Pavant Interagency Fuels Reduction Project

Hydrology Report

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Prepared by Adam Solt
Hydrologist, Fishlake National Forest

Executive Summary of Hydrologic Analysis

Values-at-Risk, Principle Issues, Issue Indicators, and Measurement: Areas encompassed in this project have different water related uses and values that may be put at risk depending on the consequences of each alternative. The important values-at-risk are: first, water quality for municipal and domestic uses, irrigation and agriculture, and cold water organisms; and second, potential flooding of communities. Principle issues are those factors that put desired uses and values-at-risk, or that determine the needs and potential or risk for watershed degradation or restoration. For this analysis the risk of production and delivery of sediment, and flooding (peakflows) from first, treatment activities, and second from severe wildfire were considered issues. Water quality for cold water organisms and downstream uses is an additional issue that was considered. The indicator of sediment production and delivery is the WEPP modeling results and measured in percent increase above the undisturbed rates (0.2 to 0.6 ton/acre/year) for the analysis area. The indicator for wildfire risk to hydrology and for water quantity is flooding potential or peakflows from severely burned areas based on Hydrain model results and measured in cubic feet per second (cfs). The indicator of water quality is whether the water is listed on the States 303d list of impaired waters; waters listed on the 303d list are considered impaired waters. Waters not listed on the 303d list implies full support of State Standards. All streams within the analysis area are currently fully supporting uses and State Standards; none of the streams are listed as impaired or partially impaired for their designated beneficial uses

Results: Tables 6 and 7 of the Hydrological Analysis show the increases of erosion rates in percent above the undisturbed rates of 0.2 to 0.6 ton/acre/year by factoring in climate, and increased peakflows in cfs and the related return interval in years based on no action-no disturbance, no action-wildfire, and proposed action-prescribed fire and thinning for Cumulative Effect Areas (CWAs). Table 6 can be summarized by saying that ranges of erosion rates for CWAs increased because of 10-year storm events (that averaged about 1.15 inches/hour) and treatments from approximately 0 to 2.6 times normal (0 to 250%) for no action-no disturbance, 0.4 to 5.6 times normal (0.9 to 3.71 t/ac/year for 100 to 1400% increase) for proposed action-prescribed fire and thinning, and 2.6 to 22 times normal (3.5 to 11.2 t/ac/year for 650 to 5500% increase) for the no action-wildfire disturbance. Table 7, can be summarized by saying that peakflows and return intervals increased within individual CWAs by the type of treatment applied; peakflows are predicted to be greater with prescribed fire and thinning on 40 to 80 percent of the same proposed treatment acres than if the acres were untreated. And predicted peakflows are approximately equal to the worst-case scenario for moderate severity fire (moderate fire over 80 percent of the proposed treatment acres) peakflows or greater when 40 to 80 percent of the same proposed treatment acres are treated with wildfire. Reasonably foreseeable actions and wildfire suppression activities may or may not increase these rates when they occur within the CWAs above these values and ranges.

Values at risk, including water quality, cold-water organisms, and communities would not be affected negatively from the proposed actions compared to wildfire and suppression. Peakflow events from storms would be lower magnitudes than those found

in wildfires, and the return intervals may or may not be lower than from wildfires (Table 7). Sediment production may or may not be less than from wildfires (Table 6). Values at risk would not likely be negatively because of designed riparian buffers along perennial streams, which would limit the amount of sediment being transported and deposited into streams, and because the channels within the Analysis Area would likely be able to pass the magnitude of flows generated from the proposed action since the channels are hydrologically connected to the floodplains, and the profile and banks are stable. If wildfires were to occur, riparian areas on perennial streams could be burned and uplands could burn at higher intensities causing the soils to be affected more negatively than if prescribed burns were to occur, which would increase flows, and would allow more sediment to be eroded, transported, and delivered into channels compared to the proposed action.

ALTERNATIVES & ISSUES

VALUES-AT-RISK

Each of the watershed areas encompassed in this project has different water related uses and values that may be put at risk depending on the consequences of each alternative.

Table 1 summarizes the presence or absence of these values for each area.

Table 1. Values-at-risk for each HUC 6 Watershed Area

Watershed	Municipal/Domestic Water Quality	Irrigation and Agricultural Water Quality	Cold Water Organisms	Communities being Flooded
Ivie Creek				
Round Valley Creek		X		Scipio
South Scipio Valley		X		Scipio
Corn Creek				
Sunset Canyon		X		Meadow
Walker Creek	X	X		Meadow
Meadow Creek		X	X	Meadow
Pine Creek		X		Fillmore
CHALK CREEK				
So. Fork Chalk Creek	X	X	X	Fillmore
Chalk Creek		X	X	Fillmore
North Canyon		X		Fillmore
Pioneer Canyon		X	X	-
Maple Canyon		X		Holden
Wide Spring Canyon		X		Holden
Wild Goose Creek		X		Holden
Scipio Pass		X		-

PRINCIPLE ISSUES

Principle issues are those factors that put desired uses and values-at-risk, or that determine the needs and potential or risk for watershed degradation or restoration. For this analysis the risk of production and delivery of sediment and flooding (peakflows) from treatment activities or severe wildfire are principle issues. Water quality for cold water organisms and downstream uses is an additional issue that will need to be addressed. The following table lists the indicators and measures that will be used to address the principle issues.

Issue Indicators and Measurement

Table 2. Shows the indicators that will be used to measure the response and expected changes to the water resources related to this project. The processes linked to these issue indicators are located in Table 3 and in the Affected Environment and Environmental Consequences section.

Table 2. Principle Issues and Indicators

Principle Issue	Principle Issue Indicators
Sediment Production and Delivery	The primary indicator of sediment production and delivery is the WEPP modeling results. Probabilities of erosion and sedimentation events, and erosion rates based on a 10-year storm event (climate). Indicator measurement will be percent increase above the undisturbed rates (0.2 to 0.6 ton/acre/year) for the analysis area. Location of coarse soils (indirect indicator only because texture is used in the WEPP model, which is the primary indicator of sediment production and delivery) (Smith 2003, Map attachment 20).
Wildfire Risk	An indicator of wildfire risk on hydrology is flooding potential or peakflows from severely burned areas based on Hydrain model. Measurement is based on flows and will be expressed in cubic feet per second (cfs).
Water Quality Standards	The indicator of Water Quality standards is State of Utah 303d list of impaired waters. The measurement is categorical: either stream's fully, partially, or not supporting State Water Quality Standards. Not being listed implies full support of standards.
Water Quantity/Flooding	Flooding potential or peakflows from severely burned areas based on Hydrain model. Flows will be in cubic feet per second (cfs).

The relationship between the principle issues and the values-at-risk is presented in Table 3.		
Values-at-Risk	**Principle Issues**	**Issue Descriptions**
Municipal Water Quality	Sediment Production and Delivery	Municipal and domestic sources of water for communities along the Westside of the Pahvant range are all use either groundwater wells or springs that are not prone to sedimentation. No surface water sources such as streams or lakes are sources for municipal or domestic water below the project areas. Therefore, municipal water quality will not be impacted from sediment production or delivery.
	Wildfire Risk	No issues are associated with this value-at-risk since the quality of water will not be affected. Wildfire will not affect the water quality of the groundwater sources that are used by the communities within and near the analysis area.
	Water Quality Standards	No issues are associated with this value-at-risk since the quality of water will not be affected. None will be affected due to the fact that all sources of domestic sources of water are from either groundwater well or spring's and not from surface water sources.
	Water Quantity/ Flooding	Water repellent soils and reducing vegetation decreases the infiltration capacity of soils and roads and can decrease base flows by synchronizing the timing of runoff during snowmelt, which collectively can have the effect of reducing the residence time of water in a watershed. This would mainly be an issue for the municipal water use if management actions reduced flows during periods of high water consumption of surface waters. This decrease in water that might have been able to recharge an aquifer or spring if it had been able to infiltrate sooner might indirectly decrease the quantity of water. This would be extremely difficult to measure or quantify, especially, since our treatment areas are mostly located near the mouths of canyons and along the toe-slopes of the Pahvant Range front where the water from undisturbed areas might only make it into aquifers down lower in or below the analysis area anyway. Droughts could have a greater impact on municipal waters than floods in the analysis area because springs and wells might not be recharged and therefore might not flow as much or even might dry up because of less rain than normal.

Livestock and Agricultural Water Quality	Sediment Production and Delivery	Slopes that have been disturbed can increase the potential for production and delivery of sediment to streams. Nutrients, minerals, and other organic and inorganic materials attached to or transported with eroded sediments can create water quality concerns. Streams in the project areas are typically diverted, ditched, or chanalized near the Forest Boundary or downstream of the Forest for agricultural purposes such as irrigation or livestock watering. Agricultural users need their chanalized water to be a good enough quality to be used on their crops and used for livestock watering. These users need their canals to not be filled up with excessive sediment. Extra nutrients would actually be beneficial for agricultural lands. Turbid or sediment filled water might affect livestock operations for short durations after storm events occurred on burned landscapes. Some maintenance of canals and diversion structures might be necessary in the event that large amounts of sediment plug or changes the ability of diversion structures or canal ways to function.
	Wildfire Risk	Fire suppression has allowed greater accumulations of biomass and debris over larger areas than was typical before fires were suppressed. These conditions can result in more intense and severe wildfire than was common historically. Increased fire severity results in greater soil and nutrient losses, less protection of the surface soil from erosion, and can cause the soil to repel water. Increased additions of nutrients and soil into streams occur from these high severity wildfire areas than from undisturbed or low to moderately prescribed fire areas. Therefore, it is desirable to reduce the risk of high severity fires on these sites.

	Water Quality Standards	Round Valley, Pioneer, Chalk, Meadow, Corn Creeks and their tributaries are all classified as class 4 streams by the State of Utah-Title 317-Standards of Water (Utah 2000). Class 4 streams are protected for agricultural uses including irrigation of crops and stock watering (Utah 2000). No streams, lakes, or reservoirs within or below the analysis area are listed as impaired or partially impaired for their designated beneficial uses including for livestock and agriculture (UDEQ 2000). Therefore, the Forest is complying with the Clean Water Act within the analysis area. Meadow Creek at Storet sites 494017, and 494018; and Chalk and S. Fork Chalk Creeks Storet sites 494020 and 494021 have had a few exceedences for phosphorous, an exceedence for aluminum, and no exceedences for all other standards in the past according to the Utah Division of Environmental Quality (UDEQ 2002). It is not all that clear why there was an exceedence of aluminum, but the exceedences of phosphorous are likely the result of livestock grazing unless fire occurred within the area around the times of the exceedences. Non-point sources of sediment such as livestock grazing, travel routes, and recreation are the most common causes of sedimentation to streams within the analysis area.
	Water Quantity/ Flooding	Wildfires (high severity) result in greater reduction in vegetation and soil cover than prescribed fires (low to moderate severity) that consequently leads to even greater amounts of stream runoff, erosion, and sedimentation. Extra water from peakflows or floods that could be used for irrigation and livestock would actually be considered a benefit. However, if the peakflows contained excessive sediment or the flows themselves damage or plug canals and diversion structures then increased peakflows are not desirable. Droughts rather than floods would have greater impacts on water quantity relating to agricultural and livestock watering operations than flooding because these users might only receive water on their lands only after older-higher priority water rights have received their water in dry years.

