Assessment of the Extent and Effectiveness of the Wellfield Protection Area and Ordinance:

The professional assessment of the geographic extent of the well field protection area and Ordinance A GIS based spatial analysis of GIS layers and development in conjunction with the County's East Milton Well Field Protection Project.

June 28, 2011

Submitted by Alan Baker, President,
Advanced GeoSpatial Inc.

Professional Geologist's Statement

he hydrogeologic analyses and interpretations assembled, discussed, and reported on in this document were prepared by a licensed Florida professional geologist as required by Chapter 492, Florida Statutes.

--------------------------------------- ---------------------------------------

Brandon N. Ashby, PG (#2589)
Independent Consulting Geoscientist

Alan Baker, PG (#2324)
President/Project Manager
Advanced Geospatial, Inc.

Certified Mapping Scientist's Statement

The mapping, GIS analyses, and professional interpretations conducted in support of this report were conducted pursuant to the Code of Ethics of the American Society for Photogrammetry and Remote Sensing (ASPRS).

Brandon N. Ashby, CMS-GIS/LIS (#GS241)
Independent Consulting Geoscientist

Introduction

In late 2010, Santa Rosa County (the County) developed an initial Wellfield Protection Zoning Overlay Area map (Figure 1), in conjunction with a Wellfield Protection Ordinance, for the purpose of source water protection in the East Milton area. The current wellfield protection area boundary was developed by the County based on the locations of the wells (and wellhead protection zones), the existence of a topographic divide which roughly parallels Highway 90, and based on land-uses in the vicinity of the wellfield. To ensure that the delineated area is sufficient to protect groundwater quality and vital recharge areas within the wellfield and the associated groundwater capture zones, the County has decided to undertake a hydrogeologic analysis of the wellfield and surrounding areas.

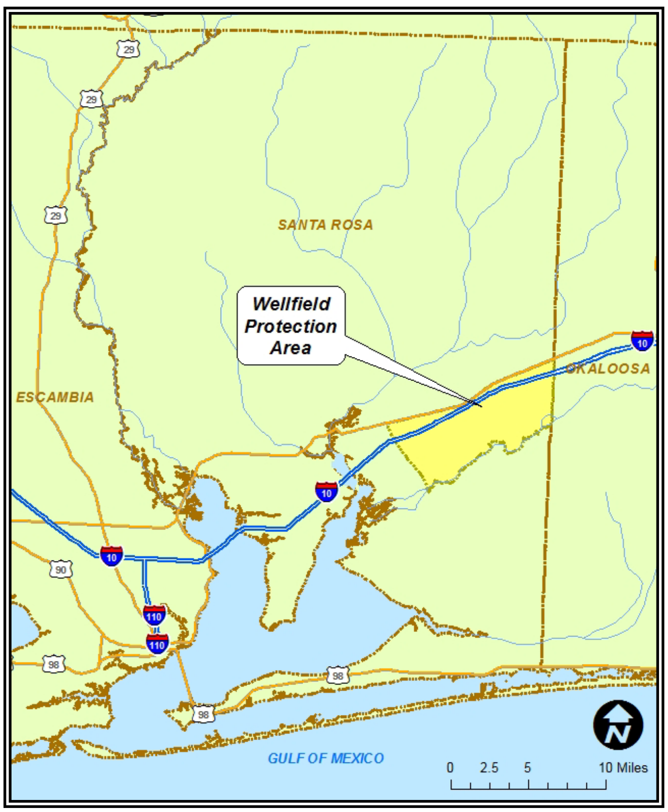

Figure1 – Location of the WPA in Santa Rosa County

This report provides an evaluation of the adequacy of the current Wellfield Protection Zoning Overlay Area Map and of the land-use limitations included in the initial Wellfield Protection Ordinance. Geospatial analyses were conducted using hydrogeologic data developed for use in Phase II of the Floridan Aquifer Vulnerability Assessment (FAVA) model, in addition to other relevant datasets and reports, to determine whether alterations to the extent of the currently protected area are warranted. FAVA Phase II included a detailed groundwater vulnerability assessment of the sand-and-gravel aquifer, which identified several areas within and adjacent to the current protected area which were deemed susceptible to contamination based on the FAVA modeling methodology. Furthermore, the report provides a series of recommendations on potential updates to both the Wellfield Protection Zoning Overlay Area Map and the initial Wellfield Ordinance. A metadata report, an informational poster, and a large-format informational poster with recommended updates to the existing Wellfield Protection Area (WPA) are provided as attachments to the report.

Project Background

The WPA encompasses two water systems, the Fairpoint Regional Utility System and East Milton Water System, which collectively supply drinking water to approximately 51% of the residences and businesses within the County. The two water systems collectively include 11 public supply wells with ten completed in the sand-and-gravel aquifer system. One Floridan aquifer system well is also located in the WPA and is operated by East Milton Water System. Additionally, there are two more proposed wells to be located within the WPA (Figure 2; Table 1). Both the East Milton Water System and the Fairpoint Regional Utility System (FRUS) operate wells in this area

The current WPA encompasses approximately 27,000 acres, and is bounded to the east by the Santa Rosa-Okaloosa County boundary and to the west by Highway 87. Highway 90, which generally follows a natural topographic divide between the Blackwater and Yellow Rivers, forms the northern boundary of the WPA. The WPA is bounded to the south by the Yellow River. Approximately 7% of the County's population lives within the WPA and a variety of commercial, agricultural, conservation, and institutional land-uses are currently present within the area (Table 2). The top three land-uses (by total acreage) within the WPA are publicly owned lands, recreation/open space, and silviculture, which collectively comprise approximately 64% of the total acreage of the WPA.

