WASATCH COUNTY
WATERSHED INVENTORY

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1 Introduction and Purpose

1.1 Wasatch Watersheds – A Critical Local and Regional Resource

The Wasatch County Watershed is a critical water resource for local as well as regional demand. Much of the water generated in Wasatch County is consumed by downstream populations who rely upon this critical resource including significant percentages in Utah County and Salt Lake County. The watershed supplies municipal potable water systems as well as irrigation water throughout Wasatch, Utah, and Salt Lake Counties. As a result, systems of dams, reservoirs, canals, and tunnels have been constructed in Wasatch County in order to efficiently route and assure sufficient supply to meet the needs nearly 75% of Wasatch Front water needs.

As a critical regional water supply, Wasatch County waters deserve great consideration toward water quality enhancement. Water quality is important not only for its direct use by society, but also as an environmental resource which provides recreational, scenic and habitat resources. Many well-established threats exist throughout Utah, of which Wasatch County is also subject to. These threats emanate from human activity such as livestock grazing, commercial and residential land development, off-road recreation, roadway construction, roadway treatments, streambed alteration and discharging of manmade material, as well as watershed burning by wildfire.

This inventory presents the critical surface waters of Wasatch County and their role in both regional and local water supply. Going further, this report presents the known impairments, threats, and potential mitigation of current impairments. This study focuses on the Jordanelle Basin and Middle Provo River (greater Heber valley) where the majority of growth is anticipated, however, the recommendations found herein are applicable to watersheds throughout the county and region. It is recommended that modifications to codes and procedures be applied county wide to have the largest possible improvement to water quality.

1.2 Wasatch County Growth

Wasatch County has gained popularity in recent years among recreationalists who find the area conducive to work and play lifestyles. Historically an agricultural region, the Heber Valley especially is becoming increasingly urbanized and commercialized. Surrounded by vast tracts of public land peppered with privately owned parcels that are rapidly becoming approved for development, it is no mystery why Wasatch County is the third fastest growing county in the country (according to U.S. Census Bureau 2018 Report). While the economic history of the County is largely agricultural, the economic future of the valley is evolving in favor of commercial and residential development catering to the recreation in the area. It is anticipated that the strong growth rate seen in recent years will continue in Wasatch County for many years or even decades.

With recent and future development in mind, water quality is of increasingly significant concern. An increasing number of water users in Wasatch County depend on clean water flowing from the pristine wilderness settings. As urbanization accelerates, adequate water quality controls will result in preservation of water quality. "Without the proper planning, studies have found that urban stormwater can have pollutant concentrations on the order of secondary treatment plant effluent for some constituents" (EPA, 1983).
In recent years, Utahns have experienced an increasing amount of impaired water bodies which have been manifested as turbidity, toxic algal blooms, aquatic species die-offs, chemical spills. With a rapidly growing population, the establishment of adequate water quality controls is both necessary and urgent in order to avoid undesirable economic, environmental and recreation interruptions.

2 Watershed Characterization

The county's watershed can be split up into basins by its three main reservoirs: Jordanelle, Strawberry, and Deer Creek. Figure 2-1 below shows the location of these reservoirs relative to nearby development and municipal boundaries overlaid on a slope steepness heat map. The Provo River is the primary watercourse through Wasatch County; its headwaters originate in the High Uinta's in Summit County roughly following the route of the Mirror Lake Highway (UT St Hwy 150) eastward to approximately Bald Mountain. With numerous tributaries, the Provo River flows continually and is a heavily relied upon water source. The succession of identified water bodies are: 1) Upper Provo River, 2) Jordanelle Reservoir, 3) Middle Provo River, 4) Deer Creek Reservoir, 5) Lower Provo River, 6) Utah Lake, 7) Various reaches of the Jordan River, and 8) The Great Salt Lake.

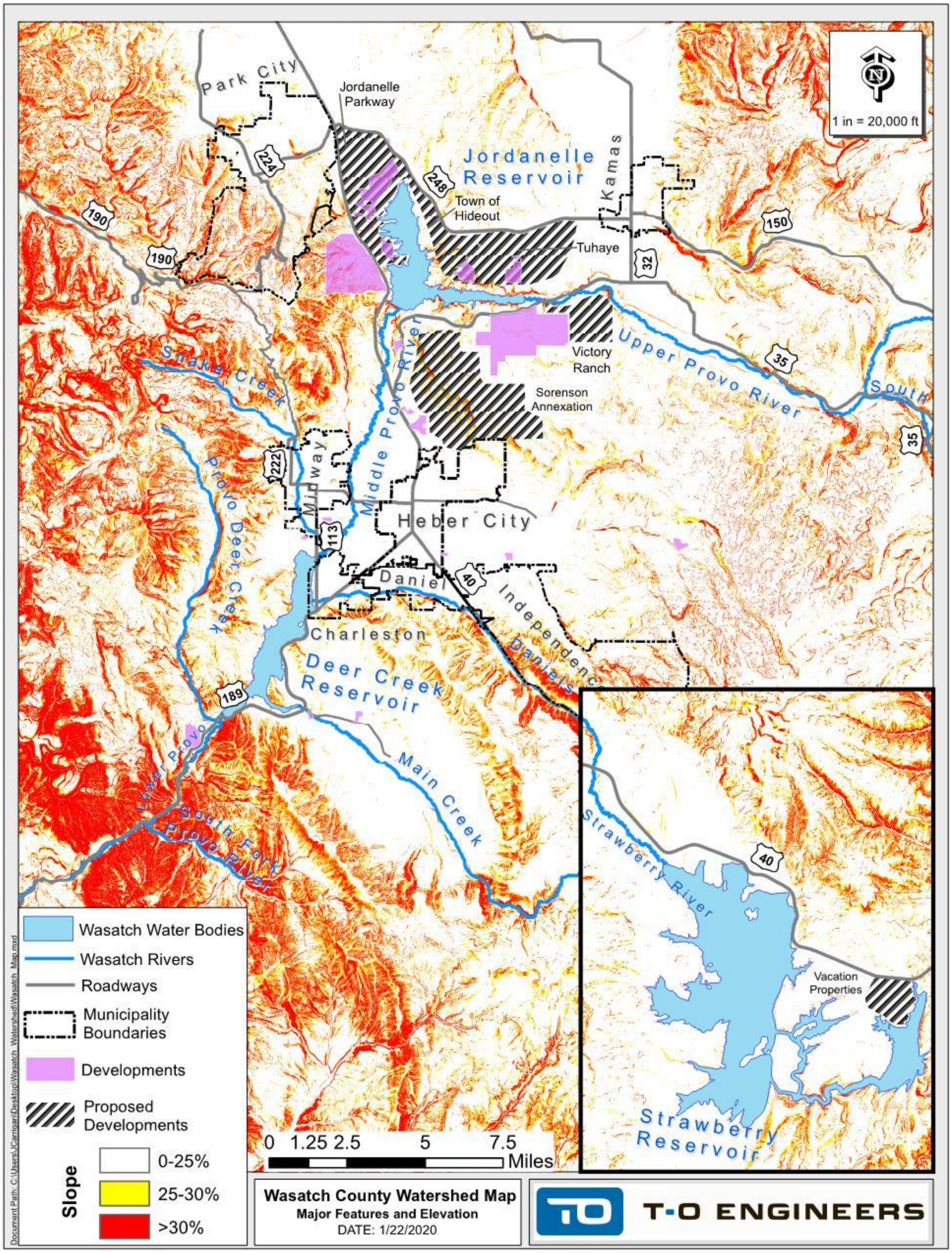


Figure 2-1 Watershed Characteristics overview

2.1 Jordanelle Reservoir Basin

Located at an elevation of about 6,100 feet, the Jordanelle Reservoir is in the northern end of the Heber Valley on the east side of the Wasatch Mountain Range. The Jordanelle dam, in the southwest corner of the reservoir, was completed in 1993 and stands over 200 feet tall. The reservoir fills two intersecting valleys, making an L-shaped configuration, and the waters stored in Jordanelle serve downstream users in Wasatch, Utah, and Salt Lake Counties. Jordanelle Reservoir is a popular swimming, fishing, boating, camping, biking and hiking destination for local and regional outdoor enthusiasts. The upstream watershed comprises an area of 165,120 acres (258 Sq. Mi), most of which is higher elevation mountain lands in the Uinta mountain range.

Its eastern arm extends approximately five miles from the dam to the Provo River, Drainage from the west face of the Uinta Mountain Range drains into the "Upper" Provo River which enters Jordanelle Reservoir at the most eastern extent of the Reservoir. Upstream of this point, land uses in the watershed include a significant degree of recreational activity such as off-roading, horseback riding, fishing, and hiking. Livestock grazing of cattle and sheep are presently permitted in relatively unregulated fashion. Several communities are established including Kamas, Woodland, Francis, and Victory Ranch.

The northern arm extends about four miles from the dam to Ross creek on the north side of the reservoir. Runoff from the east face of Wasatch Range also contributes to Ross Creek, and some flows directly in to the 320,300 acre-ft reservoir. These flows are found in multiple relatively small creeks and drainage gullies to the reservoir below. Within these smaller stream watersheds, rapid land development is occurring. Communities such as Hideout, Tuhaye, Benloch Ranch, Sky Ridge, The Extell expansion of ski infrastructure on the west side of highway 40 and Deer Crest are some of the many new out-of-town alternatives to the urbanized Park City and Deer Valley neighborhoods. Hundreds of new homes have been constructed while yet 1000's more have been conceptually approved. Some commercial development has also occurred and been approved. Commercial and residential development within the Jordanelle Reservoir basin represents a new challenge for water quality in Jordanelle Reservoir and the downstream receiving waters such as the Middle and Lower Prover River, Deer Creek Reservoir, Utah Lake, The Jordan River, and ultimately the Great Salt Lake.

2.2 Deer Creek Reservoir Basins

Deer Creek Reservoir is located in the southwest corner of Heber Valley and extends to Wallsburg Bay which terminates several miles north of the town of Wallsburg. The reservoir collects and stores spring runoff from several tributaries in the wet season which is gauged out of the Reservoir to be used for potable water and irrigation for residents of both Utah and Salt Lake Counties in the drier season. Deer Creek Reservoir is very popular for its swimming and fishing recreation, as well as its scenic setting in such close proximity to the Utah County population base. The watershed draining into Deer Creek Reservoir has an area of 171,663 acres (YYY SQ MILES) comprised of four distinct sub-watersheds. This area excludes watershed acreage above Jordanelle Reservoir, and the four sub-watersheds have the following tributary areas as shown in Table 1 and mapped in Figure 2.1:

Sub Watershed	Area(acres)
Provo River	13,821*
Snake Creek	19,564
Main Creek	45,090
Daniels Creek	93,118
Total	171,663

Table 1. Sub-Watershed Acreage

Figure 2-2. Deer Creek Tributaries

Deer Creek Reservoir and its many tributaries are most impacted by past and future land use in Wasatch County simply because the most intense land uses in the County are in very close geographic proximity to these water bodies. As such this report will go into greater depth describing these water bodies, their origins, uses, impairments and water quality solutions.

2.2.1 Provo River

Deer Creek receives the greatest share of its supply from the Provo River. Upon discharging from Jordanelle Reservoir approximately nine miles upstream, the Provo River meanders through natural and manmade pasture among mostly natural vegetation such as Cottonwood Trees and willows. The section of the Provo River between Deer Creek and Jordanelle Reservoirs is known as the "Middle" Provo River and is a nationally recognized "Blue Ribbon" fishery for trout species. The watershed area of the Middle Provo River is approximately 13,000 acres, much of which includes the developing cities of Midway, Heber and Charleston.

Both legacy land use and new development in the Heber Valley expose the Middle Provo River to increasing contamination from land development, roadway runoff, agricultural pollution, and other sources of contamination known to be harmful for drinking water, recreation, aquatic life, and riverine habitat. These pollutants include bacteria, heavy metals, hydrocarbons, and turbidity. Local jurisdictions have enacted tools and regulations to reduce contamination to the Provo River, and its water quality is better as a result. Information about these efforts is included in Section 3 of this study. Additional implementations are necessary to realize the optimization of economics and water quality on the Middle Provo River.

2.2.2 Snake Creek

Snake Creek originates high in the Wasatch Mountains northwest of Deer Creek Reservoir at elevations approaching 10,000 feet, much of which is within Wasatch Mountain State Park. The creek receives tributary flows from several streams and springs found throughout the Snake Creek Watershed, including the warm water springs like those seen at the Homestead Crater and significant flow from Pine Creek which originates in the Empire and Guardsman Pass areas. Snake Creek flows year-round and is used for many purposes: culinary, irrigation, agriculture, recreation, and beautification, mostly throughout the city of Midway.

Snake Creek flows through many areas of Midway which have been developed with homes, roads, hotels and other features, and more development is anticipated throughout Midway most of which is tributary to Snake Creek. The water quality in Snake Creek is negatively affected by urban runoff and a minor amount of agricultural land use. Common contaminants from a watershed of this type include hydrocarbons, heavy metals, turbidity and bacteria. In addition to the contaminants expected from a watershed of this type, high levels of heavy metals are present from mining activity dating back several decades. This stream has been identified as contaminated by arsenic. Septic systems remain a growing concern in the Snake Creek and other watersheds. A separate study has been completed to address septic system improvements.

2.2.3 Main Creek

Main Creek flows from its headwaters on National Forest land south of Wallsburg with tributaries from National Forest surrounding the Wallsburg Valley, and discharges to Deer Creek Reservoir near Highway

189. Main Creek and its major tributaries, Little Hobble Creek and Maple Creek are fed by snowmelt, precipitation and relatively consistent groundwater springs. A notable tributary known as Spring Creek begins at a large spring near town center of Wallsburg and supplies irrigation water to livestock and alfalfa farms between Wallsburg and Deer Creek Reservoir. The Main Creek watershed covers about 45,000 acres. About one-third of the watershed (15,000 acres) is forest, about 3,000 acres are used for agriculture, and just under half of the watershed (21,600 acres) is privately owned and in some instances used for sheep and cattle grazing. The watershed includes about 600 residents; the only town in the watershed is the town of Wallsburg.

All surface waters in the Wallsburg valley join Main Creek and discharge to Deer Creek Reservoir. Main Creek, Little Hobble Creek, and Spring Creek are designated as perennial streams. However, several irrigation diversions on each stream lead to seasonal dewatering of some tributaries, however Main Creek generally flows year-round because consistent springs contribute flow to the creek (UDNR 1991). Maple Creek is diverted completely into irrigation canals and rarely maintains a flow directly tributary to Main Creek.

