Boswell Creek Healthy Forest Initiative
Soils and Hydrology Specialist Report
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Background and Supporting Information

President Bush announced the Healthy Forest Initiative (HFI) for Wildfire Prevention and Stronger Communities on August 22, 2002. Proposed treatments for the initiative are planned to further the goals of reducing the threat of catastrophic wildfires to protect communities, firefighters, and wildlife and also promote forest health. The Boswell Creek Watershed on the Sam Houston National Forest (NF) is a part of President's Initiative.

As part of this initiative, the Sam Houston NF is proposing management activities in Compartments 69, 70, 72, 73, 74, 75, 76, 77 and 83 within the Boswell Creek Watershed. The proposal is for:

- Implementing dormant and growing season prescribed burning on approximately 9,000 acres every two to five years to reduce risk from destructive fires; and
- Thinning approximately 4,895 acres of pine stands to reduce Southern Pine Beetle (SPB) hazard.

This report addresses the soil and hydrology issues of the Boswell Creek Watershed HFI Project.

Analysis Area

The majority of the project area is located in the Boswell Creek Watershed (120401030202), a 6th level watershed encompassing approximately 15,151 acres (see Map 1). There are approximately 8,584 acres of National Forest and 6,567 acres of private lands in the project area. Also included are minor portions of three adjacent 6th level watersheds: (1) Winters Bayou – Gourd Creek Watershed (120401030201) on the west side of the project area with approximately 521 acres; (2) Winters Bayou – Hopkins Branch Watershed (120401030203) on the southeast side containing approximately 119 acres; and (3) East Fork San Jacinto River – Cobb Creek Watershed (120401030205) on the northeast side with about 172 acres in the project area.

There are 27 miles of intermittent and perennial streams and 44 miles of ephemeral streams that have been delineated and could potentially be affected by the proposed project (see Map 2). The ephemeral streams were delineated using Geographic Information System (GIS) with the 10-meter resolution digital elevation model and a representative sample was ground truthed for accuracy. The named perennial and

intermittent streams are Boswell Creek, Briar Creek, Brandy Creek, Pea Creek and Thicket Creek. Boswell Creek is a tributary to Winter's Bayou, which is also a tributary to the East Fork of the San Jacinto River.

The primary beneficial use of the streams in the project area is fisheries. There are no known domestic water sources and only minor dispersed recreational uses occur.

Surface geology in the project area is the Willis Formation of the Pleistocene Age. The Willis Formation consists of clay, silt, sand, and siliceous gravel of granule to pebble size. The formation includes some petrified wood and iron oxide concretions. The Willis Formation is greater than 100 feet thick.

Base floodplains are also found within the Boswell Creek Watershed. However, the floodplains do not have the characteristics that meet the criteria for Jurisdictional Wetlands, as defined in the Corp of Engineers Wetlands Delineation Manual. There are no other landforms and/or landscape positions within the Boswell Creek Watershed that contain the criteria needed for Jurisdictional Wetlands.

The project area is located in the Raven Hills Land Type Association (LTA). This LTA has an Order II Soil Resource Inventory completed through contracting with the Natural Resource Conservation Service (NRCS). The majority of the soils within the project area were found to consist of the Depcor, Huntsburg and Woodville Series.

The Depcor Soil Series consist of deep, moderately well drained, slowly permeable soils that formed in unconsolidated loamy sediments. These soils are on very gently sloping to strongly sloping uplands. They have a loamy fine sand surface texture that ranges to 26 inches below the surface. Subsoil for this series is a sandy clay loam that ranges to 72 inches below the surface.

Very deep, moderately well drained and very slow permeable soils that formed in thick Coastal Plain sediments are features of the Huntsburg Soil Series. These soils are on nearly level to moderately steep uplands. They have a loamy fine sand surface texture that ranges to 10 inches below the surface. The subsoil is a sandy clay loam that ranges to 72 inches below the surface.

Soils that are very deep, somewhat poorly drained and slowly permeable (the Woodville Soil Series) formed in thick beds of unconsolidated clayey Coastal Plain sediments. They are usually on nearly level to moderately steep uplands and have a fine sandy loam surface texture that ranges to 8 inches below the surface. Clay that ranges to 45 inches blow the surface, grading to a clay loam that ranges to 80 inches below the surface makes up the subsoil.

Other soils included in the area include Boy and Chotes Landman - series that are sand-cap soils with sandy surfaces that range to 47 inches below the surface. The Hatliff and Pluck Series, also found in the area, are considered floodplain type soils because they are frequently flooded. The Redco Series, a Vertisol (high shrink-swell clay to the surface), can also be found in the vicinity. (USDA-NRCS 2002).

Applicable Laws and Forest Plan Direction

The National Forest Management Act (NFMA), as found in 36 Code of Federal Regulations (CFR) Section 219, states that the agencies should determine if the conservation of soil and water resources are being ensured and the permanent impairment of site productivity is being avoided. Agencies should also determine if the desired water quality and quantity objectives are being achieved. The NFMA states that effects of the proposed management actions on riparian, soil and water quality must be considered.

Compliance with State Water Quality requirements and monitoring of the effects and adequacy of Best Management Practices (BMPs) should also be ensured. These BMPs are required under Section 319 of the Clean Water Act. Section 313 of the Act also requires that Federal Agencies comply with State and local laws and ordinances.

The 1996 Revised Land and Resource Management Plan for the National Forests and Grasslands in Texas (NFGT) or the *Plan*, defines Standards and Guidelines (S&Gs) for use while conducting management activities. These S&Gs are established for both forest-wide use and individual management areas.

Standards and Guidelines (S&Gs) are methods, measures, or practices selected to meet nonpoint source control needs. They include, but are not limited to structural and nonstructural controls, operations and maintenance procedures. Applied before, during and after pollution-producing activities, these S&Gs can be used to reduce or eliminate the introduction of pollutants into receiving waters.

Usually S&Gs are applied as a system of practices rather than as a single practice. They are selected on the basis of site-specific conditions that reflect natural background conditions and political, socially, economic and technical feasibility. Standards and Guidelines (S&Gs) are basically a preventative rather than an enforcement system. They provide a whole management and planning system in relation to sound water quality goals, including both broad policy and site-specific prescriptions.

Standards from the Record of Decision of the Coastal Plain-Piedmont Vegetation Management Final Environmental Impact Statement (VMEIS) and the State of Texas approved BMPs are found in the *Plan*. As stated earlier, the Forest Service is required to comply with these State BMPs.

The *Plan* allocates the project area into two Management Areas (MAs); MA-2 Red Cockaded Woodpecker (RCW) Emphasis and MA-4 Streamside Management Zones. About 95 percent of the National Forest land in the Boswell Creek Watershed lies within MA-2. The focus of MA-2 is to produce habitat for the endangered RCW. The desired conditions for MA-2 are open, pine forests mixed with some hardwood species.

About five percent of the project area is located adjacent to intermittent and perennial streams and designated as MA-4. The *Plan* states that MA-4 should be managed to maintain the role and function of aquatic, riparian and wetland ecosystems. The type forest communities desired in MA-4 are generally mixed hardwoods and pines.

