The Hangman (Latah) Creek Water Resources Management Plan

"Preserving, managing, and enhancing the water resources of Hangman (Latah) Creek for the benefit of humans, wildlife, and fisheries."

May 19, 2005

Sponsored by:

The Hangman (Latah) Creek Watershed Planning Unit WRIA 56

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ACRONYMS AND ABBREVIATIONS

ACRONYMS

BL	Bedload Sediments
BLM	Bureau of Land Management
BMPs	Best Management Practices
CC	California Creek
CFS	Cubic Feet Per Second
CIR	Crop Irrigation Requirement
CRP	Conservation Reserve Program
DEM	Digital Elevational Model
DO	Dissolved Oxygen
D/S	Downstream
EPA	Environmental Protection Agency
ET	Evapotranspiration
EWU	Eastern Washington University
F	Found
FC	Fecal Coliform
GIS	Geographic Information System
GPD	Gallons Per Day
GPS	Geographic Positioning System
HC	Hangman Creek
HC-I	Hangman Creek main stem/Idaho
HV	Hangman Valley
HDI	Hardin-Davis Inc.
HGA	High Growth Areas
HSC	Habitat Suitability Criteria
HSC	Habitat Suitability Curve
IFIM	Incremental Flow Method
IUGA	Interim Urban Growth Areas
JPA	Joint Planning Association
LHC	Little Hangman Creek
MC	Marshall Creek
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NF	Not Found
NP	Not Provided
NR	Not Recorded
NRCS	Natural Resources Conservation Service
NTE	Not To Exceed
NTU	Nephelometric Turbidity Units
PFC	Proper Functioning Condition
PHABSIM	Physical Habitat Simulation
PLSS	Public Land Survey System
PRISM	Parameter-Elevation Regressions on Independent Slopes Model
PSIAC	Pacific Southwest Inter-Agency Committee Sediment Yield Model
PU	Planning Unit
Q	Instantaneous Discharge
QA/QC	Quality Assurance/Quality Control
RC	Rock Creek
RCW	Revised Code of Washington
RM	River Mile
RRC	Rattler Run Creek
RUSLE	Revised Universal Soil Loss Equation
SEPA	State Environmental Policy Act
SCCD	Spokane County Conservation District
SNTEMP	Stream Network Temperature Model
SRP	Soluble Reactive Phosphorus
SRTC	Spokane Regional Transportation Council
TB	Turbidity
TKN	Total Kjeldahl
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Sediments
U/S	Upstream
US	United States
USDA	United States Dept. of Agriculture
USGS	United States Geological Survey
WA	State of Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WOC	Waters of Concern
WRIA	Water Resource Inventory Area
WSU	Washington State University
WUA	Weighted Usable Area

ABBREVIATIONS

Ac/ft/yr	Acre Feet Per Year
City	City of Spokane
°C	Degrees in Centigrade (Celcius)
Ecology	Washington State Department of Ecology
Mgal/yr	Million Gallons Per Year
Mg/l	Milligrams per liter
μs	Microsiemens
Mi^2	Square Mile
N/A	Not Applicable

EXECUTIVE SUMMARY

PURPOSE OF WATERSHED PLANNING

In 1998, the Washington State Legislature approved Engrossed Substitute House Bill 2514 (The Watershed Planning Act). The guidelines of this legislation allowed watersheds in Washington State, referred to as Water Resource Inventory Areas (WRIA), to evaluate the water resource problems and concerns directly related to population growth, fisheries, water quality, and agricultural production. The Hangman (Latah) Creek Watershed (WRIA 56) faces its own unique challenges that require collaborative efforts between local residents and agencies to critically review and resolve basin wide issues revolving around water quantity and quality.

The Spokane County Conservation District (SCCD) accepted the lead agency and facilitation roles for the development of the WRIA 56 management plan in the fall of 1999. The SCCD, under RCW 90.82, formed a central Planning Unit (PU) representing various watershed stakeholders; special districts, local residents, governmental agencies, and affected tribes. Together, the PU commenced the task of assessing and evaluating existing information, conducting short-term studies, and formulating recommendations that will affect the future of water use in the basin for many years to come. The PU developed this management document in an effort to balance and protect the watershed's instream resources, associated habitats, and economic interests.

The goals of the PU are to:

- Develop and investigate a water balance for the watershed
- Establish a public information vehicle to provide awareness and education of issues
- Establish future management guidelines to
    - Improve overall water quality
    - Reduce suspended sediment loading
    - Maintain and enhance fish and wildlife habitat
    - Maintain recreational use of watershed

The watershed planning process continued through the following three phases.

Phase 1 – Organization of the planning unit. The first year served as a platform to secure an MOA between the initiating governments, gathering planning unit members, and developing a scope of work necessary for Phase II.

Phase 2 – Watershed Assessment. The next two years consisted of conducting studies and gathering water resources information. The information was used to develop recommendations in Phase three

Phase 3 – Recommendations. The planning unit discussed the relevant issues from the watershed assessment and developed a set of recommendations for watershed management.

THE WATERSHED ASSESSMENT

The Hangman (Latah) Creek Watershed has a great deal of existing data regarding water quality, land uses and streamflow. The Spokane County Conservation District has been active in the watershed for over ten years collecting water quality data and implementing conservation practices. The US Geological Survey has maintained a streamflow gaging station (real time) near the mouth of Hangman Creek since 1948. The Coeur d'Alene Tribe has conducted the majority of the work in the upper third of the watershed.

However, water quantity information for the watershed is largely unknown or divided amongst different agencies. The Planning Unit developed a scope of work and conducted numerous studies and data gathering efforts within the watershed. The existing and gathered information indicates several primary issues and data gaps within the watershed. Recommendations to resolve these issues and fill the data gaps are proposed.

WATERSHED ISSUES

The scope of water resource issues within the watershed are wide, varied, and extend the length of the watershed. The issues are summarized within six main categories; water quantity, water quality, multipurpose storage, habitat and land use, minimum instream flow, and phase IV plan implementation.

1. WATER QUANTITY (See Section 3.5)

Hangman Creek has very little water during the critical summer flow period (July – October). The USGS gage (#12424000) has been recording stream flow in the watershed since 1948. During this time, the lowest recorded flow was 0.74 cfs in September of 1992. The average minimum monthly mean flow for the summer period is below three cfs.

This trivial amount of flow presents all sorts of problems ranging from instream flow ruling to water quality issues such as temperature. To make matters worse, the flow at the USGS gaging station only represents the lower five miles of the creek. A seepage run conducted by the Spokane County Conservation District indicated that during low flow conditions, the flow in most of Hangman Creek (80 percent) is significantly less than the flow measured at the gage. For example, a reading of four cfs at the gage indicates that most of the watershed is below one cfs.

This situation is further perplexed by the proliferation of domestic exempt wells, the high summer water use of small purveyors, and the over allocation of certificated water rights, permits, and claims. Although unlikely, if all these uses were exercised to their full extent (119 cfs), then the creek would certainly run dry.

2. WATER QUALITY (See Section 4)

The watershed drains approximately 431,000 acres and spans across two states and four counties. Land use influences, (agriculture, impervious surfaces, timber harvest, roads, etc.) as well as stream channel and flood plain alterations, over the last 100-years have contributed to "flashy" flow conditions, unstable stream banks, and substandard water quality.

Hangman Creek is a well-studied watershed suffering from anthropogenic disturbance. It is often described as one of the most degraded waterbodies in eastern Washington State. It is designated as a Class A Washington waterway in the Washington Administrative Code (WAC) Chapter 173-201A. However, point and non-point pollution sources continue to degrade the watershed. The majority of the watershed has not been able to attain the necessary requirements for the Class A designation for decades.

The basin's growth and continued poor land management has led to environmental stresses that have reduced water quality. Hangman Creek was identified on the 1998 303(d) list for not achieving State water quality standards for fecal coliform, dissolved oxygen, pH, and temperature. Recent monitoring has identified several other water quality problems not acknowledged by the 303(d) list (sediment load, turbidity, ammonia, low flows, and total phosphorus).

Hangman Creek is suspected to be the largest contributor of bedload and suspended sediment to the Spokane River. The majority of the bedload portion of the sediment load is transported downstream and deposited behind Avista's Nine Mile Dam. The suspended sediments continue through the dam's bypass system and settle out in Lake Spokane. The impacts of sediment to Lake Spokane have not been thoroughly studied.

Recently, The Spokane County Conservation District has undertaken a grant to conduct a non-point source TMDL project within the basin. The project is in its infancy, but the Watershed Implementation Team has committed to participating and supporting these efforts.

3. HABITAT AND LAND USE (See section 4.2)

There are various factors leading to the non-compliance of water quality standards on Hangman Creek. Agriculture is the significant land use within the basin (64%). The largest agricultural production areas are located in the upper to middle reaches of the watershed. Most of the cropland is non-irrigated, annual small grain production. Other crops include peas, lentils, canola, and turfgrass seed. The development of agriculture in the watershed led to a significant reduction of riparian vegetation and extensive channel alterations. The removal of native riparian vegetative buffers has reduced the natural filtering function and increased the rate of stream bank erosion.

