Water Wise Solutions and Management

A New Outlook for the Belmont Project

LAP/PUP/CEE 598 – Smarty City Sustainability and the Environment

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Introduction

The preservation and conservation of water and ecological systems in our cities are essential to maintaining a smart and sustainable future. To ensure the protection of these resources, the Belmont Project partners can benefit from various trends in smart, sustainable city ideas. This outlook provides pathways toward smart, sustainable water and ecological systems based on the latest research and case studies. An outlook being the latest information and trends to inform future Belmont work. The outlook can be the foundation for a larger vision to achieve the Belmont Team's smart, sustainable city goals. For a while, the Belmont team's outlook has been to build a smart city that uses technology to create a better and more sustainable future for its inhabitants and workers. One now needs to create a new outlook that updates the Team's thinking to account for the dramatic changes in trends in the last 18 months on what technologies could be used and what aspects of sustainability the project could pursue to achieve more sustainable pathways. To create a new outlook for the Belmont Project that focuses more on the preservation and conservation of water and ecological systems, we need to review current societal trends that prevent a city from pursuing these goals. We also need to review scholarly identified tensions (Martin, Evans, & Karvonen, 2018) that threaten the success of smart, sustainable cities.

Two main 2020 trends have accelerated the need for a new outlook that the Team may likely need to address going forward. The first trend is the increased water use, decreased water availability due to climate change and drought, conflict over water rights, and the lack of reuse of other water sources. According to the Arizona Department of Water Resources, most of the water used in the active management areas is taken from groundwater, and most of the water used is sourced from the Colorado River. Knowing this helps us as we are moving forward to know what areas of our water and ecology are being put at risk. Suppose we continue to only get a majority of our water from the colorado river. In that case, we will risk over exhausting that resource, and anyone farther down the river will have fewer opportunities to use the river if they need it. Not to mention risking the livelihood of the habitats and ecological systems that take place along the river.

The second trend is the potential repetition of past environmental justice mistakes in urban development that compromise water and ecological resources conservation. Bolin and colleagues (2005) describe how the past strategies for development in South Phoenix led to devastating environmental racism for the nonwhite residents who lived there. In their reflection towards the end, they state that, “The lack of potable water, sanitation, adequate diet, or healthcare along with the pestilential runoff of industries con-tributed to chronic health problems of South Phoenix resi-dents. While Anglo Phoenix neighborhoods had an expand-ing water and sewage infrastructure in the 1920s, none was extended to South Phoenix for decades, other than that need-ed for the growing industrial district along the rail corridor(Kotlanger 1983).” (Bolin, page 166) This article is one of many reflecting on how a lack of awareness of how past urban planning strategies that focused on expansion rather than sustaining life across the city as a whole have failed. These mistakes are only destined to be repeated in future projects if we do not take action to challenge previous design strategies to make things better.

Figure 1: Arizona Department of Water Resources diagrams of water use in the active management areas.

Source: *Arizona Department of Water Resources*. (2020, August 27). AMA Data | Arizona Department of Water Resources. https://new.azwater.gov/ama/ama-data.

As a continued reflection on the diagram above, it is also important to note that effluent water is not often used. As a result, it could be another good option to look into when moving forward as an alternative water resource to utilize more in the context of the Belmont project.

Over the last decade, scholars have developed smart sustainable city concepts. Hojer & Wangel (2015: p. 342) define a smart, sustainable city as a city that:

> "• meets the needs of its present inhabitants
> • without compromising the ability for other people or future generationsto meet their needs, and thus, does not exceed local or planetary environmental limitations, and
> • where this is supported by ICT."

A smart, sustainable city approach is desirable for Belmont to build a strong foundation that equips the city with adaptable development strategies that address the new challenging trends. Within this growing body of literature, Martin and colleagues (2018) reviewed published work and identified five tensions of smart, sustainable cities. The Belmont team moving forward must be aware of and potentially prepared to address these tensions addressed in Martin and colleagues' article. The Belmont Team should be prepared to consider what can be done to counteract the tensions that diminish smart city approaches. The following individual reflections made by the team propose alternative approaches.

The first tension addressed concerns that smart cities can fail to implement environmental protections while digitizing urban infrastructure. The Belmont project has uniquely positioned itself to be a game-changer city for combining information and communication technology (ICT) with water and ecological enhancements. If thoughtfully implemented, the "smart" in the "smart city" will be digitally focused with physical, trackable water and ecological health results. According to Höjer et al. (2015: p. 342), "It is also important to assess whether the smartness delivers the intended outcomes or not." For example, water usage and reuse. Suppose Belmont can significantly reduce water usage and increase the amount of water they can reuse, which are trackable and measurable goals. In that case, other cities will be able to learn from them and incorporate changes for their cities as well. The most important aspect of data like this is that it is clearly and openly displayed and shared so that citizens can see the changes, which encourages cooperation and discourages corruption. Open and honest communication is key to success in the long run. The digital urban infrastructure plays a strong part in the mitigation measures of water resources and sewage treatment; innovative and improved urban infrastructure systems are areas where Belmont could excel. At the same time, improve operational efficiency and integration to improve the digitalization of environmental protection. Particularly data platforms and living labs, which are intended to empower citizens to engage with urban governance processes. (Martin, 2018).

There is an apparent fear that as a city grows, so does the destruction of the environment. With this in mind, water is going to be sourced from a planned smart city approach. Belmont and those tasked with figuring out how the water will be sourced have addressed the concerns and will be pulling heavily from companies' partnerships to bring groundwater and reclaimed water to the city. The distribution and plan, as well as the backup plans the designers have for the water system at Belmont, are for the case of Arizona not harming the environment or leading it to further degradation as found in the plan for them to reclaim and process the water in a safe and sustainable model.

Keeping these strategies in mind, Belmont should maintain the protection of its natural resources as the city develops rather than being solely driven by growth.

The second tension addressed is the concern of the benefits of digital innovation being unevenly distributed. Our natural resources, such as water, need to be distributed evenly for the city to be sustainable. For equity to be enforced as one moves forward with the Belmont Project, those with influence and authority positions have the most significant impact to counteract the second tension that Martin proposes. Although we see evidence of how the passivity of authority causes the continuation or worsening of tension against smart city strategies, hopefully, this reflection causes one to propose rethinking sustainable and equitable design practices. Moving forward, it will be essential to get the city leaders involved with sharing and working towards achieving the new proposed outlook. In continued reflection of how past decisions were made to influence the urban planning of our cities, it is apparent that we need to prevent a repetition of the past by creating new policies, social structures, and even infrastructure. As a policy, I would suggest more equitable housing, so that poor residents are unevenly situated by environmentally hazardous sites. In modern cities, those sites by nature are fewer, but awareness of fair housing prices everywhere can combat environmental injustice. They are creating a social structure and government system that values inclusion and diversity.

Now that it is clear what present-day trends need to be challenged and what steps need to be taken to address the tensions that invalidate smart sustainable city approaches, the report will continue by addressing the current environmental context for the Belmont project's construction.

Context

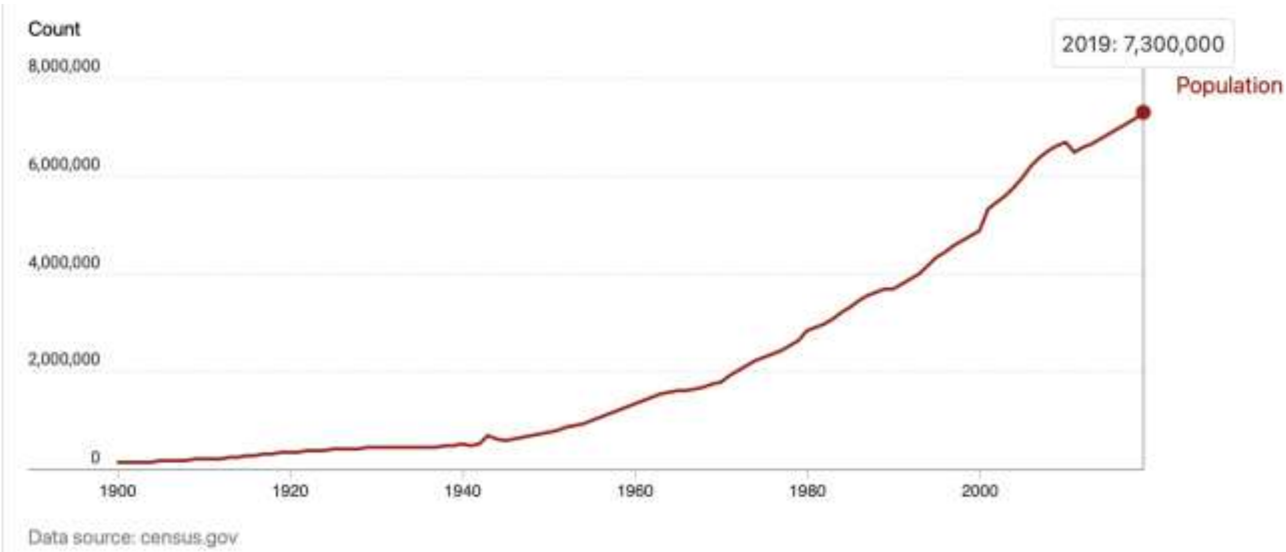
1) Arizona

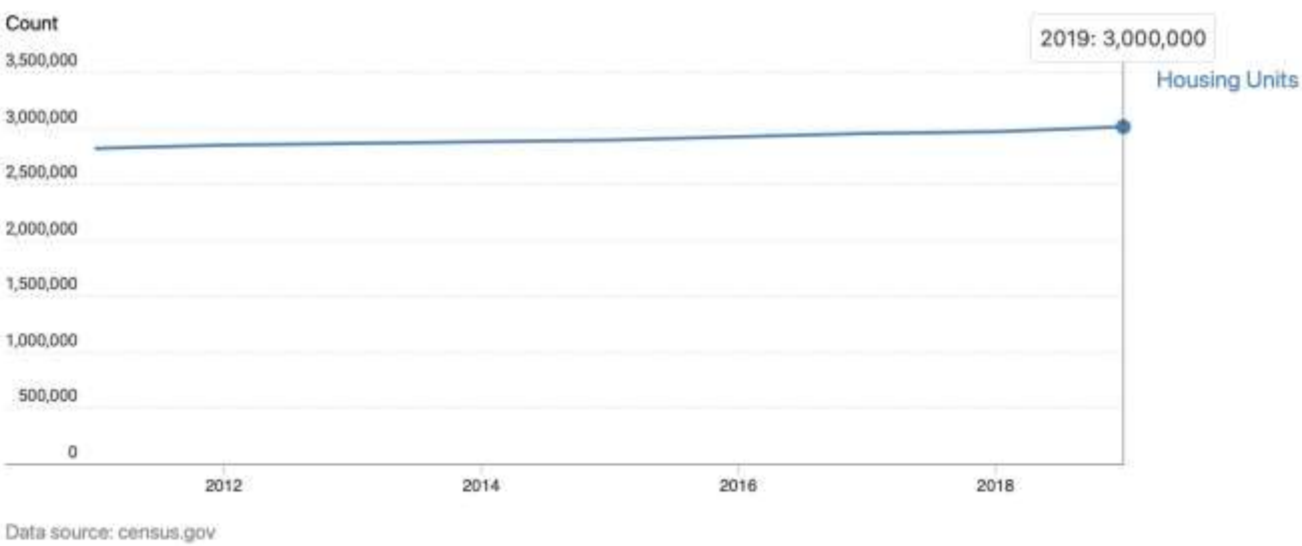
Arizona is located in the southwest of the United States, covering 295,000 square kilometers, and the state capital Phoenix. The state's climate varies greatly, and most of the region has a desert climate. The summer is dry and hot, the winter is mild, and the annual rainfall in the southwest desert area is relatively small.

