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CLERK OF THE BOARD
OF COUNTY COMMISSIONERS
MIAMI-DADE COUNTY, FLORIDA

Memorandum

MIAMI-DADE COUNTY

Date: June 3, 2014

To: Honorable Chairwoman Rebeca Sosa
and Members, Board of County Commissioners

Agenda Item No. 8(O)(1)

From: Carlos A. Gimenez
Mayor

Subject: Resolution authorizing the execution of Joint Funding Agreement No. 14GGESMC0000110 for a term of five years for water resources investigations with the United States Geological Survey in the total amount of $12,882,347.00 with funding by Miami-Dade County in an amount not to exceed $10,110,145.00, and the remaining balance of $2,772,202.00 being funded by the United States Geological Survey

Resolution no. R-525-14

RECOMMENDATION

It is recommended that the Board of County Commissioners (Board) approve the attached resolution authorizing the execution of Joint Funding Agreement No. 14GGESMC0000110 between Miami-Dade County through its Water and Sewer Department (WASD) and the United States Geological Survey for water resources investigations for a term of five years in the total amount of $12,882,347.00, with funding by Miami-Dade County in an amount not to exceed $10,110,145.00. The remaining balance of $2,772,202.00 will be contributed by the United States Geological Survey. The term of this agreement is for five (5) years beginning on the date the Joint Funding Agreement is fully executed. The investigations authorized by this Joint Funding Agreement are necessary to comply with state and federal regulatory requirements.

SCOPE

The scope of work in this Joint Funding Agreement provides three (3) major services of countywide significance including water resource investigations related to the Floridan Aquifer System and a sea level rise and climate change countywide impact analysis for the Biscayne and Floridan aquifers.

FISCAL IMPACT/FUNDING SOURCE

The fiscal impact of this Joint Funding Agreement is $12,882,347.00 of which the County will be responsible for an amount not to exceed $10,110,145.00, funded by WASD's Operating Revenues. The remaining balance of $2,772,202.00 will be contributed by the United States Geological Survey.

TRACK RECORD/MONITOR

WASD's Deputy Director for Capital Improvements and Regulatory Compliance, Juan Carlos Arteaga, AIA, NCARB, will oversee the implementation of this Joint Funding Agreement.

BACKGROUND

Groundwater Studies

On April 27, 2004, the Board approved Resolution No. R-509-04 which authorized a Joint Funding Agreement between the County and the United States Geological Survey to conduct groundwater studies of the Floridan aquifer. The tasks assigned and completed for these groundwater studies are subject to approval from the Florida Department of Environmental Protection. The objective of these groundwater studies is to evaluate the movement of wastewater treated effluent injected into the Floridan Aquifer System via the seventeen (17) injection wells at the South District Wastewater Treatment Plant. Of particular concern is the vertical migration of wastewater above the injection zone

into the designated "Underground Source of Drinking Water". The studies also require predicting the future movement of the injected wastewater effluent. The original date to complete the studies was June 2006; however, a time extension was granted by the Board in April 2007 via Resolution No. R-425-07, which extended the completion date to 2009. To date, the United States Geological Survey and WASD have completed the assigned tasks for these groundwater studies for data collected up to year 2009, but the data still needs to be incorporated into a Groundwater Flow Model which shows the direction of groundwater flow and water quality changes over time in the Floridan aquifer. Formal approval has been delayed by the Florida Department of Environmental Protection due to the complexity of the tasks; nonetheless, approval is now scheduled to be issued within thirty-six (36) months after this Joint Funding Agreement is fully executed.

Countywide Seismic Surveys

WASD operates the South District Wastewater Treatment Plant located in the southeast section of the County. At this Plant, wastewater treated effluent is disposed of via underground injection wells into the lower Floridan Aquifer System at a depth below 2,400 feet. A total of seventeen (17) injection wells have been constructed to dispose of wastewater treated effluent. Thirteen (13) injection wells are permitted to operate and four (4) injection wells are permitted for operational testing. At the North District Wastewater Treatment Plant, wastewater treated effluent is disposed of via four (4) injection wells into the Floridan Aquifer System and an ocean outfall located two (2) miles off the coast. The Central District Wastewater Treatment Plant discharges its wastewater effluent via an ocean outfall located three (3) miles off the coast.

