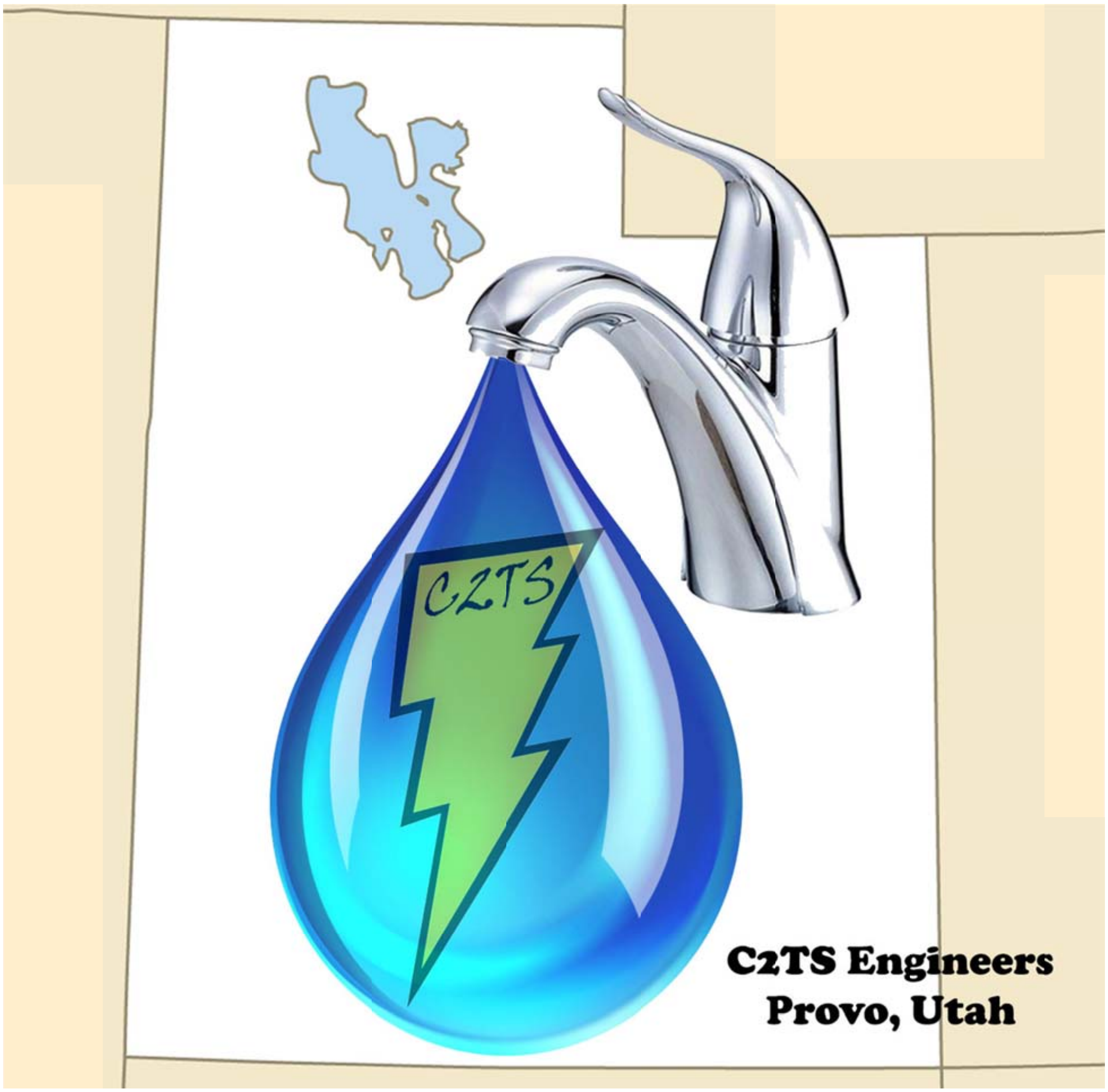
Utah Water-Energy Intensity Study



Department of Civil and Environmental Engineering
Ira A. Fulton College of Engineering and Technology
Brigham Young University

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Water Source, Treatment, and Distribution Participants

Centerville City
Fruit Heights
Granger-Hunter Improvement District
Herriman City
Highland City
Jordan Valley Water Conservancy District
Layton City
Magna Water District
Manila City
Morgan City
Mountain Regional Water Special Service District
North Salt Lake
Orem City
Panguitch
Pleasant Grove
Provo City
Sandy City
Saratoga Springs
SLCo Service Area 3
South Davis
South Weber
Spanish Fork
Springville City
Taylorsville-Bennion
West Jordan
West Point
Woods Cross

Wastewater Treatment Participants

Ashley Valley Water & Sewer
Central Davis Sewer District
Central Valley Water Reclamation Facility
Central Weber Sewer Improvement District
North Davis Sewer District
Provo Wastewater Treatment Facility
Salt Lake City Water Reclamation Facility
South Davis Sewer District (North Plant)
South Davis Sewer District (South Plant)
Spanish Fork Wastewater Treatment Plant
Springville City Wastewater Treatment Plant

Utah Water Energy Intensity Study

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Prepared for:

Prepared by:

C_2TS Engineers

Calvin Clark, E.I.T.

