or sinkholes known to have been filled. Locations of houses or other structures that have been remediated because of a sinkhole loss. Determine if nearby structures on adjacent property have been grouted. Collect dates if available.

5. Geophysical Site Characterization

- a. Concurrent with or following the site reconnaissance. Surface geophysical methods should be used (in most cases) to characterize subsurface geology, identify anomalous subsurface conditions, and to provide guidance in selecting locations for invasive tests such as trenches, borings, etc.
- b. The investigation method or methods selected should be sufficient to allow interpretation to be able to discern shallow conditions that are likely to have directly affected the structure in order to conform to the definition of “sinkhole loss” contained in §627.706 F.S.
- c. When making field measurements, it is highly recommended that more than one set of data be used to aid in an interpretation. When two or more sets of different data agree, there is a higher degree of confidence in the results and the associated interpretation. For example, if a Ground Penetrating Radar survey indicates the presence of broken dipping strata and a test boring placed in the center of the anomaly identifies very loose sediments or voids; we can have a high degree of confidence in the interpretation of the presence of an active sinkhole.
- d. Applicable geophysical investigation methods which may be useful include;
 - i. Ground penetrating radar (GPR, including 3D-GPR),
 - ii. Electrical resistivity soundings or profiling (ER),
 - iii. 2-D Multi-electrode resistivity (2DER or MER),
 - iv. Capacitive-coupled resistivity (CCR, Ohm-Mapper),
 - v. Micro Gravity survey (MGS),
 - vi. Magnetometer, Metal Detector, or EM31 measurements (often used to identify buried utilities which may impact other geophysical measurements),
 - vii. Surface Wave measurements including Multispectral Analysis (MASW) and Spectral Analysis (SASW),
 - viii. Choice of geophysical method and data reduction techniques should be in accordance with relevant ASTM or other accepted methods and chosen as

FLORIDA GEOLOGICAL SURVEY

appropriate based on local stratigraphy, hydrogeology, terrain, and cultural features. The spatial coverage of surface geophysical data should be sufficient to extend beyond the boundary of the possible sinkhole affected area. The data density should be close enough to define small localized sinkhole conditions. As one example, see ASTM Standard Guide for Selecting Surface Geophysical Methods D 6429-99.

- ix. There are other geophysical methods and technologies that are not typically used for shallow subsurface investigations; however they could have application in certain cases. Some of them are: Time-Domain Electromagnetic (TDEM) Surveys, Transient Electromagnetic (TEM) Soundings, Induced Polarization (IP), Seismic Refraction, Seismic Reflection, several cross-hole geophysical methods, and numerous remote sensing techniques. There may be other appropriate methods and new technologies are being developed by researchers continuously. If new technologies are utilized, they should be thoroughly documented in order to establish their acceptance in the geological / geophysical community, validity, and reproducibility of the method.
- e. GPR is a commonly used method for Florida sinkhole investigations owing to its ability to resolve details of shallow soil and rock conditions. The main limitation of GPR is its site specific performance and the depth of penetration is limited by shallow clays, hardpan soils, or high conductivity pore fluids. Other methods can be used when they are appropriate to the problem and local subsurface geology. Note that electrical resistivity methods are less impacted by subsurface clays or groundwater quality; however, they are prone to unique interpretation problems when utilized in urban environments where conductive and/or resistive materials near buildings and other structures are present. Direct Current ER, however, has been shown to have depth capabilities much greater than GPR approaches. Also note CCR may have limited applications in Florida due to shallow water tables which yield higher conductivity reducing signal strength.
- f. Ground penetrating radar (GPR) – has best application in dry sandy soil conditions (depth of penetration impacted by clay layers, hardpan soils, and groundwater quality).
 - i. A grid sufficient to ascertain near subsurface conditions should be designed by an experienced professional. Typically a maximum of an approximate 10-foot grid within the affected property is considered adequate.
 - ii. Include the interior of the structure, where appropriate.
 - iii. Identify affected areas on a site map for placement of subsurface tests (soil borings or soundings). The choice of boring location within an anomaly should consider proximity to the damaged structure and any significant surface or subsurface features located within an anomaly.

- iv. A shielded antenna should always be used to avoid interference from overhead and metallic objects. GPR instrumentation conditions, including the frequency of the antenna used, time settings, and other relevant parameters, should be included in the report.
- g. Electrical resistivity methods – can be especially useful where there is shallow groundwater, hardpan soils, or shallow clays (but the method is not limited to such situations, in fact it can be applied to deep groundwater and clay-free subsurface environments).
 - i. Electrical resistivity soundings (ER)
 - 1. It is critical that the locations chosen for ER investigation be selected with cognizance of electrical interferences, such as fences, utilities, and the structure itself. All possible interference sources should be noted in the report and program design must account for such.
 - 2. If ER is utilized, it is recommended that the ER investigation be coupled with GPR data or a second independent data set (such as borehole data).
 - 3. All conditions of the testing, including electrode configuration(s), data reduction methods, and number of iterations required to produce the final interpretations, will be discussed in the report.
 - ii. Two dimensional electrical resistivity (2DER or MER)
 - 1. All conditions of the testing, including electrode configuration(s), data conditioning (removal of data points, etc.), data reduction methods, and number of iterations to produce the final depth section or other interpretative results, must be discussed in the report.
 - 2. It is critical that the locations chosen for these investigations be selected with cognizance of electrical interferences, such as fences, utilities, and the structure itself. Locations of potential interferences must be discussed in the report and accounted for in program design.
 - iii. Note that ASTM Standards D-6429, D6431-99, and G57-95a address various ER procedures and data acquisition procedures. These should be followed as appropriate or deviations noted and explained.
- h. Capacitively-coupled resistivity methods (CCR).
 - i. Generally limited use in areas with shallow water table. However, instrument can penetrate to greater depths if the near-surface materials are

FLORIDA GEOLOGICAL SURVEY

relatively resistant. Shallow groundwater increases the conductivity resulting in reduced signal strength. Subject to the same conditions as identified for 2DER testing cited above.