Base floodplains found in the area are also assigned to MA-4. The S&Gs found in the *Plan* for MA-4 will mitigate any potential adverse direct and indirect or cumulative effects to these floodplains if they are followed during project implementation.

Analysis Methods/Models

In addition to the specific areas mentioned previously, acreages in adjacent watersheds were also inventoried and analyzed for consideration in the direct and indirect effects analysis. However, a detailed cumulative effects analysis was only completed for the Boswell Creek Watershed. The other watersheds (Gourd Creek, Hopkins Branch, and Cobb Creek) were not included in the detailed cumulative effects analysis affected areas because they only represent about 3.26 percent, 0.76 percent and 1.08 percent of the total project area, respectively. Given these small percentages of the total watershed area, the effects of the activities would have been inconsequential.

There are approximately 132 acres of National Forest lands inside the watershed that are not part of the project area that were included in the cumulate effects analysis. The acres of the project that are outside the Boswell Creek Watershed and the acres of National Forest inside the watershed that are not part of the project area came together as a result of existing compartment boundaries lines. The existing data that was used in this analysis was collected and stored by compartments, so these are used as the most logical boundaries.

The Texas Commission on Environmental Quality's Draft 2002 Texas Water Quality Inventory List of Impaired Streams, as required under Section 303d of the Clean Water Act, does not include the East Fork of the San Jacinto River. Therefore, Total Maximum Daily Loads (TMDLs) were not developed for this report.

No assessments or analysis for this project were made based on surface geology because the soils in the area were developed directly from the surface geology. Therefore, all assessments and analysis for interpretations were based on soil properties and characteristics. Since there are no drastic differences in the landforms and soil formations within the project area, geomorphology was not addressed.

Information from a Fuels Specialist Report contained an evaluation of data obtained from the BehavePlus computer model. This was used to consider fire behavior outputs and fireline intensity.

Potential Fire Damage Hazard ratings used were developed as part of the interpretations of a NRCS developed computer based soil survey report for the NFGT. These hazard ratings were used to reflect the potential for damage to soil nutrient, physical and biotic characteristics from fire.

A cumulative impacts model was utilized to address the possible effects of silvicultural and soil disturbing management activities on water quality and fisheries.

Direct and Indirect Effects of the Proposed Actions

Soils

A direct effect is the immediate result of an action whereas an indirect effect occurs at a later time and is usually spatially separated (see the Guide for Soil/Water/Air Environmental Effects Analysis in Documents). Road construction, road maintenance, fire line construction and reconstruction, fuel reduction burns, and timber management activities, such as construction of skid trails, temporary roads and log landings will have a direct effect on vegetation. Some trees, soils, shrubs, forbs and grasses will be displaced or removed. This will expose bare soil and create a potential for soil compaction/erosion, which will result in an indirect effect of increased runoff that may increase sediment delivery to streams. Sediment has an indirect effect on the beneficial uses of the water for fisheries and water quality. Fuel reduction burns may also affect soil properties and have a direct effect on soil biota, physics, organic matter, nitrogen, and erosion/sedimentation and water chemistry.

Soil productivity can be affected by the above activities. These activities may cause soil compaction which effects soil infiltration capacity, tree growth, loss of nutrients and soil biota. All soils on the NFGT are relatively low in available nutrients, especially phosphorus and potassium; therefore, soil moisture, texture, and structure play a major role in site productivity. Soil samples were collected on the National Forests in Texas and analyzed by Stephen F. Austin State University and Texas A&M University personnel. Findings from these analyzes indicate a low nutrient content that has a direct effect on soil productivity.

The *Plan's* Appendix F establishes parameters for allowable soil loss based on the coefficients developed by using the Modified Universal Soil Loss Equation. The proposed commercial thinning and fuel reduction burns do not exceed the soil loss tolerance values. The proposed roads and skid trails have the potential to exceed the soil loss tolerance values; however, the implementation of appropriate S&Gs will minimize the potential soil loss and keep this loss below the tolerance value. According to the *Plan*, however, monitoring has shown that similar management practices that have been implemented do not cause long-term degradation to current soil productivity.

Table 1 displays the soil map units, by acres, with pertinent interpretations showing suitability of soils for the majority of the type activities in the proposed actions. Map 3 displays the location of the soils that are being discussed. These ratings were created by utilizing tabular information found in the GIS soil database developed by NRCS. All of the suitability ratings can be mitigated to acceptable levels by implementation of *Plan* S&Gs. However, the issues of fuel reduction burns and roads are the most complex to understand and mitigate. These two specific issues are discussed in detail later in this report.

Table 1. Soil Suitability Ratings for Proposed Activities

Map Unit	Soil Name	Acres	Harvest [1] Equipment Operability	Log [2] Landing Suitability	Construction[3] Limitations Haul Roads/Log Landings	Potential[4] Fire Damage Hazard	Soil [5] Rutting Hazard	Erosion [6] Hazard Roads/Trails	Road [7] Suitability (Natural Surface)
AnF	ANNONA-FREESTONE COMPLEX, 0 TO 2 PERCENT SLOPES	96	Moderate**	Moderate	Moderate	Moderate	Severe***	Slight *	Moderate
BnB	BOY LOAMY FINE SAND, 1 TO 5 PERCENT SLOPES	370	Well *	Well	Slight	High ***	Moderate	Slight	Well
BuC	BURKEVILLE CLAY, 5 TO 8 PERCENT SLOPES	12	Moderate	Moderate	Moderate	Moderate	Severe`	Moderate	Moderate
CiA	CHOATES LOAMY FINE SAND, 1 TO 5 PERCENT SLOPES	231	Well	Well	Slight	High	Moderate	Slight	Well
DeA	DEPCOR LOAMY FINE SAND, 0 TO 1 PERCENT SLOPES	8	Well	Well	Slight	High	Moderate	Slight	Well
DeB	DEPCOR LOAMY FINE SAND, 1 TO 3 PERCENT SLOPES	356	Well	Well	Slight	High	Moderate	Slight	Well
DeC	DEPCOR LOAMY FINE SAND, 1 TO 5 PERCENT SLOPES	2646	Well	Well	Slight	High	Moderate	Sight	Well

