Brunswick-Glynn County Joint Water and Sewer Commission
1703 Gloucester Street, Brunswick, GA 31520
Thursday, July 13, 2017 at 3:00 PM
Commission Meeting Room

FACILITIES COMMITTEE MEETING AGENDA

Committee Members: **Commissioner Cliff Adams, Chairman**
Commissioner Robert Bowen
Commissioner David Ford
Executive Director Jimmy Junkin
Senior Engineer Todd Kline

PUBLIC COMMENT PERIOD

Public Comments will be limited to 3 minutes per speaker. Comments are to be limited to relevant information regarding your position and should avoid being repetitious. Individuals should sign in stating your name, address and the subject matter on which you wish to speak. Your cooperation in this process will be greatly appreciated.

APPROVAL

1. **Minutes From Facilities Committee Regular Meeting, June 13, 2017**
2. **Surplus Vehicles / Equipment –** P. Crosby

DISCUSSION

1. **USGS Annual Survey Renewal –** J. Junkin

EXECUTIVE DIRECTOR'S UPDATE

MEETING ADJOURNED

All citizens are invited to attend.
There is a possibility of a quorum of Commissioners being present.

Brunswick-Glynn County Joint Water & Sewer Commission
1703 Gloucester Street, Brunswick, GA 31520
Commission Meeting Room
Thursday, July 13, 2017 at 3:00 PM

FACILITIES COMMITTEE MINUTES

PRESENT:	**Cliff Adams, Committee Chairman** **Robert Bowen, Commissioner** **David Ford, Commissioner** **Todd Kline, Senior Engineer** **Jimmy Junkin, Executive Director**
ALSO PRESENT:	**Don Elliott, Commission Chairman** **Thomas Boland, Deputy Director** **John Donaghy, Chief Financial Officer** **Pam Crosby, Director of Procurement**

Chairman Adams called the meeting to order at 3:03 PM.

PUBLIC COMMENT PERIOD
There being no citizens that wished to address the Committee, Chairman Adams closed the Public Comment Period.

APPROVAL:
1. **Minutes from June 13, 2017 Facilities Committee Meeting**
Commissioner Ford made a motion, seconded by Commissioner Bowen to approve the minutes from the Facilities Committee Meeting on June 13, 2017. Motion carried 3-0-0.

2. **Surplus Vehicles** – P. Crosby
Pam Crosby presented the recommendation for the declaration of 5 vehicles to be identified as surplus and for the authorization of their disposal in a manner most beneficial to the JWSC. She referred to an attached memo listing the vehicles, notation of their current condition and mileage. For these items to be disposed of, they must be declared as surplus by the Commission. She explained request was for approval to move this forward to the Finance Committee and then to the full Commission for final approval. Mrs. Crosby also noted that the items will be placed on GovDeals for sale.

Commissioner Ford made a motion seconded by Commissioner Bowen to declare these items as surplus and move forward to the full Commission. Motion carried 3-0-0.

DISCUSSION:
1. **U.S.G.S. Annual Survey Renewal** – P. Crosby
Pam Crosby presented to the Committee discussion regarding the annual renewal of the U.S.G.S. Survey/Study. She noted that this is a long term survey that has been ongoing since the 1950's, which is about the water supply in Glynn County and the coastal areas, and that the reason for the study is the

concern of the Chloride concentration in specific areas, meaning saltwater intrusion. She further mentioned that there have been a couple of wells that have had to be terminated because of that intrusion. Mrs. Crosby continued to explain that basically what the study does is go through various sites and monitor the movement of salt plumes and the Chloride levels. She referenced a technical presentation prepared by Greg Cherry with U.S.G.S., and displayed portions from that presentation. Mrs. Crosby noted a slide that showed the levels of the aquifers and noted the detail of the intrusion. Also provided was a set of pictures which showed the progression of Chloride concentration in the upper water-bearing zone of the upper Floridian aquifer in Brunswick, GA from the year of 1957 to 2015. She then noted that the increase of Chloride concentration in the aquifers in this area is why the continuation of the study is important. Mr. Junkin added that even though there have been some dramatic process changes by Georgia Pacific to reduce the withdrawal rate of water for operations, there have still been increases in this problem in the last couple of years. Mrs. Crosby added that even though since 1980 both Georgia Pacific and Pinova have by more than half decreased their daily withdrawals of water, the Chlorides continue to go up, and this may be something to continue to monitor. She then presented to the Committee the expected expenditures for the study to continue for the next year, and explained that for the cost for FY2018 the cost from FY2015 has continued to be held, and the funding is shared by USGS and JWSC. She also noted that as the water authority in the community that this is an important study to be maintained and continued. Mr. Junkin added that this was included in the budget for this new Fiscal Year. He also re-emphasized Mrs. Crosby's point that as the water and sewer utility and in the act of providing water for the community it behooves us to be the leader in managing it and making sure that action is taken when action is needed. We cannot take action or recommend action without knowing the details of what's really going on and seeing the trends of progress, positive or negative. He wanted to go on record as strongly supporting the need and desire to show the ownership of the processes that belong to us as we act here in the community. There was further discussion by the Committee regarding the study and the funding thereof. Additional information will be gathered before this item is brought before the full Commission.

Chairman Elliott requested an update on the first contract for the SPLOST project. Mr. Junkin advised that the kickoff meeting had been held with discussion of progress towards the 30% design. It was also noted that pump selections had been made, and that progress is where it was expected to be. Discussion continued with updates regarding various projects that are new, ongoing and those nearing completion such as Lift Station 2032, Holly Street Project, Alder Street, Urbana, Mansfield, Canal Crossing, Altamaha, Force Main on Harry Driggers Blvd., State Road 99, etc.

EXECUTIVE DIRECTOR'S UPDATE
Mr. Junkin updated the Committee on some informal projects. Staff is working on some temporary upgrades to Lift Station 4003. There are some needs for capacity that cannot wait 18-24 months until SPLOST Project to get started and completed and other downstream issues. Staff is working on coming up with a near term package plan and bridge that gap in capacity and time until we get the SPLOST Project completed. Pricing on the temporary project is being obtained. This will give a temporary bypass to Lift Station 4003.

Meeting was adjourned at 3:43 pm.

Clifford Adams, Chairman

Attest:

Janice Meridith,
Executive Commission Administrator

Brunswick-Glynn County
Joint Water and Sewer Commission

MEMORANDUM

To: JWSC Facilities Committee

From: Pam Crosby, Director of Procurement

Date: July 13, 2017

Re: Surplus Inventory/Equipment – Approval to Full Commission

Background

JWSC staff has determined the following assets to no longer be of use to the mission of the JWSC.

DIVISION	YEAR	MAKE	MODEL	VIN
WWTD-102	1997	Ford	Ranger	1FTCR14U0VPA46559
WWTD-105	1997	Ford	F-250	1FTEF2763VNC91176
WWTD-106	1997	Ford	F-150	1FTEF15Y1TLB55720
P/CD-106	2004	Ford	F-150	2FTRF172X4CA79064
SP/MD-605 (S33)	1980	Mack	R686ST	1GDKP32Y5R3500316

Staff recommends declaring the items identified on the attached listing as surplus and authorizing their disposal in a manner most beneficial to the JWSC.

To dispose of this property, the Brunswick-Glynn Joint Water and Sewer Commission must declare the property as surplus. Once declared surplus, the Director of Procurement will dispose of the property in a manner most beneficial to the JWSC.

Staff Recommendation

Staff recommends declaring the surplus equipment, identified above as surplus, to be forwarded to full Commission to authorize its disposal in a manner most beneficial to the JWSC.

Enclosure:
Surplus Update – July 2017

Motion: ***"I make a motion that the Brunswick Glynn County Joint Water & Sewer Commission approve the additional items to be declared as surplus and disposed of in a manner most beneficial to the JWSC."***

Pamela Crosby

Subject: FW: Facilities Memo --surplus

From: Matthew Lemke
Sent: Wednesday, July 12, 2017 9:17 AM
To: Pamela Crosby <PCrosby@bgjwsc.org>; Christa Free <CFree@bgjwsc.org>
Subject: RE: Facilities Memo --surplus

Pam,

WWTD-102: 175,000 miles, no A/C, steering linkage needs replaced, motor knocks bad (probably needs rear main seal $$), extensive body rust
WWTD-105: 259,606 miles, no A/C, transmission slips,
WWTD-106: 189,405 miles, no A/C, fuel tank rusted out, interior is completely held together with duct tape.
PCD-106: 218,000 miles, motor needs extensive repairs, transmission needs replaced/rebuilt
Case skid steer: Bucket rusted out, no neutral which means extensive repairs needed for drives (transmission), very very unsafe to even start.
John Deere mini: Bent boom, left side final drive needs replaced (estimated $15k to repair)
Mack truck: Unused vehicle, extensive rust, unknown if it runs

In cooperation with the Brunswick-Glynn County Joint Water and Sewer Commission

Saltwater Intrusion in the Floridan Aquifer System Near Downtown Brunswick, Georgia, 1957–2015

Introduction

The Floridan aquifer system (FAS) consists of the Upper Floridan aquifer (UFA), an intervening confining unit of highly variable properties, and the Lower Floridan aquifer (LFA). The UFA and LFA are primarily composed of Paleocene- to Oligocene-age carbonate rocks that include, locally, Upper Cretaceous rocks (Miller, 1986; Krause and Randolph, 1989). The FAS extends from coastal areas in southeastern South Carolina and continues southward and westward across the coastal plain of Georgia and Alabama, and underlies all of Florida. The thickness of the FAS varies from less than 100 feet (ft) in aquifer outcrop areas of South Carolina to about 1,700 ft near the city of Brunswick, Georgia (Williams and Kuniansky, 2015).