According to the 2009 Draft Santa Rosa County Water Supply Facilities Plan, the County population is projected to increase by approximately 26% between the years 2007 and 2025 (Miller, 2009). As a result of this growth, additional development is expected within and adjacent to the current WPA. This trend reinforces the need for effective groundwater protection measures within and adjacent to the WPA.

Table 1. Sand-and-Gravel aquifer system public supply wells in and adjacent to the current WPA

Map ID	*Well Name*	*Water System*	*Well Dia. (in.)*	*Cased Depth (ft.)*	*Total Well Depth (ft.)*	*Well Use*
1	EMW S#1	East Milton	16	200	246	Public Supply
2	EMW S#2	East Milton	16	143	183	Public Supply
3	EMW S#4	East Milton	24	200	260	Public Supply
4	EMW S#5	East Milton	24	170	270	Public Supply
5	FRUS #1	FRUS	24	185	275	Public Supply
6	FRUS #3A	FRUS	24	135	215	Public Supply
7	FRUS #3B	FRUS	24	135	215	Public Supply
8	FRUS #4	FRUS	24	170	260	Public Supply
9	FRUS #5	FRUS	24	140	220	Public Supply
10	FRUS #6	FRUS	24	170	260	Public Supply
11	FRUS #7B Test	FRUS	24	170	260	Test
12	EMW S#6 Test	East Milton	24	160	210	Test

Table 2. Land-Uses by Acreage and as a Percent of the Total WPA

Land use Designation	*Acreage*	*Percentage of Total WPA*
Agricultural	331.72	1.2
Agricultural Homestead	1149.48	4.3
Commercial	33.27	0.1
Industrial	138.80	0.5
Institutional	14.89	0.1
Military	787.75	2.9
Mixed Residential/Commercial	46.29	0.2
Office	29.75	0.1
Publicly-Owned Lands	3329.92	12.3
Recreation/Commercial	160.81	0.6
Recreation/Open Space	10676.39	39.5
Right-of-Way	907.75	3.4
Single Family Residential	3114.85	11.5
Silviculture	3276.84	12.1
Unclassified	184.16	0.7
Utilities	97.08	0.4
Vacant Lands	2691.26	10.0
Water	25.92	0.1
	Total Acreage = 26996.95	

The initial Wellfield Protection Ordinance outlines zoning and land-use restrictions for the WPA and provides several important updates to the County's individual wellhead protection zone regulations. Article 6.05.25 specifically prohibits certain activities and land-uses within the WPA, including the following:

1) Landfills
2) Resource Extraction activities
3) Underground fuel storage activities
4) The bulk storage, handling, or processing of materials listed as Hazardous or Extremely Hazardous on Table 302.4 of 40 CFR and Appendix A to 40 CFR, part 355, respectively, and
5) Mines or mining activities.

Article 12.13.02 mandates additional land-use limitations within the County's wellhead protection zones, which are defined as 500-foot buffer zones around each public supply well completed in the sand-and-gravel aquifer system.

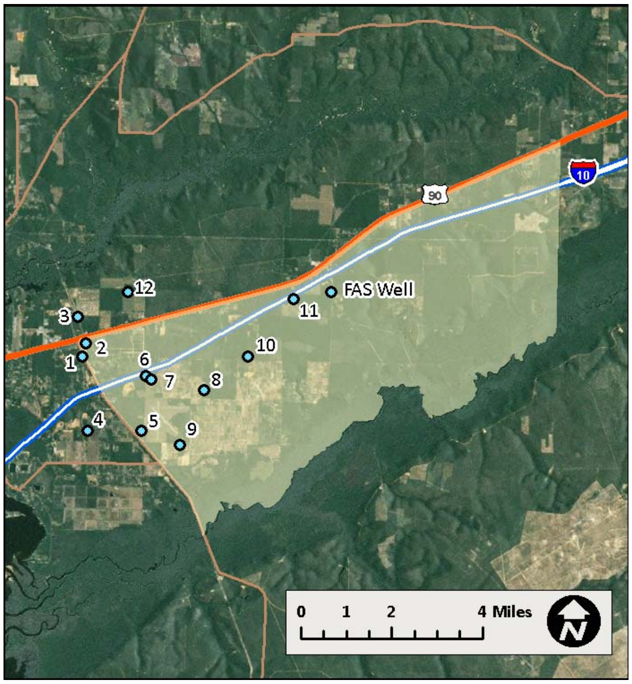

Figure 2 – FRUS and EMWS public supply wells in and around the WPA

The following land-uses are prohibited within the wellhead protection zones:

1) *Landfills, resource extraction areas, and the like;*
2) *Underground fuel storage facilities;*
3) *Projects with impervious cover of 50% or more;*
4) *The bulk storage, handling, or processing of materials listed as Hazardous or Extremely Hazardous on Table 302.4 of 40 CFR and Appendix A to 40 CFR, part 355, respectively;*
5) *Projects that require the storage, use, handling, production, or transportation of restricted substances such as toxic chemicals, petroleum products, hazardous/toxic wastes, industrial chemicals, medical wastes, and the like;*
6) *Wastewater treatment plants, percolation ponds, and similar facilities;*
7) *Mines or mining activities; and*
8) *Excavation of waterways or drainage facilities which intersect the water table.*

The Sand-and-Gravel Aquifer System

The sand-and-gravel aquifer system exists in portions of Santa Rosa, Walton, Okaloosa, and Escambia Counties in the western panhandle of north Florida and throughout southwestern Alabama (refer to Figure 3 for the extent of the sand-and-gravel aquifer in northwest Florida). The aquifer plays an important role in meeting regional water supply needs within Northwest Florida by supplying more than 114 million gallons per day (mgd) to meet demands associated with public supply utilities, agricultural operations, and other significant groundwater users in Santa Rosa, Escambia, and Okaloosa counties (USGS, 2005). The sand-and-gravel aquifer (Table 3) is an unconfined surficial aquifer which consists of a complex sequence of sands, gravel, clays, and silts (Miller, 1990).