The need to use the deep injection well disposal method has increased dramatically due to the State of Florida's Ocean Outfall Legislation. The Outfall Legislation prohibits the use of ocean outfalls as a primary means of wastewater discharge after 2025 and requires that sixty percent (60%) of the baseline flow going out of the ocean outfalls be converted to beneficial reuse. This new wastewater disposal requirement impacts the existing disposal operations at the County's Central District, North District, and South District Wastewater Treatment Plants and other water and wastewater projects planned for the future. In order to comply with the requirements of the Ocean Outfall Legislation, an estimated forty-one (41) deep injection and production wells have to be constructed over the next three (3) to ten (10) years. It is estimated that total project costs of these wells and the associated appurtenances excluding land acquisition, will total about $893,000.000.00. In addition, the construction of the South Miami Heights Water Treatment Plant will include the construction of ten (10) Upper Floridan aquifer production wells and two (2) deep injection wells. It is estimated the total project cost of these wells will be $34,000,000.00.

Seismic survey techniques have been developed to identify (in geological terms) the most appropriate location to install a deep injection well. This Joint Funding Agreement provides for the use of seismic survey techniques to identify locations for the fifty-three (53) deep injection and production wells and requires the development of a three-dimensional countywide characterization of the hydrogeological layers of the Floridan aquifer.

Sea Level Rise and Climate Change Assessment Impact Analysis

An evaluation of the increasing water supply demands of the Biscayne and Floridan aquifers will be performed including sea level rise and drainage changes resulting from climate changes.

Alina T. Hudak
Deputy Mayor

MEMORANDUM

(Revised)

TO: Honorable Chairwoman Rebeca Sosa
and Members, Board of County Commissioners

DATE: June 3, 2014

FROM: R. A. Cuevas, Jr.
County Attorney

SUBJECT: Agenda Item No. 8(O)(1)

Please note any items checked.

_____ **"3-Day Rule" for committees applicable if raised**

_____ **6 weeks required between first reading and public hearing**

_____ **4 weeks notification to municipal officials required prior to public hearing**

_____ **Decreases revenues or increases expenditures without balancing budget**

_____ **Budget required**

_____ **Statement of fiscal impact required**

_____ **Ordinance creating a new board requires detailed County Mayor's report for public hearing**

_____ **No committee review**

_____ **Applicable legislation requires more than a majority vote (i.e., 2/3's ____, 3/5's ____, unanimous _____) to approve**

✓ **Current information regarding funding source, index code and available balance, and available capacity (if debt is contemplated) required**

Approved _____ Mayor
Veto _____
Override _____

Agenda Item No. 8(O)(1)
6-3-14

RESOLUTION NO. R-525-14

RESOLUTION AUTHORIZING THE EXECUTION OF JOINT FUNDING AGREEMENT NO. 14GGESMC0000110 FOR A TERM OF FIVE YEARS FOR WATER RESOURCES INVESTIGATIONS WITH THE UNITED STATES GEOLOGICAL SURVEY IN THE TOTAL AMOUNT OF $12,882,347.00, WITH FUNDING BY MIAMI-DADE COUNTY IN AN AMOUNT NOT TO EXCEED $10,110,145.00, AND THE REMAINING BALANCE OF $2,772,202.00 BEING FUNDED BY THE UNITED STATES GEOLOGICAL SURVEY; AND AUTHORIZING THE COUNTY MAYOR OR COUNTY MAYOR'S DESIGNEE TO EXERCISE THE PROVISIONS CONTAINED THEREIN

WHEREAS, this Board desires to accomplish the purposes outlined in the accompanying memorandum, a copy of which is incorporated herein by reference,

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF COUNTY COMMISSIONERS OF MIAMI-DADE COUNTY, FLORIDA, that this Board hereby authorizes the County Mayor or County Mayor's designee to execute Joint Funding Agreement No. 14GGESMC0000110 with the United States Geological Survey for Water Resources Investigations ("Agreement") for a term of five (5) years beginning from the date the Agreement is fully executed in the total amount of $12, 882, 347.00 with funding by Miami-Dade County not to exceed the amount of $10,110,145.00, and the remaining balance of $2,772, 202.00 being funded by the United States Geological Survey; in substantially the form attached hereto and made a part hereof; and authorizes the County Mayor or County Mayor's designee to exercise the provisions contained therein.

