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Development of an Instructional Course on Fire-Protective and Low-Water Landscaping in Utah

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DEVELOPMENT OF AN INSTRUCTIONAL COURSE ON

FIRE-PROTECTIVE AND LOW-WATER LANDSCAPING IN UTAH

By

Jordan S. Goff

A thesis submitted in partial fulfilment
of the requirements for the degree

of

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In

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ABSTRACT

Development of an Instructional Course on Fire-protective

and Low-water Landscaping in Utah

By

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Utah State University, 2022

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Because of climate change, population expansion, and other factors, both wildfire and drought are becoming pressing concerns in Utah. Home landscaping can reduce risk of damage from wildfire (fire-protective landscaping) and contribute to lower water use (low-water landscaping). While it is important for homes in the wildland-urban interface in Utah to have landscaping that is both fire-protective and low-water, best practices for the two are often taught in ways that make them seem mutually exclusive. This project used existing research and best practices to develop a learning experience to teach homeowners how to implement landscaping that is both fire-protective and low-water. The ADDIE model of instructional design was used to guide the process of making the learning experience. The final product is an interactive, online course that will be published through Utah State University Extension and made available to the public. The course teaches best practices of fire-protective and low-water landscaping, how to make a landscape enjoyable to use, and the importance of making informed decisions about landscaping based on personal values.

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I would also like to thank all those who helped me produce the course, including the homeowners that graciously allowed me to use their properties as case studies, all those I interviewed to produce content for the course, and everyone who reviewed the course and provided valuable feedback.

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Project Objective

Wildfires and droughts are becoming increasingly prevalent in the western United States. Climate change is a major factor that intensifies wildfires and wildfire behavior and may increase the occurrence and severity of droughts. Climate change is projected to continue, making it critically important to design built landscapes that are resilient to these hazards. Many resources exist detailing how to design fire-protective landscapes, as well as resources detailing how to design low-water landscapes. However, there are very few resources for designing landscapes that are both fire-protective and low-water. Therefore, the purpose of this project is to create an instructional course on how to design appealing, fire-protective, and low-water landscapes in northern Utah.

Climate Change

It is becoming undeniably clear that the earth's climate is warming (Pachauri et al., 2015). This is almost certainly due to human caused emissions of greenhouse gases, especially carbon dioxide, from burning fossil fuels (Pachauri et al., 2015). Atmospheric carbon dioxide has increased from its preindustrial (before the year 1850) value of 280 ppm to 409.8 ppm in 2019 (Gray, 2007; Lindsay, 2020; Pachauri et al., 2015). Global temperatures have increased by 0.76 ° C (1.37° F) from 1850-1899 to 2000-2005 (Gray, 2007). The rate of warming is also increasing (Gray, 2007). The effects of climate change are numerous, including increased number and severity of extreme weather events, lower ocean pH, and rising sea levels (Gray, 2007; Lindsay, 2020; Pachauri et al., 2015). Even if humans stop emitting greenhouse gasses into the atmosphere, many of the effects of climate change may be irreversible, or at least will last for

centuries (Pachauri et al., 2015). This makes adapting to the effects of climate change and finding ways to build resilient cities and communities even more important (Iturriza et al., 2020). Two effects of climate change relevant to this project are an increase in droughts and wildfires.

Drought

Due to climate change, droughts are becoming increasingly severe in arid and semi-arid ecosystems in North America (Bradford et al., 2020). In the Intermountain West, of which Utah is a part, droughts are increasing in frequency and severity (Williams et al., 2020). Utah relies on snowpack-fed streams for much of its water, and snowpack is declining dramatically across the western United States (Mote et al., 2018). More precipitation falling as rain, as well as spring coming one to four weeks earlier, results in less runoff flow and therefore, less water availability in streams and storage reservoirs fed by snowpack (Gillies et al., 2012; Mote et al., 2018; Stewart et al., 2005). The long-term increase in droughts in the western United States is likely due to climate change (Khatri et al., 2018; Mukherjee et al., 2018). However, this is not totally certain, primarily because of discrepancies in definitions of droughts and methods of measurement. (Cook et al., 2004; Mukherjee et al., 2018; Sheffield et al., 2012; Wilhite & Glantz, 1985). That being said, water from snowpack-fed streams is clearly becoming less available to fill storage reservoirs.

This problem is multiplied by the fact that Utah's population is one of the fastest growing in the nation, with a 16.0% increase from 2010 to 2019, as population growth skyrocketed from 2,763,891 people to 3,205,958 people. (*U.S. Census Bureau QuickFacts*, n.d.; *Utah Population 2020 (Demographics, Maps, Graphs)*, n.d.). Utah's population in projected to reach 5,827,810 by the year 2065, more than double its present size (Kem C. Gardner Policy Institute, 2017). This will put significant strain on Utah's finite water supply (Khatri et al., 2018). Utah's rapidly

increasing population along with decreased stream flow will necessitate using less water per person.

Low-water Landscapes

Despite Utah's small water supply, 50-75% of municipal water use in Utah is used to irrigate urban landscapes, much of which is comprised of turfgrass. (*How to Irrigate Efficiently*, n.d.). Low-water landscaping has grown in popularity in recent years as people become more aware of the need to conserve water, and as homeowners seek to save money on water (Sovocool et al., 2006). There are many existing resources for designing low-water landscapes, also known as xeriscapes. These include resources available through university extension programs and water conservancy districts, as well as other books and websites.

Low-water Landscaping Design Principles

Following low-water landscaping principles can substantially reduce the amount of water a household uses on landscaping, so adoption of these principles should help alleviate the strain on Utah's water supply. Since ornamental landscaping is nonvital, the theoretical reduction of water for outside use is 100%, although due to the many benefits of maintained landscapes, this is not advisable in most situations (Inskeep & Attari, 2014). By following low-water landscaping principles, it is possible to maintain the aesthetics and usability of a landscape while reducing water use by approximately 30% (Inskeep & Attari, 2014). In addition to conserving water, low-water landscapes, especially those using native plants, provide food and habitat to pollinators and other wildlife (Martinson, 2020; Seitz et al., 2020).

The following is a summary of best practices for low-water landscaping.

Irrigation Methods

One of the most important principles of low-water irrigation design is that irrigation should be uniform (not adding unnecessary water to any areas) and use no more water than is needed by the plants being watered (Hilaire et al., 2008). Drip irrigation is often used to reduce water use and can be helpful to deliver water directly to a plant; thus, water is not wasted by delivering it where there are no plants in need of water (Schwankl et al., 2015). Drip irrigation also reduces evaporation when compared with other irrigation methods (Lamm, 2002).

Plant Selection

Low-water landscaping involves using plants that require less water than traditional landscaping plants (Hilaire et al., 2008; Inskeep & Attari, 2014; Sovocool et al., 2006). These are often native species already adapted to the climate where they are planted, as well as some well-adapted, non-invasive exotic species (Inskeep & Attari, 2014; *Principles of Water Wise Landscaping*, n.d.).

Traditional low-water planting can be very vulnerable to wildfire because while thick, drier vegetation, especially tall grasses, is a hallmark of low-water gardens (Wheaton et al., 2017), fire-protective design guidelines suggest avoiding tall, dry grasses and watering sufficiently to maintain green, succulent vegetation (Kuhns & Daniels, 2012).

Turfgrass Species

Use of turfgrass should be kept to a minimum in low-water landscapes, by planting it only in areas where it will be practical and usable. When it is used, choosing a regionally appropriate species of turfgrass can significantly reduce water use while giving similar aesthetic and functional value (Gibeault et al., 1989; Inskeep & Attari, 2014). Different turfgrass species

and varieties perform better than others depending on environmental conditions such as hours of sunlight, soil type, and elevation (Kopp & Johnson, n.d.). It is also important to consider the intended use of the turf since different species are green during different months and some species can tolerate more foot traffic than others (Kopp & Johnson, n.d.). Tall Fescue and Fine-leaf Fescues are two common options that perform well in Utah (Kopp & Johnson, n.d.). More information about turfgrass options for Utah is included in Appendix 2: Additional Low-water Landscaping Information.

Mulch and Groundcover

Using mulch to cover unplanted ground in a landscape helps retain moisture in the soil so that the landscape requires less irrigation (Özyavuz et al., 2012). Mulches also have many other benefits, including adding nutrients to the soil as they decompose and reducing weed growth (Özyavuz et al., 2012). Because wood mulch is flammable, rock mulch can be a better alternative for wildland-urban interface landscapes, although rock mulch will not contribute significantly to soil nutrient content. Rock mulch may also act as a heat sink, absorbing heat from the sun and contributing to a warmer landscape. This can be reduced by using lighter colored rock that reflects more sunlight (Taha et al., 1988).

Watering with Collected or Reused Water

Using rainwater for landscape irrigation can reduce stress on municipal water supply (Waterfall, 2006). Rainwater collection systems may be simple, such as water flowing directly from a parking lot into a landscape area, or more complex, like a system that stores water captured from a roof and uses it to regularly irrigate landscape areas (Waterfall, 2006). Another alternative water source is graywater from household uses such as laundry and showers. This shows some promise of reducing water use, but it can have concerning effects on soil salinity as

well as pathogen and other toxin content, so it should be used with caution (Sharvelle et al., 2012).

In Utah, it is legal to collect and reuse rainwater, but with certain restrictions (Utah State Code, 2013). Rainwater may be collected in a container with a capacity of no more than 2,500 gallons and used on the parcel whereon it is collected. Storage containers must be built to State Construction Code and registered with the State. Laws about greywater reuse in Utah are made by local health departments, but Utah Administrative Code dictates that health departments must allow greywater reuse, while also protecting the public from the associated health risks (Utah Administrative Code, 2020).

Figure 1: A residence with low-water landscaping. Image credit: http://perennialsforutah.com/perennial_garden_design

Wildfire

The other hazard relevant to this project is wildfire. Wildfires are becoming more common and more severe in the United States. Expenditures by federal agencies on wildfire suppression are rising; costs by Department of the Interior agencies regarding wildfire suppression are now at a five-year average of $2.6 billion USD per year, while in the 1990s, yearly expenditures never exceeded $1 billion USD (*Suppression Costs | National Interagency Fire Center*, n.d.). Climate change causes an increase in the number and severity of wildfires (Running, 2006; Westerling et al., 2006; Williams et al., 2019). Warmer temperatures make it easier for wildfires to ignite and continue burning, and warmer spring and summer temperatures

contribute to a longer fire season that continues into mid to late fall in some years (Westerling et al., 2006). Also, decreased stream flow leads to drier environments, further worsening wildfires (Westerling et al., 2006).

In addition to climate change, increases in wildfires in the western United States can be attributed to land management (Gillies et al., 2012). Because of management decisions to extinguish nearly all wildfires, forests that previously had a patchier structure after being burned by many small fires now have large, continuous areas of dense trees and vegetation. This leads to a higher risk of severe wildfires as large areas of forest can be burned in a single fire. (Westerling et al., 2006). Although land management has less effect on fires in high alpine forests because these forests previously had only large, high intensity fires, many alpine areas that were previously protected from fire by snowpack are becoming more vulnerable (Running, 2006; Westerling et al., 2006).

Wildfire risk is greatest in the wildland-urban interface (WUI). Although there is no clear standard of exactly which areas are considered to be within the WUI, it is generally defined as areas wherein human development abuts or mingles with undeveloped land (Platt, 2010; Radeloff et al., 2018; *What Is the WUI?*, 2021). One study showed that the WUI grew 33% in area from 1990 to 2010, making it the fastest growing land use type in the contiguous United States, thereby putting more homes and buildings than ever at a high risk of destruction by wildfire (Radeloff et al., 2018). This, combined with increased rates of wildfire due to climate change, makes carefully planned WUI development critical (Abney & Ma, 2020).

Fire-protective Landscapes

Strategies such as prescribed burning and large-scale fuels reduction are critical to reducing the severity of damage from wildfire on a community and a regional scale (Schoennagel et al., 2017). However, the focus of this project is on site-scale interventions. It has been shown that constructed landscapes can be designed to protect a structure, usually a home, from being destroyed in the event of a wildfire. Even in the event of a high intensity crown fire, (where the crowns of trees burn in addition to the underbrush, making the fire much more dangerous and destructive), employing principles of fire-protective landscaping greatly increases the chance of a home surviving (Cohen, 2003; Kuhns & Daniels, 2012; *Land Use Planning Can Reduce Wildfire Risk to Homes and Communities*, 2020). In fact, traditional firefighting strategies are usually ineffective against destruction of homes by wildfire because of the extreme nature and large size of most fires, making fire-protective landscaping even more important (Cohen, 2003).

Fire-protective landscaping strategies are most important in the WUI. As with most of the Intermountain West, the already large WUI is expanding in Utah (Radeloff et al., 2018; Theobald & Romme, 2007). This means that many homes and other buildings are at risk of wildfire, making fire-protective landscaping an important consideration.

Fire-protective Landscaping Design Principles

The following is a summary of best practices for fire-protective landscaping.

Defensible Space

The main component of a fire-protective landscape is defensible space, which is an area of 100-200 feet around the home or structure that is relatively clear from potential fuel (Kuhns &

Daniels, 2012; Syphard et al., 2014). Trees and stacked firewood should not be located adjacent to buildings (Kuhns & Daniels, 2012). Structures such as decks and fences that are adjacent to the house should be considered as part of the house. It is often best to replace wood decks with a less flammable alternative, like concrete pavers (Kuhns & Daniels, 2012). Outside of the 100 feet of defensible space, the adjacent wildland should be thinned and cleaned if possible to remove highly flammable debris and plants.

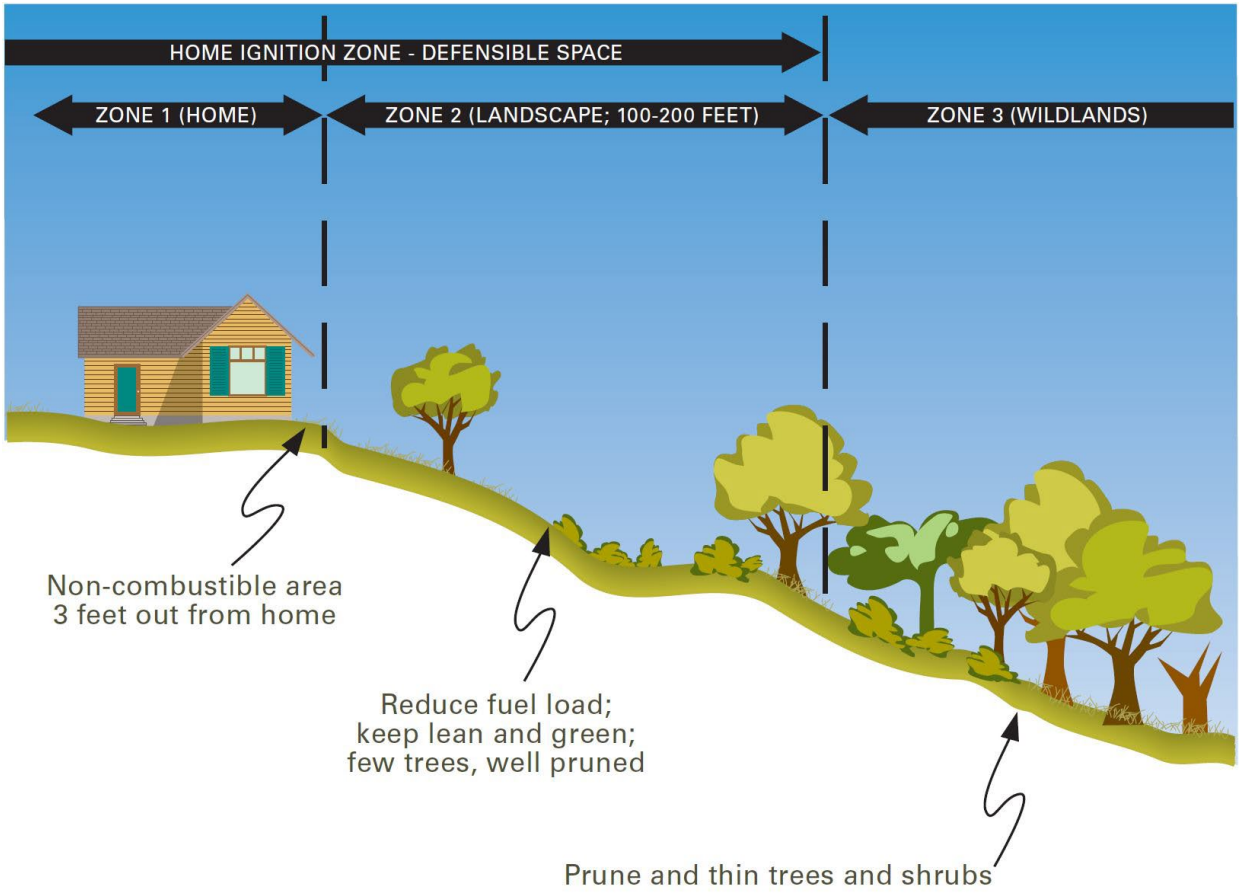


Figure 2: Defensible space (Kuhns & Daniels, 2012)

Figure 3: A home landscape with defensible space saved from fire. Image credit: https://keyt.com/news/fire/2020/05/14/defensible-space-inspections-to-begin/

In many instances, the implementation of this strategy involves large swaths of irrigated turfgrass (Kuhns & Daniels, 2012). This is effective for preventing wildfires; however, this strategy is problematic when one considers the need to use less water.