Map Unit	Soil Name	Acres	Harvest [1] Equipment Operability	Log [2] Landing Suitability	Construction[3] Limitations Haul Roads/Log Landings	Potential[4] Fire Damage Hazard	Soil [5] Rutting Hazard	Erosion [6] Hazard Roads/Trails	Road [7] Suitability (Natural Surface)
DeD	DEPCOR LOAMY FINE SAND, 5 TO 15 PERCENT SLOPES	318	WS	Moderate	Slight	High	Moderate	Moderate	Moderate
GrP	GLADEWATER-PLUCK COMPLEX, 0 to 1 PERCENT SLOPES, FREQUENTLY FLOODED	41	Moderate	Poor	Severe	Low *	Severe	Slight	Poor
Hf	HATLIFF LOAM, 0 TO 1 PERCENT SLOPES, FREQUENTLY FLOODED	369	Moderate	Poor	Severe	Moderate	Severe	Slight	Poor
HuB	HUNTSBURG LOAMY FINE SAND, 1 TO 3 PERCENT SLOPES	1092	Well	Moderate	Sight	High	Moderate	Slight	Moderate
HuC	HUNTSBURG LOAMY FINE SAND, 1 TO 5 PERCENT SLOPES	897	Well	Moderate	Slight	High	Moderate	Moderate	Moderate
HuD	HUNTSBURG LOAMY FINE SAND, 5 TO 15 PERCENT SLOPES	631	Well	Moderate	Slight	High	Moderate	Severe	Moderate
LeB	LANDMAN LOAMY FINE SAND, 0 TO 4 PERCENT SLOPES	66	Well	Well	Slight	High	Moderate	Slight	Well
LgA	LEGGETT FINE SANDY LOAM, 0 TO 3 PERCENT SLOPES	22	Well	Moderate	Slight	Moderate	Moderate	Slight	Moderate
MnB	METH FINE SANDY LOAM, 1 TO 5 PERCENT SLOPES	8	Well	Well	Slight	Moderate	Moderate	Moderate	Well

Map Unit	Soil Name	Acres	Harvest Equipment Operability [1]	Log Landing Suitability [2]	Construction Limitations Haul Roads/Log Landings [3]	Potential Fire Damage Hazard [4]	Soil Rutting Hazard [5]	Erosion Hazard Roads/Trails [6]	Road Suitability (Natural Surface) [7]
PmB	PINETUCKY FINE SANDY LOAM, 1 TO 5 PERCENT SLOPES	94	Well	Well	Slight	Moderate	Moderate	Moderate	Well
PnA	PLUCK FINE SANDY LOAM, 0 TO 1 PERCENT SLOPES, FREQUENTLY FLOODED	182	Moderate	Poor	Severe	Low	Severe	Slight	Poor
ReA	REDCO CLAY, 0 TO 2 PERCENT SLOPES	147	Moderate	Moderate	Moderate	Moderate	Severe	Slight	Moderate
eee	STRINGTOWN-BONWIER COMPLEX, 5 TO 15 PERCENT SLOPES	50	Well	Moderate	Slight	Moderate	Moderate	Severe	Moderate
WnA	WOODVILLE LOAM, 0 TO 2 PERCENT SLOPES	67	Moderate	Moderate	Moderate	Moderate	Severe	Slight	Moderate
WnB	WOODVILLE FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES	196	Well	Well	Slight	Moderate	Moderate	Slight	Well
WnC	WOODVILLE FINE SANDY LOAM, 1 TO 5 PERCENT SLOPES	568	Well	Well	Slight	Moderate	Moderate	Moderate	Well
WnD	WOODVILLE FINE SANDY LOAM, 5 TO 15 PERCENT SLOPES	310	Well	Moderate	Moderate	Low	Moderate	Severe	Moderate

1. The suitability for operation harvesting equipment. Rating assessment: The off-road transport or harvest of logs and/or wood products by ground-based wheeled or tracked equipment. The use of standard rubber-tired skidders and bulldozers used for ground-based harvesting and transport.
2. The suitability of the soil at the forest site to serve as a log landing. Ratings assessment: Efficient and effective use of equipment for the temporary storage and handling of logs. The use of grapple hooks, skidders, trucks, loaders, cable yarders and other similar equipment.

3. Ratings reflect limitations for constructing haul roads and log landings: Rating assessment: Earth moving activities to meet standards and specification for haul roads and log landings. Excavating, removal and shaping of native soil materials to develop haul roads and log landings for forest harvesting and other management activities.
4. The potential hazard of damage to soil nutrient, physical, and biotic characteristics from fire. Rating assessment: The impact of fires (prescribed or wildfire) of moderate fireline intensity (116-520 btu's/sec/ft) that provide the necessary heat to remove the duff layer and consume soil organic matter in the surface layer.
5. Ratings indicate the hazard or risk of ruts in the uppermost soil surface layers by operation of forest equipment. Soil displacement and piddling (soil deformation and compaction) may occur simultaneously with rutting. Ratings assessment: The operation of equipment on the forest sites (3-10 passes) when the soil moisture is near field capacity.
6. The hazard or risk of soil loss from unsurfaced roads/trails. Ratings assessment: The force that natural precipitation events have to dislodge and move soil materials on roads/trails and firebreaks.
7. Suitability for using the natural surface of the soil component for roads by trucks for the transport of logs and other wood products from the site. Ratings assessment: The efficient and safe transport of forest product from the site.

*Slight, Well, and Low - Soils that have properties favorable for the specified use. Satisfactory performance and low maintenance costs can be expected.
**Moderate – Soils that have one or more properties that make the soil less suitable than those rated good.
***Severe and High –Soils that have one or more properties that are unfavorable for the specified use. Overcoming the unfavorable properties requires special design, extra maintenance or costs, or field alterations.

Fire Effects on Soils

Fuel reduction burns can have a direct and indirect effect on soil nutrient, physical and biotic characteristics. Effects of fuel reduction burns on soil and water depend on fire severity and frequency, and on soil and site properties. Fire severity is determined by fire duration and intensity, which in turn depends on fuel characteristics, topography and weather. Important soil and site properties are soil moisture and nutrient content, soil erodibility and topography (Maxwell 1988). The National Wildfire Coordinating Group publication "Fire Effects Guide" also states that fire (either wild or prescribed) may have a wide range of effects on the soils, water and watershed resources of forested lands, shrublands, grasslands and wetlands. These effects include soil heating, physical properties, chemical properties, soil biota and soil nutrients (Clark 1994).

Soil heating is less obvious than erosion, but is more important because of its influence on long-term productivity. Adverse effects increase with fire severity and frequency.

Fuel reduction burns can impact soil and water by: (1) soil heating, where excess heating can kill soil biota, alter soil physics, consume organic matter and release site nutrients; and (2) soil exposure which can increase runoff and erosion. These effects can vary greatly with fuel, site and burning conditions so they are expressed as degrees of risk rather than absolutes predictions (Maxwell 1988).

Soil flora and fauna enhance soil physics and biochemical processes. Duration of heating, maximum temperatures and soil moisture most effect biotic response (Wells and others 1979). Recovery is usually rapid, but species composition can change if litter-duff or soil properties are changed (Henley and Clark 1976).

In 2003, the NRCS developed a computer based soil survey report for the NFGT that includes the Boswell Creek project area. (See Map 3 and Table 1). As part of the interpretations for the soil survey, Potential Fire Damage Hazard is rated. (See Map 4). This hazard rating reflects the potential for damage to soil nutrient, physical and biotic characteristics from fire. Ratings assess the impact of fires (prescribed or wildfire) of moderate intensity (116-520 btu's/sec/ft) that provide the necessary heat to remove the duff layer and consume soil organic matter in the surface layer.

Fireline intensity is a measure of the heat produced at the flaming front per unit length of fire front (Flue 2003). When the BehavePlus model was used to generate fire behavior outputs for a wildfire (using moderate to extreme weather conditions in the vast majority of the existing fuel types in the project area), btu intensities ranged from 146 to 515 btu/ft/sec. This range meets the NRCS criteria for high potential hazard to effect soils (see Table 1, note 4). When the model was used for a fuel reduction burn under the same conditions, the btu intensities ranged from 40 to 97 btu/ft/sec. (Flue 2003). This 40 to 97 btu/ft/sec is below the NRCS threshold for damage to soils. (Note: The NRCS references btu's/sec/ft and BehavePlus references btu's/ft/sec. For the purposes of this report, these terms are interchangeable.)