- i. All geophysical investigation reports should include:
 - i. Site maps showing locations of all measurements (stations, profile lines, traverses soundings or grids) along with all other data collection procedures and a discussion of why these locations were selected.
 - ii. Specific locations and interpretation of all anomalous areas.
 - iii. Uninterpreted raw-data should be included as appendices.
 - iv. Identify the limitations of the method, and any problems with data acquisition or data processing. Discuss any assumptions made or used as a precursor to interpreted results or data processing.
 - v. If the results of measurements are processed and interpreted by computer (i.e. data is entered into software and a cross section contoured by computer) provide other independent data or steps to verify or confirm the results.
- j. Because of the three dimensional aspects of sinkholes and other geologic hazards, every effort must be taken to ensure that the land surrounding the affected structure is adequately investigated, based on an understanding of the local and regional hydrogeology.

6. Floor Mapping (often a valuable tool to assist with the determination of structural causes of observed damage and could yield information corroborating or discounting a sinkhole as the likely cause)

- a. Used to identify locations where the structure's floor is depressed or elevated beyond tolerances allowed by the applicable Florida Building Code.
- b. Acceptable methods include (1) transit and stadia rod, (2) manometer, and (3) laser level.
- c. A base location that can be reoccupied for subsequent mapping should be identified in the report and be as permanent as possible.
- d. Care should be taken to minimize accumulation of error while moving the instrument, including use of closed loops or resection of "shot" points when utilizing transit or laser level.
- e. Accuracy of the survey measurements should be at least 0.01 foot.

- f. Differences in floor coverings should be accounted for.
 - i. Paired measurement points located at floor-covering transitions.
 - ii. Field notes should indicate the nature and thickness of floor coverings.
- g. Results reported through properly contoured map with accurate scale and elevation representations. The base location and transitions in constructed floor elevations (sunken rooms, elevated rooms, etc.) should be indicated.
- h. The results of the contour map should be compared to tolerances in floor elevation allowed by the building code prevalent at the time of construction of the structure.

7. Subsurface Geotechnical Testing & Geological Interpretations

- a. Locations of all boreholes, soundings, and other testing activities to be reported.
 - i. A control site or tie-back hole should be established for comparisons of anomalous results. In densely populated urban settings this may be difficult to access or not feasible due to overall scale of the feature vs. lot size.
 - ii. Discuss why each testing site or line was selected.
 - iii. Hole locations should be carefully located and measurements necessary to allow for relocation of the test holes should be indicated in the report.
- b. All soil testing procedures should follow ASTM methods or other published procedures. Again professional judgment prevails and should be explained.
- c. If there is more than one foot of relief on the site, a leveling device should be used to determine the relative elevations of each test hole. The benchmark used for these levels should be a permanent feature on the lot that can be easily located for future investigation.
- d. Dynamic penetration tests, such as; the Standard Penetration Testing (SPT), Baecher penetration test (BPT), and dynamic cone penetration test (DCPT).
 - i. SPT location criteria.
 - 1. Locations identified by the geophysical investigation as anomalous features.

FLORIDA GEOLOGICAL SURVEY

2. May choose to explore only those geophysical anomalies nearest the structure, preferably near areas of greatest damage with adequate justification.
 3. If no anomalies are detected or if the anomalies are distant from the damage identified during the initial site visit, locate the SPT tests in close proximity to the damaged portions of the structure.
 4. If sinkhole loss related geophysical anomalies or known or suspected sinkholes are distant, a SPT boring can be placed between the feature and the house in order to determine if the house has been affected by the processes that may have caused the remote feature.
- ii. Ensure that all potential subsurface causes of the damage are adequately characterized. Adequate characterization will include enough testing to reasonably confirm any subsurface cause(s) of the damage.
 - iii. Site and location specific drilling equipment (truck or trailer mounted models, hand augers, and tripod) should be used. The only rationale for not drilling where the cause of the damage is likely to be manifested should be human health and safety or inability to obtain legal access. These should be documented in the report.
 - iv. Utility location procedures should be followed to ensure the safety of drilling crews and others on site as well as the structure. Where local or state requirements exist for utilization of the services of utility location providers, they will be utilized. (note that utility location services will usually only work on public right-of-way and not on private property)
 - v. The boring materials recovered and their depths should be documented and described in the drilling log. It is recommended that these shallow soils be tested by a calibrated manual cone penetrometer in order to complete documentation of the relative strengths of materials encountered in the boreholes.
 - vi. All test holes should be backfilled or grouted in general accordance with applicable procedures established by the county or water management districts in Florida.
- e. Cone penetration tests - mechanical (CPT), electric CPT, piezocone (CPTU), seismic piezocone (SCPTU), resistivity piezocone (RCPTU) and horizontal stress cone (HSC). Location criteria same as for d. above.