Cold Water Organisms	Sediment Production and Delivery	Travel routes and more particular stream crossings can introduce large volumes of sediment to streams in a very short period of time when they fail. This can degrade habitat for fish and other aquatic organisms, and can negatively affect channel stability. Stream crossings can act as barriers to fish migration, reducing available habitat and isolating populations. Similarly, delivery of sediment to streams from crossings and other upland and in channel sources can fill in fish spawning and rearing habitat (i.e. pools), and can fill in the spaces between gravels, cobbles, and boulders on the streambed, which are used by a variety of aquatic organisms. Slopes that have been disturbed can increase the potential for production and delivery of sediment to streams. Nutrients, minerals, and other organic and inorganic materials attached to or transported with eroded sediments can create water quality concerns. Increased fire severity results in greater soil and nutrient losses, less protection of the surface soil from erosion, and can cause the soil to repel water. Increased sedimentation of nutrients and soil into streams occurs from these high severity wildfire areas than from undisturbed or low to moderately prescribed fire areas.
	Wildfire Risk	Wildfires (high severity) result in greater reduction in vegetation and soil cover than prescribed fires (low to moderate severity) that consequently leads to even greater amounts of stream runoff and floods, erosion and sedimentation. Nutrients, minerals, and other organic and inorganic materials attached to or transported with eroded sediments can create water quality concerns. Similarly, delivery of sediment to streams from crossings and other upland and in channel sources can fill in fish spawning and rearing habitat (i.e. pools), and can fill in the spaces between gravels, cobbles, and boulders on the streambed, which are used by a variety of aquatic organisms including macroinvertebrates.

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	Water Quantity/ Flooding	Peakflows if they are large enough can move bed materials (gravels to boulders) and can scour and erode banks. Cold-water organisms can be affected by increasing the sediment from stream crossings, stream banks, and by changing the gravel locations within channels that are used by aquatic organisms. As the flows and velocity increase so does the streams power to do work and move and change the channel. Droughts can affect cold-water organisms by decreasing streams to baseflows that only trickle in the channel between pools on some streams. This concentrates fish in the pools and can expose gravels and bars that potentially are habitat for macroinvertebrates.

Communities being Flooded	Sediment Production and Delivery	Flooding of the communities from disturbed lands poses a real threat. The Swain's fire and subsequent flooding of Holden, Utah is real example of this within the analysis area. The risk and effects of flooding increases with larger climatic events, greater area disturbed and with increasing intensity at which the areas are disturbed. Sediment production and delivery of sediment risk and effects increases hand-in-hand with flooding. There is low risk of flooding from undisturbed lands; there is a greater probability of flooding and sediment delivery by implementation of prescribed burns; and even greater risk of flooding and delivery of sediment from high severity wildfire areas.
	Wildfire Risk	High severity fires, which may be greater due to past fire suppression activities, can lead to greater effects. Wildfires have no plan or design to them and result in greater reduction in vegetation and soil cover that consequently leads to even greater amounts of stream runoff, erosion, and sedimentation. Prescribed fires commonly occur during the spring and fall when soils are wetter and therefore, the magnitude of the effects would be lower compared to wildfires.
	Water Quality Standards	Water quality standards are set up for acute and chronic levels of pollutants. Sediment and chemicals being some of these. The actual event of flooding a community would not have any standard, but the floodwater itself would exceed any standard for sediment, and likely would for some nutrients being washed off burned areas. Numerous exceedences over long periods of time constitute whether perennial streams are impaired and not by one or a few exceedences measurements in time. So, as hillslopes become revegetated after fire the magnitude and number of exceedences would diminish and the stream would not be listed as partial or fully impaired for the beneficial uses.

	Water Quantity/ Flooding	Flooding of the communities from disturbed lands poses a real threat. The Swain's fire and subsequent flooding of Holden, Utah is real example of this within the analysis area. The risk and effects of flooding increases with larger climatic events, greater area disturbed and with increasing intensity at which the areas are disturbed. Sediment production and delivery of sediment risk and effects increases hand-in-hand with flooding. There is low risk of flooding from undisturbed lands; there is a greater probability of flooding and sediment delivery by implementation of prescribed burns; and even greater probability of flooding and delivery of sediment from high severity wildfire areas.

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

The purpose of this section is to provide a context for understanding watershed processes, which are important within the project watersheds, and to describe the condition of hydrologic resources. Past and present processes, resource values, and management activities are considered. The information in the beginning of this section forms the basis for the effects analysis and comparisons made later in this section.

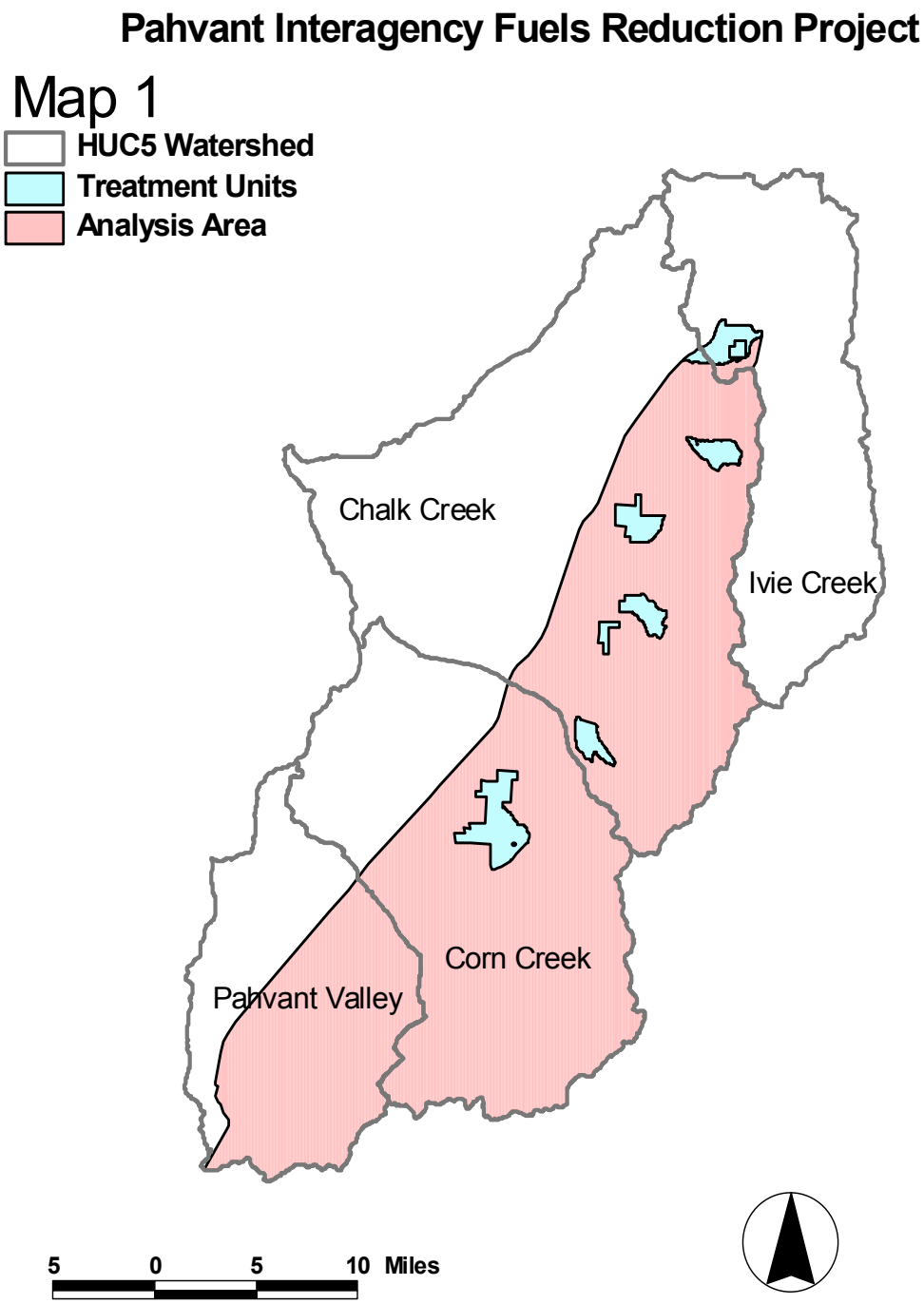
CONDITIONS

Environmental conditions in the analysis area are and have been influenced by natural events and processes (e.g., historic fires) as well as human activities (e.g., grazing and road building). Effects of natural disturbances have interacted with other land-evolving processes to form the basic character of watersheds and the dependent stream resources. Due to variability in location, frequency, intensity, and ultimately the effects of natural processes on the physical environment, dynamic landscapes with diverse conditions are formed at various spatial scales. Natural disturbance regimes (e.g. flood, wildfire, etc) and their associated properties (e.g. erosion and sedimentation rates and other influences on cold water organisms) have been altered in the analysis area by human activity. Land use activities that have modified natural disturbance characteristics include grazing, recreation, travel routes, stream modifications (constriction, channelization, diversions, culverts, and cleaning/removal of woody debris), mechanical thinning of vegetation (including the current BLM thinnings), and fire suppression.