The agricultural and recreational uses in the valley contribute considerable pollutants to Main Creek, as is typical of rural watersheds in Utah. Some regulations have been enacted to protect streams from livestock through some segments while other segments remain affected. Off-road recreation is very popular in areas of the watershed sensitive to producing erosion and turbidity immediately adjacent to otherwise pristine water sources. As a result of agricultural and recreational uses, Main Creek and its tributaries are contaminated with above natural levels of bacterial pathogens such as E-Coli (From mammal waste) and turbidity. Both contaminants promote algal blooms, decrease dissolved oxygen and cause an overall reduction in aquatic life and surface water aesthetics.

2.2.4 Daniel Creek

Daniel Creek flows northwest from its headwaters at Daniel's Summit at elevations approaching 9,000 ft down Daniels canyon and into Heber Valley collecting from several tributaries on the way. From there, Daniel Creek flows west through the Town of Daniel's various hay and livestock farms until it drains into the Deer Creek Reservoir in the town of Charleston. Daniel Creek is fed by multiple small tributaries and springs along the approximately 20-mile flow path.

Daniel Creek is exposed to the same uses as Main Creek, but generally these uses are less intense in the Daniel Creek Watershed. The steep and narrow canyon where Daniel Creek flows is not as user-friendly for off road recreation or hay raising. Several livestock grazing permits exist however, and both sheep and cattle forage among the tributaries to Daniel Creek and in Daniel Creek itself. As in Main Creek, there is little enactment nor enforcement restricting livestock from entering streams and springs, thus elevated levels of E-Coli from livestock waste and turbidity from livestock tracking in the streams is present.

2.2.5 Topography and Sensitive areas

The subject watershed has a wide central area (The Heber Valley) that is increasingly urbanized with pockets of agriculture. Irrigation ditches convey a portion of Provo River water across the eastern slope of the Heber Valley to be used increasingly for landscape irrigation. Previous studies identify sources of data that describe groundwater conditions, geology, soils, and geologic hazards. Shallow groundwater (the water table 3 to 10 feet below the ground surface) is mapped throughout the valley. Within the watershed, some slopes show a moderate potential for landslides. Figure 2-3 (after section 2.5) shows slopes above 10%. The steeper the slope, the more susceptible to erosion the slope will be, which is an important factor in the consideration of land uses on slopes steeper than 5%.

2.3 Strawberry Reservoir Basin

The Strawberry Reservoir Basin is located in the southeast region of the county. The Soldier Creek Dam in the southeast corner of the reservoir was constructed in 1974 and is 272 feet high and 1,290 feet long. Several drainages from the surrounding Uinta Mountains fill the reservoir in the spring occasionally filling Strawberry Reservoir to its maximum capacity of 1,120,000-acre feet. A series of tunnels and canals diverts the water from the reservoir to Utah Valley. Major tributaries to Strawberry Reservoir include Strawberry River, Chicken Creek, Coop Creek, Trout Creek, and a tunnel diversion which diverts flows from the south slopes of the Uinta Mountains. Each of these creeks and the reservoir itself are now home to non-native Kokanee Salmon which the Utah Department of Wildlife Resources promotes as a habitat and a sportsman's' benefit.

Strawberry Reservoir is regionally and even nationally popular for its excellent trout fishing. Overall the venue is also used for boating, kayaking, hiking, biking, and camping. Several developed campgrounds exist as well as several boat launching facilities and a full-scale marina complete with lodging and restaurant options. Recreationalists are passionate about dry-camping and off-roading in the area, which offers hundreds of miles of backcountry trails and hundreds of undeveloped camping sites. Three small communities exist within the Strawberry Reservoir watershed mostly comprised of vacation homes and remote cabins. Very little commercial development is currently present. Water quality in these tributaries is most impaired by livestock waste, unmanaged human waste from undeveloped campsites, and turbidity caused by livestock tracking, unpaved roads and OHV use. As part of a proposed residential development a waste water treatment facility has been proposed which could, if completed provide improved facilities to manage recreational waste.

Strawberry Reservoir's existence is meant for culinary and irrigation water supply to the south half of Utah County. Water from the Reservoir is conveyed by tunnel to Diamond Fork Creek which joins Spanish Fork River well upstream of Spanish Fork City.

2.4 Utah Water Quality Program

The Utah Water Quality Board, the Utah Division of Water Quality, the Utah Drinking Water Board and the Utah Division of Drinking Water are responsible for establishing minimum water quality objectives throughout the state.

In order to qualify and quantify water quality objectives, there are several factors that must be evaluated. Considerations toward the significance of each water body, it's relevance within a watershed and ecosystem, and the costs of improving the quality of water are among many other factors used to develop a meaningful water quality program for each waterbody throughout the state. As organized in Utah, The Division of Water Quality (DWQ) determines beneficial-uses for all classified water bodies in Utah. In other words, this Division is responsible for identifying the social, environmental, and economic benefits each waterbody in Utah provides, or can potentially provide. Narrative and/or numeric water quality standards (Utah Code Annotated, R317-2-7) apply to all waters in the state.

All surface waters in the Provo River watershed that are tributary to Deer Creek Reservoir, including Main, Snake, and Daniel Creeks, are classified by the DWQ for the following beneficial uses:

- 1C – Protected for domestic purposes with prior treatment by processes required by the Utah Division of Drinking Water.
- 2B – Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingesting water or a low degree of bodily contact with the water. Examples include wading, hunting, and fishing.
- 3A – Protected for cold-water species of game fish and other cold-water aquatic life, including the necessary aquatic organisms in their food chain.
- 4 – Protected for agricultural uses including irrigating crops and stock watering.

DWQ has identified Deer Creek Reservoir as impaired for not meeting thresholds supporting it's classified beneficial uses. Specifically, the lake is impaired by a lack of dissolved oxygen in the lower water column. Below is a brief description of the Deer Creek TMDL study (PSOMAS, Deer Creek Reservoir TMDL Study, 2002) and some of the progress that has been made as remediation projects have been implemented.

During the 1980s, the reservoir received very high nutrient loads which led to the growth of excessive aquatic plant life. Initially plant supports more dissolved oxygen as a result of photosynthesis. However excessive plant life causes "eutrophication" when plant material starts to die and produce CO2 rather than oxygen. This plant life cycle is natural, but excessive nutrient loading promotes excessive plant and algae growth, even to the point of large and often toxic "algal blooms". Fast growing algae depletes remaining oxygen content in the water and causes fish and other aquatic life to die off, which contributes more nutrients in the form of dead biomass of both algae and other perished aquatic life. This biomass collects on the bottoms of lakes and rivers and produces methane and other substances which further negatively impact beneficial uses like safe drinking water and recreational enjoyment. Common contaminants which result in eutrophication include nitrates and phosphates present in varying degrees of un-managed wastewater, livestock farm return flows and fertilizers. Further, turbidity reduces sunlight and ultra-violet rays from penetrating water deeply, the consequence is preventing a healthy level of underwater photosynthesis and oxygen production.

Current water quality analyses show that the reservoir has improved and could, at times, be considered a mesotrophic (intermediate level of biological productivity) lake based on the average Carlson Trophic State index. The improvements can reasonably be attributed to the focus on the water quality efforts to reduce pollution from point sources. Phosphorus sources in the watershed have been targeted for reduction to meet the recommended targets and endpoints of the TMDL study. Understanding the point sources of these contaminants and all others is a necessary step in understanding why and how eutrophication and other impairments are prevented in the future.

2.4.1 Deer Creek Water Quality History

In 1981, due to eutrophication in Deer Creek Reservoir, Governor Scott Matheson established the Jordanelle Reservoir Water Quality Technical Advisory Committee for the purpose of developing a reservoir management plan for Deer Creek Reservoir and the future Jordanelle Reservoir. Wasatch County took the lead in the preparation of the Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs which was completed in 1984. This plan identified various sources of pollution and assigned required reductions from each source to achieve the desired level of water quality in the two reservoirs and their tributary streams. This is an ongoing planning effort with annual water sampling, evaluations, and plan modifications to ensure that measures taken are reducing adverse impacts on the surface water quality in the Provo River drainage. One of the identified sources of pollution was agriculture return flows from flood irrigation. The Wasatch County Efficiency Project has resulted in the installation of pressurized irrigation on much of the farmland in the County, limiting most agricultural return flows and soil erosion on cultivated land. This project has also resulted in the conservation of water resources.

The Provo River Water Users Association (The latest term is the Provo River Watershed Council) is a collaborative entity working to ensure the best use of the water throughout the entire watershed. The association has a long history of working with Utah DEQ, State Engineers office, and local communities to improve the water quality. In addition to providing a venue for watershed planning and collaboration the association provides funding for numerous projects.

2.4.2 Ground Water Quality

Ground water quality also received a great deal of attention during the 1990s. Many homes in the unincorporated area use wells in the unconsolidated valley fill as their source of water. The valley fill also discharges 11,000-acre feet of ground water annually to the Provo River and 42,000-acre feet directly to Deer Creek Reservoir. To determine the potential impacts of the use of septic tank drain fields on the water quality of the valley fill aquifer, Wasatch County had a Hydrogeologic/Water Quality Study conducted in 1994. This study recommended that in order to protect the pristine quality of water in the valley fill aquifer, septic tank drain field use should be limited to a density no greater than one per five acres.

2.5 Source Protection Zones

The 1996 amendments to the Safe Drinking Water Act required that all public drinking water sources have a source protection plan and associated protection zone. Within these protection zones, various activities or facilities may be restricted if they will jeopardize the purity of the drinking water sources. Source protection requirements apply to both new and existing sources of drinking water. Figure 2-3 below shows the water source protection zones in the Greater Heber Valley area.

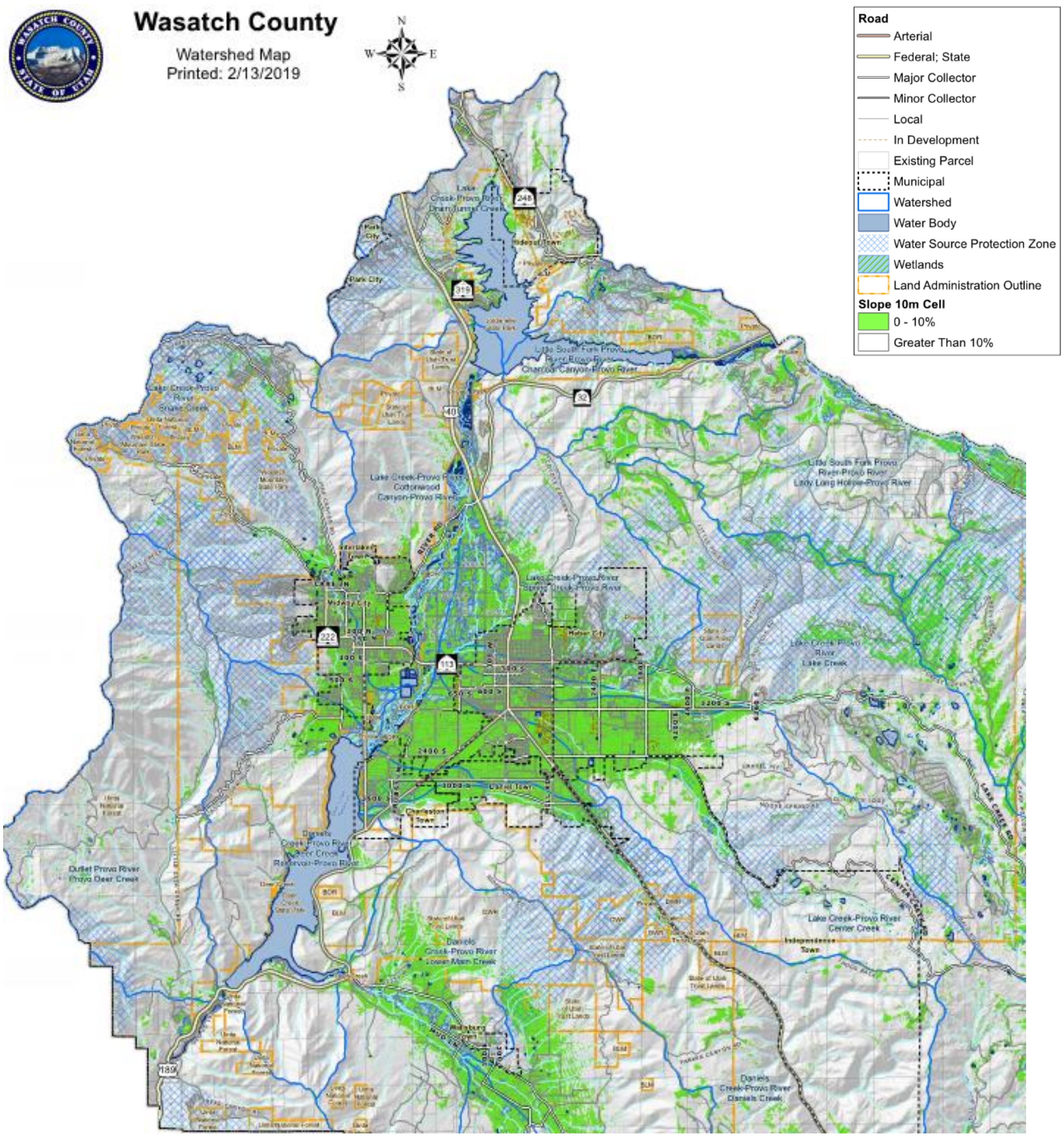


Figure 2-3. Source Protection Zones

2.6 Deer Creek Basin Land Use

2.6.1 Past, Present and Future development

Most of the valley bottoms in the area identified as the Deer Creek Basin in Figure 2-3 has historically been used for agriculture, primarily sheep and cattle raising as well as alfalfa crop generation. From the time the Heber Valley was settled, ranchers and farmers diverted water, tilled ground, and grazed their livestock with Heber Valley's relatively small but fertile geographical footprint, as well as that of Wallsburg. While very little change has occurred in the agriculture uses within Wasatch County's "Central Planning Area" of the Heber Valley ("North and South Fields" areas along the Provo River), a great degree in land use changes has occurred in the Eastern Planning zone of Heber Valley (Center and Lake Creek areas). Most of the changes that occurred in this area are a result of water and sewer infrastructure being extended by the Twin Creeks Special Service District. The extension of the sewer allowed two of the larger developments in the Lake Creek area to occur, Wild Mare Farms and Lake Creek Farms. Additional residential development has occurred and continues to materialize throughout the Valley Hills neighborhood, the Red Ledges private country club, the Wheeler Park and Timp Meadows subdivisions, Whitaker Farms, Scotch Fields, and several other subdivisions throughout Heber, Midway and unincorporated county areas.

