

Emery Water Conservancy District Hydrologic Web Site System Description

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The Emery Water Conservancy District Hydrologic Web Site is the center piece of a system of communications links, computer servers, remote measurement devices, and water gate actuators which enable water managers in the Emery Water Conservancy District to more effectively measure and control the water resources under their control.

This system description attempts to give a general overview of the county and its water issues, how the automation process works, and answer questions about the logistics of how the information gets from the river to your computer screen. If you would like a more detailed description on the history of the Emery county project itself, please see our Project History.

Emery County Description

The Emery Water Conservancy District is a water district that is entirely contained within the political boundary of Emery county. Emery county is located in the Green River Basin, east-central Utah. It is 165 miles southeast of Salt Lake City (Utah's capital city). Carbon county borders the region on the north, and was originally part of Emery county. The Green River provides a natural boundary between Emery and Grand counties on the east. On the west and south the county is bordered by the counties; Sevier (west), Sanpete (west), and Wayne (south).

The major towns are Huntington, Castle Dale, and Orangeville, with Huntington being the most populated (1,875 residents). The county population in 1995 was 10,638. This number is expected to rise to approximately 12,510 by 2020. The current growth rate is 1.9%.

The county covers 4,445 square miles of land, only 7% of which is privately owned. The federal government owns 83% of the land and the state of Utah retains ownership of the remaining 10%.

Emery county is known for the geological wonder, the San Rafael Swell. This area is said to have been a hideout for outlaws such as Robert LeRoy Parker (Butch Cassidy) and the Sundance Kid. The region also provides a great environment for fishing, hiking, rock climbing, and horseback riding. The desert scenery is said to be very unique. Emery county has a large number of pictographs and petroglyphs that can still be seen on the rocks of

the canyons and on valley hillsides. There were many tribes known to have roamed the area before a group of Mormon colonists settled the region. Among these tribes were the Fremont Indians and the Ute Indians.

The economy in Emery county is maintained mostly by the coal mining and power production industries. The economy also depends on agriculture. The average income was reported at \$13,576 in the late 1990's. Average annual precipitation is only about 7.5 inches, although precipitation levels of 30+ inches have been reported in the higher elevations in the region. Elevations range from 3,700 feet above sea level to 11,530 feet above sea level, thus providing a number of different growing climates and physiological areas. Temperatures range from an average of 22 degrees in January to an average of 72 degrees in July.

Principal Water Sources

Major Streams

The San Rafeal River is said to be the life blood of the county. The river originates in the Wasatch Plateau. The headwaters are stored in several reservoirs used for agricultural and industrial use. The river flows into Castle Valley in three branches; Huntington Creek, Cottonwood Creek, and Ferron Creek. These three branches unite to form the San Rafael River after passing through the communities and farm land. The river makes it way through the rock and desert until it eventually becomes a tributary to the Green River.

Reservoirs and Dams

There are three main reservoirs in the county: Joe's Valley Dam and Reservoir, Millsite Reservoir, and Huntington North Dam. Joe's Valley is the largest reservoir, with a storage capacity of 62,460 acre-feet. Millsite is a 435-acre reservoir at the base of Ferron Canyon with a storage capacity of 18,000 acre-feet. The Huntington North Dam and Reservoir has a storage capacity of 5,420 acre-feet and is mainly used to control the diversion of water into the Huntington North Service Canal.

Water Usage

The Emery county Project supplies 6,000 acre-feet of water for coal fired electric power generation. In addition to providing water for the power plants in Emery county, the water is used by farmers to irrigate their land. Agriculture in the area tends to center around the livestock industry. More than 90% of the irrigated area is producing hay and grain.