Building Materials

Even if the fire is not able to burn through the landscape around the house, a lofted ember may land on the house and ignite it (Cohen, 2003). For this reason, the materials of the home itself, especially the roof, should be as fire-resistant as possible. Fire-resistant roofing materials generally include asphalt and tile shingles, metal, and concrete (Kuhns & Daniels, 2012). Any roofing material used should be rated Class A, meaning it has the highest degree of fire resistance. Wooden shingles should not be used (Kuhns & Daniels, 2012).

Building Placement and Topography

Buildings should not be located at the top of ridges (Alexandre et al., 2016). This is because fire generally travels upslope, especially when propelled by wind. In clusters of buildings, a higher density of buildings correlates with a higher probability of building loss, although the exact relationship between building spatial relationships and the probability of building loss is still somewhat unclear (Alexandre et al., 2016; Syphard et al., 2012).

Fire-protective Plants

While all plants can burn, some plants are less flammable than others (Kuhns, 2010). Fire-protective plants are usually low to the ground, have high-moisture tissue, produce small amounts of litter, and contain low amounts of volatile oil or other flammable compounds (Kuhns, 2010). Generally broadleaf trees are less flammable than conifers, although all trees provide a large amount of fuel (Kuhns, 2010).

Landscapes That Are Both Fire-protective and Low-water

Although there are many existing guides and materials to assist with fire-protective or low-water landscaping, there are very few, if any, resources detailing how to design and implement landscapes that are both fire-protective and low-water. People may perceive low-water and fire-protective landscaping as being mutually exclusive. However, it is possible to design landscapes that are both fire-protective and low-water.

During the preparation for this project, several Utah State University Extension specialists with extensive experience working with the public in Utah, as well as other Utah State professors, agreed that it is possible to design landscapes that are both fire-protective and low-water, but that there is little understanding currently of how to do that. They all agreed that this is

a relevant and timely issue, and that there is a need for more understanding by the public of how these two design considerations interact.

There are also very few examples of fire-protective and low-water landscapes, or even sets of recommended best practices, that designers, homeowners, or others can use as precedent, especially in Utah. Therefore, the purpose of this project is to create an instructional course about how to design appealing, functional, maintainable, fire-protective, and low-water landscapes. The course is intended to help homeowners and landscape designers in Utah to both save water and protect their buildings and property from wildfire.

Figure 4: A landscape that balances principles of fire-protective, low-water, and comfort. Base image credit: https://extension.wsu.edu/chelan-douglas/gardening/firewise-landscapes/

Figure 5: A more naturalistic landscape also balancing fire-protective, low-water, and aesthetic values. Base image credit: https://www.dcourier.com/news/2018/jun/08/firewise-landscaping-beautiful-and-safe/

Motivation to Act

There are several theories explaining why people choose to engage in actions like implementing fire-protective and low-water landscaping that are important to consider when encouraging people to implement such changes. The theories that will be examined here are the *theory of planned behavior* and *protection motivation theory*.

Theory of Planned Behavior

The theory of planned behavior (TPB) states that a person's intention to perform a certain behavior is based on attitudes towards the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991). A stronger intention to perform the behavior means that the behavior is

more likely to be performed (Ajzen, 1991). Attitudes towards the behavior are essentially what the person thinks of the action – whether they think it is a good idea or not. Subjective norms are the person's perception of what their peers/society will think of the action. Perceived behavioral control is the degree to which the person believes that they can change their behavior.

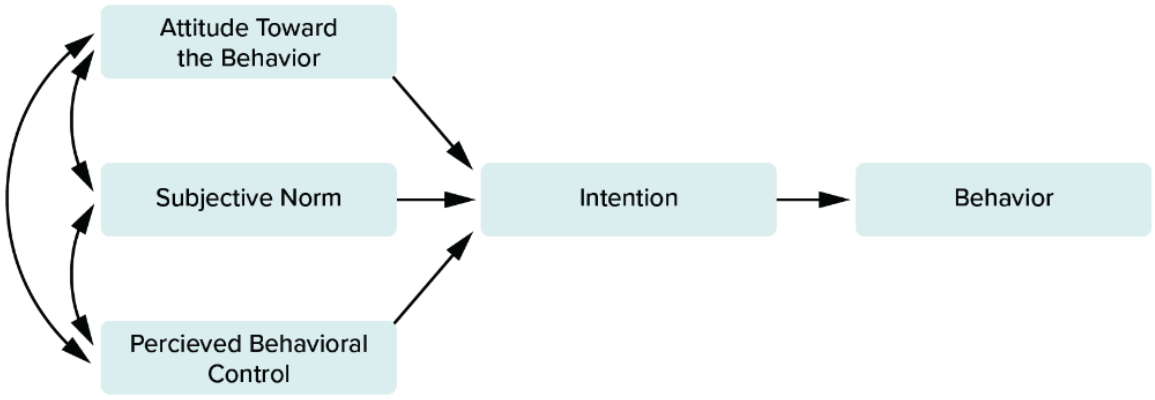


Figure 6: The theory of planned behavior (Ajzen, 1991)

TPB has been the most common theory applied in studies about public perception of wildfire and wildfire mitigation (Dupéy & Smith, 2018). TPB has been found to be an effective way of predicting which residents engage in wildfire protection activities (Bright & Burtz, 2006). In the context of wildfire mitigation, attitudes towards behavior could include the perception of wildfire risk and the importance of mitigation. Subjective norms might include what neighbors or others are doing with their landscape to protect from wildfire, and whether implementing fire-protective landscaping is generally acceptable and considered important by the person's social group. Perceived behavioral control could include whether the person believes they have the capacity, including skills, finances, and time, to implement fire-protective landscaping. TPB has been similarly applied to water conservation efforts and has been found to be an effective way of predicting intention to conserve water, as well as intention to mediate other environmental issues (Yuriev et al., 2020).

Protection Motivation Theory

Protection motivation theory (PMT) explains motivation to act in terms of avoiding noxiousness (danger or other harm). This theory claims that the factors that contribute to protection motivation (the motivation to take action to protect oneself) are the magnitude of the noxiousness, the probability of occurrence, and the efficacy of the recommended response (Rogers, 1975). PMT has been shown to be a viable model on which to base community interventions (Floyd et al., 2000). While PMT has been used and studied most intensively in public health and related disciplines, it has been successfully applied to marketing campaigns about water conservation (Nelson et al., 2011) and wildfire mitigation (Dupéy & Smith, 2018; Ghasemi et al., 2020).

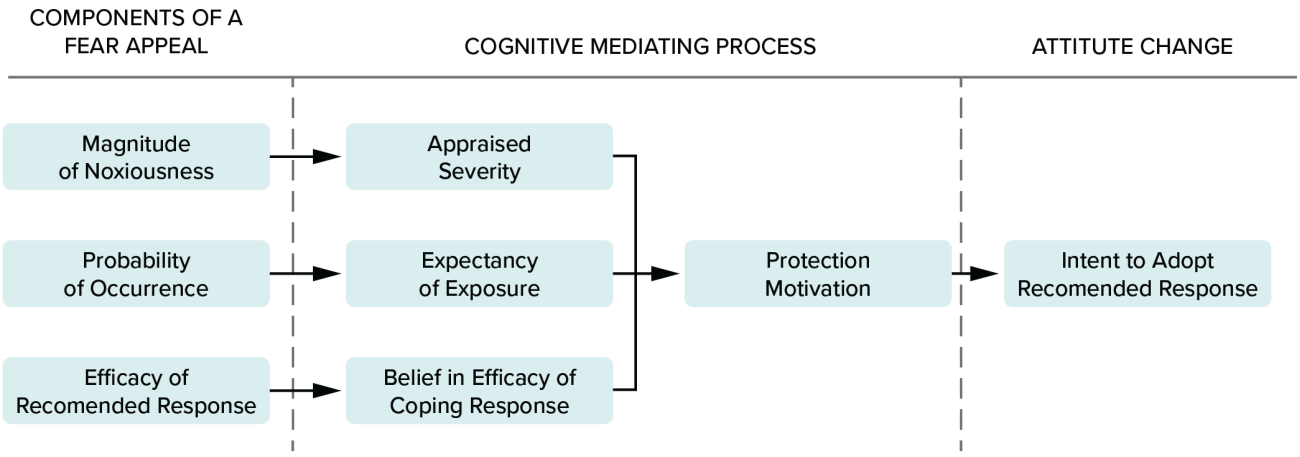


Figure 7: Protection motivation theory (Rogers, 1975)

Many things can influence the three factors considered in PMT. In the context of wildfire, past experience with wildfire appears to play an important role. Past experience has been shown in some cases to heighten residents' perception of wildfire risk and intention to mitigate, while residents with less wildfire experience are more likely to rely on the actions of government

agencies to protect them (Ghasemi et al., 2020). However, in some cases, exposure letdown can have the reverse effect, where people believe that something is less likely to happen in the future because it has happened before. Because of this, people who experience a "near-miss" with a wildfire may have a lessened perception of future risk (Larsen et al., 2021).

Intention-Motivation Gap

One potential problem with both the theory of planned behavior and protection motivation theory is that they explain which factors contribute to motivation, but they do not examine why motivation or intention to act often do not lead to actual behavior. This phenomenon is known as the intention-behavior gap. While intentions are generally a good predictor of actual behavior, several factors influence how likely intentions are to be manifested as actions (Balau, 2018; Sheeran & Webb, 2016). Intentions based on personal belief (affective attitudes) are generally stronger than intentions based on thoughts of consequences (cognitive attitudes) (Sheeran & Webb, 2016).

The most effective way to increase the probability of intentions turning into actions is developing implementation actions, which are specific plans for how and in what circumstances the action will be completed (Balau, 2018; Sheeran & Webb, 2016). This is valuable when considering how to increase the probability that people will implement desired changes in their landscapes. It is insufficient to tell people what changes to make and to motivate them to make the changes; they also need to make specific plans for how to implement the changes.

How People Learn

When designing a learning experience, it is important to consider not only what motivates people, but how people learn. Three of the most prominent theories describing how people learn are *behaviorism*, *cognitivism*, and *constructivism*. All three were used in the design of the course.

Behaviorism

The first of these theories to emerge was *behaviorism*, sometimes called *radical behaviorism*, which focuses on observable and measurable behaviors, rather than on people's mental or emotional state (Delprato & Midgley, 1992). Behaviorism posits that new behaviors are learned through stimuli and response, or in other words, in response to positive or negative reinforcement (Delprato & Midgley, 1992). Learning experiences based on behaviorism focus on providing rewards or punishments to reinforce mastery of skills or tasks being taught (Tomic, 1993). Behaviorism is related to protection motivation theory, where people are moved to action by fear of consequences.

Cognitivism

Cognitivism focuses on how people organize and remember information, rather than solely on modifying behavior (Guey et al., 2010; Khan et al., 2020). An important concept in cognitivism is moving information from short-term to long-term memory so that it can be available for use later (Khan et al., 2020). This is accomplished by presenting information in a logical, organized manner, and by using devices like analogies, images, and mnemonics (Khan et al., 2020).

Constructivism

Constructivism is a complex theory with many interpretations, but at its core, it focuses on how learners construct their own understanding of new information by giving it meaning through their experience (Hyslop-Margison & Strobel, 2007; Phillips, 1995). In constructivism, learners do their own "experiments" on their surroundings, leading to understanding through experience (Phillips, 1995). Teaching based on constructivism first elicits prior knowledge (Baviskar et al., 2009). It then seeks to build on that knowledge by introducing information that creates cognitive dissonance so the learner sees the gap between what they currently know and what they are learning (Baviskar et al., 2009). Then the new knowledge should be applied in different situations with feedback, after which the whole learning experience should be reflected upon. (Baviskar et al., 2009). An example of constructivism applied to learning could be the use of interactive demonstration gardens to teach about low-water landscaping, where learners can engage with the subject in ways that are meaningful to them and build their understanding through experience. In an online setting, constructivist theory can be applied through activities that give the student the opportunity to apply their skills, such as interactive assignments.

While constructivism provides a useful framework for understanding how people assign meaning to the things that they learn, some kinds of learning, especially learning objective facts, is better explained using other theories (Hyslop-Margison & Strobel, 2007).

The ADDIE Model

The ADDIE model is a well-studied and commonly used model for systematically designing learning experiences (Branch, 2009; Molenda, 2015). Because it has been used extensively and effectively and has provided a clear framework for instructional design, it was

decided that it would be used as the framework for designing this course. The ADDIE model consists of five steps: *analyze, design, develop, implement, evaluate*.

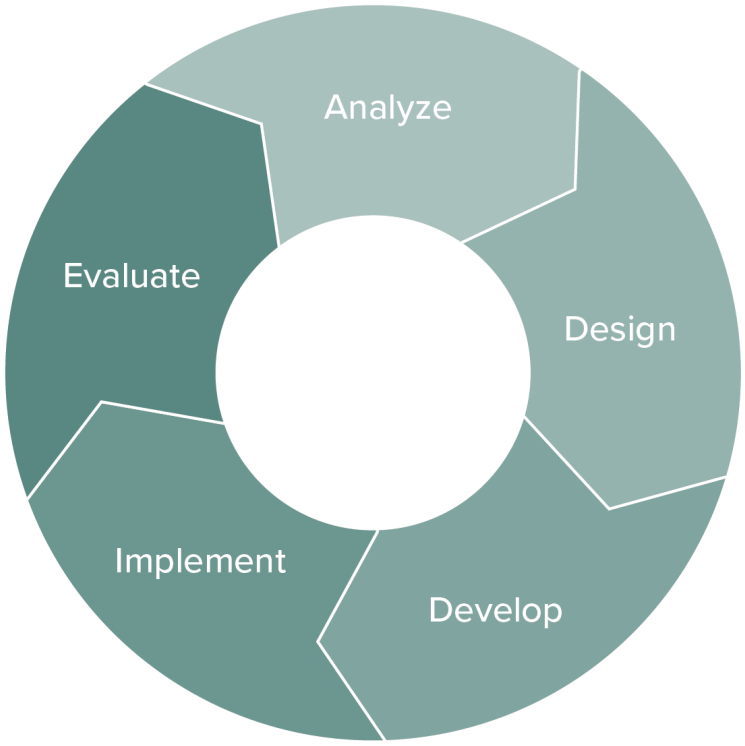


Figure 8: The ADDIE Model

This section is based on the book *Instructional Design: The ADDIE Approach* (Branch, 2009).

Analyze

Before design can begin, it is necessary to define and analyze who the learners are. In this project, the learners are the students who will enroll in the course. Analyzing the learners begins with a needs assessment. A needs assessment is often framed in terms of a performance gap, which is the gap between the learners' current behavior and their desired behavior. In the case of this project, the desired behavior is implementing fire-protective and low-water landscapes, and the gap is that these types of landscapes are often being implemented only partially or not at all.

The learners themselves are also assessed as is well as possible. It is important to find out what they already know about the topic, what their attitudes are towards the subject, what delivery methods would work best for them, and any other relevant information.

Once the gap is determined and the learners are assessed, the designer should be able to tell whether they should continue with the ADDIE model and produce an instructional experience, or if the gap will not be fixed by instruction (for example, if homeowners were not implementing landscape changes because they had insufficient funds, not because they lacked the knowledge or motivation to do it). If the gap should be able to be closed by instruction, the designer moves on to the next step.

Design

To begin the design step, learning objectives are determined. Learning objectives are a set of statements describing what the learner will be able to do by the end of the learning experience. An objective could be, “Estimate the water use of a residential landscape.” If the learning objectives are defined correctly, the learner will close the performance gap determined in the analysis step once the learning objectives are achieved.

After the learning objectives are written, a task inventory is conducted. A task inventory consists of listing all the necessary tasks to be completed before meeting the learning objectives. The task inventory is then translated into the design document or script, which is essentially an outline for the learning experience that covers all the tasks in the task inventory that the learners do not already know how to do.

Develop

Once the script or guide for the learning experience is designed, the development stage is simply producing and assembling the content according to the script. This could include producing audiovisual content, slide decks, worksheets, or anything else that will be needed for the learning experience.

Implement

In the implementation stage, the learning experience is delivered to the learners. This could be in the form of holding an in-person class, uploading the content to a learning management system and enrolling learners, or some other form of delivery. The implementation stage can include prototyping of the learning experience and testing on a small group of learners, followed by refinements before the final version is implemented with the full audience.

Evaluate

After the learning experience is completed, it is important to evaluate whether it was successful. This evaluation can inform future versions of the learning experience and other similar learning experiences. A common method of evaluating the performance of a learning experience is by using Kirkpatrick's four levels of evaluation. These levels are, from lowest to highest: reaction, knowledge, behavior, and results (Kirkpatrick & Kirkpatrick, 2016).