The watershed also has an undetermined quantity of livestock that have unrestricted access to small tributaries and the mainstem of Hangman Creek. Over the years, the removal of woody vegetation and continuous trampling by livestock has significantly degraded the riparian areas and stream banks. These issues contribute to temperature and dissolved oxygen violations that have been documented throughout the basin.

The basin has many small rural towns and two golf courses (with a third currently being developed) located on major tributaries and the mainstem of Hangman Creek. Several of these towns have wastewater treatment plants that discharge directly into a tributary or the mainstem of Hangman Creek. The flows during the summer are often inadequate for effluent inputs and may contribute to low dissolved oxygen levels and other water quality violations.

The lower reaches of the watershed are moderately urbanized, but future growth projections by the City of Spokane indicate that the Hangman basin will absorb approximately 50 percent of the city's growth over the next 10 years (SRTC, 1997). The unconsolidated sediments in the lower watershed consist mainly of alluvium and flood deposits that are highly erodible. Past and current development in these areas has removed riparian vegetation and exacerbated the sediment and nutrient loading problems.

Fish habitat and distribution throughout the watershed has radically changed over the last one hundred years. Hangman Creek once had viable populations of native redband trout and healthy runs of salmon and steelhead. The removal of riparian vegetation, channel alterations, and heavy sedimentation has significantly reduced the spawning and rearing habitat on Hangman Creek. The primary species now found in the stream are adapted to warmer, slower waters and considered undesirable as gamefish. Resident trout populations are severely depressed.

It is not difficult to assess the future outcome for water quality in the Hangman Creek watershed if the current situation is not addressed. The lower watershed will be subjected to heavy urban development, some agricultural producers will continue to farm the edges of the creek, livestock will trample the banks and pollute the water, the creek will discharge hundreds of thousands of tons of sediment into the Spokane River, and fish habitat will dwindle until only warm water species thrive. In summary, most beneficial uses will continue to be impaired

4. MULTIPURPOSE STORAGE (See Section 5)

The Hangman watershed has low to moderate precipitation (19-40 inches) of which a significant portion is lost to evapotranspiration (e.g., >75%). Much of the precipitation falls during the winter as snow. The stream hydrograph is driven by rain on snow (and frozen ground) events and results in a flashy flow regime with flooding during the spring and low flows during the summer. Groundwater recharge and groundwater supported stream baseflows are low. There is little natural water storage capacity in the watershed. Land use patterns have modified the majority of the basin from natural camus prairie vegetation to dryland crop agriculture. The effect of these land use patterns has been to further reduce the intrinsic water storage capacity of the watershed and accentuate the flashiness of the hydrologic regime, causing higher peak flows and lower summer flows, along with accelerated sediment erosion.

No one storage option will completely satisfy the wide range of physiographic features and needs of the Hangman watershed so multiple options may be the appropriate method to enhance the quantity of water for consumptive and in-stream needs. The conclusion of the Hardin-Davis Instream Flow Study (2003) stated that "Significant physical habitat gains could be produced with small increments of flow addition. Each cfs of additional water would add 5 percent or more to physical habitat value at flows below 20 cfs." This relates to the primary goal of this multi-purpose storage assessment – to increase summer low flow conditions.

To provide direct comparisons among water storage options in WRIA 56, the options were reviewed under the context of their ability to attain a standard value of 600 acre feet of water storage. A storage volume of 600 acre-feet can sustain a streamflow augmentation of approximately 3 cfs for three months.

The most cost-effective options for augmenting streamflow are the streamflow augmentation with groundwater option and wetland restoration. However, these options will only augment flows in the lower and middle portions of the watershed.

Only three major storage options provide streamflow augmentation to all areas of the watershed. These three options include catchment basins in the upper watershed, balancing basins in the upper watershed, and Smith Creek Dam development. These are however, significantly more costly options to implement.

5. MINIMUM INSTREAM FLOW (See Section 6)

A watershed and its associated streams depend upon a variety of processes to remain both ecologically and hydrologically functional. These intricate processes provide the "life and health" of the watershed and its productivity. These processes are often compromised through other uses such as agriculture, domestic supply, industry, and others. The Hangman (Latah) Creek watershed is no different. The greatest need for water and the lowest instream flow levels often coincide in the dry summer months. These conditions prompted the need to assess the availability of water and its uses, and develop recommendations to preserve instream flow levels for all beneficial uses including fisheries.

The PU funded a hydrological investigation to evaluate instream flow conditions primarily for fisheries. Flow recommendations were developed for three levels of habitat protection for resident salmonids. Unfortunately, the PU was unable to agree on all elements of a recommendation for a minimum stream flow. However, the PU agreed to continue this work during Phase IV with the Watershed Implementation Team (WIT). If a recommendation cannot be completed during this process, the Watershed Implementation Team will promptly notify Ecology that consensus could not be reached. The Department of Ecology will then complete the process if necessary.

The geology and climate of the watershed indicate that large increases in base flow are unlikely. However, significant physical habitat gains could be produced with very small increments of flow addition. Each one cfs of additional water in the main stem would add five percent or more to physical habitat values during the low-flow season.

Based on weighted usable area (WUA) versus flow and the low-flow season hydrograph, flow recommendations were developed for three levels of habitat protection for resident salmonids (rainbow trout). This was determined by the PU to be the greater priority relative to other fish species and other life stages. The recommendations were classified as optimal, minimum and critical flows for reaches above and below the confluence of Marshall Creek. Optimal flows (providing 80 percent of maximum WUA) were 50 cfs below the Marshall Creek confluence and 26 cfs above the Marshall Creek confluence. Minimum flows (at which one cubic feet per second (cfs) changed the WUA by five percent or more) were 15 cfs both below and above Marshall Creek. Critical flows (at which one cfs changed WUA by 10 percent or more) were six cfs below and seven cfs above Marshall Creek.

Recommended flows developed in the HDI study apply to the low-flow summer period. The minimum and critical levels signify flows below which physical habitat for salmonids is greatly reduced. Recommendations for overall ecosystem health would need to consider flows during other times of the year, and for other purposes.

Physical habitat increase alone may not improve salmonid potential, because stream temperatures are very warm over most of the distance. Even with a simulated additional inflow of cool water, stream temperatures were improved over only a short distance. Therefore, it appears that flow augmentation would need to be combined with temperature reduction to improve trout habitat significantly.

Temperature, as measured directly and as HDI modeled using SNTEMP, appears to be a limiting factor for salmonids in most of Hangman Creek. Additional flow, if it could be provided, would provide only limited temperature reductions under present-day conditions, due to lack of shade over much of the reach. When existing shade conditions (approximately 20 percent shade) were increased in the simulation to 70 percent shade, a significant decrease (one to two ºC) in water temperature over most of the reach resulted.

HDI, 2003 found that low flows and high summer air temperatures make it difficult to bring high stream temperatures within state guidelines for salmonid-bearing streams. HDI, 2003 believes that restoration within the study area is unlikely to make the entire Washington portion of the main stem suitable for salmonids year-round. However, the PHABSIM study indicates that even small additions to flow during the summer period would result in WUA increases for resident salmonids, and each cfs increase may increase the WUA for non-salmonids at an even greater rate. The SNTEMP study

indicates that shade restoration could significantly increase the usable stream length by salmonids compared to present conditions. Improving both conditions simultaneously would provide the greatest benefits. Further flow and temperature improvements might be possible with restoration in the tributaries and in the upper (Idaho) basin.

However, no single action (e.g. change of flow) will restore salmonid habitat conditions to its maximum potential. However, the combined effects of several projects (riparian restoration, upper watershed improvement, increased flows from tributaries) could significantly improve fish habitat in Hangman Creek.

6. ISSUES AND RECOMMENDATIONS (See Section 7)

The PU coordinated and collaborated with the watershed residents, and professional agency representatives to develop the following collection of recommendations and strategies to resolve major watershed issues and concerns. Water quantity, water quality, projected growth, instream flow, and land use recommendations reflect potential needs for changes in management of the watershed. Additional recommendations to change current policy guidelines or ordinances should be utilized by public officials as a resource in evaluating areas in Hangman Creek for issuing water rights, planning future development, and improving water quality and habitat.