Water Quality

As is usually the case, the quality of water is highest at the upper reaches of the drainages and deteriorates as it flows downstream. Salinity measurement instruments have not been installed yet, however, the state reported salinity measurements (from surface water) in 1997. The totals were as follows:

- Cottonwood Creek near Orangeville 227 mg/L
- Ferron Creek near Ferron 227 mg/L
- Huntington Creek near Huntington 193 mg/L
- Muddy Creek near Emery 219 mg/L.
- San Rafael River near Castle Dale 2,542 mg/L

Water Development

Early Development

Early evidence indicates that the Fremont Indians practiced basic ditch irrigation as well as flood irrigation. Interest in Emery county heightened in the mid-1870's when stockmen began moving their herds into the region. Ranchers and farmers were drawn by the wide-open territory and looked to relocate their herds from the crowded ranches. In 1877, Brigham Young, president of the LDS (Mormon) church, asked a group of saints to go and establish colonies in Emery county. They settled along the Huntington Creek, Cottonwood Creek, and Ferron Creek. A saw mill in Huntington Canyon was set up as early as the Spring of 1878. By 1890 the population of Emery county had risen to 2,866. In an effort to help support the growing communities, several canals were built: Huntington Canal (1884), Emery Canal (1885), Cleveland Canal (1885) and the Wakefield Ditch (1880). Many of these canals are still in service. In addition to canals, there were also ditches that were geared towards water delivery for limited and small areas.

Water Rights

By 1900 the population of Emery county had doubled from its number 10 years prior. Crops were growing on over 25,000 acres. Rapid expansion brought many problems, including disputes over water rights. The area was plagued by water rights trouble for several decades.

During the 1930's the population dropped significantly as did the coal production. Land degregation and water shortages continued to plague the area and a need for long term water storage became increasingly apparent. In 1941 the Bureau of Reclamation supported construction of a reservoir in Joe's Valley. By 1946, coal production levels were rising rapidly and county farms were bringing in revenues double that of 10 years prior. It wasn't until the Colorado River Storage Project Act of April 11, 1956 that the Emery county project was authorized. On April 4, 1961 the Emery county Water Conservancy District formed and agreed to repay 3/8 of the estimated cost for the project (\$8,000,000). Ground breaking for Joe's Valley Dam took place on June 20, 1963. This was the beginning of a solution to long term water storage.

Canal and Reservoir Automation History

Construction on Joe's Valley Reservoir began in 1963. Work on Cottonwood Creek and Huntington Canal also began that year. The bid for the Swasey Diversion Dam was awarded in 1964 to R.A. Heintz Construction Company of Portland. Swasey Diversion Dam is located 10 miles downstream from Joe's Valley Reservoir. All major features of the project were complete by the first half of 1966. After completing the construction, Reclamation turned the water management over to the Emery Water Conservancy District.

In 1993, at the request of the Emery Water Conservancy District and the Castle Valley Special Service District, the Provo Projects Office (Reclamation) assisted with the upgrading of existing water measurement facilities on Ferron Creek, Huntington Creek, Cottonwood Creek, San Rafael River, and features of the Emery county Project (see project history for details).

The lack of accurate and timely information on the state of the water supply and distribution systems, as well as, comparison with respect to where water is with where it should be, resulted in frustrations with water management; especially since the county had experienced a 6-year drought in previous years. It was obvious that a more responsive measurement and control system was needed if water management was to improve. Reclamation worked to develop a plan that would improve water management.