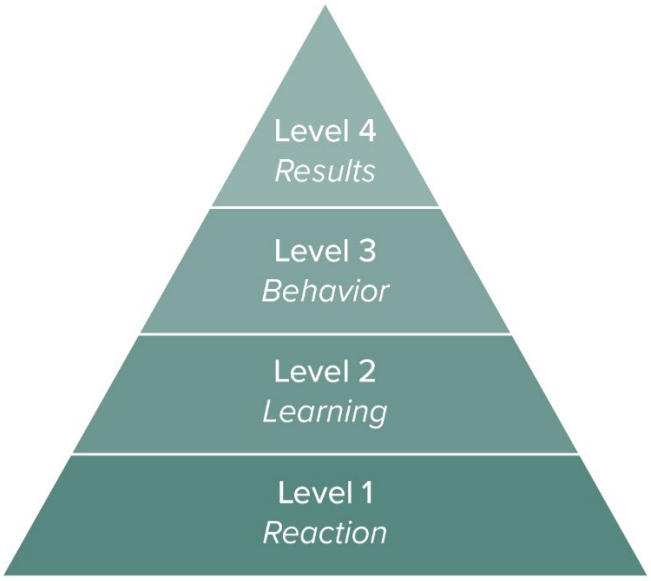


Figure 9: The Kirkpatrick evaluation model

The reaction level measures how much the learner enjoyed the course, regardless of what they learned. The knowledge level measures what the learner knows at the end of the learning experience, and the behavior level measures whether that knowledge has been translated into actual behavior. The results level measures whether conducting the learning experience had the desired results or outcomes for the organization or for the individual learner. Because USU Extension is focused on behavior change and results, it is important to measure Extension learning experiences to see if they are achieving these goals, rather than only focusing on whether learners enjoyed the experience.

CHAPTER 2: METHODS

The course was created using the ADDIE model, one of the most widely used and accepted models for instructional design. The ADDIE model consists of five steps: analyze, design, develop, implement, and evaluate. Each step of the process for making the course will be covered in detail.

Step 1: Analyze

Due to the nature of the course (an asynchronous, online learning experience that people can sign up for if they are interested), it was not possible to directly analyze the learners, as it might be in other instructional design settings. However, it was possible to glean information about the attitudes and demographics of potential students by using previously performed perception surveys.

Public Perception of Wildfire Risk Mitigation

Although information on how to design and implement fire-protective landscaping is readily available, many homeowners in the WUI choose not to implement fire-protective landscaping (Olsen et al., 2017). This can be for a variety of reasons. The threat of wildfire may seem distant, and homeowners may have other values that they decide are more important to them than protecting from wildfire (Olsen et al., 2017). However, while wildfire threat may not seem pressing, a study in Washington State found that most homeowners in the WUI are aware of the risk of wildfire, and that people knowingly put themselves and their property at risk (Brenkert-Smith et al., 2020). There are many personal values that influence whether homeowners choose to mitigate wildfire risk:

- It is expensive to implement fire-protective landscaping, usually costing thousands of dollars to re-landscape a residential yard.
- Some homeowners value the freedom to do what they want with their site, including preserving the natural vegetation and aesthetic, more than they value lowering their risk of wildfire (Chakreeyarat, 2015).
- Homeowners that place more value on protecting themselves from nature and following guidelines will be more likely to implement fire-protective landscaping (Chakreeyarat, 2015).
- More environmentally conscious homeowners may implement fire-protective landscaping to help mitigate the environmental impacts of wildfire (Chakreeyarat, 2015).

Therefore, when advising homeowners about how to implement fire-protective landscaping, it is important to recognize the variety of different values they may hold.

Public Perception of Low-water Landscaping

Although information on how to design and implement low-water landscaping is readily available, many homeowners choose not to implement low-water landscaping. This may be for a variety of reasons:

- The problem of dwindling water supplies may seem far from home when water prices remain low.
- Lawns are traditionally the favored landscape aesthetic of Americans (Mustafa et al., 2010), although many people, especially in very arid climates, are beginning to prefer lower water options (Larson et al., 2017; Tábara Cenador, 2019). Homeowners value turfgrass for aesthetics, recreation, ease of maintenance, and increased property value

(Monteiro, 2017). Many people are willing to accept some lawn being replaced by other plants, but not all of it (Hayden et al., 2015).

- Homeowners are often concerned that implementing low-water landscaping will cause their property to look strange, ugly, unkept, or out of place (Mustafa et al., 2010).
- Homeowners may not know how to install or use irrigation other than traditional spray irrigation, like drip irrigation.
- The higher initial cost of installation may convince many homeowners not to switch to low-water landscaping.

Considering these other values, especially aesthetics, is clearly important when convincing the public to implement low-water landscaping.

The Performance Gap

A performance gap is the difference between actual and desired behavior. The desired behavior is for homeowners in the WUI to implement fire-protective and low-water landscaping. Their actual behavior may be varied, but many homeowners in the WUI have not fully implemented fire-protective, low-water landscaping. This performance gap contributes to considerably heightened risk of wildfire, as detailed in previous sections, and to using far more water than is necessary.

A performance gap may be due to several different causes. It may be caused by:

- Insufficient motivation
- Lacking skills or knowledge
- Previous habitats
- The learner's environment

- Communication errors

Based on the analysis of possible learners, it is likely that their performance gap is due to lack of motivation and lack of the specific skills and knowledge needed to implement change. Because learners will have already enrolled in the course, they likely have at least some motivation, and are seeking more skills and knowledge. However, because the surveys used indicated that many people do not implement changes because of motivation-related causes, motivation was still addressed in the course.

Step 2: Design

Instructional Goals

The performance gap leads directly to instructional goals. Instructional goals are statements of what a learner will be able to do by the end of the learning experience. To close the performance gap, the following instructional goals were determined.

By the end of the course, learners should be able to…

1. Estimate the water use (low, medium, or high) of a residential landscape
2. Estimate the wildfire risk (low, medium, or high) of a residential landscape
3. Develop a plan to improve a residential landscape to make it more fire-protective and use less water
4. Implement their landscape plan, either alone or with a contractor, to actually reduce water use and wildfire risk in a landscape

Task Inventory

The next step of the design process is to develop a task inventory, which is a complete list of tasks that learners need to complete in order to achieve the instructional goals.

1. Evaluate the approximate water use (low, medium, or high) of a residential landscape
    - **a.** Identify high-, medium-, and low-water plants
    - **b.** Evaluate whether the area of turfgrass is larger than needed
    - **c.** Locate the irrigation
    - **d.** Identify different kinds of irrigation systems
    - **e.** Identify whether a planting area is using mulch
2. Evaluate the approximate wildfire risk (low, medium, or high) of a residential landscape
    - **a.** Identify highly flammable plants
    - **b.** Identify problematic fire conditions
        - **i.** Continuous vegetation
        - **ii.** Flammable building materials
        - **iii.** Excessive debris
        - **iv.** High-risk placement of structures on topography
3. Make a plan to improve a residential landscape to make it more fire-protective and use less water
    - **a.** Download and print a base map from Google Maps or other mapping program
        - **i.** Open Google Maps or other mapping program
        - **ii.** Locate the property
        - **iii.** Take a snip/screenshot of the property
        - **iv.** Print the snipped image

   b. Understand which areas on the map represent which areas on the property

   c. Identify problematic areas on the property (areas that present fire risk or require high amounts of water)

   d. Propose changes to problematic areas to replace the current condition with a condition that resolves the problem

   e. In areas where above-stated values conflict, determine which is most important and propose changes that support the value that is most important to the learner

4. Implement the landscape plan, either alone or with a contractor, to actually reduce water use and wildfire risk in a landscape

   a. Install the landscape changes from the plan (this includes many tasks that are outside the scope of the course)

   OR

   b. Find a reputable contractor

   c. Convey intentions to the contractor

Decision to Deliver the Content as an Interactive Online Course

Once the learners were analyzed and the task inventory was made, several options were considered for how to help the learners successfully complete the tasks in the task inventory. Options considered included a PDF fact sheet, a website, a series of videos shared on YouTube, and/or an interactive e-learning experience. An interactive e-learning experience was chosen because it would allow the learners to engage with the content in several different formats and increase their understanding and retention of the materials. An interactive online course would also allow the learners to practice skills as they learned them so they could be more confident

applying what they learned after taking the course. Also, USU Extension has had success recently with other landscaping related Extension courses in this format.

Decision to Use Canvas

Before creating the course outline, it was necessary to select a platform to host the course. USU and USU Extension use the Canvas learning management system for many purposes, so there were already experts available to assist in using Canvas for this course. Also, USU Extension has successfully used Canvas for other online learning courses. Since using Canvas has been very successful for other USU projects and no major problems were foreseen in using it, it was decided to format and host the course on Canvas.

Making the Course Outline

The course outline was structured using the three main approaches to human learning, which are behaviorism, cognitivism, and constructivism. Protection motivation theory and the theory of planned behavior, two relevant theories about why people decide to change behavior, were used.

Behaviorism

The principles of behaviorism were implemented in the form of quizzes that provide immediate positive reinforcement for paying attention and remembering the content. This works by allowing the learner to continue progressing in the course if they pass the quiz or making them take the quiz again to progress if they do not pass the first time. The principles of behaviorism were also implemented by videos and other content that emphasized the potential dire consequences of not following the best practices taught in the course (e.g., your house could burn down). This provides strong negative reinforcement for remembering and implementing the things learned in the course.

Cognitivism

The principles of cognitivism were implemented by providing the information in a structured format that helps the learner understand how different pieces of information relate to each other. Reiterating the content in different formats and then having the learner practice repeating and applying the content helps move it from short-term to long-term memory.

Constructivism

The principles of constructivism were implemented towards the end of the course, when the learner interacts with the content and applies the things they learned to their own property. Activities, such as making a list of which changes they will make and drawing the changes on a map of their own property encourage learners to think about what is most important to them and to have experiences applying these concepts in the real world. Also, links to websites where learners can seek out more knowledge that interests them help the learner to further understand the topic based on their own experiences and exploration.

Protection Motivation Theory

Protection motivation theory is closely related to behaviorist thought and informed the formation of the course. Protection motivation theory focuses on negative reinforcement based on fear of danger. The course emphasized that the danger of wildfire and drought is real (appraised severity and expectancy of exposure), but that there are things that can be done about it (belief in efficacy of coping response). This should lead to protection motivation and intention to adopt the recommended response.

Theory of Planned Behavior

The theory of planned behavior was also used in deciding the course layout and content. Like protection motivation theory, the theory of planned behavior posits that attitudes (Do I think

this a good idea?) and perceived behavioral control (Can I do it? Do I know how?) influence the intention to act, but the theory also recognizes subjective norms as a significant factor. This was addressed in the course by emphasizing that many other people are implementing these changes, using lines like “many people are now realizing”.

Intention-Behavior Gap

As discussed in the literature review, in many cases intentions do not lead to actual behavior, and the most effective way to overcome this issue is through specific implementation actions. The course includes assignments that require the learner to perform implementation actions – most notably, to make a plan for landscape improvements to their own property. They are instructed to select which improvements are most important to make their landscape more fire-protective, low-water-consumptive, and comfortable, and then to sketch out where those improvements will be made on their property

Step 3: Development

Selection of Case Study Sites

Two communities were selected that are very vulnerable to wildfire, due to their configuration, topography, and adjacency to thickly vegetated wildland. The communities were the foothill neighborhood by Eaglewood Golf Course in North Salt Lake, and the Suncrest neighborhood in Draper.

Figure 10: Salt Lake Valley showing the context of site selection neighborhoods

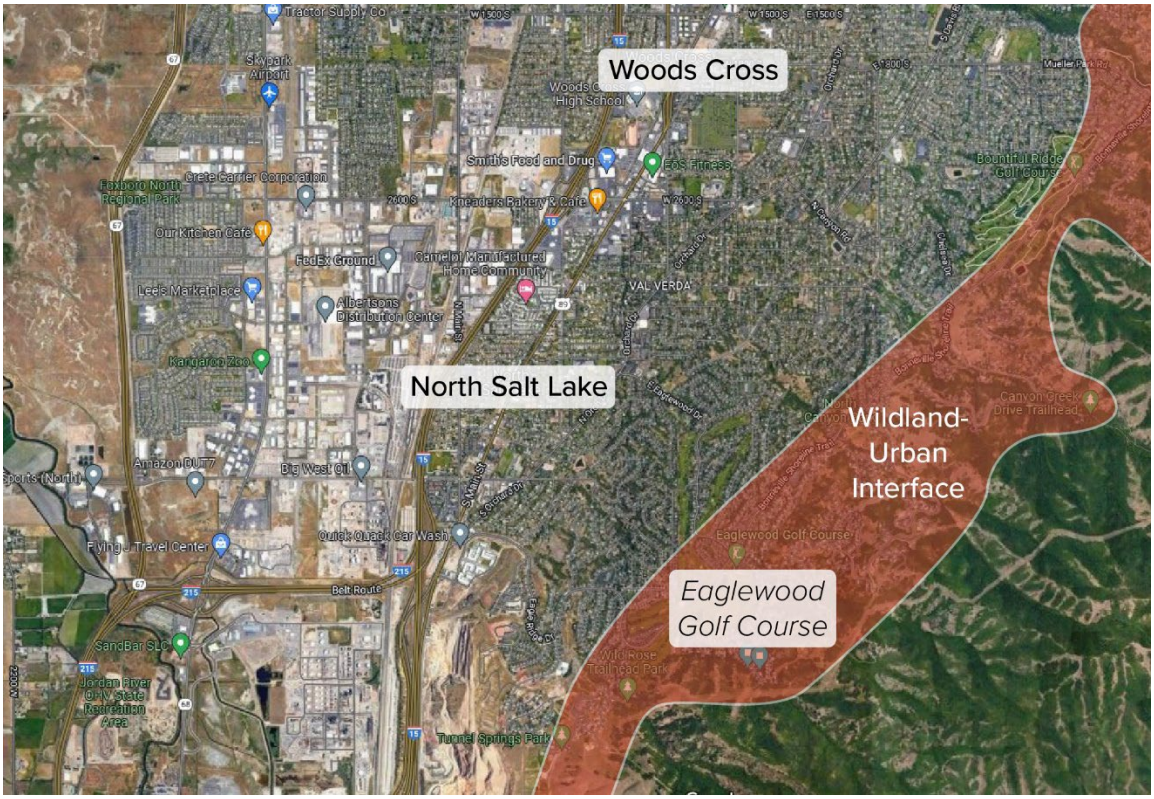


Figure 11: North Salt Lake showing WUI where sites were selected from

Figure 12: Suncrest showing WUI where sites were selected from

In both communities, I selected streets that would be at the highest risk of damage from wildfire, due to their immediate adjacency to wildland. I then approached homeowners on these streets and asked if they would be willing include their property as part of an educational course about fire-protective landscaping. While some people were immediately uninterested or dismissive, I was able to locate two willing property owners in each community, for a total of four case study sites.

Recording the Case Study Sites

Several cameras and pieces of filming equipment were used to record the case study sites. These included:

- A Canon EOS M50 camera with a 15mm-45mm lens, which was used to take still images and video.
- A DJI Mavic 2 Pro quadcopter, which was used for taking still images and video.

- An Insta360 One X camera, which was used to take 360-degree video, which was later processed using the Insta360 app into standard flat video.
- A Zhiyun Crane M2 handheld stabilizer, which was used to stabilize the Canon EOS M50 while taking some of the videos.

Each site was visited at a time arranged with the owner, and all parts of the property were recorded as thoroughly as possible using the above-listed equipment.

Selection of People to Interview

Since the course outline called for several videos of interviews with experts, it was necessary to decide who these experts would be. An initial list was compiled based on recommendations from the thesis advisory committee. Several of the people that were originally suggested were unresponsive or could not be contacted. The participants that ended up in the final course were chosen because of their expertise in the relevant topic area, their responsiveness to messages, and their willingness to be interviewed for the course. In the end, three video interviews were conducted. The interviewees were Paul Harris, a research technician in the Department of Plants, Soils and Climate at USU who specializes in irrigation; Cynthia Bee, an outreach coordinator at the Jordan River Water Conservancy District who heads the Localscapes program; and Darren McAvoy, Extension Assistant Professor of Forestry at USU.

Filming the Interviews

Each interviewee was sent questions for the interview several days in advance so they could prepare their answers. The interviews were conducted at locations that were most convenient for the interviewee and would provide good lighting and background for the video. Paul Harris was interviewed at the USU Merrill-Cazier Library in Logan, Cynthia Bee was interviewed at the Localscapes Education Center in West Jordan, and Darren McAvoy was

interviewed in his office on the USU Logan Campus. The interviews were filmed so that only the interviewee was visible, so that the focus would be on the interviewee. Each interviewee was asked to provide their responses in a way that included the question, so that the response could be used without stating the question in the course videos. The interviewees were given the chance to do as many takes as they wanted of each response until they were satisfied with the result. The videos were filmed using:

- A Canon EOS M50 camera with a 15mm-45mm lens, which was used to shoot the video.
- A tripod, which was used to hold the camera stable during the interview.
- A PowerDeWise lapel microphone with an extension cable and a TRRS to TRS converter, which was used for recording audio.

Filming Videos of Myself

Much of the instruction was delivered through videos of me explaining the content. The videos were shot using the same camera and microphone setup as the interviews. They were shot at several locations on the USU Logan campus, which were chosen because they had good backgrounds and lighting, as well as minimal noise disturbance.