SPECIAL PUBLICATION NO. 57

- i. Use of CPT soundings often is used because the data may assist with the indication of raveling soils.
 - ii. Conductivity tips are useful to determine the presence and continuity of a clay confining layer.
 - iii. All sounding locations should be located relative to landmarks so they can be identified at a later date.
- f. Auger Borings (hand, tripod, trailer, truck mounted, etc)
 - i. Advanced near the foundation for identification of soil depth and classification.
 - ii. A calibrated manual cone penetrometer is recommended for testing strengths of soils in the auger holes.
 - iii. All hand auger holes should be located relative to landmarks so they can be identified at a later date.
 - iv. If more than one foot of relief is present, the relative elevations of the borings should be determined by leveling.
 - v. It is recommended that a hand auger boring be advanced at each of the four primary corners of the structure and in any areas of concern, such as depressions elsewhere on the property.
 - vi. All holes created by auger boring will be properly filled.
- g. Manual Cone Penetrometer (CPT) Soundings
 - i. Used for determination of the relative strengths of soils near the foundation of the structure and in areas of concern.
 - ii. Hand penetrometers should be calibrated.
 - iii. Report results of the soundings, including units of soil strength measurement.
 - iv. Report whether the soil strengths determined by CPT were taken in hand auger borings or other excavations where side friction is minimal or in undisturbed soil.
- h. Foundation Test Pits
 - i. The consultant should attempt to obtain design documents from the owner or local building department if there is any question as to design elements in the foundation of the structure.

FLORIDA GEOLOGICAL SURVEY

- ii. If the foundation design and materials upon which the structure rests is unknown, at least one test pit should be dug in the vicinity of the most damaged part of the structure.
 - iii. It may be necessary for a qualified licensed engineer to supervise this activity to avoid exacerbation of the damage. A qualified engineer (geotechnical or structural) should prepare conclusions as to foundation issues based on the test pit and structural observations.
 - iv. Additional test pits may be required under the foundations of any additions to the structure. Appropriate backfilling must be done to insure foundation integrity.
- i. Ground-water Levels
- i. Depth of static water level should be measured in any hole where water is encountered. Elevation differences if present throughout the site or property should be noted and plotted. Where possible a water table map of the site, from this data should be prepared.
 - ii. If no groundwater is encountered, note in the log of each auger hole or piezometer reading.
- j. Reporting
- i. Boring logs should be prepared for all test holes (SPT, CPT, PCPT, hand auger, other test holes).
 - 1. These should include detailed soil or rock descriptions, including the Unified Soil Classification (ASTM D-2487 or -2488) and notation of mottling, bedding, small-scale lithologic variations, grain size range (gradation), and Munsell colors. Other scientifically accepted description methods can also be utilized. These should be appropriately referenced and defined. Examples include: *Field Book for Describing and Sampling Soils*, 2002, published by the National Soil Survey Center, U.S. Dept. of Agriculture; *Manual of Field Geology*, by R.R. Compton, published by Wiley & Sons, Inc.; and *Handbook for Logging Carbonate Rocks*, by D.G. Bebout, and R.G. Loucks, Handbook 5, Texas Bureau of Economic Geology.
 - 2. Terminology should conform to ASTM D-653 method or it should be defined and referenced within the report.
 - 3. Note the depth of any partial or total loss of drilling fluid circulation.

- 4. Note weight-of-rod or weight-of-hammer strength materials and voids will be noted in the boring logs. Note variable depth of bedrock.
- ii. Color photographs or soil samples should be taken of key soil conditions, such as the presence of debris or organics. Note whether sample is wet or dry when being photographed. A statement that roots were found is not sufficient to attribute the subsidence to decaying organics. If construction debris or other anthropogenic material is encountered, photograph sample materials to ensure adequate documentation.
- iii. If site relief is more than one foot, the graphic logs of the borings in the report should be placed in their relative vertical positions using the arbitrary datum used for leveling of their elevations.
- k. Soil / Sediment / Rock - Sample Containers
 - i. All soil, rock, or debris samples will be stored in properly marked, sealed containers in anticipation that they will be retained for long periods of time and are likely to be used as evidence.
 - ii. "Chain of custody" procedures should be established and followed.
- l. Other down hole testing.
 - i. Based upon professional judgment and site specific circumstances (structure size, economics, etc.) geophysical logging may provide useful information. This typically may include a natural gamma log and an induction (conductivity) log. See ASTM Standard Guide for Planning and Conducting Borehole Geophysical Logging D 5753-95.
 - ii. As above (site specific judgment), hole to hole Up-hole or Down-hole testing may be utilized in some cases to provide seismic P and Shear wave velocities or resistivity or radar data. For hole to hole seismic tests see ASTM Standard Test Methods for Cross-hole Seismic Testing D 4428/D 4428M-91.

8. Laboratory Testing

- a. If clay-rich strata are found within 20 feet of the land surface, the following laboratory tests are suggested:
 - i. A minimum of three samples should be tested according to these procedures.