Cody Hamblin, E.I.T.

Trevor Jones, E.I.T.

Sam Mineer, E.I.T.

Assisted by:

Stephen Duncan, E.I.T.

Dr. E. James Nelson, Ph.D.

Department of Civil and Environmental Engineering

Ira A. Fulton College of Engineering and Technology

Brigham Young University

EXECUTIVE SUMMARY

With Utah's population forecasted to double within the next 40 years, the demand on the state's water infrastructure will increase dramatically. Most sources of easily-accessible drinking water are rapidly approaching full utilization, meaning that future growth of the water supply will need to come from sources that are much more energy intensive (Jones and Sowby 2014). There is a growing need to evaluate the delicate resources of this desert area, and to become more economical in using energy to extract, treat, and distribute water.

The C_2TS Engineers capstone team surveyed water sourcing, water treatment, water distribution, and wastewater treatment facilities throughout Utah, to collect data about water and energy usage. The data collected from thirty-eight utilities were normalized and transferred to a Geographic Information System (GIS) shapefile, making it available to view via a GIS platform.

The data collected indicates that the state's total energy intensity (EI) is approximately 1,250 kilowatt hours per million gallons (kWh/MG). This compares favorably to a national average of 3,200-3,600 kWh/MG (Ibid). For both end-use water services and wastewater treatment plants, the most energy intensive process of the data collected was found to be operating the pumps that extract and create the head for the water.

While this study gives a basic estimation of the EI in the state, there is still a need to improve data collection and reporting methods internally, as well as to the water board of the state. Current and future operators of water and wastewater facilities should seek out means to make their facilities run as efficiently as possible.

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INTRODUCTION

As Utah continues to flourish in the desert, an increase in capacity will become necessary for water systems throughout the state to meet the demand. According to the Utah Foundation, the population of the state is projected to double by the year 2050 (Utah 2014). This population growth means the demand on water and wastewater facilities will increase. According to Steven Jones and Rob Sowby (2014):

> *Most of the current population in Utah is situated at canyon mouths and at the bases of mountains where they can divert runoff and use gravity to pressurize their water systems. Much of this less energy-intensive and less expensive water has been developed. New water developments will likely require more energy to capture, treat and distribute to consumers.*

Since the "low-hanging fruit" of water system capacity has already been utilized, the energy required to meet the demands of the future population will be significantly more than twice the energy that is currently required, if current trends continue. Therefore, there is a need to improve (decrease) the EI of current systems to offset the necessary energy-intensive efforts of the future.

The purpose of this study is to estimate the EI for the state of Utah and to compare similar utilities within the state. EI is a representation of the amount of energy used to extract, treat, and distribute water and wastewater. For this study, EI is represented by kilowatt hours per million gallons (kWh/MG). The calculation of EI requires gathering information from a sample of utilities within Utah that extract, treat, and distribute water and wastewater. This information will be used to provide a representation of the state of Utah's EI and will also provide a comparison of similar utilities throughout the state.

Data for this study was collected from entities involved with water source, water treatment, water distribution, and wastewater treatment. A brief description of these entities is described in the following subsections.

Water Sourcing

The most common water source for utilities in Utah is groundwater. Other methods of water extraction include springs, rivers, or reservoirs. Wells are used to extract groundwater, and are among the more energy intensive methods of providing source water (UDWR 2012). Jones and Sowby reported that water sourcing EI values in the United States can range between 100 and 700 kWh/MG (Jones and Sowby 2014). Groundwater pumping EI values vary by depth (Ibid).

Some municipalities have their own wells or water rights to extract their own water. Others buy water from water wholesalers, who extract the water from natural sources and sell it to municipalities for a fee.

Water Treatment

Water treatment is the process by which extracted water is treated for end-use, such as industry, drinking, or medicine. This process removes or reduces the concentration of existing water contaminants. Drinking water treatment processes include flocculation, sedimentation, filtration, ion exchange, absorption, chlorination, and ozonation (EPA 2009). Different water sources require different degrees of treatment. For example, "snowmelt runoff has remarkably high water quality, and groundwater from deeper aquifers also requires very little treatment to meet drinking water standards" (Jones and Sowby 2014).

EI values for water treatment vary by process. Groundwater treatment requires the least amount of energy (less than 100 kWh/MG), while distillation and desalination processes required for more exposed water sources are very energy intensive (7,500 kWh/MG or more) (Ibid). Additionally, Jones and Sowby suggest that "in areas where groundwater is impaired, it can often be blended with higher-quality water from other sources to meet regulation standards" (Ibid).

Water Distribution

Water distribution is the process by which millions of homes, businesses, and industries throughout Utah receive potable water for drinking, cooking, bathing/showering, or other purposes. Each municipality is responsible for distributing water to its citizens, and each has developed its own manner of doing so, as well as their own fee program for consumption. Some of the largest cities (such as Salt Lake City or West Valley City) have divided their city into smaller, more manageable “water districts,” with each individual district responsible for providing water to its own residents. The most energy-intensive component of water distribution is pumping the water to the end users.

Due to the topography and urban layout of much of the Wasatch Front, “a significant portion of water supply systems in Utah use gravity to pressurize their water system distribution” (Jones and Sowby 2014). This allows many municipalities to save on distribution energy costs. Distribution in Utah typically has an EI range of 430-680 kWh/MG [140-220 kWh/ac-ft] (Ibid).