Locally, in southeastern Georgia and the Brunswick–Glynn County area, the UFA consists of an upper water-bearing zone (UWBZ) and a lower water-bearing zone (LWBZ), as identified by Wait and Gregg (1973), with aquifer test data indicating the upper zone has higher productivity than the lower zone. Near the city of Brunswick, the LFA is composed of two permeable zones: an early middle Eocene-age upper permeable zone (UPZ) and a highly permeable lower zone of limestone (LPZ) of Paleocene and Late Cretaceous age that includes a deeply buried, cavernous, saline water-bearing unit known as the Fernandina permeable zone (Krause and Randolph, 1989). Maslia and Prowell (1990) inferred the presence of major northeast–southwest trending faults through the downtown Brunswick area based on structural analysis of geophysical data, northeastward elongation of the potentiometric surface of the UFA, and breaches in the local confining unit that influence the area of chloride contamination. Pronounced horizontal and vertical hydraulic head gradients, caused by pumping in the UFA, allow saline water from the FPZ to migrate upward into the UFA through this system of faults and conduits.

Saltwater was first detected in the FAS in wells completed in the UFA near the southern part of the city of Brunswick in late 1957 (Wait, 1965). By the 1970s, a plume of groundwater with high chloride concentrations had migrated northward toward two major industrial pumping centers, and since 1965, chloride concentrations have steadily increased in the northern part of the city (fig. 1). In 1978, data obtained from a 2,720-ft-deep test well (33H188; fig. 2) drilled south of the city showed water with a chloride concentration of 33,000 milligrams per liter (mg/L), suggesting the saltwater source was located below the UFA in the Fernandina permeable zone (FPZ) of the LFA (Jones and others, 2002).

All U.S. Geological Survey (USGS) data collected for this study, including groundwater levels in wells and water-chemistry data, are available in the USGS National Water Information System (U.S. Geological Survey, 2016).

South side of Jekyll Island, Georgia.
Photograph by Alan M. Cressler, USGS.

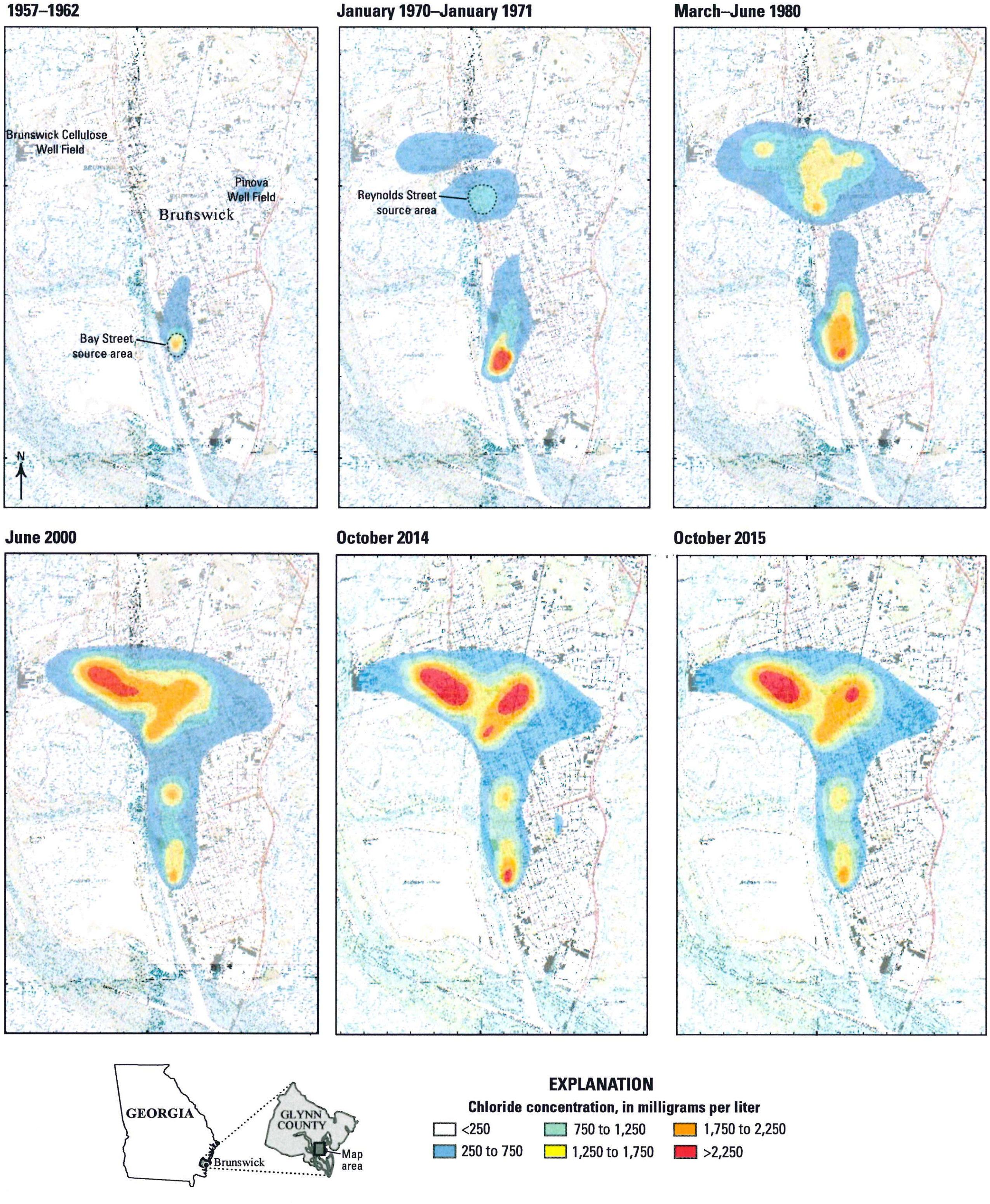

Figure 1. Chloride concentration in the upper water-bearing zone of the Upper Floridan aquifer in Brunswick, Georgia.