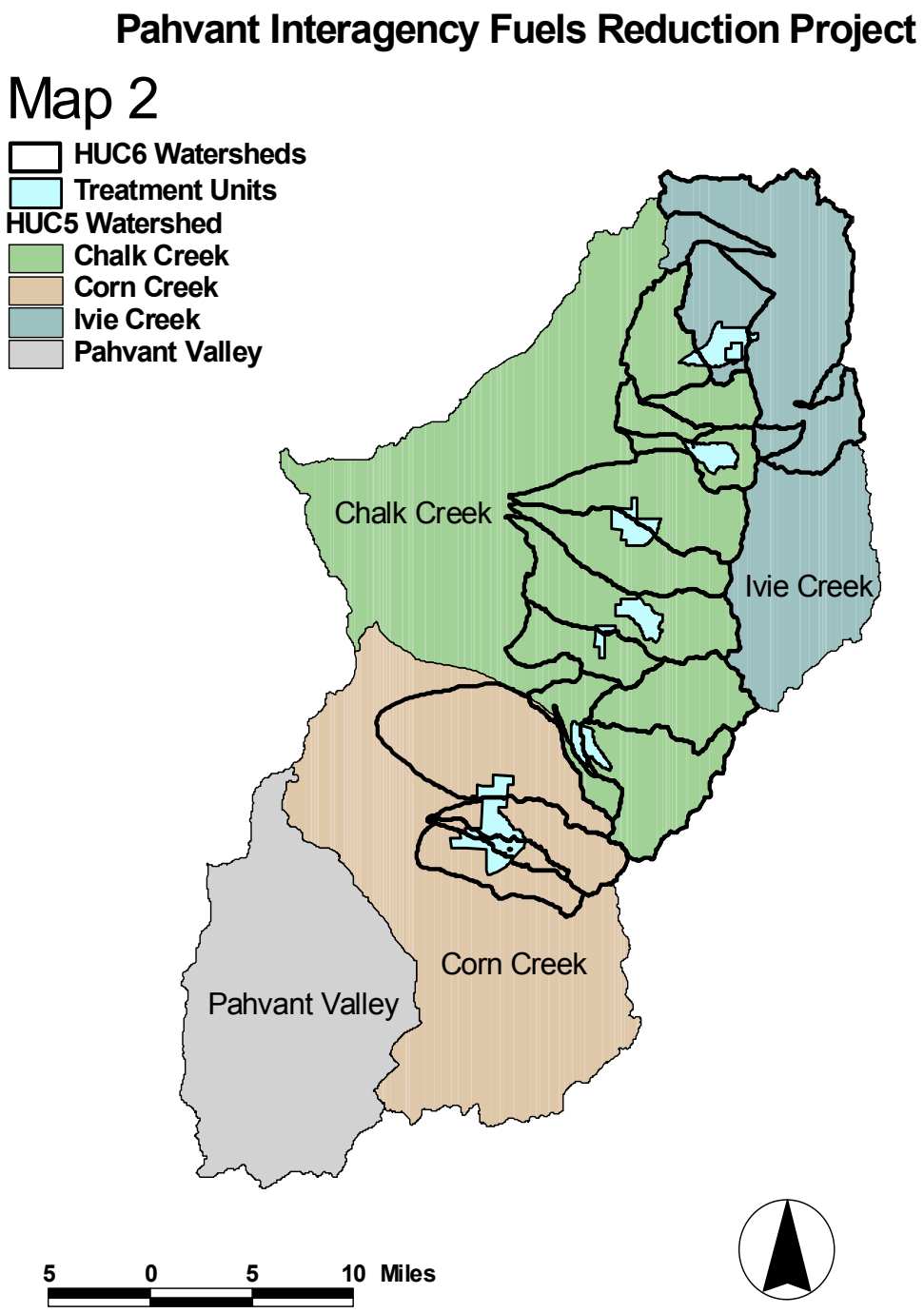
Hydrologic Hierarchy

Table 4. The levels of Watersheds and Hydrologic Units Codes (HUCs), and the treatment acres, analysis area acres, and percentages treated of the hydrological units and analysis area are shown.

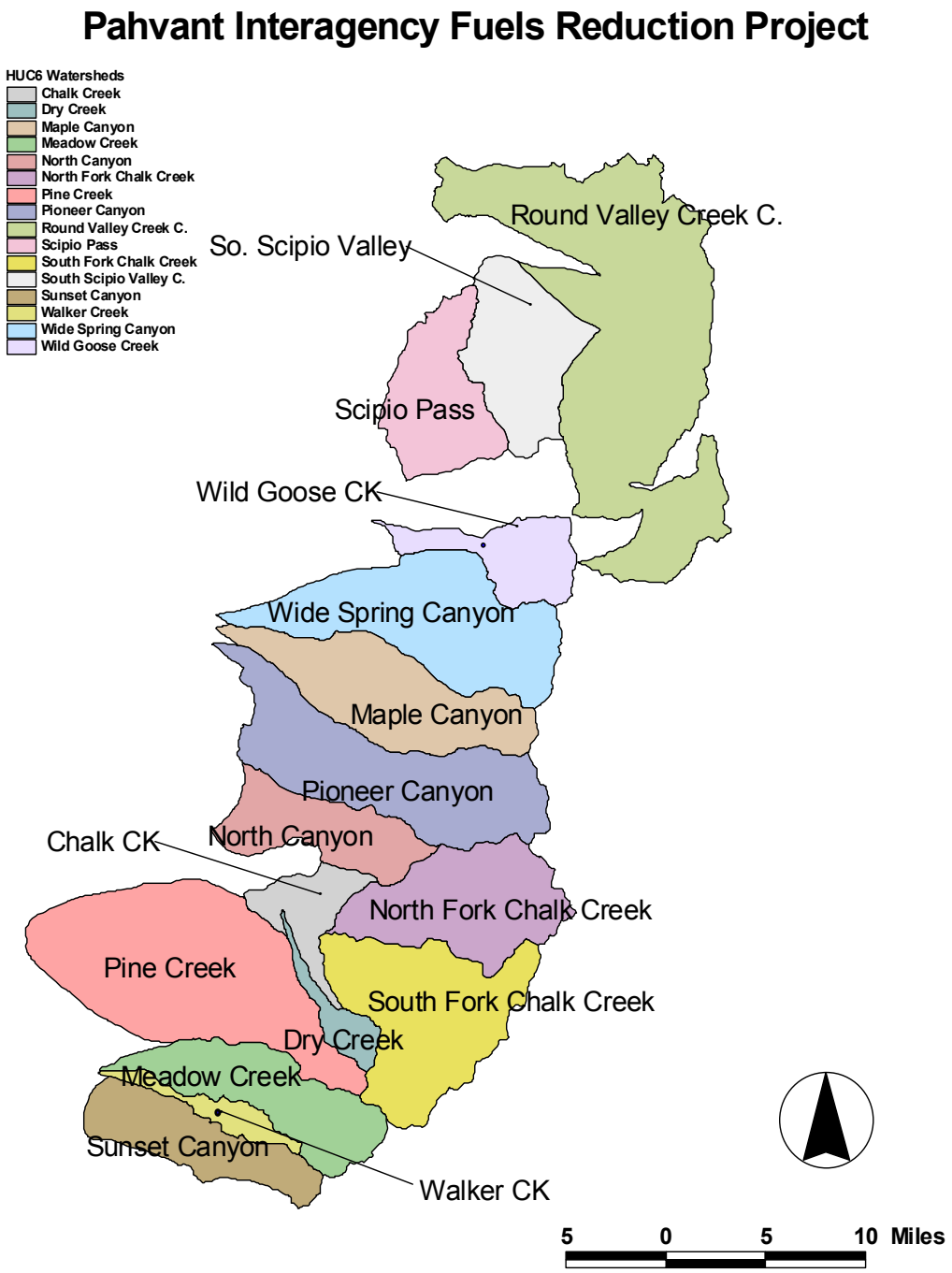
Watershed Hierarchy			Treatment	Treated
Watershed	HUC Code	**Acres**	**Acres**	**Percent**
HUC 4 Watershed				
Lower Sevier River	16030005	2,623,600	14329	0.5
HUC 5 Watersheds-See Maps 1 and 2.				
Ivie Creek	1603000501	103,420	2014	1.9
Corn Creek	1603000513	161,457	4928	3.1
Chalk Creek	1603000514	235,284	7385	3.1
HUC 6 Watersheds with proposed acres for treatment-See Maps 2 and 3.				
Round Valley Creek	160300050412	43,738	87	0.2
South Scipio Valley	160300050410	11,526	1,927	16.7
Sunset Canyon	160300050508	9,125	1,332	14.6
Walker Creek	160300050509	2,642	939	35.5
Meadow Creek	160300050510	11,423	1,756	15.4
S. Fork Chalk Creek	160300050602	17,629	808	4.6
Chalk Creek	160300050604	4,795	625	13.0
North Canyon	160300050605	8,798	323	3.7
Pine Creek	160300050606	27,598	900	3.3
Pioneer Canyon	160300050701	19,708	1,770	9.0
Maple Canyon	160300050702	14,836	1,305	8.8
Wide Spring Canyon	160300050703	19,022	638	3.4
Scipio Pass	160300050706	10,407	337	3.2
Wild Goose Creek	160300050704	6,595	1,578	23.9
Analysis Area-See Map 1.				
NA	NA	287,495	14,329	5.0



Map 1. Shows the HUC5 Watersheds, analysis area, and proposed treatment units.



Map 2. Shows the HUC5 Watersheds, HUC6 Watersheds, and the proposed treatment units.



Map 3. Shows the HUC6 Watersheds and general areas of proposed treatment units.

SURFACE WATER

Streams

Average annual flow: Chalk Creek is 30.1 cfs, and 7.0 cfs on Meadow Creek (note: the period of record for these gages are not extensive and are for only 26, and 9 years respectively)
Bankfull discharge: Chalk Creek is 221 cfs, and Meadow Creek is 43 cfs (based on the 1.5 year floods for each stream record)
Annual flood peaks: Occur predominately from spring snowmelt and partially from summer thunderstorms
Perennial Streams: Corn Creek (24.1 miles), Meadow Creek (6.5 miles), Chalk Creek (35 miles), and Pioneer Creek (4.3 miles)

Lakes, Reservoirs, and Diversions

No large lakes or reservoirs are found within the analysis area.

Canals divert nearly all streams at the mouth of front canyons or lower on private lands where streams are chanalized and appear linear in form. Nearly all the water leaving public lands in streams is used for agricultural irrigation or livestock watering; all of the domestic water diverted from public lands is piped water from springs or groundwater and is not from surface waters (Drinking Water Sources) (USEPA 2003).

METEOROLOGY

Precipitation

Average annual precipitation: 13 to 15 inches at the Scipio, Fillmore, Kanosh, and Cove Fort weather stations (Elevations of 5000 to 6000 feet mean sea level); 32.3 inches (1971-2000) at the *Pine Creek Snotel station (8800 feet mean sea level-*See Table 2 and the associated explanation below in the drought section); and over 36 inches near White Pine Peak (over 10,220 feet mean sea level)
Type: Rain and Snow
Duration: Approximately 68 storms a year
Frequency/Intensity: 2-year/1-hour precipitation is approximately 0.75 in/hr; 10-year/1-hour is approximately 1.15 in/hr
Timing: 65% of annual precipitation falls from October to April

Drought:

Table 5. Precipitation at the Pine Creek Snotel site for the previous seven Water Years (WY 1996-2002) that are averages of two different 3-decade periods are shown in table 5.

Pine Creek Snotel Site-Pahvant Range			
Water Year (WY)	**Precipitation Inches**	**Percent of Normal Precipitation**	**Average 3-Decade Period**
2002	26.1	81	#
2001	30.6	80	*
2000	32.7	86	*
1999	35.8	94	*
1998	44.9	118	*
1997	41.9	110	*
1996	24.8	65	*
# 32.28 inches per year (3-decade average for 1971-2000) as used by NRCS *38.08 inches per year (3-decade average for 1961-1990) as used by NRCS The change in 3-decade average was done by the NRCS and they are the source of Snotel site data for Utah. It is unclear why they changed in 2002 to the new 3-decade average at that time.			
A Water Year (WY) begins October 1 and ends September 30 of the next year; So, WY 2002 began October 1, 2001 and ended September 30, 2002.			

Notice the 3-decade average precipitation decreased by 5.8 inches over the last decade shift (38.08 - 32.28 inches = 5.8 inches in Table 2). Also notice that the NRCS started using the lower 32.28 inches per year precipitation average starting in WY 2002 and that the previous 6 years were based on the higher 38.08 inches per year average precipitation value in Table 5.