Wastewater Treatment

Wastewater treatment facilities receive the sanitary sewer of a city and cleanse the water to acceptable effluent standards. The size and technology of the wastewater plants depend on the area they serve and any additional effluent standards imposed on the facility. Some of the technology implemented at wastewater treatment facilities in Utah includes screens, clarifiers, aeration basins, trickle filters, activated sludge, anaerobic digesters, UV disinfection, and chlorination baths. There are approximately thirty mechanical wastewater treatment plants in Utah, in addition to several lagoon treatment systems (CH2MHill 2010). On a national scale, aeration treatment processes are the most energy intensive (Ibid). The efficiency of a treatment plant also depends on the capacity of the plant. Wastewater Treatment EI values in Utah historically range from 1,230-2,610 kWh/MG [400-850 kWh/ac-ft] (Ibid).

Report Outline

In this report, details of the study will be outlined. The data collection and analysis processes are summarized. The results of the study and recommendations for the future are also included in this report. Appendices are included to supplement the body of this report.

DATA COLLECTION

Collecting data from water utilities across the state was the crucial component of this project. Although water data is regularly reported to the Utah Division of Water Rights, entities are not required to report energy usage related to the water processed. In order to estimate EI, it was necessary to personally contact entities throughout the state and request their water and energy data. The entities which participated in the study are incorporated into the GIS dataset. Before collecting the data, a letter from the Division of Drinking Water was created to endorse the data collection activity, shown in Appendix A.

Methodology

To determine the most efficient data collection process, several methods were discussed, including:

1. Phone conversations
2. Emailing a questionnaire to be answered and returned
3. Sending a link to fill out a Google Form (online survey)

After assessing the benefits and drawbacks of each method, it was decided to first initiate contact with different entities over the phone and then email the link to an online survey for them to report their total water and energy usage. The online survey had qualitative questions built into it, which allowed the representatives to give additional details about their facility. Making the initial contact via phone call provided the opportunity to clarify the purpose of the study and increased the chance of receiving feedback. Providing the online survey gave the survey participants the opportunity to find and report the data at their own pace.

After attempting to contact the utilities and distribute the data collection form, it became apparent that there were deficiencies with this method. The longer online survey was too detailed for utilities to complete in a timely manner, in addition to the other responsibilities demanding their attention. After some discussion, it was decided that the data collection process would be broken into two parts. The first part of the data collection would include the initial phone contact and email message with a link to a revised survey. In the revised survey (included in Appendix B), no qualitative questions were asked. After the representatives had a chance to respond to the shortened survey, a follow-up email containing qualitative questions was sent, which were tailored specifically to their process and function. Some of the qualitative questions asked include those provided in Table 1. Throughout this entire process, the form was continually modified and updated as contacts submitted their feedback.

Table 1: Example of Qualitative Questions

How does the utility track its energy use, and how regularly?
What energy-related policies, plans, or goals does the utility have?
What energy problems have occurred or are anticipated?
Which process at the facility consumes the most energy?
What kind of treatment technology is used at the facility?
Are there any short-term or long-term goals for improvements to the process or reducing energy consumption?

Water & Energy Nexus Summit

Several group members attended the First Annual Water & Energy Nexus Summit, presented by the Rural Water Association of Utah and the Governor's Office of Energy Development. The summit addressed the issue of energy efficiency in water systems, so it served as an educational opportunity for the team. There were a number of water representatives from various municipalities and water districts present at the summit. Several business cards were exchanged after the summit, and at least one utility's data was provided as a result of this experience. Beyond this, however, there were not many opportunities for the group to interact with other attendees.

Data Collection Evaluation

In the process of data collection, the team reached out to every municipality with a population of 10,000 or more, as well as at least one municipality from each county in Utah. In many cases, this contact consisted of no more than an unsolicited email or a message left on a city employee's voicemail. For some of the smaller municipalities, it was more efficient to send unsolicited emails through their websites and/or to the city's public works directors with a simple request for data. For the larger municipalities and facilities, it was necessary to make the initial contact via a phone conversation before sending an email with the survey.

In the process of contacting the various municipalities, it became clear that many cities were not very mindful of how much energy was being consumed by their water-related processes. Although most had a clear idea of water usage numbers and could respond with relative ease, few were prepared to provide data on energy usage. Some cities were very accommodating, but there were several that did not respond in a timely manner or did not provide all of the requested data.

DATA ANALYSIS

Since various organizations reported different facets of their water and energy usage, the data was normalized into a format compatible with GIS software. After processing the data, the energy intensity was calculated, and a GIS dataset was prepared.

Assumptions and Limitations

While processing the data, there were several assumptions made to normalize the data which the various entities provided. One assumption was the dollar cost of energy. For the scope of this project, it was assumed that the typical water organization paid an average of $0.15 for one kilowatt hour of energy. This was assumed only when the various water entities were able to provide their monetary energy costs, but not actual energy consumption figures. However, this is a fairly crude assumption: in reality, the cost per kilowatt hour varies depending on the time of day, billing plan, and several other factors. This assumption is conservative in that it yields a lower energy usage, therefore a higher EI.

