A WATER QUALITY DATABASE FOR GEORGIA CITIZENS

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Abstract. The Georgia Environmental Protection Division Georgia Adopt-A-Stream program has launched an interactive online water quality database to serve the state of Georgia. This online database is intuitively simple to navigate, requires minimal software – some data has been developed for display on Google Earth – and is free and open for the general public to access. All water quality data can be viewed online. In addition, all data can be downloaded in Excel files. The database also collects programmatic information such as levels of volunteer, local coordinator and trainer participation. Since launching the database, the program has seen a two-fold increase in participation.

INTRODUCTION

When Georgia Adopt-A-Stream's volunteer monitoring program was initiated in 1993 the primary emphasis of the program was to recruit and train volunteers. By 1995 this aspect of the program was firmly in place. This success brought new challenges however especially in areas relating to data management as volunteers began reporting data. Initially, all data was reviewed by Adopt-A-Stream staff for compliance with the program's quality assurance, quality control (QA/QC) plan. Data forms were filled and shared on request. A better system for managing data was needed.

In 1997, the first computer based Paradox database was created to house all volunteer water quality data. In 2000, a Microsoft Access database was created that allowed for further manipulation and analysis of data. In addition, this database was networked to allow for multiple staff members to access in simultaneously.

In the summer of 2005, a Georgia Institute of Technology research professor developed an application for displaying and graphing all volunteer monitor sites and associated data on Google Earth. This initial project for displaying Georgia Adopt-A-Stream data was the foundation for contracting with a database programmer to develop a fully interactive, online volunteer water quality monitoring database.

In 2007, the Georgia Environmental Protection Division contracted with the Georgia Cooperative Extension Service Soil, Plant, & Water Analysis Lab to program an online version of the Georgia Adopt-A-Stream volunteer water quality monitoring database.

DATABASE PRIORITIES

There were several important considerations that had to be met when creating the online database. First, the database had to be user friendly and intuitively simple to navigate. Since staff time was limited for providing training on using the database, volunteers needed a product they could understand and manipulate with minimal training.

Second, it needed to use non-proprietary, open software that did not require the user to download or purchase additional software. A big problem with many online databases is the requirement that the user purchase additional software to use and view data. The Georgia database would strive to use simple formats that did not require additional software.

Third, we wanted the database to be visually attractive to individuals with limited experience and training using a database. We also realized that volunteers want to "see" their data on the Internet. Seeing their data means more that viewing tables, but also seeing their water quality parameters graphed and charted and displayed through basic GIS methods on maps.

Most of all, the database needed to be a place the volunteers felt comfortable navigating, entering data and viewing information. The most effective way to achieve this was to involve the end user in the programming process throughout the entire database design and demonstration stages, and even after going live with a functional online database.

Potential users of the database participated in the creation of the database in a variety of ways; volunteers were asked to test the database and provide feedback; staff met directly with participants to receive feedback; professional water quality scientists were asked to review the product; and input was received from the Adopt-A-Stream Advisory Board Research Committee and from Adopt-A-Stream local program coordinators.

In addition, users are encouraged to notify Adopt-A-Stream of problems with the database and provide ideas on improving the database: a "Contact us" link is located in the upper right hand corner of every web page. A message submitted through this link is delivered to Adopt-A-Stream staff and to the database programmer, creating opportunities for quick, direct feedback to the end user. It was understood that the volunteer or professional end user would become discouraged if their needs were not quickly addressed.

The database also needed to satisfy another very important aspect of volunteer monitoring in Georgia: in addition to capturing volunteer water quality data, we needed to capture statewide and local program information. In fact, before the database was released to volunteers, efforts were made to satisfy the needs of these local programs, the Adopt-A-Stream coordinators and trainers.

These efforts included mechanisms for trainers to register their training workshops, manage their volunteers' information (certification and contact information) and capture levels of volunteer activity (hours contributed, active groups and monitoring sites, number of participants and new participants), capture new group and new site activity, the number of streams and watersheds monitored, and total number of participants. Most importantly, the database needed to capture the total time commitment in hours contributed from all volunteers by state, region, county and city. This information is invaluable in determining the total amount of effort contributed by volunteers.

Another key consideration when designing the online database was the knowledge that we needed to be able to make changes, upgrades and address problems quickly. We realized that to make the database as relevant as possible, we had to have complete and instantaneous access to the website and server to troubleshoot problems. The solution was to house the online database offsite at the Cooperative Extension Service Soil, Plant, & Water Analysis Lab.