WY 2003 as of March17, 2003 and status of drought: Snow Water Equivalent is 13 inches of the normal 22.5 inches for 58% of normal received. Total Precipitation is 13.7 of the normal 16.6 inches for 83% of normal received. This percentage currently is similar to the amount of precipitation received for the previous three years (81,80, and 86% of normal). Meaning we have just been slightly above drought levels (drought being defined as starting at 75% of normal annual precipitation) for four years in a row so far here in the Pahvant Range. However, if you took WY 2002 precipitation of 26.10 inches and divided it by the 1961 to 1990 average of 38.08 like all the previous years instead of 32.28 inches, then WY 2002 would not only be considered a below average year but the first drought year (68.5% instead of 81% of normal) since WY 1996, and possibly WY 2003 the second if precipitation persists as it has been. Even though WY 2002 was not considered a drought based on the Snotel data, it should not be considered a positive thing, since the Pahvant Range received 5.8 inches per year less precipitation on average than the 3-decade average used for the previous 6 years (Previous Water Years Precipitation) (Current Water Year Precipitation) (USDA NRCS 2002, and USDA NRCS 2003).

Air Temperature
Average annual temperatures: Maximum is 65 °F, minimum is 35°F; and mean is 50°F
Extremes recorded: -40 and 107 °F

ADDITIONAL CHARACTERISTICS

Elevation: Ranges from approximately 4800 to over 10,220 feet mean sea level at Mine Camp, and White Pine Peaks
Aspect: West
Analysis Area: 287,495 acres of the Western-half of the Pahvant Range extending west towards Interstate-15
Slope: Terrain ranges from 0 to 2% on nearly level alluvial fans up to 90% on very steep canyon walls and tops of ridges

LAND TYPES

Definition and description: The Pahvant Interagency Fuels Reduction Project-Soil Resources Management report, written by Mike D. Smith (Soil Scientist), shows in tables 2 and 3 (pp. 7-9) the soil mapping symbols, unit and soil names, and the taxonomic classifications of soils. Attachment maps 1 to 6 show where soils are located within treatment units. Maps of geology types within individual treatment units are found in attachments 13 to 18 of the Smith report (Smith 2003). Andrew E. Godfrey, (Geologist) has written about how the Pahvant Range and Canyon Mountains were formed (Godfrey Pleistocene).

Erosion Potential: The Soil Resources Management report, in Table 8 (p. 30), shows the estimated annual soil erosion rates of the soils within the analysis area, and compares normal erosion rates without climate as a factor to those from prescribed fires and unwanted wildfires based on the R1/R4 sediment yield model (Smith 2003).

According to Smith: "soils formed in calcareous deposits of limestone or dolomite located on very steep terrain and all soils having properties inherited from sandstone parent materials are subject to water-repellent ground conditions, mudslides and debris flows following severe burning disturbances (Smith 2003, p. 22)." Both Smith's and Godfrey's (Pahvant Range and Canyon Mountains) descriptions helps in understanding about how the soils were formed based on the geologic parent material within the analysis area. Map attachment 20 shows where these coarse textured soils are located, and help us know where soils and hydrology potentially could be affected by fire (Smith 2003, and Godfrey Pleistocene).

STREAM CHANNELS

Description: Lower Meadow Creek is classified as a B3 Rosgen Channel (moderately entrenched, moderate gradient of 2 to 4%, riffle-dominated channel with infrequently spaced pools, very stable plan and profile, stable banks, cobble dominated bed material). Upper Meadow Creek is a B4a Rosgen Channel, which is the same as B3 but with gradients of 4 to 9%, and gravels dominating the bed material (Rosgen 1994). Entrenchment likely has increased because of livestock grazing over the last 100+ years, and by travel routes being constructed in and near riparian areas. Streams have access to their floodplains for the most part, but there are areas where moderate entrenchment has occurred.

The channels of the other streams in the analysis area will have similar forms as those of Meadow Creek (B3 and B4a). Watersheds in the analysis area have dendritic drainage patterns until streams reach the mouth of the canyons or private lands where they are generally canalized, appear linear in form, and the water used for agricultural and livestock watering purposes. The face drainages on the range front only flow during large storm or snowmelt events.

Photograph of Lower Meadow Creek taken 8/7/02 at the integrated riparian inventory site. The channel is classified as a B3 Rosgen channel type.

Photograph of Upper Meadow Creek taken 8/7/02 at the integrated riparian inventory site. The channel is classified as a B4a Rosgen channel type.

State of Utah 2000 Approved 303d List of Impaired Waters: No streams, lakes, or reservoirs within or below the analysis area are listed as impaired or partially impaired for their designated beneficial uses (UDEQ 2000). Therefore, the Forest is complying with Forest Standards and Clean Water Act within the analysis area.

Stream Classes and Uses: Round Valley, Pioneer, Chalk, Meadow, Corn Creeks and their tributaries are all classified as 2B, 3A, and 4 streams by the State of Utah-Title 317-Standards of Water (Utah 2000). Class 2B streams are protected for recreational secondary contact use such as boating, wading, and similar uses. Class 3A are protected for cold water species of game fish, and other cold water aquatic life, including aquatic organisms in their food chain. Class 4, are protected for agricultural uses including irrigation of crops and stock watering (Utah 2000). To reiterate, none of these streams are listed on the State 303d list of impaired waters (UDEQ 2000).

Water Quality sampling data: Meadow Creek at Storet sites (database of all water quality samples) 494017, and 494018; and Chalk and S. Fork Chalk Creeks Storet sites 494020 and 494021 have had a few exceedences for phosphorous, an exceedence for aluminum, and no exceedences for all other standards in the past according to the Utah Division of Environmental Quality (UDEQ 2002). It is not all that clear why there was an exceedence of aluminum, but the exceedances of phosphorous are likely the result of

livestock grazing unless fire occurred within the area around the times of the exceedences. Non-point sources of sediment such as livestock grazing, travel routes, and recreation are the most common causes of sedimentation to streams within the analysis area.

Travel Routes

Travel routes are located throughout the analysis area. In the areas where roads and trails are located in or near riparian areas and when these routes are not maintained to standards the potential for sedimentation increases. Surface erosion occurs on most forest roads because their surfaces, cutslopes, fillslopes and associated drainage structures are usually composed of erodible material and are exposed to rainfall and concentrated surface runoff. Proper maintenance of roads helps in decreasing the amount of sediment being added into the streams from the roads themselves, as well as decreases the changes associated with interception, concentration, diversion, and extension of the stream drainage network. Maintenance to standards disconnects the roads from the streams and reduces the effects they have on streams and water quality.

Management Areas (MAs): Walker Creek has a small section within the Meadow treatment unit that is managed as MA-10E, and South Fork Chalk Creek has a small MA-10E section but it is not within a proposed treatment area. MA-10E emphasis is to protect or improve first quality and second quantity of municipal water supplies. The South Fork of Chalk, and Pioneer Creeks have areas managed as MA-4A where the emphasis is on fish habitat improvement near treatment units. The Horse Hollow treatment area is well away from this MA boundary (at least 300 feet). Within the proposed Pioneer treatment unit some of acreage is part of the MA-4A management area type, although none of these acres proposed acres for treatment are within 100 feet of the stream. Everywhere else is found within the MA-6B, which emphasis livestock grazing.

Roadless Area Characteristics Analysis
Resources or features that are often present in and characterize inventoried roadless areas include:

(1). Soil, water, and air – These three key resources are the foundation upon which other resource values and outputs depend. Healthy watersheds provide clean water for domestic, agricultural, and industrial uses; help maintain abundant and healthy fish and wildlife populations; and are the basis for many forms of outdoor recreation.

The current proposal for reduction of hazardous fuels on NFS Lands includes the use of mechanical treatments with low to moderate intensity prescribed fire to prevent uncharacteristic wildfires from occurring along the Pahvant Range front. No new roads will be constructed in relation to these treatment activities and units and therefore activities would be limited to areas that have already been impacted.

If implemented, the fires would leave the land with a charred appearance and with slightly higher peak flows and sediment yields. Fire is a natural process within the

analysis area, so having fire within the analysis area is not adding an unnatural mechanism that previously was not there historically. All known domestic and industrial water sources within the analysis area are from either springs or groundwater sources. So, the concern of water quality is not over this type of use or quality. The concern of water quality is more over water quality for fish and macroinvertebrates. All treatment areas require that no treatment occur within at least 100 feet of perennial stream channels, and be burned when soils are wet enough to not impact them greatly. Therefore, the impacts to fish and macroinvertebrates will be minimal since most of the eroded sediment will be trapped within the riparian areas. The impacts will be minimal on agricultural uses of water since, the major concern for this type of use is greatly increased amounts of sediments that might block diversion structures and they are not likely to occur.

(2). Sources of public drinking water – NFS lands contain watersheds that are important sources of public drinking water. Careful management of these watersheds is crucial in maintaining the flow of clean water to a growing population.

All known domestic and industrial water sources within the analysis area are from either springs or groundwater sources. So, concern over water quality for this type of use or quality is not as great on NFS lands within the analysis area as it might be in areas where surface waters are the primary source of drinking water. The NFS watersheds are indirectly a source for drinking water of the communities along the Pahvant Range; the water that comes from these drainages needs to infiltrate and then move through the aquifer to the spring and well sites to become the source of drinking water.

Hydrologic Responses to Fires

Fires can alter soil and vegetation characteristics resulting in increased quantity of flows: Reduction of vegetation and forest floor litter results in decreases in interception and evapotranspiration, and infiltration rates. This means increased water becomes available for overland flow and stream runoff. Increased flows in turn lead to increased erosion and sedimentation (Zwolinski 2000). Prescribed fires (low and moderate severity) are designed so that vegetation remains in some form (wood, litter, and duff) to cover soils (Zwolinski 2000). Wildfires (high severity) have no plan or design to them and result in greater reduction in vegetation and soil cover that consequently leads to even greater amounts of stream runoff, erosion, and sedimentation. High severity fires, which may be greater due to past fire suppression activities, can lead to greater effects including water repellent soils since formation is dependant on heating temperatures and soil moisture (Robichaud 2000). Prescribed fires commonly occur during the spring and fall when soils are wetter and therefore, water repellency would be minimal which would lead to not as great of increases in water yield compared to wildfires (Robichaud 2000).