The team was aware that water wholesalers increase the water's head that is supplied to their customers. This means that municipalities which receive water from wholesalers may not have to spend as much energy in their own distribution systems. However, information was not readily available to determine the actual amount of water that was purchased by the municipalities from wholesalers, or the resulting energy that was already spent on that water. The problems encountered in dealing with this limitation are addressed in Appendix C.

Calculating Energy Intensity

The ultimate goal of the data collected was to determine the EI of water services for the state of Utah. To aid in the data analysis, Microsoft Excel workbooks were created to organize the information in an efficient manner. Data for each facility or entity that participated was recorded in its own workbook, each with multiple spreadsheets. Additional worksheets in the workbook outline the monthly water and energy usage for each of the entity's processes (pumps, wells, treatment processes, etc.). The detail included in each sheet directly reflects the quantity and quality of data provided from study participants.

Table 2 shows an example summary table for Mountain Regional Water Special Service District. It is important to note that not all values in this table may be filled for each entity. For example, the North Davis Sewer District handles wastewater treatment and does not have values for extracting groundwater, or providing head for potable water for an area. This also means that some cities may not have values for water treatment, since another entity treats the water before or after use.

Table 2: Water and Energy Data for Mountain Regional Water Special Service District

	Total Water (MG)	Total Energy (kWh)	Energy Intensity (kWh/MG)
Source	239	744,895	3,122
Treatment	296	592,802	2,006
Distribution	1,697	1,783,966	1,051
Wastewater	-	-	-
Total System	2,231	3,121,663	1,399

Note: The completeness of the table varied by facility and the quantity of data provided.

The EI for each site is calculated intermediately, as well as for the overall entity. The EI is calculated as follows:

$$EI = \mathrm{E}/Q$$

where: EI = Energy Intensity

E = Energy (kWh)

Q = Volume of Water (million gallons)

To calculate the EI for the whole state, the total water volume and total energy usage values were summed. This accounted for all of the energy data collected being divided by all of the water data collected, equaling the total EI for the state of Utah.

Summarizing Data (GIS Dataset)

To visualize the information collected, each entity's data was combined to a central spreadsheet and then converted into a GIS dataset. A composite address locator for the state of Utah was downloaded from the Utah AGRC website (AGRC 2015). This tool allows the addresses for each entity to be converted into a geospatial location within UTM Zone 12N. The approximate locations are within the shapefile, along with the calculated EI values. The shapefile was processed by the Inverse Distance Weighted (IDW) tool in ArcMap to create a distribution map that represents statewide EI values. Entities with similar EI's will be represented by color, and a physical representation on the map will display their spatial location. Therefore, the map does not represent the overall EI for Utah, but rather a representation of how the EI is distributed across the state. Maps for the Water EI and Wastewater EI are included in Appendix E and Appendix F, respectively.

RESULTS

After receiving water and energy data from thirty eight entities across the state, a state-wide EI was calculated to be approximately 1,250 kWh/MG. The energy intensities of the different water entities are summarized in Table 3.

Because different water facilities were contacted during this study, the following subsections outline some of the results reported from different entities across the state. These subsections include general findings, specific examples of energy efficiency, and recommendations for improving the water and wastewater facilities in Utah.

Table 3: Summary of EI for Statewide Water and Wastewater Processes

	Water (MG)	Energy (kWh)	Energy Intensity (kWh/MG)
Source	28,580	50,080,690	1,750
Treatment	1,830	3,359,770	1,840
Distribution	11,440	9,924,410	870
Water Total	41,850	63,364,860	1,510
Wastewater	63,850	68,390,200	1,070
Statewide Total	105,700	131,755,070	1,250

Municipalities – Treatment and Distribution

Municipalities, for the most part, have not documented energy use as carefully as water use. Most cities have low energy intensities (1,000 and 2,000 kWh/MG) compared to the national average.

Some municipalities have successfully reduced their energy intensities. Mountain Regional Water Special Service District has done an excellent job at reducing their EI over the last several years, as well as keeping records of energy use. Much of this has come from an increase in punitive rates at peak times, as well as relentless focus on improving the efficiency of their water systems. Their average is 90 gallons per capita per day, which is around one quarter of their per-capita usage before they began to focus on reducing per capita water and energy conservation (Evans 2015).

In other cases, high energy values are unavoidable. Terry Polluck, the general manager of Magna Water Improvement District (MWID), indicated that their energy usage is higher than would otherwise be the case, since MWID runs an electrodialysis reversal facility (EDR). The reason for this energy-intensive system is to clean up wells contaminated by local industrial processes.

For most municipalities, the first step to improve their energy intensities is simply to be aware of the energy costs for their water systems. Conducting an audit can help identify areas of improvement. After which, the measures to reduce EI will vary by city, but may include reducing loops, removing pressure-reducing valves, timing pump usage or plugging leaks (Evans 2015).

Wastewater Treatment

As a result of receiving data from eleven wastewater facilities, it was clear that the most energy intensive process depended on the facility and the local topography. Most of the wastewater facilities reported that creating head through pumps were some of the highest energy consumption processes. Other processes that use a significant source of energy are the trickling filter and activated sludge processes. In the activated sludge process, there is a significant energy investment to run the air blowers, which is crucial to optimizing the activated sludge process.