Editing and Producing the Content

Diagrams to be used in the course were drawn using Adobe Illustrator, with the framework for some diagrams produced in Trimble Sketchup. Some diagrams were also edited in Adobe Photoshop. The diagrams were designed to be simple, clear, and high contrast, so that they would be easy to understand for anyone taking the course. Course documents, like the WUI scorecard, were produced in Adobe InDesign and Adobe Acrobat Pro.

The videos were edited in Adobe Premiere Pro. The videos combined the diagrams, video interviews, videos and voiceovers of myself, videos of the example sites, stock video footage, stock images, and stock music. All stock content came from legitimate free content websites like unsplash.com and pixabay.com, and was used legally.

The Plant List

The plant list for the course was created based on the existing list of "firewise" plants from USU Extension. Each plant was checked using the Missouri Botanical Garden Plant Finder and other nursery or plant society websites, and those with high water needs were removed. Those with dry or medium water needs remained, and their water needs were noted on the list. Most of the trees on the original list had high water needs, which resulted in the list having only three tree species. With assistance from Dr. Larry Rupp, USU Professor Emeritus in Ornamental Horticulture, more trees were added to the list that have low water needs and fit the characteristics of fire-protective plants. Because learners using the plant list may not be able to find the exact plants at their local nursery, characteristics of fire-protective plants are explained at the top of the list.

Step 4: Implementation

Once a draft version of the course was completed in Canvas, it was sent for review to professionals in wildfire and low-water landscaping. The feedback received was incorporated into the final version of the course. A complete list of feedback received and how it was implemented can be found in Appendix 3: Critiques and Responses.

Now that the course is completed, USU Extension will manage it indefinitely. The course will be available for anyone to take on the USU Extension website.

Step 5: Evaluation

Although evaluation will be performed after the completion of this thesis, the course will gather data that can be used in future evaluations of the course. The evaluation tools in the course are focused on two categories: 1. Who is the course reaching? and 2. How well is the course accomplishing its goals?

The first question, whom the course is reaching, is addressed with a demographic survey at the beginning of the course. The survey asks the learners about their gender, race/ethnicity, ZIP code, property value, and property use.

The course addresses the second question, how well the course accomplishes its goals, using Kirkpatrick's four levels of evaluation. These are assessed in the post survey. The survey asks questions to determine whether the students liked taking the course (Level 1: reaction), if their knowledge improved about fire-protective and low-water landscaping (Level 2: knowledge), and what kinds of changes they intend to make to their landscape after taking the course (Level 3: behavior). It is difficult to assess results (Level 4: results) because it is not possible to observe the learners after they are finished taking the course.

In addition to the post survey, students submit work during the course as they complete activities. These files will be kept and could be evaluated to determine how people interacted with the course, perhaps showing which modules learners expended more effort on than others and giving insight into learner preferences in landscaping.

CHAPTER 3: RESULTS

The finished course will be published on the USU Extension online courses page, which can be found at https://extensioncourses.usu.edu/

The course is titled “Landscaping in the Utah Wildland-Urban Interface”. Publishing the course online will make it available to the public. Anyone will be able to take the course for a small fee that will support the maintenance of the course and the Extension website.

Course Overview

The structure of the final course is shown in *Figure 8: Course wireframe* on the following page. The course follows the structure determined using the ADDIE model, as described in the Methods section. A combination of instructional videos, text, informational graphics, activity worksheets, and quizzes are used to convey the content and guide the learner through the course. The course includes some pages that contain non-interactive instruction such as videos, images, and text, such as “Understanding Wildfire.” Other pages contain quizzes or other interactive content, such as “Wildfire Quiz” and “Site Inventory Practice”. Images and other content from the course are included in Appendix 1: Course Content. Videos from the course can be accessed through links included in that appendix.

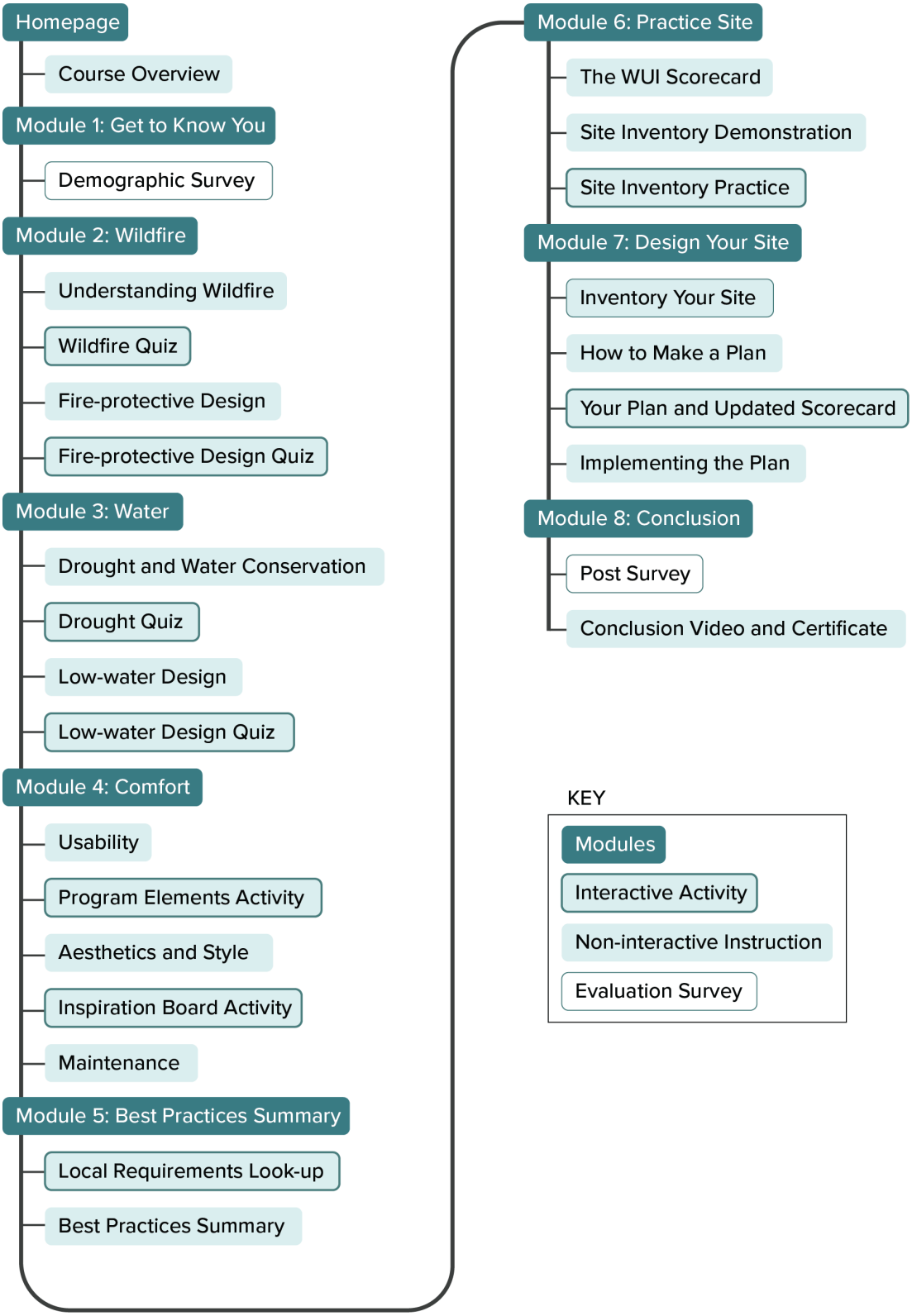


Figure 13: Course Wireframe

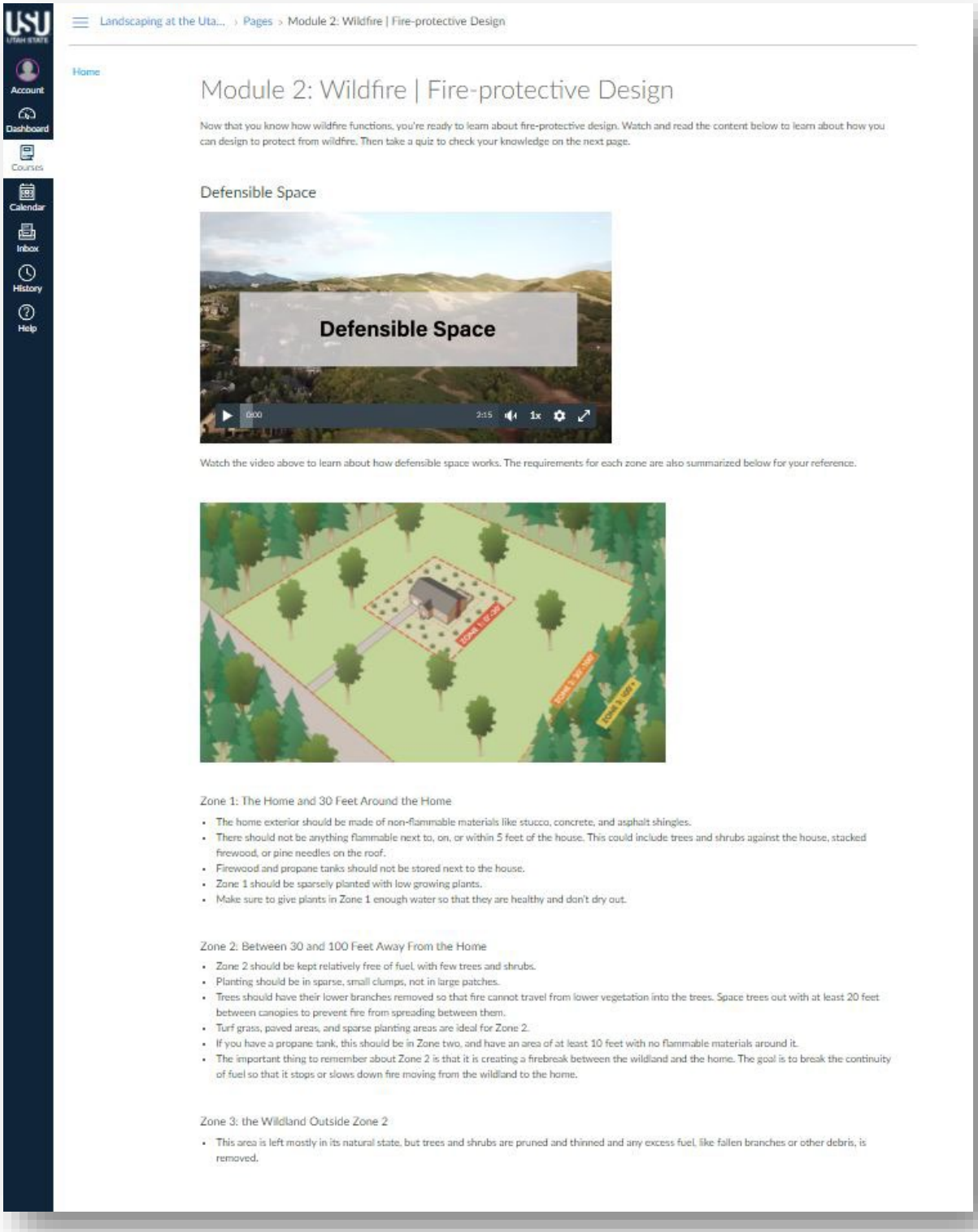


Figure 14: A sample of how the course is presented in Canvas

CHAPTER 4: DISCUSSION AND RECOMMENDATIONS

Limitations of the Project

While the project was successful in producing a complete, useful course to educate the public, there were some limitations. One of the biggest limiting factors was the lack of certain technical skills and the lack of any budget to hire professional assistance. Before starting this project, I had very little experience in shooting video, video editing, or Canvas course design. As a result, much of the video that was shot was too low quality to use in the course. Also, since I had little experience making Canvas courses and no budget to hire a professional instructional designer, the Canvas course is not particularly customized to the content, and mostly follows the basic Canvas template.

Another limitation of this project was that the learners could not be evaluated directly before making the course, so it was necessary to rely on surveys of homeowners living at the WUI for the analysis step of the ADDIE model. Those surveys may not accurately represent the people that will take the course, and that could have misguided the way that the content was presented.

The post survey may not accurately measure behavior change, because by asking what changes people are planning on make to their landscapes, we are only gathering data about intentions, which may or may not lead to actual behavior.

Since there has been very little research about landscapes that are fire-protective and low-water in Utah, there were few examples of landscapes that are successful in both categories to use as precedents. Although it was relatively simple to specify the criteria for such a landscape,

having few actual examples may have resulted in overlooking unforeseen difficulties that may arise when combing those two sets of best practices.

It was assumed, based on conversations with professionals, that many people find or would find current best practices for low-water and fire-protective landscaping contradictory. However, this assumption was not backed by surveys of the public and could be somewhat inaccurate.

Even with these limitations, this project produced a course that shows promise of successfully educating people about better landscaping practices in the Utah WUI and leading to important changes in landscaping practices.

Overlap with and Differences from the Firewise USA Program

The Firewise USA program by the National Fire Protection Association has similar objectives to this course, and an argument could be made that the existence of the Firewise USA program negates the need for this course. Firewise USA provides public education about wildfire and a certification process for communities and sites. Firewise USA is more focused on communities than this course. The main difference is that this course also focuses on low-water landscaping, which is a critical need in Utah and may interfere with fire-protective landscaping if not done properly. This course also provides an option for those who are not interested in pursuing a certification process but simply want to learn more about the subject.

Recommendations for Future Research

USU Extension Evaluation of Course

First, I would recommend that USU Extension, or a researcher working therewith, examine the data gathered from this project (via student submissions) after the course has been

implemented for several years. This would finish the ADDIE model by completing the evaluation stage. Evaluation is an important step in the ADDIE model because it informs the development of future courses and offers an opportunity to correct mistakes made in the current version of a course. Since the course collects data as learners use it, it would be possible to assess both the effectiveness of the course, and in which areas it and similar courses should be improved in the future. The data may also inform other public education efforts in the WUI.

Effectiveness of Fire-protective and Low-water Landscapes

Since there are no studies on the effectiveness of fire-protective and low-water landscapes, it would be useful to conduct a study in an area that has experienced a wildfire to see how low-water landscapes interact with wildfire. More frequent droughts and wildfires will necessitate more common use of this kind of landscaping, so it will be important going forward to understand how low-water landscaping specifically performs in fire conditions.

Perception Survey About Fire-protective and Low-water Landscapes

It would also be useful to conduct a survey about people's perceptions of the interactions between low-water and fire-protective landscaping best practices. As stated in the limitations section, little is currently known about this topic. Since it will be increasingly important for homes in the Utah WUI to implement these kinds of landscapes, a better understanding of how people perceive them will aid in efforts to persuade people to make changes. The survey could ask if respondents think that the two are mutually exclusive or would interfere with each other. It could also ask if respondents would consider implementing such a landscape on their own property and examine the motivation behind their answer.

Incorporating Other Learning Theories

The course was designed using standard, established instructional design theory and methods. While these methods have proven to be effective, there are other learning theories and guidelines that could be incorporated into the course to improve understanding and retention of the information. Universal Design for Learning (UDL) is a set of guidelines that recognizes how different learners prefer to engage with content in different ways. UDL encourage the use of multiple means of engagement, representation, and expression (*UDL: The UDL Guidelines*, 2018). Including more ways for learners to interact with the content could help the course reach a larger audience and improve retention.

Another idea that could be helpful in improving the course is *cognitive load*. A person can only manage so much cognitive load at a time, or in other words, can only process a certain amount of information at one time (Sweller, 1988). This means that it is important to reduce *extraneous cognitive load* (aspects of the course that require effort and attention, but do not contribute to learning), and increase *germane cognitive load* (aspects of the course that contribute to learning) (Dirksen, 2016; Sweller, 1988). This could mean streamlining some aspects of the course while introducing more "friction" and complexity in others (Dirksen, 2016).

The Course as a Prerequisite

Several Extension professionals have expressed concern that in many of the workshops they conduct, some members of the audience are so unfamiliar with the topic that the whole workshop is spent explaining basic content. This leaves little time for answering questions and providing feedback to participants. Requiring completion of this course as a prerequisite for

Extension workshops about wildfire could help with this problem by ensuring a base level of familiarity with the material.

It might also be helpful to make completion of the course a prerequisite for obtaining building permits for property in the WUI. Although this would not guarantee that people would adopt the behaviors taught in the course, it would, at the least, ensure that new homeowners in the WUI are aware of the risk of wildfire and know what to do to protect themselves. If it is found to be impossible or impractical to require completion of the course before issuing a building permit, flyers could be distributed to new and potential homeowners informing them about the course.

Making Governments Aware

Many municipal governments appear be unaware of the need for low-water or fire-protective landscaping. If more government personnel were made aware of the content of the course, it could lead to laws requiring or incentivizing these kinds of landscapes. It would be advantageous for USU Extension to focus not only on making this content available to the public, but also to city, county, and state government officials.