Water and Sediment Yields: Water and Sediment yields vary depending on precipitation, evapotranspiration, soils, vegetation type, fire severity, geology, topography, and proportion of the vegetation burned (Robichaud 2000). According to Robichaud "Sediment yields after prescribed burns and wildfires range from very low in flat terrain and in the absence of major rainfall events to extreme in steep terrain affected

by high intensity thunderstorms. Soil erosion after fires can very from under 0.4 to 2.6 ton/acre/year from prescribed burns to over 9 to 49 ton/acre/year from wildfires (Robichaud 2000)." WEPP or sediment erosion modeling results for treatment areas within the analysis area had rates from 0.9 to 3.71 ton/acre/year from prescribed fires and 3.5 to 11.2 ton/acre/year from wildfires based on if a 10-year storm event were to occur. The results from the WEPP modeling runs were compared to the basic erosion rates calculated by Smith (0.2 to 0.6 ton/acre/year) to arrive at the range increases in erosion found in Table 6. Based on Robichaud's rates of erosion listed above the 3.71 ton/acre/year that I calculated using WEPP might be a little higher than he found in the field, although based on the accuracy of the WEPP model, which is plus-or-minus fifty percent, then WEPP could predict values of up to 3.9 (2.6 X 1.5 is 3.9) tons/acre/year and still be within the range calculated by Robichaud. Individual WEPP modeling runs (html files) are found in the WEPP Folder of the hydrologist files c.d., and the average and 10-year WEPP values in the Pahvant_II.xls spreadsheet file on the Data worksheet in the project file. Water repellent conditions may persist at the ground surface and within the topsoil horizon for a period of 1 to 5 years according to Smith on soils within the analysis area (Smith 2003, p.10). Erosion rates will therefore decrease more from those predicted in WEPP after each year until they return back to the normal undisturbed rates.

Water Yield and Hillslope Modeling: The HYDRAIN-HYDRO (Integrated Drainage Design Computer System) model can be used to predict peakflows from ungaged watersheds (Hydrain 1999). The approach is to use the rational method to arrive at peakflows. The model can be calibrated using gaged streams or regional regression equations. The equations used to calculate peakflows that are then used as part of the calibration are accurate in estimating stream flows based on areas and elevations (USGS 1999) and Regional Curve (USGS 1999, and Deiter and Peterson 2003). The calibrated model is then used to predict flows based on using greater runoff coefficients than the calibrated coefficient for prescribed and wildfire areas, which gives you peakflows from drainages with proposed prescribed fires, and from wildfires. Hydrain uses rainfall intensities, runoff coefficients, topography, and drainage areas for the prediction of flows.

The Water Erosion Prediction Project (WEPP) model can be used to predict hillslope erosion from disturbed forest events including prescribed fire and wildfires (Elliot et al. 2000). The approach is to predict the erosion occurring after a disturbance by modeling the desired years of climate. The results will emphasize the risk of various erosion events occurring immediately after fires and until the area has recovered (Robichaud 2000). For example, 10 years of storm data will be used to predict the 10-year return interval event that has a probability of 0.1 of occurring. The 5-year return interval and the 2-yr return interval are also predicted (Elliot et al. 2000).

Note: that a 10-year value will be exceeded, on the average, about once every ten years and that the 2-year value will be exceeded, on the average once every two years, and five times in ten years. There is a 1/10 or ten percent chance that a value equal to or greater than the 10-year value will occur a given year. Conversely, there is ninety percent chance that precipitation, runoff, erosion, or sediment yield will be less than the 10-year value. Also note, the accuracy of a predicted erosion rate is, at best, plus or minus fifty percent

due to the fact that erosion rates are highly variable. Even observed study plots have values that vary widely from year to year (Elliot et al. 2000). WEPP uses climate, soil texture, topography, and plant communities in the prediction of sediment yields.

PROCESS DESCRIPTIONS AND INDICATORS FOR THE PRINCIPLE ISSUES

Sediment Production and Delivery

Sediment production and delivery, as used in this analysis, refers to surface erosion from hillslopes. Increasing fire severity results in greater peakflows (flooding), nutrient losses, and promotes erosion by reducing or eliminating protective organic soil layers and by causing the soil to repel water. For the above reasons, locations of coarse soils that are prone to formation of water repellent layers will be one indicator (indirectly) to assess wildfire risk. The coarse soils found on Map 20 of the Pahvant Interagency Fuels Reduction Project-Soil Resource Management Report were identified and then subsequently indirectly used as part of the WEPP model, which uses soil textures as one parameter in predicting erosion from hillslopes (Smith 2003, Map attachment 20) (Elliot et al. 2000). The primary indicator of sediment production and delivery is the results from the WEPP modeling, which compares the rates of erosion factoring in climate (10-year return interval) above the 0.2 to 0.6 ton/acre/year rates given in Table 8 of the Pahvant Interagency Fuels Project-Soils resource management report (Smith 2003, p. 30) for the no action-unburned, no action-wildfire, and proposed action-prescribed fire.

Wildfire Risk

Fire plays an important role in helping to maintain nutrient cycling. Unfortunately, fire suppression has allowed greater and more continuous accumulations of biomass and debris over larger areas than was typical before fires were suppressed. These conditions can result in more intense and severe wildfire than was common historically. Intensity describes the rate of heat created by the fire for a given period of time. Severity describes the total amount of heat generated by the fire. A very intense fire may not be severe if it burns for a short period of time. Fire severity is a function of fire intensity and duration. Small diameter fuels typically play a larger role in fire intensity than do large diameter fuels because they burn more readily and quickly. Large diameter fuels add to fire severity primarily because they burn much longer than fine fuels. Decreasing the intensity can reduce risk related to the potential for severe wildfire. Increasing fire severity results in greater peakflows (flooding), nutrient losses, and promotes erosion by reducing or eliminating protective organic soil layers and by causing the soil to repel water. Therefore, fire severity is usually more important than intensity in determining affects to water quality. For the above reasons, peakflows will be used as an indicator to assess wildfire risk. This will be done by showing the change in predicted peakflows from a design storm event (10-year/1-hour) from the Hydrain model based on no action-unburned to no action-burned by wildfire, and to the proposed action-prescribed fire.

Water Quality Standards

Water Quality Standards, as used in this analysis, refers to the State of Utah 303d list of impaired waters, refers to any stream that is not complying with State of Utah-Title 317-Standards of Water for their designated uses (Utah 2000). Actual field water quality samples are the source of knowing whether streams are actually exceeding any of the standards and gives indications whether a stream should be listed on the 303d list. The reason the 303d list will be used is because the State knows whether our samples are meeting their standards or not; they keep a database of all water quality samples within the state. This indicator is categorical: streams are fully supporting, partially supporing, or not supporting the designated uses (Utah 2000).

Water Quantity/Flooding

Water Quantity or flooding, as used in this analysis, refers to peakflows. Unfortunately, fire suppression has allowed greater and more continuous accumulations of biomass and debris over larger areas than was typical before fires were suppressed. These conditions can result in more intense and severe wildfire than was common historically. Increasing fire severity results in greater peakflows (flooding), nutrient losses, and promotes erosion by reducing or eliminating protective organic soil layers and by causing the soil to repel water. Peakflows will be used as the indicator because they are the measure of flood magnitudes. This will be done by showing the change in predicted peakflows from a design storm event (10-year/1-hour) from the Hydrain model based on no action-unburned to no action-burned by wildfire, and to the proposed action-prescribed fire.

EFFECTS ANALYSIS

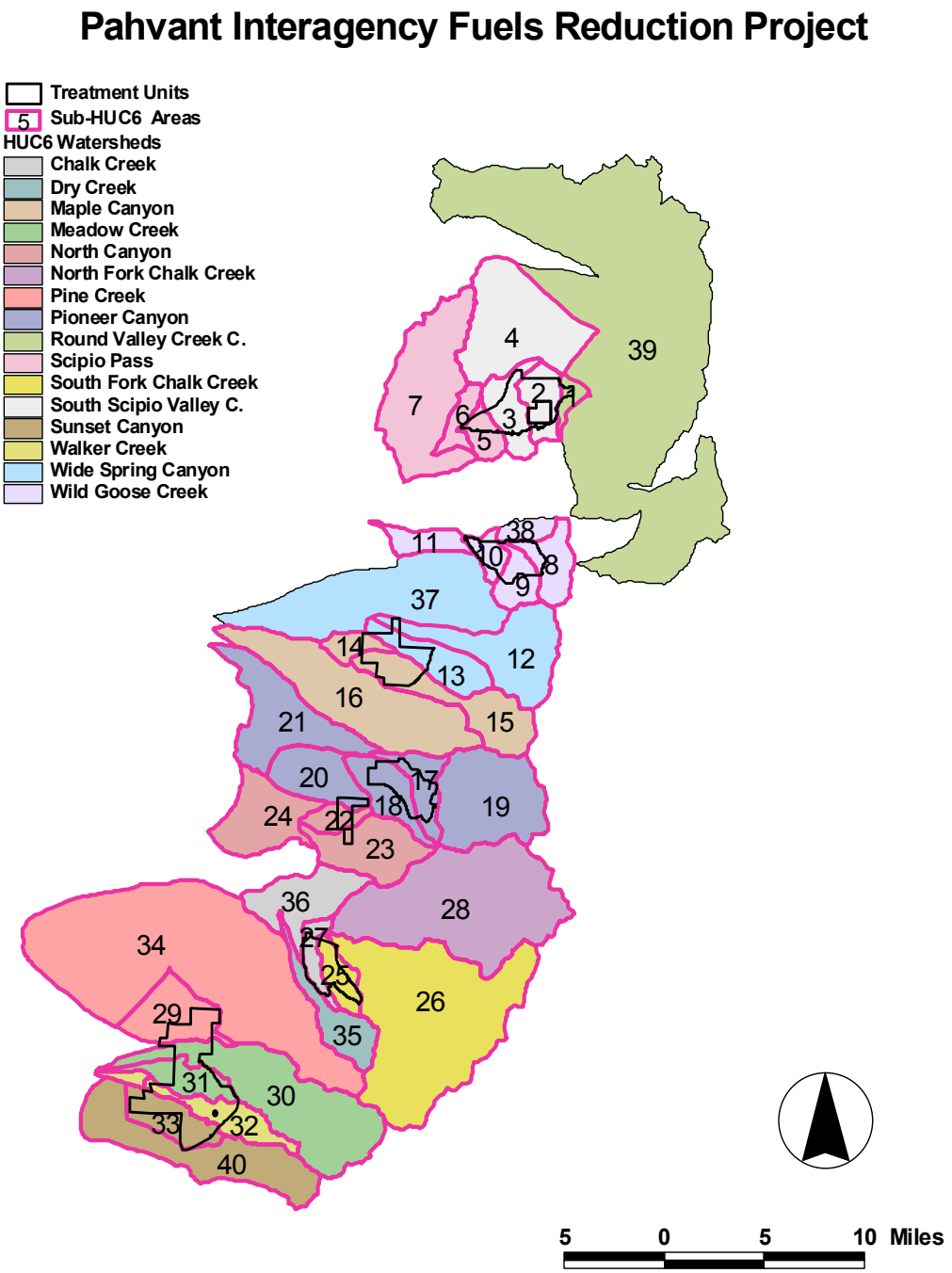
INTRODUCTION

The purpose of this section is to discuss the direct, indirect, and cumulative effects of the proposed and reasonably foreseeable activities. The discussion of effects is based on the principle issues and indicators identified in Alternatives and Issues section and the conditions and processes presented earlier in this section.

SCOPE OF ANALYSIS

The pink colored sub-HUC6 areas that make up larger cumulative effects watersheds for this assessment are displayed in Map 4. A cumulative effects watershed (or cumulative watershed area (CWA) is the logical culmination point of water flow where the effects of the distributed project activities could possibly integrate or synchronize over time and space and be addressed cumulatively in a larger watershed. Cumulative watershed effects are greatest and easiest to detect at the highest point in the watershed where the individual effects overlap in time and space (MacDonald 1989). The analysis includes effects from past, present, and reasonably foreseeable activities.