Across Santa Rosa, Escambia, and Okaloosa counties, the aquifer is up to 450 feet thick and includes three distinct zones: the surficial zone, the low permeability zone, and the main producing zone (Pratt et al., 1999). The main producing zone of the sand-and-gravel aquifer ranges from confined to semi-confined across the study area. In some portions of the aquifer, laterally discontinuous clay beds within the surficial zone create localized perched water-table aquifer conditions.

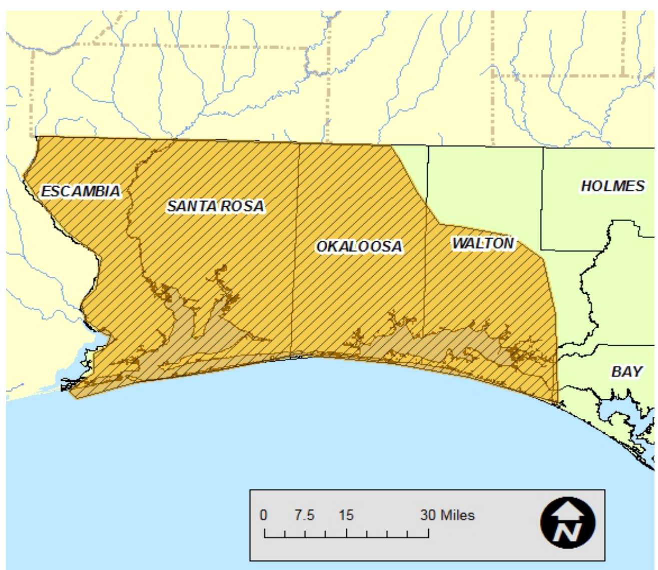

Figure 3 – Extent of the sand-and-gravel aquifer system in Northwest Florida

Due to the generally unconfined nature of the upper portion of the aquifer system, the groundwater in the system is considered highly vulnerable to contamination associated with activities occurring at the land surface (Miller, 1990). Within the study area, the sand-and-gravel aquifer system overlies the Floridan aquifer system, which consists of a thick sequence of marine-origin limestone, dolostone, and anhydrites. Although the sand-and-gravel aquifer contains three distinct zones across much of its extent, for the purposes of this assessment, the vulnerability of the aquifer system is addressed as a whole.

Source Water Protection & Groundwater Vulnerability

A variety of methods can be used to determine where source water protection efforts should be focused, depending on the type of aquifer and the land-uses present in and around a public supply wellfield. Typically, groundwater flow modeling is conducted to determine the extent of the cumulative (or individual) capture zones or cones of depression associated with the wells in the wellfield. Groundwater protection regulations are often focused on these zones, as the groundwater in these zones is eventually withdrawn through the supply wells in the wellfield. Theoretically, contamination from activities occurring at land surface which occurs within mapped wellhead capture zones has a higher likelihood of migrating to the supply wells, thereby endangering source water quality.

A key component of our approach to determine the sufficiency of the current WPA and the Wellfield Ordinance was an analysis of the aquifer vulnerability and land uses within the existing wellhead capture zones. Existing and future land use GIS data provided by the County, in addition to relative aquifer vulnerability data from FAVA Phase II, source water protection areas/wellhead capture zones from the Florida Department of Environmental Protection (FDEP), and topographic and potentiometric data from FDEP and the Northwest Florida Water Management District (NWFWMD) were used to perform the analysis.

The following sections describe the data used to conduct our assessment and the analyses conducted with each data set.

FAVA Phase II – Sand-and-Gravel Aquifer Vulnerability Assessment

The vulnerability assessment of the sand-and-gravel aquifer, conducted during FAVA Phase II, is an important tool in understanding aquifer susceptibility to contamination. The FAVA Phase II methodology involves a scientific approach in which multiple, detailed hydrogeologic data sets which are pertinent to aquifer vulnerability were synthesized and modeled to derive a single, raster-based visualization of aquifer vulnerability across the sand-and gravel aquifer system. The sand-and-gravel aquifer vulnerability analysis used the following data sets:

Table 3. Hydrogeologic Framework of the Sand-and-Gravel aquifer system (Adapted from Miller, 1990)

<table>
<tr><th>Series</th><th colspan="3">Stratigraphic & Hydrologic Units</th><th>Lithology</th></tr>
<tr><td>Holocene & Pliocene</td><td>Alluvium & Terrace Deposits</td><td rowspan="4">SAND AND GRAVEL AQUIFER</td><td>Surficial Zone</td><td>Poorly sorted silt, sand, clays, and gravel.</td></tr>
<tr><td>Pleistocene</td><td>Citronelle Fm.</td><td>Confining Zone</td><td>Poorly sorted sands with some hardpan layers.</td></tr>
<tr><td rowspan="4">Miocene</td><td>Choctawhatchee Formation</td><td rowspan="2">Main Producing Zone</td><td>Sand, shell, and marl</td></tr>
<tr><td>Alum Bluff Grp., Shoal River Fm., & Chipola Fm.</td><td>Sand with lenses of silt, clay, and gravel</td></tr>
<tr><td>Pensacola Clay</td><td colspan="2">CONFINING UNIT</td><td>Grey sandy clay; acts as a basal confining unit</td></tr>
<tr><td>St. Marks Fm.</td><td colspan="2">FLORIDAN AQUIFER SYSTEM</td><td>Limestone and Dolomite</td></tr>
</table>

Soil Hydraulic Conductivity Theme - The infiltration rate of water through soils is a key element in the analysis of aquifer vulnerability, as soils are an aquifer system's initial line of defense against the downward leakage of potential contaminants (Baker, 2009).