Arizona Population

Arizona is home to a diverse population. About one-quarter of the state is made up of Indian reservations that serve as the home of 27 federally recognized Native American tribes, including the Navajo Nation, the largest in the state and the United States, with more than 300,000 citizens.

Since the 1980s, the proportion of Hispanics in the state's population has grown significantly due to Mexico's migration. (Arizona, 2021)





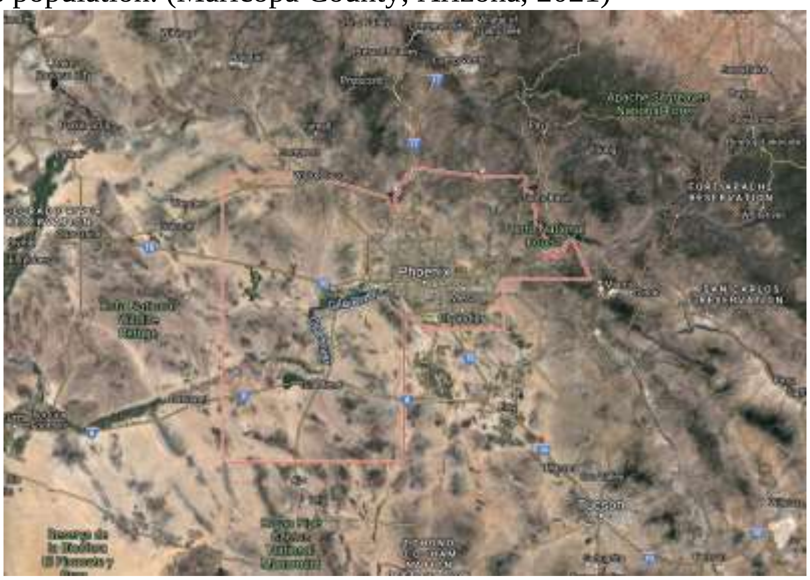
2) Maricopa County

Maricopa County is located in the south-central part of the U.S. state of Arizona. According to the U.S. Census Bureau, the county has a total area of 9,224 square miles (23,890 km2), of which 9,200 square miles (24,000 km2) in the land and 24 square miles (62 km2) (0.3%) is water. Maricopa County is one of the largest counties in the United States by area, with a land area more significant than that of four other US states. From west to east, it stretches 132 miles (212 km) and

103 miles (166 km) from north to south. It is by far Arizona's most populous county, encompassing well over half of the state's residents. It is the largest county in the United States to have a capital city.

Maricopa County Population

The U.S. Census Bureau estimated its population was 4,485,414 as of 2019, making it the state's most populous county and the fourth-most populous in the United States, containing about 62% of Arizona's population. (Maricopa County, Arizona, 2021)



3) Phoenix

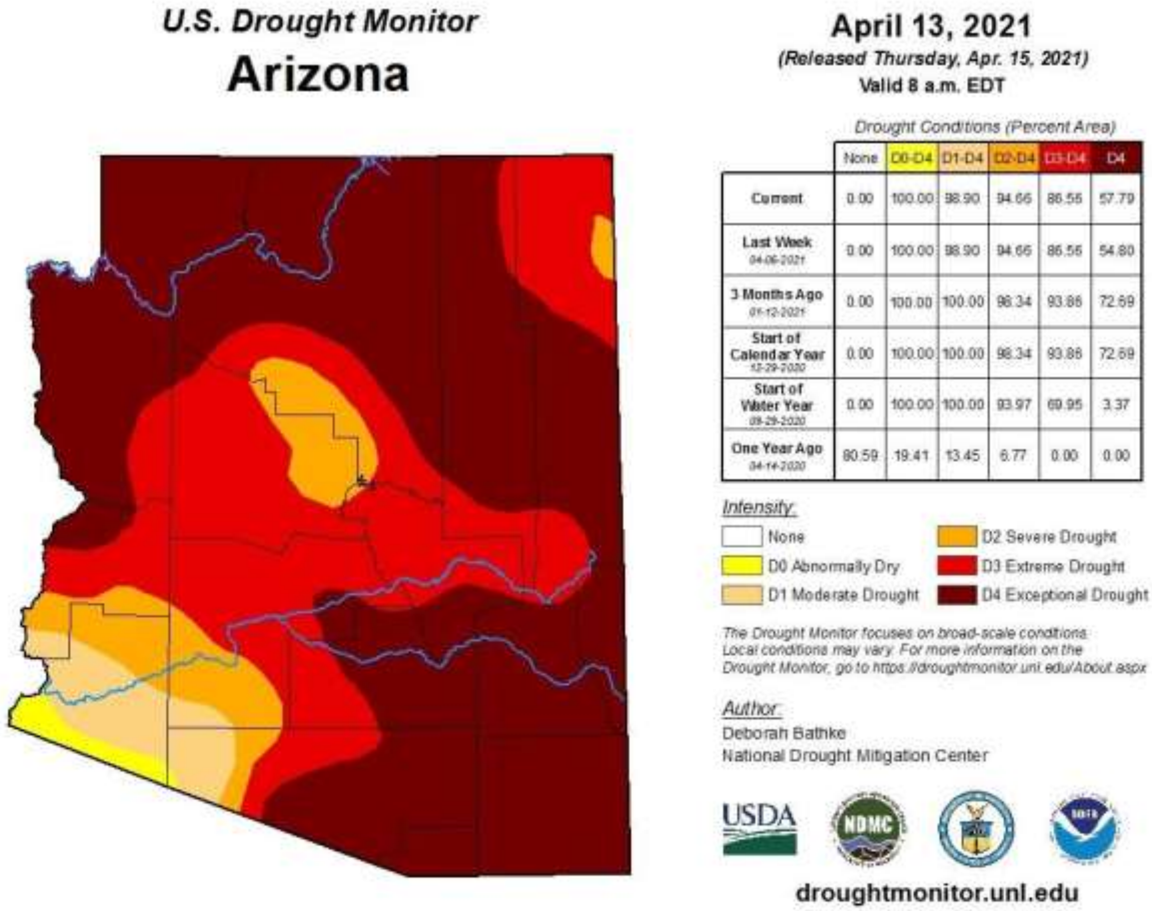
Phoenix is the capital and largest city of Arizona in the United States. Phoenix is the anchor of the Phoenix metropolitan area, also known as the Valley of the Sun, which in turn is part of the Salt River Valley. Phoenix is the seat of Maricopa County and the largest city in the state at 517.9 square miles (1,341 km2), more than twice the size of Tucson and one of the largest cities in the United States.

Phoenix Population

Phoenix is the most populous city in Arizona, with 1,680,992 people (as of 2019). It is also the fifth-most populous city in the United States, the largest state capital by population,[5] and the only state capital with more than one million residents. The city averaged a four percent annual population growth rate over 40 years from the mid-1960s to the mid-2000s. (Phoenix, Arizona, 2021).

4) Arizona Drought

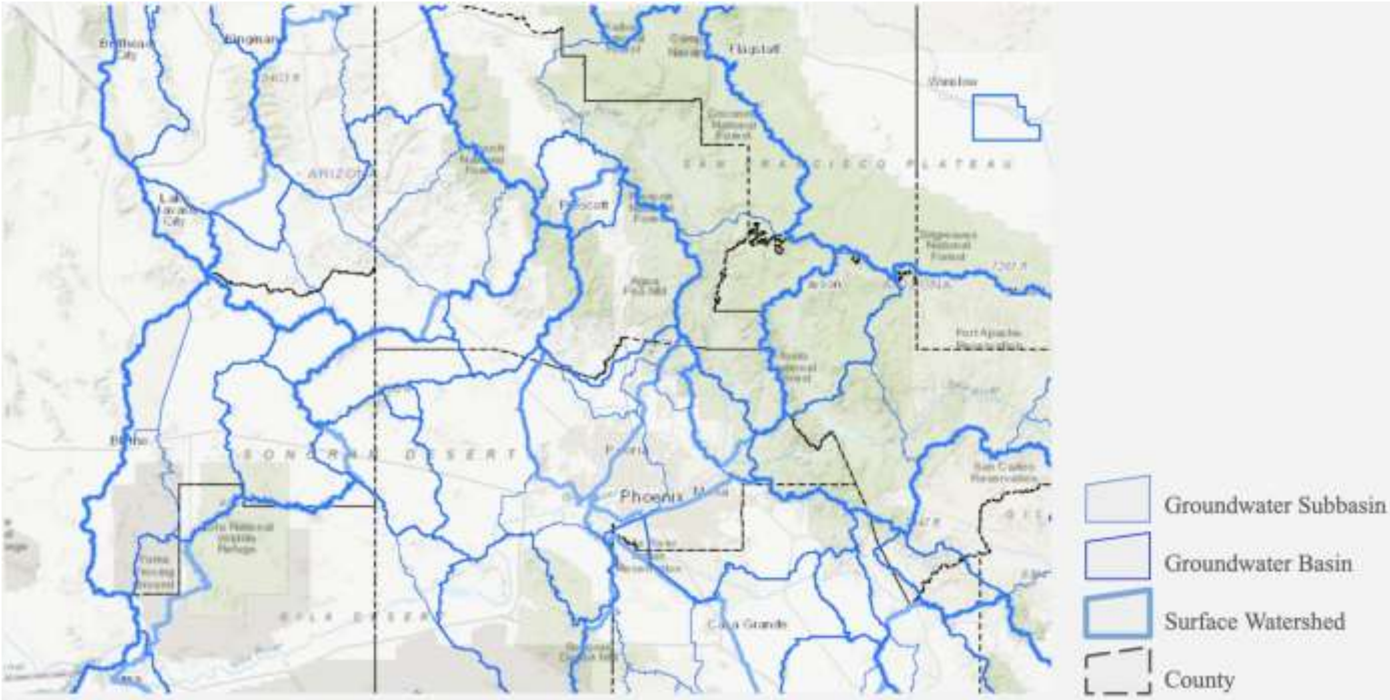
Information used by the MTC (The Arizona Drought Monitoring Technical Committee confers) in advising the Drought Monitor authors includes numerous drought indices, precipitation and streamflow data, and impacts data. Arizona is arid and is only getting worse as time continues and climate change comes into effect.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	98.90	94.66	86.55	57.79
Last Week 04-06-2021	0.00	100.00	98.90	94.66	86.55	54.80
3 Months Ago 01-12-2021	0.00	100.00	100.00	98.34	93.86	72.69
Start of Calendar Year 12-29-2020	0.00	100.00	100.00	98.34	93.86	72.69
Start of Water Year 09-29-2020	0.00	100.00	100.00	93.97	69.95	3.37
One Year Ago 04-14-2020	80.59	19.41	13.45	6.77	0.00	0.00

5) Arizona Water Facts

Arizona has developed a diverse portfolio of water supplies and management strategies that serve as the foundation of our State's robust water system, such as surface water, groundwater, etc. This diversity allows Arizona to more effectively manage water resources, enable the state to subsist with the effects of existing drought conditions, and provides more options in planning for our state's future economic growth. (Water Your Facts)