The recommendations for the Hangman Creek Watershed Management Plan attempt to undertake the difficult existing issues. It provides long-term guidance to protect and manage the existing water resources. The Plan does this by addressing the following issues;

- Projected Future Growth
- Growth Management
- Priorities of Future Water Allocation
- Water Conservation, Reclamation, and Re-use
- Groundwater/Surface water Interactions
- Actual Water Use/Allocation in the Basin
- Streamflow Augmentation and Storage
- Water Quality (Flow Related) Parameters
- Septic Systems
- Wellhead Protection
- Planning, Shorelines, and Development
- Fisheries Habitat
- Minimum Instream Flow Ruling
- Implementation Process

7. PHASE IV PLAN IMPLEMENTATION (See Section 8)

The Planning Unit has agreed by consensus to continue watershed planning through Phase IV funding. The first step will be to develop a new MOA between participating local governmental jurisdictions and other appropriate stakeholders. This new group will form the core of a decision-making body required to continue the watershed planning process. This interim body, called the Watershed Implementation Team would be responsible for detailing a Scope of Work and structuring a longer-term formal body responsible for future implementation measures. The Watershed Implementation Team will be a body similar to the Planning Unit and its' current stakeholder membership. The Spokane County Conservation District (SCCD) has been designated as the Lead Agency. The SCCD will submit and administer the Phase IV grant application. The Watershed Implementation Team will then select and hire a professional consultant to facilitate and develop the Detailed Implementation Plan.

Another important element of this management plan is that it should be considered a "working" document. It must be able to consider and accept new technology or advancement in areas that prove to be more effective and efficient (costs and strategies). This type of adaptive management promotes a need for periodic review of the plan. It is recommended that this plan be reviewed in 18 months after it is approved by the appropriate County Commissioners.

PHASE IV FUNDING

House Bill 1336 provides the funding mechanism for Phase IV activities. Phase IV allows up to $400,000 in grant funds over a five-year period. Funding will be available for up to $100,000 per year for the first three years of implementation. A two-year extension may be available for up to $50,000 each year. These grants require a ten percent match which can include in-kind goods and services, cash, or through local agreements with participating governments, federal agencies, and other stakeholders. Additional funding sources will also be identified during the first year of Phase IV.

EARLY ACTION ITEMS

The Planning Unit developed a list of interim actions to be implemented between approval of the Watershed Plan by the Planning Unit and finalization of the Phase IV Implementation Agreement (See Section 8). These actions are not prioritized and will be implemented as opportunities provide. Funding will be limited to Phase III funds not otherwise utilized in the WRIA 56 Planning Process and/or funding volunteered by Planning Unit participants.

Recommendations, Strategies, Priorities, and Schedule

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
WATER QUANTITY							
ISSUE 1: PROJECTED FUTURE GROWTH **According to current data collection efforts and reports, some municipal water systems may not have enough water to meet projected future growth.**	M						
R1.a. Evaluate the potential to purchase or lease, valid current water rights for municipal supply.	H						
Strategy Research and develop a mechanism for this process.	H	X				WIT, WDOE	2,000 – 50,000
R1.b. Reclamation, conservation and reuse strategies shall be encouraged to increase water available for beneficial uses in the watershed.	H						
Strategy Further investigate opportunities.	M		X			WIT, LJ, STH	5,000 – 10,000
ISSUE 2: GROWTH MANAGEMENT **Projected growth over the next 20 years could have severe impacts on the water resources in the basin. Growth should be managed to minimize impacts**	H						
R2.a. Separate watershed management units may be identified and managed differently for water rights if future studies indicate a disparity between sub-basins and their groundwater/surface water relationships.	H						
Strategy Identify funding sources and develop studies to better understand groundwater/surface water interactions within the sub-basins of the watershed.	M	X				WIT, WDOE	0

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R2.b. All proposed changes in GMA Comprehensive Plans, that affect housing density and require new withdrawals and/or the issuance of new water rights from the watershed should be strongly dependent on water availability.	H						
Strategy Further development of water availability information is required to assist local jurisdictions with future land use planning.	H		X			WIT, LJ	5,000 – 20,000
Strategy: Local jurisdictions should develop a better understanding of the aquifer and water availability before conducting land use planning in the basin.	H		X			WIT, LJ	20,000 – 100,000
Strategy: Request Counties, Cities, and/or Regional Health Districts to evaluate the quantity of water necessary (currently 1 gallon per minute), from a domestic exempt well before a building permit is issued.	H	X				LJ, RHD, WIT	2,000 – 10,000
R2.c. Land use regulators should utilize water availability estimates described in the Watershed Management Plan. Minimum parcel size should be based on sub-basin estimates in areas where exempt wells will be the main source of domestic water.	M						
Strategy: All new domestic exempt wells should be regulated by any future Minimum Instream Flow Ruling developed by Ecology.	M			X		WDOE, WIT	5,000 – 100,000
Strategy: Policies that will limit the maximum daily withdrawals of domestic exempt wells to less than 5000 gallons per day should be investigated.	M		X			LJ, SC	0 – 5,000
Strategy: Request Counties, Cities, and/or Regional Health Districts to evaluate the quantity of water necessary (currently 1 gallon per minute,), from a domestic exempt well before a building permit is issued.	H		X			LJ, RHD	0 – 5,000
ISSUE 3: PRIORITIES OF FUTURE WATER ALLOCATION **It is important to ensure adequate water supplies for instream and out-of-stream uses within the basin. Priorities need to be set for the watershed.**	H						

Issue Category Recommendation/Strategy	Priority[1] Ranking (H, M, L)	Preliminary Schedule[2]				Potential[3] Stakeholder Commitments	Costs[4] ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R3.a. Future allocation of water rights should be apportioned accordingly. **1. Municipal** **2. Domestic (group, domestic exempt)** **3. Stock water (requiring less than 5,000 gallons per day for ranging cattle)** **4. Light Industrial** **5. Commercial (retail, commercial livestock)** **6. Stock water (requiring greater than 5,000 gallons per day)** **7. Agriculture (irrigated)** **8. Heavy Industrial**	H	X				WDOE, WIT	0
R3.b. Initiate a watershed based negotiation to achieve a cooperative agreement to address cross state line availability of water (both surface and groundwater).	H						
Strategy: A process should be initiated to develop collaboration between appropriate multi-state stakeholders and agencies.	H		X			WIT, LJ, STH	5,000 – 10,000
ISSUE 4: WATER CONSERVATION, RECLAMATION, AND RE-USE **The Planning Unit recognizes that the watershed may be fully allocated. Water savings will occur from implementing water conservation measures. Communities may want to consider instituting a plan to prevent shortages in the future.**	H			X	X		
R4.a Work with water purveyors to implement conservation programs required by the new Municipal Water Law.	M						
Strategy: A coordinated effort should be initiated between the State Department of Health and the water purveyors. A process should be facilitated to convene local purveyors to develop coordinated conservation provisions. These can take the form of individual plans.	M		X			SC, DOH, STH, WIT	10,000 – 20,000
Strategy: Assess the need for additional conservation measures in the basin (aside from Municipal Water Law)	M		X			WIT	2,000 – 5,000
R4.b. Identify funding sources for small town infrastructure upgrades (*i.e.* leak detection, repair, storage, metering).	H						

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: Funding sources should be identified.	M		X			WIT, DOH	2,000 – 5,000
R4.c. Develop new legislation to prevent water saved by improved irrigation efficiency or conservation from being subject to relinquishment (systems who are not municipal water suppliers).	H						
Strategy: Appropriate legislation should be drafted and submitted.	M		X			WIT	2,000 – 5,000
R4.d. Options for keeping current water rights and place of use in the watershed should be explored.	M						
Strategy: Further investigation is needed to develop alternatives	M		X			WIT	2,000 – 5,000
R4.e. Funding should be requested from the Legislature to purchase or lease saved water (from R4.d.).	M						
Strategy: A formal request should be developed and submitted to the Legislature.	L		X			WIT	0 – 2,000
R4.f. The potential to utilize the Conservation Futures Program for purchasing water rights should be explored.	M						
Strategy: The Conservation Futures Program should be explored to investigate this opportunity.	M		X			WIT, SCPR	0 – 2,000
R4.g. A coordinated water conservation education/information program should be developed and implemented. This program may be coordinated with a larger regional effort.	H						
Strategy: A program should be developed. This program may also be developed in coordination with a larger regional program.	H		X			WIT, LJ	10,000 – 100, 000 (10,000 – 20,000 annual O&M)

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R4.h. Encourage the use of water conserving programs, actions, and technology (*i.e.* xeriscaping, low flow toilets and shower heads) for domestic (group, domestic exempt), light industrial, heavy industrial, commercial, agriculture, irrigation, and municipal uses.	**H**						
Strategy: This program should be developed and coordinated with appropriate agencies and departments.	**H**		**X**			**SC**	**10,000 – 20,000**
R4.i. A watershed drought management plan should be developed. This plan will initiate specific actions to be taken to conserve and preserve water in the basin.	**H**						
Strategy: A plan should be developed. This plan may be coordinated with a larger regional effort.	**H**		**X**			**WIT**	**5,000 - 10,000**
ISSUE 5: GROUNDWATER/SURFACE WATER INTERACTIONS **Groundwater withdrawals from the deep basalt aquifer system in the upper basin do not have an immediate, direct impact on stream flows in the upper basin (Buchanan 2003). However, groundwater withdrawal in the upper basin may indeed have an impact on surface water flows in the lower basin, but it may be delayed by many years or decades. Furthermore, the impact may be so small that it would not be measurable in the lower basin.**	**H**						
R5.a. The groundwater connections between sub-basins should be studied and better defined.	**M**						
Strategy: A scope of work should be developed and funding for this study should be identified.	**H**		**X**	**X (study)**		**WIT**	**1,000 – 3,000 setup (50,000 – 100,000 study)**
R5.b. Groundwater levels need to be monitored to determine if aquifer mining is occurring within the basin.	**H**						
Strategy: A scope of work should be developed and funding for this study should be identified.	**H**		**X**	**X (study)**		**WIT**	**1,000 – 3,000 setup (20,000 – 50,000 study)**