According to research, prior to the 1900s pine forest types in the southern U.S. burned every three to eight years, drier sites burned every one to four years; fires were regularly set by Native Americans, settlers, hunters, ranchers, farmers or were lighting caused (RMRS-GTR-42, Vol. 2, 2000). With these frequent burns performed in one to five year intervals, fire intensity would have been less severe prior to the 1900s. By controlling wildfires in more recent history, the potential for damage by wildfire is much higher.

Based on the above analysis, the high fuel loading of the area, and the history of wildfire in east Texas, the direct effect of no action (which assumes the area would eventually be burned by a wildfire under moderate to extreme weather conditions) would result in damage to those soils that have a severe fire damage rating (see Table 1).

The direct/indirect effects on soil properties by the proposed actions (based on the results of modeling and literature review) will be within acceptable limits. The proposed actions will result in fireline intensities of 40-97 btu's/sec/ft, which is within acceptable limits.

Underburns (fuel reduction burns) more frequent than every three years pose high risks to soil quality on all sites (Maxwell 1988). Soil biota is not affected, but forest floor biota is reduced and cannot fully recover before the next burn. Loss of site organic matter exceeds 10 percent. Annual underburns also impair soil physical properties. The proposed action includes initial fuel reduction burns in fuel types 7 of potentially two years in succession. This would be a dormant season burn followed in approximately 18 months by a growing season burn. This is needed due

to the size of the underbrush to be controlled. This would only be implemented to achieve a condition that can be maintained on a burning cycle of three to five years. This two-consecutive-year burn concept was discussed with Maxwell (personal comm. on 7/14/03) and he agreed this successive burning would be an acceptable one-time effect. He also stated that this is needed to achieve the desired condition that can be maintained.

Hydrology

As a direct effect, or more often an indirect effect, some amounts of soil may find its way to the stream course, even under unmanaged conditions. While it is impracticable to eliminate all soil from entering a stream, it is possible to limit and prevent soil from directly entering streams.

Through implementation of the S&Gs, direct and indirect effects from the proposed action activities will be minimal. The Southern Forest Resource Assessment Draft Report (USDA-Southern Region and Southern Research Station 2002) supports this finding. It states that the nonpoint source pollutant of greatest concern to forest management is sediment, which reaches stream channels primarily through erosion. Rainsplash and sheet erosion account for the majority of hill slope erosion. Silvicultural BMPs are designed to reduce non-point source pollution and maintain stream channel integrity so that State Water Quality Standards are met. Where their effectiveness has been evaluated, they have achieved that goal. The Texas Forest Service (TFS) most recent forestry BMP monitoring was conducted between August 16, 2000 and April 23, 2002. This monitoring found that the NFGT sites had an overall implementation effectiveness of 98.4 percent, with no significant risks to water quality identified. (TFS 2002).

Monitoring and evaluation (M&E) is used to determine the implementation and effectiveness of management activities. Reviewing individual and combinations of S&Gs across the forest has shown that when the S&Gs are properly implemented, management activities such as fuel reduction burns, timber thinning, road construction and road maintenance do not have a considerable adverse effect on soil, water and their associated beneficial uses (M&E Report 2000-2001). Adherence to the S&Gs mitigates concerns for soil rutting, compaction, damage from harvest equipment and impacts from road construction and road maintenance. Research conducted by Texas A&M University on NFGT and private lands indicates that sediment production from grazing and silvicultural activities on these lands produced sediment yields within the range of an undisturbed forest (Texas Agricultural Experiment Station 1991). Therefore, the main concern on impacts to the soil is the potential for damage from burning.

Based on the results from research and monitoring efforts and the mandatory implementation of S&Gs, any adverse direct or indirect effects resulting from these proposed management actions is unlikely.

Roads Effects on Hydrology

Research has also identified sediment as one of the most important non-point source pollutants of surface waters. The impacts on water quality from the practices described in the proposed action would be similar to those described in the VMEIS (pp IV-97 through IV-116). In forested areas, the predominant source of sediment is from the construction and maintenance of access roads,

which contribute as much as 90 percent of the total sediments. Sediment production from Coastal Plains forest roads having little or no slope can be dramatically reduced through road management practices (Appelboom, et al 2002). Little or no slope conditions mentioned above characterize the roads in this project area.

During field investigations in the Boswell Creek Watershed, numerous occurrences where roads have altered the natural drainage patterns in the watershed and caused direct and indirect effects (i.e. runoff, downcuts and gullying) were observed. The roads in question were originally designed to minimize potential erosion by the installation of wing ditches and cross drain culverts. However, the Roads Analysis Report (RAP) for Boswell Creek Watershed documents that the wing ditches have concentrated water, resulting in runoff reaching stream channels. In the RAP, recommendations were made for:

1. Spacing wing ditches closer together, and
2. Reducing the run-off from wing ditches by constructing a "J" hook and/or sediment basin at the end of wing ditches to slow water flow and provide for percolation in a sediment basin.

The RAP also prioritizes site-specific recommendations for roads in the watershed and recommends decommissioning approximately 6.3 miles of road (Lewis 2003). This report is available in the project file.

Implementing the actions recommended in the RAP and the proper construction and maintenance of the roads for the proposed action will present an opportunity to correct road-related erosion and sedimentation problems, and result in improvements to the current condition of the watershed.

Fire Effects on Water

Wildfire and prescribed fire may have direct and indirect effects on both water quality and quantity (NWCG 1994). The "Fire Effects Guide" additionally states that there are no conclusive studies that clearly demonstrate that fire causes long-term increased water yield (Clark 1994). Temporary (for a few years) increases in water yield may occur following large "clean" fires (fires consume the litter and debris) because although direct

evaporation may increase, water detention by litter and debris and transpiration both decrease. The litter and debris reduce surface flow of water over the soil. Transpiration decreases from the removal of green vegetation. However, this effect on water yield is quickly reduced as vegetation and litter return.

The literature is replete with the evidence of fire-induced changes is water quality, including increased sedimentation and turbidity, increased stream temperatures and increased concentrations of nutrients resulting from surface runoff. Wildfire and prescribed fires on forestlands, shrublands and grasslands have the potential to decrease on and off-site water quality, and often requires mitigation. Effects may be short or long-lived. Burns on flat to moderate slopes have a much less risk for impacts to water quality than steep slopes (NWCG 1994).

A study under similar conditions to Boswell Creek was conducted on the Sabine National Forest in 2000. Results from the study identified that immediately following a spring fuel reduction burn there was an increase in conductivity, turbidity, sulfate, ammonium, apparent color, true color, BOD, total solids, total suspended solids and total dissolved solids in an adjacent stream. The reference stream was monitored monthly for this study. The increases in water chemistry characteristics were likely a result of the spring burn, heavy rain or a combination of both. The monthly data for these water chemistry parameters returned to pre-burn levels by the next month of sampling. This indicates only a temporary effect on water chemistry by the fuel reduction burn or heavy rain. This study also sampled macroinvertebraes and fish communities at the same time water chemistry samples were taken. The samples showed no effect on the macroinvertebrates of fish communities (Moore 2002).