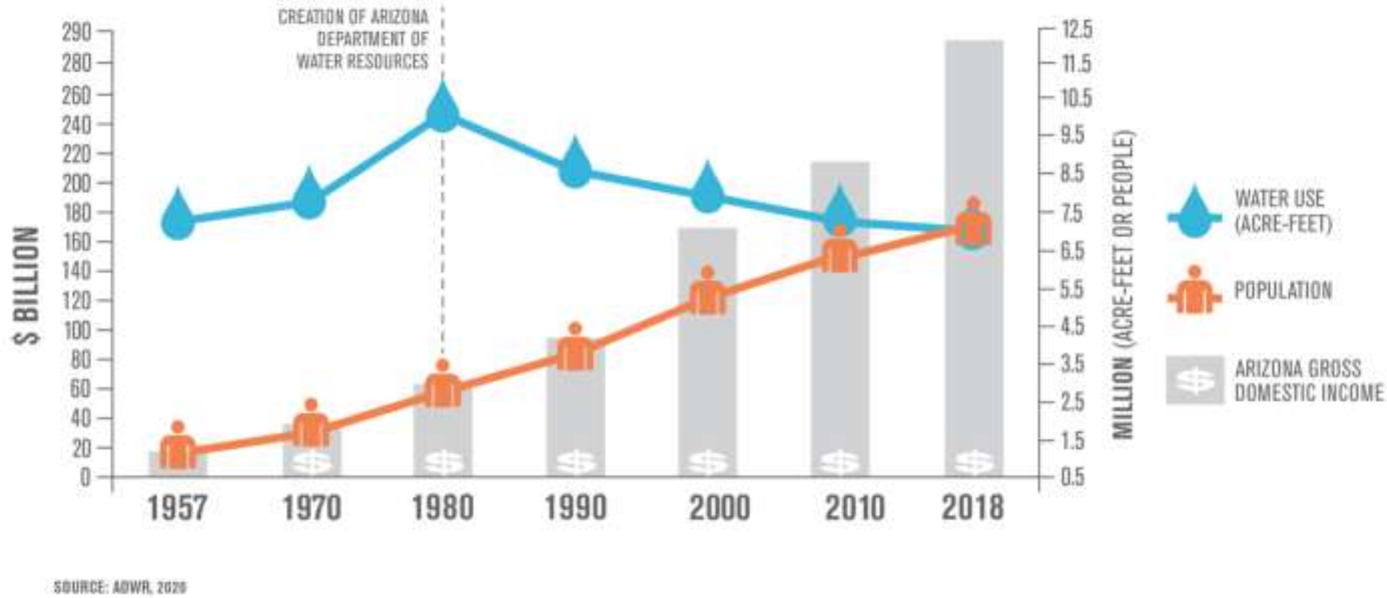
Surface water from lakes, rivers, and streams is Arizona's primary renewable resource. To make the best use of the surface water when and where it is needed, storage reservoirs and delivery systems have been constructed throughout the state. Most notable are the primary reservoir storage systems located on the Salt, Verde, Gila, and Agua Fria Rivers.

Arizona's Water Supplies

In Arizona, groundwater accounts for 40 percent of our total statewide water use. Groundwater is found beneath the earth's surface in natural reservoirs called aquifers. In most cases, the water stored in these reservoirs has been in place for millions of years. (Groundwater in Arizona) In 1980 Arizona passed the Groundwater Management Act, which protects water users and reduces the State's reliance on unsustainable groundwater supplies in the State's most heavily populated areas. The Colorado River is Arizona's most significant renewable water supply. Arizona has the right to use 2.8 million acre-feet annually of Colorado River water. Reclaimed water is treated to a quality that can be used for purposes such as agriculture, golf courses, parks, industrial cooling, or maintenance of wildlife areas. As Arizona's population grows, more treated wastewater will become available. (Water Your Facts)

Arizona's Water Use by Sector (2018)

Arizona's Water Management Success



2021 State of the Team's Focus Area

Understanding where Arizona's water comes from and where it needs to be is of the utmost importance if this project is successful. There are certain economic limitations of water, and the team will strive to integrate its proposals and focus on the economy in mind. With this understanding, one of the primary ideas is not to retrofit any of the installed technology, whether it's underground basins or concrete pavements, or even installed water channels that will be interconnected throughout the city. Because of this, there will need to be a master plan that is well thought out from the beginning. The focus will be to plan for easy access to the technologies. Not having to retrofit should be a goal because it will lower the cost of material and labor in the long term. Our team has broken down our focus area into three subcategories, each addressing Arizona's social, ecological, and technological water conservation trends.

The primary focus is the stormwater management systems and the conservation of wildlife corridors. The goal should be to preserve as much of our natural desert vegetation and natural wildlife as possible. The focus is to target innovative water solutions used to develop stormwater management systems and green infrastructure. The case studies outline such technology dealing with the management of stormwater. Through the trends, the sourcing of Arizona's water will determine if this city will be sustainable through the years.

The focus is to create a space for both community and native wildlife that allows both parties to thrive and connect. The ecological side of the argument is to increase biodiversity and preserve local water tables and habitats. Finally, technological pursuits are based on simplified stormwater management and water recycling to reduce costs. The discussion around the technology is that it is to be functional and aesthetically pleasing, integrate with nature and its natural processes to rehabilitate or sustain sites within Arizona. There is an understanding that nature benefits humans when close in proximity; it aids in attitude and mental health.

Technology and the careful selection of what systems work or what systems push the boundaries of innovation is what a smart city aims to accomplish. The focus should be on the Sustainable Drainage System model, low impact development, and ideas surrounding the Turenscapes, which lead to the conservation of the wildlife corridors. Nature is at the forefront and should work right alongside technology. A technological-driven city behind the scenes with Arizona's nature visible around the site.

Arizona is dry and arid in climate and the management of the stormwater will come in seasons. Throughout the smart city of Belmont, there will need to be a well-thought-out system of washes through parks, residential areas, and business hubs. Water will be stored and used for irrigation or whatever the city requires. Washes and drains are a common technology that is used in stormwater management but as referenced in the case studies, LID and SUDS technology will show new improvements to the ideas and techniques used in harvesting water. We will look at 4 different trends. Trend 1: The repetition of past mistakes. Trend 2: Increase water use as the population grows. Trend 3: Failure to implement environmental protections. Trend 4: Uneven digital distribution population growth and housing growth. With these trends in mind, our team will focus on the concept of resilience. A resiliency plan and its anticipated implementation will be key during the long periods of heat and sun exposure, as well as the heavy rainfall when it does rain during the monsoon months.

The trends of 2021 have revolved around the pandemic and how it has influenced culture. Creating an environment that uplifts Arizona's value as a desert should be preserved and water will play a big role in the cooling and conservation of these landscapes where people will reside.

Case Studies

The Belmont Project is an innovative and cutting-edge approach to the vision of a futuristic sustainable city. However, when it comes to technology that can solve the water dilemma of the desert, there is no reason to reinvent the wheel. Solutions already exist that are tailor-made for the desert and, if feasible, should be considered when planning green infrastructure within Belmont. A smart design incorporates viable solutions that are useful for not only rainy days but blue sky days as well—all the case studies listed in the table below showcase such technologies and innovations.

Case Study	Location	Landscape Architects	Additional Information
Underwood Family Sonoran Landscape Laboratory	Tucson, Arizona	Ten Eyke Landscape Architects	https://www.landscapeperformance.org/case-study-briefs/underwood-sonoran-landscape-laboratory
George "Doc" Cavalliere Park	Scottsdale, Arizona	JJR & Floor Associates	https://www.landscapeperformance.org/case-study-briefs/doc-cavalliere-park#/overview
Orange Mall Arizona State University Campus	Tempe, Arizona	Colwell Shelor	https://www.landscapeperformance.org/case-study-briefs/ASU-Orange-Mall
Elmer Avenue Neighborhood Retrofit	Los Angeles, California	Stivers & Associates, Inc.	https://www.landscapeperformance.org/case-study-briefs/elmer-avenue-neighborhood-retrofit
Puyangjiang River Corridor	Pujiang County, Zhejiang, China	Turenscape	https://archello.com/project/puyangjiang-rivercorridor

Valdebebas: Stormwater Management	Madrid, Spain	N/A	https://www.sciencedirect.com/science/article/abs/pii/S0959652617323636?via%3Dihub

Case Study #1

The Underwood Family Sonoran Landscape Laboratory is a former university parking lot reclaimed to create a Sonoran Desert demonstration landscape. The 1.2 acres of former Greyfield now contained arid design principles throughout that were low- cost and integrated nature of the site and the buildings' form and structure. The site aimed to address the issue of stormwater runoff and collection and create a living laboratory that engaged and inspired the public. Stormwater runoff was collected through micro-basins and sunken court areas that both were multi-functional. The micro-basins could retain up to 5,500 gallons, but they also Sonoran Desert habitat, which increased soil stability, biodiversity and provided shade for the site. The sunken courts were usable as outdoor classrooms and spaces to gather during blue sky days, and during rain events, the permeable decomposed granite and concrete walls doubled as a retention basin. The landscape architects wanted the building and landscape to be seamless; to achieve this, they integrated a vertical 11,600- gallon cistern to harvest and store HVAC condensate, roof runoff, and greywater from drinking fountains. The water was then, in turn, utilized for irrigation. The native, drought-tolerant plant palette, coupled with the high-efficiency drip irrigation, ensured that evapotranspiration and external potable water usage were kept to a minimum.

Case Study #2

George “Doc” Cavalliere park began as an underperforming regional stormwater detention basin. Due to its location adjacent to the pristine desert habitat, a careful plan was implemented to minimize disturbance. This was achieved through the use of over 400 gabion baskets which created steep vertical walls while adding storage volume, slope stabilization, and aesthetic beauty and function. The storage capacity of runoff is now 49.5 acre-feet and the runoff from a 100 year, 2-hour storm event can be fully captured and infiltrated. A 34-acre park was also added to the site for the surrounding communities. The built structures blend into the site through the use of natural materials that match the harsh desert, like that of gabion baskets, weathered steel, and concrete. The site consists of 30% permeable surfaces. This included the parking lot, which is decomposed granite. The parking area also consists of native vegetation planted for shade and increased habitat. Native plants were planted, reused, or preserved throughout the site to mitigate site degradation. The native plants will be watered with high-efficiency drip irrigation for the establishment period, roughly three years for trees and one year for shrubs, and then slowly weaned off the irrigation. The system will no longer be needed. Artificial turf was installed instead of grass, and in addition to the use of native plants, 88% of potable water usage for irrigation is saved.