2.6.2 Pastureland, Hay Fields, and Agriculture

Most of the alfalfa, grass and hay lands are in the valley bottom or lowest slopes. There are some alfalfa fields on steeper slopes particularly around Midway. Most are now sprinkler irrigated. Between crop farming, horseback riding, motorized and non-motorized trails and other recreational uses, the control of noxious and invasive plants is a growing concern. As sensitive areas are degraded, erosion increases and the opportunity for invasive weeds to thrive is provided. The invasive weeds typically represent a higher fire danger and choke out native species which control and balance runoff and water quality naturally. The result is increased erosion, increased biomass, and decreased water quality.

The county is 70% publicly owned, leaving 30% of land that is owned and maintained privately. Due to this high quantity of privately held land, property owner education about water quality, erosion, noxious weeds, and other impacts are a necessary step in mitigating pollution and contamination of Wasatch County's watersheds. In the past many local farmers have participated in natural resource conservation strategies, however the population continues to change, and education and outreach must intensify even as there are several large areas of contiguous farmland and pastureland being considered for residential and commercial development. If or when these developments occur, it is imperative that residents are educated about water quality strategies and the Best Management Practices that can be implemented at each residence. In addition, there are several full-time farmers in the area, along with part-time farmers; many farms are being purchased and operated by property owners without a complete knowledge of basic natural resource conservation practices.

Many livestock owners and boarding operators exist in the county watershed. Many of these facilities would benefit from additional technical assistance and guidance for appropriate manure management, range and pasture management, and the prevention of erosion to nearby washes and waterbodies. While the operations of these types of land uses represent a significant contribution to local water body pollution, the steps required to greatly reduce pollution is straightforward and affordable, such as limiting livestock from surface waters and re-routing storm runoff to simple treatment features.

Very few orchards or row crops exist in Wasatch County. A handful of very small apple orchards exist, and occasionally pumpkin and corn crops are produced. As land uses continue to evolve, any orchards or row crops that are proposed could generate erosion leading to turbidity in local waters, as well as contribute pesticides and fertilizers to surface flows eventually reaching local waters.

2.6.3 Forest Lands

Typical uses such as recreation and grazing exist throughout the many forests and unincorporated public lands within the Deer Creek Reservoir Basin. Previously described in previous sections, these uses are summarized as insignificant contributors to water quality degradation when properly managed and enforced. Maintenance of dirt roads and hiking trails to reduce dust and erosion can significantly minimize increased turbidity from non-natural sources, particularly when roadways and trails are in close proximity to streams and lakes; even when not in close proximity, heavy rains can transport sediment and cause increased turbidity from damaged areas. Livestock tracking and fecal matter represent high quantities of pollution in forest watersheds; yet prevention of tracking and defecating within stream banks and other sensitive areas represents a significant achievable water quality improvement opportunity.

2.6.4 Wildfire

The Wasatch County watershed is largely undeveloped with a large majority of land that is prone to wildfire. Fire burns essential native vegetation which is the best and natural source of protection against erosion. Due to Utah's geographic and climatological setting Wasatch County and surrounding areas have experienced ground-stripping forest fires followed closely by heavy rain and snowfall. The result is severe erosion which carries vast amounts of nutrient-laden sediment into nearby creeks, rivers, and lakes, and may potentially disrupt the quality of groundwater.

The severe potential and impacts of wildfire in Wasatch County warrant the control of wildfire as a high priority among local jurisdictions. The County should appropriately allow for (and has provided) means for the Wasatch County Fire Department, National Forest Service, and Bureau of Land Management to appropriately manage forest, remove dead stand, establish clearance zones around developments and limit the schedule and geography of when and where fireworks and open fires are permitted. Although even the best efforts can not entirely prevent uncontrolled wildfires, proper education, investment and regulation will prevent many degrees of water quality contamination and it's aftermath.

2.7 Current Wasatch County BMP's

Wasatch County currently has requirements for erosion control planning outlined in Wasatch County - *A Guide for Erosion and Sediment Control (1996)*. This guide overviews temporary erosion and sediment control BMP's that were the industry standard in 1996. Some of these BMP's include Stabilized (construction) Entrances, Diversion Dikes, Benching, Check Dams, Silt Fence, and Inlet Protection. Although theses BMP's are still used today, they are only temporary methods of preventing erosion, not comprehensive long-term solutions to a wide range of contaminants.

Appendix 5 of the Wasatch County code discusses some permanent erosion and sediment control BMPs. The primary stormwater BMP required by the County for developments is a "Water Quality Basin" sized to capture and contain the runoff volume from a two-year, twenty-four-hour storm at a minimum. These water quality basins detain or retain stormwater which prevents flooding, reduces downstream erosion, and allows sediment to settle before stormwater is slowly released from the site. The County code also has language stating that every practical effort should be made to prevent erosion from occurring at the source. This "requirement" encourages positive water quality strategies but lacks any sort of numeric objective and enforcement mechanism; therefore the "requirement" is often ignored in the practice of erosion control strategies deployed by developers. More requirements are needed to dictate when, where and what types of BMP's need to be installed to prevent discharge of contaminated stormwater, not only for sediment control, but for all types of pollution which could further contribute to the eutrophication challenges at Deer Creek Reservoir.

3 Previous Studies

3.1 1974 National Lake Eutrophication Study

This watershed has a long history of water quality interest by many Federal, State and local agencies, as well as the general public. Poor water quality conditions were first documented in the National Lake Eutrophication Study in 1974. Of the 27 lakes studied, Deer Creek Reservoir ranked twentieth most eutrophic. At the time of the study, the reservoir was eutrophic with anaerobic conditions developing during the July hypolimnion and persisted until September. Anaerobic conditions often existed under the ice cover in the January through April period. Algal growth was limited by phosphorous throughout the summer, except for localized nitrogen limitations during August.

The phosphorous loading in 1974 was determined to be 23,850 kilograms per year, including estimates of direct precipitation and immediate runoff. The reservoir outlet released a total of 15,605 kg/yr of phosphorus giving a phosphorus retention coefficient of 0.35. Based on the Vollenweider model it was determined that a 55 percent reduction in the 1975 phosphorus loading would be necessary to reduce the reservoir trophic state to borderline between eutrophic and mesotrophic. This implied a target loading of 10,730 kg/yr of total phosphorus (see 208 Water Quality Study).

3.2 1975-76 Mountainland Association of Governments

In the 208 Areawide Water Quality Management Study of major lakes in Summit and Wasatch counties, Deer Creek Reservoir was found to be strongly eutrophic in the shallow north end (main inflow end). Undesirable blue-green algae were dominant in this area, particularly during the heavy growth months in late summer. The deeper south end was found to be mesotrophic with the more desirable diatom algae being dominant throughout the summer. However, in the late summer the entire reservoir experienced anaerobic bottom conditions. The Larsen-Mercier model predicted an even more eutrophic condition than was observed in the reservoir.

At that time, the amount of phosphorous from inflowing streams were determined to be 23,760 kg/yr. However, the 208 Study did not include estimates of additional phosphorous introduced from precipitation, groundwater flow, and peripheral surface wash that would bring the total to about 27,000 kg/yr. The average annual phosphorus concentration was 0.074 mg/l based on a stream inflow of 260,500 acre-feet per year. A 50 to 60 percent phosphorus reduction was recommended to achieve a mesotrophic to slightly eutrophic condition in the reservoir. This resulted in a 1985 target loading of 14,355 kg/yr.

3.3 1984 Water Quality Management Plan

In a July 1979 letter, Governor Scott Matheson committed the State of Utah to the development of a Reservoir Management Plan for the proposed Municipal and Industrial System of the Bonneville Unit of the Central Utah Project. This action was taken in response to environmental issues raised in the Bonneville Unit Municipal and Industrial System Draft Environmental Impact Statement. The Governor's commitment was followed by action of the Bureau of Reclamation to include a reservoir management plan in the list of mitigating measures for construction of the Jordanelle Reservoir.

Due to the Clean Lake Studies, the Deer Creek and Proposed Jordanelle Reservoir Water Quality Management Plan was prepared cooperatively by the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) in 1984. The JTAC consists of representatives from over twenty Federal, State, local and private organizations, who are involved with water resource management within the Provo River drainage. This new management plan was considered an update to the 208 study previously discussed in 2.3.2.

The 1984 plan documented an average of approximately 25,000 kg/yr of total phosphorus was entering Deer Creek Reservoir. The plan identified goals for reducing the average phosphorus load by 11,000 kg/yr. Table 2-1 shows the goals outlined in the 1984 plan as well as an estimate of the actual reductions achieved since 1984. Many agencies and groups have spent considerable time and money on water quality, erosion control, and related projects to improve water quality in Deer Creek Reservoir.

3.4 Heber Valley Regional Wastewater Treatment Plant

In response to water quality concerns, the Heber Valley Special Service District (HVSSD) constructed three aerated lagoons with winter storage, chlorination, and land application disposal to treat and dispose of municipal wastewater. The HVSSD facility was originally put into service for Heber City and Midway with the potential for expansion when growth in other areas made it necessary. Reductions in total phosphorus due to the HVSSD facility have been estimated at 5,000 kg/yr. The facility became operational in 1979.

In 1993 and 1994, wastewater facility plans were completed for the Jordanelle Reservoir Basin and the Twin Creeks Special Service District, respectively. Each made plans to utilize the HVSSD treatment facilities to handle the wastewater from their service areas. In this extended capacity, the HVSSD facility will prevent nutrients from entering the Jordanelle Reservoir by treating wastewater at the existing facility. Also, septic tanks have been brought off-line in the Twin Creeks areas as the sewer system has been extended into the service district.

3.5 Snake Creek Rural Clean Water Program

The objective of the Snake Creek Rural Clean Water Program was to reduce pollution from agricultural sources through the implementation of best management practices on lands south of Midway and west of Highway 113. The project was completed in 1993 and the reductions in total phosphorus from the Program have been estimated at 1,000 kg/yr.

3.6 Construction of Jordanelle Reservoir

The construction of Jordanelle Reservoir, upstream from Deer Creek Reservoir, was identified as a means to trap phosphorus from the Upper Provo River through phosphorus retention and sedimentation. The Jordanelle Dam was completed in April 1993 and was filled by 1996. The Jordanelle Reservoir is operated by a Selective Level Outlet Works (SLOW) Tower. This tower allows more flexibility in the operations of the reservoir. The Bureau of Reclamation and the Central Utah Water Conservancy District have completed studies to determine operational procedures that assure downstream water quality and flow targets are met. Since 1996 there has been a reduction in phosphorus loads ranging from 2200 kg/yr to 3500 kg/yr.

3.7 Clean Lakes Program

The Clean Lakes Phase I Study and the 1984 Management Plan identified dairy and feedlot operations, housing construction, development of ski resorts, agricultural return flows and stormwater as a significant source of nutrients. The implementation of BMPs was recommended to reduce the phosphorus loadings. The Deer Creek Clean Lakes Phase II Program was initiated to address these sources. In 1994 the Mountainlands Association of Governments and the Utah Department of Environmental Quality completed the final report for the Deer Creek Reservoir Clean Lakes Phase II Study. The primary objective of Phase II was to address recommendation of the 1983 Clean Lake Phase I Study. The final report documents the measures that were recommended or implemented to reduce agricultural pollution and to educate the public about these pollution sources. Eleven agricultural operations in the watershed participated in implementing improvements to their operations. Improvements included the construction of concrete manure bunkers, liquid waste lagoons, piping of ditches through corrals, fencing of riparian areas, fertilizer management plans, and off-stream livestock watering systems. The public education program involved the printing and distribution of water quality brochures to the general public and a water quality booklet for use by educators. Wasatch County implemented planning and zoning measures to protect water quality such as sediment control from recreation areas and construction sites. The County also addressed stormwater and flood control issues.

3.8 Fish Hatchery Phosphorus Removal

The Clean Lakes Phase I Study also identified phosphorus from fish hatcheries to be a controllable source. In an effort to comply with the water quality objectives, settling ponds were constructed at the Midway Fish Hatchery and phosphorus limits were set through a Utah Pollutant Discharge Elimination System (UPDES) Permit. However, in 1989 the permit was renewed without any phosphorus limits. Through the work of JTAC members the UPDES permit issued in March of 1995 again included phosphorus limits. It has been estimated that 625 kg/yr of phosphorus has been reduced through efforts at the Midway Fish Hatchery.

3.9 Tri-Valley Watershed Plan

In 1996, the Natural Resources Conservation Service (NRCS), through the United States Department of Agriculture's Small Watershed Program (PL-566), assisted Wasatch Soil Conservation District and Wasatch County in developing a land treatment watershed plan. The plan addressed natural resource problems and opportunities within the 248,000-acre watershed. Purposes of the Tri-Valley Watershed Project were water conservation, improved fish and wildlife habitat, and water quality. On-farm irrigation systems fulfilled the purpose of water conservation and improved fish and wildlife habitat. The on-farm systems were considered a priority because the conserved water would be used to enhance in-stream flows to benefit fish habitat. Some water quality improvements were a result from decreased surface runoff and decreased deep percolation. A detailed sediment yield study for various sub watershed areas appeared in the Tri-Valley Watershed Plan. The sub watersheds with significant erosion were then targeted for further study to identify appropriate best management practices.

3.10 Chlorophyll Response Model

In 1984 the U.S. Bureau of Reclamation used data on Deer Creek Reservoir for the period 1975, and 1980 to 1983 to develop two mean summer chlorophyll A response models. These models were used to assess the impacts of changes in annual inflow total phosphorus concentrations, and annual discharge volume on the mean summer chlorophyll A concentrations in Deer Creek Reservoir.

The Chlorophyll A Response Model suggest that hydrodynamics in the reservoir may be influenced by the reservoir's discharge, affecting the availability of phosphorus in the reservoir. Higher flows through the reservoir would be expected to flush nutrients in the hypolimnion, reducing the phosphorus available to algae in the fall turnover and reducing the production of algae.

The response model makes it obvious that even with a fixed target phosphorus concentration or load, variations in the natural system (i.e., weather, phosphorus retention, hydrodynamics, etc.) will cause a variable response in the production of chlorophyll, algae, and the trophic state of the reservoir.

The analysis using this model shows that if the inflow phosphorus is held to 40 ug/l, the reservoir will be mesotrophic most of the time and borderline eutrophic or worse only 10% of the time. In an average water year this target is approximately 14,000 kg/yr; however, in wetter years it would be 21,000 kg/yr or 12,000 kg/yr in a drier year.

3.11 Deer Creek Water Quality Model

The Central Utah Water Conservancy District, with the support of JTAC members, in 1995 developed a predictive computer model to simulate water quality in Deer Creek Reservoir. The purpose of the mathematical model was twofold; one, to assist in a better understanding of past problems associated with algal blooms that clogged water treatment plant filters and caused taste and odor problems, and two, to guide management decisions to improve and protect water quality in Deer Creek Reservoir. CE-QUAL-W2, a two-dimensional hydrodynamic water quality model which was developed and maintained by the U.S. Army Corps of Engineers' Waterways Experiment Station, was selected to accomplish this.