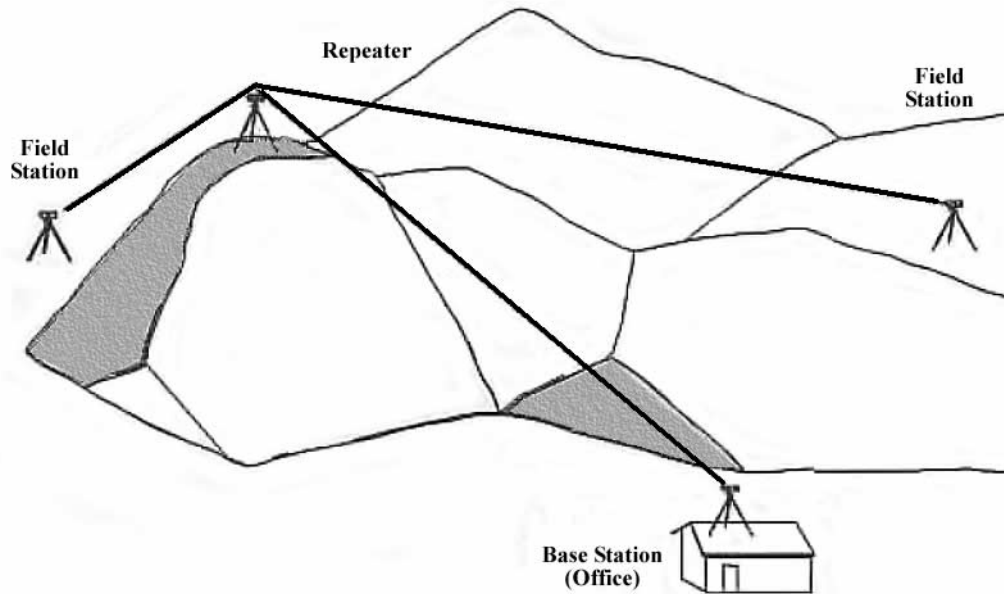
The goal of Reclamation's draught project was to design and install a comprehensive real-time (radio telemetry) hydrologic data collection and control system for the Emery Water Conservancy District and the Castle Dale Special Service District. The system was intended to improve the responsiveness of the water delivery system. The system was designed to be expandable and has continued to grow since the initial setup.

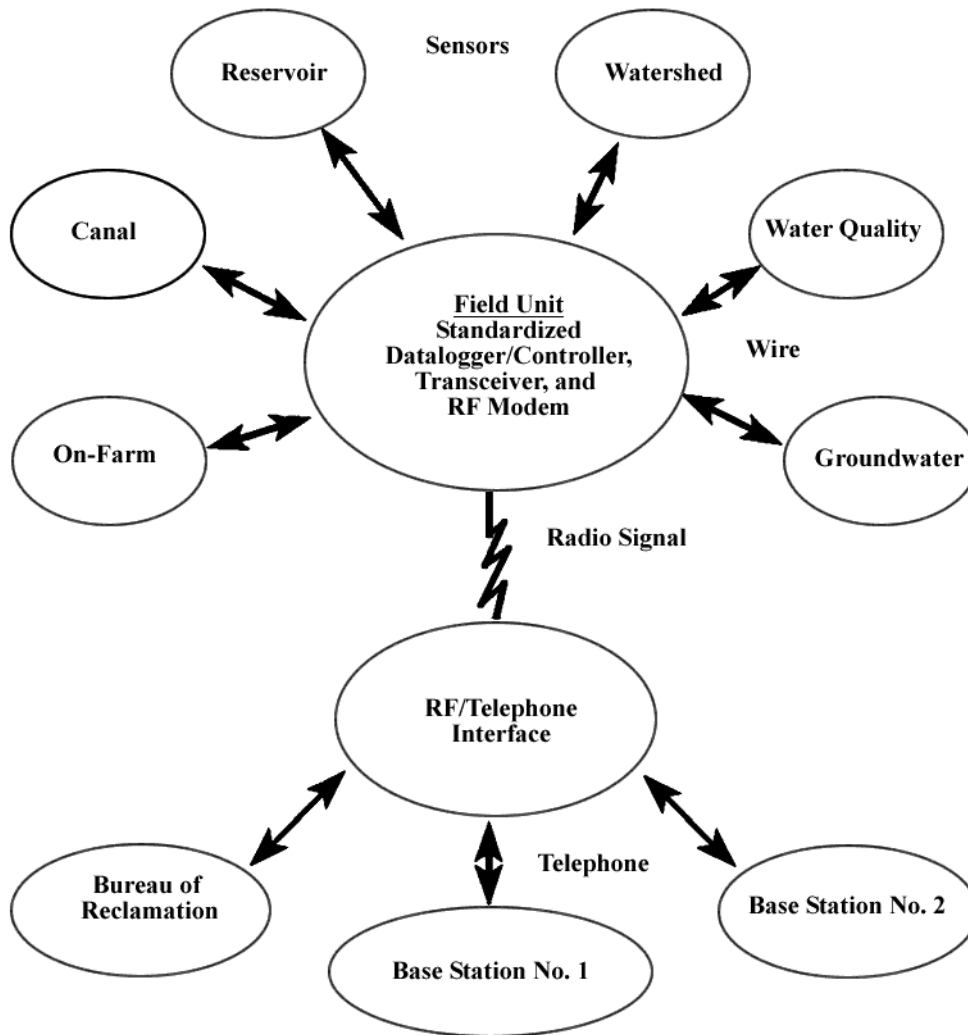
A base station for the collection, storage, display, and dissemination of "real-time" and historic data was established at the EWCD office. EWCD staff remodeled their building to provide a room for all the real-time computer equipment. They originally installed two telephone lines and currently have a DSL line to the office that is specifically used for data monitoring and collection. Outside their office, the EWCD staff installed a 30-foot tower with antenna. The antenna has an RF-to-telephone (refer to Figure 1 for a diagram of the communications network)