Issue Category Recommendation/Strategy	Priority Ranking[1] (H, M, L)	Preliminary Schedule[2] Per Plan Approval	05-06	07-11	11 +	Potential Stakeholder Commitments[3]	Costs ($)[4] (TBD During Implementation Phase)
R5.c. A study should be conducted to evaluate whether groundwater from adjoining watersheds is being utilized by municipalities on the edge of watershed (Tekoa, Cheney, Spangle). The addition of a dedicated monitoring station (well) should be established.	L						
Strategy: A scope of work should be developed and funding for this study should be identified.	M		X	X (study)		WIT	1,000 – 3,000 setup (20,000 – 50,000 study)
R5.d. A new permanent gaging station should be developed between the upper and lower watershed. This will help determine water interchange rates, instream flow levels (regulatory and recreational)	L						
Strategy: A real time gaging station should be established and maintained. Funding for the station should be identified to help support this.	M		X			USGS, WIT	20,000 – 30,000 setup (25,000 annual O&M)
R5.e. Encourage the establishment of a new permanent gaging station near the stateline.	L						
Strategy: This station should be established and maintained. This station may be implemented through joint entities/stakeholders.	M			X		CDT, STH, USGS	20,000 – 30,000 setup (25,000 annual O&M)
ISSUE 6: ACTUAL WATER USE/ALLOCATION IN THE BASIN **The total certificated water rights in the basin are approximately 48 cfs. However, the actual use in the basin is not known.**	M						
R6.a. Determine the need for addressing compliance and enforcement of water rights and claims. Required resources should be identified.	H						
Strategy: The Watershed Implementation Team should determine the need and requirements for compliance and enforcement issues.	H		X			WDOE, WIT	2,000 – 5,000
R6.b. Determine the need and support for adjudication in the watershed. If supported, the appropriate sub-basins should be prioritized for adjudication.	M						
Strategy: The Watershed Implementation Team should determine the need and support for adjudication and then prioritize sub-basins as needed.	M		X			WIT	2,000 – 5,000

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R6.c. If appropriate, a petition should be filed with the State of Washington for general adjudication of water rights in the basin.	L						
Strategy: File a petition (if necessary).	L		X			WIT	1,000 – 2,000
MULTIPURPOSE STORAGE							
ISSUE 7: STREAMFLOW AUGMENTATION AND STORAGE **The Hangman Creek Watershed is routinely impacted by low flows during the critical summer months of July through September. Improvements in storage and augmentation may prove to be beneficial to communities and stream flow levels.**	M						
R7.a. The Cities and Towns of Spangle, Rockford, Tekoa, and Latah should evaluate and investigate the causes for unaccounted water in their Public Water Systems. If high levels are found, actions should be taken to reduce the unaccounted for water.	H						
Strategy: If necessary, a leak detection program should be developed for these towns.	H			X		LJ, WIT	10,000 – 20,000
R7.b. A streamflow augmentation program should be developed and implemented for Hangman Creek.	M						
Strategy: New and existing wells should be drilled and/or pumped to augment the streamflow with groundwater. This water may be purchased or leased.	L				X	WIT, WDOE, LJ, STH	50,000 – 250,000 (0-12,000 annual O & M)
Strategy: Water rights should be purchased or leased from The City of Tekoa to augment streamflows.	M			X		WIT, WDOE, LJ,	
Strategy: Develop a system to utilize inchoate water rights, on a temporary basis, from appropriate cities and towns within the watershed.	M		X			WIT, WDOE, LJ, STH	
Strategy: Historic and current wetland sites should be acquired and restored.	H			X		WIT, WDOE, LJ,	

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: Catchment basins should be built to capture and store water.	M				X	STH, WIT	4.5 to 7.5 million (2.35 million annual O&M)
Strategy: Balancing basins should be built to capture and store runoff during peak periods.	L				X	LJ, WIT, STH, WDOE, WDFW	2.0 to 2.5 million (200,000 annual O & M)
Strategy: Dams should be built in the upper watershed to capture and store water.	L		X			WIT,	50,000 to 13 million (0 to 10% of installation costs for annual O & M)
Strategy: Beaver ponds should be encouraged and protected throughout non-developed portions of the watershed.	M		X			WIT, STH,WDFW	0-1,000
Strategy: An education program on storage activities and benefits should be regionally coordinated and implemented. Funding should be identified.	M		X			WIT, STH, LJ	10,000 (annual)
Strategy: A cost-share program for snow fencing should be developed and maintained.	M		X			WIT, SCCD	50,000 to 100,000 (20,000 annual O & M)
Strategy: Living and constructed snow fencing should be encouraged and supported throughout the watershed.	M		X			WIT, LJ, SCCD	0
Strategy: Vegetated buffer strips should be encouraged and implemented throughout the watershed.	H		X			WIT, LJ, SCCD	0
Strategy: No-till/Direct Seed tillage operations should be encouraged throughout the watershed.	H		X			WIT, SCCD, LJ	0
Strategy: A No-till/Direct Seed Demonstration Program should be initiated and funded.	H		X			WIT, LJ, SCCD	100,000 – 750,000
Strategy: The Rock Creek sub-watershed should be targeted for reforestation efforts.	M		X			WIT, LJ, SCCD, STH, NRCS	33,750,000 – 168,750,000
R7.c. Encourage change of source for water rights from surface to ground water where feasible. Additional incentives may help involvement.	M						

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: This option should be further explored..	M	X				WIT, WDOE	0 – 5,000
WATER QUALITY							
ISSUE 8: WATER QUALITY (FLOW RELATED) PARAMETERS **Hangman Creek is listed on the 1998 303(d) List of impaired water bodies for four flow related parameters (fecal coliform, pH, dissolved oxygen, and temperature).**	H						
R8.a. Participate in Lake Spokane D.O. TMDL process related to point and non-point sources in the Hangman Creek watershed.	H						
Strategy: The Watershed Implementation Team should participate in the Lake Spokane TMDL process	M	X				WIT	2,500 – 5,000
R8.b. Participate in the Hangman Creek TMDL project.	H						
Strategy: The Watershed Implementation Team should participate in the Hangman Creek TMDL process	H	X				WIT	2,500 – 5,000
R8.c. The information (data) gaps for short and long-term water quality needs should be evaluated.	H						
Strategy: Information (data) gaps and needs should be evaluated. An action plan should be developed.	H		X			WIT, SCCD, HCTMDL	2,000 – 5,000
R8.d. The long-term trends of sediment loads should be evaluated.	H						
Strategy: A coordinated effort should be organized to evaluate trends.	H		X			WIT, SCCD, USGS, HCTMDL, WDOE	5,000 – 10,000
R8.e. The stream gaging operation throughout watershed should be maintained to assist with the TMDL study. The stations will assist in the determination of pollutant load allocations.	H						

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: The gaging stations should be maintained	**H**		**X**	**X**		**SCCD, HCTMDL, WIT**	**10,000 – 25,000 (annual O&M)**
R8.f. The installation of additional gaging stations to monitor the effects of BMP implementation should be supported. These BMPs should be recommended through the TMDL process.	**M**						
Strategy: Additional gages should be established (if necessary)	**M**		**X**			**SCCD, WIT, HCTMDL**	**20,000 – 50,000 setup (20,000 annual O&M)**
R8.g. Stock watering impacts to surface waters should be minimized throughout the watershed.	**M**						
Strategy: An action plan should be developed to minimize livestock impacts. This effort should be coordinated with appropriate agencies	**H**	**X**				**WIT, SCCD, WDOE, HCTMDL**	**2,000 - 5,000**
R8. h. Incentives should be developed to encourage off creek watering systems for livestock.	**H**						
Strategy: A coordinated effort to develop incentives for off creek watering systems should be organized. This effort should be coordinated with appropriate agencies.	**H**	**X**				**WIT, SCCD, WDOE, HCTMDL, SC**	**2,000 – 5,000**
R8.i. Incentives should be developed to improve riparian zones.	**H**						
Strategy: An action plan to improve riparian zones should be developed. This effort should be coordinated with appropriate agencies.	**H**	**X**				**WIT, SCCD, WDOE, HCTMDL, SCSC**	**2,000 – 5,000**
ISSUE 9: SEPTIC SYSTEMS **Septic systems that are failing, improperly maintained or non-functioning can provide contaminants to surface and ground water.**	**M**						
R9.a. An education/information program should be initiated for septic system construction, care and maintenance.	**M**						
Strategy: A program should be initiated and supported.	**M**		**X**			**SC, RHD**	**10,000 – 20,000 (15,000 annual O&M)**