Observations

When starting this project, it was anticipated that it would be a very difficult challenge to design landscapes that would be both fire-protective and low-water, because the two seem so different. However, after researching more extensively, it became apparent that there were only a few conflicts between the two sets of best practices. For example, fire-protective landscaping often calls for large, water-intensive lawns, but those can be easily substituted with sparse, low-water planting areas. Low-water landscaping in Utah often features dense, dry vegetation, but

that is not necessary. In fact, the sparser vegetation recommended by fire-protective practices reduces water use even further. Overall, while there are some important pitfalls to avoid, implementing landscaping that is both fire-protective and low-water should not be exceptionally difficult or complex. The best practices are simple – the biggest challenge seems to be the matter of conveying them to public effectively and thereby convincing people of their importance. This project should be a starting point, eventually leading to widespread implementation of fire-protective, low-water landscaping in the WUI. I hope that researchers, government officials, landscape designers, developers, homeowners, and others will continue to study this topic and make changes so that we can enjoy the places we love while being prepared for nearly inevitable droughts and wildfires in the future.

APPENDIX 1: COURSE CONTENT

This appendix includes all the diagrams, quizzes, and worksheets contained in the course, along with the course plant list. The videos contained in the course can be accessed using the links in this appendix.

Video Links

Welcome (1. Welcome.mp4 - 58.1 MB)

Location in course: *Homepage* | *Course Overview*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=0&article=2655&context=gradreports&type=additional

What are Wildfires (2. What are Wildfires.mp4 - 81.3 MB)

Location in course: *Module 2: Wildfire* | *Understanding Wildfire*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=1&article=2655&context=gradreports&type=additional

The Fire Triangle (3. The Fire Triangle.mp4 - 142.8 MB)

Location in course: *Module 2: Wildfire* | *Understanding Wildfire*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=2&article=2655&context=gradreports&type=additional

Wildfire Travel (4. Wildfire Travel.mp4 - 47.5 MB)

Location in course: *Module 2: Wildfire* | *Understanding Wildfire*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=3&article=2655&context=gradreports&type=additional

Defensible Space (5. Defensible Space.mp4 - 70.0 MB)

Location in course: *Module 2: Wildfire* | *Fire-protective Design*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=4&article=2655&context=gradreports&type=additional

Darren McAvoy Interview (6. Darren McAvoy Interview.mp4 - 72.5 MB)

Location in course: *Module 2 | Wildfire | Fire-protective Design*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=5&article=2655&context=gradreports&type=additional

Drought and Water Conservation (7. Drought and Water Conservation.mp4 - 74.8 MB)

Location in course: *Module 3 | Water | Drought and Water Conservation*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=6&article=2655&context=gradreports&type=additional

Cynthia Bee Interview (8. Cynthia Bee Interview.mp4 - 164.8 MB)

Location in course: *Module 3: Water | Low-water Landscaping*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=7&article=2655&context=gradreports&type=additional

Paul Harris Interview (9. Paul Harris Interview.mp4 - 328.0 MB)

Location in course: *Module 3: Water | Low-water Landscaping*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=8&article=2655&context=gradreports&type=additional

Usability (10. Usability.mp4 - 65.3 MB)

Location in course: *Module 4: Comfort | Usability*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=9&article=2655&context=gradreports&type=additional

Aesthetics (11. Aesthetics.mp4 - 26.1 MB)

Location in course: *Module 4: Comfort | Aesthetics and Style*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=10&article=2655&context=gradreports&type=additional

Maintenance (12. Maintenance.mp4 - 21.5 MB)

Location in course: *Module 4: Comfort | Maintenance*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=11&article=2655&context=gradreports&type=additional

Best Practices Summary (13. Best Practices Summary.mp4 - 24.4 MB)

Location in course: *Module 5: Best Practices Summary | Best Practices Summary*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=12&article=2655&context=gradreports&type=additional

Example Walk-Through (14. Example Walk-through.mp4 - 223.7 MB)

Location in course: *Module 6: Practice Site | Site Inventory Demonstration*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=13&article=2655&context=gradreports&type=additional

Making a Plan (15. Making a Plan.mp4 - 86.5 MB)

Location in course: *Module 7: Design Your Site | How to Make a Plan*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=14&article=2655&context=gradreports&type=additional

Conclusion (16. Conclusion.mp4 - 19.2 MB)

Location in course: *Module 8: Conclusion | Conclusion Video and Certificate*

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=15&article=2655&context=gradreports&type=additional

Diagrams

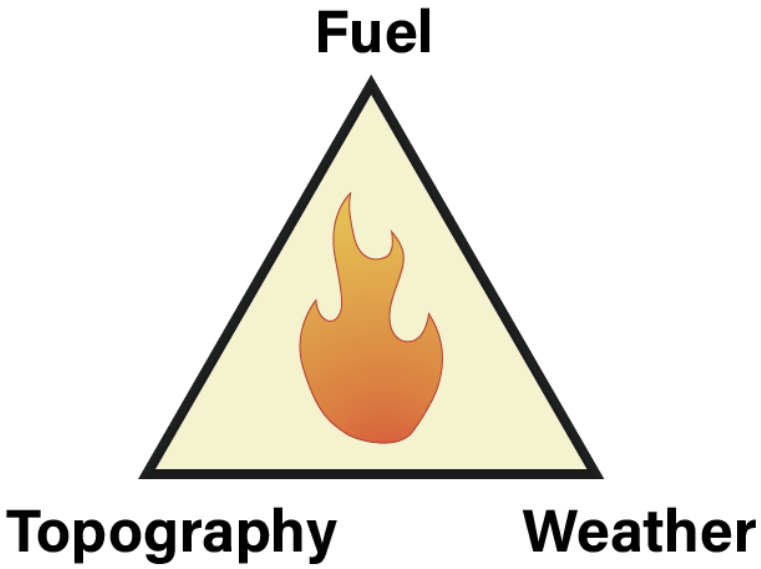


Figure 15: The fire triangle, showing the three main factors that influence wildfire behavior. Location in course: Module 2: Wildfire, Understanding Wildfire

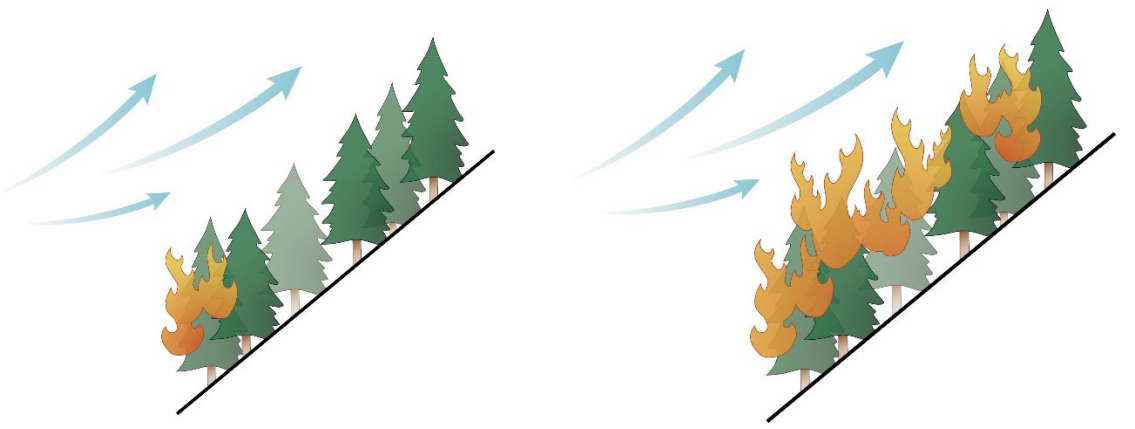


Figure 16: Diagrams illustrating how wildfire often travels uphill. Location in course: Module 2: Wildfire, Understanding Wildfire

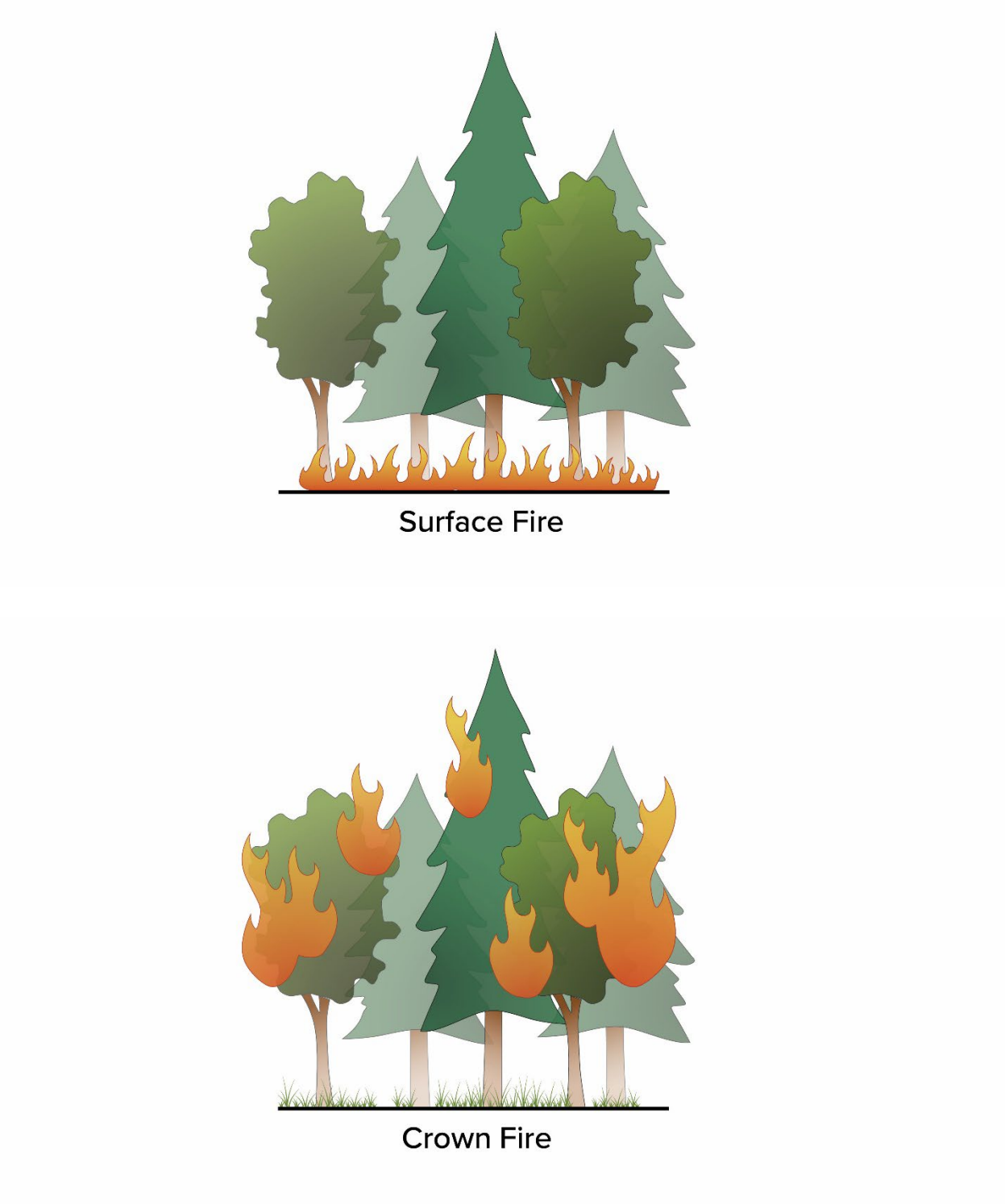


Figure 17: Diagrams illustrating the difference between surface fires and crown fires. Location in course: Module 2: Wildfire, Understanding Wildfire

Figure 18: Diagrams illustrating fire spreading through continuous vegetation. Location in course: Module 2: Wildfire, Understanding Wildfire

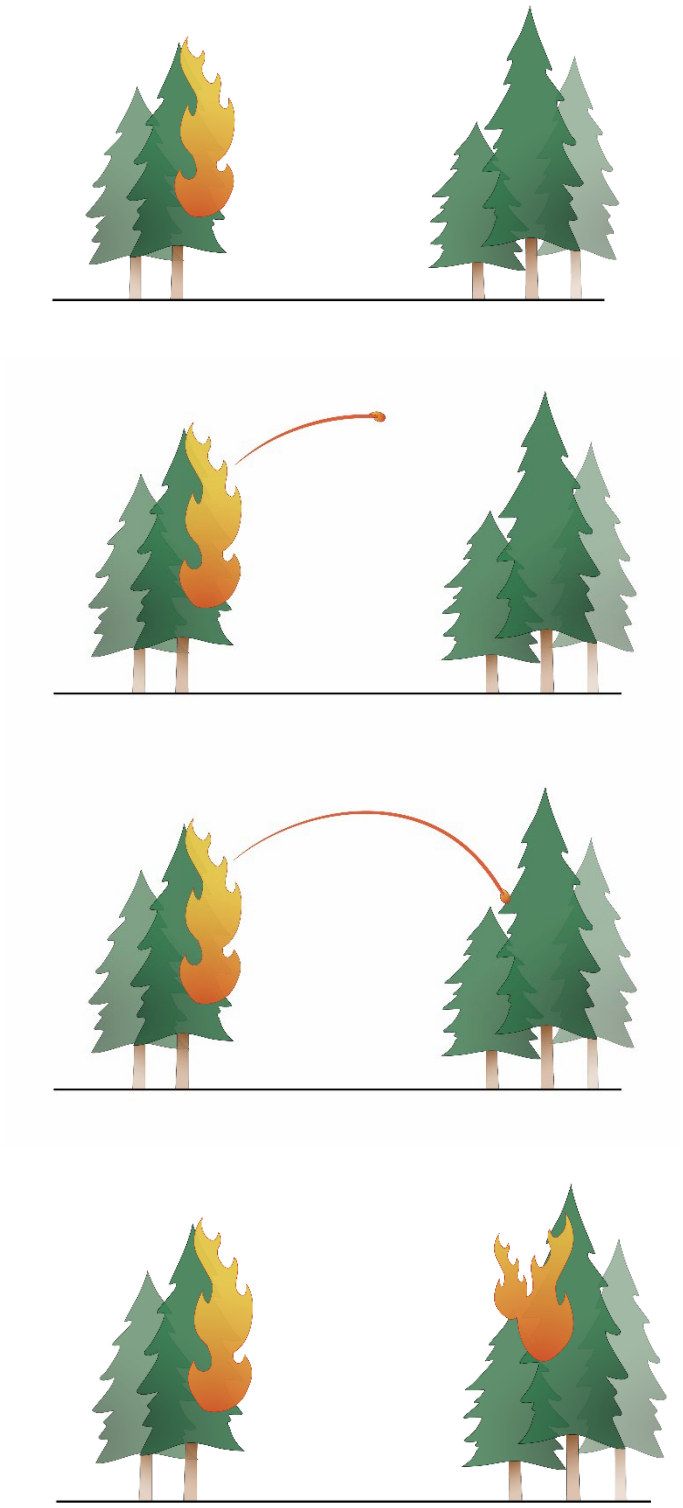


Figure 19: Diagrams illustrating fire spreading by lofted ember. Location in course: Module 2: Wildfire, Understanding Wildfire

Figure 20: Diagrams illustrating how ladder fuels allow fire to spread from surface vegetation into the crowns of trees. Location in course: Module 2: Wildfire, Understanding Wildfire

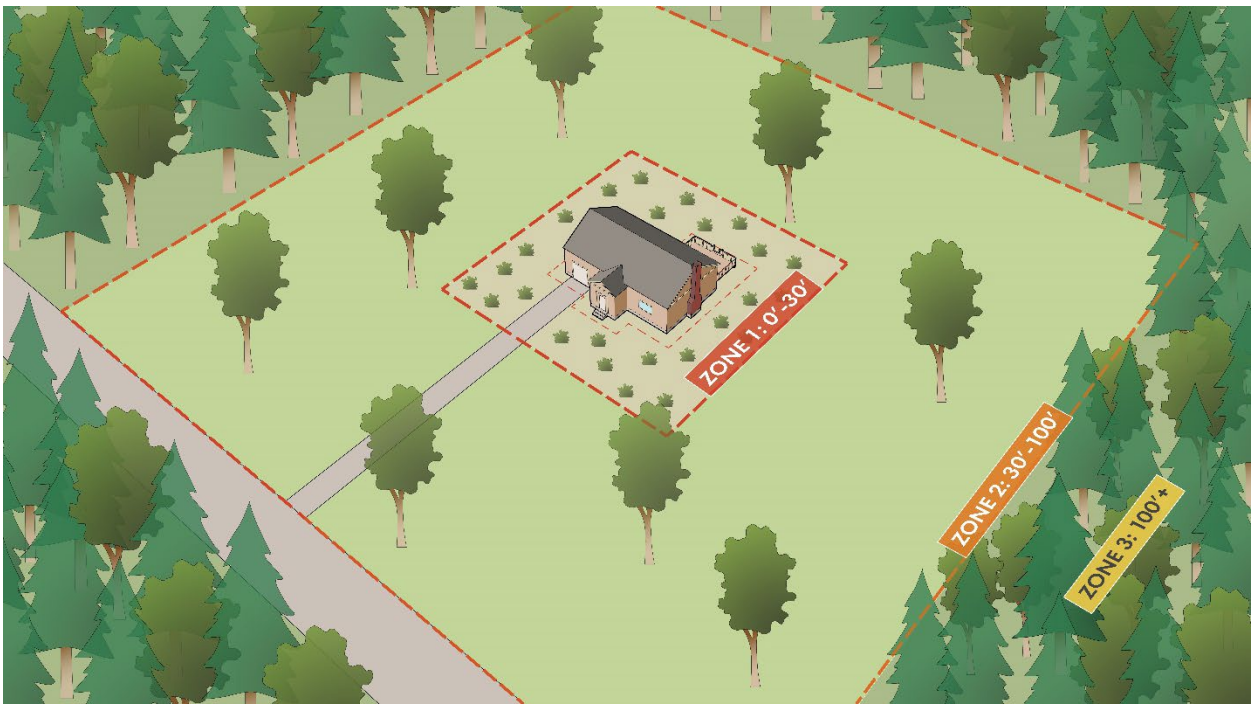


Figure 21: Diagram showing the three zones of defensible space. Location in course: Module 2: Wildfire, Fire-protective Design