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interface attached at the base. Weather sensors are also installed on the tower (See Photograph 1). Two repeaters were installed in the mountains above Huntington and Castle Dale to improve communications.

Initially, data collection equipment was installed in existing gauging stations along various canals, creeks, and rivers - 17 sites in all. The EWCD purchased almost all of the equipment for the real-time system and assisted with and directed all aspects of the installation. Monitoring equipment was also installed at two different springs. Since the initial installation, the system has grown to over 70 stations with sensors of all types. In addition, the EWCD has real-time control on two structures and plans to automate two more.





Web Site History

Originally, the information collected from the monitoring stations was transferred from the station to the EWCD office via VHF radio. Reclamation was also able to view the information. Employees of EWCD could look up the information from a computer at home or in the field. The various monitoring and automation systems in the county were generating substantial amounts of data, but essentially it was unavailable to all but a few water managers.

The rapid rise in the development and use of the Internet meant that many of the water managers were either getting on-line or considering it. It became apparent that getting the real-time data onto the Internet might become a good way to distribute the data to a wide audience without requiring the water users to purchase more specialized equipment.

In 1999, StoneFly Technology began to design and maintain a public website where the information would be displayed. Since then the site has been upgraded and changes are made almost daily. Efforts to improve the type and quality of information available, as well as the readability of the data, create an ever-changing and evolving site: www.ewcd.org.

Web Site: www.ewcd.org

What the site has to offer

Introduction

The website is maintained by StoneFly Technology out of St. George, Utah. The site is designed to serve a wide variety of users with varying purposes regarding the information. In an attempt to meet the different needs, data and information is displayed in a number of ways and in a number of places.

A variety of time-series information is available. One of the most popular displays is of hourly flow data for the previous seven days. Since most of the field sites are solar powered, a display showing battery voltage is critical. A diagnostics section provides this kind of information for troubleshooting purposes as well as maintenance and repair purposes.

In addition to real-time displays, there is also descriptive information posted on the web site. There is an extensive history of what is known as the *Emery county Project*. This offers details about the county and its political history, its water history, and many more details about the area. There is also a Frequently Asked Questions (FAQ) document for basic help with navigating the site and finding information. The detailed descriptions of the real-time (automation) equipment and a comprehensive list of manufacturers and vendors is also posted on the site.

Web site usage is also monitored. A comprehensive log is maintained, which allows web site designers to assess the utility of the various tables and displays.

Reservoir, River, and Canal Monitoring

There are several real-time data monitoring sensors in place across the county at various sites. The web site makes all of the data these sensors collect easily accessible and interpretable. A user is able to click on the category for which he or she would like to view information and diagrams as well as tables with information are loaded. Generally, at a glance a user can collect a lot of important information about the site. The picture will tell what the sensor is monitoring (i.e. current flow), the current reading on the sensor along with the units being used, and a color. The color index is a unique way of showing how recently the data being displayed was taken. The color index is used throughout the site to indicate the timeliness of the data.

Currently there are 3 reservoirs with sensors and automation equipment installed; Millsite, Huntington, and Joe's Valley. These monitoring sites have several different sensors installed. Everything from the gate height, to the inflow rate or outflow rate, the reservoir height, the air temperature, etc. can be viewed.