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R9.b. A septic maintenance program should be established. Inspections should take place every three years. Septic system pumping should occur every six years.	M						
Strategy: A program should be initiated and maintained	L		X			RHD	20,000 – 50,000 (20,000 annual O&M)
R9.c. Incentives should be developed for replacement and/or upgrades of substandard septic systems.	M						
Strategy: A coordinated effort to develop incentives should be organized.	M		X			WIT, RHD	2,000 – 5,000
ISSUE 10: WELLHEAD PROTECTION **Wellhead protection is lacking in the smaller communities throughout the watershed.**	L						
R10.a. The needs for wellhead protection in smaller communities should be identified.	M						
Strategy: The needs should be identified. An action plan should be developed	M		X			WIT, LJ	5,000 – 10,000
R10.b. Potential funding sources for wellhead protection in smaller communities should be identified.	M						
Strategy: Potential funding sources should be identified	M		X			WIT, LJ	1,000 – 5,000
R10.c. The impacts of storm water handling in smaller communities should be identified.	M						
Strategy: Impacts of storm water handling should be identified. An action plan should be developed.	M		X			WIT, LJ	2,000 – 5,000
R10. d. Identify potential funding sources for storm water system plans with wellhead protection program.	M						

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: Potential funding sources should be identified	M		X			WIT, LJ	1,000 – 5,000
HABITAT AND LAND USE							
ISSUE 11: LAND USE PLANNING, SHORELINES, AND DEVELOPMENT **The types and extents of land uses appropriate for the watershed should be compatible with the Watershed Management Plan's goals. These plans include both water quantity and water quality issues (future TMDL Plan). Riparian area and flood plain encroachment continues to occur throughout the basin (rural and urban).**	H						
R11.a. All development and construction proposals within the watershed should have a SEPA review and be reviewed by the Watershed Implementation Team for compatibility with the watershed management plan.	M						
Strategy: The Watershed Implementation Team should request to be on review lists of all relevant agencies.	H	X				WIT, LJ	0
R11.b. All County and City Land Use Planning intended for WRIA 56 should be reviewed/coordinated with the Watershed Implementation Team for compatibility with the watershed management plan.	H						
Strategy: A coordinated effort should be made with local planning departments to review land use planning proposals within the basin.	H	X	X			WIT, LJ	2,000 – 5,000
R11.c. The local Shoreline Management Plans and/or Critical Areas Ordinance should include a restriction on commercial, residential, and industrial development along streams, within the 100-year flood plain, and the associated channel migration belts.	H						
Strategy: The Spokane County Conservation District, the local jurisdictions, and Ecology should provide technical assistance to the extent possible.	H	X				WIT, LJ, SCSC	2,000 – 5,000

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: The Watershed Implementation Team should make recommendations to land-use authorities for Shoreline Management Plans and Critical Area Ordinances.	H						
R11.d. If new commercial, residential, and industrial development within the 100-year flood plain occurs, then mitigation should be required for fish and wildlife impacts.	H						
Strategy: A coordinated effort should be made to review policies and provide comments.	H	X	X			WIT, LJ, SCSC	2,000 – 5,000
R11.e. All streamside/shoreline land uses (eg. Agricultural, urban, residential) subject to the jurisdiction of local regulations should implement Best Management Practices and establish appropriate riparian buffers to protect streamside habitat and water quality.	H						
Strategy: Local jurisdictions should enforce local regulations to extent possible. An education and awareness program should be developed.	H		X			WIT, SCSC, LJ, STH	5, 000 – 10,000 (annual)
R11.f. Technical assistance should be available for landowner consultation	H						
Strategy: Technical assistance should be available through various sources	M	X				SCCD, WDOE, PC, SC, WC	2,000 – 20,000
R11.g. Shoreline Management Plan regulations and Critical Area Ordinances should be enforced to the extent possible.	H						
Strategy: All local jurisdictions required to regulate shorelines should maintain adequate staffing for enforcement.	H	X	X			LJ	30,000 – 75,000 (annual)
R11.h. Greenbelts or conservancy corridors should be established to improve and enhance fish and wildlife habitat.	M						
Strategy: Applications should be coordinated, developed, and submitted to the Spokane County Conservation Futures Program.	M		X			WIT	1,000 – 3,000

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
R11.i. A complete channel migration zone delineation project should be funded within the watershed and should be considered in future land use regulations.	M						
Strategy: A scope of work should be developed. Funding sources should be identified.	M	X	X (study)			WIT	1,000 – 3,000 setup (10,000 – 50,000 study)
R11.j. The current delineation of the 100-year FEMA flood plain designations should be reassessed. New boundaries should be determined by a professional engineer.	M						
Strategy: A coordinated action plan should be developed and submitted to FEMA.	M		X			WIT, WDOE, SC, WC, FEMA	1,000 – 3,000
R11.k. Conduct feasibility study of a land acquisition/relocation program for structures within the 100-year flood plain.	L						
Strategy: A scope of work should be developed. Funding sources should be identified	L		X			LJ, WIT	2,000 – 5,000
R11.l. Develop and maintain public awareness and education programs for riparian area function, benefits, and flood plain encroachment (This should be inclusive of residents, developers, and a broad range of stakeholders).	H						
Strategy: A coordinated program should be developed. This program should be maintained over the long-term. Funding should be identified.	H	X				WIT, SCSC, LJ, SC, WC, WDOE	2,000 – 5,000 setup (10,000 – 20,000 annual O&M)
R11.m. The local jurisdictions should develop a coordinated flood response plan in conjunction with a flood warning system.	H						
Strategy: A plan should be developed and coordinated with local jurisdictions.	H		X			SCEMS, LJ, WC, WIT	5,000 – 10,000
R11.n. Establish a riparian restoration program for the watershed.	H						

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: A program should be coordinated, developed and implemented. Funding sources should be identified. This program should be maintained.	H	X				SCCD, WIT, LJ, HCTMDL, SC, WC, SCSC, WDOE	2,000 – 5,000 setup (20,000 – 50,000 O&M)
R11.o. Pursue the reservation of a portion of the Conservation Futures Program to fund the acquisition of high priority riparian shorelines.	H						
Strategy: The Watershed Implementation Team should coordinate with the Spokane County Parks and Recreation Program to discuss the potential and process.	H	X				WIT, SCPR	0
R11.p. Identify high priority riparian habitat to submit for consideration in the Spokane County Conservation Futures Program.	H						
Strategy: A process to determine high priority habitats should be developed. Priority habitats should be identified. An application should be developed and submitted to the Conservation Futures Program.	M	X				NRCS, WIT, SCCD, WDFW, SCSC	2,000 –5,000
R11.q. Coordinate and continue Riparian Buffer Cost-Share/and or loan programs.	H						
Strategy: The program should be coordinated and maintained. Funding should be identified.	H		X			WIT, SCCD	10,000 – 20,000 (annual O&M)
ISSUE 12: FISHERIES HABITAT **Fisheries within the Hangman watershed are stressed due to poor habitat, water quality and low water quantity issues.**	M						
R12.a. Fish barriers should be identified and mapped within the mainstem and tributaries. A feasibility plan to identify the benefits of removal of these barriers and an action plan to remove identified barriers should be developed.	H						
Strategy: An action plan should be developed to identify, map, and evaluate potential fish barriers.	H	X (study)				WIT, WDFW, SCCD	2,000 – 5,000 setup (20,000 – 50,000 study)

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: Further action for identified fish barriers should be developed.	H		X			WIT, WDFW, SCCD	2,000 – 5,000
R12.b. Conduct Proper Function Condition Assessment (PFC) on the remaining tributaries in the Hangman Creek Watershed.	H						
Strategy: An action plan should be developed and coordinated. Funding sources should be identified.	H	X (study)				WIT, SCCD, SCSC	1,000 – 3,000 setup (10,000 – 30,000 study)
R12.c. Evaluate whether the current hydrology is capable of supporting flows required for returning migratory salmonids.	L						
Strategy: A body of hydrological information should be developed, analyzed, and reviewed.	L		X			WIT, CDT, WDFW	1,000 – 3,000
PHASE IV PLAN IMPLEMENTATION							
ISSUE 13: IMPLEMENTATION PROCESS **The success of the Hangman Creek Watershed Plan depends upon the formation of a Watershed implementation Team, local acceptance of the plan, and participation of local and stakeholders, and coordination of regional efforts.**	H						
R13.a. An Implementation Plan MOA shall be developed between local governmental agencies and other required stakeholders.	H						
Strategy: The Spokane County Conservation District shall undertake the development and completion of an Implementation Plan MOA.	H	X				SCCD, WIT	500 - 1,000
R13.b. At such time as a Memorandum of Agreement between the Initiating Agencies is complete, a lead agency should be identified to develop the Phase IV grant application and assume administrative responsibility for the grant.	H						
Strategy: The Spokane County Conservation District should be tentatively identified as the lead agency for plan implementation until such time as the Memorandum of Agreement formalizes this position.	H	X				SCCD, WIT	0