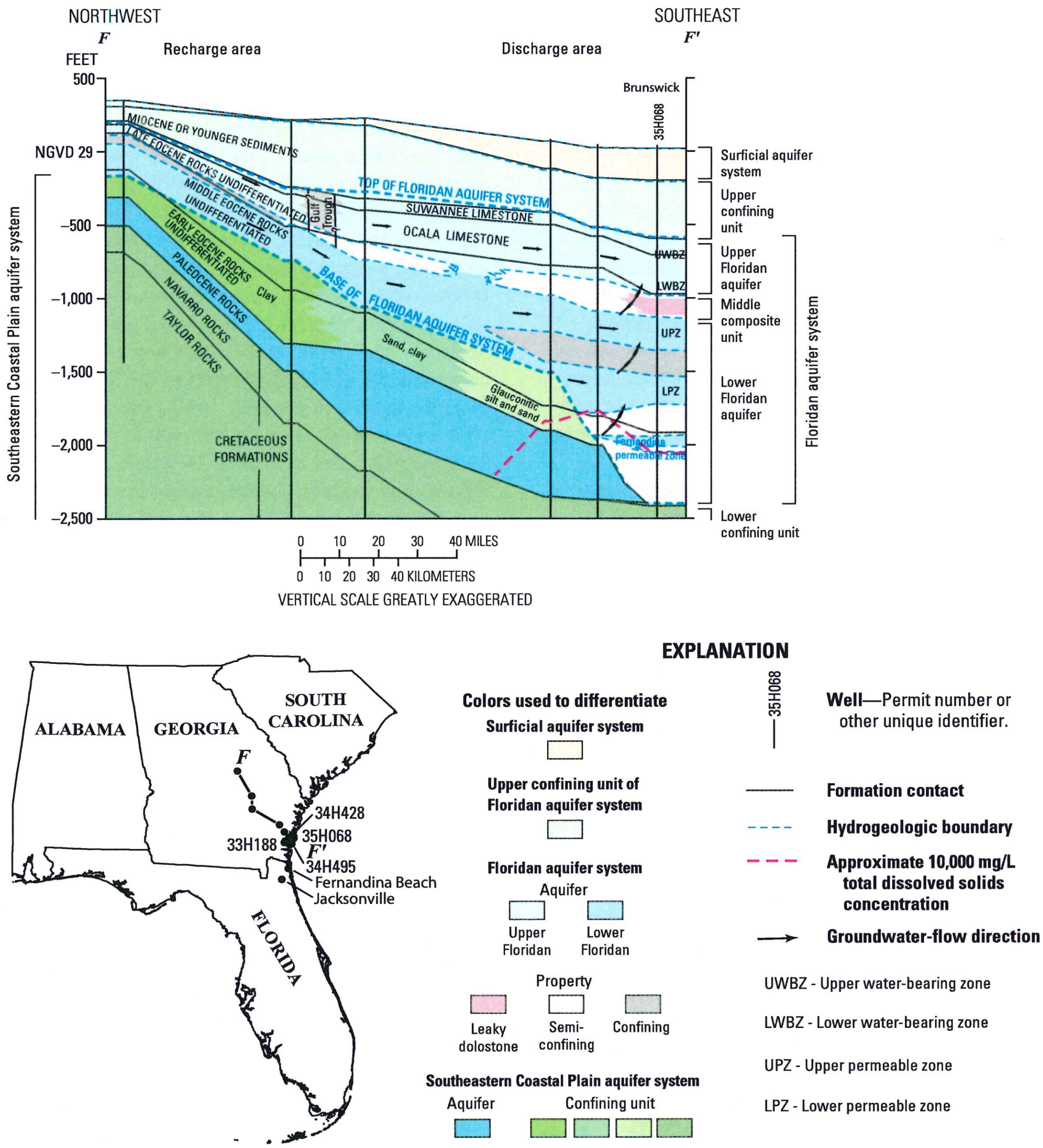

Figure 2. Generalized hydrogeologic cross section *F–F'* and groundwater-flow directions (modified from Williams and Kuniansky, 2015).

Groundwater Levels, Groundwater Pumping, and Flow in the Floridan Aquifer System

Prior to development of the UFA in the late 1800s, groundwater levels in the Brunswick area were estimated to be as high as 55 ft above land surface [65 ft above the North American Vertical Datum of 1988 (NAVD 88)] and groundwater flow was in an easterly direction toward the coast (Johnston and others, 1980). Since that time, the UFA has become a major source of water supply for industrial and municipal use along coastal Georgia, including Glynn County and the city of Brunswick. In Glynn County, large withdrawals began in the early 1940s, mostly by industry, and increased by 11.6 million gallons per day (Mgal/d) between 1950 and 1960 to a reported total of 55.3 Mgal/d during 1960 (Cherry and others, 2011). Groundwater use peaked in the early 1980s with reported average annual pumping rates of 58.8 and 19.5 Mgal/d at Brunswick Cellulose Inc. and Pinova Inc. (formerly Hercules Inc.), respectively, and an average annual pumping rate of 9.8 Mgal/d (fig. 3) for public supply (Krause and Randolph, 1989; Jones, 2001).

A steady increase in pumping since predevelopment caused groundwater-level declines in the UFA ranging from 20 ft in southernmost Glynn County to as much as 80 ft near pumping centers in northern Brunswick. This increase altered the natural groundwater-flow direction from eastward toward the coast to north and northeast toward the center of pumping in Brunswick (Jones, 2001). Groundwater use near the city of Brunswick has steadily declined since 1990. Water conservation measures in effect during late 2011 at the Brunswick Cellulose well field reduced pumping from about 35 Mgal/d to 23.3 Mgal/d during 2015 (S. Swan, Brunswick–Glynn County Joint Water and Sewer Commission, written commun., August 2015). A similar decline in groundwater use occurred at the Pinova well field, with a reduction in pumping from about 6 Mgal/d in 2010 to 4.2 Mgal/d during 2015. Pumping for public supply in Brunswick–Glynn County also decreased slightly from 9.8 Mgal/d during 1980 to 9.3 Mgal/d in 2015. Groundwater use from the UFA for public supply in Brunswick–Glynn County declined despite an increase in population from 54,980 persons in 1980 to 83,579 in July 2015 (U.S. Census Bureau, 2015).

Water levels in the UWBZ of the UFA (well 34H328; fig. 3) are primarily influenced by changes in pumping. The early part of the record from 1939 to 1948 indicates that water levels were about 40 ft above NAVD 88. Over the following 30 years, as pumping increased, water levels declined by more than 30 ft, and a cone of depression formed near the industrial well fields in the northern part of Brunswick. This period was followed by a recovery in water levels in the early 1980s, when industrial groundwater users reduced pumping by 23.5 Mgal/d. Since the mid-1980s, water levels in well 34H328 have ranged between 8.5 and 14.3 ft above NAVD 88. During the peak of groundwater use in the early 1980s, the water levels in the UFA were near sea level (NAVD 88) in the northern part of the Brunswick area and about 15 ft below NAVD 88 near the industrial well fields (Johnston and others, 1980).

During October 2015, water levels from continuous recorders and synoptic water-level measurements were collected from 50 wells completed in the UWBZ of the UFA. The potentiometric surface map (fig. 4) constructed using these water-level data indicates the general direction of groundwater flow is from the southwest in neighboring Camden and Brantley Counties towards the northeast across Glynn County and into McIntosh County. The water-level contours indicate that a portion of groundwater flow is captured and directed toward pumping centers in northern Brunswick. This captured flow is evident from the 15- and 10-ft contours that surround the pumping centers, indicating groundwater flow toward downtown Brunswick from the southwest, the southeast, and

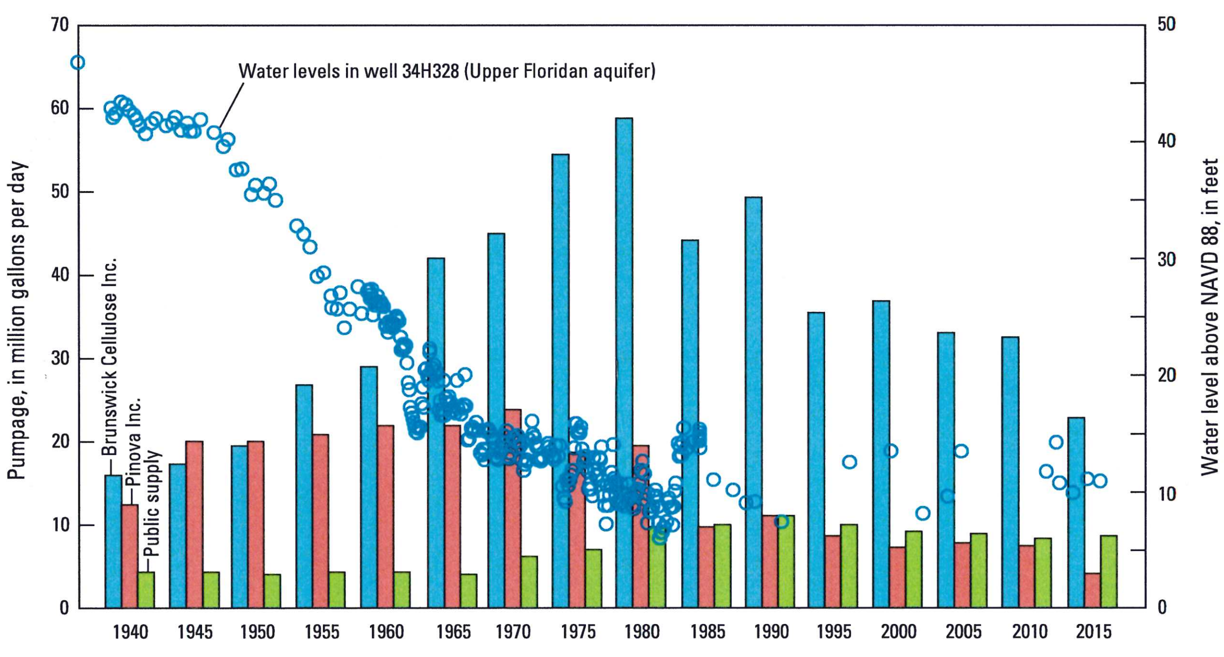

Figure 3. Major groundwater pumpage from the Upper Floridan aquifer in the Brunswick–Glynn County area, Georgia, 1940–2015 and water levels in well 34H328, 1939–2013 (see fig. 2 for well location).

the north. The map of downtown Brunswick (inset, fig. 4) shows the 10-ft contour covering the northwest part of the city near the Brunswick Cellulose well field, which is an indication of the continued presence of a cone of depression caused by pumping. However, when compared to previous contour maps, the October 2015 potentiometric contours near the Brunswick Cellulose well field indicate that water levels have increased since the peak of pumping during 1980.