The foregoing resolution was offered by Commissioner **Lynda Bell**, who moved its adoption. The motion was seconded by Commissioner **José "Pepe" Diaz** and upon being put to a vote, the vote was as follows:

Rebeca Sosa, Chairwoman			**aye**
Lynda Bell, Vice Chair			**aye**
Bruno A. Barreiro	**absent**	Jose "Pepe" Diaz	**aye**
Esteban L. Bovo, Jr.	**aye**	Barbara J. Jordan	**aye**
Sally A. Heyman	**aye**	Dennis C. Moss	**absent**
Jean Monestime	**aye**	Sen. Javier D. Souto	**aye**
Xavier L. Suarez	**aye**	Juan C. Zapata	**absent**
Audrey M. Edmonson	**aye**		

The Chairperson thereupon declared the resolution duly passed and adopted this 3rd day of June, 2014. This resolution shall become effective ten (10) days after the date of its adoption unless vetoed by the Mayor, and if vetoed, shall become effective only upon an override by this Board.

MIAMI-DADE COUNTY, FLORIDA
BY ITS BOARD OF
COUNTY COMMISSIONERS

HARVEY RUVIN, CLERK

By: ***Christopher Agrippa***
Deputy Clerk

Approved by County Attorney as
to form and legal sufficiency.

Henry N. Gillman

ORIGINAL

Form 9-1366
(Oct. 2005)

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

JOINT FUNDING AGREEMENT

Customer #:	6000001226
Agreement #:	14GGESMC0000110
Project #:	MC00E2J
TIN #:	59-6000573
Fixed Cost Agreement	YES

FOR

FLORIDA WATER SCIENCE CENTER - FT. LAUDERDALE/DAVIE

THIS AGREEMENT is entered into as of the, day of signature, 2014 by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the MIAMI-DADE COUNTY, party of the second part.

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation AQUIFER HYDROGEOLOGIC FRAMEWORK, MODELING TOOLS AND EVALUATING SEA-LEVEL RISE, MIAMI-DADE COUNTY herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of $0.00

   (a) by the party of the first part during the period

Amount	Date	to	Date
$2,772,202.00	signature date		5 years from execution

   (b) by the party of the second part during the period

Amount	Date	to	Date
$10,110,145.00	signature date		5 years from execution

   The term begins on the date it is fully executed and ends 5 years from the date the agreement is fully executed.

   (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

   (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

9-1366 (Continuation) Customer #: 6000001226 Agreement #: 14GGESMC0000110

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.

9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040). Billing documents are to be rendered QUARTERLY. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

U.S. Geological Survey United States Department of the Interior		MIAMI-DADE COUNTY	
USGS Point of Contact		**Customer Point of Contact**	
Name:	Nancy Baroud	Name:	Virginia Walsh
Address:	4446 Pet Lane, Suite 108 Lutz, FL 33559 DUNS#: 137783937/TAS: 144/50804	Address:	3071 S.W. 38th Avenue, Rooom 554-10 Miami, FL 33146
Telephone:	813.498.5013	Telephone:	786.552.8266
Email:	nbaroud@usgs.gov	Email:	WALSHV@miamidade.gov

Signatures and Date

Signature:	Date:	Signature:	Date:
Rafael W. Rodriguez	3/26/2014		
Name: Rafael W. Rodriguez		Name: Carlos A. Gimenez	
Title: Director, FL WSC		Title: Mayor, Miami-Dade County	