Figure 22: Flammable and nonflammable roofing materials. Location in course: Module 2: Wildfire, Fire-protective Design

Figure 23: Flammable and nonflammable deck/patio materials. Location in course: Module 2: Wildfire, Fire-protective Design

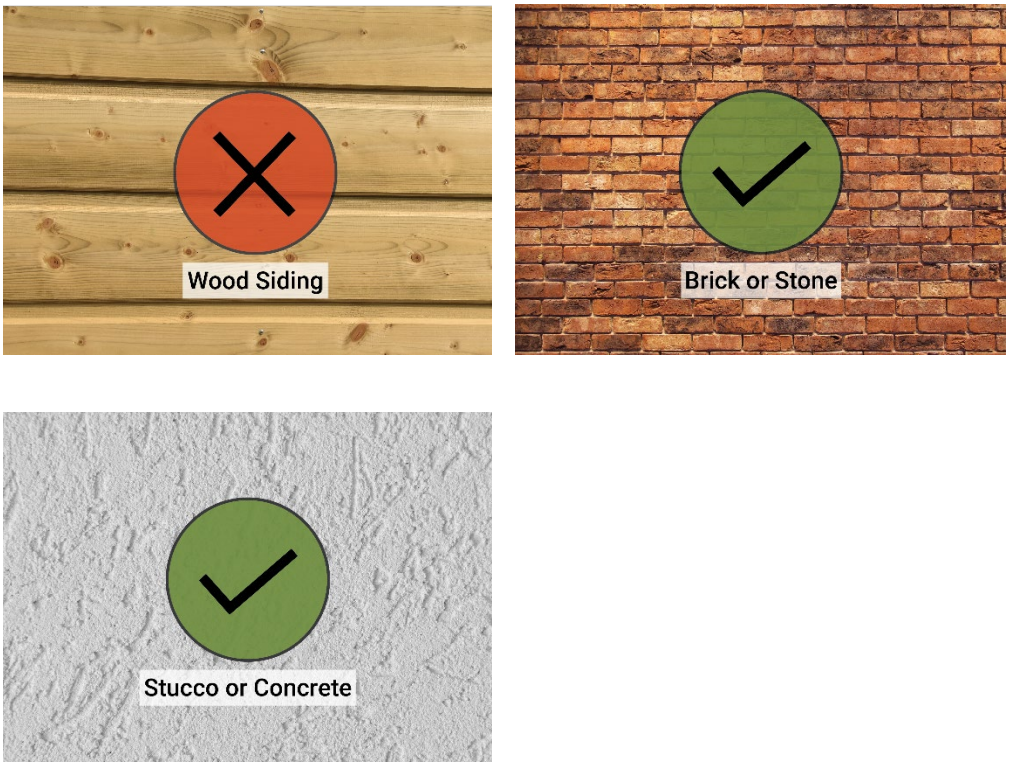


Figure 24: Flammable and nonflammable siding materials. Location in course: Module 2: Wildfire, Fire-protective Design

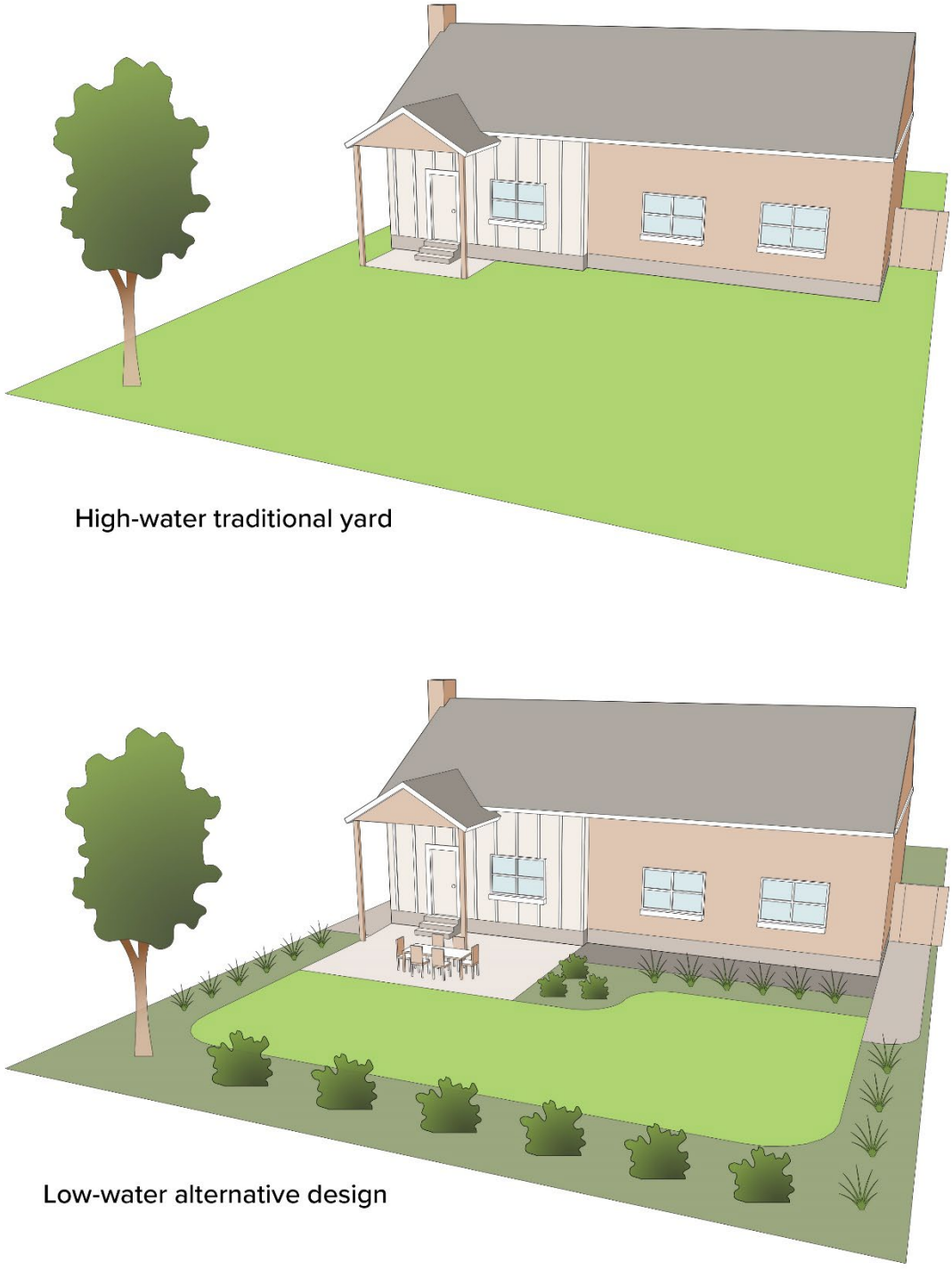


Figure 25: Diagrams illustrating a traditional, high-water landscape and a low-water alternative design. Location in course: Module 3: Water, Low-water Design

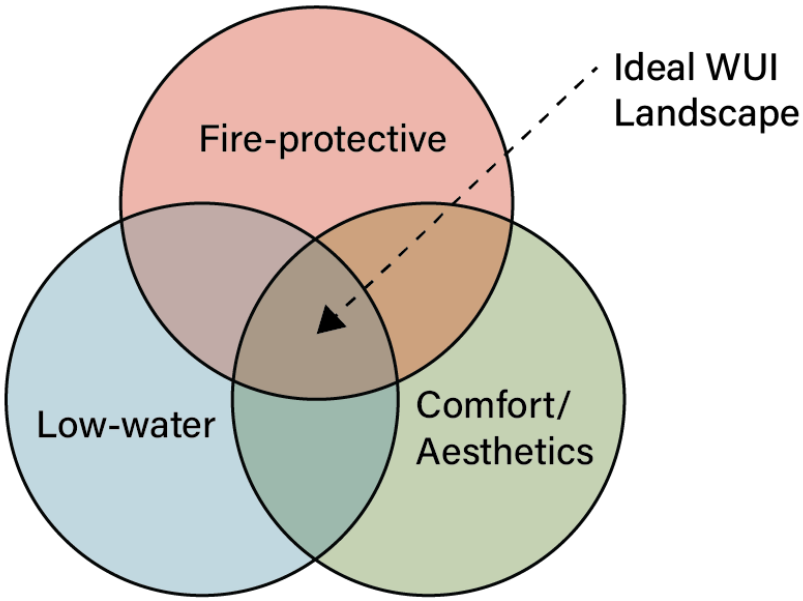


Figure 26: Diagrams illustrating the traits of an ideal WUI landscape. Location in course: Module 5: Best Practices Summary, Summary Video

Figure 27: An example landscape plan. Location in course: Module 7: Design your Site, How to Make a Plan

Quizzes, Surveys, and Quiz-based Interactive Activities

Module 1: Get to Know You, Demographic Survey

Survey description:

Take this quick demographic survey so we can know who we are reaching with this course.

Question 1: What is your gender?

- Male
- Female
- Other
- Prefer not to answer

Question 2: How do you identify yourself?

- African American
- American Indian/Alaskan
- Asian
- Hispanic/Latino
- White
- Native American/Pacific Islander
- Other
- Prefer not to answer

Question 3: What is your zip code (Leave blank if you prefer not to answer)

- *Text entry box*

Question 4: What is the value of your property at the wildland-urban interface (including the house or any other buildings)?

- Less than $50,000
- $50,000 - $100,000
- $100,000 - $250,000
- $250,000 - $500,000
- $500,000 - $1,000,000
- $1,000,000 - $5,000,000
- More than $5,000,000
- Prefer not to answer

Question 5: What is the purpose of your property at the WUI?

- Full-time residence
- Personal vacation home
- Short-term rental
- Long-term rental
- Commercial
- Other
- Prefer not to answer

Module 2: Wildfire, Wildfire Quiz

Quiz description:

Take this quiz to check your knowledge about wildfires. You can take it as many times as you need to get 100% before moving on.

Question 1: Why do we need to be prepared for wildfires more now than ever? (Select all that apply)

- Utah's air pollution contributes to larger wildfires
- Climate change is contributing to more, larger fires (*correct*)
- Fire suppression has contributed to larger wildfires (*correct*)
- Wildfires are more common in Utah in the summer because of how much snow we get in the winter
- Based on current trends, we will probably continue to have large, dangerous wildfires (*correct*)

Question 2: What three things are the main contributors to wildfire behavior (the fire triangle)?

- Weather, Hydrodynamics, and Fuel
- Fuel, Topography, and Weather (*correct*)
- Topography, Fuel, and Season

Question 3: True/False: Wildfire can only travel between two fuel sources that are in contact with each other.

- True
- False (*correct*)

Question 4: Fire generally travels fastest…

- Uphill (*correct*)
- Over flat land

- Downhill

Fire burning in the tops of trees is called a…

- Surface fire
- Crown fire (*correct*)
- Canopy fire

Why are ladder fuels called that?

- They allow firefighters to climb trees to fight wildfires
- They look like a ladder, since their branches stick out at the sides
- They allow fire to move from the surface into the crowns of the trees (*correct*)

Module 2: Wildfire, Fire Protective Design Quiz

Quiz description:

Take this quiz to check your knowledge about fire-protective design. You can take it as many times as you need to get 100% before moving on.

Question 1: Which of these are fire-protective materials for home exteriors? (Select all that apply)

- Stucco (*correct*)
- Concrete (*correct*)
- Logs
- Wood siding
- Concrete board (*correct*)
- Asphalt shingles (*correct*)
- Cedar shake shingles
- Metal roofs (*correct*)

Question 2: True/False: Propane tanks should be stored next to the house.

- True
- False (*correct*)

Question 3: Trees and other fuels in Zone 2 should be...

- Spaced at least 20’ apart (*correct*)
- No farther than 20’ apart
- In large groups

Question 4: The wildland outside Zone 2…

- should be pruned and thinned (*correct*)
- is outside the defensible space, so does not need to be maintained

Question 5: Traits of fire-protective/low-flammability plants include (select all that apply):

- Low flammable compound content (*correct*)
- Smaller varieties (*correct*)
- High water content (*correct*)
- Dry and thick foliage
- Drop a lot of leaves or needles

Question 6: When possible, Zone 2 should be:

- 30-100’ around the home (*correct*)
- 100-500’ around the home
- 20-30’ around the home

Question 7: True/False: It is best to place buildings on the tops of hills

- True
- False (*correct*)

Drought Quiz

Quiz description:

Take this quiz to check your knowledge about drought and water conservation. You can take it as many times as you need to get 100% before moving on.

Question 1: What is a drought?

- A prolonged shortage of water (*correct*)
- Reservoirs running out of water
- No rain for three consecutive months

Question 2: Why, other than drought, may we see more water shortages in the future?

- Growing population with a not growing supply of water (*correct*)
- Groundwater draining through dry soil
- Less effective water treatment facilities

Question 3: Why do "traditional" landscapes (large lawns and imported plants) need so much water in Utah?

- Those kinds of plants are not adapted to live in an arid climate (*correct*)
- Utahans have large families, so they have large yards too
- The canal systems here lose a lot of water

Module 3: Water, Low-water Design Quiz

Quiz description:

Take this quiz to check your knowledge about low-water landscape design. You can take it as many times as you need to get 100% before moving on.

Question 1: Why is using drip irrigation often an ideal way to use less water in planter beds?

- Because the water comes out in spherical drops, it evaporates less quickly
- The small tubing allows less water through than larger traditional pipes
- It only puts exactly how much water is needed, where it's needed (*correct*)

Question 2: Which type of spray head is usually the most water efficient for landscapes?

- Spray Heads
- Rotator Heads (*correct*)
- Rotor Heads

Question 3: Lawn should be...

- Wherever it looks best.
- Only where it will be useful. (*correct*)
- Everywhere.

Question 4: To develop the deepest and most resilient root system, turf grass should be given...

- less frequent, deep waterings. (*correct*)
- frequent, shallow waterings.

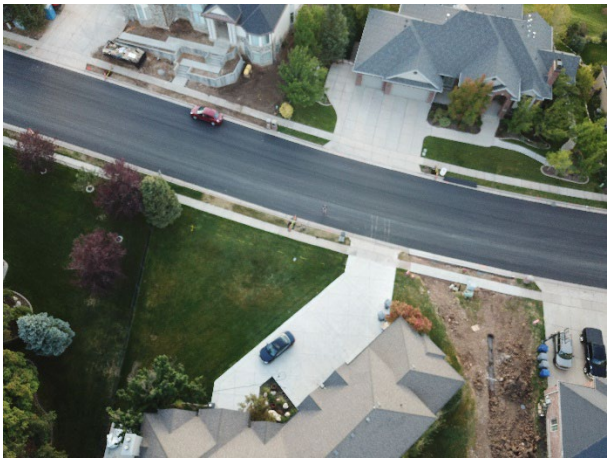
Module 6: Practice Site, Site Inventory Practice

Quiz description:

For this activity, practice "walking" around a yard and looking for the things that you've learned about in the course so far, both for ideal and non-ideal conditions. After entering in your notes about all the pictures, you'll be able to see answer notes about each picture. You will probably

have slightly different notes than those in the answers, but compare them to see if you are missing any important things.

This is the property you will be assessing, seen from above. The trees by the side yard connect to the wildland behind the property.