DATABASE DESIGN AND CREATION

An innovative consideration in designing the database was the decision to fully integrate the database driven functionalities within the website. Although this type of database driven website is commonplace on the Internet (i.e. my.yahoo.com, gmail.com, facebook.com) this was a novel approach to the world of volunteer water monitoring websites.

Integrating the website and the database creates a dynamic system that provides immediate and continues updates on volunteer efforts. For instance, the front page of the Adopt-A-Stream website is continuously updated with water monitoring activity, such as the number of active sites and groups (Figure 1). The front page also displays a map with all active and historical monitoring sites. A tab above the map allows the user to refine the map to see all active sites or historical sites with chemical, biological or bacterial data or to view all sites. All information is continuously updated as we receive it.

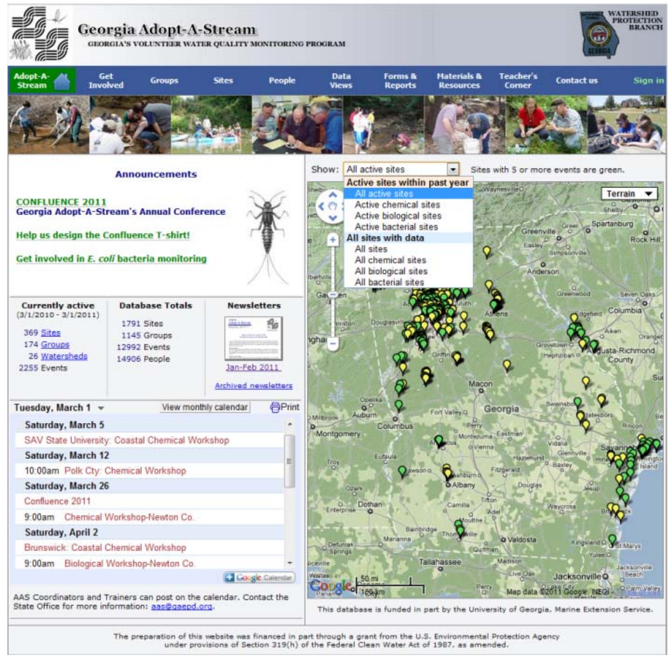

Figure 1. Front page of Adopt-A-Stream website

The website page that displays our local Adopt-A-Stream coordinators is also database driven. This ensures that trainer status and their region of focus is always updated and accurate.

The tabs across the top of the database provide links to general program information and to the database. General information includes how to get involved in the program, materials and resources like monitoring manuals, power point presentations, and other support material. The database sections include links to all individuals involved in the program; monitoring group and monitoring site information; different options for viewing the data; and a tab for entering workshop and monitoring data, in addition to queries that display data.

DATA DISPLAY AND ACCESS

The entry point to Georgia's online database is the map on the front page. The map has hotlinks for each monitoring site. Click a hotlink to pull up a box with additional information such as links to view group and monitoring site information (Figure 2). Click on Terrain to view other map options such as satellite view or a topographic map. All water quality data is accessible by all users; no monitoring data is password protected.

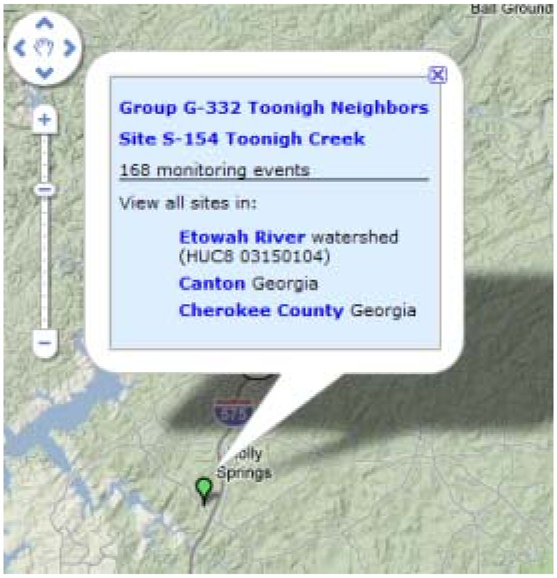

Figure 2. Entry point to view data

By clicking on the group link, the user will toggle to the Group page (Figure 3). The group page houses information on the group's activity, including all registered monitoring sites, dates of activity and the number of sampling events that have occurred. In addition, all monitoring site information can be downloaded into Excel files. This page also keeps track of each group member's certification status. The top of the group page provides an entry to search for other groups.