Signature: Date: 4/2/14

Name: Henry N. Gillman

Title: County Attorney

1. Project Title: Aquifer Hydrogeologic Framework, Modeling Tools and Evaluating Sea-Level Rise, Miami-Dade County

2. Background: The Floridan Aquifer System (FAS) in Miami-Dade County is currently being used for disposal of treated wastewater, specifically into the deepest part of the FAS, by deep-well injection methods. It is likely that the need to do this will increase in the future. U.S. Environmental Protection Agency (U.S. EPA) revisions to Underground Injection Control (UIC) regulations in 2005 and state-mandated elimination of ocean outfalls as a primary means of municipal wastewater discharge have made it necessary for well owners and operators to reform current disposal practices. The state has also mandated that 60% of the baseline flow going out the ocean outfalls be converted to beneficial reuse. Because of the strong interconnection between the surface water system and the shallow aquifer system, the Biscayne aquifer, which is also the primary (exclusive) source of drinking water for the county, the capacity to apply beneficial reuse at the surface or in the Biscayne aquifer is limited. One option for beneficial reuse would include injection of treated wastewater for Aquifer Storage and Recovery (ASR) into shallower parts of the FAS, specifically, the Upper Floridan aquifer. Miami-Dade County is concerned about the effects of increasing water-resource management activities in the FAS. Of particular concern is the potential for vertical migration of wastewater above the injection zone and into a U.S. EPA-designated Underground Source of Drinking Water (USDW), which has occurred at a number of wastewater-injection sites in southeastern Florida (Maliva and others, 2007). The County is also developing inter-aquifer operational management plans to optimize the use of water resources, and needs to consider effects of increasing withdrawals from the Floridan aquifer on the optimized usage of the Biscayne aquifer.

3. Problem: Miami-Dade County has construction permits from the State of Florida Department of Environmental Protection (FDEP) to allow to operationally test Class I Injection Wells, with associated monitoring wells, at the South District Wastewater Treatment Plant (SDWWTP); which is owned and operated by the Miami-Dade Water and Sewer Department (MDWASD). In order to obtain an operational permit for four Class I injection wells for the disposal of non-hazardous high-level disinfected domestic wastewater at the SDWWTP, Miami-Dade County is required to evaluate the fate of injected waters and any native waters that have been or are likely to be affected by migration of injectate into the protected upper part of the FAS.

As part of a previous study, the U.S. Geological Survey (USGS) constructed a groundwater flow and solute-transport model to test hypotheses for injectate migration at the SDWWTP (Dausman and others, 2010). Results indicated that, although vertical effluent migration could occur as diffuse upward flow through confining units, flow along a local pathway of enhanced permeability (e.g. around compromised well casing) is more likely. As part of this previous study, MDWASD constructed a monitoring well and collected data from the well to constrain model calibration. The Joint Funding Agreement expired before the well was completed, so the model does not represent the local hydrogeologic system, as would be interpreted from the monitoring well. Instead, the flow system represented in the model is based on a combination of information from a regional hydrogeologic framework of both the Upper and Lower Floridan aquifers for all of southern and central Florida (Reese and Richardson, 2008) and local studies by McNeill (2000, 2002).

To better manage water-resource activities involving the FAS or deeper units, the hydrogeologic framework must be refined. Since the publication of Reese and Richardson (2008), more hydrogeologic data have been collected for the FAS throughout the County, including the monitoring well at SDWWTP, and additional wells in adjacent Broward County. In addition, seismic-reflection data that have been acquired near both SDWWTP and North District Wastewater Treatment Plant (NDWWTP) can be integrated with the new and existing well data. These more recently collected data, and data planned to be collected in the near future, would allow for an upgraded interpretation of hydrogeologic features of the FAS, critical for sustaining and protecting the County's water resources. For example, seismic data collected at the continental shelf and Biscayne Bay offshore of the County, and along County canals show evidence for tectonic faults and multiple karst collapse structures (Cunningham and Walker, 2009; Cunningham and others, 2012). These structural features have potential to act as relatively high permeability vertical passageways for the upward buoyant migration of fresh wastewater across lower permeability rocks that compose semiconfining units of the FAS.

With the likelihood that deep wastewater injection into the Boulder Zone will increase in the future and only after expensive HLD, one possible solution is to use deeper Cretaceous formations for elimination of treated wastewater. Very little is known about the units underlying the Boulder Zone in Miami-Dade County. Successful use of the Cretaceous as a wastewater injection unit would require sufficient permeability and overlying confinement, as well as hydraulic pressures that allow injection at reasonable rates.

Miami-Dade County will soon drill a Cretaceous test well at Central District Wastewater Treatment Plant (CDWWTP) to explore the option of constructing Class I municipal injection wells for injection of treated domestic wastewater into Cretaceous formations. The test well will be drilled to an approximate depth of 10,000 ft below the surface and primarily explore for (1) potential permeable wastewater disposal zones within Cretaceous formations, and (2) confinement between the base of the FAS and top of Cretaceous permeable zones. This is the first time a hydrologic test well has been drilled in southern Florida to the depth of Cretaceous formations. Because no other Cretaceous hydrogeologic test wells have been previously drilled as deep as Cretaceous formations in Miami-Dade County, the spatial distribution of hydrogeologic characteristics of the Cretaceous formations would be uncertain. Marine seismic-reflection data could be acquired and used to extrapolate the well data throughout the County beyond CDWWTP, allowing a more reasonable evaluation of the Cretaceous formations for Class I injection wells at CDWWTP and possibly other WWTPs.