The cumulative effects areas (CWAs), found in Map 4, and Tables 6 and 7, were chosen based on the amount and types of proposed activities planned within the basins and because they are logical cumulative affects areas as described above (MacDonald 1989).



Map 4. The pink colored Sub-HUC6 Areas (numbered areas) are used as part of the cumulative affects analysis. The Sub-HUC6 Areas are used by themselves as CWAs and added together in other cases to form CWAs for logical modeling units in both the Hydrain and WEPP models. See Tables 6 and 7 for descriptions and modeling results relating to the Sub-HUC6 areas.

METHODS

Data Collection

The level of review and information collected within each effects area was based on the values-at-risk (beneficial uses), the amount and type of proposed activities, stream and hillslope gradients and lengths, existing vegetation types and cover percentages, and soil sensitivity to water repellency. The level of discussion in this report is varied according to the level of risk that the proposed actions pose to the beneficial uses within a given watershed. Soils, precipitation, travel routes, watersheds, streams, current vegetation, ortho-photo quads, and elevations maps stored in the Forest geographical information system (GIS) files were used extensively. The current conditions of the hydrologic resources in the effects areas were established by interpreting information from stream and riparian inventories, GIS files, historical records, watershed conditions analyses, published scientific literature, and discussions with Forest Fish and Wildlife Biologists, Soil Scientist, and Hydrologist.

Analysis

Sediment Production and Delivery

Cumulative changes in sediment production from hillslopes are estimated using the Water Erosion Prediction Project (WEPP) model (Elliot et al. 2000). WEPP can be used to predict hillslope erosion from disturbed forest events including prescribed fire and wildfires (Elliot et al. 2000). The WEPP approach entails the use of climate information for a specific modeling period (10-years), soil texture, current vegetation or treatment element (low or high severity fire), percent cover by vegetation and rock, and information relating to the hillslope profiles in the prediction of erosion. The results emphasize the risk of various erosion events occurring immediately after fires (Robichaud 2000). For example, 10 years of storm data will be used to predict the 10-year return interval event that has a probability of 0.1 of occurring. The 5-year, 2-year, 1-year return interval and the average erosion rates are also predicted when performing the 10-year modeling run (Elliot et al. 2000).

Table 6 shows the percent increases in erosion for each Sub-HUC6 Unit above the 0.2 to 0.6-ton/acre/year ranges found in Table 8 of the Soil Resources Report (Smith 2003). The new increased range was calculated by taking the average Undisturbed WEPP value of erosion in t/ac/yr for each Sub-HUC6 Unit and comparing it to both of Mike Smith's end range values of 0.2 and 0.6 ton/acre/year and then calculating what percent increases had occurred. In some cases the calculated WEPP value were smaller than one or both of the (0.2 and 0.6) range values, and in these cases the percent increase was given as 0 percent (e.g. Sub-HUC6 number 3 had 0 to 0 % increase above the 0.2 to 0.6 rates). The prescribed fire and wildland fire ranges of percent increases in erosion rates were calculated the same way as the undisturbed ranges. Individual WEPP modeling runs (html files) are found in the WEPP Folder of the hydrologist files c.d., and the average and 10-year WEPP values in the Pahvant_II.xls spreadsheet file on the Data worksheet in the project file.

Table 6. The Sub-HUC6 Units and CWAs that were modeled in WEPP, ranges of % increases factoring in climate are above the 0.2 to 0.6 t/ac/year values found in Table 8 of Mike Smith's Report (Smith 2003) that did not factor in climate. The % increases ranges of erosion rates are shown for each Sub-HUC 6 unit and CWA based on no disturbance for all of the Sub-HUC6 acres (alt. 1 no action-no wildfire), prescribed fire on just treatment acres (alt. 2), and wildfire (alt. 1 no action-wildfire) of treatment acres. The WEPP model values ranged from 0.9 to 3.71 t/ac/year from prescribed fire (0.4 to 5.6 times normal), and 3.5 to 11.2 t/ac/year from Wildfire (2.6 to 22 times normal).

Sub-HUC6 #	Sub-HUC6 UNIT Name	Total Acres	Proposed Treatment Acres	% Of Area	Alternative 1 % Increase Factoring Climate	Alternative 2 % Increase Factoring Climate	Wildfire % Increase Factoring Climate
1	Grabalt E	624	87	14	0-150	327-1180	1567-4900
2	Grabalt EC	1831	893	49	0-105	252-955	1272-4015
3	Grabalt WC	2180	1034	47	0-0	72-415	847-2740
33	Sunset Canyon	2353	1332	57	8-225	518-1755	990-3170
32	Walker CK	2642	939	36	0-20	132-595	1295-4085
30	Meadow Creek N	9508	534	6	0-20	133-600	1365-4295
31	Meadow Creek S	1915	1222	64	0-45	160-680	1157-3670
29	Meadow E (New)	3348	900	27	0-40	165-695	1130-3590
25	Horse-SFChalk (E)	1373	808	59	0-165	352-1255	1140-3620
27	Horse South-Chalk	1044	625	60	0-130	253-960	1013-3240
22	Frampton SC (N)	982	228	23	0-100	212-835	830-2690
23	Frampton South	3853	95	2	0-45	180-740	997-3190
17	Pioneer North (E)	1879	757	40	0-180	333-1200	977-3130
18	Pioneer South (W)	2428	846	35	0-150	280-1040	1090-3470
20	Frampton North	3096	167	5	7-220	287-1060	833-2700
14	Holden SC N	966	271	28	0-120	237-910	963-3090
15	Holden South	4514	1034	23	0-20	157-670	528-1785
12	Holden North	5580	74	1	0-30	123-570	625-2075
13	Holden Northcenter	2670	564	21	0-0	50-350	500-1700
8	Wildgoose East	2062	376	18	0-95	200-800	1333-4200
9	Wild Goose Center	1510	588	39	0-190	338-1215	1497-4690
10	Wildgoose West	911	615	67	17-250	412-1435	1175-3725
5	Grabalt West	2353	337	14	0-70	222-865	488-1665
CWA	***Cumulative Effect Area***				**%**	**%**	**%**
2,3	***So. Scipio-CE***	4011	1927	48	17-250	397-1390	1763-5490
5	***Scipio Pass-CE***	2353	337	14	0-95	227-880	883-2850
8,9,10,11,38	***Wild Goose-CE***	6595	990	15	0-135	213-840	1275-4025
12,13	***Wide Spring-CE***	8520	638	7	0-35	133-600	640-2120
14,15	***Maple Canyon-CE***	5480	1305	24	0-15	115-545	750-2450
12,13,37	***Pioneer Canyon-CE***	19708	1770	9	2-205	320-1160	958-3075
14,15	***North Canyon-CE***	4836	323	7	0-45	177-730	997-3190
30,31	***Meadow Creek-CE***	11423	1756	15	0-0	97-490	1187-3760
25,26,27,28	***Chalk Creek-CE (3)***	31276	1434	5	0-95	170-710	720-2360
32	***Walker Creek-CE***	2642	939	36	0-20	132-595	1295-4085
33	***Sunset-CE***	2353	1332	57	8-225	518-1755	990-3170
1	***Round Valley-CE***	624	87	14	0-150	327-1180	1567-4900

Wildfire Risk and Flooding of Communities

The HYDRAIN-HYDRO model can be used to predict peakflows from ungaged watersheds (Hydrain 1999). The approach is to use the rational method to arrive at peakflows. The model can be calibrated to design peakflows using gaged streams or regional regression equations that are able to calculate specific return interval events (2,5,10, 25, 50, and 100 years). These two equations, used to calculate peakflows ,use areas and elevations (USGS) and areas and geology types (Regional Curves) as parameters (USGS 1999, and Deiter and Peterson 2003). The model is calibrated by arriving at a peakflow value (cfs) that is within or very close to the values calculated by the two equations. The additional data needed for calibration of the model for each unit, includes hillslope gradient and length, stream gradient and length, drainage area, and the 10-year/1hr storm event intensites that are calculated using the process described on the Pahvant_II spreadsheet.xls (NOAA worksheet) found on the hydrologist c.d. found in the project file (NOAA 1973). The average 10-year/1hour intensity is approximately 1.15 inches/hour for treatment units within the analysis area.

After the model was calibrated, the runoff coefficent that gave the peakflow value expected was then used for any subsequent untreated acres of the Sub-HUC6 and CWA unit (averaged about C=.05) models; a prescribed burn coeffient of 0.1 was applied to low severity prescribe burn acres, a coefficient of 0.3 for moderate severity prescribed fire acres, and 0.5 for wildfire acres in the subsequent models. Each Sub-HUC6 and CWA unit was calibrated, and then modeled for low severity prescribed fire at 40% of the treatment acres (best case scenario for prescibred fire), moderate severity prescibed fire at 80% of the treatment acres (worst case scenario for prescribed fire), and high severity fire at both 40% (best case scenario for wildfire) and 80% (worst case scenario for wildfire) of the treatment acres. In this way, the ranges of increases in peakflows (cfs) that are found in Table 7, which are the measure of flood magnitudes, were estimated for each of the alternatives: no action-no disturbance and no action-wildfire, and proposed action-prescribed fire.

Following the prediction of peakflows in Hydrain, the regional curve equations (Peterson and Deiter 2003) that were used in calculating the peakflows were then used again in the calculation of the return intervals of the flows found in Table 7 using the spreadsheet (Pahvant_Returninterval.xls located on the hydrology c.d. found within the project files). For example, for Sub-HUC6 number 1, the Q10 flow went from the 10 year event to somewhere between a 10 and 19 year event for prescribed fire, and somewhere between a 19 and 30 year event if wildfire were to occur on the same number of acres as were proposed for treatment within the Sub-HUC6s and CWAs. Return intervals rather than percent increases in peakflows give a better idea of whether channels are able to handle the increase in peakflows or not. Properly functioning channels and riparian areas that are hydrologically connected to their floodplains, well vegetated, and have stable banks and profiles are able to pass nearly all storm events. However, if channels are extensively downcut and disconnected from their floodplains than the energy, sediment, and water that these floods carry could cause additional degradation to the channels and become a source of additional sediment. Stream crossings (where roads or trails cross streams) including culverts and the fill materials around the culverts might be washed and add

additional sediment to the streams if they are not designed for large enough storm events. Streams within the analysis area are only moderately entrenched in a few locations, but still have connectivity to floodplains, and have stable banks, and profiles. The peakflow values calculated using Hydrain found in table 7 as noted before show both the best-and-worst case scenarios for both prescribed fire and wildfires on the same number of acres as those proposed in alternative 2. Since, fires tend to burn with a range of severities in mosaic patterns it would be safe to assume that for prescribed fire that the peakflow values would be about those found in the middle of the range, and not similar to the worst case scenario values of table 7, and that the channels based on current conditions would be able to pass the peakflows generated from the proposed actions based on the mid-range return intervals of table 7. Even the best case scenario values from table 7 for wildfires are still much closer to the worst case values of prescribed fire, and therefore would have more likelyhood of damaging stream channels when compared to the lower peakflow and return interval values calculated for prescribed fires.