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		
Strategy: At such time as the Memorandum of Agreement between the Initiating Agencies is complete, the lead agency shall develop and submit the Phase IV grant application to the Washington State Department of Ecology.	**H**	**X**				**SCCD, WIT**	**1,000 – 1,500**
R13.c. The current planning unit shall continue for no longer than one year under the current Operating Procedures or until such time as a completed MOA for Phase IV specifies otherwise.	**H**						
R13.d. A Detailed Implementation Plan should be developed.	**H**						
Strategy: A Detailed Implementation Strategy shall be developed for this watershed. The plan may include milestones, timelines, funding mechanisms, and obligations of local stakeholders.	**H**		**X**			**WIT, LJ, STH**	**50,000 – 100,000**
R13.e. The Watershed Implementation Team will work to develop and recommend a Minimum Instream Flow(s) for the Hangman Creek Basin.	**H**						
Strategy: The Watershed Implementation Team will continue to work on the minimum instream flow (s). If a recommendation cannot be made, the Watershed Implementation Team will promptly notify Ecology that consensus could not be reached.	**H**		**X**			**WIT**	**5,000 – 10,000**
						EST. TOTAL	**500,000 – 170.7 million**

Notes:
1. **The rankings of H = high importance; M = medium importance; L = low importance.**
2. **The schedule is preliminary and subject to change and/or funding opportunities.**
3. **The stakeholders indicated in the table are not obligated to any financial commitments at this time. This designation indicates the potential stakeholders only.**
4. **The estimated costs will be further developed during the first year of the implementation phase (Detailed Implementation Plan).**

Issue Category Recommendation/Strategy	[1]Priority Ranking (H, M, L)	[2]Preliminary Schedule				[3]Potential Stakeholder Commitments	[4]Costs ($) (TBD During Implementation Phase)
		Per Plan Approval	05-06	07-11	11 +		

CDT is Coeur d'Alene Tribe
DOH is Department of Health
FEMA is Federal Emergency Management Agency
HCTMDL is Hangman Creek TMDL Workgroup
LJ is Local Jurisdictions
NRCS is Natural Resources Conservation Service
PC is Private Consultants
RHD is Regional Health District
SC is Spokane County
SCCD is Spokane County Conservation District
SCSC is Spokane County Shorelines Committee
SCPR is Spokane County Parks and Recreation
STH is Stakeholders
USGS is United States Geological Survey
WC is Whitman County
WDFW is Washington State Department of Wildlife
WDOE is Department of Ecology
WIT is Watershed Implementation Team

1.0 INTRODUCTION AND BACKGROUND

Hangman (Latah) Creek, herein referred to as Hangman Creek, is a trans-boundary watershed that begins in the foothills of the rocky mountains of northern Idaho and spans across the southeastern portion of Spokane County, Washington (Figure 1). It encompasses over 689 square miles (approximately 430,000 acres). The watershed is dominated by dryland farming, but, like other eastern Washington watersheds, is experiencing increases in urbanization and changes in land use practices. The land use changes have caused increasing pressure for water development and have prompted the need for the protection and management of stream flows and related aquatic and riparian habitat.

Agriculture has been the dominant land use in the Hangman Creek Watershed since the early 1900s. By the early 1920s, a significant portion of the farmable land had been cleared and cultivated for the production of wheat, barley, peas, and lentils. Thousands of acres of forest and riparian areas were cut and cleared. Miles of stream channel were straightened and new ditches were dug to quickly move water off the farm fields. These modifications, along with stream meander cutoff by roads changed the watershed's hydrological response. The system became stressed with heavy sediment loading, poor water quality, and accelerated stream bank erosion. The altered hydrology produces flashy, and sometimes damaging storm events during the winter and spring months (over 20,000 cfs). Yet, the base flow in the summer period barely covers the main stem throughout a majority of the watershed (daily average flows of less than one cfs have been recorded on numerous days). As a result of the streamside modifications and upland land uses, Washington State water quality standards for temperature, dissolved oxygen, pH, and fecal coliform are routinely violated.

Beginning in the early 1970s, many efforts were made to manage and improve land use and water quality in the basin. The Soil Conservation Service (currently the Natural Resources Conservation Service), the local conservation districts, private landowners, and producers have implemented Best Management Practices (BMPs), initiated conservation tillage operations, stabilized stream banks, and rehabilitated riparian areas. A management plan was developed in the early 1990's and several monitoring/research studies were conducted to provide baseline information. The management plan provided a better understanding of the behavior and water quality concerns of the watershed. However, water quantity issues in Hangman Creek, such as instream flow protection and basin-wide water use have never been fully evaluated.

1.1 The 1998 Watershed Planning Act

As the population of Washington State increases, the availability of clean water becomes more uncertain. Clean water is needed to sustain community growth, but the use of additional ground water and surface water sources must take other instream and out-of-stream uses into consideration (such as recreation and fisheries). In 1998, the Washington State Legislature developed and approved The Watershed Planning Act (RCW 90.82) to address these issues (Appendix A)

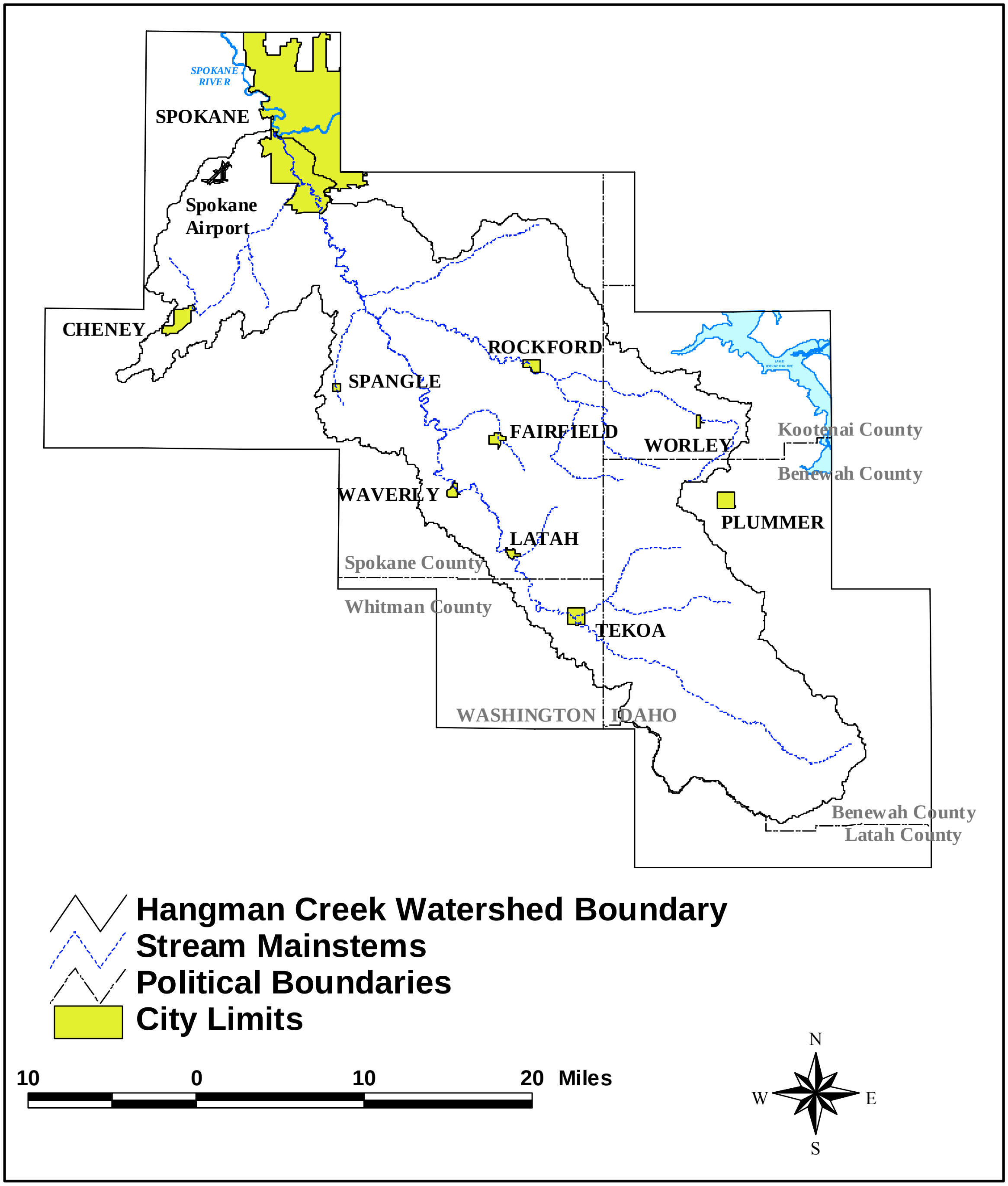

Figure 1: Hangman Creek Location Map

The purpose of the Act is to assess current and desired future conditions, and propose wise and sustainable management for the resources of each WRIA in Washington State. Currently, there are 62 WRIAs defined by the Washington State Department of Ecology. Each WRIA is delineated by the natural boundaries of the watershed. However, in many instances, the WRIAs cross multiple state and county jurisdictions and complicate the procedures for coordination. The Watershed Planning Act enables the local agencies, citizens, and various stakeholders to convene a formal planning group to discuss and develop recommendations to govern the future of water appropriations. The Act is administered through the Washington Department of Ecology (Ecology) in the form of a grant. The act provides the foundation for the initiating governments to commence planning according to three major planning phases. A fourth phase was added to the process in 2003.