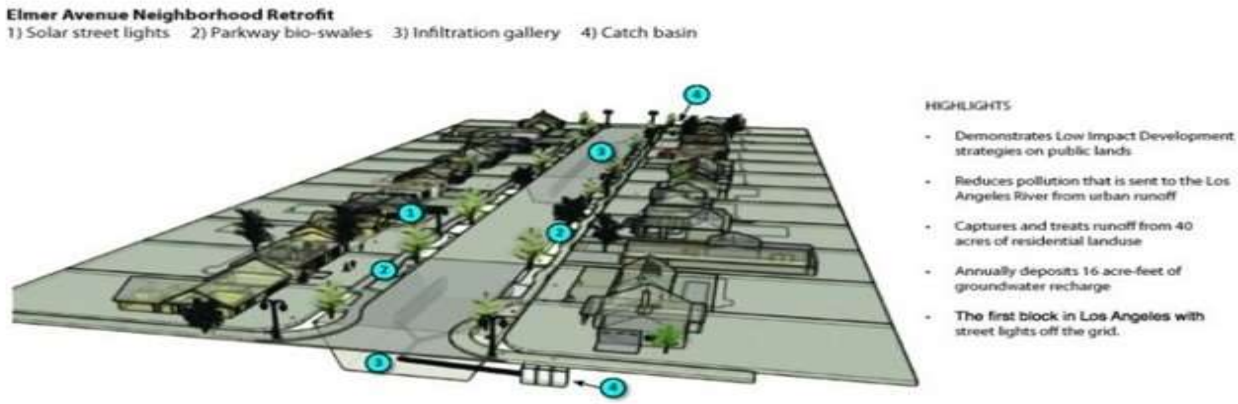
Case Study #3

The Orange Mall green infrastructure project converted an asphalt roadway into a pedestrian mall and multi-purpose space. “The integrated design utilizes low impact development (LID) techniques to address both urban heat and stormwater management” (Landscape Architecture Foundation, 2021). A system of Bioretention basins allows for stormwater to be captured and processed into the connecting rain garden or the infiltration dry well. The basins also assist in improving water quality through natural filtration. The site utilizes only native plant species or those that are desert-adapted, watered with a drip irrigation system, and supplemented by storm events. Innovations using a suspended modular pavement system assist the plants, especially the trees, by allowing the root system to flourish and spread, leading to more considerable shade coverage in the future. This site addressed the microclimate by removing the asphalt, installing permeable pavement systems, and planting trees and palms for increased shade and heat reduction. The pavement system also has a high solar reflectance index (SRI) which mitigates the heat of the material’s surface, further reducing the overall heat of the site. During construction, materials were reused, recycled, or composted to reduce debris going to a landfill. While this project was a retrofit, the lessons learned from this project could be applied to a future build from the ground up.

Case Study #4

The Elmer Avenue neighborhood retrofit is a 4-acre city block project that transformed a residential street through the implementation of best management practices (BMPs) regarding stormwater management. The street was not walkable and frequently flooded. To address these issues, the neighborhood was fitted with “vegetated bioswales and a subsurface infiltration gallery that runs the length of the street, allowing up to 16-acre-feet of water to recharge groundwater supplies annually”(Landscape Architecture Foundation, 2021). Additionally, the project included permeable pavers, rain barrels, and trench drains to enhance stormwater capture further. The infiltration gallery has the capacity for 750,000 gallons of runoff; the 24 bioswales can capture and treat up to 115,000 gallons of runoff and provide a drastic increase in plant material that potentially increases habitat and pollinator corridors. Annually this landscape design infiltrates stormwater at up to 5.4 million gallons, improves water quality, and reduces the homeowner’s use of potable water by 30%. Additionally, this project “increased soil sequestration potential by approximately six times, resulting in 7.25 tons of carbon sequestered annually by soil and plant tissue” (Landscape Architecture Foundation, 2021). This project addressed the water supply and flooding issues that Los Angeles faces and increased the overall health and livability of the homeowners in the neighborhood.

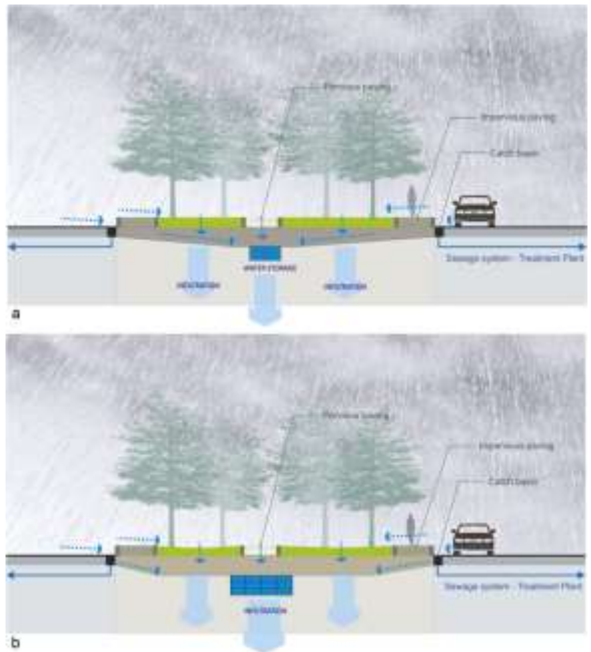


Case Study #5

Puyangjiang River Corridor was a “degraded 10-mile-long river corridor, covering an area of 484 acres, that was ecologically recovered and transformed into a lush and high performing greenway that reconnects human beings with nature” (Archello, 2021). During the rapid industrialization of the area, the river corridor turned from a pristine river to a polluted and degraded river shell. The project’s goals were to remediate the damage done, preserve and restore natural vegetation, and reconnect the citizens with the landscape. To accomplish goal one, the concrete and impermeable surfaces along the river’s edge were removed, and riparian edges were reintroduced to form a green sponge, filter the contaminated water, and assist with flood control. Instead of completely starting over to accomplish goal two, any existing vegetation, cultural sites, bridges, or the like were kept, serving as a connection to the past. Goal three was achieved through paths weaving throughout the site and connecting both sides of the river. Interpretive areas were also built to relay the importance of the river and its history. This project highlights the importance of preserving and restoring wild places and their necessity in highly urbanized areas.

Case Study #6

Valdebebas, in Madrid, aimed to improve water management in urban settings through the use of Low Impact Development (LID and Sustainable Drainage Systems (SuDS). The process of low impact development was to increase water efficiency by lowering the amount of high water use lawns, installing sub drip irrigation around vegetation, and a centrally located control hub of the irrigation system that uses input from a weather station to maximize efficiency. SuDS focused on green infrastructure like permeable surfaces, green roofs, rainwater collection that help the city restore its hydrologic table. The use of SuDS is important because it can tie into existing drainage systems but also increases the potential of the water to not need to be sent to treatment plants. The parks throughout Valdebebas utilized these SuDS methods and saw an increase in stormwater storage capacity through increasing the amount of permeable surfaces and planting areas. Additionally, tying back into the need for region specific design, SuDS and LID is applicable for different climate conditions.



Case Studies Overview

A clearer understanding of technologies available to incorporate into a smart desert city appeared by examining these case studies. With the threat of drought looming, it is more important than ever to maximize the potential for rainwater capture and reuse. Bioswales increase habitat connectivity, improve soil stability, ecological diversity, and increase the health and well-being of the surrounding communities. “The fundamental problem with conventional stormwater management may be the mindset. It does not treat water as a valuable resource but more like a problem to be solved, or even worse, as a waste product” (Karvonen, 2011). Water management techniques can be utilized to enhance a city's plan. A smart city, or any desert city for that matter, is dependent on the availability of water. The main takeaways from these studies were that pristine desert could be minimally impacted even while significantly improving water management in an arid environment.

Outlook for Belmont

Our central vision is to create a water-wise system for the development of Belmont that is sustainable and environmentally conscious. Belmont has a water allotment that covers the legal requirements for development; however, we believe there will be little need to access this allotment with proper planning and development. As was stated in the I-11 Supercorridor: A Next Generation Infrastructure Case Study, "Water remains the single most critical factor that will define the future economy of Arizona" (Gann, Lotzgesell, & Janelle, 2014, pg. 47). If Belmont wants to stand as an example for future cities it needs to manage water in a way that is sustainable and innovative. We suggest four goals that will aid in this vision and create a water-wise development plan to stand as a best practice for future generations. The goals are: Prevent groundwater depletion and ideally replenish groundwater reserves, Manage stormwater efficiently, Incorporate native vegetation to aid water conservation, provide shade, improve mental health, and mitigate habitat destruction, and Develop a water resiliency plan to mitigate the effects of prolonged drought and climate change.

Prevent groundwater depletion and ideally replenish groundwater reserves: Currently, in Arizona, 42% of water being used is groundwater (ADWR, 2020). A significant value of the Belmont Project is to do things differently, and water usage is no exception. The Elmer Avenue Neighborhood Retrofit in Los Angeles, California, is an excellent example case study in water management and aquifer replenishment. In Elmer Ave. there were major issues with aquifer depletion and flooding. To help combat these problems, the city started the retrofit project, which was intended to recharge groundwater supplies through stormwater runoff and reduce area flooding. The 40-acre residential area can capture 750,00 gallons of runoff and filter it through 24-hour bioswales and infiltration galleries built under the streets.

The project produces an estimated sixteen acre-feet of groundwater supplies (Robinson, 2011).

Manage stormwater efficiently: Arizona State University's Orange Mall was an on-campus green infrastructure project aimed at improving the quality of life of students and faculty while also being water-wise. The mall effectively drains all stormwater in bio-detention areas, where it is later processed at an off-site infiltration well to recharge groundwater. The project saves an estimated thousand gallons of water annually and lowered on-site temperatures by roughly twenty-two degrees Fahrenheit (Cheng, n.d.).

In Scottsdale, Arizona, George "Doc" Cavalliere Park is a case study on making stormwater facilities multifunctional. Not only does it provide adequate flood control, as it was designed to retain water from a two-hour, one hundred year storm event, but it also provides space for residents to recreate, even implementing cooling features so the park can be used during hot summer months (Martin & Colter, 2012).

Incorporate native vegetation to aid water conservation, provide shade, improve mental health, and mitigate habitat destruction: The Puyangijang River in China supports around 400,000 residents. As the surrounding city grew, the river became polluted, and both people and the environment were majorly affected. In 2014 the local government launched a restoration project with the help of a landscape architecture firm. The project restored ten miles of the damaged corridor. It healed "the physical and mental damage done to the local community, who have suffered the degraded environment for decades due to relentless development" (Archello, n.d.).

The Underwood Family Sonoran Landscape Laboratory was "designed as a low-cost, research-oriented, educational public space focusing on water-conscience design solutions while creating urban wildlife habitat and biomass" (ASLA, 2017). As a multifunctional space it manages stormwater during storm events, but also provides space for outdoor classrooms during blue sky days.

Develop a water adaptation plan to anticipate unexpected events. Always updating and adapting to new information: In a recent publication by the Lincoln Institute of Land Policy, they express the need for land and water planning to be integrated together, stating, "many are rediscovering a singular truth about land and water: when you plan for one, you have to plan for both" (Hansman, 2021). As Belmont moves forward the need to have a comprehensive water plan becomes even more important. While the case studies and strategies we have discussed are site specific or single strategies, all of them can be scaled to larger areas. The goal is to have a spider web of green infrastructure strategies and building networks that all work together to meet the goal of water management during storm events and pleasant social spaces on blue sky days.

One design strategy for implementation is sustainable urban drainage systems (SUDS), which is an effective tool that restores local hydrological systems by increasing green open space, reducing impervious surfaces, and increasing retention or slowing water through strategies such as rainwater harvesting and green roofs (Rodríguez-Sinobas, 2018). SUDS have no limit to how big or small they have to be. They combine an array of green infrastructure strategies, such as bioswales and water harvesting to create a network that purifies and replenishes groundwater.