The hydraulic conductivity of soils is especially important in areas where effective aquifer confinement does not exist. Soil hydraulic conductivity is defined as "the amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient" (United States (U.S.) Department of Agriculture, 2005). The detailed hydraulic conductivity data set used in the FAVA study (Figure 4) was developed in 2006 by the Natural Resources Conservation Service (NRCS). The initial data was obtained in an ESRI shapefile format from NRCS and was transformed into a raster-based format for use in the FAVA study.

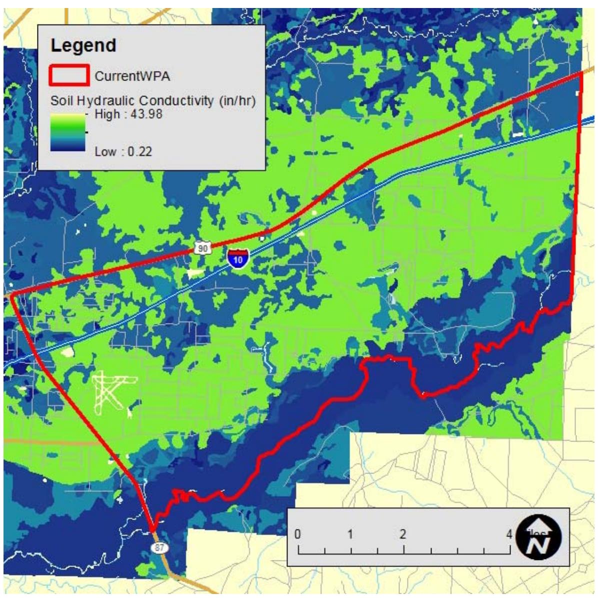

Figure 4 – Soil Hydraulic Conductivity Theme

Closed Topographic Depression Theme - Karst features, which include sinkholes, swallets, and other closed topographic depressions, can provide preferential pathways for the migration and concentration of groundwater into underlying hydrostratigraphic units and may increase an aquifer systems susceptibility to contamination where they are present (Baker, 2009).

Closed depressions are generally shown as hatchured lines on topographic maps, and their shapes are typically circular or elongated polygons. The closer a site is to a closed depression or a series of depressions, the greater the overall vulnerability of the underlying aquifer(s).

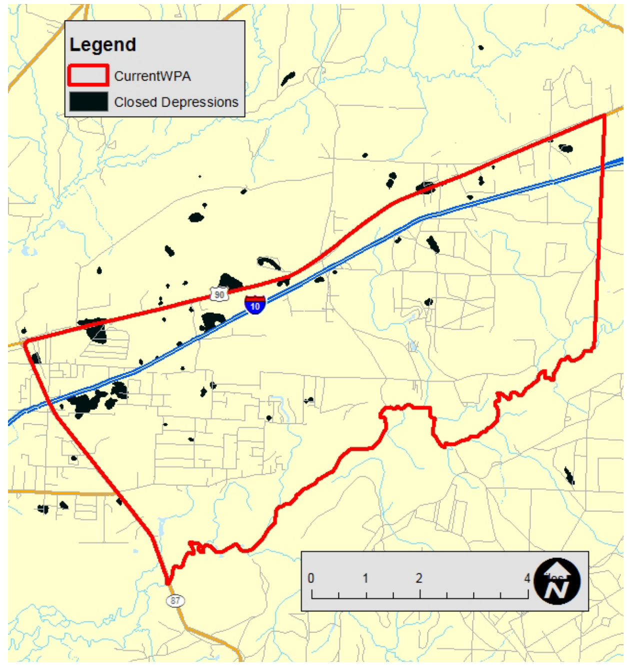

Figure 5 – Closed Topographic Depression Theme

The closed topographic depressional-features layer used in the FAVA study (Figure 5) was developed by digitizing said features from U.S. Geological Survey (USGS) topographic 24K quadrangle maps on a statewide basis. The depressional-features theme was further developed by buffering the features into 30-meter zones out to a distance of 3,000 meters to allow for proximity analysis (Baker, 2009).

Depth to Water Theme – Depth to water is the vertical distance from land surface to the underlying water table (Figure 6). This theme was developed by subtracting a water table surface elevation raster layer from a high-resolution Digital Elevation Model (DEM). The water table surface elevation raster was created using depth to water measurements obtained from the NWFWMD and using a linear regression methodology developed by Nic Sepulveda of the USGS (2002) to create a surface (Baker, 2009).