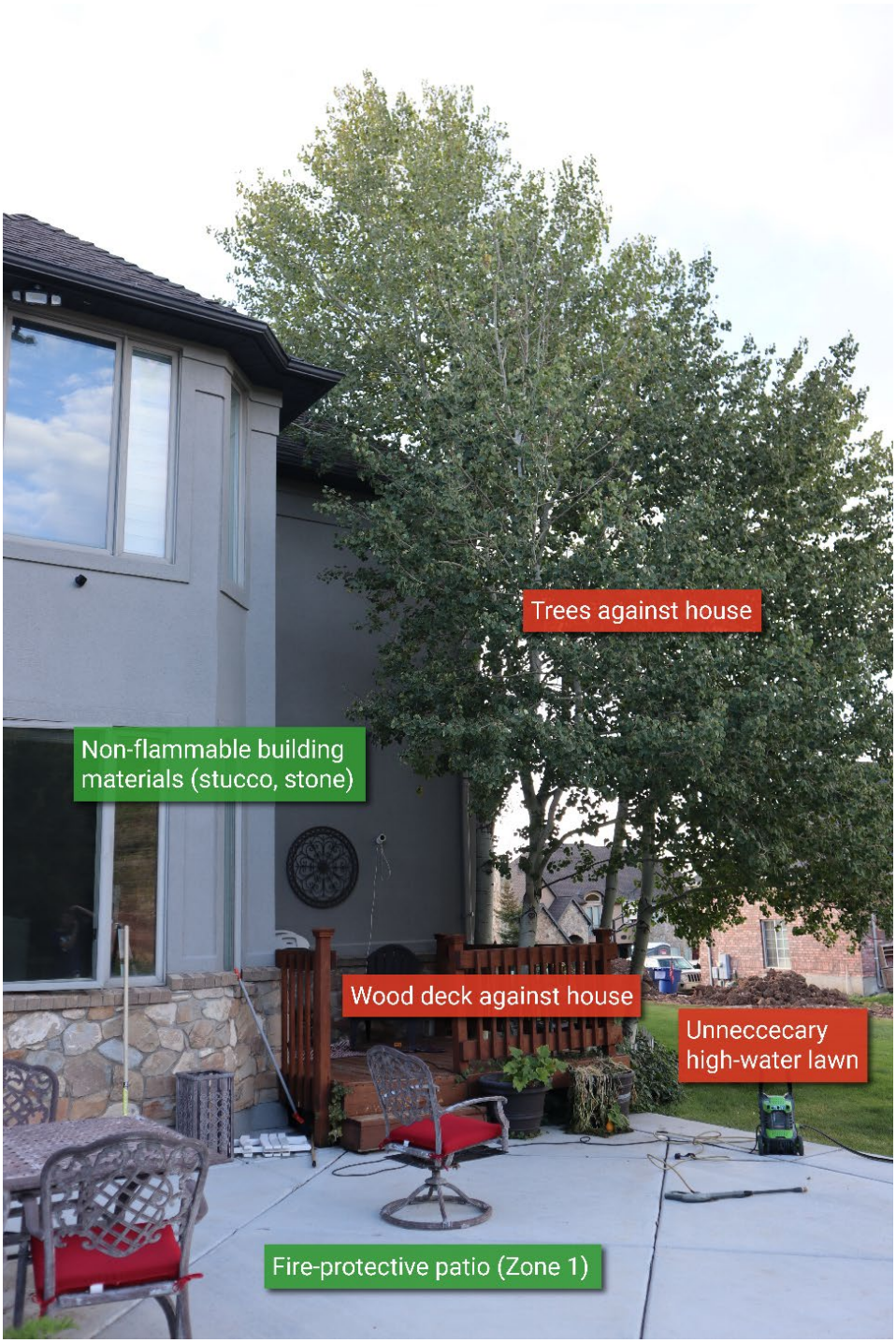
Here is the scorecard as a reminder of what to look for:

[The WUI scorecard is included on the Canvas page].

Question 1: What do you see (ideal or non-ideal) in this image that you would take note of for the scorecard?

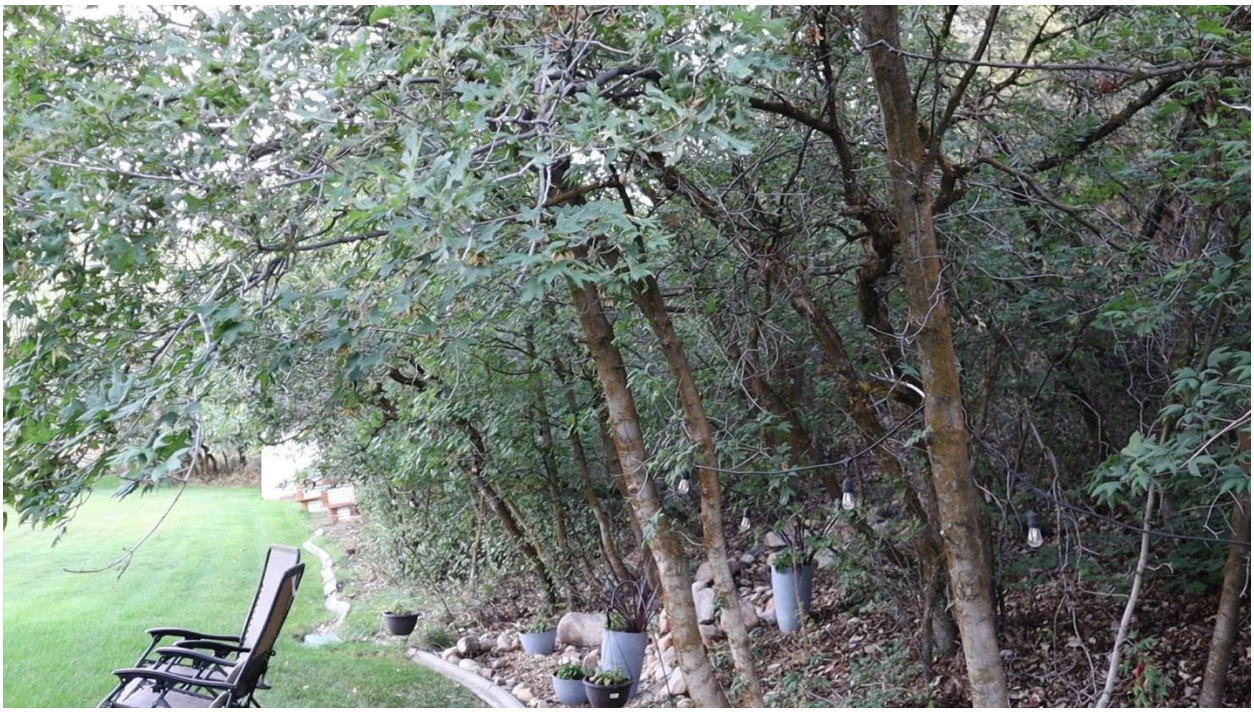
- *Text entry box*

Answer image for Question 1:



Question 2: What do you see (ideal or non-ideal) in this image that you would take note of for the scorecard?

- *Text entry box*



Answer Image for Question 2:

Question 3: What do you see (ideal or non-ideal) in this image that you would take note of for the scorecard?

- *Text entry box*

Answer image for Question 3:

Question 4: What do you see (ideal or non-ideal) in this image that you would take note of for the scorecard?

- *Text entry box*

Answer image for Question 4:

Question 5: What do you see (ideal or non-ideal) in this image that you would take note of for the scorecard?

- *Text entry box*

Answer image for Question 5:

Module 8: Conclusion, Post-survey

Survey description:

Let us know what you thought of the course so that we can improve this course and other extension materials in the future. Then go to the next page to watch the conclusion video and receive your certificate of completion!

Question 1: Did you enjoy taking this course? Why or why not?

- Text entry box

Question 2: Do you feel more prepared to protect your property from wildfire after taking this course?

- Yes
- No

Question 3: Do you feel ready to convert your landscape to use less water (if needed) after taking this course?

- Yes
- No

Question 4: Do you feel like this course was worth your time to take it? Why or why not?

- *Text entry box*

Question 5: Do you plan to make changes to your landscape after taking this course?

- Yes
- No

Question 6: If you do plan to make changes to your landscaping after taking this course, how much do you anticipate they will cost?

- *Text entry box*

Question 7: Do you have any suggestions for future versions of this course?

- *Text entry box*

Worksheets

WUI Landscape Scorecard

Date:

FIRE	No	Some	Yes
Is the house free of flammable exterior materials?	0	1	2
Are there not large plants, flammable structures, or other fuel adjacent to the house?	0	1	2
Is there a low continuity of vegetation and other fuels in Zone 2 (between the home and the wildland)?	0	1	2
Are highly flammable plants (conifers and others) avoided?	0	1	2
Are trees pruned to remove their lower branches?	0	1	2
Is Zone 3 (the wildland) pruned and has excess debris removed?	0	1	2
Fire Total			

WATER	No	Some	Yes
Are planter areas watered by drip, not spray, irrigation?	0	1	2
Is the lawn only as large as it needs to be for its intended use?	0	1	2
Does the lawn have water saving sprinkler heads?	0	1	2
Does the lawn use a low-water species of grass? (Unlikely in older developments)	0	1	2
Is mulch (wood or rock) used to cover exposed soil in planting areas?	0	1	2
Do planting areas use low-water/xeric plants?	0	1	2
Water Total			

COMFORT	No	Some	Yes
Can the landscape be used for what you want it to be used for?	0	2	4
Do you like how the landscape looks?	0	2	4
Is the maintenance of the landscape manageable for you?	0	2	4
Comfort Total			

Figure 28: The WUI Scorecard

WUI Landscape Scorecard Johnson Residence - Proposed Plan

Date: 1/20/2021

FIRE	No	Some	Yes
Is the house free of flammable exterior materials?	0	1	(2)
Are there not large plants, flammable structures, or other fuel adjacent to the house?	0	1	(2)
Is there a low continuity of vegetation and other fuels in Zone 2 (between the home and the wildland)?	0	1	(2)
Are highly flammable plants (conifers and others) avoided?	0	(1)	2
Are trees pruned to remove their lower branches?	0	(1)	2
Is Zone 3 (the wildland) pruned and has excess debris removed?	0	1	(2)
Fire Total	10		
	(6 existing)		

WATER	No	Some	Yes
Are planter areas watered by drip, not spray, irrigation?	0	1	(2)
Is the lawn only as large as it needs to be for its intended use?	0	1	(2)
Does the lawn have water saving sprinkler heads?	(0)	1	2
Does the lawn use a low-water species of grass? (Unlikely in older developments)	(0)	1	2
Is mulch (wood or rock) used to cover exposed soil in planting areas?	0	1	(2)
Do planting areas use low-water/xeric plants?	0	1	(2)
Water Total	8		
	(5 existing)		

COMFORT	No	Some	Yes
Can the landscape be used for what you want it to be used for?	0	2	(4)
Do you like how the landscape looks?	0	2	(4)
Is the maintenance of the landscape manageable for you?	0	2	(4)
Comfort Total	12		
	(10 existing)		

Figure 29: An example of the WUI Scorecard filled out

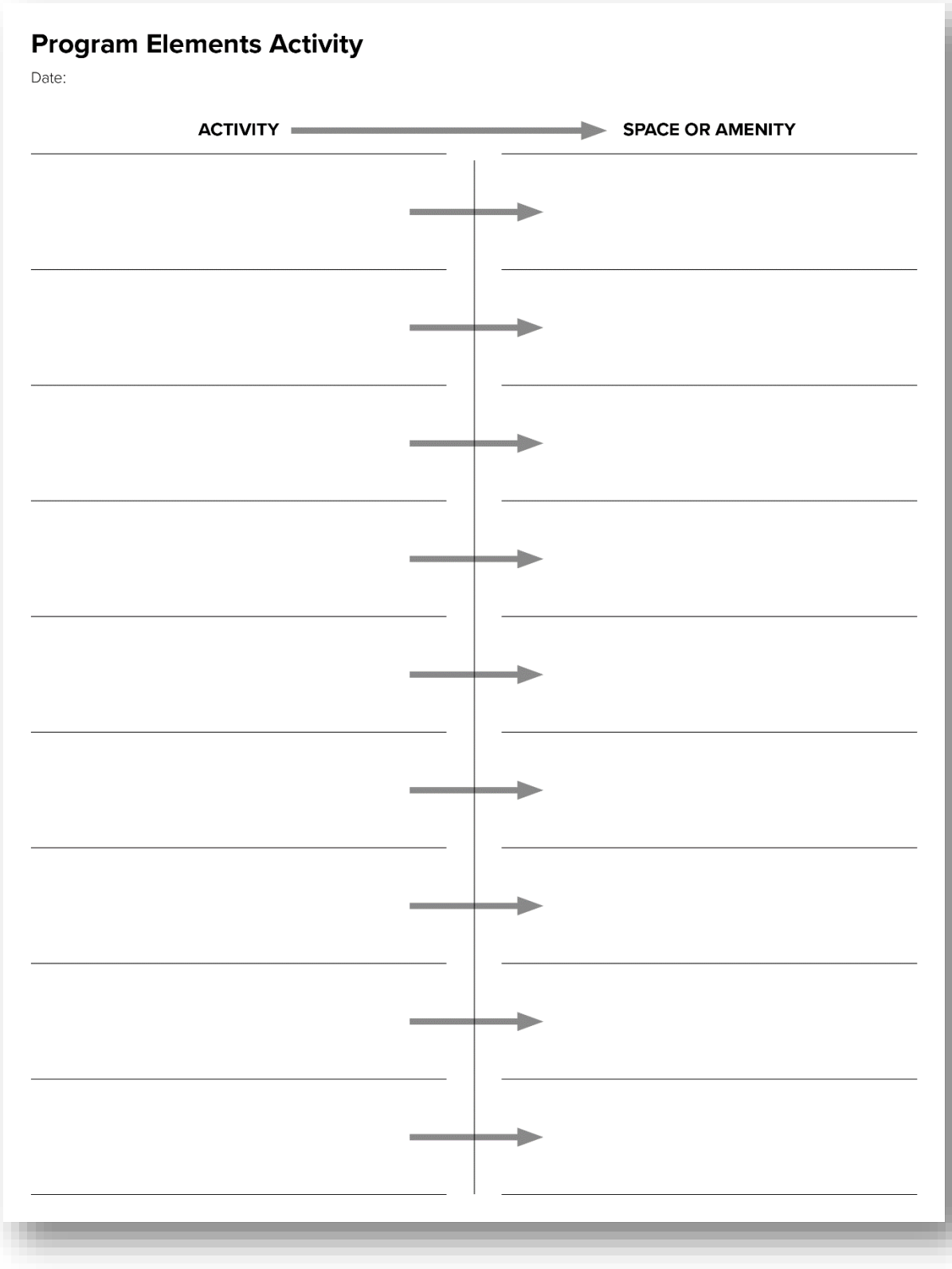


Figure 30: Program Elements Activity Worksheet

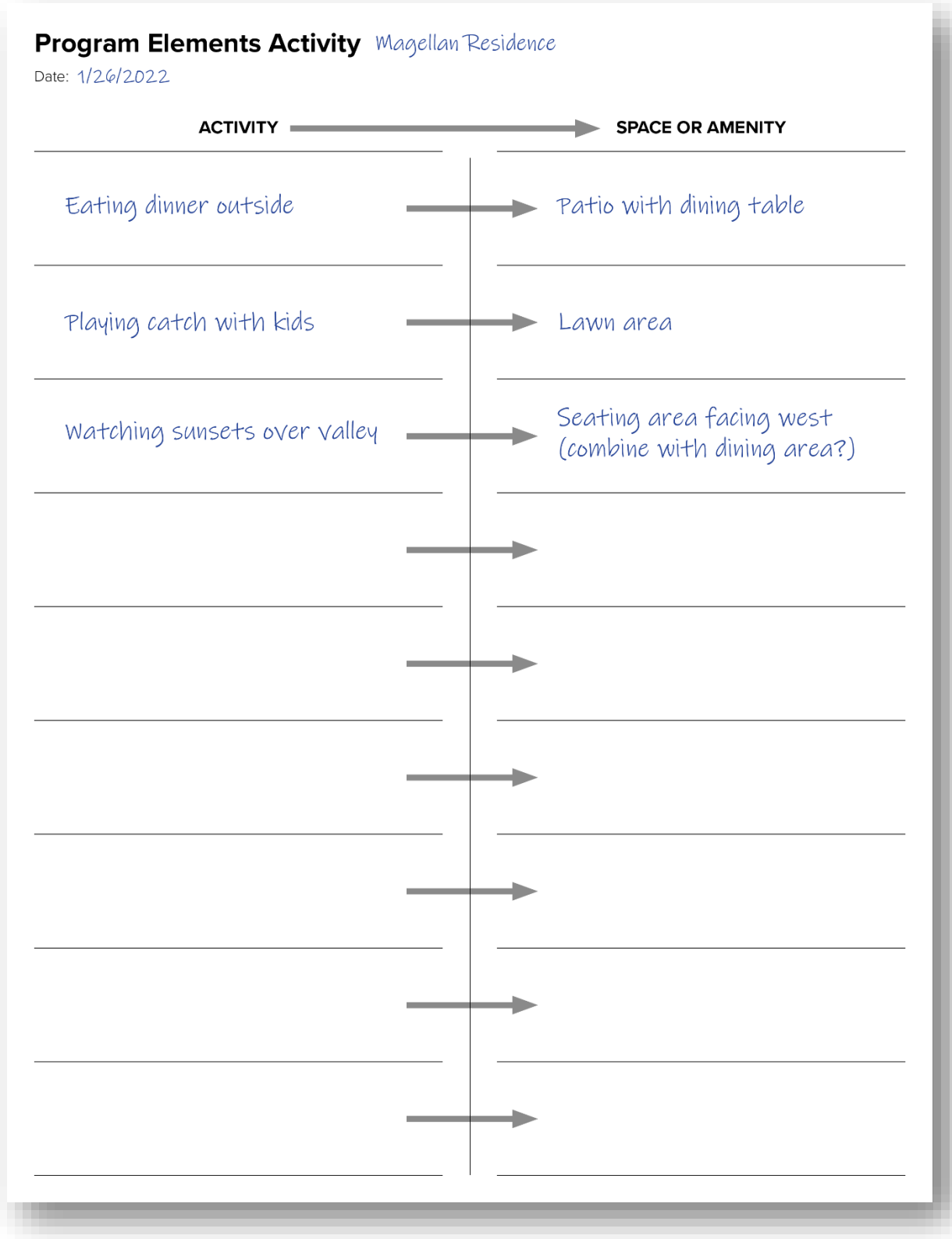


Figure 31: An example of the Program Elements Activity Worksheet filled out

Utah Wildland-Urban Interface Plant List

This list is intended to be a starting point when selecting plants for your landscape at the Utah WUI. These plants are all relatively fire-protective and low-water. Remember that while some plants are more flammable than others, **all plants can burn.**

You may not be able to find these exact plants, but **look for the traits of fire-protective plants** in whatever plants you choose.