The analysis to develop the model found Deer Creek Reservoir to be mesotrophic based on concentrations of total phosphorus (TP), algal chlorophyll and Secchi transparency in the surface water observed during summers of 1985 to 1994. Seasonal mean values of total nitrogen (TN) and TP suggested that the overall TN:TP ratio was approximately 20 which is the point phosphorus would be considered as the limiting nutrient for algal growth. Occasionally, the TN:TP ratio declined to around 10 in the late summer indicating that nitrogen could regulate some components of the algal community in Deer Creek.

The study found decreasing long-term trends in TP and TN concentrations in the reservoir which indicated overall success of point-source and non-point source pollution control programs in the watershed.

3.12 Wasatch County Water Efficiency Project and Daniels Replacement Project

The Wasatch County Water Efficiency Project (WCWEP) and Daniels Replacement Project (DRP) were mandated by U.S. Congress in the Central Utah Project Completion Act (CUPCA). The purpose of WCWEP was to increase the efficiency of water use in the Heber Valley by lining irrigation canals to prevent leakage and install a pressurized delivery system to facilitate conversion of flood irrigation farms to sprinkler irrigation. These improvements were meant to bolster stream flows in the Heber Valley and enable the DRP. The WCWEP enables 3,675 acres of farmland to be converted to pressure irrigation. It is estimated that 23,000 acre-feet of water will be conserved each year.

The DRP delivers water to the Daniels Irrigation Company and eliminates the previous need to divert water from the Strawberry Reservoir basin. The elimination of this trans-basin diversion increases the natural inflow into Strawberry Reservoir by 2,900 acre-feet benefiting fish and fish spawning.

These projects benefit water quality by reducing the return flows from farms in the Heber Valley which are a significant source of nutrient pollution to Deer Creek Reservoir. The projects were completed in 2001 and improvements to water quality should begin to be apparent.

3.13 Deer Creek Resource Management Plan

The Deer Creek Resource Management Plan, for Federal Project Lands surrounding Deer Creek Reservoir, was initiated in 1993 by the Bureau of Reclamation. The overall goal was to develop management strategies to protect and maintain the purposes for which the Provo River Project was authorized by congress, as well as provide long-term management direction for proposed future uses.

The Plan was divided into two phases. Phase One was completed in late 1993 and consisted of researching existing planning efforts, determining plan goals and objectives, and public meetings. Phase One also included an inventory of data to address issues and outlined the procedure to accomplish Phase Two work.

Phase Two involved the development of possible alternatives for management of the resources in the project lands to ensure water integrity. A modified Alternative 1 (proposed alternative) was identified as the least damaging alternative. The modification included allowing grazing on project lands east of U.S. Highway 189 as long as best management practices were implemented.

The Plan describes the activities necessary to achieve the desired future condition of the project and includes: Area-wide goals and objectives, Area-wide management requirements, Specific area management direction, Lands suited and not suited for resource use and production, and Monitoring and evaluation requirements. The Deer Creek Resource Management plan was adopted in 1998.

3.14 Provo River Restoration Project

The goal of the Provo River Restoration Project (PRRP) was to restore the Provo River in Heber Valley from below Jordanelle Dam to Deer Creek Reservoir. In the past many areas of the river have been straightened for construction of flood control levees. In 1999, the Utah Reclamation Mitigation and Conservation Commission began the Provo River Restoration Project (PRRP) between Jordanelle Dam and Deer Creek Reservoir to restore the river's pattern and ecological function to a more natural condition.

The PRRP consists of constructing a multiple thread meandering channel, reconnecting the river to existing remnants of historic secondary channels and constructing small side channels to recreate aquatic features. Existing levees are set back to create a near natural flood plain that allows the river to change course naturally. Planting and fostering streamside vegetation will provide the necessary environment for healthy fisheries. Side channels and ponds will improve fish habitat and create habitat for wetland dependent wildlife.

Utah Division of Wildlife Resources and U.S. Bureau of Reclamation in 1999 initiated the project by carving new meanders, side channels and wetland ponds in and around the Provo River from about 1.6 miles downstream of Jordanelle Dam to Highway 40. The area was revegetated and an angler access site along this reach was also improved. This work was coordinated with the Central Utah Water Conservancy District, which rebuilt diversion facilities as part of the Wasatch County Water Efficiency Project.

In the Fall, 2000, an additional 1.3 miles of the river was restored between Highway 40 and the bridge crossing on River Road in Midway. Similar to the work upstream, this river reach was taken out of a straightened, diked channel and carved into new meanders, accompanied by side channels and wetland ponds. The project along this reach is mostly complete. Other items, such as, revegetating disturbed areas, constructing additional wetland ponds, constructing two additional side-channels, and completing a new angler access site to include a restroom, resurfaced driveway and parking area, were completed in the Spring, 2001.

3.15 Annual Water Quality Implementation Reports

The 1984 Management Plan also suggested that the status of water quality in the Provo River, Deer Creek Reservoir and Jordanelle Reservoir be reported annually. Since 1984 Water Quality Implementation Reports have been prepared by Wasatch County under the direction of the Jordanelle Technical Advisory Committee. These reports accomplish the following:

- Present the results of the annual water quality sampling
- Identify exceedances of water quality parameter standards
- Identify trends in water quality
- Analyze the effectiveness of current management practices, and
- Recommend action for further progress towards water quality improvement.

3.16 Summary

The majority of past studies in the area have focused on phosphorus related constituents of concern (COC's) typical of a rural watershed. However, as the Heber valley transitions into a small metro area additional COC's are likely to become increasingly relevant.

4 Ongoing Studies

In 2013, the EPA announced a new framework for implementing the Clean Water Act (CWA) Section 303(d) Program. The new Program Vision is informed by the experience gained over the past two decades in assessing and reporting on water quality and in developing approximately 65,000 TMDLs nationwide. It enhances overall efficiency of the CWA 303(d) Program, encourages focusing on priority waters, and provides States flexibility in using tools in addition to TMDLs to restore and protect water quality.

The prioritization process has been guided by the Division's mission statement: "Protect, maintain and enhance the quality of Utah's surface and underground waters for appropriate beneficial uses; and protect the public health through eliminating and preventing water related health hazards which can occur as a result of improper disposal of human, animal or industrial wastes while giving reasonable consideration to the economic impact."

With the recognition that there is not a "one size fits all" approach to restoring and protecting water resources, Utah has developed tailored strategies to implement its CWA 303(d) Program responsibilities in the context of our water quality goals. While the Vision provides a new framework for implementing the CWA 303(d) Program, it does not alter Utah's responsibilities or authorities under the CWA 303(d) regulations.

The following waterbodies in Wasatch County were recognized as high priority for TMDL studies to be completed by 2022. These following three studies are in progress by the Utah Division of Water Quality.

-Snake Creek TMDL for Arsenic and E. Coli

-Upper Provo River TMDL for Aluminum and Zinc

-Spring Creek (Tributary to "Middle" Provo River) TMDL for E. Coli

5 Constituents of Concerns

Historically, water quality concerns have been dominated by agricultural and recreational activities. As development pressures throughout the valley increase the stormwater pollution "*Constituents of Concern*" are anticipated to shift toward municipal and industrial pollutant sources. While ongoing efforts should be made to minimize agricultural and recreational water quality degradation, future regulations must consider the evolving land uses throughout Wasatch County in order to adequately protect water quality and maximize the value of the beneficial uses of local waters. As the watershed is currently becoming increasingly urbanized, and is expected to be significantly developed and re-developed, local jurisdictions must mitigate the contaminants known to occur in such a watershed:

1) **Sedimentation** and **turbidity** occur as a result of unstable soils. Typical manmade sources of turbidity are construction sites, paved and especially unpaved roadways, and livestock tracking in or near streambeds and ponds/lakes. A significant source of turbidity during and following storm events is runoff from higher angle slopes especially slopes with disturbed ground surfaces or stripped vegetation. The majority of such surfaces are manmade and can be mitigated as described later in this report.
2) **Nutrients** such as phosphorous and nitrogen come from manmade sources such as fertilizers, livestock grazing, and decomposing biomass such as dead deer or elk on a roadway. Wastewater from treatment plants has been a focus for nutrient reduction for several decades, and although there is nutrient constituents present in wastewater treatment plant discharge, the majority of nutrient loading typically is not associated with treatment plants.
3) **Hydrocarbons** result from fossil fuel usage and petrochemical processing. Sources include fueling stations, parking lots, roadways, and other surfaces where motors which leak oil or fuel, as well as roadways made of asphalt or "slurry sealed".
4) **Heavy Metals** such as arsenic, iron, selenium, zinc, mercury, and many others sometimes occur naturally, but are also always present with machinery and certain industries like mining as a non-natural contamination. In either soluble (dissolved) or particulate form, and whether occurring naturally or otherwise, heavy metals represent a significant health risk as a well-established cause

of various cancers. Typical vehicle use sacrifices several heavy metals found in tires and brakes such as zinc and copper (among others). Roadways, parking lots, industrial sites and certain processing facilities generate significant amounts of heavy metals which are usually readily carried away in stormwater to storm drains and end up in local water bodies affecting human and aquatic life negatively.

5) **E-Coli** and other **bacteria** are found wherever humans or other animals leave bodily fluids including fecal matter, blood, vomit, or decomposing biomass of any kind. Bacteria accelerates eutrophication of water bodies and renders water unsafe for human consumption and even recreation.
6) **Medications** have been found to negatively affect even large bodies of water with small concentrations of some medications which will disrupt aquatic life reproductive systems and potentially cause a local or regional ecosystem imbalance. These imbalances are what typically lead to eutrophication and other water quality challenges.

Other known impairments include the **alkalinity**, **Ph**, and **temperature** of local water bodies, each of which are as critically important to the sustained quality of water as any of the contaminants mentioned above. PH affects the toxicity of heavy metals since lower PH makes heavy metals more soluble in the water source. Soluble heavy metals are much more difficult to remove from water at treatment plants, and intermittent occurrences of heavy metals in drinking or recreational waters may not be realized for treatment considerations. Temperature affects reaction rates of other contaminants as well, and generally warmer temperatures promote eutrophic conditions as well as decreased vitality for many fish species which keep water ecosystems balanced.

5.1.1 Soil Erosion Hazard Due to Development and Recreational Activity

Due to significant growth and development activities in Wasatch County, there are large areas of land which are being denuded and disturbed during construction activities. Many development activities increase the potential for sediment, debris, and other pollutants to be transported with storm water runoff into storm drain facilities.

Sediment is typically rich in nutrients such as phosphorous and nitrogen some of which is molecularly bound (as opposed to dissolved). Sediment is common in most surface flow, but especially in stormwater runoff and especially from areas of disturbed and unstable ground surfaces. Typical sources of sediment within the county boundaries include construction sites, paved and unpaved road surfaces, ephemeral washes, off road vehicle venues, agricultural sites, and livestock grazing particularly on hillsides and/or in or near streambeds. To exacerbate the manmade issue, many areas within the county convey runoff from these locations by pipeline or gutter systems directly to the local waterbody without any opportunity to settle the sediment along its course. Suspended sediment in creeks, rivers, and lakes increases turbidity which prevents light from penetrating the water. The lack of ultraviolet rays penetrating the depths of water causes aquatic plants to die due to lack of sunlight for photosynthesis. Lakes and ponds become the deposit basins for all this sediment and nutrient and more quickly become prone to revealing the negative effects of nutrient loading and eutrophication.

These nutrients promote the excessive growth of algae. As previously described, this process is called eutrophication. Areas of excessive algae growth, also called algae blooms, deplete oxygen in the water resulting in die-offs of aquatic animals lacking sufficient oxygen. Such an example is where the lower Provo River is dammed and gauged near Vivian Park; extensive manmade deposition of sediment results in algal blooms early in the summer even when waters are swift and cold. The algal blooms grow and shrink at times throughout the remaining summer months but are typically present and give the textbook indications of sedimentation and nutrient loading.

According to the 2013 Wasatch County Resource Assessment (UACD, 2013), soil loss by erosion in Wasatch County averages 0.021 tons of soil per acre since the late 1980's. Clearly, erosion represents a significant impairment of local and regional water quality. By reducing erosion, not only is nutrient-rich soil preserved in place for sustainable vegetation growth, but water quality is greatly increased due to a decrease in turbidity and a decrease of nutrient loading resulting in clearer and cleaner water less likely to become eutrophic.

5.1.2 Urban Development

Stormwater runoff from urban landscapes contain high concentrations of most of the pollutants listed above, resulting in a significant source of pollution which impair receiving waters and compromise the identified beneficial uses. An understanding of local stormwater conditions such as pollutant loading, and point source identification is an important component in developing water quality regulations. The more urbanized a region may be, the more likely local water bodies are to be negatively impacted by nutrients, herbicides, and pesticides used to fertilize vegetation, control weeds, and exterminate insects and vermin. Heavy metals and hydrocarbons from cars and from the roadway materials increase. All of these constituents represent a negative impact to local and downstream waterbodies. Appropriately developed management strategies to target contaminant load reductions and improve natural and manmade impairments will result in reliable and sustainable water quality benefits.

To minimize the impairment of beneficial local waterbodies by stormwater runoff, the EPA initiated a two-phase process for implementing stormwater regulations. Phase I was first implemented in 1990 and affected certain types of industries, construction sites larger than 5 acres, and cities with a population larger than 100,000.

Phase II of EPA's stormwater regulations, which was first implemented in 2003, affects smaller construction sites and any areas designated as Urbanized Areas by the U.S. Census Bureau. Phase II rules apply to any community outside an urbanized area that has a population greater than 10,000 and a population density higher than 1,000 people per square mile.

Further, state laws dictate that for construction sites disturbing more than 1 acre anywhere in the state, including the Wasatch watershed, the project owner is required to obtain a permit for the stormwater discharges associated with construction activities. Commonly known as "Stormwater Pollution Prevention Plan" (SWPPP) or "Erosion Control Plan", permit holders are charged with the responsibility of preventing erosion and controlling erosion where it may occur despite best practical efforts. The Division of Water Quality issues permits for stormwater discharges associated with construction activities and requires the use of best industry practices to achieve the greatest level of erosion protection. After construction, developments are permitted through local jurisdictions and are required to mitigate flooding and long-term water quality impacts through “Site Design”, “Source Control” and “Structural Control” implementations, the first two of which are also known as “Low Impact Design” strategies.

6 Implementation Methods and Strategies

6.1 Overview

A large portion of the water supply to Salt Lake and Utah counties originates or flows through Wasatch County. As such the County should put forth its best effort to care for the watershed and the influence that the County has on it. Maintaining effective and reasonable policies centered around correct purposes and goals will be essential to protect the future of Utah’s water supply and quality. It is important to implement strategies which also allow for Wasatch County to continue its path of economic growth while maintaining agricultural history and recreational opportunities.