One of the long-term concerns for Miami-Dade County is the effect of sea-level rise on water resources. Sea-level rise will exacerbate seawater intrusion, and inter-aquifer management practices will need to account for it. Seawater intrusion has increased in the Biscayne aquifer since urban development began in the region. Though not heavily pumped, salinity in the shallower, permeable units of the FAS is known to be elevated in some locations, and generally increases with depth to the Boulder Zone, which has salinities comparable to seawater. Any modification to pumping or injection distribution that are being considered for water supply, beneficial re-use, or wastewater disposal operations, will need to account for this transient condition.

4. Objectives and Scope

The objectives of this study are:

(1) To predict the fate of treated wastewater injectate at the SDWWTP in the Boulder Zone under a variety of possible future pumping and injection distributions, and the fate of treated reuse injectate at SDWWTP, CDWWTP, and the planned West District Wastewater Treatment Plant (WDWWTP);

(2) Refine the hydrogeologic framework of the FAS, and construct a hydrogeologic framework for the underlying sub-Floridan confining units and the upper part of Cretaceous formations in the eastern part of Miami-Dade County, which will include calculation of probability of fluid-flow pathways along faults related to karst and tectonics;

(3) Construct geodatabase, geomodeling, and hydrologic flow model tools that may be used by the Miami-Dade County to assist in future water resource management activities of the FAS and deeper units;

(4) Predict the effects on other parts of the hydrologic system (including the overlying Biscayne aquifer) as a result of possible future ASR operations, and future conditions, such as sea-level rise.

5. Relevance and Benefits

Results of this proposed study will help MDWASD manage their water resources by expanding the knowledge base of the FAS, and underlying sub-Floridan confining units and Cretaceous formations. Additionally, the benefits of this work for the County include the ability to ensure the regulatory agencies that management of their water resources is based on unbiased and impartial science, scrutinized and held to of the high technical standards that the USGS provides.

There has been concern that widespread use of the Floridan aquifer system for multiple and conflicting uses could result in unforeseen hydrologic consequences. In spite of the fact that the Upper Floridan aquifer has been designated by the USEPA as a USDW in the area, the FAS is not yet used substantially for potable water supply in southeastern Florida, because of the greater accessibility and high productivity of the shallower Biscayne aquifer. Increasing demands on the Biscayne aquifer, as well as its susceptibility to saltwater intrusion, is limiting its use. Information gathered from the study will enhance understanding of FAS in South Florida, including its potential as an alternative potable water supply, and for disposal or storage of injected waters. As use of the Biscayne aquifer is becoming increasingly controlled, and as legislation is limiting ways communities can address wastewater disposal, the FAS is becoming a resource of increasing importance. Since the FAS is one of the most productive aquifer systems in the world, this study will contribute critical information relevant to water resource management on a regional or perhaps larger scale.

This study aligns directly with the strategic science direction for water outlined in USGS circular 1309 (USGS, 2007) by quantifying, forecasting, and securing freshwater for America's future. It also aligns directly with programmatic elements outlined in the draft Florida Water Science Center (FLWSC) Strategic Science Plan 2012-2022, including: program goal 2 – advancing understanding of the

occurrence, transport and fate of contaminants in surface and groundwater systems. Additionally, this study would support elements of program goal 1 – providing hydrologic science to support water management that balances the needs of Man and Nature; and program goal 3 – predicting changes in the quantity and quality of water resources in response to changing climate and landscape change.

6. Approach

Five designated tasks address the four objectives of the study. Tasks include data acquisition, development of 3-D geomodels of the FAS and underlying units, and the development of groundwater flow and solute transport models to simulate various water-management activities and projected conditions.