Phase I: Organization of Planning Unit. This phase developed a mission statement and established goals, objectives, and the scope of work for Phase II. This phase was completed in 2001 (Sections 1.0 and 2.0 of this report).

Phase II: Conduct Watershed Assessment. The watershed assessment consisted of compiling existing water resources information, conducting short-term studies, and identifying data gaps. Phase II was completed in 2003 (Section 3.0, 4.0, 5.0, and 6.0 of this report).

Phase III: Develop a Watershed Plan and Recommendations. Phase III consisted of developing recommendations and identifying alternative solutions for future management of the basin. Phase III was completed in 2004 (Section 7.0 of this report).

Phase IV: Plan Implementation Strategy. Phase IV provides a mechanism for coordinating and overseeing the actual implementation of the alternatives and recommendations of the plan. It also includes supporting activities such as public information, education, and potential research requirements (Section 8.0 of this report).

1.2 The Purpose of the Watershed Plan

The Watershed Planning Act of 1998 provided a unique opportunity to assess and evaluate the overall water resources in the Hangman Creek watershed. This watershed planning process brings the local agencies and citizens together to develop a water balance, discuss key issues, and organize management recommendations for future water use and instream needs.

The Hangman Creek Watershed Plan specifically addresses WRIA 56, although the headwaters (upper third of basin) reside in northern Idaho. The evaluation of the basin did include relevant water resources information and data from Idaho. The overall Watershed Plan focuses on an approach to define water availability and management by:

- Assessing the amount of surface and groundwater that is physically and legally available for all uses (water rights, etc.).
- Providing recommendations for future instream and out-of-stream uses.
- Identifying the key water resource problems and issues in the watershed.
- Providing recommendations consisting of strategies and mitigation options.
- Proposing feasible alternative solutions to water resource issues.
- Developing an implementation strategy that includes a long-term water resource management program for the basin (including monitoring needs).
- Providing clear assignment of responsibilities for management program.
- Developing a long-term system for acquiring and incorporating new information and adapting management strategies.

2.0 PHASE I: THE PLANNING PROCESS

2.1 Initiating Governments

In 2000, the Spokane County Conservation District (SCCD) organized the required initiating governments within the Hangman Creek basin into a formal Planning Unit (PU) for purposes of assessing and managing the water resources of Hangman Creek. The PU also was to pursue strategies that include key elements of water quantity, quality, instream flows, and habitat. These governments were crucial to the overall planning process, developing a scope of work, determining the planning unit composition, and eventual development and implementation of the plan's recommendations. The following entities entered into a Memorandum of Agreement (Appendix B):

- All counties with territory in WRIA 56 (Spokane County, Whitman County)
- Largest city or town in WRIA 56 (City of Spokane)
- Largest water purveyor in WRIA 56 (Hangman Hills Water District, Number 15)
- Tribes with reservation land in WRIA 56 (There are no tribes with reservation land within WRIA 56 in Washington, but the Spokane and the Coeur d'Alene Tribes were invited to participate)

2.2 Scope and Key Issues Addressed

The initiating governments played an essential role in determining the direction and overall scope of the watershed planning process. They chose the SCCD as the Lead Agency. The SCCD's responsibilities included the administration and facilitation of the grant.

The initiating governments, under RCW 90.82, agreed to address the required water quantity element. In addition, they chose to undertake all the optional elements in accordance with available funding and time constraints. The initiating governments aspired to address these issues due to their influence on current and future water availability in the management area.

Planning Elements

- **Water Quantity** (Required) – This element involves assessing water supply and use in the management area, and developing strategies for future use. The continued increases in population and associated land use changes may significantly influence the stream flows in Hangman Creek. A water balance was developed to assess the current situation and recommend future action (Section 3.5).

- **Water Quality** (Optional) – This element examines which standards are not being met, the degree and causes of the violations, and develops recommendations for monitoring and TMDL considerations. Hangman Creek is currently on the

- Washington State 303 (d) List for violations of water quality standards for fecal coliform, pH, temperature, and dissolved oxygen. Suspended and bedload contributions to the stream during the winter and spring months continues to be a major problem for aquatic biota. This element was funded and completed (Section 4.0).

- **Habitat** (Optional) – This involves the coordination and development of the watershed plan to protect or enhance fish habitat in the management area. The Hangman Creek watershed does not support the population or required habitat of salmonids that it did 100 years ago. This element was not funded and essentially replaced by the new storage component (Section 4.2).

- **Storage** (Optional – added by Ecology in 2002) – This element assesses the possibility and feasibility of augmentation strategies within the basin. The loss of wetlands and the conversion of grassland and forest to cropland has most likely had a significant impact to potential water storage in the watershed. This element was funded and completed (See Section 5.0).

- **Instream Flow** (Optional) – This element investigates the hydrological requirements of beneficial uses in the watershed. Hangman Creek appears to be flow-limited during the summer months. Flows routinely drop below 10 cfs. Final recommendations for the adoption of a minimum instream flow were submitted to Ecology for review and intent for ruling. This element was funded and completed (Section 6.0)

2.3 The Planning Unit

The next step for the SCCD and the initiating governments was to compile an all-inclusive list of potential planning unit members. The list included all watershed stakeholders that were considered important to the planning process and/or had the potential to be affected by the recommendations or implementation of the plan. The goal was to engage and motivate a collaborative, stakeholder-driven effort to address the water quantity and quality issues of the watershed.

The initiating governments and invited stakeholders of the watershed convened for the first official Planning Unit (PU) meeting in September, 2000. The PU consisted of many local agencies, stakeholder organizations, and private citizens that were interested in the watershed planning process; including state and federal regulatory agencies, city and county governments, special districts, environmental organizations, business and industry groups, and affected tribes (Appendix D). Although the Washington State watershed boundaries do not include tribal reservation lands, the watershed is considered to be ancestral grounds of both the Spokane and Coeur d'Alene tribes. Therefore, both were requested to participate in the long-term process.

2.4 Operational Procedures

The PU elected to define and document operational procedures for conducting watershed planning in the Hangman Creek watershed. The operational procedures were intended to increase the efficiency and productivity of meetings, assist the PU in decision making, define the roles and responsibilities of the Lead Agency, and provide a systematic course of action to resolve conflicts (Appendix E).

All decisions by the PU, except for administrative issues, were based on consensus building. The voting members defined consensus as a general agreement or accord. Consensus was not reached if one voting governmental representative voted "No." However, if that representative "abstained" from the vote or stated, "I cannot vote yes, but am willing to allow the process to go forward and will not take any action against the decision", then the vote was considered a consensus.

2.5 Mission, Goals, and Objectives of the Watershed Management Plan

The PU developed the following mission, goals and objectives from formal discussions during official PU meetings. They reflect the vision of the PU members and what they believed should be the final result of the watershed planning process for Hangman Creek.

Mission Statement:

To preserve, manage, and enhance the water resources of Hangman (Latah) Creek for beneficial uses of humans, wildlife, and fisheries.

Goals:

2.5.1 Investigate to Determine Water Balance Needs

Objective 1: Determine and summarize the current water balance during various flow periods; compare that information to existing water rights, actual surface and groundwater use, and pending applications for changes, transfers and new water use permits

Objective 2: Develop a greater understanding of ground water connections of associated aquifers and surface water

Objective 3: Identify and quantify interaction and contributions of ground water and surface water to surface flows

2.5.2 Establish Public Information Vehicle for Watershed Planning

Objective 1: Develop multiple sources of information for residents.

Objective 2: Encourage citizen participation in the watershed planning process.

Objective 3: Inform and educate the public on water resources issues.

2.5.3 Improve Overall Water Quality

Objective 1: Strive to meet and maintain Washington State Class A and EPA water quality criteria for all parameters and beneficial uses.

Objective 2: Reduce nutrient and waste loading from point and non-point sources.

Objective 3: Summarize data and cooperate with Ecology, the State of Idaho, the Coeur d'Alene Tribe and the Spokane Tribe in developing TMDLs for pollutants exceeding Class A criteria.

2.5.4 Reduce Suspended Sediment Loading

Objective 1: Encourage the maintenance of flood plains and enhance their functions and values.
Objective 2: Assess and encourage landowners to reduce erosion.
Objective 3: Assess current conditions and encourage the improvement of riparian areas and wetlands.
Objective 4: Evaluate stormwater management practices and recommend improvements.

2.5.5 Maintain and Enhance Fish and Wildlife Habitat

Objective 1: Promote and encourage the planting of native vegetation along streambanks.
Objective 2: Assess instream flow needs.