The current and future population and commercial growth in Wasatch County and the resultant urbanization warrant revisions to the current water quality enhancement requirements and practices. In Council and with citizens input expressed, effective and appropriate standards and ordinances can be adopted which yield positive economic and recreational outcomes locally, as well as overall betterment of the water supply critical to a growing population downstream.

Based on the discussion with representatives of many Wasatch County Departments, and in consideration of the history and current status of water quality in the County as described in previous sections, potential implementation strategies and specific practices are recommended as organized and presented below.

6.1.1 Best Management Practices

Best Management Practices (BMPs) are defined as measures, methods of operation or practices which are designed to prevent or reduce water pollution from specified sources and which are consistent with the most effective methods developed and/or used in a given industry- in this case, the water quality industry.

6.1.2 Code Enforcement Perspectives

Two primary ideologies exist in the regulation of stormwater throughout the United States. Present in various form, there is no singular option that is deemed “correct”. The most appropriate regulations and their structure of enforcement are dependent on desired outcomes, political settings, and the collective desire to adopt innovation.

The first and more prominent water quality program (nationally speaking) is the "**Solution Regulation**" program. Under this format, testing and proving are developed which manufacturers and innovators must engage and satisfy in order for their device or solution to be "approved". These types of programs tend to assume that "all stormwater is equal" and all devices or solutions treat stormwater similarly. Examples of programs currently in place around the country include "Technology Assessment Program – Ecology" (TAPE) and "New Jersey Comprehensive Assessment Tool" (NJCAT). Many State DOT's operate their own unique "Approved" or "Qualified" product lists and include water quality solutions in their program. Locally, this method would establish strict and uniform specifications resulting in very little design flexibility or innovation. The assumption of this method is that the specifications established by the County could be met by implementing strict policies, strict product approvals, and strict construction and maintenance oversite. Typically, achieving an appropriate ordinance requires more upfront research and development which is in turn easier to enforce via design review and field inspections. However if stormwater is acknowledged as relatively differentiated from one site to another (and it often is), it is possible that "approved" solutions are inappropriately or ineffectively deployed, and that many times a solution is required which is not necessary considering performance needs and economics.

The second type of water quality regulation format is referred to as "**performance based"** regulation, meaning the code would establish performance parameters and the responsibility to assure such parameters are met is upon the developer working with a civil engineer and contractor. For example, both Colorado and Idaho (both considered *Performance Based* regulators) stipulate that stormwater discharge from a given site must meet specified effluent standards, such as 30 milligrams per liter TSS, or 0.52 nanograms per liter to avoid damage to fish. Performance-based specifications place the burden of identifying and establishing BMP strategies directly on developers in partnership with their consulting professionals. Proposed designs are reviewed by governing authorities to assess the solutions are reasonable. During construction, inspectors and consulting engineers review the physical implementation of water quality solutions. Upon occupancy of the site it is up to the owner to operate the water quality facilities in a satisfactory manner such that if or when stormwater effluent from the site is tested, regardless of site circumstances, the stormwater must meet the effluent standards conditioned upon the site (which should emanate from identified impairments of downstream receiving waterbodies). The consequences of not meeting the standards need to be substantial to motivate developers to adhere, and as such fines of hundreds or thousands of dollars are often associated with failed test results. Under this format, specifications for design and implementation are typically easier to establish and generally absolve local jurisdictions of the risk connected with attempting to identify "approved" solutions as described above. Under this program, the County and local jurisdictions would establish a monitoring program adequate to test effluent, assign fines if necessary and update the effluent standards in an equitable fashion.

Recommended Implementation

Wasatch County residents, business leaders, and elected officials have historically embraced the political ideologies of "less control" by government and more freedom for individual citizens and singular entities. Rather than comprehensive government controls, the majority of Wasatch County constituents currently prefer decision-making autonomy relatively unbounded by bureaucratic constraints. Yet the County must become involved in the protection and perpetuation of sustainable critical resources, especially that of local water bodies for their use as potable water, recreational safety, environmental significance, and as economic stimulus. The County's overall interest necessitates involvement in a manner that residents and businesses alike can participate in water quality objectives in an open and competitive market which offers a wide range of solutions and associated costs. To this end, it is recommended that the County focus on "**Performance Based**" regulation measures to achieve water quality goals. The message becomes "*The County has water quality goals for our developers to satisfy however the developers choose and can reasonably demonstrate compliance*". Rather than dictating that developers must install "widget A", the County conditions that *a widget* must be implemented which meets the following effluent requirements; x, y, z….

This approach not only affords developers and contractors the flexibility to consider and select among many available options, it further emphasizes the underlining objective which is the successful realization of cleaner site discharge and comparatively cleaner, less contaminated local water bodies, and the perpetuation of the many beneficial uses enjoyed in the Wasatch County watershed.

As another point of adequate implementation, any stormwater solution requires proper operation and maintenance. Just like we cannot send infinite quantities of raw sewage to a treatment plant without adjustments in controls and processes at that plant, structural and site-design stormwater pollution removal solutions all require maintenance to remove captured pollutants and sediment, assure proper conveyance feature functionality, and adapt to changing site uses. Enforcement of this activity is typically achieved by way of codes and covenants that exist in perpetuity from the original property developer or redeveloper, onward.

6.2 Stormwater Control Systems

Erosion is the result of many circumstances whose control merits individual discussion. In identifying how to minimize sediment transport, it is helpful to discuss the stormwater system. Precipitation or other sources of free water at the ground surface collect or "concentrate" and flow over the steepest path available to lower elevations until reaching lakes, reservoirs, streams, or rivers. Some surface water can evaporate and infiltrate into the soil even when it is flowing, and some can be taken up by vegetation, or it can be directed by human interference. Stable watersheds exhibit the following: Minimal erosion, clearer and cleaner water, and a high tolerance for heavy rains. These factors are due to a balance of natural sustainable large or small vegetation and interlocked soil particles undisturbed by human activity or other factors. Unstable watersheds exhibit the following: A low tolerance for heavy rains with muddy flows, erosion scars, head cutting across banks, distressed native vegetation, exposed roots, invasive weeds, and an unnatural degree of exposed soil. The negative affect on otherwise natural runoff processes can usually be avoided through education, ordinance, and enforcement. Given the County's geographical area of jurisdiction, it is likely that the County has the greatest measure of influence in protecting the watershed in the mid and higher elevations, while the Cities of Heber, Midway, Daniel, Charleston, and Wallsburg can target the greatest benefits in the lower valleys and urban tributaries draining to local receiving waters such as Provo River, Main Creek, Snake Creek and Deer Creek Reservoir.

6.2.1 Municipal Separate Storm Sewer System

When publicly managed as a broad utility system, infrastructure such as curb and gutters or street-side swales, storm drains and retention/detention basins are considered "Municipal Separate Storm Sewer Systems" (MS4s). These MS4s must be registered and permitted through Utah Department of Environmental Quality, Water Quality Division. Due to population thresholds Wasatch County will soon exceed, Wasatch County will become a regulated MS4 within perhaps 2-5 years. The well-established functions of a regulated MS4 include:

1. Public Education
2. Public Outreach
3. Construction Phase "**Stormwater Pollution Prevention Plan**" (SWPPP) implementation and enforcement
4. Post-Construction "**Stormwater Management Plan**" (SWMP) implementation and enforcement
5. Routine Inspection and Maintenance
6. Proper Municipal and Private Operations

6.2.2 Localized Stormwater Management

A common goal of LID is to de-centralize and disconnect stormwater flow paths, the purpose being to put stormwater runoff in contact with pervious ground surfaces which reduce runoff and promote pollutant capture onsite, rather than discharging all concentrated and polluted flows to MS4 facilities and ultimately, to local waterbodies. This form of LID can be accomplished by providing redundant infiltration zones for roof runoff, parking lot runoff, and dispersing of other concentrated flows. Swales, basins, underground galleries and rain gardens are effective site design tools.

Two types of stormwater control facilities are common in developments in Wasatch County which collect, treat, and reduce stormwater runoff. Section 16.28.07 of Wasatch County Code states that "Required stormwater runoff collection facilities shall be designed so as to retain stormwater runoff on development sites for a sufficient length of time so as to prevent flooding and erosion during stormwater runoff flow periods except in areas where master storm drainage systems have been approved…" to mitigate increased flows. These basins are further discussed in Section 16.40 Appendix 5 of the County Code. Retention basins are constructed as localized depressions with banks adequate to retain water until it infiltrates into the soil and evaporates. The effectiveness of retention basins depends on the infiltration rate of the native subgrade soils. Detention basins are intended to hold or "detain" stormwater while it is released at a determined rate of discharge intended to avoid downstream flooding and erosion impacts. Detention and Retention ponds allow many pollutants such as sediment and the metals and nutrients bound to sediment to settle out of the water and be retained for future collection and appropriate landfill disposal.

Retention and detention basins as well as other stormwater features such as swales are often landscaped with grass. The live vegetation is helpful in nutrient uptake calming of turbulence which in turn promotes higher rates of sediment settling. The landscaped features add aesthetic beauty to sites and are even used as open space and parks. Care should be taken not minimally fertilize these areas only as needed; fertilizer is one of the pollutants the County is seeking to minimize.

Many developments cannot spare the additional land area required for a traditional pond. As a result, the design of these sites often included buried infiltration galleries that can be used in the same manner as retention or detention basins. Similarly, the performance of underground galleries and their functionality particularly as a retention feature depends on the infiltration rate of the native soils.

For purposes of pollutant control and effectiveness of retention basins and galleries, these features should be maintained well, meaning that frequent inspection is performed to apprise operators when accumulation of sediment is noticed, or when drawdown times become extended. All types of these basins eventually become occluded and less efficient at infiltrating runoff. Further, accumulated sediment and the pollutants bound to the sediment may become resuspended and flushed downstream, adding further imperative to the need for inspection and maintenance.

Recommended Implementation

The use of detention and retention basins as surface (open-air) or underground stormwater control facilities should include adequate design to prove that post development runoff is equal to or less than pre-developed conditions, which will have the anticipated outcome of minimized flooding and minimized erosion and pollutant discharge. Basins are "volume based" BMPs because their design depends on a determined quantity of stormwater which must be managed, and determining these quantities and sizes is a well-established practice; however, the County may choose to dictate certain design parameters. For example, Infiltration rates of the existing soil strata should be conducted with ASTM methodologies and reasonably reduced to a predictable long term and sustainable rate for basin design and performance (roughly 25%-50% of observed design investigation rates). County guidance should codify the dispersion of basins within Title 16, especially sites that are one acre or larger in size. Such design promotes sustainable infiltration practices resulting in lower maintenance, longer service life, and better balance of post-development hydrology. County could provide examples of well-designed basins masked as landscape features or even usable open space when site parameters allow. A designer must also review the locations of wellhead protection zones, and appropriate design strategies implemented: In Zone 1, infiltration BMPs are not permitted. In Zone 2, infiltration BMPs may be permitted provided that the design includes features to mitigate constituents of concern prior to reaching the infiltration zone.

6.2.3 Swales vs. Curb and Gutter

Although a seemingly specific practice to discuss on such a broad topic, the debate between use of curb and gutter versus green swales is worthwhile. Green swales (a.k.a. "*Bioswales*" and "*Vegetated Swales*") are an economic alternative to a typical curb and gutter collection system along a roadway. Aside from the obvious construction savings, swales allow for subsurface infiltration as well as filtering of pollutants. Swales should be rip-rapped and grassed for long-term durability. Although green swales require more land space, they maintain a more natural aesthetic. Wasatch County is largely rural or undeveloped and makes for a good location to implement more green swales in harmony with County's stated values to retain its rural setting.

Like any other feature, swales require maintenance. Swales can be damaged or impacted by re-landscaping and re-grading by residents unintentionally, or by parking or driving on/in them. As a landscape feature, swales require some degree of maintenance ranging from weekly mowing or mowing three to four times per summer – depending upon the landscape styles and vegetation types chosen. Riprap at inlets and outlets makes a swale more durable and less likely to erode, and that riprap will need to be maintained from uninformed removal, wheel traffic and other rare but possible occurrences.

Recommended Implementation

Swales must be designed to provide contact time, thus are considered a "flow-based" BMP. From a site's associated hydrology study, a flow rate and velocity can be determined and using such data, the bioswale can be designed with adequate minimum lengths. The County may develop a calculation aid for this purpose which is easy to utilize and review. The County can also dictate types of grass and engineered soils for maximum sustainable performance. Inspection and maintenance criteria should be adopted and enforced by covenant or ordinance.

6.3 Erosion Control in New Development

6.3.1 Zoning

Effective county planning and appropriate zoning can minimize erosion issues. The County is observing an increase in higher-density residential and commercial development. Agriculture, though still a very large geographical percentage of the County, is diminishing. Pollution constituents and concentrations vary greatly between agricultural, residential, and commercial development. However, it should be noted that contrary to common belief, residential development frequently causes more nutrient pollution (e.g. fertilizers) than crop farmers because crop farmers are more judicial and economical (limiting) in their use of fertilizer. Other contaminants such as hydrocarbons and heavy metals may be more "bearable" in some locations than in others immediately adjacent to waterbodies. Thus, water quality concerns comprise a viable basis for zoning ordinances. Politically, various perceptions and paradigms must be considered to adequately protect the watershed and maintain life and economy as desired in the County.

Recommended Implementation

It is recommended that the county evaluate a number of current codes and development policies to evaluate ways to better balance water quality protection with the need for development. These recommendations include, for example, limit hillside development in areas with predominant slopes greater than 20-30%, and prohibit development when slopes are 30% or greater. Certain utilities and ski lifts may be carefully considered and planned on such slopes. Or zoning could encourage 'clustering' which involves building medium to high density housing in a small percentage of the total area of one or several parcels with the remaining land undisturbed as open space. Where zoning is effectively "grand-fathered", overlay zones can be utilized to enforce increased water quality improvement as enforceable when properties change hands or are re-developed, remodeled, or otherwise altered by permit. Some agencies have adopted codes which allow the transfer of development rights away from steeper slopes or environmentally sensitive areas on to properties likely to have less water quality impacts. A similar policy could be adopted in Wasatch County to relocate some of the grandfathered rights to protect water quality while protecting vested rights.

6.3.2 Design of Temporary and Permanent Drainage Features

When storm water is concentrated to in flow rates greater than what the soil has historically been exposed to, an increased rate of erosion will result. Shown in Figure 6-1, concentrated flow can erode large drainage gullies, cause head cutting, and strip the ground surface. Concentrated runoff should never be allowed to flow over fill slopes or natural banks in a concentrated form. If there is no other option to avoid concentrated flows, design and implement structural solutions such as "Turf Reinforcement Mats" (TRM) or underground piping to a stable discharge location. Many manufacturers provide erosion control and stormwater conveyance products well suited to adequately resolve bank erosion concerns.