***Task 1*: Fate and Transport of Deep Well Injectate at the South District Wastewater Treatment Plant, Miami, Florida: Model Update and Injection Scenario Simulations**

Task 1 Objectives: The modified variable-density ground-water flow and solute transport model of the SDWWTP (Dausman and others, 2010) will be used to address these objectives:

1. Evaluate movement of injected waters within the Floridan aquifer system with the additional and updated information;
2. Predict the future movement of injected fluids under a range of different injection scenarios. This information will be useful for managing future operations at the wastewater treatment facility.

Approach:

1. Incorporate hydrogeologic data from the most recently drilled monitoring well and re-evaluate the conceptual model.
2. Compile inventory of 7 additional years of operational and observation data (from 2005-2012).
3. Modify and update the existing model with new hydrogeologic data and 7 additional years of operational and observation data (from 2005-2010), and calibrate comprehensive predictive model.
4. Run predictive scenarios, to be determined in consultation with MDWASD.

Deliverables:

1. Presentation to cooperator on preliminary results (end of 6th Q)
2. Journal article or SIR at end of task (year 3)

Task 2: 3D seismic surveys of CDWWTP, SMHWF, SWWF, WWF, and WDWWTP

Task 2 Objectives: The main objective of this task is to define and refine the geologic and hydrogeologic ramework of the ICU, FAS, sub-Floridan confining unit, and Cretaceous Formations at CDWWTP, South Miami Heights Well Field (SMHWF), Southwest Well Field (SWWF), and West Well Field (WWF), and the planned WDWWTP by incorporating new 3D seismic-reflection data at each of the well fields and the wastewater treatment plants. Depth of seismic investigation will depend on data quality. In addition, at SMHWF new well information will to be acquired over the duration of the project and incorporated into the development of the SMHWF geologic and regional hydrogeologic FAS framework as time permits. At CDWWTP and SMHWF, knowledge of this refined framework will provide the County with subsurface

information that will be used as a hazard survey to locate drilling sites for production, monitoring, and injection wells at the well field. Calculation of probability of fluid-flow pathways along faults related to tectonics and karst will be provided. Also, the information may be incorporated into future groundwater flow and transport models for any of the three well fields that can be used by the county for management of the three well-field's FAS water resources. The quality of these products, especially porosity, is contingent on reflection-seismic data acquisition geometry and data quality, and processing quality.

Approach:

1. Compile data for selected existing wells at or near the CDWWTP, SWWF, WWF, and the planned locations of SMHWF and WDWWTP.
2. Acquire, process, and interpret seismic-reflection data at CDWWTP, SWWF, WWF, and the planned location at the SMHWF and WDWWTP.
3. Acquire and interpret hydrologic, geologic, and geophysical data from a new Cretaceous well to be drilled at the CDWWTP and multiple FAS wells to be drilled at SMHWF.
3. Calculate probability of fluid-flow pathways along faults related to tectonics and karst.
4. Apply seismic inversion to calculate and display porosity, where feasible, on seismic profiles.
5. Sequence stratigraphy in wells will be correlated to seismic-sequence stratigraphy to create a robust 2-D and 3-D sequence stratigraphy for aquifers and confining units.
6. Create geomodel of ICU, FAS, sub-Floridan confining unit, and Cretaceous Formations using seismic-reflection and well data.
7. Generate maps, cross sections, and 2-D or 3-D visualizations of key stratigraphic horizons, seismic sequences, and structural features from the ICU, FAS, sub-Floridan confining unit, and Cretaceous Formations.
8. Define the hydrogeologic framework of the FAS at SMHWF. Activities may include: identifying major high permeablity zones and confining units in the FAS, and boundaries of important lithostratigraphic and hydrostratigraphic units; constructing hydrogeologic cross sections and three-dimensional geologic model.

Deliverables:

1. A SIR or journal article(s) or both.
2. Data compiled for this study will be provided in digital format, including editable files of cross sections.

***Task 3*: Refinement of the Geologic and Hydrogeologic Framework of the Intermediate Confining Unit, Floridan Aquifer System, Sub-Floridan Confining Unit, and Cretaceous Formations in the Miami-Dade County area**

Task 3 Objectives: The objective of this task is to refine the geologic and hydrogeologic framework of the intermediate confining unit (ICU), FAS, sub-Floridan confining unit, and Cretaceous formations in Miami-Dade County area. This will be accomplished for the FAS by incorporating hydrogeologic information collected since publication of Reese and Richardson (2008). Knowledge of this refined framework is intended to be incorporated into future updates of existing groundwater flow and transport models used by the county for management of water resources, for example, the SDWWTP model and will assist in the decisions related to the management of Miami-Dade County groundwater

resources of the FAS. The quality of these products, especially porosity, is contingent on seismic-reflection data acquisition geometry and data quality, and processing quality. Testing of probability of vertical fluid flow through the FAS using seismic-attribute calculation will be conducted over potential fluid-emission structures offshore of southeastern Florida.