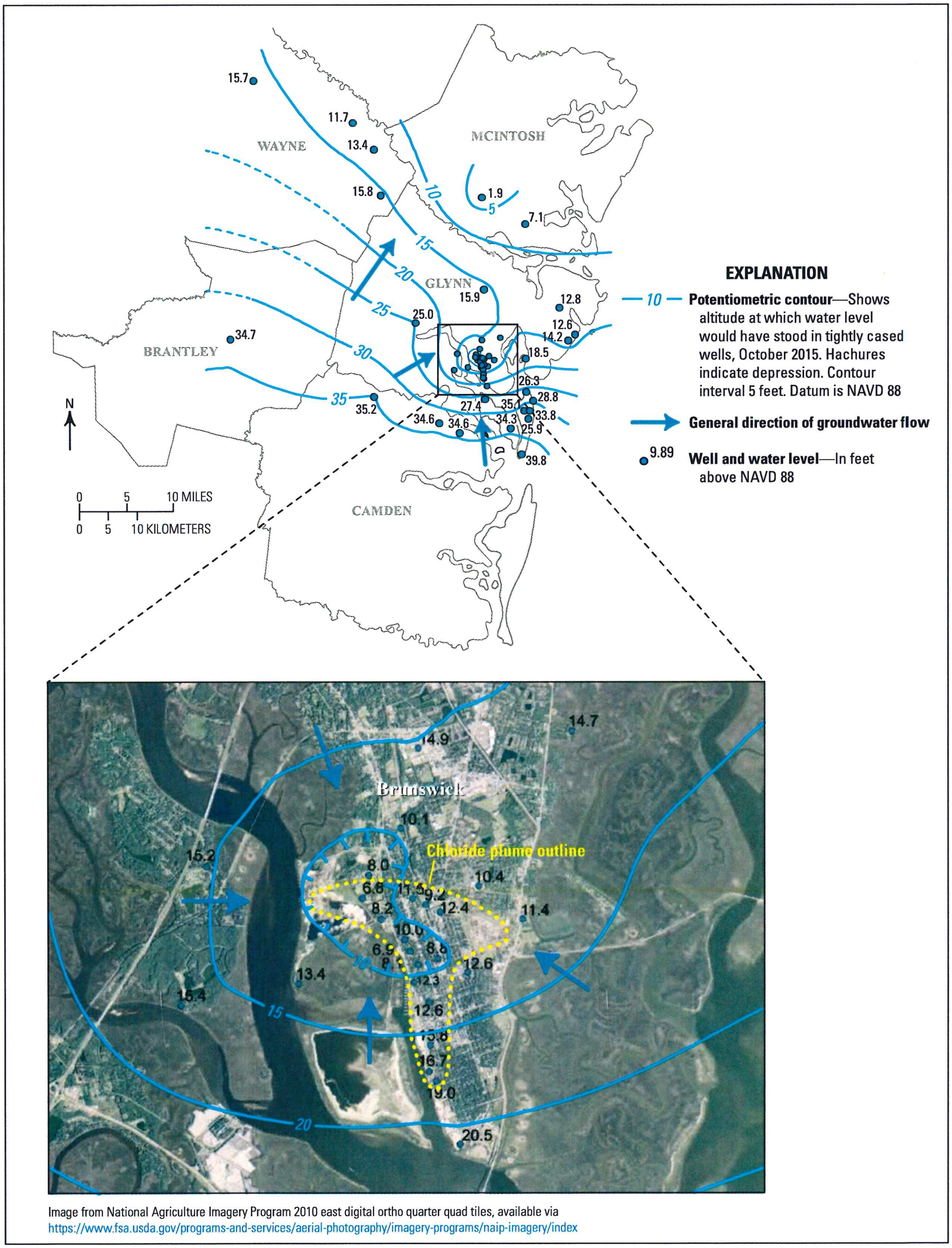

Figure 4. Potentiometric surface of the Upper Floridan aquifer, Brunswick–Glynn County, Georgia, October 19–22, 2015.

Chloride Concentrations in the Upper Floridan Aquifer

The area of chloride contamination in the UWBZ of the UFA near the city of Brunswick during October 2015 was mapped using groundwater samples collected from 33 wells. The chloride concentration in an approximate 2-square-mile area near the city of Brunswick was greater than the 250-mg/L State and Federal secondary maximum contaminant level (SMCL) (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000) and exceeded 2,250 mg/L in part of the area (fig. 1). The extent of chloride concentrations shown on the October 2014 and 2015 maps is similar to the extent shown on the map published for 2000 (Hamrick and Cherry, 2015), with areas of highest chloride concentration found in the northern part of the city, as well as near the Bay Street source area in the southern part of the city (fig. 1). The potentiometric surface map (fig. 4) of the UWBZ of the UFA near downtown Brunswick indicates that the groundwater-flow direction is northwest from the Reynolds Street source area (fig. 1) toward the Brunswick Cellulose well field. The long-term changes in chloride concentration are consistent with the primary groundwater-flow direction, which controls the lateral movement of chloride from the Bay Street source area (fig. 1) toward the north and then from the Reynolds Street source area toward the industrial well fields. Low horizontal hydraulic head gradients in the UWBZ of the UFA toward the Pinova well field, or another source of chloride contamination, possibly allow an area of elevated chloride concentrations to extend to the northeast from the Reynolds Street source area.

A comparison of results from separate groundwater samples collected during October 2014 and October 2015, in 12 wells open to the UWBZ of the UFA, indicates a maximum increase in chloride concentration of 8.8 mg/L and a maximum decrease of 390 mg/L (fig. *5A*). The outline of the chloride plume is shown in figure *5A* for the UWBZ of the UFA. The maximum decrease in chloride concentrations was reported in well 34H393 (390 mg/L), located within the Bay Street source area. Increases in chloride concentrations were limited to 8.8 mg/L in well 34H344, located south of the Pinova well field. Chloride concentrations in the northern part of the chloride plume, near the Reynolds Street source area, decreased in wells 33H130 (310 mg/L), 34H424 (320 mg/L), and 33H133 (230 mg/L). The mean decrease in chloride concentration for 12 wells over the 1-year period was 145 mg/L.

A comparison of results from separate groundwater samples collected during October 2014 and October 2015, in six wells open to the LWBZ of the UFA, indicates a maximum increase in chloride concentration of 70 mg/L and a maximum decrease of 320 mg/L (fig. *5C*). Near the Reynolds Street source area, within the central part of the chloride plume, decreases in chloride concentration ranged from 320 mg/L (well 34H402) to 20 mg/L (well 34H354). Decreases in chloride concentration were also evident near the industrial well fields, with an 80-mg/L decrease in well 34H334 south of Pinova and a 250-mg/L decrease in well 33H154, which is located east of the Brunswick Cellulose plant. The mean decrease in chloride concentration for the six wells was 124 mg/L.

Due to increasing chloride levels in well 34H134, modifications were made to the well to reduce water inflow from the deeper part of the aquifer. The bottom of the well, between the depths of 942 ft and 724 ft, was sealed with concrete grout, thereby eliminating water production from a 218-ft zone that yields higher chloride water. Subsequently, a water sample collected by the USGS in October 2015 from the modified well 34H560 showed a decrease of 26 mg/L in the chloride concentration (fig. *5A*) since the plugging of the lower zone, which indicates a slight reduction in the upward migration of chloride into the open interval of the well. Chloride concentrations have increased in well 34H134/34H560 from near background levels (20 to 30 mg/L) during June 2000 (32.0 mg/L) to 96 mg/L for the sample collected during October 2015 (fig. *5B*). This increase in chloride suggests either a lateral movement of chloride in the UWBZ from the plume or the continued upward migration of chloride from lower depths. In late 2009, well 34H134/34H560 was equipped to monitor daily changes in specific conductance. Specific conductance is a surrogate for chloride concentration and is used to monitor the potential movement of saltwater into the freshwater zones of the UFA (Cherry and others, 2011).

Decreases in the chloride concentration in several wells open to the UPZ in the LFA suggest reduced upward flow from the LFA into the UWBZ and LWBZ of the UFA. The groundwater sample collected in October 2015 at well 34H391, which taps the UPZ of the LFA, had a chloride concentration of 2,430 mg/L, indicating a decrease of 540 mg/L when compared with the sample taken in October 2014. Results from water samples collected from LFA well 34H399, which is open to a slightly deeper interval of the UPZ than well 34H391, indicated a chloride concentration of 5,530 mg/L during October 2015 and a decrease of 130 mg/L over a 1-year period. Well 33H188, which is open to the deeper FPZ of the LFA, had a chloride concentration of 11,500 mg/L during July 2013. Results from a discrete groundwater sample collected from well 34H495 (location shown in fig. 2), at a depth of 2,720 ft (lower portion of FPZ) during August 2000, had a chloride concentration of 26,000 mg/L, which is higher than the 19,000-mg/L chloride concentration of modern seawater (Hem, 1989; Falls and others, 2005).