The wastewater treatment plant for the North Davis Sewer District reported the ability to cogenerate some of the energy used in their plant. According to plant manager, Myron Bachman, the North Davis Sewer facility is currently working towards generating 80% of their own energy. Other plants are planning to replace 30 year old functional pumps with more energy-efficient pumps. Newer pumps can have a soft starter built into the system, which can reduce the mechanical stress on the motor and the electrodynamic stresses on the electrical system, which in turn can extend the overall lifespan of the unit, while conserving energy (Teschler 2014).

DISCUSSION

Comparing Utah's statewide EI of 1,250 kWh/MG to the summary given by Jones and Sowby (2014), Utah appears to have the lowest EI of any state for which data is available. Utah's EI compares favorably to that of Northern California (5,400 kWh/MG), Massachusetts (3,200 kWh/MG), and Wisconsin (3,600 kWh/MG). It is important to recognize this is not a final conclusion of Utah's EI, and that verifying the correct value will require additional research. Despite the need for verification, Utah's water suppliers should be commended for their work in reducing the energy usage required by their water-related processes. Additionally, credit belongs to early settlers who planted communities in areas with easy access to mountain runoff. (UDWR 2012)

Some uncertainty existed regarding the correct manner to calculate a statewide EI value. The statewide EI of 1,250 kWh/MG was obtained by summing the total water used from all entity types, summing the total energy used from all entity types, and dividing the two numbers directly. However, if the sum of energy intensities of each process were taken, then the state EI would be 5,530 kWh/MG. After discussion among team members, it was decided that this method of summing EI's may overestimate the state's EI significantly, because it would fail to account for the effects of double-counting water usage between processes. However, it should be noted that this method of summing EI's would produce an overall value that is more comparable to national values.

Collecting data from thirty-eight different water related entities was a success of this project, considering the time constraint of the study, and the team's limited experience with the industry. There is additional data to collect and to consider in order to provide a confident approximation of EI across the state. For example, data from Salt Lake City was not available to the group, which accounts for 6.5% of the population of Utah. Another city to collect data from is St. George, with a population of 72,000 in an arid region of southern Utah.

From the data collected, cities in similar geographical situations provided comparable results. Cities along the Wasatch Front had fairly similar EI values, despite their different sizes or amounts of water and energy used. This is likely due to the fact that they had similar sources (including groundwater and snowmelt runoff) and distribution methods (such as gravity driven or pre-pressurization). Data from isolated cities had a significantly higher EI value.

The variability of data across the state is likely caused by a variety of factors, including:

1. Variations in local topography
2. Foresight that was taken in designing energy-efficient water treatment/distribution systems
3. Installing and maintaining energy-efficient pumps or other system components

4. Local circumstances – such as environmental pollution – which required additional water purification systems (e.g. Magna's use of EDR)

During the collection process, efforts were made to normalize the data in a uniform manner, so that water and energy values were not double-counted. For example, water vendors can provide head to their customer, which means their customers do not need to invest as much energy to move the water to their consumers. Although every effort was made to capture this effect, there is susceptibility for the data to be incomplete or misrepresentative of the actual water and energy usage, since the movement of water is a complicated process on a state-wide level.

There was also a potential for misrepresentation due to non-response, as data was only received from half of the contacted entities. This could potentially introduce a bias in the results, since those that were able to provide energy data were those that were already making an effort to track energy, and were therefore more likely to be conservation-minded.

Attending the Water-Energy Nexus Summit provided first-hand experience with the level of awareness which exists about water-related energy usage. Most of the participants in the event were clearly well-informed and passionate about water and energy conservation efforts. The awareness to document energy usage could increase as more representatives from different entities participate in the Nexus Summit.

Overall Efficiency Improvements

To improve the efficiency of the state's water facilities, it is recommended for their management to collaborate with peer facilities, and coordinate with the Utah Department of Environmental Quality (DEQ). On the DEQ's website (www.deq.utah.gov), there is a 45-page energy savings handbook, prepared with suggestions on improving the different aspects of efficiency. For example, there is information concerning energy and power rate dynamics, pumping system efficiencies, water source efficiencies, and funding opportunities for future improvement (Utah DEQ 2015).

CONCLUSIONS

This preliminary study showed that Utah's overall EI was around 1,250 kWh/MG. This is significantly below the national average of 3,200 to 3,600 kWh/MG. Part of the difference may be due to fact that a large portion of Utah's populations lives in areas with relatively easy access to clean groundwater and mountain runoff. This low value could also have been due to errors or discrepancies while collecting or normalizing the data, which have yet to be fully reconciled. There could be other methods for calculating EI, which should be standardized to provide a fair comparison between states.

Although it is possible that these results suffer from inadvertent error, it is likely that Utah has a relatively low EI, especially when compared with other states. Utah has benefitted from a very high concentration of residents in areas with easy access to high-quality water sources.

Future expansion of Utah's water supply, however, may be more difficult and energy intensive. Future population growth will likely come in areas that do not enjoy such easy access to clean water. Climate change-induced desertification may increase EI values in areas that currently enjoy natural water sources. Therefore, more clearly understanding the EI of the various water processes in the state is a crucial effort. The data collected in this study should be continually collected and refined, to help water entities through the state prepare for future growth in Utah in the most energy efficient manner possible.