Underburns increase solubility and export of some nutrients; however, increases in stream concentrations are not significant (Maxwell 1988).

Macroinvertebrates are important organisms in the food chain of aquatic systems. They process fine organic debris deposited in streams or lakes and provide a main food source for fish. Declines in diversity, density and numbers of taxa occur when streams systems are adversely impacted by disturbances. For example, wildfires can result in 10 percent morality where both sides of the stream are burned. However, prescribe fires generally do not adversely impact aquatic macroinvertebrates. The key factor for immediate effects is fire intensity, which is generally low for prescribed fires (particularly near or within riparian areas). Elevation of streams temperatures and sedimentation can cause delayed impacts or indirect effects. Compensation mechanisms such as increased primary productivity within and along stream channels ultimately result in recovery or increases above initial levels of macroinvertebrate populations 2-50 years post-fire. (Neary 1996).

Fish mortality occurs mainly with wildfires. Immediate mortality may result from heating of streams. Delayed effects to fish populations usually result from reduced dissolved oxygen levels and increased sediment. Increased sediment is the most problematic since recovery periods from sedimentation are much longer than from elevated temperatures (Neary 1996). There is little to no effects of prescribed burning on fish because stream temperatures are not increased and the implementation of the S&Gs minimizes any changes in water chemistry or sedimentation.

If no action is taken, it is assumed this area may eventually burn as a wildfire and therefore will have the same effects described in the Soil section of this report. The intensity of the fire will be much higher resulting in a burn that consumes the majority of the litter and duff. This will greatly increase the risk of creating direct/indirect effects to water quality. Research and historical observations indicate that the risks of effects from the fuel reduction burns in the proposed action are minimal. Furthermore, fuel reduction burns are designed to minimize the effects to aquatic resources through control of burn intensity, erosion control and other referenced S&Gs.

Cumulative Effects of the Proposed Actions

The analysis of cumulative impacts is a requirement of the National Environmental Policy Act (NEPA). Cumulative effects are those direct and indirect effects that result from a proposed action when added to other past, present and reasonably foreseeable actions (see the Guide For Soil/Water/Air Environmental Effects Analysis in Documents). This analysis includes all actions on National Forest System lands and private lands regardless of who undertakes the actions. Cumulative impact can result from individually minor, but collectively significant actions taking place over time.

Soils

Implementation of the proposed actions may have minor negative short-term effects to soil properties (i.e. productivity, compaction and biota). However, when the S&Gs are applied the long-term negative cumulative effects will be minimized and are unlikely to have negative cumulative effects.

Implementation of no action would have no immediate effects to cumulative impacts. However, it is assumed this area may eventually burn as a wildfire which could have negative effects on the soil properties due to excessive soil heating.

Hydrology

Cumulative Effects Model

The NFGT was assisted by Alan Clingenpeel of the Ouachita National Forest in developing a Cumulative Impacts Model for the Forests and Grasslands. The model was used to address the cumulative impacts or effects of silvicultural and soil disturbing activities management activities on water quality, fisheries and other beneficial uses. Changes in land uses and disturbances were modeled with respect to increases in sediment.

Assumptions used in the model were checked against the field conditions and it was determined that the model was applicable to this project.

The quantitative outputs from the model are subject to interpretation and the proposed actions are assumed to occur in the first year of implementation. In reality, the actions could be spread out over five years or more. In addition, thresholds levels use a theoretical natural/undisturbed condition as a baseline which assumes a 100 percent closed mature tree canopy condition over the entire watershed area (public and private ownership). The model does not have the ability to show the results of improvements made to current conditions as a result of implementation of the proposal. Examples of this would be improvements/repairs made to road stream crossings and leadoff ditches within the project. Therefore, results of the model must be interpreted as a "worst case" scenario and applied as a comparative tool in analyzing alternatives.

Sediment is an appropriate measure to estimate the effects of management activities on water quality and its associated beneficial uses on forested lands (Coats and Miller 1981). Sediment increases adversely affect fish productivity and diversity (Alexander and Hansen 1986). There may be other cumulative impacts such as increases in water yield as a result of harvesting methods. However, water yield models do not characterize the impacts of all management activities such as road construction and the increase in water yield is generally less than the natural variability. Changes in water nutrients or nutrient fluxes within streams as a result of management activities are minor and not an appropriate consideration of cumulative effects at the Forest Plan level. The model used predicted sediment yields as the surrogate for determining cumulative impacts for water quality.

Some measure of the effect of management activities on beneficial uses is required. Many fish species are sensitive to sediment and studying their population dynamics and habitats is a method of monitoring fish sensitivity to sediment increases. This process is described in Endemism Sediment Profiles (Scott, Clingenpeel and Leftwich 2002). Endemic/darted/minnow profiles were developed based on soil mapping units.

The baseline used in the model assumes an undisturbed forest floor with no roads. It should be recognized that using such a baseline would result in high percentage increases, since baseline values can indicate little to no erosion or sediment. The percentage values below are only used as a mathematical index and should not be viewed as a true indication of effects or impairment, but rather a level where additional monitoring and mitigation may be required.

From analysis of existing fish collections, predicted sediment increases less than 2,200 percent (Level 1 threshold) for the clay loam soil, the predominate soil type in this watershed and do not pose a threat to existing fish populations. Values between 2,200 percent and 6,400 percent (Level 2 threshold) pose an increased risk for aquatic communities where population declines in endemics, darters and minnows may occur. Proposed projects that fall within this range pose an increased risk and require additional monitoring of fish collections prior to project implementation. Projects with predicted sediment values greater that 6,400 percent (Level 3 threshold) have a high potential for adverse cumulative impacts on water quality or its beneficial uses. Additional mitigations include requirements for additional monitoring prior to a decision and no net increase of sediment from Forest Service activities.

The model used addresses sediment increases as an acute problem by estimating all probable future actions to occur in the first year the sale is sold (which is a worst-case scenario). It needs to be noted that this "worst-case scenario" will not occur as a result of implementing the proposed actions. In reality, the actions will occur over a number of years as opposed to a single year. Thus, the impact in a given year will be much less that the gross amount predicted based on all actions occurring in a single year.

The model also addresses the past activities within the watershed and considers the impacts (or recovery rates) that are determined to persist for two to three years based on the activity. For example, a timber harvest in 2001 is assumed to be fully recovered by 2004.

Implementing the proposed action will result in an estimated 2,575 percent increase above the natural/undisturbed condition. Although this increase is slightly above the 2,200 percent Level 1 threshold, there is actually a low risk for adverse cumulative impacts on water quality or beneficial uses since the project will not occur in one entry and there will be significant improvements in the road system. Additional monitoring of the aquatic biota should occur to determine the actual condition of the aquatic ecosystem. This monitoring should logically take place at the three previous sites sampled by Texas A&M University. Based on findings from this monitoring, the project will proceed as planned or additional mitigation will be required. In addition, any short-term increased levels of sedimentation would decline in one to two years. Sediment levels, therefore, would be within acceptable levels and not have long-term detrimental affects on aquatic resources.