A comparison of results from separate groundwater samples collected during June 2000 and October 2015, in 12 wells open to the UWBZ of the UFA, indicates a maximum increase in chloride concentration of 550 mg/L and a maximum decrease of 678 mg/L (fig. *5B*). The maximum increase in chloride concentration was reported in well 33H133 (550 mg/L), east of the Brunswick Cellulose plant. Well 34H424 had a chloride increase of 230 mg/L, which coincides with one of the two areas with the greatest chloride concentrations north of the Reynolds Street source area. The maximum decrease of 678 mg/L (well 34H469) was also located in the northern part of the chloride plume and may be the result of preferential flow paths and changes in local hydraulic head gradient caused by nearby pumping. Well 34H393, located within the Bay Street source area, had a decrease in its chloride concentration of 90 mg/L. North of well 34H393, chloride concentrations decreased in wells 34H112 (230 mg/L), 34H125 (317 mg/L), and 34H434 (190 mg/L). The mean decrease in chloride concentrations for 12 wells over the 16-year period (June 2000–October 2015) was 54 mg/L.

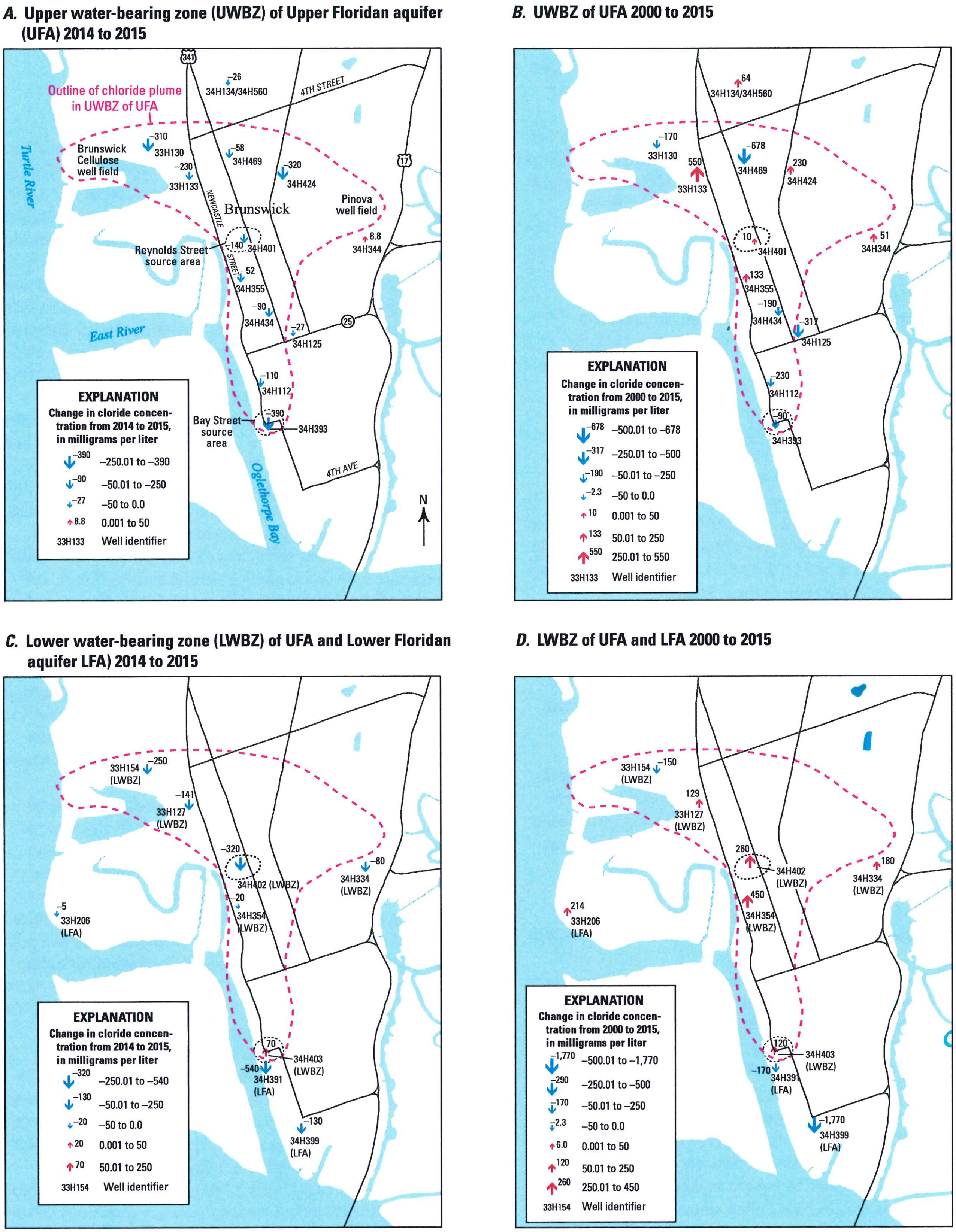

Figure 5. Change in chloride concentration in the Upper and Lower Floridan aquifers in the Brunswick area, Georgia.

A comparison of results from separate groundwater samples collected during June 2000 and October 2015, in six wells open to the LWBZ of the UFA, indicates general increases in chloride concentration ranging from 120 mg/L (well 34H403) to 450 mg/L (34H354; fig. 5*D*). The mean increase in chloride concentration in four wells (33H127, 34H402, 34H354, and 34H334) located near the Reynolds Street source area was 255 mg/L. The mean increase in chloride concentration for six wells open to the LWBZ of the UFA was 172 mg/L. Increases in the chloride concentration in well 34H334 (180 mg/L) suggest the lateral movement of chloride in the LWBZ of the UFA outside the current inferred boundary of the chloride plume in the UWBZ of the UFA. The only decrease in chloride concentration in the LWBZ of the UFA over the 16-year period was the 150-mg/L decrease reported in well 33H154.

A comparison of results from separate groundwater samples collected during June 2000 and October 2015, in three wells open to the UPZ of the LFA, indicates an increase in the chloride concentration in well 33H206 of 214 mg/L and decreases of 1,770 mg/L in well 34H399 and 170 mg/L in well 34H391. These results suggest a continued vertical migration of chloride from the FPZ of the LFA into the UFA near the Brunswick Cellulose well field. These results also suggest a change in the vertical hydraulic head gradient near the Bay Street source area that has reduced chloride concentrations in wells 34H391 and 34H399. The chloride distribution within the LWBZ of the UFA and UPZ of the LFA are difficult to map because fewer wells are open to these zones.

Additional groundwater samples were collected from seven production wells at Brunswick Cellulose to assess the vertical movement of chloride near the Brunswick Cellulose well field (fig. 6). The seven active production wells tap different water-bearing zones of the UFA, with three wells open to the UWBZ of the UFA and four wells open to both the UWBZ and LWBZ of the UFA. The chloride concentrations in the three production wells open to the UWBZ of the UFA ranged from 18.5 to 75 mg/L and are located outside of the chloride plume area. The chloride concentrations in the four production wells open to the UWBZ and LWBZ of the UFA ranged from 176 to 1,000 mg/L. In three of these four production wells, chloride concentrations exceeded the SMCL of 250 mg/L, indicating a deterioration of water quality with depth and suggesting greater rates of lateral movement of chloride within the LWBZ.

Additional groundwater samples were collected from two production wells at the Pinova well field to assess the lateral movement of chloride in the UWBZ of the UFA near the well field. Numerous production wells at Pinova were originally constructed in the UWBZ and LWBZ, but open intervals tapping the LWBZ were plugged during the mid-1960s to improve water quality in the well field (Cherry and others, 2011). Results from the samples collected during October 2015 indicate a sharp transition in chloride concentration from near background levels of 16.9 mg/L in well 34H450, which is located outside the chloride plume area, to 533 mg/L in well 34H413, which is located near the center of the facility (fig. 6). These two wells are located approximately 1,360 ft apart. The USGS well-cluster site located south of the Pinova well field has a well open to the UWBZ and another well open to the LWBZ of the UFA. Chloride concentrations from samples collected during October 2015 show chloride levels above background (70 mg/L) in well 34H344, which is open to the UWBZ, and elevated chloride levels (1,180 mg/L) in well 34H334, which is open to the LWBZ of the UFA.

Water Chemistry of the Upper Floridan Aquifer

Water samples were collected and analyzed for major ions from seven production wells tapping the UWBZ of the UFA and from six production wells tapping both the UWBZ and LWBZ of the UFA. The results of the analyses indicate that groundwater chemistry changes with depth in the UFA and approaches the composition of modern seawater in the FPZ of the LFA. Previous analyses performed by Falls and others (2005) show the isotopic composition of groundwater in the FPZ of the LFA to be fossil seawater trapped in the formation. The groundwater chemistry of the chloride plume in the UFA near downtown Brunswick indicates it is a mixture of about 10 to 20 percent of FPZ fossil seawater and 80 to 90 percent freshwater from the UFA.