Recommendations for Future Studies

While this study has been able to give a fair representation of statewide EI, there remains a need to improve the data collection process and reporting standards for future studies. Several ideas to improve future studies include:

- Studying correlation between effluent quality and EI for wastewater treatment plants
- Integrate values from the Utah DRW database
- Improve understanding of effect between entities (wholesalers and cities)

- Improve accuracy of water quantities within an entity
- Define role and effects of secondary water on EI
- Develop educational materials to help entities communicate with each other
- Re-run spatial analysis with different analysis tools and compare results

An interesting topic to investigate is the correlation between EI and the effluent produced from wastewater treatment processes. For example, while reaching out to the wastewater treatment plants, it became apparent that there are correlations between effluent quality and energy usage, which makes it a monumental task to compare EI's between plants in a meaningful way. These specific details were not captured in the scope of this study, which would be an appropriate subject in a future study.

Often during this research, the values reported were significantly different from those that were found in the DWR system. There would be great value in using the DWR system for the quantities of water, reporting that information back to each entity for confirmation, and soliciting the energy that they used to produce the related water value. The discrepancies between water values collected and those reported to the DWR database are discussed in Appendix D.

A difficulty faced in the project was capturing the relationship between water wholesalers and water consumers. While every effort was made not to double count water exchanged between entities, this was an objective too great to capture in the scope of this project. For future studies, it is important to understand and account for the relationship between entities.

While processing the data for each entity, it was brought to the research team's attention that there was an inadvertent chance to overestimate water values within an entity. While this was not resolved in the scope of this project, it is important to ensure that future studies do not double count water values, or else the EI values may appear lower than real EI.

Another variable is the role of secondary water, which is frequently used for irrigation. The scope of this project excluded secondary water but was unable to thoroughly separate culinary water distribution from secondary water distribution. For future studies, these values should be clearly defined and separated from the beginning of the study.

Future studies should also prepare more effective educational materials to help the water entities communicate in a succinct manner. Distinguishing between source and distribution was difficult for the research team, as well as many of the utilities, because these processes are closely related. Investing time to discuss the differences between source, treatment, and distribution numbers with the water entities would likely save time and effort during data processing.

While creating the spatial analysis of the data provided, the IDW tool was used to interpret the variation of EI across the state. For future studies, other GIS tools could be used and compared with the output of the IDW tool.

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GLOSSARY OF TERMS

DEQ	Department of Environmental Quality
DWR	Division of Water Rights
EDR	electrodialysis reversal facility
EI	energy intensity
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
IDW	Inverse Distance Weighted
JVWCD	Jordan Valley Water Conservancy District
kWh	kilowatt-hour (per month/hour/year, as specified)
kWh/MG	kilowatt-hour per million gallons
MG	million gallons
MWID	Magna Water Improvement District
UTM	Universal Transverse Mercator coordinate system

Appendix A: Division of Drinking Water Letter of Endorsement

The Division of Drinking Water is interested in promoting energy efficiency among water systems in the State. The Division has, with help from select water systems and consultants, prepared a Handbook that gives directions on saving energy. That Handbook can be obtained from the Division's web site at: www.drinkingwater.utah.gov and then click on: Drinking Water Energy (Cost) Savings Program.

The effort that these BYU students are engaged in will provide valuable information that will help quantify the energy usage of water systems. This effort connects with the Division's program of saving energy. Consequently, I encourage water systems to participate in BYU's study and look for ways to reduce their energy usage.

Kenneth H. Bousfield, P.E.
Director, Utah Division of Drinking Water

C₂TS Engineers

Appendix B: Energy Intensity Study (revised form)

If you would prefer to provide some information in another manner, any additional spreadsheets or attachments may be sent directly through email.

* Required

Name of Facility *

Address or Location *

Process *

If reporting for multiple water processes, please submit separately for each.

- Source
- Wastewater
- Treatment
- Distribution
- Other:

Owner of Facility

If applicable

Year of Water and Energy Data *

Please submit the most recent year of water and energy data you have.

Total Water Processed for the Year *

Please specify units (MGD, etc.)

[Continued on reverse side]

Total Energy Usage in Using/Moving Water Specified Above *

If the energy usage data is unavailable, please include the energy bill for water-related purposes, specifying the units

Name of Contact *

Contact Email Address

Contact Phone Number

Thank you

Thank you for your help with this study. If you have additional information that you could share with our research team, please email c2tsengineers@gmail.com. We appreciate your help with this study.

[End of survey]

Appendix C: Case Study – Herriman City EI Calculation

A possible discrepancy that could affect municipal energy intensities was discovered while analyzing data about wholesaler water. When water wholesalers such as Jordan Valley Water Conservancy District (JVWCD) deliver water to their customers, the water is generally delivered with enough head that the municipalities do not need to pressurize the water further. Therefore, the municipalities are able to distribute this water to their customers without using their own energy. However, most municipalities do not rely solely on wholesalers to provide the public with water, and therefore have their own sourcing, treatment, and distribution facilities. The problem arises when these municipalities report water usage, including water received from wholesalers, without indicating how much was extracted by the municipality and how much was received from the wholesaler. In this situation, there are three possible methods that were considered in reporting overall water and energy data. Each method has its own advantages and disadvantages.