Figure 6-1 Erosion on fill-slope from concentrated flow.

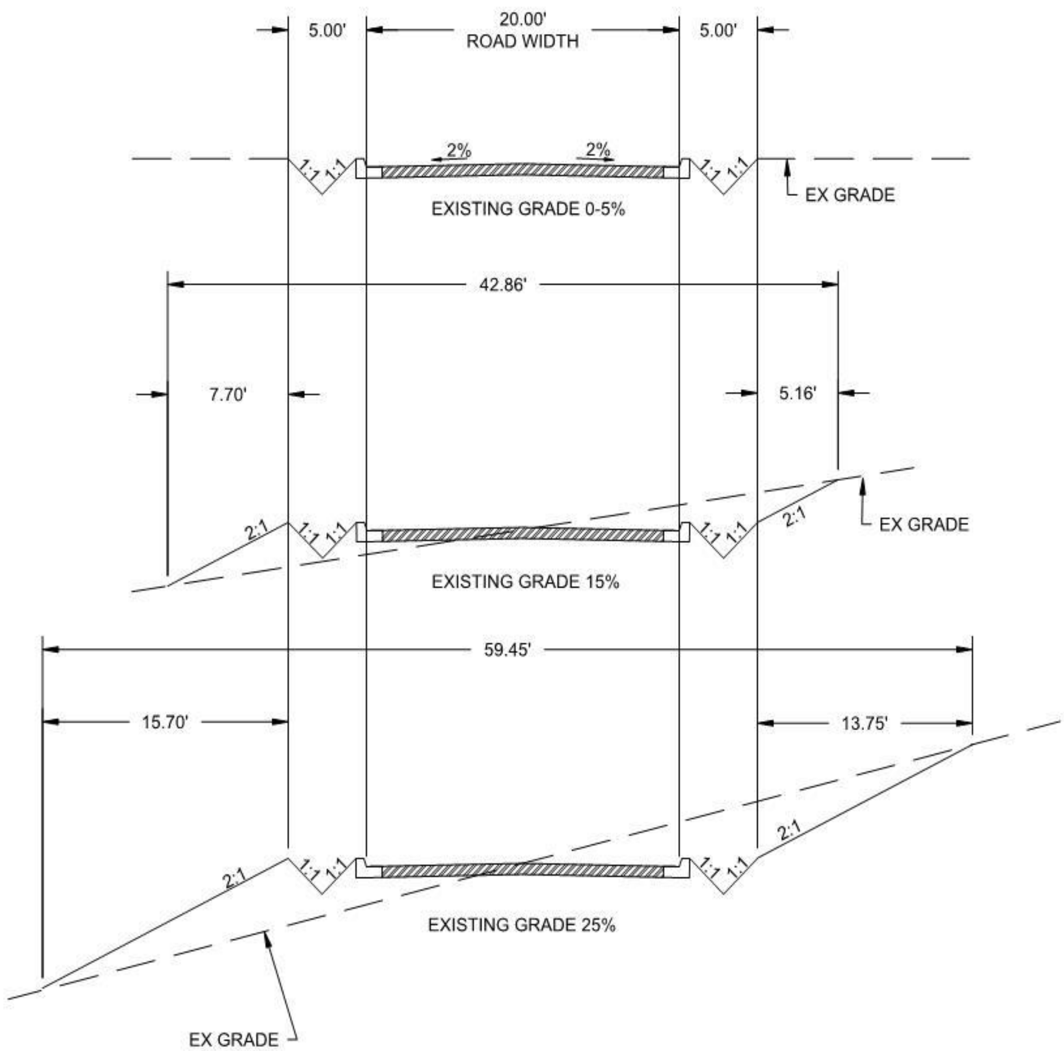
Recommended Implementation

Update the County Storm Water design requirements to require concentrated discharges to be mitigated. County may require surface discharges to be unconcentrated or otherwise piped or protected with TRMs. Potential dispersed drainage patterns should be considered using multiple flowline paths and/or sheet flow across the proposed development. Where drainage discharge is unavoidable, the discharge should be analyzed for erosion potential and adequate design. In many cases, an underground pipe or lined swale may be the simplest solution. In any case, discharge is often contaminated and should be treated prior to leaving a site in order to protect downstream receiving waters. The County should review discharge conditions in their review processes for developments, subdivisions, and plat plan sets.

6.3.3 Grading

An important principle involved in each of these sub-sections is that steeper slopes increase runoff velocity. The greater the velocity of the water, the higher erosion severity. For example, a slope that is twice as steep erodes approximately four times as much. One of the most widely used equations to estimate soil loss due to erosion is the Revised Universal Soil Loss Equation 2, otherwise known as RUSLE2. Updated in 2003, RUSLE2 is used to predict the long-term average rate of rill and interrill erosion (USDA, 2019). Rill and interrill erosion are the removal of layers of soil from the land surface by the action of rainfall and runoff. The four major factors the RUSLE2 equation takes into account are climate, soil type, topography, and land use. Details on the methodology of the RUSLE2 equation are located in Appendix A. Particularly, development on steeper slopes of 15% or more need to be evaluated for the impact that the disturbance will have. The steeper the cross slope, the more impactful the development will be due to the need to lay back slopes fill slopes, and with these filled and laid back slopes come increased stripping of existing vegetation and surface disturbance greatly more susceptible to erosion.

The following illustrations are design cross sections used to demonstrate the impact of road or driveway implementation relative to the amount of ground disturbed in order to lay back slopes on flat slopes of 0-5% cross slope up to cross slopes of 25%. The disturbance cross section on a 25% cross slope is nearly three times that of a same road built on a cross slope of 0-5%. In addition, the steeper slope is approximately 8 times more susceptible to erosion. The combination of a larger disturbed area combined with steeper slopes creates the potential for up to **24 times more erosive potential** for the same road. This outcome would hold for any roadway width and suggests that building on steeper slopes induces exponentially more surface disturbance and resultant erosion.



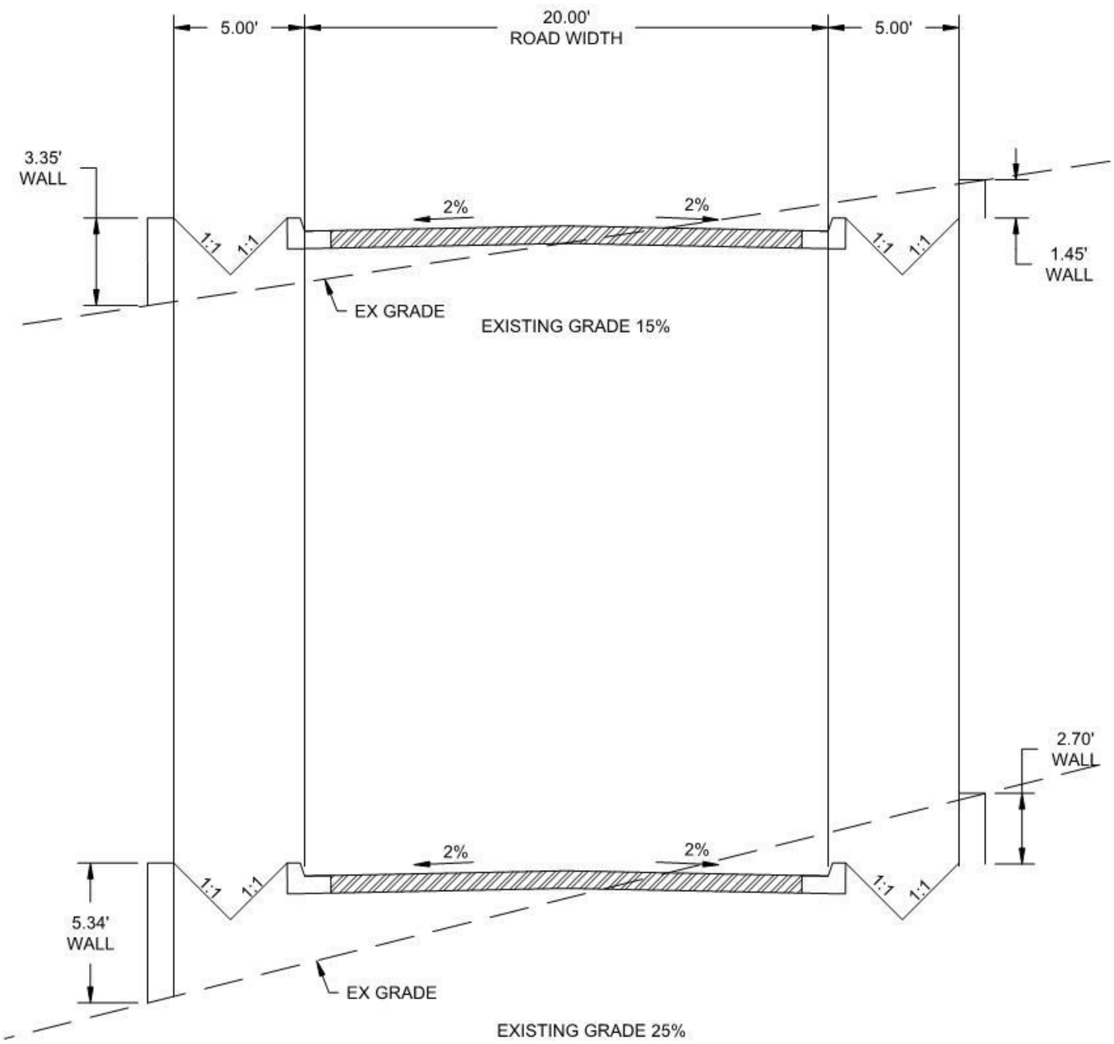
ROAD CUT SLOPE CROSS SECTION EXHIBIT

5 0 5 10

SHEET 1 OF 2

T-O ENGINEERS

2211 W. 3000 S.
HEBER CITY, UT 84032
PHONE: (435) 315-3168 WWW.TO-ENGINEERS.COM
E-FILE: ROAD CROSS SECTION EXHIBITS.dwg DATE: 1/16/20 JOB: 190076



ROAD CUT SLOPE CROSS SECTION EXHIBIT

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SHEET 2 OF 2

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Maximum Developable Grades

Given Wasatch County's climate, soil type, and cover management, we have estimated using RUSLE2 that slopes over 25% generate soil losses greater than the best management practices of 5 tons/acre/year (University, 2019).

The current County code, and many surrounding codes limit construction on slopes greater than 30% Figure 6-2 shows the areas in Wasatch County with slopes greater than 30%. It is recommended that the Code be modified to eliminate almost all land disturbance activities in slopes greater than 30%. Some exceptions maybe properly designed recreational trails, fire access roads, utilities, and carefully planned utility access routes.

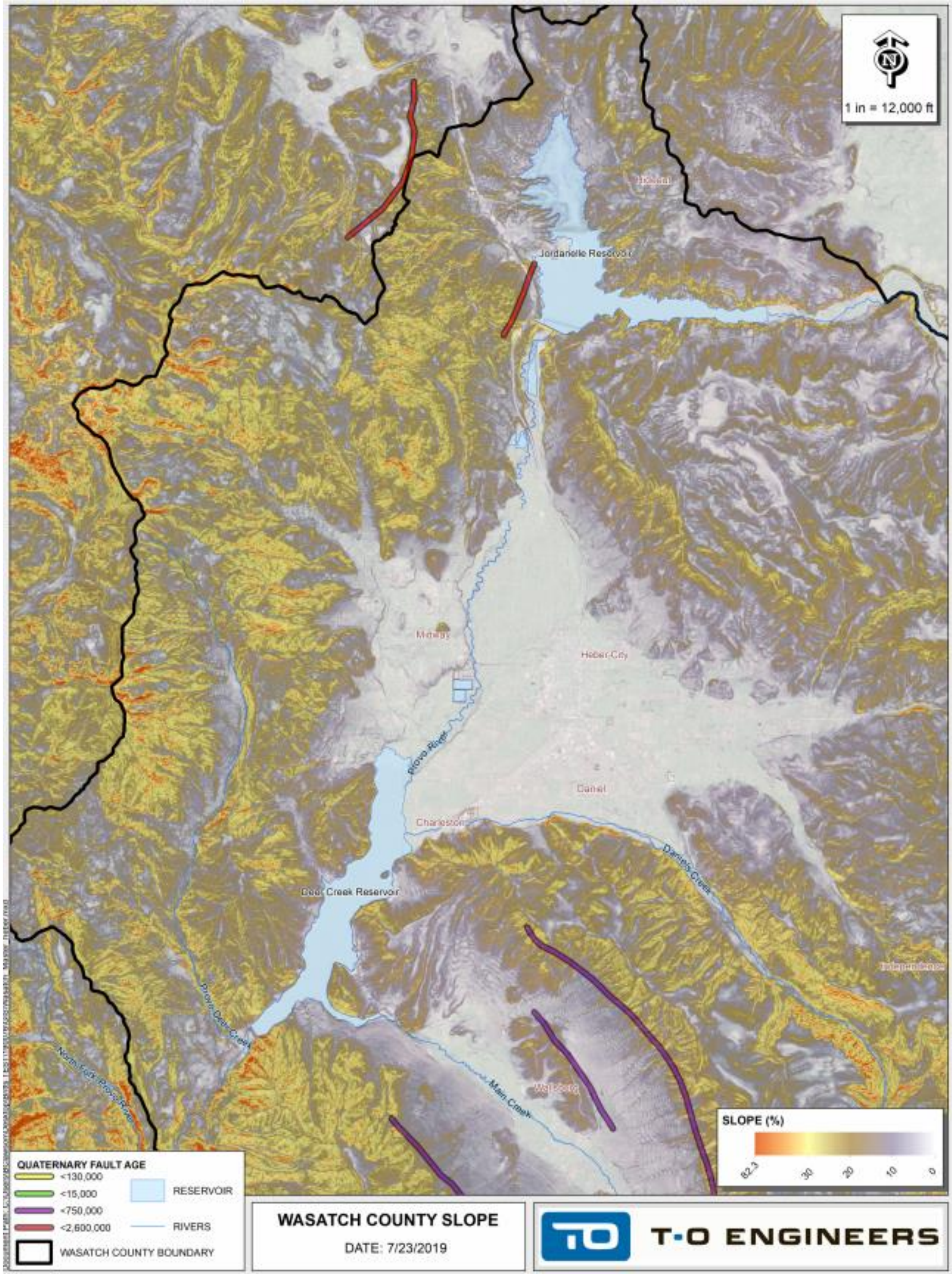

Figure 6-2 Steep Slopes in Wasatch County

Recommended Implementation

Currently, Wasatch County code (16.27.24) restricts that "each lot must have a contiguous building area that is a minimum of five thousand (5,000) square feet at thirty percent (30%) or below natural grade:" Development on native grade 25% or more requires that a geotechnical engineer perform a slope stability analysis specific to the proposed building location. However, slope stability analyses rarely incorporate the ability of the slope to seed and retain vegetation. Although the code restricts *building envelopes* in areas sloping greater than 30%, it does not prohibit development in such steep locations; when a development strategically places buildings in areas with slopes less than 30%, it is common that driveways, roads, landscaping and grading are implemented in native slopes of 30% or more. Rarely is construction on such steep slopes a necessity with a few exceptions: fire access, trails, and emergency accesses. Residential development on steep slopes presents many challenges to the county beyond water quality and erosion and a prohibition of development on steeper slopes is supported by numerous considerations. Not allowing any construction above 30% and restricting all land disturbance related to development on slopes between 20% and 30% with minimal cut and fill area's and volumes would support preservation and water quality.