Past research has shown the rapid recovery of the Boswell Creek Watershed following significant disturbance. The predictions made by the model for this project can be put into context by comparing the results to the model's estimates for past activities in the same watershed. In the mid 1980s, a SPB epidemic occurred on the Sam Houston National Forest where a number of outbreaks became established in the Boswell Creek Watershed. The SPB

infestations eventually affected about half of the watershed. Suppression efforts included chainsaw felling followed by salvage logging. The salvaged stands were mechanically site prepared by combinations of chopping, shear/windrow and burning, then planted with loblolly pine from 1986 through 1990. Approximate 3,000 acres of National Forest lands were treated in this watershed.

The model was used to compare the impacts from the SPB epidemic to the proposed action. This model only included the site preparation and fire line construction activities. It did not include timber harvesting, road construction/maintenance and associated activities. The majority of these activities occurred from 1985-87. The model resulted in erosion rates of approximately 1,070 Tons/Yr as compared to the proposed action impacts of approximately 475 Tons/Yr. The approximate sediment produced during the epidemic was more than twice as much as the proposed action. In the mid 1990s, Texas A&M University conducted fish sampling in the Boswell Creek Watershed and the fish populations were evaluated as healthy (Healy 2002). Therefore, even with this very high level of site disturbance from the epidemic treatments, the streams in this watershed have either recovered or maintained a healthy fish population.

Implementing no action has been estimated to produce a 1,442 percent increase above the natural/undisturbed condition, which is below the threshold of 2,200 percent where a threat is first posed to existing fish populations. However, under the assumption that a wildfire will occur within the watershed in the future, sediment increases from a wildfire would likely have a high risk for detrimental affects on aquatic resources.

Cumulative effects to water quality from implementation of the proposed action and no action will be within acceptable limits based on this analysis. The proposed action will result in an additional decrease of the current level of sedimentation in streams by improving road drainage, correcting existing culverts that are not functioning properly and decommissioning 6.3 miles of roads.

Conclusions

Based on the above analysis, the proposed commercial thinning and fuel reduction burns do not exceed the soil loss tolerance values. The proposed roads and skid trails have the potential to exceed the soil loss tolerance values; however, the implementation of appropriate S&Gs will minimize the potential soil loss and keep this loss below the tolerance value.

Since there are high fuel loadings in the area and considering the history of wildfires in east Texas, the direct effect of no action (which assumes the area would eventually be burned by a wildfire under moderate to extreme weather conditions) would result in damage to those soils that have a severe fire damage rating. The direct/indirect effects of fire on soil properties by the proposed actions (based on the results of modeling and literature review) will be within acceptable limits.

Through implementation of the S&Gs, direct and indirect effects from the proposed action activities on hydrology will be minimal. Based on the results from research and monitoring efforts, any adverse direct or indirect effects resulting from these proposed management actions is unlikely.

Implementing the actions recommended in the RAP and the proper construction and maintenance of the roads for the proposed action will present an opportunity to correct road-related erosion and sedimentation problems, and result in improvements to the current hydrologic condition of the watershed.

Since it is assumed this area may eventually burn as a wildfire, taking no action will allow a wildfire to affect water quality. The intensity of the fire will be much higher resulting in a burn that consumes the majority of the litter and duff. This will greatly increase the risk of creating direct/indirect effects to water quality. Research and historical observations indicate that the risks of effects from the fuel reduction burns in the proposed action are minimal. Furthermore, fuel reduction burns are designed to minimize the effects to aquatic resources through control of burn intensity, erosion control and other referenced S&Gs.

Implementation of the proposed actions may have minor negative short-term cumulative effects to soil properties (i.e. productivity, compaction and biota). However, when the S&Gs are applied the long-term negative cumulative effects will be minimized and are unlikely to have negative cumulative effects.

Taking no action would have no immediate effects to cumulative impacts. However, it is assumed this area may eventually burn as a wildfire which could have negative effects on the soil properties due to excessive soil heating.

Cumulative effects to water quality from implementation of the proposed actions or no action will be within acceptable limits based on this analysis. The proposed actions will result in an additional decrease of the current level of sedimentation in streams by improving road drainage, correcting existing culverts that are not functioning properly and decommissioning 6.3 miles of roads.

Additional Implementation and Monitoring Needs

The majority of the proposed activities will be adequately mitigated by the proper implementation of the existing S&Gs from the *Plan*. However, two areas identified in this report need additional implementation direction or monitoring: (1) existing road maintenance; and (2) cumulative impacts.

Existing road maintenance in the Boswell Creek Watershed has altered the natural drainage patterns in the watershed and caused direct and indirect effects (i.e. runoff, downcuts and gullying). Recommendations made to address these issues are:

1. Spacing wing ditches closer together, and
2. Reducing the run-off from wing ditches by constructing a "J" hook and/or sediment basin at the end of wing ditches to slow water flow and provide for percolation in a sediment basin.

Site-specific recommendations made for roads are found in the RAP. These recommendations need to be implemented for existing roads as soon as feasible and used in future roadwork. Implementation may be limited by available funding.

The second area of concern is cumulative impacts. Modeling indicated that the proposed actions exceed the established Level 1 threshold. Implementing the proposed actions will result in a 2,575 percent increase above the natural/undisturbed condition. Although this increase is slightly above the 2,200 percent Level 1 threshold, there is actually a low risk for adverse cumulative impacts on water quality or beneficial uses since the project will not occur in one entry and there will be significant improvements in the road system. Additional monitoring of the aquatic biota will need occur to determine the actual condition of the aquatic ecosystem. As stated earlier, this monitoring should logically take place at the three sites previously sampled by Texas A&M University. Based on the findings from this monitoring, the project can proceed as planned or additional mitigation measures may be required.