Method 1 disregards the water values reported from the wholesaler, as long as that wholesaler is also accounted for elsewhere. This method assumes that the EI for this amount of water has already been accounted for when calculating the total EI for the state of Utah.

Method 2 includes the water in the calculations, but not the energy. The reason being that *for that particular entity*, there was a certain amount of water used, but that entity used only as much energy as they reported. Therefore for this particular entity, the EI is represented locally.

Method 3 uses the EI calculated from the given wholesaler to calculate the energy used on that water, multiplied by the amount of water that is sold to the municipality. This would likely give a more accurate representation for each individual municipality. However, since water and energy data from JVWCD is already being represented in the statewide EI calculations, this method would result in counting the water provided to the municipality and the associated energy twice in the final calculation. An additional setback is that data was not provided for any wholesaler besides JVWCD, so it would be impossible to provide a similar representation for cities that obtain water from other wholesalers.

Herriman City provided data concerning the amount of water they bought from JVWCD in addition to the water they processed on their own. This data was used to investigate the potential issues mentioned above. After their data was analyzed by the three different methods, the energy intensities were compared. Method 1 is shown in Table 4, Method 2 is shown in Table 5, and Method 3 is shown in Table 6.

Table 4: Method 1 for Calculating EI for Herriman

Leaving off Wholesaler Data			
	Total Water (MG)	**Total Energy (kWh)**	**Energy Intensity (kWh/MG)**
Source	1,193	1,764,562	1,480
Treatment	0	0	0
Distribution	838	915,683	1,092
Wholesale	0	0	0
Total System	2,031	2,680,245	**1,320**

Table 5: Method 2 for Calculating EI for Herriman

Including Water			
	Total Water (MG)	**Total Energy (kWh)**	**Energy Intensity (kWh/MG)**
Source	1,193	1,764,562	1,480
Treatment	0	0	0
Distribution	838	915,683	1,092
Wholesale	869	0	0
Total System	2,900	2,680,245	**924**

Table 6: Method 3 for Calculating EI for Herriman

Including Water and Energy			
	Total Water (MG)	**Total Energy (kWh)**	**Energy Intensity (kWh/MG)**
Source	1,193	1,764,562	1,480
Treatment	0	0	0
Distribution	838	915,683	1,092
Wholesale	869	1,216,836	1,400
Total System	2,900	3,897,080	**1,344**

The EI for Jordan Valley is 1,400, and Herriman purchased 869 million gallons of water from Jordan Valley. Solving the EI equation for energy, the energy used for that water equals 1400 * 869 = 1,216,836 kWh of energy. This energy can be included in the EI equation as part of the sum of total energy.

Method 1 (without any wholesaler data) and Method 3 (including all wholesaler data) appear to give fairly comparable results. However, in some cases the municipalities may have included the water received from wholesalers without indication, but excluded the energy the wholesalers invested. Method 2 is a representation of this. In this example, if the data for Herriman were to include the wholesale water, the difference would be nearly 30%.

Several entities are likely to have included water from a wholesaler without specifying. This is a potential limitation for the validity of this project. In future studies, it is recommended to specifically ask municipalities how much water was received from wholesalers. This would allow more consistent comparison between municipalities statewide.

Appendix D: Case Study – Comparing Values to DWR Database

After receiving data through contacting entities, the team compared these values to the values found on the Utah DWR website. Compared to the DWR values, some reported values were much higher and others were much lower, and the average discrepancy was 50% to 100%. The results are reported in Table 7 and Table 8.

Table 7: Comparison of Collected Values and DWR Values

Entity Name	Collected Values (MG)	DWR Values (MG)	Difference in Values	Percent Change
Ashley Valley Water & Sewer	986	-	-	-
Centerville City	373	421	-48	13%
Central Davis Wastewater	2,555	-	-	-
Central Valley Water Reclamation	18,250	-	-	-
Central Weber Sewer Plant	11,936	-	-	-
Fruit Heights	137	144	-7	5%
Granger-Hunter Improvement District	1,790	7,754	-5,964	333%
Herriman City	2,031	1,891	140	7%
Highland City	2,976	0	2,976	100%
Jordan Valley Water Conservancy District	38,450	1,946,649	-1,908,199	4963%
Layton City	1,307	3,895	-2,589	198%
Magna Water District	3,331	1,339	1,992	60%
Manila City	53	75	-22	41%
Morgan City	146	210	-64	44%
Mountain Regional Water Special Service District	2,231	628	1,603	72%
North Davis Sewer District	8,030	-	-	-
North Salt Lake	2,589	1,315	1,274	49%
Orem City	3,304	7,578	-4,274	129%
Panguitch	19	0	19	100%
Pleasant Grove	1,383	1,457	-74	5%
Provo City	10,110	7,677	2,432	24%
Provo City Water Reclamation	4,745	-	-	-
…	…	…	…	…