A trilinear plot was used to classify the water type of the UWBZ and the LWBZ of the UFA based on major cation and anion compositions (Piper, 1944). The major ion compositions were plotted as a percentage of total milliequivalents per liter for the major cations and anions for 13 groundwater samples (fig. 7). The major ion compositions of groundwater from several depth intervals within the FPZ of the LFA and modern seawater are included to show potential sources (Hem, 1989; Falls and others, 2005). The trilinear plot indicates groundwater from the UWBZ of the UFA is a mix of cations, with calcium (Ca^{2+}) plus magnesium (Mg^{2+}) ranging from 74 to 85 percent, and the remaining 15 to 26 percent from sodium (Na^{+}). Potassium (K^{+}) is considered a minor component, with concentrations ranging from 1.7 to 2.2 mg/L. The anion composition is a mix of sulfate (SO_4^{2-}) plus chloride (Cl^{-}) ranging from 54 to 71 percent, with the remaining 29 to 46 percent composed of bicarbonate (HCO_3^{-}).

The most noticeable change, with the introduction of groundwater from the LWBZ of the UFA, is the increase of the anion chloride and the cation sodium, which is a major component of trapped fossil seawater from the FPZ of the LFA. The trilinear plot indicates mixed groundwater from wells open to the UWBZ and LWBZ of the UFA is composed of 33 to 61 percent sodium and 39 to 67 percent calcium plus magnesium. The anion composition is dominated by sulfate plus chloride ranging from 71 to 95 percent and 5 to 29 percent bicarbonate. The trilinear plot shows groundwater transitions, along with increased depth, from a calcium-magnesium-chloride-sulfate type to a chloride type. The groundwater chemistry of two samples collected from deep well 34H495 and a sample from modern seawater were used as endmembers or potential sources. The composition of modern seawater is 78 percent sodium, 22 percent calcium plus magnesium, and 99 percent sulfate plus chloride, with chloride and sulfate concentrations of 19,000 and 2,700 mg/L, respectively (Hem, 1989). Sprinkle (1989) attributed the major sources of dissolved constituents (common ions) in the FAS to the dissolution of calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), and gypsum ($CaSO_4 \cdot 2H_2O$) and the solubility of calcite (HCO_3^{-}). Chloride and sodium increase where freshwater and saltwater mix.

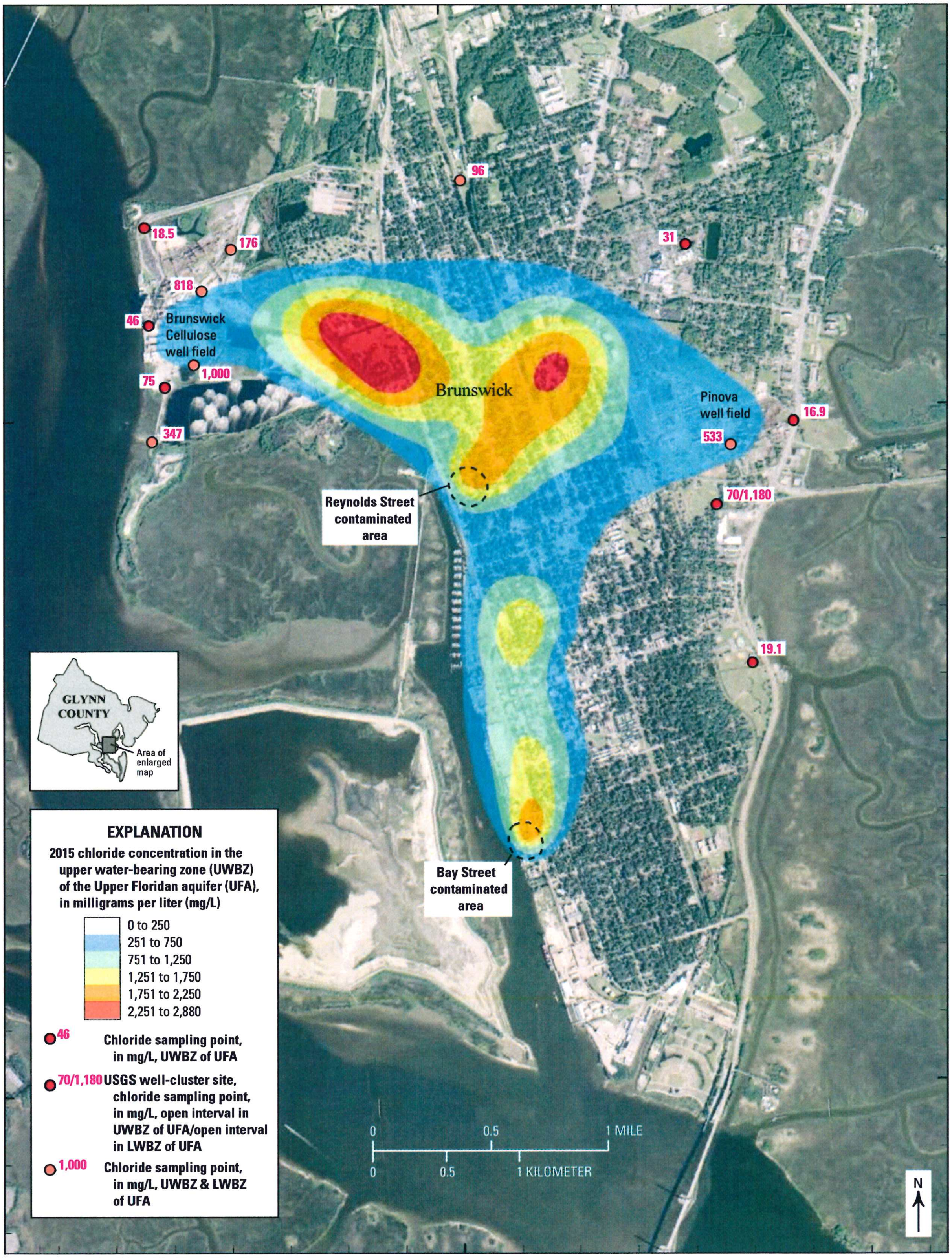

Image from National Agriculture Imagery Program 2010 east digital ortho quarter quad tiles, available via https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/index

Figure 6. Chloride concentration in the upper water-bearing zone (UWBZ) of the Upper Floridan (UFA) aquifer during October 2015 and chloride concentration at select production wells open to the UWBZ of the UFA and UWBZ and lower water-bearing zone (LWBZ) of the UFA in the Brunswick area.

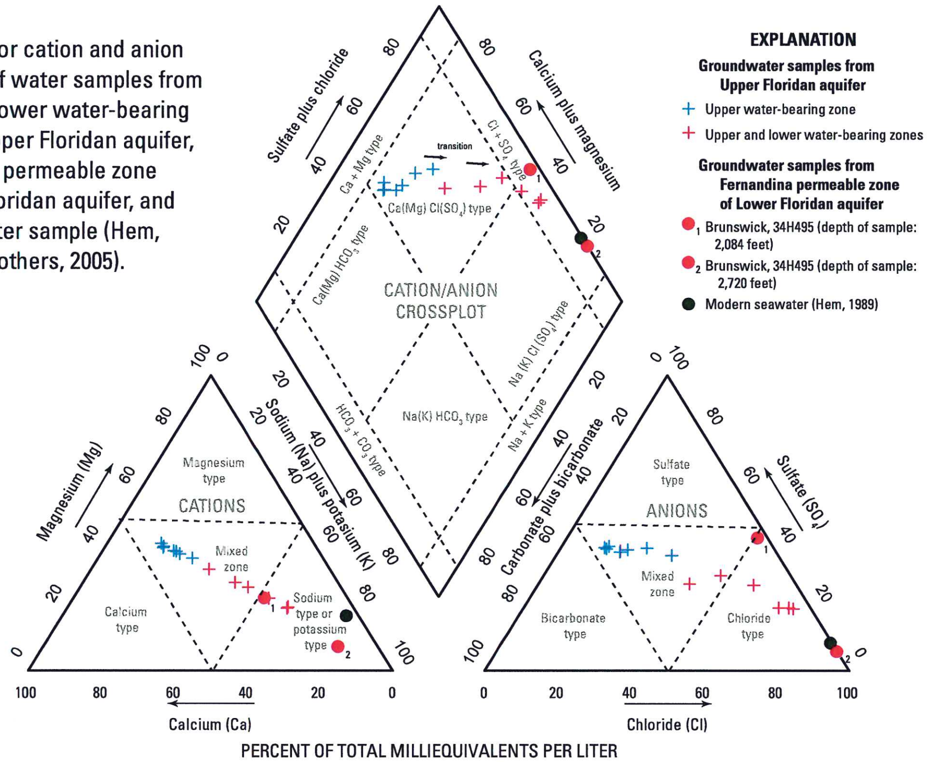

Figure 7. Major cation and anion compositions of water samples from the upper and lower water-bearing zones of the Upper Floridan aquifer, the Fernandina permeable zone of the Lower Floridan aquifer, and modern seawater sample (Hem, 1989; Falls and others, 2005).