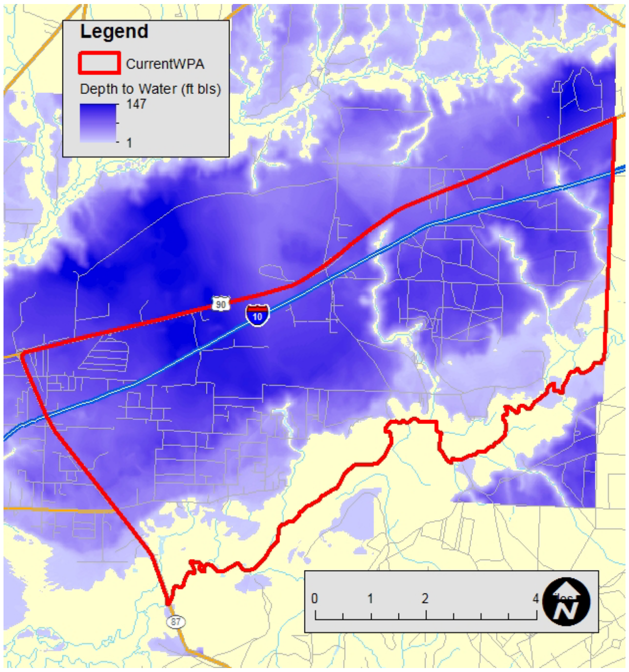

Figure 6 – Depth to Water Theme

The input data sets for the sand-and-gravel vulnerability assessment were generalized to assess which portions of each layer have the greatest relationship with the locations of training points, which are actual monitoring well locations used in the calibration of the FAVA model. Aquifer vulnerability criteria, assessed at each of the training point locations, are used to refine the sensitivity of the model by determining the threshold(s) that maximize the spatial association between the patterns observed in the input data layers (Baker, 2009).

Table 4. Input Themes to the FAVA Model		
Theme	***Range of Values***	***Range Associated with the Highest Aquifer Vulnerability***
Soil Hydraulic Conductivity	0.03 to 43.98 in./hr.	9.20 to 43.98 in./hr.
Proximity to Closed Topographic Depressions	30 to 3,000+ m.	< 1,470 m.
Depth to Water	1.0 to 116.0 ft.	< 33 ft.

The FAVA sand-and-gravel modeling process defined binary breaks for each of the three data sets. The binary breaks essentially create two separate spatial classifications, one with a stronger relationship to the training points, and one with a weaker association to the training points. The ranges for each model input theme and the range associated with the greatest aquifer vulnerability for each input theme are shown in Table 4.

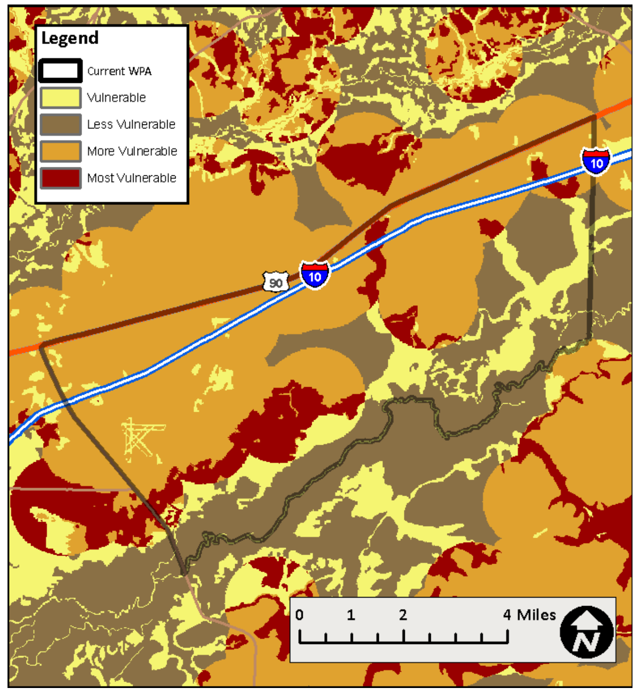

Figure 7 – Relative Aquifer Vulnerability Index

The FAVA model then concurrently processed the generalized input layers to derive a single output raster layer, which was classified into four relative aquifer vulnerability rankings (Figure 7). The output of the modeling effort indicates that the areas ranked most vulnerable generally have a shallow depth to water, high soil conductivity values, and are in close proximity to closed topographic depressional-features (Baker, 2009). A full description of the modeling process conducted to derive the model output can be found in the FAVA Phase II Report (Arthur et.al, 2007).

It is important to note that the FAVA GIS modeling methodology and model outputs underwent an extensive quality assurance/quality control process, as well as several years of sensitivity testing and peer review prior to publication.

Wellhead Capture Zones

Source water protection area delineations were obtained from FDEP's Source Water Assessment and Protection Program in an ESRI shapefile format (Figure 8). For wells which serve a population of more than 1,000 people, FDEP requires a delineation of the five-year wellhead capture zone, which corresponds to the areal extent of groundwater which is predicted to provide recharge to the wellhead over a five-year period. Where groundwater modeling has not yet been conducted by the FDEP, 1,000-foot buffer zones are used in place of the five-year capture zones. Wells 10 and 11 (shown in Figure 8) do not have buffer zones delineated by FDEP. However, for the purposes of this study, 1,000-foot buffer zones have been delineated and added to the figure.

According to Charles Gallion, head of the FDEP Source Water Assessment and Protection Program (SWAPP), groundwater capture zone modeling has only been conducted for three of the 11 East Milton/FRUS public supply wells (Table 5; C. Gallion personal commun, June 15, 2011). The FDEP has no current plans or funding to perform capture zone modeling for the additional eight wells.

Mapped source water protection/capture zone areas for six of the 10 current East Milton/FRUS public supply plus one proposed well (Map ID 11) wells are fully within the current WPA, while the capture zones for the remaining five existing wells plus one proposed well (Map ID 12) are either partially within the WPA or are completely outside of the boundary. A comparison of the FAVA output (Aquifer Vulnerability Theme) with the extents of the individual source water protection/capture zones indicates that the majority of the acreage within each capture zone is classified as "Most Vulnerable" per the FAVA model (Table 5).

For the capture zones outside of the current WPA, it appears that the protections afforded by Article 12.13.02 of the Wellfield Protection Ordinance are not sufficient to protect source water quality within the five-year wellhead capture zones (or 1,000-foot wellhead protection zones).