Another plan development strategy is to use low impact development (LID). As defined by the EPA, "LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product" (EPA, n.d.). Going into the development of Belmont with the attitude that stormwater is a resource and not waste will change how things in the city are constructed. From the simple steps of collecting roof runoff in cisterns, to creating large bioretention recreation areas, LID will make a significant impact on how Belmont develops.

Considering 2020 Trends

One of our main goals for our vision is to develop a water adaptation plan to anticipate unexpected events while adapting to new information released. Looking back at previous years and learning from their trends is crucial for smart development. The year 2020 resulted in many changes to normal life. The COVID-19 pandemic can be seen as an example of how extreme these unexpected events can impact life. People's habits and desires changed. Due to lockdown, many people experienced a lack of urban green space, with visitation numbers decreasing by almost two-thirds. Viewing nature or going on a jog was simply seen as non-essential in the midst of a pandemic. In a study by (Ugolini et al., 2020) respondents interviewed stated during lockdown, they missed the idea of spending time outdoors the most, specifically green space. Observing nature and breathing fresh air were also missed. This stresses the importance of the idea that humans have a sense of biophilia within themselves. The findings support the idea that the value of large and open urban green spaces within cities is only rising. What we are looking for in our green infrastructure projects is to create these multi-use spaces that not only filter and manage water but create areas for people to recreate and enjoy nature. To create a more resilient city designers should consider incorporating large, open area green parks in order to satisfy the public’s desire for urban green space, thus allowing adequate space for social distancing during visitation.

Another big trend observed in 2020 was extreme heat and drought. Last summer was the hottest summer on record for Arizona (Jensen 2020). With this came a lot of water issues and heat island issues. As Belmont designers plan to implement these green infrastructure projects, they should change the water usage of the area to help restore the aquifers and help replenish that water that's disappearing as temperatures go higher. Natural environment and native vegetation in design has been shown to reduce urban temperatures and is key for urban heat island mitigation (Coutts et al., 2012). Adaptation to these rising temperatures is essential for long term sustainability.

Conclusion

When looking at the Belmont project, it is important that we remember why it is being built. To be realistic, this world runs on money and economic growth. It would be ignorant to assume that Belmont or any other project is any different just because they’re labeled “smart cities.” In truth, that title must be earned. The key is realizing the economic potential that a project has while using technology to preserve our social and ecological values. In our case, the natural capital, water. We must keep in mind that it is easier to develop a business idea than to implement it. Things will not always go as planned, but it is essential to learn from previous mistakes. Since this project is being developed in the Sonoran desert, it is essential that we use every last drop sustainably; otherwise, future generations will not survive. This is why we must research as many previous projects as possible, learning the key takeaways from each one, positive and negative. What technologies will aid us in creating a better future? Look at George “Doc” Cavaliere park site, Elmer Avenue Neighborhood Retrofit project, the Underwood Family Sonoran

Landscape Laboratory, along with many other examples. Lessons have been learned from each case study. This will help us create a smart water system for the development of Belmont that is sustainable and environmentally conscious. It is important to never stop adapting to new trends and learning what technologies work and don't work. Our group stresses the importance of integrating water management design with the natural environment as this is beneficial for ecological and social values. Using SUDs and LID will help designers achieve this goal by minimally impacting the natural habitat already in place. Remember our goals of

- ○ Prevent groundwater depletion and ideally replenish groundwater reserves
- ○ Manage stormwater efficiently
- ○ Incorporate native vegetation to aid water conservation, provide shade, improve mental health and mitigate habitat destruction
- ○ Develop a water adaptation plan to anticipate unexpected events. Always updating and adapting to new information

If arrogance is shown here, our future wars will no longer be fought over oil or gold, but the most desirable of them all, water.

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Appendix A Tension 1 Reflections

Melissa McKinley

LAP 598 - Assignment 3

Smart cities are the way forward in our modern civilization. The key is to clearly define what “smart city” means and have very measurable goals. A smart city, in my eyes, is one that wears multiple hats and becomes a rich diverse ecosystem, of not only people, but the plants and animals too. Nature has processes, like carbon storage and water filtering, perfected so why do we fight against these processes for industrialized options? Smart goals and cities should not be complicated or overly designed but take inspiration from the natural processes. I chose the tension of failing to implement environmental protections while digitizing urban infrastructure. Endless amounts of data are collected daily but where does it go and what benefit has it provided? We have known for years that we were destroying our oceans with plastic but until recently, very little has been done about it. I contend that “smart cities' ' should have goals to meet of increasing biodiversity, reducing waste, reusing wastewater and overall improving the quality of life of the people in the city. These should not be empty promises but clear obtainable goals that every citizen actively works toward. Environmental protections may be on the forefront of everyone's minds, but is our digital world more of a hindrance than a benefit?

Existing in a digital world has many benefits, especially when it comes to raising awareness on important issues. There is an instant connectivity that is achieved through social media platforms that can reach an audience globally. For example, the Black Lives Matter movement swiftly went from local marches to worldwide involvement. There is a power to having information at our fingertips, but the problem is, who acts on the information and are we really making a positive difference? I constantly get bombarded by emails, social media posts and even actual mail, detailing the urgent response needed to clear cutting, habitat loss, use of pesticides, and so much more. I am sure that my situation is not a unique one, but how many people actually act, whether it be by donation, volunteering, or switching to reusable straws? It's hard to say. A digital presence and information are nothing without results and boots on the ground. I can put air sensors all over town and collect pollution numbers, but the real difference is made in what I do to improve those numbers. There are endless people that have jumped on the "green movement" boat, but there are very few truly making a change. Big corporations have been going on record stating that they have goals to reduce their carbon footprint by [insert date here], but we should be keeping track of their efforts and whether they are just full of hot air, through digital platforms. Much like a LEEDS certification, smart cities need to have guidelines they must adhere to, in order to be deemed a smart city. All the digital infrastructure in the world makes no difference without accountability.

The Belmont project has uniquely positioned itself to be a game changer city. If correctly implemented, the "smart" in the "smart city" will be digitally focused with physical, trackable results. According to Höjer et al., "It is also important to assess whether the smartness delivers the intended outcomes or not". For example, water usage and reusage. If Belmont can significantly reduce water usage and increase the amount of water they are able to reuse, which are trackable and measurable goals, then other cities will be able to learn from them and incorporate changes for their cities as well. The most important aspect of data like this is that it is clearly and openly displayed and shared so that citizens can see the changes, which in turn encourages cooperation and discourages corruption. Open and honest communication is key to success in the long run and where the digital urban infrastructure plays a strong part. Citizens also need to understand the ramifications of turning a blind eye to problems, like the amount of oil we consume daily. According to 'Green Manhattan' we consume about eight hundred and fifty million gallons of oil a day and we all know but choose to "live like alcoholics in denial" (Owen). With the access to information, we need to read, understand, and acknowledge these problems. We cannot simply wait for someone else to deal with it.

Natural resources should not be owned, monopolized, or abused for monetary gain. Resources are not a product and should not be viewed in a consumerism light. The main issue with technology is it disconnects people from the natural world. They do not understand the importance of milkweed to a butterfly, or an undammed river to salmon. Natural processes are not singular events and no one thing will fix an issue. When companies have land rights or water rights over an area, it becomes increasingly difficult to invoke change. This contributes to the neglecting of environmental protections for the turn of a buck. According to Locke, water from nature belonged to all "but that in the pitcher is his only who drew it out". This way of thinking and ideals cannot exist in a functional modern society.

The importance of a digital infrastructure in our modern world cannot be understated. However, there need to be checks and balances to what is claimed and what is achieved. There is no limit to the doors that the digital world can open to the everyday person, but we also need to ensure that it is not all talk and no action. Personally, I believe smart cities should be nature focused. We need to share this planet with all if we truly hope to prosper. If Belmont, or any future city, can only be one thing, I hope it is an embodiment to the beauty and adaptability to life on this planet. Ultimately, a smart city is not smart because of technology, but because of the passion and commitment of its citizens to create change. It is in this commitment to their home and to each other, that they can rise out of the ashes and demand to be heard. They can ensure that they are the stewards of the land, the voice for the oppressed and unheard, and the bringers of change.

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Kristen Hu (Die Hu) LAP 598 - Assignment 3

Introduction

According to the continuous increase of urban population and the impact of climate change, water application and management have become an important part of supporting sustainable urban development. Therefore, I focus on water sustainability and resilience challenges in urban design and planning. And I chose the digitisation of infrastructure and environmental protection form Tension 4. The interaction between the gray digital infrastructure and the ecosystem is one of the development priorities and visions of smart cities, which has become the goal and core of smart cities for embedding digital technology in urban infrastructure. Also I argue that smart city plans and practices focus on water governance and water infrastructure development and Belmont Project should be taken to maximize the improvement of water resources and bring the benefits for the smart city design. In addition, I made three points about the importance of this tension to the Belmont project: the first is mitigation measures for water resources and sewage treatment, the second is the interaction of gray infrastructure and ecosystems to protect water resources, and the third The point is to provide strategic assessment and governance capabilities for smart cities to maximize sustainable development.

Tension 4: Digitisation of infrastructure and environmental protection

A sustainable smart city will face a variety of tensions and challenges, especially the relationship and interaction of multiple factors in urban planning and practice. Over half of the empirical studies reported that smart city initiatives and developments had a strong focus on the digitisation of grey urban infrastructure to realise efficiency gains. (Martin, 2018) However, how to achieve infrastructure efficiency gains through embedded digital technology has become more The central argument of the obvious tension challenge. These technologies are expected to enable the integration and optimisation of grey infrastructure, in turn leading to major gains in operational efficiency. (Martin, 2018) This is a vital part of the core goal of the smart city vision, but it is necessary to understand the technology Whether it is possible to realize the adaptability and flexibility as the gray foundation to support and improve operational efficiency. The smart city vision pays scant attention to the ecosystems that are supposedly protected, either within or beyond the city. Interaction between ecosystems. Urban ecosystems including green space and infrastructure, which improve the quality of life of citizens and reduce environmental impacts of the urban metabolism. (Martin, 2018) At the same time, as a smart city design plan and practice is currently one of the overlooked issues. In fact, one case shows that green space and infrastructure do help provide important support in the development of smart cities. report that environmental sensing played a role in smart city development in Barcelona, and also present the urbanisation of green spaces as a successful outcome of the same processes of development. Non-digital forms of grey infrastructure development with potential environmental benefits were addressed in some smart city initiatives. (Martin, 2018) Therefore, it can be seen that while emphasizing digitalization, it is necessary to balance the relationship, potential and value between non-digitalization. And apply the potential of the two to the operating system technology of urban communities and suburbs and the environmental benefits of green spaces. The role of digital technologies in enabling the development, maintenance and use of green infrastructure. (Martin, 2018) This may provide a framework for water and sewage treatment in smart city, while achieving maximum technical support (gray infrastructure, green space, etc.). However, as a planner in the design of smart cities, you need to determine how to apply scientific knowledge: Knowledge and opportunities for change come into conflict with existing practices and institutions, planners (1) use their experiences to contextualize information, (2) avoid the risk of failure, and (3) request that policies are first developed in order to legitimate action. (Hamstead, 2019). In particular, in the practice of smart sustainable cities, urban construction is carried out, and more complete and effective methods and solutions are implemented. On the other hand, it emphasizes improving the ability of policy management to take effective action and information and communication technology. For smart cities, there are also challenges and other tensions: the assessment, or the indicators included in an assessment, that defines the important characteristics of a smart sustainable city. (Höjer, 2014) Assessment of smart cities in sustainable development It is necessary, and it is necessary to evaluate more complete development methods and practices from a systematic perspective. In addition, mitigation measures for water resources and sewage treatment are also crucial: Cities must craft mitigating measures at the same time as they encourage technology for efficiency improvements. (Höjer, 2014) Infrastructure can create effective mitigating measures for development and trade, etc. System Support. Infrastructure development and investment have led to substantial improvements in wellbeing and wealth. Through the implementation of systems for transport, power, water and sewage management, life for billions of people has been improved. (Höjer, 2014) Therefore, it is here to show support for infrastructure The importance of development and seeing the potential of sustainable smart cities that support water conservation.