FLORIDA GEOLOGICAL SURVEY

- ii. Atterberg limits.
 - iii. Percent natural moisture content.
 - iv. Gradation (grain-size) distribution information, including the fraction smaller than the 200-mesh U.S. Standard sieve.
 - v. It is recommended that the fraction smaller than the 200 mesh sieve should be determined to identify the percent silt and clay, and that a hydrometer test, or equivalent, be conducted to determine the percent smaller than 2 microns.
 - vi. If shrink / swell clays are suspected, an appropriate mineralogy test should be conducted. Typically this would be an x-ray diffraction interpretation. Alternatively elemental / chemical analysis also has use in this regard.
- b. If organic-rich soils are suspected or detected within the exploration depth, the natural moisture content and percent organics should be determined on representative samples. If “peat” is recovered, then a grain size distribution and composition description should be carried out on such samples.
- c. If debris, including natural wood fragments and construction debris, is detected and considered a possible cause of the damage, there is no need for laboratory testing.
- i. Document the nature and extent of the debris through samples and photographs that illustrate the size and make-up of the debris.
 - ii. Samples of the debris will be collected and retained (see below), where practicable.

9. Structural Inspection

- a. Many sinkhole claims may be the result of deterioration, construction defects or modifications in structures. Therefore, a qualified structural engineer should evaluate the damage that cannot be directly attributed to natural earth processes to ascertain the cause and origin of the damage and assess integrity of the structure.
- b. The engineering inspection should be in concert with the geoscience assessment and be of a sufficient scope for determination as to whether the damage is consistent with sinkhole activity or some other geological process, anthropogenic subsurface causes (buried utilities, etc.) , or any structural or construction related causes.
 - i. Structural issues of concern include compliance with the prevalent

building code at the time of construction,

- ii. The effects of modification of the structure, including building additions, changes in load- and non-load-bearing walls, and modifications of the foundation, and
 - iii. The effects of leaking water or sewer lines, other buried utilities, wind damage, or other events that may cause damage.
- c. The final report should include:
- i. Photographs of the damage, including damage critical to cause determination, and information locating the subject(s) of the images(s).
 - ii. A listing of damage by room or elevation with analysis of damage causes, where evident.
 - iii. A statement as to the cause(s) of damage from the perspective of the structural analysis.

10. Final Report

- a. Include all of the documentation cited above, plus
- i. A simple explanation of the consultant's professional opinion as to the cause of the damage within a reasonable degree of engineering or scientific probability.
 - ii. Include all of the evidence used to draw conclusions concerning causation.
 - iii. It is not sufficient to say that the cause is not a sinkhole – the cause of damage should be suggested.
 - iv. All raw, uninterpreted data should be included as appendices. This allows the reader to better understand the data source used to derive the various anomalies and geologic or geotechnical interpretations, and it enables later investigators to understand the results.
- b. If no cause can be identified, the investigator should recommend additional testing to determine the cause(s).
- c. The report will contain a statement certifying the results of the investigation according to the requirements of §627.707 F.S.

FLORIDA GEOLOGICAL SURVEY

- d. All persons responsible for the interpretation of the data and preparation of the conclusions of the report shall be registered as either an engineer or geologist in Florida and will sign and seal the report indicating their profession and registration number.
- e. A copy of the final report should be submitted to the Florida Geological Survey if legally permissible.

11. Retention of Samples and Data

- a. All photographs, field notes, and other documentary materials will be retained by the consultant for an appropriate period of time.
- b. All soil, sediment, rock, or debris samples will be retained by the consultant for an appropriate period of time.