Emery county has three main rivers; the San Rafael, Muddy, and Green rivers. There are several monitoring stations set up along these rivers, with more to be added in the future. Three main canals also provide water to the county, namely the Huntington, Cottonwood, and Ferron Canal. These canals and their diversions are also monitored at several sites. All of the information can be viewed by clicking on the "Canals" or "Rivers" category from the main menu. The county also has 13 springs that provide water and have monitoring equipment installed.

In addition to the graphical representation of data, all the data can be viewed in tabular form. Data can be found for almost any time period up to two years previous. Graphs are dynamically generated to show the values for the past day, seven days, one month, three months, or nine months. This can be a great tool in recognizing patterns or seeing disturbances in the water flow.

Weather Information

There are currently seven weather stations in Emery county. All are equipped with several sensors. Information collected includes; current temperatures, humidity, precipitation, wind gusts, wind speed, wind direction, panel temperature, soil temperatures, battery voltage, and solar radiation. The weather page also contains information based on averages, mean values, and the data collected for the month or for the day. Some of the calculated or accumulated information includes; total precipitation for the current month, the temperature high and low for the current day, or the largest wind gust. In addition to the weather stations, there is a link to a Php Weather page which displays current weather information for the Price Airport.

The weather page utilizes several simple mathematical concepts as well as some complicated algorithms to calculate and display other useful information. One of the newest additions to the weather page is the evapotranspiration information. This information is calculated based on the data that is collected. The calculations of the previous day and earlier can be viewed for comparison. This new information is intended to inform users about how much water to use when watering their crops and plants. In addition, reservoir evaporation calculations will soon be displayed. Algorithms use the information the sensors record to calculate the approximate amount of evaporation from the reservoir. More of this type of information or improvements on the delivery of this information will be likely in the future.

There are several other types of information available under the weather section. There are links to the national weather service, which provides updates on current storm warnings, as well as a summary of expected conditions throughout the day in various cities across the state. The Western Regional Climate Center provides information on Snow Pack for many areas of Utah year round. There are five snow pack sensor stations set up in Emery county. More detailed information regarding the snow pack can be found in the SNOTEL report.

Diagnostics

Providing real-time or current data is the highest priority of the website. Due to the vast area and the remote location of some of the sensors, the diagnostics page is one of the most important for site administrators. It helps diagnose what is causing data to remain un-updated. This page is available to everyone, so even users can look and see where the trouble is coming from. Some of the features of this page include battery voltage and the latest data time insertion. In addition to helping with troubleshooting at the stations, the diagnostics page also has links to the web site statistics page mentioned earlier. As stated previously, this helps the developers at StoneFly Technology know what is most often used and concentrate their efforts on updating those areas first.

Other Features

The site has many other things to offer besides just the display of data collection from sensors, although that is its main purpose. The site hosts a photo gallery containing pictures for almost all of the stations and the equipment used. It also has pictures from the EWCD office and recreational activities that Emery county has to offer. There are also several QRTV 360 degree Panoramas - these allow the user to control the camera and see 360 degrees around the site. It is a virtual pan of the area. There is also a historic map of Emery county and a project description. One of the newest features of the site is weather banners that other web sites can post and the information will automatically update. Webmasters can find these under the "About" section.

How the Site Works

The data is collected and stored at the station. Usually once every hour the data is transmitted via the VHF radio and telephone equipment and inserted into a database. The web server is an Apache powered web server run on a Red-Hat Linux system. Most code on the website is written using a combination of HTML and PHP. Various scripts that help to run the site are written in Perl. The code is programmed to dynamically query the database (using MySQL) to find the most recently inserted data for the station. Case statements within the code then determine which color should be displayed with the data to show the timeliness.

Internet Camera System

In 1999 StoneFly Technology installed an Internet camera system overlooking Castle Dale (directed north). This camera takes high-quality color images of the area every 10 minutes. Since the first camera installed in 1999 (still in use), StoneFly has installed four other cameras at various sites in the area. These include a Castle Dale southwest view, Horn Mountain east view, and two Swasey Diversion views. When installed at a monitoring station the cameras provide a way to visually verify what is going on at that station. The image can be used to check for trash build-up in front of gates or for vandalism. The camera types are all different, depending on the location. For more specific information, please refer to the specific webcam page.