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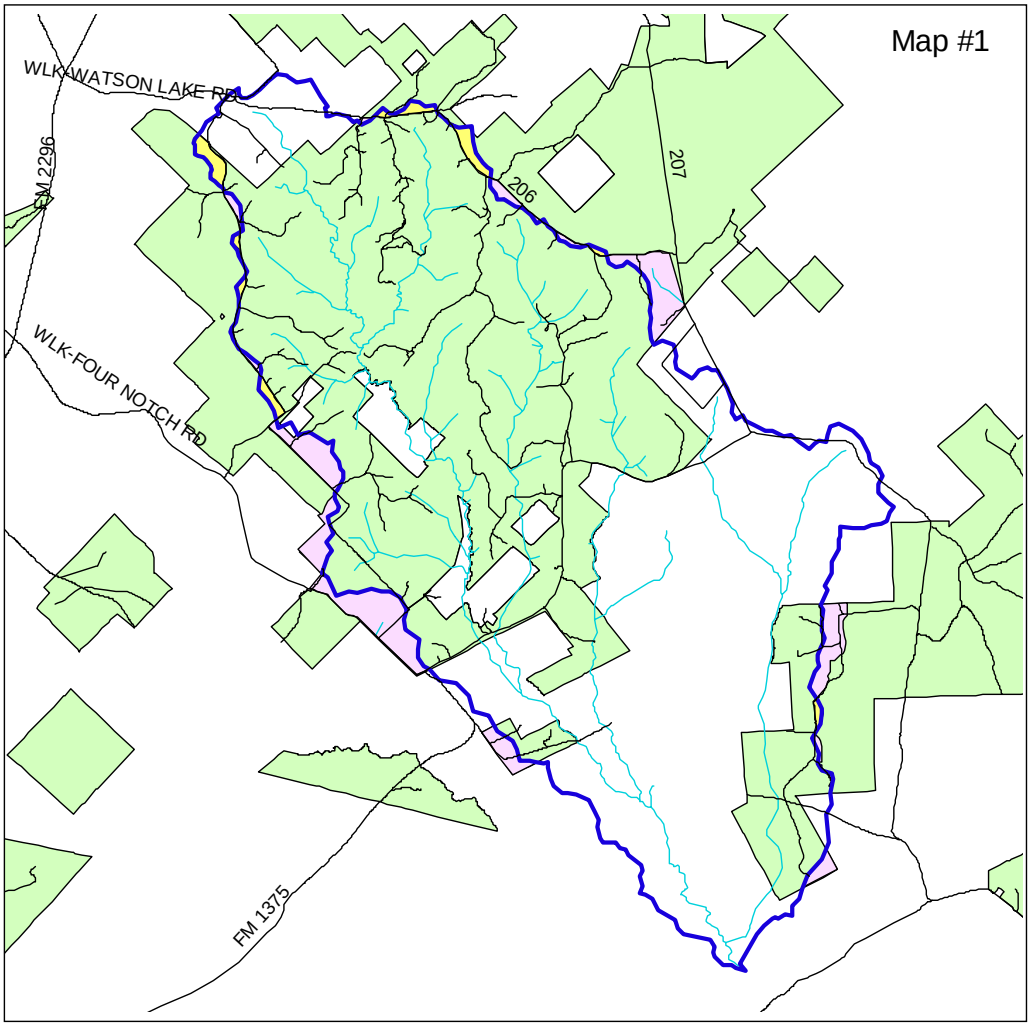
Boswell Creek Watershed
Sam Houston National Forest



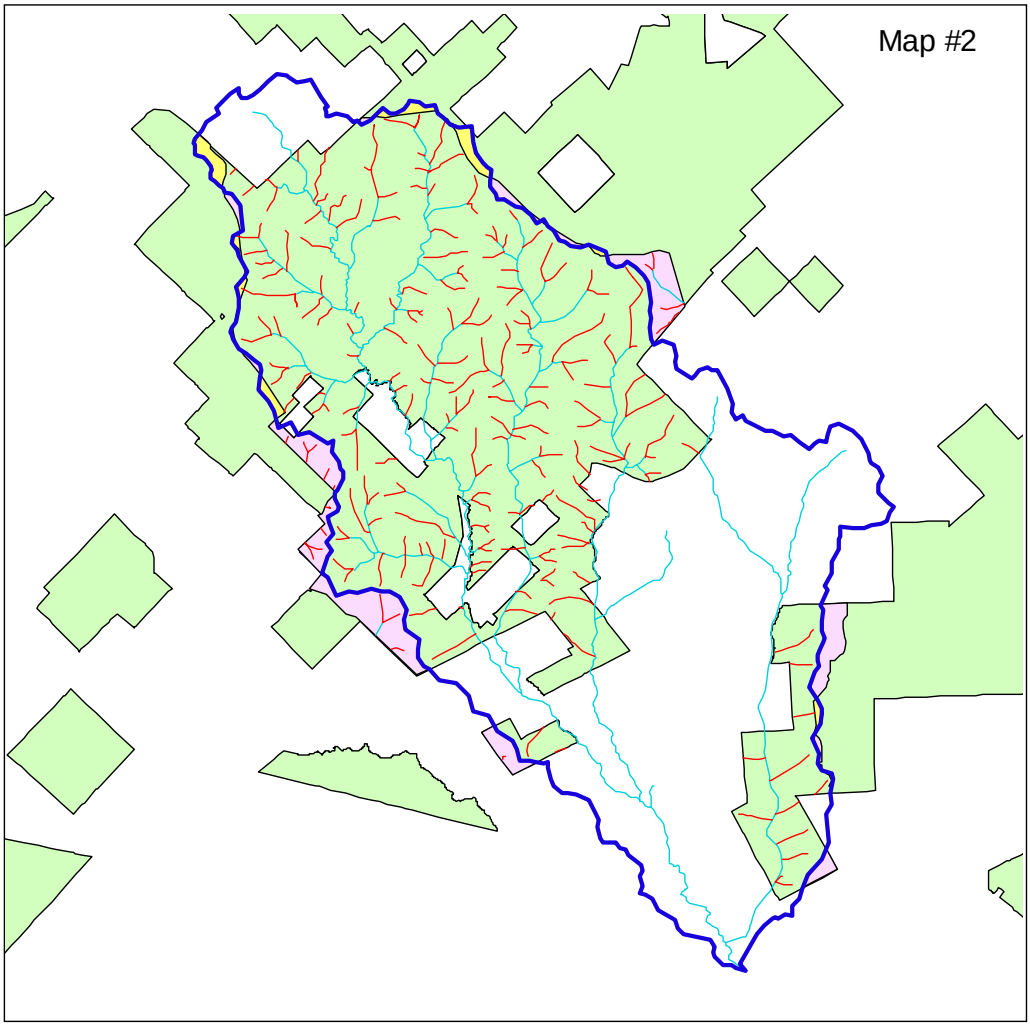
Watershed Boundary
Areas Inside of Watershed - Excluded From Project
Areas Outside of Watershed - Included In Project
Roads
Streams- Perennial and Intermittent
National Forest
Private