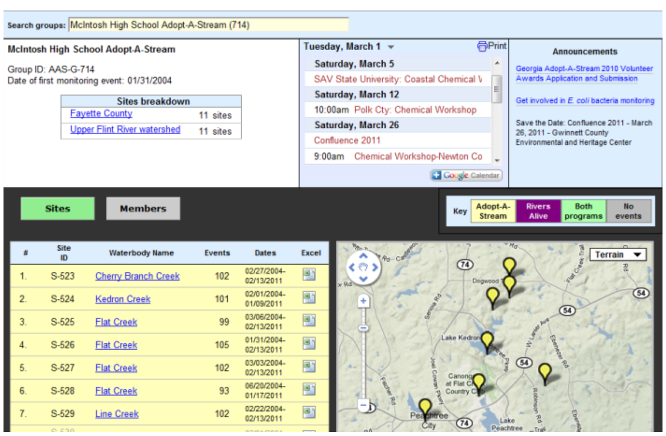

Figure 3. Snapshot of the group page

From the Sites tab, group page or front page of the website, the user can find individual monitoring sites (Figure 4). The sites page includes a map of the monitoring site, including graphs displaying all monitoring data. Click on one of the graphs to view large graphs of all data and a table displaying individual parameter readings (Figure 5). The sites page also includes links for viewing all monitoring sites by city, county or watershed.

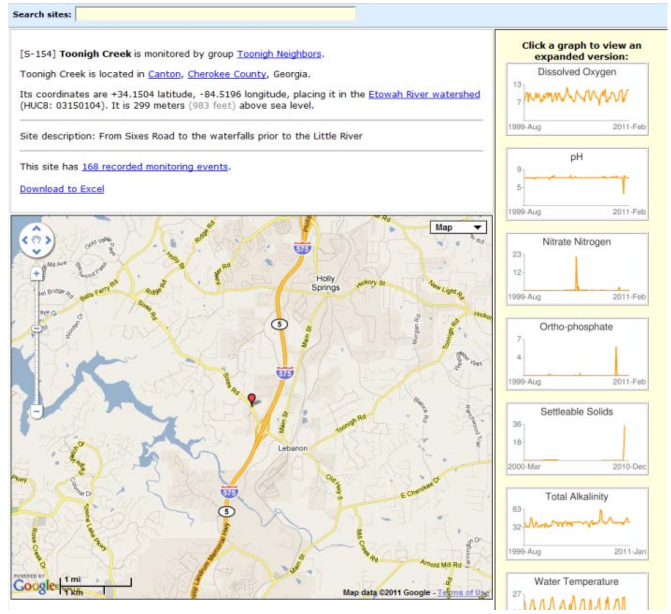

Figure 4. Site map and background information

Water monitoring data can be viewed in its entirety from the site page (Figure 5). Clicking on a data point on the graph highlights the parameter reading in the table. By selecting two parameters, using the Ctrl function to select the second parameter, the user can display graphs of both parameters and assess correlations such as the inverse relationship between dissolved oxygen and water temperature. The user can also view monitoring event data forms by clicking on "form" in the Event ID row. The graphs can be displayed in lines, points or bars. The user can refine the graph display by clicking on the y-axis display.

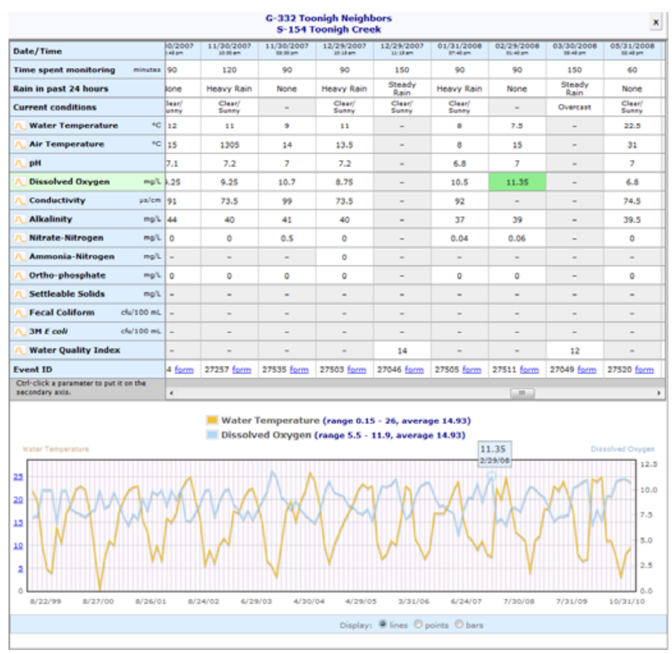

Figure 5. Site data and graph of dissolved oxygen over water temperature

The online database also provides a variety of different views within which to search for and access site data (Figure 6). By using the Data Views tab, the user can conduct site searches by city, county, watershed, water plan and coastal area. The views include a map and a snapshot of monitoring activity, displaying all active and historical sites and event information, including graphs that provide a snapshot of overall water quality parameter trends.