Conclusion
Therefore, in the mitigation measures of water resources and sewage treatment, innovative and improved urban infrastructure systems are required. At the same time, improve operational efficiency and integration to improve the digitalization of environmental protection. Particularly data platforms and living labs, which are intended to empower citizen to engage with the processes of urban governance. (Martin, 2018) Although smart sustainability faces tensions and challenges, in the long run it does have what the public sector advocates Smart cities are also the main goal for stakeholders to achieve urban sustainability. Such a trajectory would reframe the smart-sustainable city vision as a radical alternative to existing modes of urban production and involve more revolutionary modes of urban design, management and operations. (Martin, 2018) The key here is sustainable smart city development models and broader interactions promote efficiency and increase the potential for sustainable development and the growth of conceptual frameworks.
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LAP 598 - Assignment 3

Code Belmont: War for the Water Ways

A general rule of thumb, the average person can survive three days without water introduced into their body's system. Water is undoubtedly critical for the human population's survival, but what happens to those who take for granted the water that seemingly flows endlessly out of the house faucet? In an ever fast-growing environment of cities and towns within the United States, there is constant consumption of more natural resources and worrying less about the consequences. Such consequences are outlined in Martin and his colleague's paper titled Technological Forecasting and Social Change. Their goal is to address the technologies present in the digital realm and how they interact with the smart cities model. The tension described that will be addressed is the tension of economic growth, and it pertains to the expansion and development of water systems within smart cities. The innovative city model, such as Belmont's case, reveals the benefits of reducing and recycling water and bringing economic growth and social equity to developing cities. Ethical and effective sourcing and distribution of water accompanied by technology such as apps and advertisements prove that the tension of economic growth and social equity does not permanently harm or accelerate environmental or economic degradation.

Just sourcing for water regarding the Belmont project will better the economic growth, "From the perspective of environmental protection, critics argue that economic growth relies on, and creates, increased demand for material resources, accelerating environmental degradation"(Martin). There is an apparent fear that as a city grows, so does the destruction of the environment. With this in mind, water is going to be sourced from a planned smart city approach. Belmont and those tasked with figuring out how the water will be sourced have addressed the concerns and will be pulling heavily from companies' partnerships to bring groundwater and reclaimed water to the city. The distribution and plan, as well as the backup plans the designers have for the water system at Belmont, are for the case of Arizona not harming the environment or leading it to further degradation as found in the plan for them to reclaim and process the water in a safe and sustainable model. This recycling model of water will cost the city less money and resources to pull and find water outside the system. This idea is only achievable through the planning and implementation of technology.

As personal technology and digital advertisements continue to advance, water distribution is readily available and reduces the overall consumption of material recourses. Many individuals produce waste when they throw away used bottles or cups of water. The tension of intelligent cities and technology is described when "Viitanen and Kingston (2014) argue that smart city advocates vastly overestimate the potential of digital innovations and technologies to decouple consumption and associated demand for material resources from economic growth" (Hornborg, 2009; Kostakis et al., 2016). Belmont and those working there could take a lesson from the Smart City construction efforts in France. Who designed an app and a water fountain system that has dramatically reduced waste and, in turn, gave individuals access to clean water.

The technologies and free distribution of water reduce waste of resources such as water and uplift the spirit of social equity. Martin claims that the studies of smart cities have not been sufficient as they state,

"Rather, they contend that economic growth will continue to rely on ever-increasing consumption of material resources, regardless of the purported 'green' benefits of the pervasive deployment of digital technologies across the smart city. In the absence of detailed studies, smartness is not expected to reduce flows of resources (energy, water, materials) through, and emissions (CO_2 and other waste) from, cities to levels which respect planetary limits" (Rockström et al., 2009; Steffen et al., 2015).

Smartness and the studies that pertain the smart cities can be shown in many parts of the world. As previously stated, the example about France's adoption of applications and fountains concerning clean filtered water to the general public uplifted their cities' economic growth and social equity. In theory, if Belmont can implement some of these plans in their water distribution, it would counter the tension of degrading water and economic growth.

Arizona's future smart city, Belmont, reveals the benefits of reducing and recycling water. Economic growth and social equity are indeed concerns for developing cities. Considering the ethical and effective sourcing and distribution of water will be vital for Belmont's future prosperity as a Smart city. As the name implies, the use of technology such as apps and advertisements in the digital realm proves helpful in opposition to the idea that economic growth and social equity are unsustainable. Water is a basic human need and, in a lot of ways, necessary for the progress and future development of the technological world. Smart cities will be the progress and future of Arizona. Belmont will be the stepping stone for what is to come throughout the state and, hopefully, the world.

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Smart Sustainable Cities: Definition and Challenges Mattias Höjer and Josefin Wangel

Appendix B Tension 2 Reflections

Madison Gidley
LAP 598 - Assignment 3

Smart City Essay

Under further investigation of Martin's second tensions, one can truly understand how, in light of the study of smart cities, even distribution of digital innovation will prove to be challenging. As a refresher, Martin's second tension of smart sustainability tensions state that, "the benefits of digital innovation will be unevenly distributed,". (Martins, page 3) Martin continues to state that critics worry that through trickle down economics, digital resources will inevitably only be distributed in wealthy residential areas. The trickle down economics mentioned is specifically in reference to issues of social equity in cities. On top of that, consumer lifestyles of affluent residents work against environmental protection strategies. From this it can be claimed that when smart cities look to sharing technologies using decisions based on wealth, the smaller income citizens will get little resources and less of a say of where those are distributed. To counteract this in light of the Belmont Project, our history, city officials, and rules of regulation will need to be taken into account in order to effectively pursue smart city design.

In order to overcome this tension, all citizen's voices must be heard by giving them equal opportunities. To do this, the best tool at one's disposal is to reflect on the past to avoid repeating decisions that lead to exclusion of different people groups. In the Geography of Despair, the authors discussed the history of development in South Phoenix and how it led to devastating environmental racism for the non white residents who lived there. In their reflection towards the end they state that, "few resources are today being directed toward rehabilitating South Phoenix and mitigating industrial hazards in its neighborhoods, reinforcing a century-long pattern grounded in racial exclusion and class privilege." (Bolin, page 166) Steps and programs were being made to counteract the impact of past decisions, but without the active enforcement from city officials, those resources are not being used to the fullest capacity. This has made change towards equity extremely slow going. So in light of the Belmont Project, we need to do what we can to get city officials on board to support decisions of design that promote equity, otherwise we risk overlooking underrepresented groups. In Whitaker's article, The Rise of Black Phoenix, they give us more insight into how lack of regulations in the past to prevent real estate agents from excluding potential home buyers based on their race has made it incredibly difficult for those minority groups to have the opportunity to live in certain neighborhoods. The author states that in the past, "Blacks had 'no choice but to remain in or near segregated sections regardless of their economic position' because the 'real estate agents and loan companies exerted the leadership in Arizona housing practices’,”. (Whitaker, page 206) So at the time, it was a misconception that minority groups in general could not afford wealthier neighborhoods. There were some who could but real estate agents just chose not to accept offers from those buyers. In the future, to prevent this, regulations might need to be put into place to ensure that this kind of behavior does not continue. These examples of how housing was not equitably distributed, are other examples of how our resources in cities are at risk of being unevenly distributed if we do not pay careful attention to not silo control of resources to one private group. In reflection of how this applies to digital resources that can be potentially used in the city, Martin proposes that technologies should enable, be owned, and operated by the community rather than run by just a few.

In order for equity to be enforced as one moves forward with the Belmont Project, those with positions of influence and Authority have the greatest impact to counteract the second tension that Martin proposes. Although we see evidence of how the passivity of authority causes the continuation or worsening of tension against smart city strategies, hopefully this reflection causes one to propose rethinking sustainable and equitable design practices. Hopefully this helps us to envision goals for change as we continue to make steps toward preserving healthy futures for our cities.

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LAP 598 - Assignment 3

The Belmont Project: An Opportunity to Create Social Justice

The Belmont Project, west of Phoenix, AZ is a unique opportunity to create a modern smart city that follows all three pillars of sustainability, social, economic, and environmental. However, in an article by Martin et al., he presents five "tensions" that exist between smart cities and sustainability. One of these tensions states, "the benefits of digital innovation will be unevenly distributed" (2018, p. 271). The authors are arguing that residents of a smart city who are not of an affluent class, will be "marginalized" and treated as second class citizens. I would agree with Martin et al.'s argument but would also add that when creating a city, it is important to recognize potential social inequality and try to mitigate their effects. To properly prevent injustice, it is important to analyze the past and prevent it from repeating.

Belmont itself has limited history. However, it is located close to Phoenix, which has an extensive history on early settlement and a system that institutionalized racism. In an article written by Whitaker, it breaks down the settlement of Phoenix from the perspective of a person of color. Though Phoenix during its settlement was seen as an opportunity to start fresh, it still held many racial social systems, mostly caused by the affluent white population seeking to create a "desert metropolis" with "white only" restrictions (2000, p. 203). Pretty early in the development of the city, the office holding whites sought an appearance on the national stage. To accomplish this goal, they created an image of a white-man's city where the Native American, Latino, and Black communities were restricted or removed. This was exacerbated by Jim Crowism and the legal separation of facilities across the city (Whitaker, 2000). Through these struggles the black community never gave up, but it certainly created a bigger obstacle for them to succeed.

Associated with the institutional racism of the early days of settlement, are the lasting impacts of environmental justice that occurred in Phoenix. Historically throughout the U.S., Blacks and minority groups have been disproportionately situated close to hazardous sites and by consequence have received a larger exposure to toxic and hazardous materials. Phoenix was no exception and as early as the 1890's "a variety of land uses [were] not permitted in Anglo Phoenix" (Bolin et al., 2005, p. 163) but could be found in South Phoenix. The balance of environmental justice is tricky because the cheapest land is going to be located by the least desirable locations and those who can afford to live away from pollution and hazards are going to do so. Then the question arises of how to prevent environmental injustice in a new city such as Belmont.

Understanding historical racism gives a good perspective on what are some of the weaknesses of our current cities. As minority groups have been stuck in environmentally hazardous places and restricted to what the white hegemony allowed them to do, they have often been left behind on technology advancement. A good example of this in the automobile. An article by King et al. describes how vehicle ownership is related to poverty and disadvantage (2019, p. 2). At one point the automobile was a new technological innovation that has ultimately shaped the way that we build our cities. Had more care been put into creating an equitable society the damage that personal vehicles do to low-income families could be mitigated. Often it is as simple as building and maintaining a robust public transportation system instead of focusing only on vehicles.