Table 5. Source Water Assessment and Protection Areas

Well Name	***Water System***	***SWAPP Method***	***Within WPA?***	***Total Acres***	***Percent of Acreage Classified as <u>Most Vulnerable</u> per the FAVA Model***
EMWS #1	East Milton	5-year capture zone	Partial	99	87.4%
EMWS #2	East Milton	5-year capture zone	Yes	93	81.9%
EMWS #4	East Milton	5-year capture zone	No	99	71.1%
EMWS #5	East Milton	1,000-ft. wellhead buffer	No	72	91.3%
FRUS #1	FRUS	1,000-ft. wellhead buffer	Partial	72	100%
FRUS #3A	FRUS	1,000-ft. wellhead buffer	Yes	72	100%
FRUS #3B	FRUS	1,000-ft. wellhead buffer	Yes	72	100%
FRUS # 4	FRUS	1,000-ft. wellhead buffer	Yes	72	98.6%
FRUS #5	FRUS	1,000-ft. wellhead buffer	Yes	72	93.5%
FRUS #6	FRUS	1,000-ft. wellhead buffer	Yes	72	90.8%
FRUS #7B Test	FRUS	1,000-ft. wellhead buffer	Yes	72	100%
EMWS# 6 Test	East Milton	1,000-ft. wellhead buffer	Yes	72	98.2%

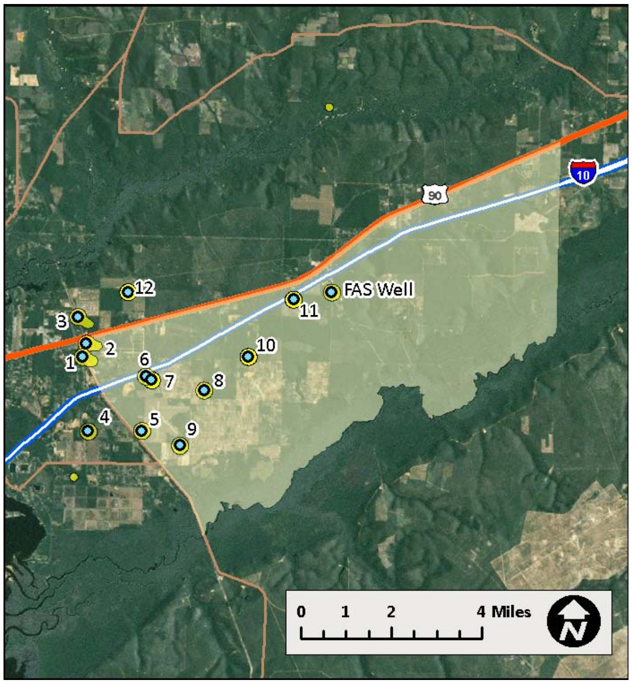

Figure 8 – SWAPP Zones in and adjacent to the WPA

Article 12.13.02 specifies land-use limitations within 500 feet of public supply wells within the County boundary. Based on the sizes of the source water protection/capture zone areas, additional land-use protections are warranted for the region surrounding each wellhead.

Minimally, the current WPA boundary and associated land-use restrictions should be extended to encompass each of the individual source water protection/capture zones.

Furthermore, groundwater modeling should be conducted to determine the five-year capture zones for each of the wells in the WPA. If the modeling has been completed then the identified zones should be incorporated.

Existing Contaminated Sites

Spatial data reflecting current and historic contaminated sites was acquired from FDEP for use in the analysis of the WPA (Figure 9). Based on the FDEP data, no active contaminated sites appear within the wellhead capture zones/source water protection areas; however several active and inactive solid waste sites are located within the WPA boundary. Additionally, seven petroleum contamination sites (leaky underground storage tanks) exist on the northern and western periphery of the WPA. Most of these sites, with the exception of several solid waste facilities, are participating (or participated) in one of several FDEP-administered cleanup programs, and there are essentially no local regulations or programs that could be effectively implemented to hasten their remediation. It is advisable that the County maintain a current inventory of contaminated sites within and immediately adjacent to the WPA. Knowing the location and status of each of these sites will be important during the siting of new public supply wells in the area.