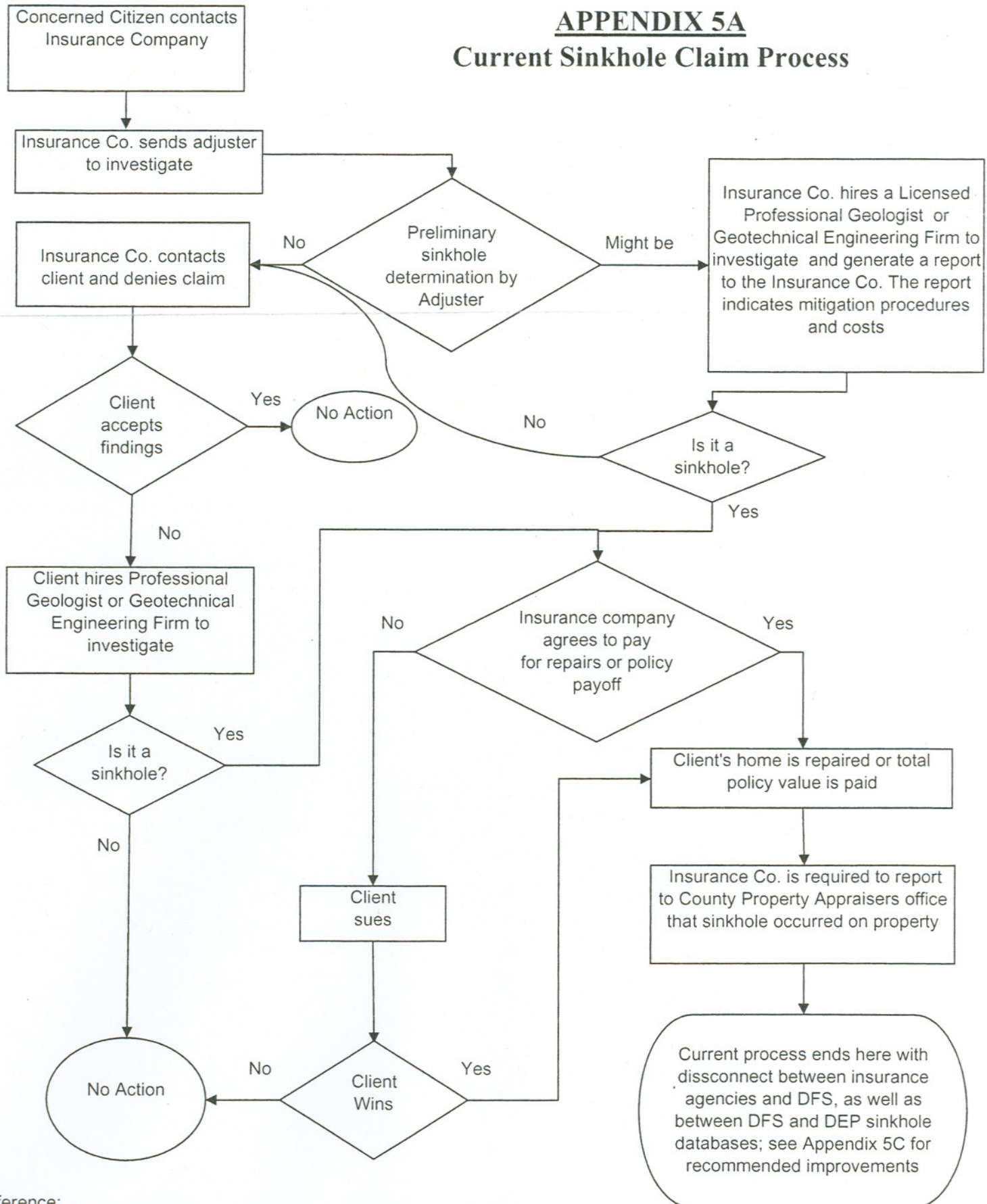
APPENDIX 5
Process Flow charts

5A. Current DFS Sinkhole Claim Process

5B. Current DEP Sinkhole Reporting Process

5C. Benefits of Recommendations in this Report

APPENDIX 5A Current Sinkhole Claim Process

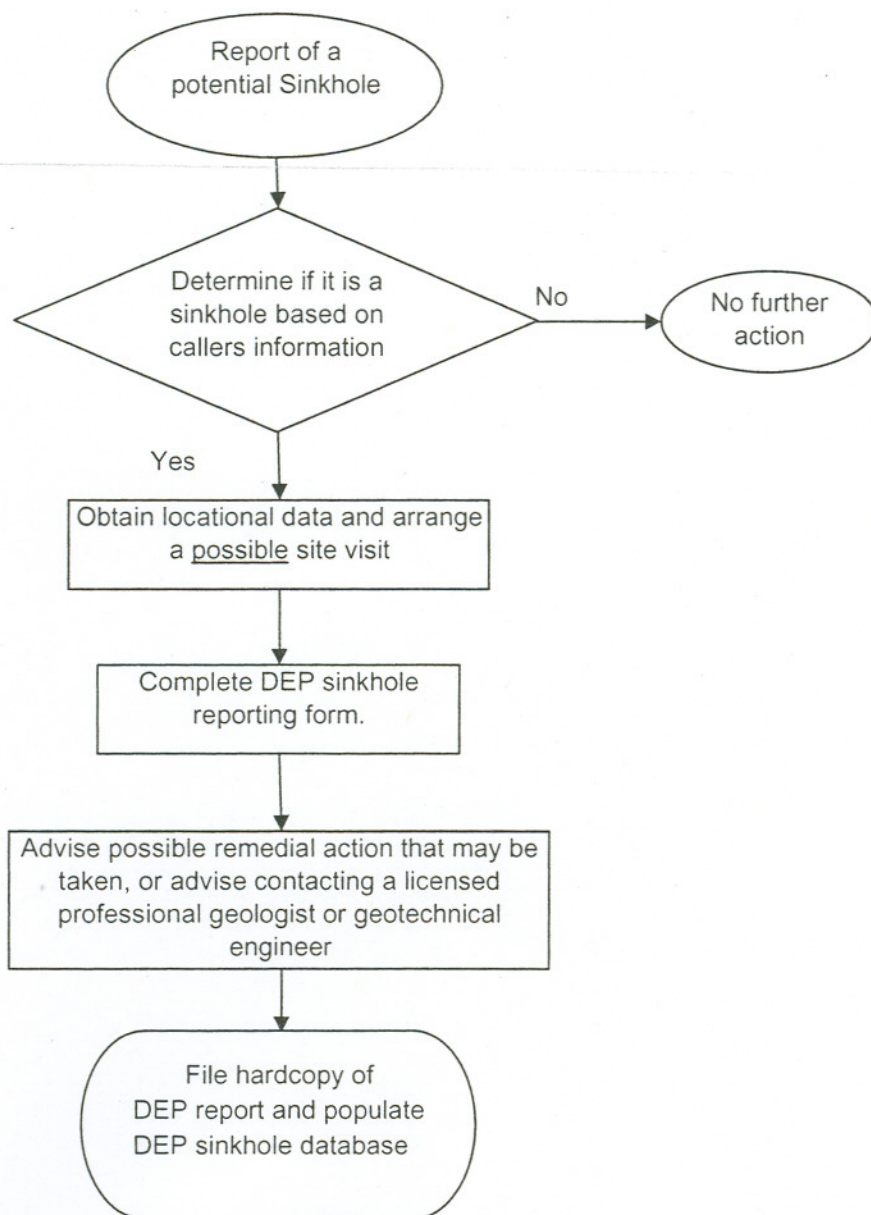


Reference:

http://www.flSenate.gov/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=Ch0627/PART10.HTM