As has been shown, social injustice often starts from the beginning of a settlement and once it is established it can be difficult to completely remove. It is important that when starting the

Belmont Project that many of these social justice issues are examined and the changes are made so history is not repeated. As Martin et al. argues, the digital innovations of a smart city are going to help the affluent and leave the lower-class residents to struggle like normal (2018, p. 271). To prevent repetition of the past, new policies, social structures, and even infrastructure can be used. As a policy I would suggest more equitable housing so that poor residents are unevenly situated by environmentally hazardous sites. In modern cities those sites by nature are fewer but awareness of fair housing prices everywhere can combat environmental injustice. Creating a social structure, and government system that values inclusion and diversity. Also, a society that is actively involved can prevent the institutionalization of racism and disadvantage. Finally building an infrastructure system that is not exclusive for those who can afford the cost of entry but an infrastructure system that allows anyone to access no matter what they own or do not own. If during the creation of Belmont as a brand-new city remembers to keep social justice in mind, many of the past errors and modern dilemmas that we face can be overcome.

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Appendix C Case Studies

Case Study 1

Melissa McKinley

Water and Ecosystems Group

Underwood Family Sonoran Landscape Laboratory

Case Study

Water. Often seen as the cornerstone of a successful and flourishing society, it is also a word not often used synonymously with the desert. In order for a desert city to be successful, smart or not, it needs to address how we use, store, and manage water. As a member of the water and ecosystems group, we recognized the importance of green infrastructure and water management and our case studies reflect how other cities and places have tackled the issue through innovation. I chose to do a case study on the Underwood Family Sonoran Landscape Laboratory located on the University of Arizona campus in Tucson, AZ. This project embodies the desert and the natural processes that occur within nature that can be applied to desert building projects in the future, including the Belmont project. The defining feature of a smart city should be its ability to improve its connection with the natural environment, and better the lives of the people within its boundaries.

The current site of the Sonoran Landscape Laboratory was the site of a crumbling old Architecture building and a sea of asphalt used for student and teacher parking, totaling approximately 1.2 acres. It was an underutilized 'greyfield' and did not represent U of A's commitment to sustainability. The reclamation of this space allowed the university to build, what they referred to as, a 'living laboratory'. The project was designed by Christy Ten Eyke and Todd Bridges and completed in 2007. This space now serves as a biodiverse multi-functional space for students, researchers, faculty, and visitors. The initial proposal for the site was due to stormwater runoff flowing toward the entrance of the proposed new building site. To mitigate this, the designers wanted to create a space that could act as a bio sponge, but also be a water-conscience, urban habitat for wildlife and plants. The design team worked under five guiding principles that ideally would be incorporated in any desert building project moving forward. These principles were water sustainability, reduction of the urban heat island effect, reduction of urban flooding, reconnection with nature, and the creation of an interpretive oasis. All these principles speak to the necessity of shade, water, habitat, and tranquility that is lacking in most outdoor spaces.

The Landscape Laboratory was "designed as a low-cost, research-oriented, educational public space focusing on water-conscience design solutions while creating urban wildlife habitat and biomass". The main focus of this space was water management and how to effectively collect and reuse stormwater runoff as well as the graywater from the building. This was achieved through an integrated building and landscape system and collection cisterns that were connected to low flow drip systems for the vegetation. The amount of water needed to establish all the vegetation planted would have been counterproductive to the site's goals without this reuse of the available water network. The social implications of building a space like this are immense. It became more than an outdoor classroom or path. It is not a space to be inspired, to teach, to learn, to conduct research and a piece or essential habitat for reintroduced species. The increase in biodiversity and the mitigation of the urban heat island effect and urban flooding, all speak to the power of simplicity and natural ecological processes.

The project was funded through donors of both time and materials. All the materials and the labor for planting, lighting and irrigation were donated by local companies, which totaled approximately $650,000. This project demonstrates the positive outcome that can occur when a community comes together for the mutual benefit of a space. This becomes increasingly important for areas that cannot afford to fund a project of this caliber but would greatly benefit from a project of this nature. The school identified a problem with existing infrastructure and decided to mediate the situation, a bottom-up approach that involved the local community and students and faculty. Since the materials and labor were locally sourced, this improves the strength of the community and improves their willingness to be a part of creating something in their area. As a result of the donations and hard work of the community, there is now a beautiful space that they can be proud of and that is inspiring future generations to build and create sustainable, eco-friendly spaces.

The Belmont Project is focused on developing a new vision of how cities are built and imagined. Desert cities have not paid enough attention to the necessity of water. Utilizing cisterns to collect and reuse gray water, from water fountains and HVAC condensate, is a low-tech way to conserve water and give back to the desert environment. The major takeaways from this case study were that nature and natural processes can be a strong force to rehabilitate or sustain a site, functionally and aesthetically. Additionally, there are numerous studies about the benefits of nature and proximity to nature, on humans. The Belmont Project should be a technology driven city behind the scenes but a natural, sustainable, water-conscience city first. The five guiding principles from above should heavily influence the Belmont Project but especially the reconnection with nature. As Gary Snyder says "Nature is not a place to visit. It is home".

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Case Study 2

George "Doc" Cavalliere Park, Scottsdale AZ

George "Doc" Cavalliere Park is located in Scottsdale Arizona and is the culmination of more than 20 years of planning (SITES, 2012). The park was a modern innovative idea to merge a stormwater management facility with a park facility that could benefit users and preserve the desert environment. The park sits on 34 acres of land and the project cost a total budget of $4.3 million (LPS, 2012).

Doc Park was previously a stormwater management facility, or from what I could gather a stormwater retention pond, and the size needed to be increased while preserving the natural desert habitat. While doing the needed upgrades for the stormwater facility, a sustainable park was created. The goals of the project were as follows, “minimize the impacts of development, preserve upland Sonoran Desert habitat, minimize the impact of summer high temperatures on park visitors, reduce long term maintenance costs, improve stormwater management, and to utilize a design aesthetic that fits within the desert surroundings" (Martin & Kaylee, 2012, p. 2).

The construction of the park was funded through a bond initiative from the city. As the construction started it was clear that it was coming in under budget so adjustments were made to make the park more maintenance friendly by adding things such as artificial turf (LPS, 2012).

Through the park construction there were some major features that they focused on. The first was the stormwater retention facility quickly into construction was discovered was not up to the county and cities code of 100-year 2 hour event (Martin & Kaylee, 2012, p. 3). In addition to the stormwater management the park also contained a Photovoltaic shade structure over a playground, extensive use of LED lighting, Automated water misting to prevent the turf from overheating, and permeable pavement.

Overall, the park succeeded in expanding the stormwater facility, creating a recreational space for residents and protecting the desert environment. Because of its innovative and sustainable design it received reward from several organizations including the AIA Western Region, and the Arizona Chapter ASLA (LPS, 2012). With enough thought and time into many stormwater management facilities, they can be upgraded to the level of sustainability and functionality that Doc Park has achieved.

There are several major takeaways that can be applied to the Belmont Project. The first is the beautification of stormwater management. In a lot of ways, stormwater runoff is an after thought of construction and ends up being open space that is not utilized. I see this as a problem because here in Arizona there are not that many storm events so most of the time these spaces are not being used for any purpose. If they are converted to parks, then they can be used year-round.

Another application for the Belmont Project is the preservation of the natural environment. Any city that we construct is going to destroy natural habitat. In creating parks that preserve this habitat, we preserve an important part of our region. The Sonoran Desert is unique in its biodiversity and types of species. Any measure that we can take to create or preserve habitat is a major win.

There are also other things to consider in this park design that are small adjustments that make big impacts. The first is their design with the environment. They used locally sourced rocks to create gabion baskets that not only increased the amount of water the facility could hold but it provided an aesthetic that was very pleasing. Another small feature that is important to water management was their use of permeable roads. Again, using locally sourced granite they had permeable roads that not only fit the environment but provided a hydrological benefit. The last

The design concept they included was their use of a PV shade structure and LED lighting. Together they created an energy efficient environment that reduced the overall carbon footprint of the park.

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Case Study 3

Andrew Ayala

LAP/PUP/CEE 598: Smart City Sustainability

March 8th, 2021

Belmont, Meet the Orange Mall Green Infrastructure Project

Smart cities are just on the horizon, and in the case of Arizona, this is quite literal. The Belmont project set to be Arizona's first smart city will use many disciplines, all interacting and learning from one another. A project at this scale, if planned and done well, can bring prosperity to the individuals who dwell within the city. Belmont is an ambitious city project that seeks to be sociable, ecological, and technologically advanced. The project brings experts and innovators into the discussion and process to lay the groundwork and comply with the concerns of the environment, society, and technology as a whole.

Arizona State University proudly holds the title of being the university with the highest innovation output of studies and technology than any other university in the country of the United States. The Belmont project started to integrate Arizona State University's students and experts to develop this smart city further. The university has in its past work in smart city solutions to improve campus and environmental life. Belmont's development can learn from Arizona State's one-time water management project. One such action was called the Arizona State University Orange Mall Green Infrastructure Project (Cheng).

Arizona State University uses such sustainability projects to help educate students in various schools. In 2019, ASU sought to better the campus and the culture of the students. ASU developed the project to address the social, ecological, and technological systems believed issues. The area under retrofit provides socialization and relaxation for students. The improvement to this area was redirecting stormwater runoff (Cheng). It was accomplished by a series of bio-detention and various retention areas and later to be processed in an off-site infiltration well that recharges groundwater. The new process saves an estimated thousand gallons of water annually. Arizona needed this project more than ever to address the rising temperatures, flooding, and water loss that Arizona experiences. Saving water and using it for air conditioners and irrigation are just some of the stored water's uses. The water quality is improved alongside the capacity the underground basins can hold. The project helped lower temperatures on-site of roughly twenty-two degrees Fahrenheit (Cheng).

The stakeholders of this development were Arizona State University and Maricopa county as a whole. The project was funded and paid for by the university. The process was backed by students and the board of Maricopa county's project and water specialists. There was very little if any opposition to the Arizona State University Orange Mall Green Infrastructure Project. The project received silver level certification by the U.S. Green Building Council Sustainable SITES Initiative. Students and faculty of the university supported the entire process and furthered the certification process (SITES). The certification award came to the university and students to protect the natural environment, keep the spaces clean and open, deal with rainwater, and finally, for heat and light pollution reduction. ASU budgeted the whole development process at three million dollars.

Arizona State seeks to continue to study the managed stormwater within the basins. ASU considered the malpractices of some stormwater management and opted to work in tandem with the natural environment. The water flows from the landscape to the basins, where the stormwater is naturally filtered and flows to groundwater slowly to the salt river (Harris). Unlike other practices in which the captured water would flow in pipes and quarries, quickly collecting trash on the way to the river. This project sought to address an environmental, social, and technological need.

The Belmont Project could learn a lot from this case study and the improvements made to this site. It is important to note the environment in which the Belmont smart city will be erected in Arizona, the same place where this ASU Project was based. It is also worth noting that the students at Arizona State are helping out with the development of Belmont. Belmont's key learning lessons that can take away from this project are material uses and the construction system process. The use of thinner and more porous concrete pavers meant water would move easier and prevent flooding. The thinner pavers gave more comfortable access to what is housed underneath them in repairs or further retrofit construction projects. Color and durability were essential for the pavement (Cheng). It would reflect the heat more accurately away from the ground. ASU used the modular suspended pavement system on the orange mall project. It would be a reasonable consideration for Belmont to ensure a thriving tree or cacti maturation to create shade or preserve the natural landscape. It improved moisture retention in the area and lowered the temperature of the environment in which it was housed. Belmont is going to be a city that will have to manage its stormwater. The basins system and its utilization in the Orange Mall Green Infrastructure Project improved the temperature and filtration, and ecological use of the stormwater. The Belmont Project could make similar constructions to preserve and store water for future use in whatever Belmont would require for irrigation or other various uses.