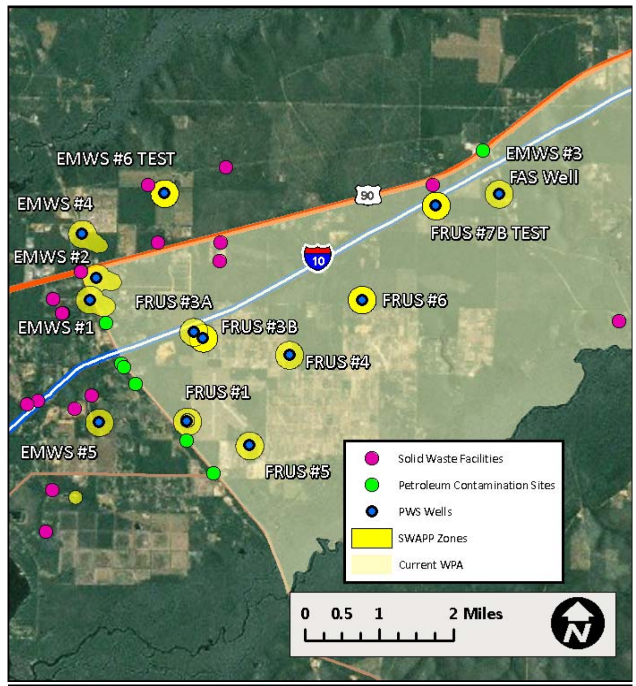

Figure 9 – Contaminated Sites in and adjacent to the WPA

Topographic and Potentiometric Data

Topographic and potentiometric datasets were also examined in support of determining where potential recharge areas in and around the wellfield may exist. Although detailed recharge maps of the sand-and-gravel aquifer are not available, general recharge areas can be inferred based on water level and elevation characteristics. Recharge to the sand-and-gravel aquifer is typically greatest in topographically elevated areas (with the greatest depths to groundwater), such as hilltops or ridges, and is generally less at lower elevations, especially near surface water bodies, which may receive discharge (baseflow) from the aquifer (UF IFAS, 2011). Because the northern boundary of the WPA (along Highway 90) roughly follows the local topographic divide (ridge) between the Blackwater and Yellow Rivers, substantial recharge areas up-gradient of the supply wells are already protected within the WPA. To ensure the future functionality of the recharge areas within the WPA, impervious area limitations, such as those outlined in Article 12.13.02, should be incorporated into Article 6.05.25.

Updates to the WPA Boundary & the Wellfield Protection Ordinance

While the WPA protects vital wellfield recharge areas and effectively protects substantial undeveloped acreage, which could be used to expand the wellfield in the future, alterations to the WPA boundary (provided in the enclosed large-format WPA map in Appendix A) are warranted. The overall WPA boundary should be expanded to the west and southwest of the current boundary to encompass the capture zones/source water protection areas for the four public supply wells which are fully or partially outside of the current WPA.

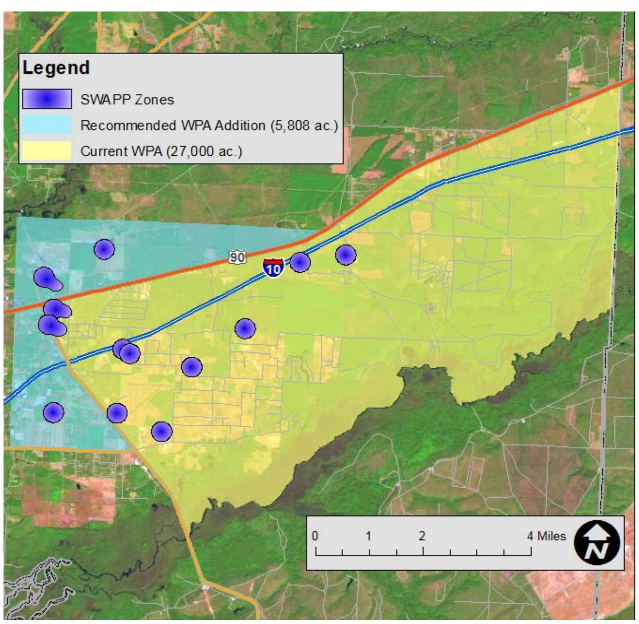

Figure 10 - Recommended Addition to the Current WPA

The recommended new WPA boundary (Figure 10) will protect approximately 32,808 acres, an increase of 5,808 acres over the current WPA. From the western extent of the current WPA boundary at Highway 87, the new WPA should extend westward along Hickory Hammock Road until a point slightly west of B. Lowery Road. From Hickory Hammock Road, the new boundary should extend due north under I-10 and follow Persimmon Hollow Road until the intersection at Highway 90. From Highway 90, the boundary should continue due north to the Blackwater River. From the river, the boundary should head roughly east to meet the current WPA boundary at Highway 90, slightly northeast of the intersection of Highway 90 and Pond Road. The updated boundary was digitized using the County's current land-use layer (elum.shp) as a guide for the boundary line. Therefore, the recommended boundary lines are concordant with the mapped divisions between various land-uses in the vicinity of the wellfield. A summary of land-uses present in the recommended WPA is provided in Table 6.

We recommend updating the Wellfield Ordinance by adopting selected provisions of the Article 12.13.02 for the entire WPA. Additionally, the County should investigate the feasibility of implementing limitations on septic systems in large planned residential developments within the WPA. Large developments which are not connected to a sanitary sewer system could constitute appreciable nutrient and bacteriological loading to the groundwater system. This will be especially important as the residential population residing within the WPA grows.

Suggested updated land-use limitations for inclusion in the Wellfield Protection Ordinance (Article 6.05.25) are as follows:

1) *Landfills, resource extraction areas, and the like;*
2) *Underground fuel storage facilities;*
3) *Projects with impervious cover of 50% or more;*
4) *The bulk storage, handling, or processing of materials listed as Hazardous or Extremely Hazardous on Table 302.4 of 40 CFR and Appendix A to 40 CFR, part 355, respectively;*
5) *Projects that require the storage, use, handling, production, or transportation of restricted substances such as toxic chemicals, petroleum products, hazardous/toxic wastes, industrial chemicals, medical wastes, and the like;*
6) *Wastewater/reclaimed water sprayfields, land application sites, percolation ponds, and similar facilities;*
7) *Mines or mining activities;*
8) *Excavation of waterways or drainage facilities which intersect the water table; and*
9) *Onsite septic systems for residential developments with greater than 100 planned housing units*

Conclusions

In summary, an assessment of the current WPA boundary and the Wellfield Protection Ordinance was conducted using several GIS data sets. The analyses conducted in support of this assessment yielded the following conclusions:

Table 6. Land-Uses by Acreage and as a Percent of the Total WPA (with the Recommended Addition)

Land use Designation	*Acreage*	*Percentage of Total WPA*
Agricultural	639.95	2.0
Agricultural Homestead	1539.33	4.7
Commercial	63.86	0.2
Industrial	290.66	0.9
Institutional	268.97	0.8
Military	787.75	2.4
Mixed Residential/Commercial	84.20	0.3
Office	29.75	0.1
Publicly-Owned Lands	4236.70	12.9
Recreation/Commercial	160.81	0.5
Recreation/Open Space	11378.55	34.7
Right-of-Way	1237.20	3.8
Single Family Residential	3812.91	11.6
Silviculture	3997.58	12.2
Unclassified	259.14	0.8
Utilities	220.32	0.7
Vacant Lands	3771.53	11.5
Water	25.92	0.1
	Total Acreage = ~32,808	

- Large portions of the WPA were determined by the FAVA model to be “Highly Vulnerable” to groundwater contamination.