Approach:

1. Compile data for selected existing wells that reach total depth in the ICU, FAS, sub-Floridan confining unit, and Cretaceous Formations in Miami-Dade County.
2. Acquire, process, and interpret new 2D regional seismic-reflection data and integrate 3D seismic data at CDWWTP, SWWF, WWF, and the planned locations of SMHWF and WDWWTP into the 2D seismic-reflection framework.
3. Acquire and interpret hydrologic, geologic, and geophysical data from a new Cretaceous test well at CDWWTP and new wells at SMHWF.
4. Where and when possible, collect additional hydrogeologic data, for example, borehole geophysical log data at appropriate test wells in the ICU, FAS, sub-Floridan confining unit, or Cretaceous formations.
5. Calculate probability of fluid-flow pathways along faults related to tectonics and karst.
6. Apply seismic inversion to calculate and display porosity, where feasible, on seismic profiles.
7. Sequence stratigraphy in wells will be correlated to seismic-sequence stratigraphy to create a robust 2-D and 3-D sequence stratigraphy for aquifers and confining units.
8. Create geomodel that includes the ICU, FAS, sub-Floridan confining units, and deeper Cretaceous aquifer units using seismic-reflection and well data.
9. Generate maps, cross sections, and 2-D or 3-D visualizations of key stratigraphic horizons, seismic sequences, and structural features from the Cretaceous through the FAS.
10. Refine the hydrogeologic framework of the FAS in Miami-Dade County; activities may include: identifying major high permeablity zones and low permeability confining units in the FAS, and boundaries of important lithostratigraphic, sequence stratigraphic, and hydrostratigraphic units; constructing hydrogeologic cross sections or three-dimensional hydrogeologic models.
11. Train Miami-Dade County WASD staff in use of ROXAR RMS geomodeling software for updating FAS cross-sections in house.
12. Multi-beam bathymetry mapping, high-resolution backscatter water-column gas detection, and remotely-operated-vehicle fluid and gas detection to confirm seismic-attribute calculations of vertical-fluid flow probability.

Deliverables: A USGS SIR or journal article(s) or both. Data compiled for this study will be provided in digital format, including editable files of cross sections.

***Task 4:* County-wide groundwater flow and solute transport model of the FAS**

Task 4 Objectives: The objective of this task is to develop a county-scale flow and transport model of the FAS, integrating the updated hydrogeologic framework. This model will be used as the basis for future development of telescoped, well field-scale predictive models of groundwater flow and transport.

Approach:

1. Compile existing water-level, pumping, injection and water quality data for the FAS in Miami-Dade County to determine vertical model extent, simulation period and calibration targets;
2. Using geomodel of updated hydrogeologic framework, create flow and transport model framework;
3. Calibrate model to existing conditions; estimate flow gradients and salinity distribution in the FAS;

Deliverables:

1. Presentation to WASD on preliminary results
2. Journal article or USGS report at end of task

***Task 5* Vulnerability of the Biscayne aquifer and Floridan Aquifer system to Sea level rise**

Task 5 Objectives: The objective of this task is to evaluate the vulnerability of the Biscayne and Floridan aquifers to increasing inter-aquifer demands and operational activities, for future conditions which may include sea-level rise and precipitation and drainage changes as a result of climate change.

Approach:

1. Using an existing County-scale model of the Biscayne aquifer system, simulate effects of increasing withdrawals with sea-level rise.
2. Using the county-wide groundwater flow and transport model developed in task 3, simulate regional effects of the increasing withdrawals and injection with sea-level rise.
3. Technical reviews on modeling results may be provided on an as-needed basis.

Deliverables:

1. Reviews provided on an as-needed basis
2. Proceedings papers, journal articles, or approved presentations documenting simulation results using existing models

7. QA/QC

The USGS will calibrate the models to generally match observed groundwater levels, salinity and injectate concentrations. The USGS will investigate model sensitivity and articulate model limitations. The models will be documented and archived according to relevant USGS Office of Groundwater policy memos.