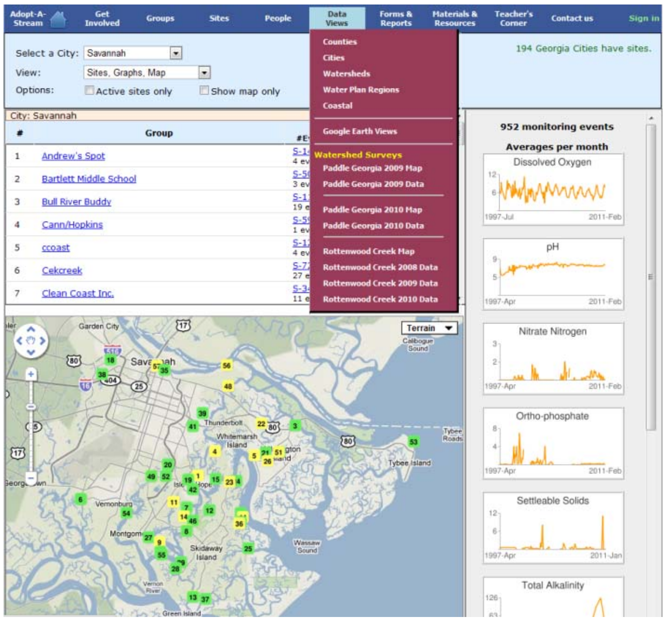

Figure 6. Data views at the city level

The online database also displays information through Google Earth (Figure 7). Options include displaying HUC 8, 10, and 12 watersheds, National Pollutant Discharge Elimination System sites, USGS Nationwide Streamflow Gauges and Georgia 305(b)/303(d) listed water.

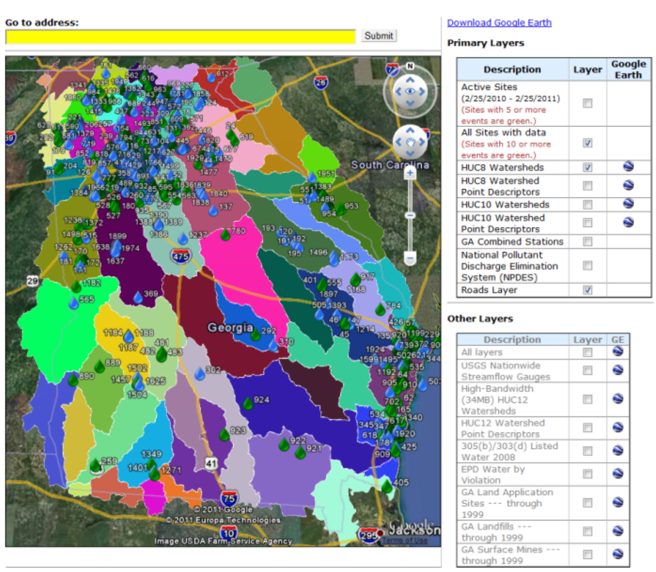

Figure 7. Site display with Google Earth layers

Some of our volunteers engage in watershed-wide monitoring activity (Figure 8). This type of monitoring involves the collection of numerous samples from different sites on a single day. The database map interface allows for simple GIS views of each parameter by site, graphically displaying the range of parameter readings across the watershed in a gradient shade of yellow to red. Each monitoring site also displays a number reading for the selected parameter. This simple GIS display allows the user to make quick assessments of water conditions. Groups monitoring watersheds for many years can identify trends within the watershed by toggling from one year to another. In addition to the map view, all parameters are displayed in a table and graphed by lines, points, and bars.