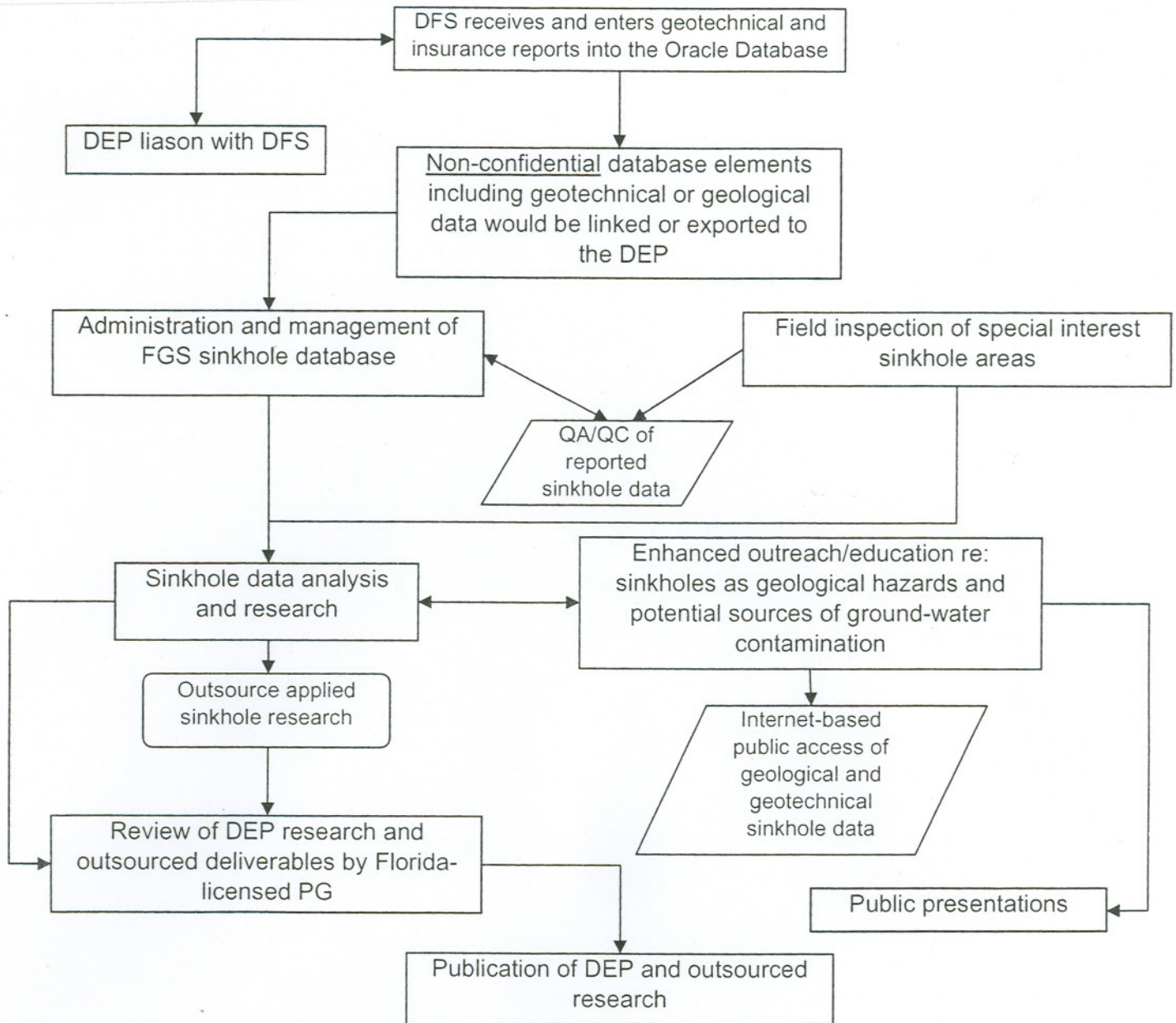
APPENDIX 5B

Current DEP Sinkhole Reporting Process



APPENDIX 5C

Benefits of Recommendations in this Report

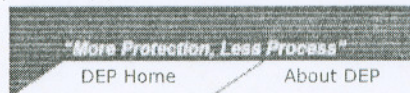


APPENDIX 6

Sinkhole Reporting Form



Florida
Department of Environmental Protection



Search:

GO

Programs

Contact

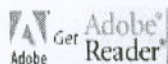
Site Map

Programs

- » [FGS Home](#)
- » [Coastal](#)
- » [Data Acquisition](#)
- » [Education](#)
- » [Hydrogeology](#)
- » [Investigations](#)
- » [Oil and Gas](#)

Information

- » [About Us](#)
- » [Contacts](#)
- » [Data & Maps](#)
- » [Events](#)
- » [Forms](#)
- » [Geologic Topics](#)
- » [Links](#)
- » [Newsletters](#)
- » [Publications](#)
- » [Rules](#)
- » [Statutes](#)



Florida Geological Survey - Forms

Sinkhole Report Form

The Sinkhole Data Form can be printed here and filled out manually or it can be opened in Word 6.0 or as a Adobe .pdf and filled out digitally or printed and filled out manually. For faster response use the Adobe .pdf file - save to your hard drive and e-mail to rick.green@dep.state.fl.us. To use the Adobe pdf file you will need to obtain the free copy of Adobe Acrobat Reader. For more information regarding the Sinkhole Data Form, please contact [Rick Green](#).