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USGS/Brunswick–Glynn County Cooperative Water Program–State Fiscal Year 2018

Submitted to

Brunswick–Glynn County Joint Water and Sewer Commission

prepared by

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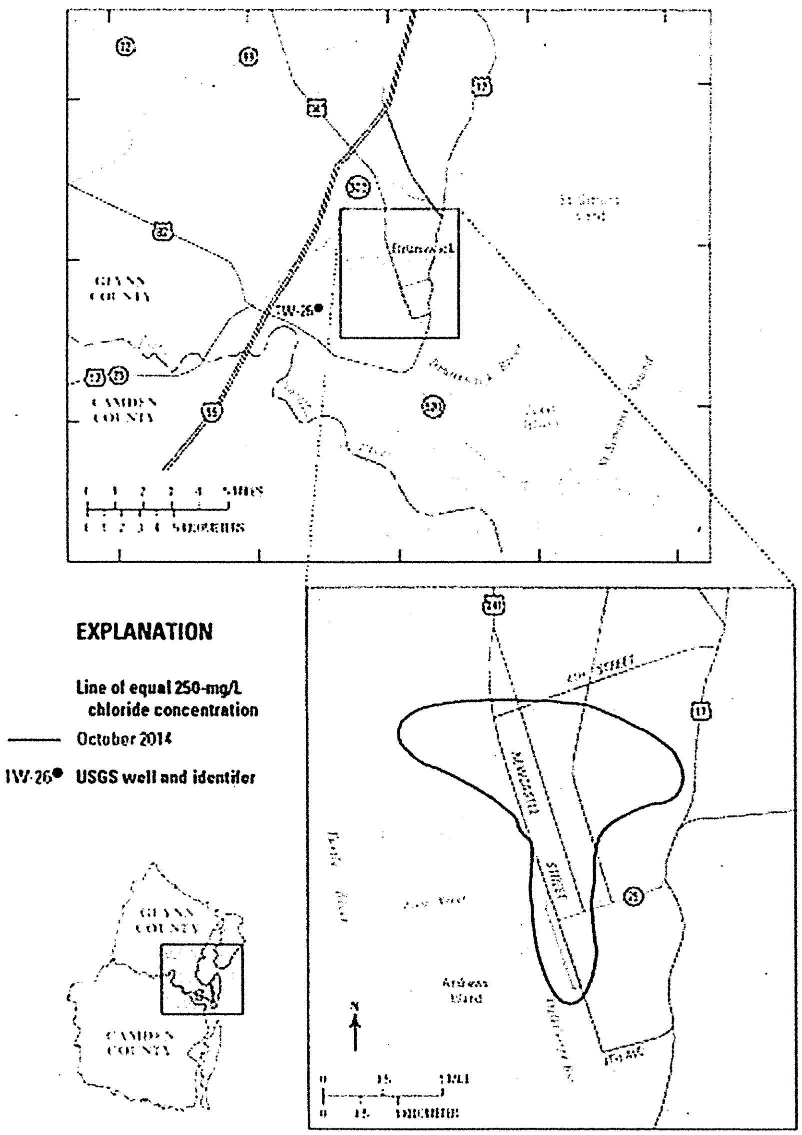
June 13, 2017

INTRODUCTION

In the Brunswick–Glynn County, Georgia, area (see figure below), saltwater has been entering the Upper Floridan aquifer (UFA) for about 50 years. As of 2015, within a 2-square-mile (mi^2) area in downtown Brunswick, the aquifer yielded water with a chloride concentration greater than 2,000 milligrams per liter (mg/L), which is greater than the State and Federal secondary maximum contaminant level of 250 mg/L (SMCL; Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). In 1978, data obtained from a 2,720-foot-deep test well (TW-26) drilled southwest of the city suggest the source of saltwater was located below the UFA in the Fernandina permeable zone (FPZ) of the Lower Floridan aquifer (LFA; Jones and others, 2002). A recent study of the Floridan aquifer system (FAS) by the U.S. Geological Survey (USGS) referred to this deeper interval as the Oldsmar permeable zone (Williams and Kuniansky, 2015). Saltwater contamination has limited further development of the UFA in the Brunswick area, prompting interest in the development of alternative sources of water supply, primarily from the shallower surficial and Brunswick aquifer systems. Monitoring groundwater conditions and performing studies to better define the occurrence of saltwater contamination and assess alternative water sources is important for proper management of water resources in the Brunswick–Glynn County area.



PROBLEM

Earlier delineation of the chloride plume area by Gregg and Zimmerman (1974) at Brunswick, in Glynn County, Ga., indicated the area with high chloride concentrations is controlled by the permeability of the UFA, local pumping rates by industry and public-supply providers, and horizontal and vertical hydraulic head gradients in the Floridan aquifer system (FAS). Groundwater use in the UFA peaked during 1980 at 88 million gallons per day (Mgal/d) and since that time implemented water conservation measures have reduced pumping rates to 37 Mgal/d during 2015. Areas with high chloride concentrations first appeared in the southern portion of the plume area during the early-1960s and in several decades had migrated north toward two industrial well fields (Cherry and Peck, 2017). The movement and extent of the chloride plume has forced the closure of several wells and three active public-supply wells are located less than a mile from the line of equal 250 mg/L chloride concentration.

OBJECTIVES

The objectives of the proposed saltwater intrusion study near Brunswick , Ga., are to assess solute movement since the previous sampling periods and simulate groundwater levels, flow directions, and possible movement of the chloride plume using a groundwater-flow model developed previously for this project (Cherry, 2015).

These objectives can be subdivided into specific tasks, which are listed sequentially:

- Continue maintenance and data collection from the 10-well continuous recorder network (including real-time Perry Park, Brunswick Villa, and Hospital plume-monitoring sites).
- Continue annual chloride sampling and analysis, and construct chloride-concentration and water-level maps for the October 2017 sampling event.
- Collect groundwater samples from 7 GP Cellulose, 2 Pinova Inc., and 3 Brunswick–Glynn County JWSC production wells for analysis of major ions and selected trace constituents to determine groundwater composition in the northern portion of the chloride plume and identify vertical interaction between the Upper and Lower Floridan aquifers.
- Continue development and updates for the project website including new capabilities for display of GIS data layers and continuous groundwater-level information.
- Develop solute transport model to evaluate various water-management scenarios in support of decisions in the Brunswick-Glynn County area, such as evaluating optimal pumping distribution to maintain plume position.

RELEVANCE AND BENEFITS

The analysis of chloride concentration in the FAS supports long-term data trend analysis of data collected since the mid-1960s and helps to identify high-chloride source areas in the LFA. The USGS has the skills needed to better define the hydrogeologic framework of aquifers, physical characteristics of watersheds, geochemical aspects of soil, land-cover change, land-use practices, and related environmental factors, all of which affect the movement of water and its quality (U.S. Geological Survey, 2007). In addition, management of water resources for multiple purposes will be improved by increased understanding of processes affecting water movement, storage, quality, and use, through a combination of new tools, concepts, and discoveries (Evenson and others, 2013). The study also supports GaEPD's initiative to decrease water consumption and find alternative water resources to the UFA. The collection of groundwater and hydrolgeologic data, development of a groundwater-flow model, and simulation of water management scenarios supports the USGS Water Strategy Goal 1, Objective 3 "Assessment of water resources and their suitability to meet human and ecosystem needs"; Goal 3, Objective 1 "Development and application of models to predict potential effects of changes in population, land use, climate, and management practices upond future water availability condsidering human and ecological needs"; and Goal 4, Objective 4 "Providing tools that allow managers to detect and respond to emergencies related to water-quality degradation of all kinds—natural, accidental, and intentional".

APPROACH

Data collection will include continued maintenance and operation of 10 continuous groundwater monitoring wells open to the upper Brunswick aquifer, UFA, and LFA. Three of these wells (34H560, 34H552, and 34H514) are equipped to measure real-time specific conductance data, which is used as a surrogate for chloride concentration, and is used to monitor the potential movement of saltwater into the freshwater zones of the UFA. A correlation between chloride concentration and specific conductance was established from 58 wells sampled during 2008 to predict a range of chloride concentration from the real-time specific conductance data (Cherry and others, 2010, p. 45). Real-time specific conductance probes will be recalibrated and cleaned in the field every two months to ensure the accuracy of the equipment and prevent instrument drift. The data from these groundwater sites along with synoptic water-level measurements collected at approximately 26 wells open to the FAS will be used to construct potentiometric-surface maps of the UFA and evaluate vertical hydraulic head gradients at 13 well cluster sites. The potentiometric-surface maps of the UFA will provide general groundwater-flow directions, horizontal hydraulic head gradients, and are influenced by local groundwater withdrawals. All water-level measurements collected at individual wells and downloaded from continuous monitoring wells will be input into the USGS National Water Information System (NWIS; http://waterdata.usgs.gov/ga/nwis/); all data will be served publicly via NWISWeb. Groundwater-level measurements from the continuous monitoring network provide essential data to evaluate changes in the groundwater resource over time and the effectiveness of groundwater management and protection programs (Taylor and Alley, 2001).