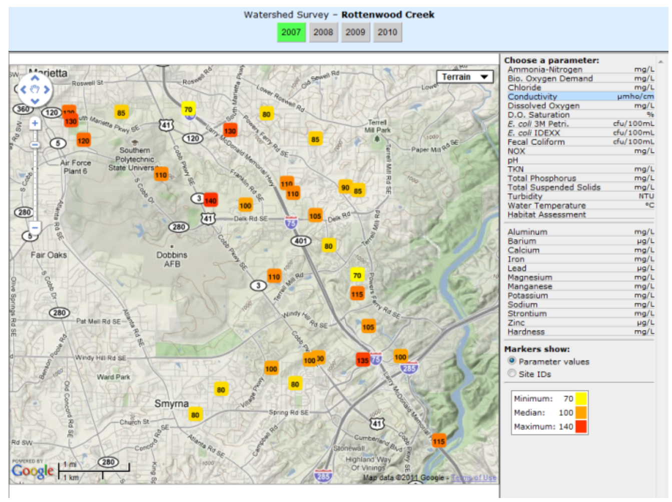

Figure 8. GIS display of water quality parameters across a watershed and by site over time

A major achievement of the online database is a simplified format for registering monitoring sites (Figure 9). Specifically, through the use of Google Maps, the online database allows for seamless and accurate capture of site location. The user simply locates their monitoring site on the map, activates the topographic layer and zooms in on the water body, then right clicks the exact location to capture the longitude and latitude.

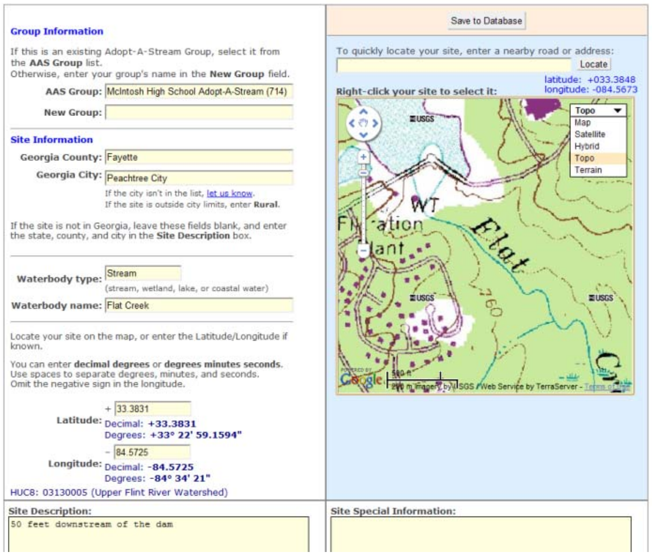

Figure 9. The online registration captures site latitude and longitude

QUALITY CONTROL AND PROGRAM DATA

The most important aspect of the online database is the capture of water quality monitoring data through online forms for physical, chemical and biological parameters. This includes individual forms for macroinvertebrate and bacterial data, in addition to freshwater and coastal physical and chemical data forms. Once data is entered and submitted, a PDF is created for historical documentation.

The online forms have been programmed with quality control checks. The forms only accept data that fall within accepted thresholds for the parameter. For instance, an "error" is displayed if a pH value outside of the 0 to 14 reading is entered. Water parameter readings outside accepted standards for streams in Georgia are automatically flagged for follow up in the outliers page (Figure 10).

Adopt-A-Stream staff review the outliers page, follow up with volunteers when necessary, and make recommendations on rejecting or accepting data. In addition to the outliers page, all data is manually reviewed by our database programmer for accuracy. Volunteers are notified of questionable data reporting and are prompted to make corrections if they are due to data entry errors.

Select a parameter: Dissolved Oxygen

AAS Outliers

Group	Site	Date	Dissolved Oxygen
G-1438 The Hans	S-1847 Hog Wallow Creek	10/02/2010	0
G-623 Higgins Family	S-378 Willeo Creek	01/10/2010	0
G-557 Clayton State University	S-826 Tributary of Panther Creek	06/26/2007	0
G-714 McIntosh High School Adopt-A-Stream	S-524 Kedron Creek	03/06/2010	0
G-1079 MiltonGrowsGreenHopewellMS	S-1373 Camp Creek	02/01/2010	0
G-225 Environmental Club of Walton High School	S-149 Sope Creek	10/12/1998	17
G-104 St. Anne's Streamers	S-41 Beaverbrook Stream	07/26/1999	17
G-463 Unitarian Universalist Congregation Atlanta	S-29 Fern Creek	01/15/2003	18
G-763 Z-Team	S-616 Toccoa River	12/07/2005	19.3
G-104 St. Anne's Streamers	S-41 Beaverbrook Stream	06/29/1999	19.5

Figure 10. Examples of dissolved oxygen data entries captured by the outliers page

Volunteer certification status is also an important component of quality control; the online database captures volunteer certification status and notifies volunteers when it is time to recertify (volunteers must recertify annually). Only certified volunteers may submit water quality data. Program trainers can easily enter new volunteer information or seamlessly update volunteer status through online forms. This interface captures the type of workshop certification, such as chemistry QA/QC or bacterial trainer workshop; date, location and duration of the workshop; and volunteer and trainer(s) information. The online database then generates certificates and a cover letter that can be printed or e-mailed to workshop participants. The database also keeps track of and notifies volunteers of certifications about to expire (volunteers must recertify annually).