For more information on Sinkholes please see out main [sinkhole](#) page.

Sinkhole Report Form

PLEASE COMPLETE and RETURN TO:

FLORIDA GEOLOGICAL SURVEY
903 West Tennessee St.
Tallahassee, FL 32304-7700 (850) 488-9380
Fax: (850) 488-8086

Person Filling Out the Form:

Address:

Phone:

This form has been prepared to help the observer in collecting data on new sinkhole occurrences. These reports, in conjunction with information from other sources, will provide a comprehensive data source on sinkhole events.

1. DATE and time sinkhole was first observed:

Month _____ Day _____ Year _____
Time _____ am/pm.

2. LOCATION:

LONGITUDE: _____ Degrees _____ Min _____ Sec.

LATITUDE: _____ Degrees _____ Min _____ Sec.

County: _____ T _____ R _____ Section _____,
_____ 1/4 of _____ 1/4. 7-1/2 min. Quad. Name _____

Name and Address of property where sinkhole occurred:

Phone: () _____

3. SINKHOLE DATA: (Circle or fill-in the blank).

SIZE and SHAPE: Are dimensions measured _____ or estimated _____?

Is the sinkhole roughly circular _____ or elongate _____?

Sinkhole DIMENSIONS at surface: LENGTH _____ feet;
WIDTH _____ feet. DEPTH of sinkhole below land surface: _____ feet

Approximate SLOPE of sinkhole walls when first observed: _____.
(Flat land slopes 0; a vertical wall slopes 90).

Is there WATER in the sink? _____ Y _____ N.
DEPTH of water below land surface: _____ feet.

Is LIMESTONE visible in the walls of the sink? Y _____ N _____.

Is a CAVERN or cavity visible in the sink? Y _____ N _____.

4. CIRCUMSTANCES OF COLLAPSE: How long did it take for the sinkhole to form? _____

Were there any probable TRIGGERING MECHANISMS, such as: new construction nearby _____; new well-drilling nearby _____; blasting nearby _____; heavy loading of the ground _____; heavy rainfall _____; heavy ground-water pumpage _____; other _____.

Were there any PRE-COLLAPSE INDICATORS, such as: ponding of runoff _____; ground cracks _____; tilting of posts or trees _____; small preliminary holes _____; turbidity in nearby well _____; changes in nearby vegetation (wilting) _____; other _____.

Was there any property damage? ____ Y ____ N Describe in
COMMENTS, below.

Was sink filled or repaired? ____ Y ____ N.
Is this planned? ____ Y ____ N.

5. TERRAIN CHARACTERISTICS:

TOPOGRAPHY: flat, hilltop, slope, valley bottom, depression.
Please describe any drainage channels or structures that are in the
immediate area: _____

LAND USE / COVER: cropland, pasture (or similar), forest, grove,
wetland, suburban (low density), urban (high density), industrial
SOIL TYPE at the site (eg.: white clean sand, orange clayey sand,
etc.): _____

Is this sink in line with, or very near, other recent sinks? ____ Y ____ N

Is this sink in line with, or very near, older sinks or lakes?
____ Y ____ N. Please explain:

ADD ANY OTHER COMMENTS OR OBSERVATIONS HERE:

PLEASE SKETCH THE SINKHOLE ON BACK OF THIS FORM.

APPENDIX 7: DESCRIPTION DATA ELEMENTS NEEDED BY DEP AND COMBINED LIST DEP AND DFS DATA ELEMENTS

The data elements needed by DEP include:

1. A primary reference number assigned to each sinkhole event for identification allowing a relational database to be constructed for follow-on events.
2. The property owner's contact information where the sinkhole event has occurred, should an investigator need to contact the owner for entry permission to examine the event.
3. Event location information including latitude & longitude with degrees, minutes and decimal seconds and including the datum used to collect the GPS position. Datum information is used to ensure proper projection into the geographic information system (GIS) used to develop maps and perform spatial analysis. Additionally a township, range and section (TRS) should be collected to assist in quality control of the location data. If the latitude or longitude is not provided the TRS data will provide approximate location within one square mile of the actual event.
4. The geological elements, such as the dimensions of the event, water, limestone or cave visibility, drainage structures, pre-collapse indicators and triggering mechanisms to assist in analyzing the type and basis of sinkhole development. Land-use indicators can be used to identify possible causes and indicate problematic areas of sinkhole development, such as commercial or industrial areas where overburden has been removed or modified.
5. A validation element to identify those sinkholes that have been investigated by a PG or geotechnical/engineering firm with PG expertise to allow for greater control of data and elimination of events caused by other miscellaneous reasons for ground subsidence. The DEP's Florida Geological Survey does not have the ability to verify sinkholes that have been reported statewide.