REQUIRED DESIGN CRITERIA FOR ALL ACTION ALTERNATIVES

The following specific design criteria would be applied as part of the proposed action. The purpose of these measures is to completely avoid, or to the fullest extent possible, minimize the potential for adverse effects to soil and water resources. The effects analysis assumes their implementation.

- Low- to moderate-intensity prescribed fire would be used in order to promote the creation of a patchwork burn pattern of burned and unburned vegetation, and to protect soil resources.
- Where necessary, hand or “black” lines would be constructed along the perimeters of treatment units in order to contain prescribed fire within the treatment units. Hand lines and black lines are created by removing vegetation along a line by hand tools or hand burning, respectively. These lines would be constructed prior to the implementation of treatments that involve the use of prescribed burning.
- Grazing pastures within treatment units would be rested from livestock grazing for a minimum of two growing seasons following a prescribed burn in that unit. Pastures would be rested for an additional season(s), where necessary to allow grasses to rejuvenate.
- Where necessary, treated areas may be seeded to promote recovery of ground cover to protect soil resources. Seed mixes may be comprised of grass, forbs, and shrubs. Only noxious weed free seed mixes would be used.
- The Forest Service and BLM would prepare a prescribed fire burn plan for each treatment unit prior to prescribe burning. The prescribed burn plan would describe methods and conditions under which prescribed burning would occur in order to accomplish project objectives.

- A minimum of two trees per acre would be retained for wildlife habitat in pinyon-juniper targeted for cutting. Trees with cavities that are observed during cutting of pinyon or junipers will be retained for cavity nesting bird species.
- Vegetation treatments would not occur within a 100-foot buffer of perennial streams, in order to avoid potential negative affects to riparian resources.
- In the event a prescribed fire escapes control, it would be considered a wildfire and would be treated accordingly, including implementation of burn area emergency rehabilitation (BAER) measures.

Table 7. The results of the Hydrain model for each Sub-HUC6 and CWA area, and how the 10-year peakflows (Q10) increase as prescribed fire or wildfire occur in the units. The range increases in peakflows are shown for the proposed action-prescribed fire, and for no action-wildfire. The return intervals (years) for each management action are also shown. The return interval means that instead of being a 10 year event, the peakflow would become a larger flow value than the Q10 event (e.g. for Sub-HUC6 number 1, the Q10 flow would go from the 10 year event to somewhere between a 10 and 19 year event for prescribed fire, and somewhere between 19 and 30 year event if a wildfire were to occur on the same number of acres as were proposed for treatment).

Sub-HUC6 UNIT **Name**	**Sub-HUC6 #**	**Hydrain Q10 Alt. 1 cfs**	**Hydrain Prescribed Fire cfs**	**Hydrain Wildfire cfs**	**Return Interval years Prescribed Fire**	**Return Interval years Wildfire**
Grabalt E	1	39	41-58	59-74	10-19	19-30
Grabalt EC	2	71	95-284	257-445	18-261	200-500
Grabalt WC	3	79	111-329	297-516	20-303	236-500
Sunset Canyon	33	81	126-425	380-679	23-469	379-500
Walker CK	32	85	118-329	297-508	19-242	182-500
Meadow Creek N	30	170	191-315	293-416	14-40	34-79
Meadow Creek S	31	73	113-385	345-617	23-472	383-500
Meadow E (New)	29	98	130-334	301-505	18-184	129-467
Horse-SFChalk (E)	25	62	90-285	258-454	21-362	291-500
Horse South-Chalk	27	54	74-223	204-353	19-283	225-500
Frampton SC (N)	22	51	57-107	101-151	12-41	37-91
Frampton South	23	106	110-132	128-150	11-16	15-21
Pioneer North (E)	17	74	99-313	244-475	19-318	164-500
Pioneer South (W)	18	84	112-302	273-463	19-215	158-500
Frampton North	20	93	99-137	131-169	11-21	20-34
Holden SC N	14	52	59-114	108-163	13-48	43-119
Holden South	15	112	149-372	336-559	18-164	113-429
Holden North	12	126	129-145	142-158	10-14	13-16
Holden Northcenter	13	87	106-226	207-328	15-78	63-237
Wildgoose East	8	77	88-168	156-236	14-50	43-123
Wild Goose Center	9	65	81-204	180-304	16-124	86-376
Wildgoose West	10	51	65-190	177-302	17-222	179-500
Grabalt West	5	82	93-165	154-226	13-43	37-89
Cumulative Effect Area	***CWA***					
So. Scipio-CE	2,3	104	171-587	520-935	25-500	418-500
Scipio Pass-CE	5	78	89-160	150-224	13-43	38-94
Wild Goose-CE	8,9,10,11,38	138	174-390	353-569	17-99	81-307
Wide Spring-CE	12,13	159	183-322	298-437	14-47	40-98
Maple Canyon-CE	14,15	124	171-454	407-690	19-223	162-500
Pioneer Can-CE	12,13,37	246	322-734	659-1071	19-150	101-371
North Canyon-CE	14,15	119	131-205	193-267	13-32	27-58
Meadow Creek-CE	30,31	184	256-663	590-997	21-236	172-500
Chalk Ck-CE (3)	25,26,27,28	305	374-741	672-1039	17-81	64-214
Walker Creek-CE	32	85	118-329	297-508	19-242	182-500
Sunset-CE	33	81	126-425	380-679	23-469	379-500
Round Valley-CE	1	39	41-58	59-74	10-19	19-30

Management Areas and Goals

The treatment units lie almost entirely within Forest Service Management Area 6B, intensive grazing management. A small area within the Meadow treatment unit lies in Management Area 10E. As Part of Management Prescription Area 10E, which provides for municipal water supply and watersheds, we are directed to manage non-forested areas to improve streamflow through increased on site water yields and to meet State water quality standards (Fishlake National Forest Land and Resource Management Plan 1986). The Forest standard is to meet State water quality standards (Fishlake National Forest Land and Resource Management Plan 1986, p. IV- 4). The Forest Plan goals for soil and water are to maintain water quality, manage municipal watershed to protect quality of water supplies, maintain productive streams, lakes, and riparian areas and mitigate hazards on floodplains, and to maintain or improve soil productivity and restore areas with watershed problems (Fishlake National Forest Land and Resource Management Plan 1986, pg. IV- 4-5). The plan also recommends special protection and management to floodplains, wetlands, and riparian areas within a minimum of 100 feet from the edges of all perennial streams (Fishlake National Forest Land and Resource Management Plan 1986, p. IV- 33). This buffers the riparian and channels from disturbances and helps maintain healthy fish habitat, streams, and water quality. An Additional goal of the 2002 Utah Fire Amendment states: "Ecosystems are restored and maintained, consistent with land uses and historic fire regimes, through wildland fire use and prescribed fire." (Utah Fire Amendment, 2000, p. A-40).

DIRECT AND INDIRECT EFFECTS COMMON TO ALL ALTERNATIVES

Within the cumulative effects areas there are only a few reasonably foreseeable Forest Service and BLM activities that possibly could affect values at risk: one project is the Maple Hollow Campground and Road Restoration project, which is in the process of being planned and implemented; second, is additional hazardous fuel and vegetation treatment projects that are likely but not in the planning process yet; third, is to treat areas with Mormon cricket problems with bait.

Treating crickets would have the effect of limiting the amount of vegetation eaten by crickets that would aid in covering soils, and limiting the amount of erosion from the lands treated with bait. Depending on the type of bait used and the method of application then some pesticides may or may not make it into streams and may or may not affect the macroinvertebrate communities found with in streams, or may or may not affect the water for use by individuals, communities, and values at risk.

The BLM thinnings will continue to be done and will likely be finished this year and therefore were considered as part of the existing condition for all alternatives in this analysis.

Activities, such as grazing (on Public Lands as a whole), hunting, and recreation will continue as they have been and are not part of the decision for this environmental

assessment. Grazing within the treatment units with prescribed fire will need to have livestock management changes as per the required design criteria.

On private lands within the analysis area, the trend is for more of the lands bordering the Public Lands to be developed such as those found in Frampton Heights, but no new development plans are known at this time.

On State lands, they have shown interest in treating additional lands within the analysis area by attending a few of the initial project meetings, although because of budget constraints they do not have plans to treat any lands at this time and have not attended any of the subsequent meetings.

The current erosion rates and peakflows are the results of past and current activities on the public lands and many other factors such as geology and climate. The streams and hillslopes are in good enough conditions that our streams are complying with State water quality standards and the Clean Water Act. Therefore, it is not very likely that all of these activities together will increase sedimentation to streams or degrade the streams enough to have them listed on the State 303d list of impaired waters.

The road restoration of the Maple Hollow Project listed above will actually improve the quality of water by reducing or eliminating unnecessary stream crossings and moving a portion of the road away from the channel. The long run effects will be to decrease sedimentation of Maple Hollow, and thus increased water quality from the Maple Hollow Road project.

The Swains Fire still might need a couple of years to be completely rehabilitated on the steep mountainsides of upper Maple Hollow, and therefore it has some probability of flooding the Community of Holden. This does not mean we cannot plan implementation of treatments within the Holden Springs treatment unit, it just means we need to be aware of the risks of implementing prescribed fire within the next 1 to 2 years.

DIRECT AND INDIRECT EFFECTS OF THE NO ACTION ALTERNATIVE

Under this alternative, both the Forest Service and Bureau of Land Management continue to maintain the long-term productivity and hydrologic function of soil and water resources. Sediment and water yields will remain as they have been and will be consistent with meeting all standards and guidelines relating to State water quality standards, assuming no wildfire or other disturbance occurs. The hazardous fuel loadings will likely continue to increase, which could lead to unwanted, high severity wildfire. In this event, teams would be called upon to fight the fire, and to assess the impacts of the burn, and to decide if emergency stabilization and rehabilitation would need to be implemented.

In the case that wildfire does impact soil and water resources, then the magnitudes of erosion rates and peakflows would be similar to those described in this report (Tables 6 and 7) and those of the Soil Resources Report Table 9 (Smith 2003, p.30). Soils may or may not become water repellent. Increased peakflows or floods could occur similar to

those that resulted from the Swains Fire. Erosion rates, landslides, and slumping may increase above those rates of undisturbed and prescribed fires conditions. Channels and stream crossing would be at risk from large floods, and water quality would decrease during storm events until the hillslopes recover with vegetation and lose their water repellency. Additional effects associated with wildfire would be those associated with fire suppression. Fireline construction including hand and dozer lines would directly impact soils by displacing top soil and compacting sub-soils, which could lead to additional sedimentation of streams and covering of cold water organism habitat by ash and sediment than that would come off the burned areas. An additional impact could be the addition of retardants on the hillslopes that could inadvertently wash into streams, thus affecting fish, macroinvertebrates, and water quality.

DIRECT AND INDIRECT EFFECTS OF THE ACTION ALTERNATIVE

If the proposed action alternative were chosen, prescribed burning and thinning activities would be implemented. These actions and their effects on sediment production and delivery, and possible flooding are described below.