Minimizing Disturbance to Native Grade

Wasatch County values not only its historic and social heritage, but also the native geographic conditions, namely the many mountains and hills found county-wide. Current consensus is that efforts should be made to minimize disturbance to existing topography. This goal not only maintains the inherent physical beauty of natural mountain viewsheds, but also sustains the stability and persistence of native vegetation thus minimizing erosion and pollution of the watershed. Regardless of slope steepness, a common design strategy is to minimize disturbance of inclined areas because erosion potential is much greater. The greater the disturbance to native conditions, the higher the possibility that severe erosion and watershed pollution will occur. Wasatch County's future code should embrace the full intent of this regulation in order to maximize the objective. Namely, the County should limit 1) **Depth** of cut and fill, 2) **Volume** of depth and fill, and 3) **Area** of depth and fill. By limiting the depth, the County can assure that future development does not introduce long term erosion potential of manmade slopes and preserve the natural pitch and "Angle of Repose" most likely to naturally prevent erosion. By limiting the Volume and Area of cut or fill per acre, the County can further assure disruption of native slope/terrain is prevented, and that large areas of erosion-inducing disturbance are avoided.

Recommended Implementation

The intent of the current Wasatch County code is that 'major land disturbance' is to be avoided by 'limiting mass grading.' Section 16.27.25 also states "The project will preserve major natural site features and existing vegetation." It is not clear, however, how to quantify these guidelines. Wasatch County could specify with greater detail what is meant by "Major Land Disturbance" and "Major Natural Site Features'. For example, limits of maximum cut or fill, quantity of various types of vegetation (shrubs, trees, for example) that may be removed, and extents of grading that may be permissible, preservation of ridgelines, among other considerations, may individually or collectively limit disturbance to native grades and potential impairment of stormwater runoff. Because civil designers often design maximum cuts or fills over large areas of native topography, the County may carefully consider the limits to which large developments may or may not extend cuts or fills even if they are not of maximum depth.

6.3.4 Stormwater Pollution Prevention Plans

Part of an MS4 permit dictates that municipalities must permit construction activity by regulating illicit discharge specifically during the construction phase of projects. It is in this phase of the project that SWPPP plans are developed and implemented. This section discusses what is required of developers and contractors during development construction in compliance with SWPPP objectives.

6.3.4.1 Implementation of Additional and Modified BMP and SWPPP Ordinances

Additional BMPs

The County may update the permanent and/or temporary erosion control BMPs required on ground slopes between 15% and 30%. Tighter spacing of wattles, more robust silt fences, temporary or long-term seeding or mulching, collection traps or other practices should be considered. County Inspections are a critical component to any successful SWPPP plan as many contractors either do not understand or choose to ignore the proper implementation and maintenance. Adequate slope stabilization would be a requirement prior to authorization to proceed with other site construction activities. For example requiring stabilization of phase 1 before phase 2 can be started.

A critical element of SWPPP's is that of "inlet protection", or the protection of the existing storm drain system from sediment and erosion which typically occurs on and downstream from construction sites. Many current practices for storm drain inlet protection are widely regarded as inadequate (state and nationwide) as municipalities have not advanced as far as current technology and design methods. Throughout most of Utah, inlet protection consists of some variation of filter fabric being placed over, under or around a storm drain inlet, or even fewer effective sandbags placed around an inlet. Often the sandbags are damaged or overtopped with sediment. The fabric barriers rip and are not replaced. Often these barriers are left in place and present a long-term clogging situation which threatens local properties with flooding. Wasatch County could enhance this element of SWPPP's by disqualifying many of the error-prone products, increasing the inspection and reporting frequency of these items, instituting penalties and fines for improper use, and withholding of Certificates of Occupancy until inlet protection products are collected and storm drain systems cleaned (when impacted by a construction project). Better inlet protection performance serves not only water quality purposes for flows with outfalls into local waterbodies, it also reduces sedimentation of storm drains and the associated cleaning and jetting otherwise the default responsibility of local jurisdictions.

Another source of significant sedimentation is wheel tracking from dirt to pavement on nearby streets. Particularly in wet conditions, this wheel tracking represents a high degree of sediment transport and roadway pollution which often is washed into nearby stormwater facilities causing the same issues described in the inlet protection discussion above. The recommended solution for wheel tracking is for contractors to provide stabilized construction entrances made of angular rock which cause most of the mud and dirt to disengage from tires prior to entering the public right of way or paved street. In some cases, a wheel spray station can be used in automated or manual modes. While it is likely that some mud and dirt will be found on paved streets next to construction sites, measures should be taken to reduce this sediment load particularly adjacent to receiving waterbodies and where storm drain systems convey runoff directly to said waterbodies.

The County may consider establishing guidance for what types of BMPs are recommended or allowed, and which BMP's are recommended or required in sensitive areas. To obtain justification for such recommendations, the County would benefit informationally by surveying what SWPPP BMPs are in use and the degree of their effectiveness and user friendliness.

Maintenance and Enforcement of SWPPP BMPs

The current code does not require maintenance of BMPs. SWPPP inspection requirements are generally increasing in both frequency and intensity around the State Utah. For example, State code now requires SWPPP contact information on all construction sites, as well as stormwater monitoring, weekly reports with photos and certified signatures. Wasatch County has several neighboring municipalities from which SWPPP enforcement measures can be observed and adopted, including Summit County, Park City, Orem City, Provo City and others.

Utility Installations and other Erosion Inducing projects

The County has observed issues when large utilities are installed (such as an electricity transmission line, or large pipeline). Concerns center around the fact that the alignments frequently run up steep slopes and the slope is left unvegetated post-construction. Sometimes these alignments are seeded post-construction, but the seed fails to germinate, and significant erosion ensues. The County should consider increasing bonding projects where the County is left at risk for erosion failures, with a portion dependent on the seed taking, requiring SWPPP plans to remain open until vegetation has been restored and other incentives for the contractor to fully restore the area as quickly as possible.

6.3.5 Revegetation

Stripped ground surfaces pose a significant risk of erosion, even relatively flat ground regardless if the slope was manmade or natural. Beyond the removal of the vegetation which "abstracts" rainfall and holds soil in place with roots, typical stripping also disturbs 100% of the ground surface so that the most critical and erosive soil layer becomes extremely unstable. Therefore, removal of vegetation especially by grading or other stripping machinery should be quickly remedied; the stripped area should be stabilized by seed or mulch and other features such as wattle and silt fence (if needed to prevent sediment transport) as soon as possible during construction where/if feasible and upon completion of construction without almost any exception. This requirement can also take the form of code or ordinance.

Although clearing brush does not necessary qualify as "disturbing vegetation", the topsoil should either remain or be replaced and ground-level vegetation should exist (e.g. grasses). Complete removal of vegetation may be acceptable in emergency scenarios such as firefighting, however an effort to mulch and seed such areas is well justified post-emergency.

6.3.6 Post-Construction Stormwater Management Plans

Stormwater Management Plans (SWMP's) differ from SWPPP's because they propose stormwater infrastructure and outline the performance and maintenance procedures at a given site for the long-term operation or "post construction" phase of a developed site whereas SWPPP's are typically intended for the construction phase control of sediment and other stormwater pollution prevention. SWMP's present all the features used at a site to manage stormwater, which may include generic aspects such as "pervious landscaped areas" and specifically designed proprietary devices or designs which target stormwater pollutants, volumes and/or flow. The SWMP typically takes the form of a hydrology study presented in report format and is combined with sheets in the plan set which depict storm drain infrastructure and water quality features with associated construction, maintenance, and operation details.

While SWPPP's are typically required for all land-disturbing construction project sizes and types, a SWMP for projects which disturb 1.0 acre or more is a common requirement around most of the United States. The essential elements of a "Stormwater Management Plan" include:

1) Depiction of the proposed site location on a regional map
2) Identification of receiving water bodies in succession of nearest to farthest including a listing of the beneficial uses and impairments identified for each waterbody.
3) Identification of the Stormwater Constituents of Concern which will likely be generated at the proposed development
4) Engineering calculations deriving the flows and volumes generated from a "First Flush Flow" based on local rainfall, soil and vegetation types, and other pertinent hydrology data.
5) A plan depicting the quantifiable mitigation of the "Constituents of Concern" based on a "First Flush Flow" rain event.
6) Engineering calculations, manufacturer literature, warranties, or other material which justify and satisfy the requirement to mitigate pollutants in a long-term sustainable fashion.
7) Recommended inspection intervals and maintenance procedures
8) A **Covenant and Agreement** to inspect and maintain all stormwater features subject to penalty as defined by Wasatch County.

Recommended Implementation

County personnel may pursue the development of a "Stormwater Management Plan" template which will assist developers, designers, and County personnel in meeting the State and EPA requirement to mitigate the long-term risks of illicit discharge based on site use and setting. Utilization of a template will streamline review and approval processes while tasking design engineers to adequately assess the water quality situation site by site. SWMP's would typically not be required as part of a conceptual planning proposal to the Planning Commission, but the key demands and solutions for a proposed development should be identified with likely solutions by the time preliminary approvals are sought. Final approval requires a fully developed, reviewed, and approved SWMP, which is a separate item from SWPPP's and should be uniquely evaluated as to their different intents. Once approved and constructed, the County can assure the intended results are pursued through the long-term inspection and maintenance of public as well as private stormwater facilities by one of two options: 1) Enforcing private performance of the inspections and maintenance with deliverables presented to the County in the form of a report meeting the County's stated criteria and a semi-annual or annual basis (or as needed), or 2) Collect fees for the County to perform these tasks and issue work orders to contractors if or when stormwater quality facilities are in need of maintenance or repair.

6.4 Trails

Wasatch County is a popular destination for outdoor recreation, especially hiking and mountain biking. The County's residents and visitors value the developing trail systems and the County desires to maintain existing trails and integrate them with future development. Trails are seen as appropriate additions in areas too steep for physical development and in unique settings along creeks, rivers, lakes, viewpoints and even to interconnect neighborhood and urban areas. A narrow footpath presents a likely exception to the notion that steeper grades must not be disturbed provided that the trail is truly a minimal width and is properly designed and well maintained. Trails do present an erosion risk; however, those risks are made negligible by proper design.

Recommended Implementation

Trail design considerations are important as trails represent one aspect of development and recreation which is highly sought, and which directly contradicts erosion control ideology. Wasatch County can realize the maximum benefit and negligible risk; Minimizing the trail grades and requiring interpterion's in steep grades through detailed design guidelines will reduce the risk of trail erosion. Trail grades should rarely match the steepest natural grade in the area, the exception being on relatively flat terrain. A proper trail cross section maintains the prevailing flow direction of runoff without concentrating the flow in or along either side of the trail. Trail design should avoid direct ascension of a hill face and should instead institute "switchbacks" to ascend terrain steeper than about 7%. Trail steepness should not exceed approximately 8%. Design should include erosion control features such as "water bars" and bridges. Trails should maintain 25 feet from wet and dry streambeds and necessary crossing should include adequate boulders, logs or bridges to prevent streambed disturbance. Trails crossing steep slopes from uphill banks form during trail construction and remain highly erodible and unsupportive of vegetation; efforts should be made (and potentially enforced regulation) to minimize these "cuts" and to stabilize them with native topsoil and plants. Uphill bank cuts could be limited to a minimal height and slope. To further limit erosion, it is recommended that soft surface trails be limited in width to the extent possible. In the case that a trail shares an alignment with different feature, such as a fire break or fire escape route, the County will assess the appropriate design parameters such as those found in county code section 16.38.

6.5 Water Treatment

6.5.1 Septic Systems

Septic systems infiltrate untreated sewage directly into the ground where biological processes break down the caustic elements of sewage relatively clean water percolates into the ground. The nature of septic systems is of concern for the fact that inappropriately designed, inadequately maintained, or exceeding a certain threshold density of septic systems could majorly impair water quality anywhere in the County Watershed. Even a minor tributary becoming negatively impacted by septic system induced contamination is a major implication for local water bodies and the many associated beneficial uses, including the contamination of ground water should septic loading become too intense for natural processes to digest. Wasatch County Department of Health standards suggest that the existing regulation of one dwelling with a septic system per 5 acres safe and sustainable. This standard along with increased inspection and reporting requirements will provide the County with an inventory of septic systems in use and their functionality.

Recommended Implementation

Wasatch County should periodically re-evaluate the appropriate density, uses and allowable locations for septic systems to be implemented. The influence of septic systems on groundwater quality is always of such concern that ongoing review and analysis is merited which may lead to frequent policy and practice changes. Implementing an inspection and maintenance program is a viable step for the County to take which would assure that the County's health standards are being met and to show that the systems are being inspected and maintained as a sustainable solution throughout the County. Inspection and Maintenance activity can be verified by a template report on an annual basis. The use of septic systems and requiring clustered development will require careful consideration to cluster the housing while still providing sufficient distance between drain fields. It maybe that enhanced treatment systems, or treatment facilities will be required as part of clustered development.

6.6 Agriculture

Agriculture plays a significant role in the water quality of regional waterbodies. Strategies to minimize pollution from agricultural sources have been developed for many decades and implemented in varying degrees of adequacy, attitude, and effectiveness. Many livestock raisers are excellent stewards of soil, vegetation, and water resources. Yet there are many obvious opportunities to significantly mitigate contamination of local waterbodies by enacting measures great and small. The presence of livestock in streams represents significant inducement of erosion and the deposition of fecal matter which contain dangerous bacteria such as E-Coli and Giardia, any of which arriving at already beneficially utilized waterbodies presents a significant impairment. Wasatch County can assist livestock raisers in their use of public and private lands first by education and demonstration.