All report(s) and/or journal article(s) authored by USGS personnel will conform to USGS Fundamental Science Practices (http://www.usgs.gov/fsp/), which include quality assurance and quality control elements.

8. Information Products

1) Task 1: USGS report or journal article documenting SDWWTP model update and simulation results
2) Task 2: A SIR or journal article(s) or both describing hydrogeology and structural features identified at the CDWWTP, SMHWF, SWWF, WWF, and the planned WDWWTP.
3) Task 3: A SIR or journal article(s) or both, describing the regional hydrogeology.
4) Task 4: USGS report, journal article, proceedings papers or approved presentations documenting model and county-scale hydrologic budget and selected scenario simulations.

9. References

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Miami-Dade Water and Sewer Department, 2010, Justification for the Cretaceous Class I municipal injection well alternative: a white paper, 28 p.

Reese, R.S., and Richardson, E., 2007, Synthesis of the hydrogeologic framework of the Floridan aquifer system and delineation of a major Avon Park permeable zone in central and southern Florida: U.S. Geological Survey Scientific Investigations Report 2007-5207, 60 p.

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U.S. Geological Survey, 2007, Facing tomorrow's challenges—U.S. Geological Survey science in the decade 2007–2017: U.S. Geological Survey Circular 1309, x + 70 p.

10. Project Schedule:

Start Date: Immediately after Joint Funding Agreement No. 14GGESMC0000110 is fully executed.
End Date: Five (5) Years after the date Joint Funding Agreement No. 14GGESMC0000110 is fully executed.

11. Personnel

Miami-Dade County (Cooperator)

- Virginia Walsh, Miami-Dade Water and Sewer Department, Senior Professional Geologist, Chief Hydrogeology Section, Planning Division. walshv@miamidade.gov, 786-552-8266

USGS Duty Station Administration

- Robert Renken, USGS, Office Chief, rarenken@usgs.gov, 954-377-5922
- Dorothy Sifuentes, USGS, Studies Chief, dfpayne@usgs.gov, 954-377-5902

USGS Hydrogeology Staff

- Kevin J. Cunningham, USGS, kcunning@usgs.gov, 954-377-5913
- GS-14 Hydrogeologist/Hydrogeophysicist
- GS-12 Hydrogeologist
- 2 ROXAR RMS Geomodeling Technicians, USGS
- GS-13 Groundwater Hydrologist, Flow and Transport Modeling
- GS-11 GIS specialist, USGS
- GS-9 Hydrogeologist, USGS
- GS-5, Hydrogeologist, USGS
- Graphics Specialist, USGS

CESU Cooperative Agreement Seismic-Reflection Staff

- Seismic-reflection interpreter
- Student assistant

Contracted Seismic-Reflection Staff

- Cameron Walker, Walker Marine Geophysical Company, walkermarine@yahoo.com, 561-995-7764

12. Project Budget:

The tables below assume a start date of January 1, 2014. If the start date is not January 1, 2014, the total budget will remain the same, and the distribution over the timeline will be adjusted accordingly. The USGS matching share is dependent on the availability of the Federal/State Cooperative Program funds.

	FY1	FY2	FY3	FY4	FY5	total by task
task 1	304,042	257,939	103,714	0	0	665,695
task 2	1,090,366	1,566,950	1,875,914	868,858	757,028	6,159,116
task 3	856,584	2,174,764	1,037,214	952,580	869,406	5,890,548
task 4	0	0	243,022	239,971	127,133	610,126
task 5	21,574	21,574	21,574	21,574	68,413	154,709
total by FY	2,272,566	4,021,227	3,281,438	2,082,983	1,821,980	13,480,194

	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	Totals
USGS Coop	$ 554,441	$ 554,441	$554,440	$554,440	$554,440	$2,772,202
USGS Bureau & Science Support	$ 119,569	$119,569	$119,569	$119,569	$119,571	$597,847
Miami-Dade	$ 1,598,556	$3,347,217	$2,607,429	$1,408,974	$1,147,969	$10,110,145
	$ 2,272,566	$4,021,227	$3,281,438	$2,082,983	$1,821,980	$13,480,194