Prescribed Burning and thinning for Fuel Reduction

Roughly, 40 to 80 percent of 14,329 acres in Alternative 2 are scheduled for thinning and prescribed burning. Higher elevation snow could be used for control lines in either early spring or late fall. Soil moisture would be at least 12 to 15 percent water by weight regardless of the season when a unit is burned (Smith 2003). Firelines would be frequently waterbarred to prevent erosion as part of fireline BMPs. Nutrients such as carbon would be volatilized during the burn, but the higher soil moistures resulting from burning coupled with higher soil temperatures would increase nutrient cycling making more of the stored nutrients available to plants. Plants, especially on units burned in the spring, would quickly capture these nutrients. The riparian buffer areas along perennial streams would function as filter zones for upslope runoff. Reducing existing fuel loadings would decrease the potential for severe wildfire within the analysis area. The Cumulative Watershed Effect areas (CWAs) values and ranges found in Tables 6 and 7 show predicted cumulative effects values and ranges of current and proposed actions on peakflows and erosion rates of areas within the analysis area.

Both pre-burn and post-burn soil monitoring should be done within the coarse soil areas of the Grabalt, Meadow, and Horse Hollow treatment units because these soil types are susceptible to water repellent conditions. These soils should not be burned if they are below the 12 to 15 water percent by weight to protect these soils. Post-burn monitoring will show whether broadcast seeding is necessary to expedite vegetation, soil, and water resource recovery within these units. Attachments 19, 20, and 21 in the Soil Resources Report show where fragile soils should be monitored for water repellency, compaction, puddling, and accelerated erosion rates (Smith 2003).

CUMULATIVE EFFECTS TO VALUES-AT-RISK

Cumulative effects include the combined impacts of past, present, reasonably foreseeable and proposed management actions. Over the past 100+ years, the exclusion of burning, grazing practices, and climatic conditions have resulted in unnatural accumulation of hazardous fuels within the analysis area. Specifically, there is a serious potential for uncharacteristic wildfires to occur in close proximity to communities within and near the analysis area. Associated with these fires is the genuine potential for flooding, mudslides and debris flows if significant portions are damaged by severe wildfire burning conditions. The Cumulative Watershed Effect areas (CWAs) values and ranges displayed in Tables 6 and 7 show predicted cumulative effects of no action, no action with wildfire, and proposed action on erosion rates and peakflows within the analysis area.

No Action

The streams and hillslopes are in good enough conditions such that water quality parameters are complying with State standards, the Forest Plan, and the Clean Water Act. Therefore, it is not very likely that foreseeable activities will increase sedimentation to streams or decrease the streams enough to have them listed on the State 303d list of impaired waters, or will lead to their degradation. The road restoration of the Maple Hollow Project listed above will actually improve the quality of water by not having a few unnecessary stream crossings, and relocation of a portion of the road away from the channel. The hydrologic values-at-risk will not to be affected negatively if the no action alternative is chosen, unless high severity fires were to occur.

If unwanted high severity wildfire were to occur then the cumulative effects would be those found in Table 6 and 7 for each CWA under the Wildfire Alternative plus the indirect and direct effects of the foreseeable actions, and the effects related suppression of wildfire. Values-at- risk, including water quality, and cold-water organisms, and communities would most likely be affected negatively by wildfire. Flooding events similar to those that occurred in Holden may or may not occur within the analysis area, and genuinely could flood Holden again, or the other communities near and in the analysis area. Water quality would likely be affected negatively during runoff and storm events until the burned or black area became revegetated and the water repellent soils nearly rehabilitated. The decrease in water quality would not likely causes streams to be put on the State 303d list, but downstream uses would be affected as is discussed in Table 2. Excess sediment would periodically affect diversion structures and possibly livestock and agricultural uses of water. Cold-water organisms might be directly affected by ash and sediment (such as clogging gills) or indirectly by changing water chemistry, or coving spawning or food sources habitat in gravels. Increased peakflows cumulatively would increase the ranges of sediment being removed from the hillslopes, channels banks and beds, and stream crossings above those found in Table 6 of this report. The hydrologic values-at-risk would likely be affected if high severity fire were to occur.

Proposed Action

If the proposed actions were to occur, then the cumulative effects would be similar to those found in Table 6 and 7 for CWAs under Prescribed fire Alternative plus the indirect and direct effects of the foreseeable actions. Values at risk, including water quality, and cold-water organisms, and communities would not likely be affected negatively from the proposed actions plus the foreseeable actions because riparian buffers will be used along perennial streams, and because the high values of peakflows and erosion rates from tables 6 and 7 represent for the most part what the absolute range of scenarios would be for prescribed fire, with the actual values more likely being mid-range values rather than the worst case values because the prescribed fire would likely burn in a mosaic pattern of low, moderate and unburned areas within a treatment unit. It would take numerous events to all happen for the worst case scenario for prescribed fire to occur including: 1) the 10-year storm event to happen within the first year after treatment of a particular unit (probability of 10% per year), 2) to burn exactly 80% of the treatment acres of a unit, 3) to burn with only moderate intensity fire within a burn unit, which is not likely, and 4) transport off of hillslopes and delivery of eroded sediment into channels would need to happen too.

The channels within the Analysis Area would most likely be able to handle all the increase in peakflows, since the channels are hydrologically connected to their floodplains, and the banks and profile are stable. Water quality may or may not be affected negatively during large runoff and storm events that could result in short-term exceedences until the burned area became revegetated. These decreases in water quality would not cause streams to be put on the State 303d list or lead to permanent degradation of the water quality. Downstream uses for livestock would be only affected during larger storm events and even then only temporarily. Sediment production and delivery would be less than from wildfires (Table 6) and would not likely affect diversion structures. Cold-water organisms might be minimally be affected by ash and sediment; nutrients may temporarily change water chemistry and cover some important habitat for fish and their food, and generally only temporarily after large storm and runoff events.

Monitoring and mitigation: Both pre-burn and post-burn soil monitoring should be done within the coarse soil areas of the Grabalt, Meadow, and Horse Hollow treatment units because these soil types are susceptible to water repellent conditions. These soils should not be burned if they are below the 12 to 15 water percent by weight to protect these soils. Post-burn monitoring will show whether broadcast seeding is necessary to expedite vegetation, soil, and water resource recovery within these units. Attachments 19, 20, and 21 in the Soil Resources Report show where fragile soils should be monitored for water repellency, compaction, puddling, and accelerated erosion rates (Smith 2003).

CLEAN WATER ACT

Army Corp Discharge, Dredge and Fill Permits
The proposed thinning and prescribed fire would not require any permits. No wetlands are found within the analysis area that would be affected by the hazardous fuels reduction work.

Water Quality Limited Stream Segments
There are no WQLS stream segments listed by the State of Utah within the project or analysis area. None are expected to be after implementation of the proposed action.

Antidegradation Policy for Beneficial Uses
More frequent and less severe wildfires historically occurred within the assessment area, and the aquatic resources would have been adapted to flooding and sedimentation events from these burned areas. The proposed actions would introduce this type of fire process into the assessment area with some control. Thus, it is not anticipated that the beneficial uses would be degraded by application of proposed actions.

Management Recommendations
Reduce fuel loadings in intermittent drainage channels, retain integrity of riparian areas, avoid intense fires, which may promote erosion, retain sufficient ground cover to prevent erosion of burned sites, remove all debris added to stream channels as a result of prescribed burning, and install water bars and other drainage diversions in roads.

Summary of Hydrologic Analysis

Values-at-Risk, Principle Issues, Issue Indicators, and Measurement: Areas encompassed in this project have different water related uses and values that may be put at risk depending on the consequences of each alternative. The important values-at-risk are: first, water quality for municipal and domestic uses, irrigation and agriculture, and cold water organisms; and second, potential flooding of communities. Principle issues are those factors that put desired uses and values-at-risk, or that determine the needs and potential or risk for watershed degradation or restoration. For this analysis the risk of production and delivery of sediment, and flooding (peakflows) from first, treatment activities, and second from severe wildfire were considered issues. Water quality for cold water organisms and downstream uses is an additional issue that was considered. The indicator of sediment production and delivery is the WEPP modeling results and measured in percent increase above the undisturbed rates (0.2 to 0.6 ton/acre/year) for the analysis area. The indicator for wildfire risk to hydrology and for water quantity is flooding potential or peakflows from severely burned areas based on Hydrain model results and measured in cubic feet per second (cfs). The indicator of water quality is whether the water is listed on the States 303d list of impaired waters; waters listed on the 303d list are considered impaired waters. Waters not listed on the 303d list implies full support of State Standards. All streams within the analysis area are currently fully supporting uses and State Standards; none of the streams are listed as impaired or partially impaired for their designated beneficial uses.

Results: Tables 6 and 7 of the Hydrological Analysis show the increases of erosion rates in percent above the undisturbed rates of 0.2 to 0.6 ton/acre/year by factoring in climate, and increased peakflows in cfs and the related return interval in years based on no action-no disturbance, no action-wildfire, and proposed action-prescribed fire and thinning for Cumulative Effect Areas (CWAs). Table 6 can be summarized by saying that ranges of erosion rates for CWAs increased because of 10-year storm events (that averaged about 1.15 inches/hour) and treatments from approximately 0 to 2.6 times normal (0 to 250%) for no action-no disturbance, 0.4 to 5.6 times normal (0.9 to 3.71 t/ac/year for 100 to 1400% increase) for proposed action-prescribed fire and thinning, and 2.6 to 22 times normal (3.5 to 11.2 t/ac/year for 650 to 5500% increase) for the no action-wildfire disturbance. Table 7, can be summarized by saying that peakflows and return intervals increased within individual CWAs by the type of treatment applied; peakflows are predicted to be greater with prescribed fire and thinning on 40 to 80 percent of the same proposed treatment acres than if the acres were untreated. And predicted peakflows are approximately equal to the worst-case scenario of moderate severity fire (moderate fire over 80 percent of the proposed treatment acres) peakflows or greater when 40 to 80 percent of the same proposed treatment acres are treated with wildfire. Reasonably foreseeable actions and wildfire suppression activities may or may not increase these rates when they occur within the CWAs above these values and ranges.

Values at risk, including water quality, cold-water organisms, and communities would not be affected negatively from the proposed and foreseeable actions compared to wildfire and suppression. Peakflow events from storms would be lower magnitudes than those from wildfires (Table 7). Sediment production would be less than from wildfires (Table 6). Values at risk would not likely be negatively affected because of designed riparian buffers along perennial streams, which would limit the amount of sediment being transported and deposited into streams, and because the channels within the Analysis Area would likely be able to pass the magnitude of flows generated from the proposed action since the channels are hydrologically connected to the floodplains, and the profile and banks are stable. If wildfires were to occur, riparian areas on perennial streams could be burned and uplands could burn at higher intensities causing the soils to be affected more negatively than if prescribed burns were to occur, which would increase flows, and would allow more sediment to be eroded, transported, and delivered into channels compared to the proposed action.

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