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Case Study 4

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LAP/PUP/CEE 598: Smart City Sustainability

March 8th, 2021

Learning from the Past

Water is essential to human survival. Roughly sixty percent of the human body is made up of water. However, water is a finite resource. Our society has evolved around the use of water but sadly we have neglected its abundance. As our population grows exponentially, water demand is steadily increasing. On top of this, the issue of climate change is only getting bigger. As temperatures rise every aspect of society increases water use, especially agriculture. Consider all these factors and it results in an unsustainable use of water. Current and future cities within society must change and plan the current scale of water usage, otherwise water famine could trigger riots and potentially water wars. Therefore, it is essential for the Belmont Project to research previous studies of water management and all the lessons learned. Industrial, commercial, and residential areas all come with different water problems and challenges, however, residential will be the focus of this paper. More specifically, the Elmer Avenue Neighborhood Retrofit will be examined as an example of transforming an average residential block into a "green street."

The general Los Angeles area faces a large amount of water supply challenges. The city relies heavily on imported water and has reduced much of its groundwater aquifers. The Council of Watershed Health is an organization which had the goal of monitoring decentralized stormwater performance and its safety. They started the Los Angeles Basin Water Augmentation Study (WAS), resulting in the Elmer Avenue Neighborhood Retrofit with the goal to recharge groundwater supplies through stormwater runoff. The site was picked because previously Elmer Avenue had no stormwater infrastructure and was prone to frequent flooding. The project contains forty acres of residential land use along one city block. A large number of city departments and stakeholders worked together with the Council of Watershed Health. Meetings were held with the community where residents voiced concerns and gave feedback on design solutions. The total cost of the Elmer project was $1.8 million compared to a traditional storm drain system at an estimated $1.2 million dollars (Robinson, 2011). The question remains, was the more expensive "green" technology justified?

The main component of the new infrastructure was the underground infiltration system gallery below the street. This system can capture 750,000 gallons of runoff. Twenty-four bioswales were installed to remove pollutants from stormwater through soil and vegetation. Catch basins were placed on each end of the block to divert water from the street to the infiltration galleries. Catch basins also helped with filtering out sediments and trash. Participating private residences installed smart meters, permeable paving surfaces, rain barrels and six-thousand feet of drip irrigation. Thirteen of these rain barrels were put in, each with a fifty-five-gallon capacity for roof run-off. Solar Street lighting was also installed, making this the first block in Los Angeles with street lights off the grid. The result is that 5.4 million gallons of stormwater gets infiltrated annually (Robinson, 2011).

The Elmer Avenue Neighborhood Retrofit is a modern design with a "Green Street" approach. After upgrading its previously poor stormwater infrastructure, it proved enhancement to surface water quality and annually recharges sixteen acre-feet of groundwater supplies (Robinson, 2011). The project backed up its cost. On the other hand, there are some lessons to be learned from this project. The bioswales are collecting more trash and sediment than estimated which increases the burden on the homeowners. Accounting maintenance funds into the project cost is one way to solve this. Some private residents wanted to buy in to certain installed features after seeing results on other properties. Designers need to account for these people who did not agree to initial participation. Additionally, a project containing this many stakeholders needs an extended amount of time to discuss design features and implementation. Belmont designers need to consider adapting the sustainable strategies implemented in the Elmer Avenue project for their residential areas as a benchmark, along with considering the issues that the development encountered. The future can be bright and wet for the Southwest if we learn from our past mistakes and practice sustainable water management.

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Case Study 5

Madison Gidley

LAP 598: Smart City Sustainability and the Environment

Paul Coseo

March 8th, 2020

Smart City Case Study: The Puyangjiang River Corridor

The Puyangjiang River Corridor reclamation project is located in the east of Pujiang County, Zhejiang, China. The city has a population of 100,000 with about 400,000 residents living within the vicinity of the river. For hundreds of years the river was used to support the livelihood of its residents but as time went on and the city experienced a rapid increase of industrialization, the river became a polluted eye sore. Not only was this bad for the natural environment but the river gave the city a bad image. Eventually the government decided that steps needed to be taken to change this.

The project’s conception began in 2014 when the local government launched a campaign to restore the environment of the city to a higher quality of life. As a result of this the Puyangjiang River was set up as a pilot project that would set the standards of design for future restoration projects. To decide on the final design the city organized a competition for local designers to submit proposals for the project. And as a result Turenscape was chosen and commissioned to execute the final design. Turenscape’s project statement proposed to transform the damaged 10 mile corridor into a ecologically recovered multifunctional greenway that reconnects the community to nature while also healing, “ the physical and mental damage done to the local community, who have suffered the degraded environment for decades due to relentless development.” (archello, paragraph 1) In addition to addressing the pollution, Turenscape also wanted to create a space that the community could use at any point in the year despite the fact that the river is a major flood zone. When designing the new vision for the river Turnscape kept three main strategies in mind. They began first by taking measures to address pollution. Most of the pollution was caused by overused chemical fertilizers that flowed into the river from the nearby farm fields. To address this the team removed the concrete that lined the river and replaced it with riparian plain vegetation that was able to adapt to flooding (since the area is known to have a lot of flooding from monsoons). The new vegetation not only aesthetically softens the view of the river but also acts to catch the polluted surface flow to create ecological buffers that slow and cleanse the river naturally. The second strategie that was used was to preserve existing vegetation and integrate it into the new design so that cultural heritages and existing structures preserved the memory of the past for future generations to experience. The final strategy was to create opportunities for residents to connect with nature by activating the space with walking paths, biking paths, and boardwalks that share the natural and cultural stories of the river corridor with visitors.

The main takeaways that are important to consider is that this project used a top down approach to address ecological issues of the river and was funded by the government. There was sadly very little public involvement in the design process which for our project we can hopefully learn to do better. In regards to controversy, I was not able to find anything specific other than that the client, Pujiang County Government, was pleased and the project was widely accepted by the public.

Thankfully the project was successful and in just three years after its construction completion in December 2016, the river was restored back to its original glory decades before its industrialization. When moving forward with the Belmont project it will be good to acknowledge that effective strategies to support a healthy ecological system of both the environment and its residents are to restore, preserve, and make connections. And while the top down approach may have been effective in this instance, it is important to make steps to involve the community with the design conception process as much as possible to get their feedback and insist on how we can honor and tell the story of Belmont for future generations to come. Regulations should also be put in place to protect the rights of the people who live there and prevent as much negative impact on the environment as possible.

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Case Study 6

LAP / PUP/ CEE 598/ LAP 494: Smart City Sustainability and the Environment Spring 2021 Assignment 4 – Case Study Kristen Hu (Die Hu)

Stormwater Management : The Case Study of Valdebebas

This case study is about technologies and criteria for sustainable urban stormwater management. Based on this project, low impact development measures (LID) and sustainable drainage systems (SUDs) are introduced to improve the benefits of water resources management in Valdebebas urban development.

Project Background

Climate change has an impact on the rainfall pattern of cities, especially the cities are more vulnerable to floods. According to the rapid development of urbanization, the impervious area and drainage mode are increased, and the hydrological response area of natural watershed is also changed. This means that the infiltration in many areas is reduced and the runoff is increased, leading to frequent floods and water pollution. Therefore, in the Valdebebas project, the implementation of rainwater management provides an applicable and feasible opportunity to achieve environmental sustainability. This requires expanding urbanization and complex infrastructure to enhance the resilience of the system, and improving the management of urban water cycle to reduce room temperature gas emissions.

Low Impact Development Measures (LID)

The Valdebebas infrastructure was privately planned and funded by the land owners and handed over to the city of Madrid in exchange for development rights. (Rodríguez Sinobas, 2018) In the Valdebebas project, LID measures are adopted to enhance the infiltration area through infrastructure, promote the runoff to penetrate into the unsaturated area, and increase the available storage capacity. The infrastructure is effectively connected to the municipal circulating water system for park irrigation, and recycled water is obtained from the local water treatment plant. The main water efficiency measures adopted were: Reduction of water thirsty lawns, accounting for only 3% of the surface area of urban green open spaces. Installation of subsurface drip irrigation to reduce water loss from evaporation and providing water directly to the root area. Centrally automated control of the irrigation system, connected to a weather station. Design and installation of SuDS in all park areas. (Rodríguez-Sinobas, 2018)

Sustainable Urban Drainage Systems (SuDS)

The project's landscape design team promoted suds as a solution for developing Valdebebas's infrastructure specifications. Suds method has become an effective tool to restore natural urban hydrological technology, including increasing green open space area, reducing impermeable sidewalk area and peak flow. For example, rainwater harvesting, green roofs and permeable pavements can reduce the total volume delivered to the sewage treatment system in urban areas. The overall benefits for the city as compared with a traditional sewage system, including recharging the Valdebebas aquifer, proved to be convincing and a green light was given for what was then considered an experimental urban practice. (Rodríguez-Sinobas, 2018)

However, Large scale application of suds in Valdebebas phase I park in 2009 (stage 1), a total of 18 green space designs combined with sustainable drainage system. Among the enhanced overall sustainability objectives of the project implementation is to replenish groundwater reserves with rainwater and excess water from green areas. As a result, suds has a low construction cost and can increase the use of rainwater on site while reducing energy and treatment related costs. In addition, the new park has gained good experience from earlier parks, with a total area of 6 ha reopened in 2016 (stage 2): Pervious capability of the new parks has been improved, with an increased surface area of plantings and permeable paving increased to 65% of the surface area as compared to 53% in stage 1. The SuDS have been enhanced to increase the storage capability for stormwater, while the intention is to monitor water infiltration at certain points in the system. (Rodríguez-Sinobas, 2018)

Conclusion

The project shows that the suds adopted by the park for stormwater management is an applicable asset in Valdebebas, while providing benefits for other diversified environmental services. For example, it is conducive to urban beautification and local water recovery to maintain the soil moisture content standard. And the aquifer can be used as a charge. In addition, it should be noted that the impact of climate change must be clearly considered in the design of suds, because some specific adjustments may need to be determined according to the local climate and environmental conditions, so as to ensure the targeted enhancement of system flexibility.

Applicability & Solution for Belmont

According to the case study, suds method and stormwater management standards have been proved to be a sustainable water use, especially for the proposed design standards, which are applicable to different climatic conditions and environmental conditions. This means that similar rainwater management method (SUDs) can be considered in Belmont project to realize the sustainable development of smart city. This can not only achieve environmental sustainability, but also provide opportunities for applicability and feasibility. The differences in technology and standards between the designs of likewise and suds do not come from the conventional urban drainage system, and they are easily and effectively connected with the existing traditional urban drainage system and sewage treatment plant. With a future increase in use of SuDS, city water treatment infrastructure will be able to downscale as treatment needs are reduced. (Rodríguez-Sinobas, 2018) Therefore, stakeholders can apply the method and standard to develop Belmont project. The use of suds system can effectively reduce costs and sewage treatment costs, and solve ecological and technical problems, such as rainwater management and water pollution issues by climate impact.

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