Transfer of data between agencies:

The platform of the DFS sinkhole solution will be compatible with that of DEP. Additional funding to accomplish interagency data transfer is not anticipated at this time. Data transfers can be accomplished in a variety of straightforward methods, including regular data pulls from DFS to DEP. The DEP Bureau of Information Systems has this ability to seamlessly allow the DEP/FGS to access the data as often as needed.

DEP and DFS data elements to be included in new solution:

REQUIRED BY	FIELD DESCRIPTION	FIELD TYPE	FIELD FORMAT
DEP	Reference number	NUMERIC	99999999
DEP	Date added to the database	DATE	MM/DD/YYYY
DEP	Date information revised	DATE	MM/DD/YYYY
DEP/DFS	Owners name	TEXT	Open Text
DEP/DFS	Owners street address	TEXT	Open Text
DEP	Address where sinkhole event occurred if other than owners	TEXT	Open Text
DEP/DFS	Owners city	TEXT	Open Text
DEP/DFS	Owners zip code	TEXT	99999-9999
DEP/DFS	County or origin	TEXT	Open Text
DEP	Owners phone	TEXT	(999) 999-9999
DEP/DFS	Datum of Latitude and Longitude	TEXT	Open Text
DEP/DFS	Latitude in Degrees Minutes decimal Seconds format	TEXT	DD MM SS.SS
DEP/DFS	Longitude in Degrees Minutes decimal Seconds format	TEXT	DD MM SS.SS
DEP	Section - Public Land Survey System (PLSS)	TEXT	S99
DEP	Township - PLSS	TEXT	T99(N or S)
DEP	Range - PLSS	TEXT	R99(E or W)
DFS	Date claim reported	DATE	MM/DD/YYYY
DFS	Type of policy	TEXT	Open Text
DFS	Limit of insurance on dwelling / structure	FLOATING	\$999,999,999.00
DFS	Value of property damage to dwelling / structure	FLOATING	\$999,999,999.00
DFS	Was dwelling / structure deemed a total loss?	LOGICAL	True/False
DEP	Date sinkhole observed	DATE	MM/DD/YYYY
DEP	Time sinkhole reported	LONG INTEGER	24-hr clock
DEP	Sinkhole width in FT	LONG INTEGER	1 - 99,999
DEP	Sinkhole length in FT	LONG INTEGER	1 - 99,999
DEP	Sinkhole depth in FT	LONG INTEGER	1 - 99,999
DEP	Methodology used to gather dimensions	TEXT	M/E/U
DEP	Shape of sinkhole	TEXT	Enlongated, Circular, Other
DEP	Observed wall slope degrees - zero references ground plane	LONG INTEGER	0 - 90
DEP	Is water visible in sinkhole?	LOGICAL	True/False
DEP	Is the underlying limestone visible?	LOGICAL	True/False
DEP	Is a cave visible?	LOGICAL	True/False
DEP	Are drainage structures in area?	LOGICAL	True/False
DEP	Land use indicator	TEXT	Comma-delimited, coded value
DEP	Pre-collapse indicators	TEXT	Comma-delimited, coded value
DEP	Triggering mechanisms	TEXT	Comma-delimited, coded value
DEP	Has sink been repaired?	LOGICAL	True/False
DEP/DFS	Has sinkhole been validated by a geotechnical professional?	LOGICAL	True/False
DEP	Miscellaneous Comments	MEMO	Open Text

APPENDIX 8: Participating staff

Department of Environmental Protection (DEP)
and
Department of Financial Services (DFS)

Staff Participating in Cooperative Planning Discussions and Reporting

DEP

Dr. Walter Schmidt, P.G. – State Geologist & Chief, Florida Geological Survey.
488-4191, walt.schmidt@dep.state.fl.us
Dr. Tom Scott, P.G., Assistant State Geologist for Geologic Investigations, 488-
9380, thomas.scott@dep.state.fl.us
Dr. Jon Arthur, P.G., Assistant State Geologist for Hydrogeology, 488-9380,
jonathan.arthur@dep.state.fl.us
Mr. David Anderson – GIS & Database Organization
488-4191, david.anderson@dep.state.fl.us
Mr. Rick Green, P.G. – Geologist, Sinkhole database oversight.
488-4191, rick.green@dep.state.fl.us
Mr. Frank Rupert, P.G. – Sinkhole educational outreach and response to public
inquiries. 488-4191, frank.rupert@dep.state.fl.us
Mr. Steve Spencer, P.G. – Historical database compilation and public assistance.
245-3117, steve.spencer@dep.state.fl.us

DFS

Mr. Gregory M. Thomas, FLMI, CPM, CLU, ACS – Chief, Bureau of Education,
Advocacy & Research. 413-5768, greg.thomas@fldfs.com
Mr. David Fisher, Senior Management Analyst & Sinkhole Ombudsman
413-5708, fisherd@dfs.state.fl.us
Ms. Denise A. Overstreet, Manager, Insurance Applications Engineering
413-2389, overstreetd@dfs.state.fl.us
Dr. Raymond Spudeck, Senior Research Economist, Office of Insurance
Regulation. 413-5043, ray.spudeck@fldfs.com