The internet cameras can be used by the National Weather Service to verify weather conditions. For convenience and to allow water users and meteorologists to see changes that have occurred over the previous 24 hours, the still images are available.

Full-Time Internet Connections

The commissioner of the Emery Conservancy Water District has a DSL line to his office to ensure a fast and open internet connection to access the information. Equipment that gives each user a wireless full-time Internet connection has been installed. The radio links which connect the water users to the Internet use license free 900 MHz spread-spectrum radio modems. The range on these radios is up to 50 miles. This type of full-time connection is used to connect the water manager(s) homes to the information regarding their water district. A custom-build router was installed at the home of the commissioner. The router allows the manager to connect his home computer, using an inexpensive network card and cable, to the Internet. This link allows the manager or commissioner to always have access to the information. Since the Internet connection is always "on", there is no set up time involved with looking at the web site. Essentially this means that the latest water data is only a mouse click away. The routers accommodate multiple computers. The speed of the Internet data link is between 57 kbps (thousand bits per second) and 115 kbps.

Future of the System

The automation/Internet system of the Emery Conservancy Water District continues as a work in progress. The site has been operational since 1999, but there have been many changes and additions since that time. There will continue to be more. A list of some of the additions that are scheduled to take place in the near future follows.

Evaporation Models

A more extensive evapotranspiration model is currently being developed.

Voice-synthesized Phone interface

This type of program would be used almost exclusively by the water users, specifically the commissioners and seasonal ditch riders. It will allow a user with the correct pass code to call the station and request various data that has recently been recorded. The advantage to this would be that problems with the internet would not affect the transmission and distribution of the data to a limited but critical audience.

More Sensors

As part of the continual process (rather than a product), the need for more sensors of various types will arise to provide better and more accurate real-time data to the water users. Some of these sensors might include more air temperature readings, salinity sensors, and soil moisture probes at the weather stations or other monitoring stations.

System Evolution

The nature of this technological intervention needs discussion. Reclamation's projects in the past have had beginnings and ends. For example, in the past, the agency constructed a dam and then turned it over to the water users to pay for and operate. In the case of automation and Internet technologies, there is a continually evolving product. The technologies get more sophisticated and less costly with each passing day. As the technologies get more complex, so do the needs of the water users. With real-time technologies we are promoting a process more than a specific product.

How this process might work is described in Eric S Raymond's seminal monograph: "The Cathedral and the Bazaar." Raymond likens a traditional approach to product development to constructing a cathedral, an edifice carefully crafted by artisans working in inspirational isolation, with no beta released before its time. The process he envisions (the bazaar), however, is more promiscuous. No quiet, reverent cathedral building here, rather a

noisy bazaar of differing agendas and approaches out of which a coherent and stately system emerges. The mantra becomes "Release Early, Release Often." It is this "bazaar" process that we have tried to emulate on the Emery Water Conservancy District automation/Internet project.

Traditionally, Reclamation had a fairly rigid product development process (cathedral). This approach was taken in the development and installation of large SCADA (Supervisory Control and Data Acquisition) systems. The problems with the cathedral process for small-scale automation systems are numerous: (1) it is too costly; (2) it takes too long; (3) hardware and software are frequently proprietary; (4) the customer does not always get what he or she needs; and (5) it is difficult for the product to evolve.

With the everybody-get-involved, bazaar-style development, the product evolves rapidly over time in concert with technological change and maturing water user needs. Prototypes (both hardware and software) are rushed to the field; feedback is critical. It becomes necessary for everybody involved in the project to interact, something the Internet facilitates.

Sources of Information

- <http://utahreach.usu.edu/emery/index.htm>
- http://provo.uc.usbr.gov/progact/ca/proj_emery.html
- Water History
- <http://www.uscitiesonline.com/utemerycounty.htm>
- <http://www.media.utah.edu/UHE/e/EMERYCT.html>