- The current WPA does not include all of the FDEP mapped source water protection/wellhead capture zones. Five of the individual source water protection//wellhead capture zones are within the WPA, two are partially within the WPA and two are fully outside of the WPA.

- The current WPA appears to encompass significant aquifer recharge areas up-gradient of most of the supply wells.

- Article 12.13.02 of the Wellfield Protection Ordinance outlines land-use restrictions for the 500-foot buffer zones surrounding each wellhead. The 500-foot buffer zones are not sufficient to protect source water quality given the local hydrogeologic conditions and does not cover the mapped FDEP source water protection/wellhead capture zones of 1,000 feet. For reference the 1,000-foot zones are approximately 72 acres whereas the current 500-foot buffer zone encompasses 18 acres.

Recommendations

Based on the analyses and research conducted in support of this report, we offer the following recommendations:

- Expand the WPA boundary to encompass the mapped source-water-protection//wellhead capture-zone areas that correspond with each of the ten East Milton/Fairpoint public supply wells. Refer to Appendix A, map of the recommended boundary. Also see the submitted WPA Addition submitted as part of the GIS deliverables for this project.

- Develop a groundwater monitoring plan for the WPA and vicinity. Water quality trends could be identified through periodic monitoring or examination of data currently collected by the utility system and could be used to further evaluate the effectiveness of the Wellfield Protection Ordinance. Alternatively, coordinate with agencies such as NWFWMD and USGS, who may already perform groundwater monitoring in the vicinity of the WPA to keep up to date on local groundwater quality trends.

- Perform groundwater modeling to determine the five-year capture zones for each of the East Milton/FRUS wells. Make additional adjustments to the WPA boundary based on the results, if warranted. Additionally, prior to installing new public supply wells in the WPA, five-year capture zone modeling should be conducted for the proposed well locations and pumpage. The capture zones should be overlain with a current inventory of contaminated sites and land uses to ensure that the new wells will not have a significant risk of groundwater contamination.

- Consider adopting language to the Wellfield Protection Ordinance prohibiting septic tanks for residential developments with greater than 100 planned housing units and limiting impervious acreage within new developments. Adopt the groundwater protection measures outlined in Article 12.13.02 into Article 6.05.25, which would better protect the entire WPA.

References

Arthur, J.D., Wood, H.A.R., Baker, A.E., Cichon, J.R., and Raines, G.L., 2007, *Development and Implementation of a Bayesian-based Aquifer Vulnerability Assessment in Florida*: Natural Resources Research Journal, v.16, no.2, p. 93-107 http://adgeo.net/fava2.php

Miller, J.A., 1990, *Ground Water Atlas of the United States: Alabama, Florida, Georgia, and South Carolina*, HA-730G, [Online] available ***http://pubs.usgs.gov/ha/ha730/ch_g/G-text3.html***.

Tainshing, Ma, Thomas R. Pratt, Jim Dukes, Roger A. Countryman, and Gary Miller, 1999, *Susceptibility of Public Supply Wells to Ground Water Contamination in Southern Escambia County, Florida*, Northwest Florida Water Management District Water Resources Special Report 99-1.

Florida Department of Environmental Protection, 2011, *Source Water Assessment and Protection Program,* [Program Webpage], Retrieved from http://www.dep.state.fl.us/swapp/assess.asp

Sepulveda, N., 2002, *Simulation of Ground-Water Flow in the Intermediate and Floridan Aquifer Systems in Peninsular Florida*, U.S. Geological Survey Water-Resource Investigation Report 02-4009, 130 pp.

United States Department of Agriculture, Natural Resource Conservation Service, 2005, *National Soil Survey Handbook*, Title 430-VI, [Online] available ***http://soils.usda.gov/technical/handbook/.***

University of Florida, 2006, *Estimates of Population by County and City in Florida:* April 2007: Gainesville, University of Florida, Bureau of Economic and Business Research.

Baker, A.E. and Cichon, J.R., 2009, *Sand-and-Gravel Aquifer Vulnerability Assessment Phase II - Escambia, Santa Rosa, and Okaloosa Counties* [Poster Report prepared for the Florida Department of Environmental Protection / Florida Geological Survey], 1pp.

Defosset, K.L., 2004, *Availability of Ground Water from the Sand-and-Gravel in Coastal Okaloosa County, Florida*, Northwest Florida Water Management District Water Resources Technical File Report 04-01.

Richards, C.J., Thomas R. Pratt, and Katherine A. Miller, 1997, *Wellhead Protection Area Delineation in Southern Escambia County, Florida*, Northwest Florida Water Management District Water Resources Special Report 97-4.

University of Florida Institute of Food and Agricultural Sciences, 2011, *Groundwater in Escambia County, FL,* [Webpage], Retrieved from http://escambia.ifas.ufl.edu/water_natural_resources/groundwater.htm

Assessment of the Extent & Effectiveness of the WPA & Wellfield Protection Ordinance

Appendix "A"