Recommended Implementation

Certain aspects deserve straightforward consideration and potential regulation such as the presence of livestock in wet streambeds as well as seasonal streambeds which may be dry at times. Streambed setbacks, off-stream water supply for cattle and sheep, and seasonal waste cleanup are some of the regulations Wasatch County can institute on public or private lands which shed water to local waterbodies with beneficial uses. For boarding and concentrated grazing on private lands, runoff can be diverted to treatment facilities such as sand filters which significantly reduce nutrients, bacterial loads, and sediment-laden discharges. Where livestock grazing occurs, water quality monitoring can be instituted as a tool for the county to identify problematic areas and partner with livestock raisers to implement improvements. As with all other uses, agricultural land uses warrant ongoing BMP development and adaptation, particularly as emerging technologies are realized, and water quality improvement potential becomes accessible.

6.7 Summary of Recommended Implementations

6.7.1 Performance Based Regulations

Wasatch County should commence development of performance-based water quality regulations which not only satisfy EPA requirements but also provide sustainable water quality practices which protect local waterbodies from manmade impairment and reduce overall contaminant loading. This should include updating storm water design manual to include low impact development, proper run-off calculations, as well as performance and measuring criteria for water quality devices.

6.7.2 Post-Construction SWMP O&M Agreements

Wasatch County should institute a program of requiring SWMP's for the life of a site. Utilizing templates and/or allowing customized solutions which meet local TMDL requirements will be a task performed by designers and quantitatively assessed by County plan reviewers. Ongoing inspection, maintenance, and operation backed by a threat of potential fines will assure long-term benefits of water quality implementations are being realized. The program may take many different forms but ultimately results in the verification that money spent on stormwater solutions is not wasted but rather that the investment is maximized in terms of the most beneficial results being realized.

6.7.3 Restrict Grading on steep Slopes

Wasatch County's mountainous landscapes do not always offer ideal land development opportunities due to several safety, environmental, and water quality factors. Limitation of development on slopes producing rapid erosion and other safety concerns related to slope stability, fire, and access will exponentially limit the County's involvement and liability when future catastrophes occur. Steep slope developments contribute greatly to water quality pollution during rainstorms and snowmelt episodes

6.7.4 Limit Maximum Cut and Fill

By instituting limits on the maximum allowable cut and fill per acre, the County's water bodies will benefit due to preservation of native grades and slopes which remain stable during rainfall and snowmelt. Encouraging development transfer from steep slopes to flatter areas and support clustering to the extent feasible will offset any restriction to limit disturbance on steep slopes.

6.7.5 Institute Bonding Requirements to Ensure complete erosion control

Wasatch County should institute a program of ongoing inspection, maintenance, and operation to assure long-term benefits of water quality implementations are being realized; The program may take many different forms but ultimately results in the most beneficial results being realized for dollars spent on required water quality solutions.

6.7.6 Require SWPPP Plans and SWPPP Inspections

The County can comply with the State's and EPA's Construction Phase permitting by requiring SWPPP plans and inspections which satisfy erosion control mitigation and other potential sources of contaminants. County can develop templates for streamlined design, review, and enforcement and require designers to assure that erosion control requirements are satisfied even if custom controls are required. Weekly and monthly inspections with potential fines for mis-managed SWPPP's in the field will assure the County is enacting all feasible means to enforce the SWPPP program.

6.7.7 Ongoing Water Quality Education, Incentive, and Enforcement

Continual education of residents, ranchers, and other land users generates awareness and impacts attitudes. The County can work with targeted groups in appropriate degrees of intensity to increase education and promote Non-Structural BMP's related to operation habits, activity awareness, and impact avoidance. Further, the County can incentivize targeted users whose participation represents strategic opportunity to achieve greatly enhanced water quality in nearby receiving water bodies. Recreators and others may be educated likewise but must also assume a certain degree of responsibility enforceable by fines and other actions when such obvious responsibilities are neglected, ignored, or abused.

7 References

EPA. (1983). *Results of the Nationwide Urban Runoff Program - Volume I.* Washington, D.C.

Epic. (2012). *Wallsburg Coordinated Resource Management Plan.* Heber City.

PSOMAS. (1991). *Upper Provo River Water Quality Management Plan.*

PSOMAS. (2000). *Heber Valley Storm Water Management Plan.*

PSOMAS. (2002). *Deer Creek Reservoir TMDL Study.* Salt Lake City.

Reclamation, U. D. (2012). *Jordanelle Reservoir Resource Management Plan.*

Stream Bank Fencing: Green Banks, Clean Streams. (2019). From PennState Extension: https://extension.psu.edu/programs/nutrient-management/educational/best-management-practices/stream-bank-fencing-green-banks-clean-streams

UACD. (2013). *Wasatach County Resource Assessment.*

University, M. S. (2019). *RUSLE On-Line Soil Erosion Assessment Tool*. From http://35.8.121.89/cgi-bin/rusle_constr.cgi

USDA. (2019). *Water Erosion (RUSLE2)*. From USDA: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/tools/rusle2/

USGS. (1991). *Hydrology of Heber and Round Valleys.*

8 Appendix A

8.1.1 Overview of Major Factors

Climate: The most important climatic variable used by RUSLE2 is rainfall erosivity, which is related to rainfall amount (how much it rains) and intensity (how hard it rains). Another important climatic variable is temperature because temperature and precipitation together determine the longevity of biological materials like crop residue and applied mulch used to control erosion. Climate varies by location, and choosing a location in RUSLE2 chooses the erosivity, precipitation, and temperature values needed to apply RUSLE2 at a particular site.

Soils: Soils vary in their inherent erodibility as measured in a standard test involving a "unitplot." A unit plot is 72.6 ft (22.1 m) long on a 9% slope and is maintained in continuous tilled fallow (no vegetation) using periodic tillage up and down slope to leave a "seedbed-like" soil condition. The USDA-NRCS has assigned soil erodibility values for most cropland and similar soils across the US. RUSLE2 includes a procedure for estimating soil erodibility for highly disturbed soils at construction sites and reclaimed mined land. The RUSLE2 user typically selects a soil by soil-map unit name from a list of soils in the RUSLE2 database.

Topography: Slope length, steepness, and shape are the topographic characteristics that most affect rill and interrill erosion. Site-specific values are entered for these variables. See the section on Definitions for additional information concerning these variables.

Land Use: Land use is the single most important factor affecting rill and interrill erosion because type of land use and land use condition are features that can be most easily changed to reduce excessive erosion. RUSLE2 uses the combination of cover-management (cultural) practices and support practices to describe land use.

8.1.2 RUSLE2 Methodology

RUSLE2 uses the conservation of mass principle to compute estimates of rill and interrill erosion. This principle can be illustrated by considering a segment of the overland-flow path shown below in Figure 8-1 RUSLE2 Methodology (USDA, 2019).

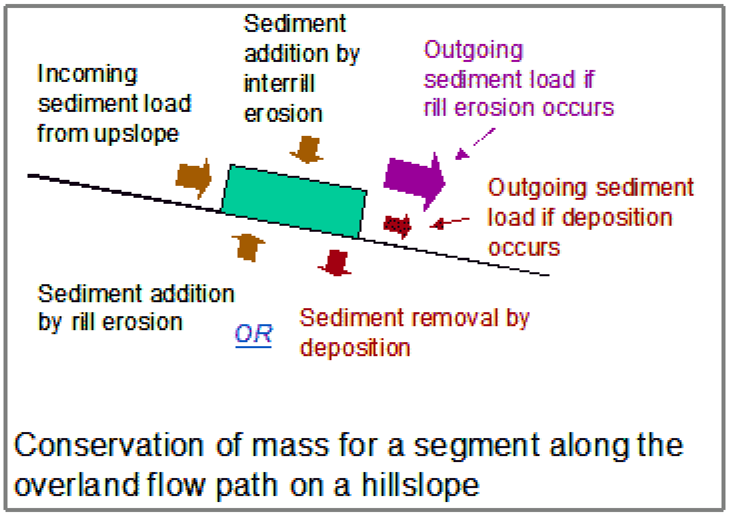

Figure 8-1 RUSLE2 Methodology

If rill erosion occurs within the segment, the amount of sediment leaving the segment (sediment load) = the amount of segment that enters the segment from upslope + the amount of sediment produced by interrill erosion within the segment + the sediment detached within the segment by rill erosion. If deposition occurs within the segment, the sediment load leaving the segment = the sediment load that enters the segment from upslope + the amount of sediment produced by interrill erosion within the segment - the sediment deposited within the segment. If net detachment occurs by both rill and interrill erosion, the sediment load increases along the slope, which is typical for uniform, convex, and mildly concave slopes. If net deposition occurs, the sediment load decreases along the slope in the depositional area, which is typical of strongly concave slopes. In contrast to the USLE and most applications of RUSLE1, RUSLE2 can be applied to concave and complex slopes where deposition occurs. Thus, RUSLE2 can compute sediment yield from hillslopes where deposition occurs.

RUSLE2 computes net detachment each day using a variation of the familiar USLE factors:

$$A = r\ k\ l\ S\ c\ p \qquad [1]$$

where: A= net detachment (mass/unit area), r = erosivity factor, k = soil erodibility factor, l = slope length factor, S = slope steepness factor, c = cover-management factor, and p = supporting practices factor. The lower-case symbols represent daily values. Upper case symbols used in the USLE and RUSLE1 represents annual values. Each factor, except the slope steepness factor S, in equation 1 changes as environmental conditions change daily and as cover-management conditions changes with specific events, like a soil-disturbing operation. Although the values used for each factor are daily values, they represent long-term average conditions for that day.

Request for Qualifications
Wasatch County Consulting Firm

Background:

Wasatch County is soliciting the services and requesting the qualifications of a professional planning/engineering/transportation firm ("Consultant"), to work with Wasatch County on a local planning assistance grant primarily funded by UDOT to update the County's General Plan and respective ordinances to better facilitate multi-modal and context sensitive connected roads and trails.

Wasatch County is a fast growing community with a diverse range of development types. The Consultant will work directly with county planning staff, engineering, the Fire District and possibly the Planning Commission and County Council.

The following scope of work will be expected to be delivered by the Consultant:

Scope of Work:

1. Analyze existing General Plan language with specific focus on the transportation section, and compare with existing ordinances to identify areas of conflict or redundancy as well as areas that are not addressed or need to be addressed better.
2. Analyze the existing street network, specifically in the valley floor, for a potential local street plan to identify critical future corridors to protect as development occurs.
3. Use data driven, research backed, best practices, strategies and tools to improve connectivity and use those for implementation throughout the unincorporated portions of the County and more specifically:
    - Provide goal and policy language for the General Plan that will provide guidance for an efficient multi-modal transportation system, including streets with a non-motorized component.
    - Provide goal and policy language that creates a context sensitive connected street network.
    - Provide goal and policy language that takes into account the varying topography of Wasatch County and allows flexibility where strict connectivity would negatively impact other important characteristics of the County, such as protecting views by limiting excess cut and fill slopes.
    - Provide draft language to update codes as necessary to reflect new General Plan goal and policy recommendations.
    - Provide guidance for implementation of modified grid networks and not rigid rectangular blocks.
    - Provide goal and policy language for the General plan to encourage non-motorized trail/bike lane connections to augment the street network and provide options to reduce traffic congestion and increase recreational opportunities.
    - Augment existing language and update the County Code and General plan, if applicable, to require connected streets while also allowing some flexibility.

- Identify areas in the County where multiple existing goals or policies could be fulfilled through County initiated street and/or trail capital improvement projects.
- Provide recommendations on traffic control, striping and signage to allow better traffic flow and reduce conflict areas between multi-modal options.

Required Content of the Request for Qualifications (RFQ):

1. Cover letter stating the Consultant's interest to participate. Letter of transmittal should be on official business letterhead.
2. Statement of affirmative action that the Consultant does not discriminate in its employment practices with regard to race, color, religion, age (except as provided by law), sex, marital status, political affiliation, national origin, or handicap.
3. Proof of insurance which will cover both the Consultant, and any subcontractors the Consultant utilizes to provide services to the County; Wasatch County requirement is:

   A. Worker's Compensation sufficient to cover all Consultant's employees pursuant to Utah State statutes. The certificate and policy shall provide that coverage thereunder shall not be canceled or reduced without at least thirty (30) days prior written notice to County.

   B. Commercial General Liability insurance in the minimum amount of $1,000,000 per occurrence with a $2,000,000 aggregate. The certificate and policy shall provide that coverage thereunder shall not be canceled or modified without at least thirty (30) days prior written notice to County. Consultant shall furnish such Certificate of Insurance, acceptable to County, verifying the foregoing concurrent with the execution hereof and thereafter as required.

   C. Professional liability insurance in the minimum amount of $1,000,000 per occurrence.

   D. Automobile Liability insurance in the amount of $1,000,000.

   E. All policies of insurance provided shall be issued by insurance companies licensed to do business in the State of Utah.

4. Organizational chart showing the Consultant's team involved including individual members with their title, telephone number, and resumes, and potential sub-consultants.
5. Relative job experience history specifically related to projects similar to the scope of work and demonstrating that the consultant has the expertise to provide all the information needed to comply with the scope of work. This section should clearly identify the disciplines the Consultant has experience in and how all aspects of the scope can be addressed by the consulting group.
6. Demonstrate how your firm can address the requirements of the scope of work.
7. A minimum of 3 references, including name, address, and telephone numbers of persons who can attest to performance of relevant work projects.
8. The project is limited to a maximum of $50,000. No additional fees are available beyond this set amount.
9. Estimated date for completion of the scope of work.
10. Conflicts: Consultant, and Consultant's subcontractors will not be able to contract with the County and any third party for work on the same, or substantially related projects, in the County's discretion.

Selection Criteria:

The selection criteria for this RFQ will be evaluated based upon the following:

- Previous Experience working with municipalities and demonstration that the Consultant can and will accomplish the items listed in the Scope of Work.
- Demonstration that the Consultant can do the scope of work with minimal supervision.
- Provide all Required Content outlined above, and other items requested in this RFQ.
- Anticipated costs and how costs will be handled.
- Estimated completion date, and assurances of the Consultant's ability to meet the estimated completion date.
- Ability to enter into a contract fully resolving all aspects of the business transaction, to include price, delivery date, delivery terms, acceptance period and criteria, warranties, funding terms, and such other terms and conditions as are appropriate.
- Approval by the Wasatch County Council, the purchasing agent, and the Planning Director.

After reviewing the RFQ the County reserves the right to accept applicants that they feel, in their sole discretion, best accomplishes the intent of the RFQ.

Time frame for submittals:

Complete submittals in a pdf version with all items listed shall be sent to the planning department at Planning@wasatch.utah.gov by Friday June 19th at 5:00 p.m.

Conclusion:

Wasatch County is interested in providing a connected and efficient street network for multi-modal transportation to minimize traffic and congestion as much as possible and allow residents options to use various transportation options.

Proposals must be sent to:

Wasatch County Planning Department by e-mail in a pdf version at Planning@wasatch.utah.gov