- Generally, **avoid conifers**, which are trees and shrubs with needles, such as pines, spruces, firs, and junipers. Because of flammable compounds in most conifer needles, they ignite more quickly. Broad-leaf trees, such as maples, oaks, ash, lindens and many others, are better options for trees.
- **Smaller varieties are better** because they provide less fuel.
- Make sure to not plant trees that drop more seeds, leaves, and branches than you are willing to regularly clean up. Try to choose **less messy plants.**

HERBACEOUS PLANTS

Species	Common Name	Water Needs	Notes
Achillea filipendulina	Fernleaf Yarrow	Dry to Medium	
Achillea - other species & hybrids	Yarrow	Dry to Medium	Some may have flammable oils
Aquilegia species	Columbine	Medium	
Bergenia species	Berginia	Medium	
Centranthus ruber	Red Valerian	Medium	
Cerastium tomentosum	Snow-in-summer	Dry	
Coreopsis auriculata var. Nana	Dwarf Mouse Ear Coreopsis	Medium	
Coreopsis perennial species	Coreopsis	Dry to Medium	
Delosperma species	Hardy Ice Plant	Dry to Medium	
Dianthus plumarius	Pinks	Medium	
Erigeron hybrids	Fleabane	Dry to Medium	
Gaillardia x grandiflora	Blanketflower	Dry to Medium	
Geranium species	Hardy Geranium	Dry to Medium	
Hemerocallis species	Daylily	Medium	
Heuchera sanguinea	Coral Bells	Medium	
Iberis sempervirens	Evergreen Candytuft	Medium	
Lavandula species	Lavender	Dry to Medium	
Leucanthemum x superbum	Shasta Daisy	Dry to Medium	
Limonium latifolium	Sea-lavender	Medium	
Linum perenne	Flax	Medium	
Liriope spicatum	Lily-turf	Medium	
Lupinus species & hybrids	Lupine	Medium	
Oenothera species	Primrose	Dry to Medium	
Papaver species	Poppy	Medium	
Penstemon species & hybrids	Penstemon	Dry to Medium	

Species	Common Name	Water Needs	Notes
Potentilla neumanniana ‘Nana’	Spring Cinquefoil	Medium	
Potentilla nepalensis	Nepal Cinquefoil	Medium	
Salvia yangii	Russian Sage	Dry to Medium	May be weedy
Salvia species & hybrids	Sage	Dry to Medium	
Sedum species	Stonecrop	Dry to Medium	
Sempervivum tectorum	Hen and Chicks	Dry to Medium	
Stachys byzantina	Lamb’s Ear	Dry to Medium	May be weedy
Yucca filamentosa	Yucca	Dry to Medium	
Delosperma species	Hardy Ice Plant	Dry to Medium	
Arctostaphylos uva-ursi	Manzanita	Medium	

SHRUBS AND WOOD VINES

Species	Common Name	Water Needs	Notes
Atriplex species	Saltbrush	Dry to Medium	
Ceanothus americanus	New Jersy Tea	Dry to Medium	
Cotoneaster dammeri	Bearberry Cotoneaster	Medium	
Cotoneaster horizontalis	Rock Cotoneaster	Medium	
Hedera helix	English Ivy	Medium	May be weedy or invasive
Lonicera species & hybrids	Honeysuckle	Dry to Medium	
Mahonia repens	Creeping Oregon Grape	Medium	
Parthenocissus quinquefolia	Virginia Creeper	Medium	
Pyracantha species	Firethorn	Dry to Medium	
Rhamnus species	Buckthorn	Medium	
Rhus aromatica	Three Leaf Sumac	Dry to Medium	
Rhus - other species	Sumac	Dry to Medium	May be weedy
Ribes species	Currant	Medium	
Rosa rugosa	Rugosa Rose	Medium	
Syringa vulgaris	Lilac	Dry to Medium	Look for small varietes
Vinca major	Large Periwinkle	Dry to Medium	
Vinca minor	Dwarf Periwinkle	Dry to Medium	

TREES

Species	Common Name	Water Needs	Notes
Malus floribinda	Crabapple	Medium	
Heuchera sanguinea	California Redbud	Medium	
Populus tremuloides	Quaking Aspen	Medium	

Species	Common Name	Water Needs	Notes
Amelanchier species	Serviceberry	Medium	
Cercocarpus ledifolius	Mountain Mahogany	Dry	
Prunus besseyi	Sand Cherry	Dry to Medium	
Koelreuteria paniculata	Goldenrain Tree	Dry to Medium	
Gleditsia triacanthos	Honeylocust	Medium	
Gymnocladus dioicus	Kentucky Coffeetree	Medium	
Ginkgo biloba	Ginkgo	Medium	
Ulmus parvifolia	Lacebark Elm	Medium	
Prunus virginiana ‘Canada Red’	Canada Red Chokecherry	Dry to Medium	
Acer tataricum	Tatarian Maple	Medium	
Acer ginnala	Amur Maple	Medium	
Acer grandidentatum	Bigtooth Maple	Medium	
Crataegus ambigua	Russian Hawthorne	Dry to Medium	
Cladrastis kentukea	American Yellowwood	Medium	

APPENDIX 2: DRIP IRRIGATION

Drip Irrigation System Components

This section is an overview of components used in drip irrigation and how they work together.

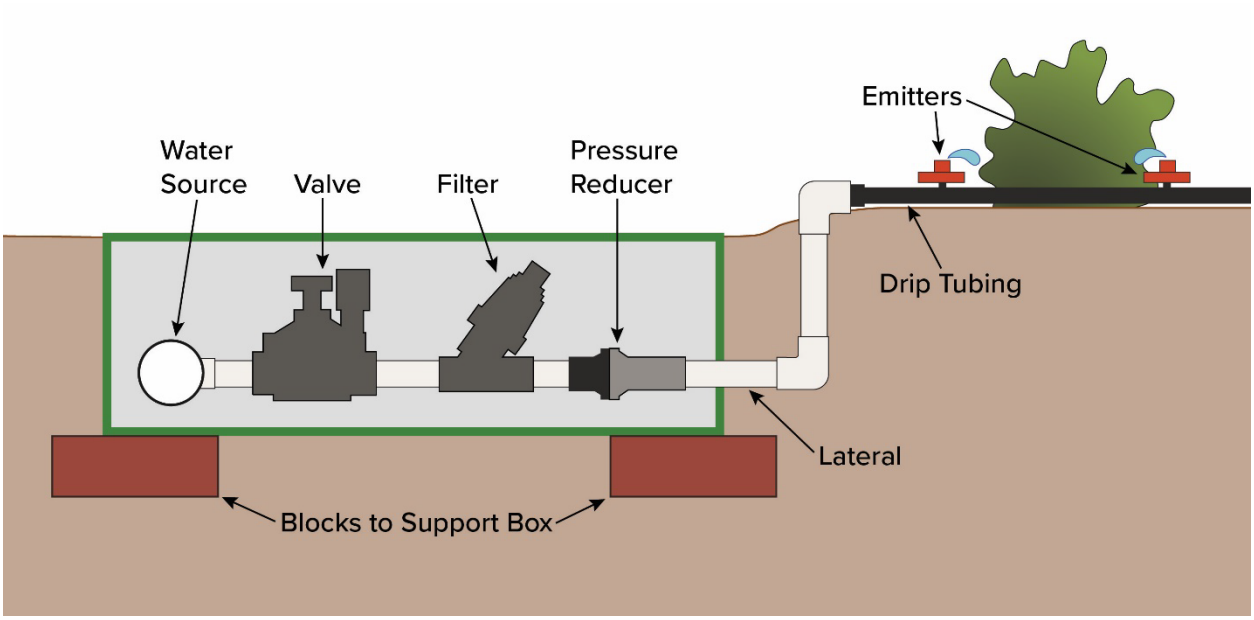


Figure 32: A basic configuration for a drip irrigation system

Connection to Water Source to Drip Tubing

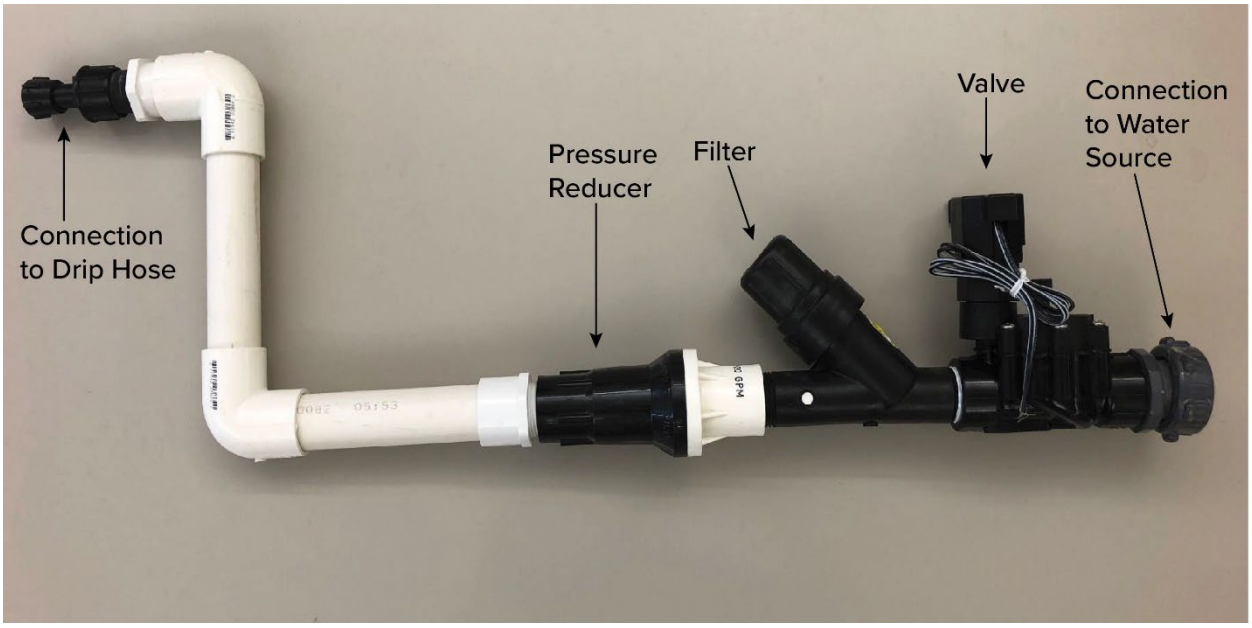


Figure 33: Propper configuration of components between the water source and drip tubing. Photo from Paul Harris

Several complements are needed between the water source/main line and drip tubing. The valve allows the drip area to be turned on and off. Valves may be manual, or more commonly, electronically controlled through an irrigation clock. The filter keeps soil or other debris from clogging the tubing and emitters. Filters are especially important in drip irrigation systems because many of the components are small and clog easily. The pressure reducer takes the pressure down from the main line to a level that will work for the drip system.

Drip Tubing

There are several different kinds of drip tubing, or drip hose. Each works slightly differently, but they all function by allowing small amounts of water to come out where it is needed.

Polyethylene Tubing

Polyethylene tubing, sometimes just called poly tubing, can be used to effectively transport water to where it will be distributed into smaller tubing, or the tubing can have emitters inserted directly into it. Poly tubing is very versatile, but other kinds of tubing can be more convenient in certain situations.

Figure 34: Polyethylene drip tubing. Image credit: https://www.homedepot.com/p/DIG-1-2-in-700-O-D-x-500-ft-Poly-Drip-Irrigation-Tubing-B37/100163329

Inline Emitter Tubing

While standard poly tubing must have emitters attached to it, some kinds of tubing have emitters already installed inside of them. This works well if water needs to be distributed at regular intervals over an area, and it can save work by not requiring each emitter to be installed individually.

Figure 35: Inline emitter tubing. Image credit: https://www.netafimusa.com/agriculture/drip-irrigation/

Soaker Drip Tubing

Soaker tubing is also useful for areas that need relatively even distribution of water, but instead of using emitters regularly spaced along the hose, the water soaks through the material.

Figure 36: Soaker drip tubing, image credit: https://latimesblogs.latimes.com/home_blog/2011/08/soaker-hoses.html

Drip Tape

One other option for drip tubing is drip tape. Drip tape is common in agricultural applications and is most useful for large areas that need even distribution of water. It is easy to install, but it offers fewer options for customization and is harder to incorporate into the aesthetics of a landscape than some other options.

Figure 37: Drip tape, image credit: https://www.groworganic.com/blogs/articles/drip-irrigation-part-3-using-drip-tape-in-the-garden

Drip Tube Fittings

Drip tube fittings allow pieces of pipe to be attached to each other. There are many options for drip tube fittings. Fittings have options for different angles and may be threaded or barbed. The most important thing to remember is to use fittings from the same brand as the tubing being used.

Figure 38: Drip tubing fittings, image credit: https://www.rainbird.com/products/xf-dripline-insert-fittings

Drip Emitters

There are also a huge variety of drip emitters. Some attach directly to poly tubing, while others attach to smaller tubing that is then attached to larger poly tubing. Emitters may emit water in drops, a small stream, or a spray.

Figure 39: Point source drip emitters, image credit: https://www.hunterindustries.com/en-metric/irrigation-product/micro-irrigation/point-source-drip-emitters

Figure 40: A micro spray emitter, image credit: https://www.digcorp.com/professional-irrigation-products/fan-micro-sprayers/

Turfgrass Species and Cultivars for Utah

As stated in the literature review, there are several options for species and varieties of turfgrass, some of which use less water than others. This overview of turfgrass appropriate for Utah is based on work by Utah State Extension (Kopp & Johnson, n.d.). Four common turfgrass options in Utah are Kentucky Bluegrass, Tall Fescue, Fine-Leaf Fescue, and Perennial Ryegrass.

Kentucky Bluegrass

Figure 41: Kentucky Bluegrass, image credit: https://www.pennington.com/all-products/grass-seed/resources/all-you-need-to-know-about-kentucky-bluegrass

Kentucky Bluegrass is one of the most common turfgrasses. It is best for lawns that will have a lot of traffic and full sun to partial shade. It can be very water intensive, but there are some low-water cultivars, such as Baron, Everglade, Award, Bedazzled, and Total Eclipse.

Tall Fescue

Figure 42: Tall Fescue, image credit: https://www.pennington.com/all-products/grass-seed/resources/all-you-need-to-know-about-tall-fescue

Tall Fescue is an ideal general purpose turfgrass option for Utah. It has both high sun and shade tolerance. It is deep rooting, so it can often survive on less water than Kentucky Bluegrass.

Fine-Leaf Fescue

Figure 43: Fine-leaf Fescue, image credit: https://www.gardeningknowhow.com/lawn-care/specific/fine-fescue-grass/growing-fine-fescue.htm

Fine-Leaf Fescue can be another suitable option. It does well in shaded areas and grows slowly.

Most Fine-Leaf Fescues have relatively low water needs.

Perennial Ryegrass

Figure 44: Perennial Ryegrass, image credit: https://www.pennington.com/all-products/grass-seed/resources/all-you-need-to-know-about-perennial-ryegrass

Perennial Ryegrass provides a formal, lush appearance, but it can be high maintenance. Because of its high water needs, it is probably not the best option in most situations.

Links to External Content

Several links to external content are included in the course. They are included below in the order they appear in the course.

USU Extension Wildfire Page: https://extension.usu.edu/preparedness/wildfires

Localscapes Website (about low-water landscaping): https://localscapes.com/

USU Extension Turfgrass Page: https://extension.usu.edu/yardandgarden/research/turfgrass-cultivars-for-utah

Pinterest (to assist in making an inspiration board): https://www.pinterest.com/

APPENDIX 3: CRITIQUES AND RESPONSES

Review Critiques and Responses

The following is a summary of critiques received and how the course was adjusted accordingly. This table is a summary of comments, not verbatim critique.

Reviewer	**Comment**	**Response**
Dax Reid, WUI Coordinator	The picture on the page "Implementing the Plan" does not contribute to the message of the page	Changed to three new pictures that better support what the page is about
Duncan Fuchise, WUI Coordinator	Fix grammatical error in demographic survey	Fixed grammatical error
Duncan Fuchise, WUI Coordinator	Change wording of quiz question about ladder fuels to be clearer	Question reworded
Duncan Fuchise, WUI Coordinator	Emphasize that Zone 2 should slow down fire, even though some things in it can burn	Reworded defensible space section to say that Zone 2 will slow down fire, but not stop it
Duncan Fuchise, WUI Coordinator	Quiz question suggests that it is not good to build at the bottom of hills when this is not always the case	Changed quiz question to mention only not building at the tops of hills

Larry Rupp, USU Professor Emeritus	Add more trees to the plant list	More trees were added to the plant list, using species suggested by Dr. Rupp

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