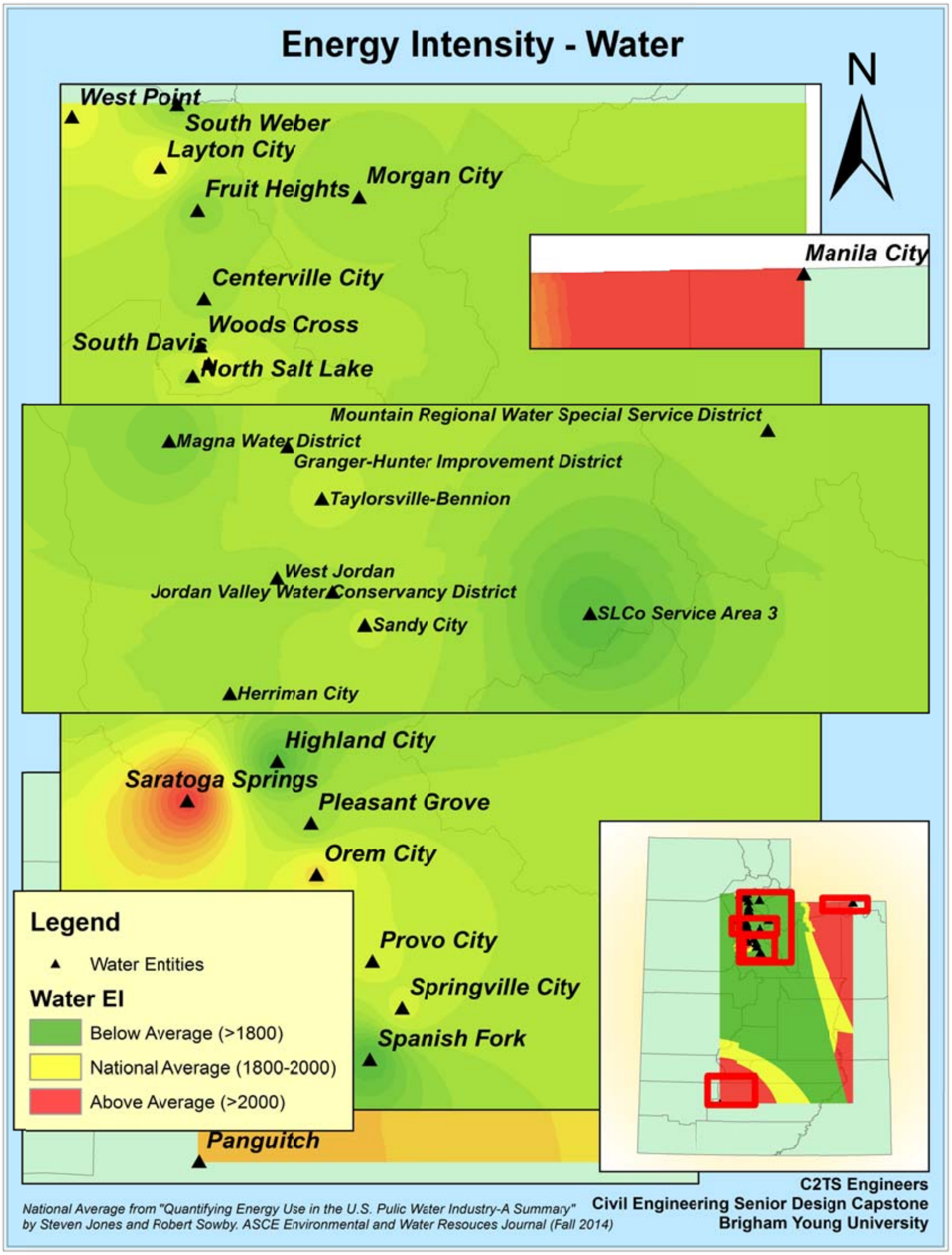
Table 8: Comparison of Collected Values and DWR Values (continued)

Entity Name	Collected Values (MG)	DWR Values (MG)	Difference in Values	Percent Change
…	…	…	…	…
Salt Lake City Water Reclamation Facility	10,608	-	-	-
Sandy City	4,885	8,291	-3,405	70%
Saratoga Springs	472	0	472	100%
SLCo Service Area 3	121	126	-5	4%
South Davis	256	897	-641	250%
South Davis Sewer District North Plant	1,971	-	-	-
South Davis Sewer District South Plant	1,971	-	-	-
South Weber	188	167	21	11%
Spanish Fork Wastewater	1,497	-	-	-
Springville City	1,677	3,512	-1,835	109%
Springville Wastewater	1,307	-	-	-
Taylorsville-Bennion	4,202	3,903	298	7%
Spanish Fork	3,343	923	2,420	72%
West Jordan	2,598	6,871	-4,273	165%
West Point	12	170	-158	1336%
Woods Cross	362	425	-63	17%

One possible reason why some values from collection efforts were higher is that entities may have included water received from wholesalers in the values they reported to the team. This would result in an entity reporting water in their totals that they did not use energy to produce (see Appendix C). One possible reason for lower values from collection efforts could be the reporting of secondary water. There seems to be some confusion in the industry of how to report secondary water, as different entities do not classify secondary water in a consistent manner. Many entities include secondary water in their reports to the DWR, but not all included it in their report to the team.

There were also several entities for which there were no values found on the DWR website. Most of them were wastewater related, but there were also several municipalities that were missing. Although the DWR has a good system in place, there is still much refinement that needs to occur in water data reporting.

Appendix E: Water Energy Intensity Map



Appendix F: Wastewater Energy Intensity Map