An important component of the database is documentation of levels of activity with the program. A Monthly/Yearly Summaries page was created to automatically update volunteer activities as information is submitted. In addition to capturing volunteer monitoring activities, such as the number of active groups and sites, number of monitoring events and streams sampled, the table also captures the labor contribution of the volunteer. Since the online database forms capture the amount of time each volunteer spent at each monitoring event and the length in time of each workshop, the value of the program in monetary terms can be extrapolated based on the Independent Sector's estimate of the value of volunteer time (Figure 11).

Monthly/Yearly Summaries

Select a Region or County: State of Georgia

State of Georgia Summary:

Volunteer Hours | Volunteer Dollars | Volunteers Trained | Events | Event Participants | New Sites | New Groups | Active Groups | Active Sites | Active Streams

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2003	16979	13353	15245	11952	12464	8066	18362	6372	20607	18550	14290	9327	165567
2004	11294	12914	12662	11518	14834	10519	21271	10689	9975	15767	23760	6325	161528
2005	13743	14479	16505	10910	12550	15253	9249	19781	21375	12477	14789	9036	170147
2006	12957	21780	17049	13608	12295	17604	15214	19103	35414	29451	20037	10582	225094
2007	12062	23732	25267	17746	11674	19346	19045	23709	43494	26998	28572	17814	269459
2008	11696	30537	28501	36840	37118	21940	18917	52705	52725	30044	46145	32706	399874
2009	25976	29065	41536	16921	20343	53557	25007	36260	71857	28482	36321	31026	416351
2010	27650	32605	42820	32460	26004	44545	28544	72983	73997	46185	52462	26167	506422
2011	32774	25577	47										58398

Volunteer dollars are calculated at $20.25/hour for volunteers and $23.30/hour for workshop trainers. Trainers are considered "volunteers" when participating in monitoring events.

See **Volunteer Hours** for the calculation of hours.

Figure 11. Summaries of volunteer labor contribution in dollars

A MODERN DATABASE TO SERVE GEORGIA

Georgia has benefited greatly by being a latecomer in the online database world. Specifically, the state had the benefit of having first reviewed other state's programs and seeing what worked, thereby gleaning the best ideas for our program. Also, by waiting to create Georgia's online database, we were able to take advantage of many new programming advances for capturing and displaying information.

The online database in its present form went live in the fall of 2009. The database is now fully integrated into the Georgia Adopt-A-Stream website. Based on our research, Georgia has launched what appears to be the first online volunteer monitoring website with a fully integrated database. This important detail allows for instantaneously updated information throughout the website, providing real-time updates on volunteer and monitoring activity. It also allows for instantly updated programmatic information.

The fact that the database displays information in real time is important. This distinction makes the entire website more relevant and is the reason most likely for such a dramatic increase in participation. It also means information can be more effectively shared, and analysis of water quality information can occur continuously.

For a database to maintain relevance, it has to be able to change with needs and emerging technologies. To sustain a dynamic database, the programmer must be aware of and prepare to make constant changes, modifications and updates. In selecting the programmer to contract with the Georgia Adopt-A-Stream database, it was just as important to find a competent programmer, as it was to find someone who understood the changing needs of the program. Fortunately, the contract for database programming has been continuous, allowing for relevant updates and improvements.

CONCLUSION

Georgia has successfully created an online database for sharing volunteer water quality information. This information can be displayed and accessed in a variety of different formats. All data has been submitted following an EPA approved quality assurance, quality control plan. The database uses free software and requires minimal training to use. Georgia citizens can access the database using all major web browsers. Since launching the database, there has been a two-fold increase in water monitoring. Historically much effort has been expended on collecting water quality data only to have it languish in obscurity after it has been generated. It is often forgotten that proper management of data is equal to if not more important than the generation of the data in first place. With changing technologies, new software and new devices for sharing information, the future of the database is as wide open as our resources for taking advantage of these changes.