The annual groundwater sampling for chloride concentration from 40 to 50 wells with open intervals in the FAS will be used to determine the spatial distribution of the chloride plume in the upper water-bearing zone of the UFA. Groundwater samples will be collected in accordance with USGS sampling protocol where sufficient volume of water is purged from each well to ensure the dissolved chloride concentration is representative of the aquifer (U.S. Geological Survey, 2006). The groundwater samples collected for analysis of chloride concentration will be delivered to TestAmerica Laboratories Inc. (TAL) located in Savannah, Ga. TAL will perform analysis for specific conductance (method 120.1) and chloride concentration (method 325.2) within the specified 28-day holding times for each of the methods. The results will be provided to USGS staff in a final report issued by TAL within 14 days of analysis, including laboratory procedures for quality assurance and quality control (QA/QC). The final report submitted by TAL will be reviewed by USGS personnel for additional QA/QC prior to entry into the USGS NWIS database; all data will be served publicly via NWISWeb.

Groundwater samples will be collected from 12 production wells and analyzed for common ions to evaluate differences in water quality between the upper and lower water-bearing zones of the UFA. The identification of groundwater types within the FAS from this analysis and previous studies can assess potential sources of chloride contamination to the UFA. The groundwater samples will be collected and shipped to the USGS National Water Quality Lab (NWQL) located in Denver, CO., for analysis of common ions. The lab results will be reviewed by USGS personnel for additional QA/QC prior to entry into the USGS NWIS database; all data will be served publicly via NWISWeb. The reporting of cations (positively charged ions) include calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K). The reporting of anions (negatively charged ions) include bicarbonate (HCO_3), sulfate (SO_4), chloride (Cl), and fluoride (F). A profile of the chloride concentration during the drilling of 2,720 foot well TW-26 indicates a transition from the freshwater of the UFA to the relict seawater sampled in the FPZ of the LFA (Jones and others, 2002; Falls and others, 2005). The ratios of common ions expressed in milliequivalents can indicate differences in the sources of carbonate material and relative mixing between the UFA and the LFA.

The spatial analysis of data utilizes ArcGIS ArcMap to construct potentiometric-surface maps of the UFA in the Brunswick/Glynn County area and evaluate distribution of chloride concentration within the upper water-bearing zone of the UFA. The interpolation of water-level elevations from the 50 to 60 wells located in the Brunswick/Glynn County area produces 5-foot contours of the potentiometric surface of the UFA, which will be further refined upon review based on interpretation of data points and position of contours. Groundwater-flow directions are inferred as perpendicular to potentiometric surface contours with tightly spaced contours implying steeper hydraulic head gradients. Previous constructed potentiometric-surface maps of the UFA indicate general groundwater-flow directions from neighboring Camden County toward the downtown Brunswick area (Cherry and Peck, 2017). A cone of depression is evident in the northern portion of the chloride plume near the Brunswick Cellulose well field. The edge of the plume is defined by the line of equal 250 mg/L chloride concentration, or the SMCL for dissolved chloride (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). Groundwater samples for chloride concentration will be collected from 40 to 50 wells with open intervals in the FAS in addition to the groundwater samples collected from 12 production wells and analyzed for common ions. An interpolation will be performed using available data for chloride concentrations from wells open to the upper water-bearing zone of the UFA within or near the plume to identify the area (greater than 250 mg/L chloride; SMCL) with previous results indicating dissolved chloride values greater than 2,250 mg/L in several wells. Two chloride source areas have been identified with one at the southern base of the plume (Bay Street) and another where the plume widens toward the two industrial well fields (Reynolds Street).

The modified Brunswick groundwater model was calibrated to stressed steady-state for two annual periods, 2000 and 2004 based on availability of pumping data and water-level measurements (Cherry, 2015). This was a freshwater only model and did not include movement of solute within and near the boundaries of the chloride plume. Another longer-term project objective is to continue to evaluate various solute transport codes, which would have the capability of simulating chloride-plume movement in the FAS under current and future hydrologic conditions. The modified groundwater model of Cherry (2015) will be used to develop a solute transport model incorporating the history of groundwater pumping and groundwater-quality data (chlorides) collected since the early-1960s in the Brunswick/Glynn County area. Pumping distribution will be updated to incorporate new production wells in the Brunswick and Floridan aquifer systems and utilize the most recent pumping rates available. Groundwater-management scenarios using the new solute transport model will be developed based on the Brunswick–Glynn County Joint Water and Sewer Commission (JWSC) Master Plan, input from the Water Resources Management Advisory Committee (WRMAC) of Glynn County, and consultation with GaEPD. The number of groundwater-management scenarios will be capped between 6 and 8 based on consultation with stakeholders and groundwater users of the UFA in Glynn County. Simulated changes for each of the groundwater management scenarios will be documented in the final report, including assessment of groundwater-flow directions and relative rate of solute movement near the chloride plume.

PRODUCTS

Results from the October 2017 groundwater sampling and synoptic water-level measurements will be documented in a final USGS Fact Sheet (FS). The project website will be redesigned with significant findings from the October 2017 groundwater sampling and synoptic water-level measurements posted (http://ga.water.usgs.gov/projects/brunswick/). The generated potentiometric-surface and chloride plume maps of the upper water-bearing zone of the UFA are subject to an internal USGS review process for Data Releases and will be posted to the project website following final approval.

TIMELINE

Activity	State Fiscal Year 2018			
	Q1	Q2	Q3	Q4
Develop solute transport model				
Redesign project website				
Collection of groundwater data				
Data analysis				
Meeting to review results				
Final report draft				
Final publication of USGS FS				

The project duration is 12 months and the proposed timeline assumes a beginning on July 1, 2017 and ending on June 30, 2018. Any delay in the initiation of the project, which cannot start until the Joint Funding Agreement is signed, will result in a corresponding extension of the timeline but no increase in costs.

PERSONNEL

A USGS Hydrologist will serve as project chief on a part time basis to ensure proper quality control in the analysis of data and preparation of the final publication. Hydrologic Technicians will assist with the annual chloride sampling and collection of water-level measurements to assess local groundwater-flow directions and any changes in the position of the chloride plume. Members of the publications unit will assist with completion of illustrations and layout for final publication.

PROJECT BUDGET

Task	Cost
Develop solute transport model and run simulations	$103,075
Groundwater network (10 wells) and groundwater sampling	$110,975
Final publication of USGS Fact Sheet	$25,000
Total	$239,050

Funding	Cost
USGS	$110,000
Brunswick–Glynn County JWSC	$129,050
Total	$239,050

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United States Department of the Interior

U.S. GEOLOGICAL SURVEY
South Atlantic Water Science Center
720 Gracern Road, Suite 129
Columbia, SC 29210

June 12, 2017

Pamela Crosby
Director of Purchasing
Brunswick/Glynn County Joint Water and Sewer Commission
1703 Gloucester St.
Brunswick, GA 31250

Dear Ms. Crosby,

Enclosed are two signed originals of our standard joint-funding agreement for the project(s) South Atlantic Water Science Center Water Resources Investigations, during the period July 1, 2017 through June 30, 2018 in the amount of $129,050 cash from your agency. U.S. Geological Survey contributions for this agreement are $110,000 for a combined total of $239,050. Please sign and return one fully-executed original to Crystal Stallworth at the address above.

Federal law requires that we have a signed agreement before we start or continue work. Please return the signed agreement by **July 1, 2017**. If, for any reason, the agreement cannot be signed and returned by the date shown above, please contact Gregory Cherry by phone number (678) 924-6632 or email gccherry@usgs.gov to make alternative arrangements.

This is a fixed cost agreement to be billed quarterly via Down Payment Request (automated Form DI-1040). Please allow 30-days from the end of the billing period for issuance of the bill. If you experience any problems with your invoice(s), please contact Crystal Stallworth at phone number (678) 924-6691 or email at castallw@usgs.gov.

The results of all work performed under this agreement will be available for publication by the U.S. Geological Survey. We look forward to continuing this and future cooperative efforts in these mutually beneficial water resources studies.

Sincerely,

Brian E. McCallum
Acting Director

Enc.: 17ESMPG00000061(2)