N

1 0 1 2 Miles

Map prepared 7/16/03

Boswell Creek Watershed
Ephemeral Streams



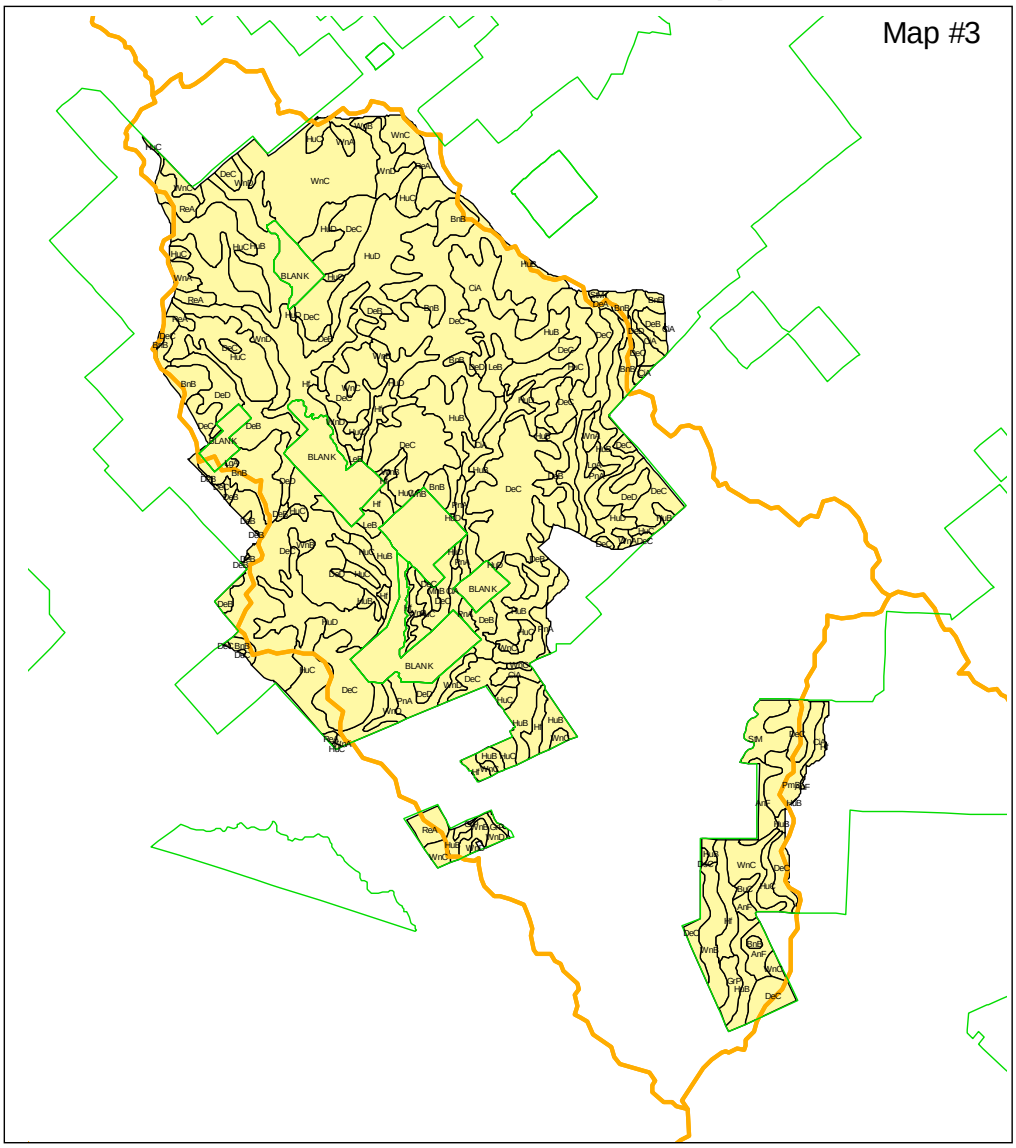
Watershed Boundary
Areas Inside of Watershed - Excluded From Project
Areas Outside of Watershed - Included In Project
Ephemeral Streams
Streams- Perennial and Intermittent
National Forest
Private

N

1 0 1 Miles

Map prepared 7/16/03

Boswell Creek Soil Map



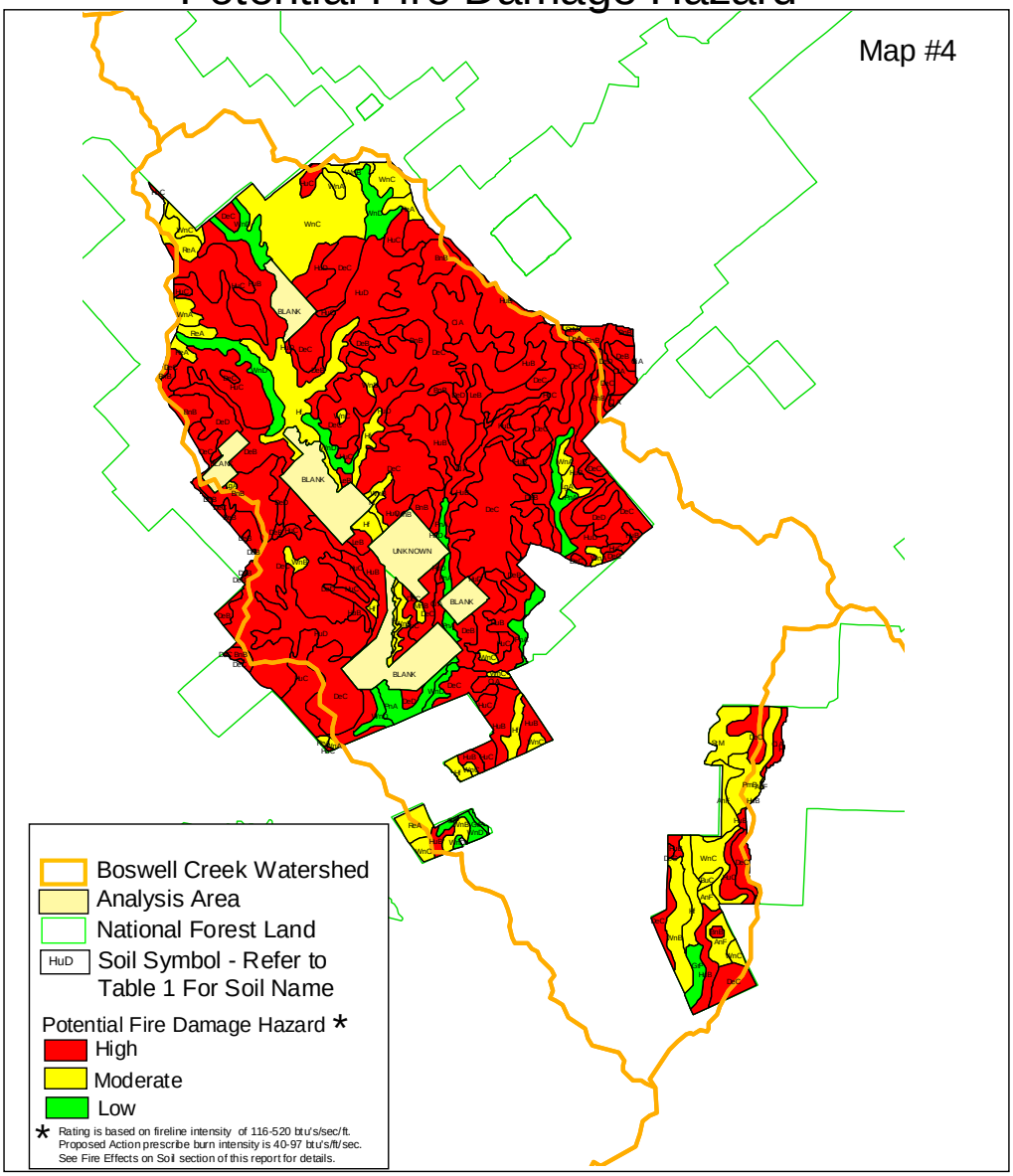
Boswell Creek Watershed
Analysis Area
National Forest Land
HuD Soil Symbol - Refer to Table 1 For Soil Name

N

1 0 1 2 Miles

Map Prepared 7/16/03

Boswell Creek Soil Map
Potential Fire Damage Hazard



Map Prepared 7/16/03

N

1 0 1 Miles