2.5.6 Maintain Recreational Use of Watershed

Objective 1: Determine instream flow needs.
Objective 2: Educate and inform residents of responsible uses and opportunities.

2.6 Public Participation and Awareness Program

The PU provided many different opportunities for the public to participate in the development of the watershed management plan (See Appendix E, Page E-13).

2.6.1 Regular Monthly Meetings

The planning unit generally met on a regular basis every month (second Tuesday of the month) unless circumstances prevented it. Additional monthly meetings occurred as needed to conduct Planning Unit business. On occasion, planning meetings were held at locations within the watershed. All meetings were advertised through direct mailing or email notices to interested parties. In 2004, meeting minute summaries and notices were posted in the local newspaper (North Palouse Journal). All notices and agendas were also posted on the watershed planning website. Every official planning unit meeting was open to the public. A 15-minute time slot at the beginning and end of each meeting was provided for public comment. Meeting minutes were documented, distributed, and archived on the website.

2.6.2 Public Meetings/Presentations

The PU conducted a series of public meetings to increase awareness of the project and to solicit comments on its progress and direction. Meeting attendance ranged from six to over 35 people and did not appear to be dependent upon location and time. Some meetings in the rural areas were just as well or poorly attended as the meetings near the city centers.

Notices and flyers for public meetings were usually posted on the website and local newspapers. Personal invitations (notices) to public meetings were not comprehensive for the watershed due to costs. However, a notice for the "Final Recommendations" public meetings was extended to every resident listed within the watershed (over 15,000 addresses). Two meetings were held on November 11th (Fairfield, WA) and 16th (St. Stephen's Church) to inform the residents of the plan's recommendations and to solicit comments regarding all aspects of the document. The comment period was open from November 11, 2004 through December 22, 2004. All comments were compiled, reviewed, and addressed by the Planning Unit (Appendix O).

2.6.3 Special Presentations/ Educational Displays

The PU participated and/or was represented in various types of public activities and local agency meetings in an effort to promote additional project awareness and coordination within the watershed. These activities took the form of conferences, fair booths, local community meetings, and local agency meetings.

2.6.4 Media/Newsletters

The PU utilized several different media outlets to disburse plan information and assessment data (local newspapers, radio, television, and newsletters).

2.6.5 Focus Groups/Surveys

In an effort to educate the public regarding the watershed planning process, focus groups were formed. The focus groups met several times during the Fall of 2002. Questionnaires were distributed to participants at the end of classes, meetings, and focus groups. The questionnaires were designed to evaluate how participant's knowledge levels changed for both watershed management in general and specifically for the Hangman Creek watershed. Awareness and understanding increased from 15 to nearly 80 percent throughout the focus groups.

2.7 Relationship to Other Programs and Planning

The Hangman Creek Watershed Management Plan will ultimately be approved, and to a large extend implemented by local cities and counties through their comprehensive plans. All existing rules, laws, ordinances, and programs have been reviewed and incorporated into the plan where appropriate.

2.8 Plan Conformance to SEPA/NEPA

In accordance with RCW 90.82, the Hangman Creek watershed planning process has satisfied the State Environmental Policy Act (SEPA) considerations at the non-project level. SEPA was enacted by the legislature to assist local and state agencies in the process of evaluating potential environmental impacts of proposed actions. A SEPA review process provides information to agencies, applicants, and the public to encourage environmentally sound proposals (Ecology, 1998). In 2003, Ecology developed and submitted a Final Environmental Impact Statement (EIS) for Watershed Planning under Chapter 90.82 RCW. Under SEPA, the Planning Unit has agreed to the "Adoption and Determination of Significance (DS) option. This option proposes that Ecology's statewide nonproject document generally addresses probable significant adverse environmental impacts associated with watershed planning under provisions of Chapter 90.82 RCW (Appendix P). The EIS fulfills the SEPA environmental review requirements for actions that may be needed to adopt the plan, including instream flows. Specific recommended actions of individual plans may require project-level, or non-project SEPA review prior to implementation.

The National Environmental Policy Act (NEPA) is only triggered by an action of a federal agency that may have potential adverse affects on the environment. The Hangman Creek Comprehensive Plan does not currently entail participation by any federal agency (through action, funding, or permitting). However, in the future, if any amendment or addition to the plan requires federal involvement, then it may be necessary to comply with NEPA requirements.

3.0 PHASE II: TECHNICAL ASSESSMENT AND FINDINGS

3.1 Technical Assessment and Validation Process

The Technical Assessment Protocol is designed to obtain agreement among planning unit members over the purposes, types, and methods for data collection in advance of gathering information. The PU did not develop a formal written procedure for technical assessments; rather a detailed scope of work was developed for each major data collection study. The scope of work for each study was developed and approved by the PU in consultation with the researchers. For the instream flow study, an instream flow sub-committee was formed to review the scope of work before final presentation to the PU.

All major new data collection studies undertaken during Phase II had a detailed scope of work approved by the PU. The only data collection effort not covered with a specific PU developed scope of work was the SCCD stream gage network. No technical assessment protocol or scope of work was developed because the SCCD already had the network established following USGS procedures as outlined in Rantz and Others (1982). Full details of the network and the data collection procedures are provided in *The Hangman Creek Water Quality Network: A Summary of Sediment Discharge and Continuous Flow Measurements (1998-2001)* by the SCCD (2002).

The Technical Validation Process adopted by the PU was the objective review of projects and data by the entire PU. The PU held ongoing project reviews for adequacy and validity of procedures, data collection methods, and results. Frequent project update reports and presentations were made by the researcher to the PU. The review process allowed all PU members to review and comment on the technical data and findings. Comments from the PU members during the project reviews and on draft reports directed the studies and technical information collected.

3.2 Basin Description

3.2.1 Climate

The Hangman Creek watershed is in a maritime-continental transition climatic zone and has characteristics of both damp coastal weather and more arid interior conditions. In general, the Hangman Creek watershed has an arid climate during the summer months and a mild coastal climate during the winter months. The mouth of Hangman Creek is at an elevation of approximate 1,700 feet, and with the headwaters at an elevation of approximately 3,600 feet, the watershed experiences an orographic effect that increases the annual average precipitation from less than 18 inches per year at the mouth, to over 40 inches per year in the southeastern headwaters (SCCD, 1994).

3.2.2 Regional Geology

The headwaters of the Hangman Creek watershed begin in mountains formed by the Idaho Batholith. Hangman Creek then flows through the rolling loess hills of the Palouse region and into an area of basalt cliffs and canyons. In reaches below Rock Creek (Figure 1), Hangman Creek then flows through sedimentary hills of sand, gravel, and cobbles deposited during the ancestral Glacial Lake Missoula floods.

Bedrock in the lower watershed is mainly Miocene basalt flows with pockets of Tertiary biotite granite and granodiorite (WDNR, 1998). During the Miocene, the basalt flows would periodically dam rivers and form lakes. Material deposited in these lakes formed dense laminated clay and silt deposits that are resistant to erosion. Wind-blown silt (loess) accumulated up to 200 feet over the basalt flows and formed the dune shaped hills.

During the Pleistocene period, lobes from glacial ice sheets blocked several major drainages and produced extensive lakes. The largest of these was Glacial Lake Missoula, which at one time covered over 3,000 square miles. There were at least 40 separate flood events from Glacial Lake Missoula (Waitt, 1980). The floods left major channels in the eastern Washington region, removed loess deposits, and deposited much of the sand, gravel, cobble, and boulders found in the lower reaches of Hangman Creek.

3.2.3 Upper Hangman Creek Sediments

Soils above Rock Creek in the Hangman Creek watershed have formed from a wide variety of materials. The materials include volcanic ash, silty loess, glacial deposits, alluvium deposited by streams, and material weathered from basaltic, granitic, and metamorphic bedrock. In the upper Hangman Creek area, much of the farmed soil is derived from loess deposits. The loess settled in the region approximately 100,000 years ago. The loess deposits are up to 200 feet thick and form dune-like hills. The present day loess deposits are areas where sheet and rill erosion tends to account for almost 90 percent of the soil loss from cropland (USDA, 1978).

3.2.4 Lower Hangman Creek Sediments

The easily erodible stream bank material in the lower Hangman Creek watershed influences Hangman Creek below Duncan (River Mile 18.8). The stream banks form high bluffs within the meander belt that supply large quantities of sediment to the stream. The bluffs influenced the meander pattern of Hangman Creek (although highway 195 now is the predominant influence for lower Hangman Creek). The unconsolidated material generally consists of one or more of three major alluvial deposit types. The deposits are the Latah Formation (lake deposits), Glacial Lake Missoula flood deposits (sand, gravel, and cobbles), and post-Missoula flood alluvium (SCCD, 1994).

3.3 Existing Data and Studies

There have been numerous studies of the Hangman Creek watershed. Several of the studies are for limited time periods and for specific sites. These studies provide information relative to specific flows and stream conditions, and may not be representative for current conditions. Generally, these studies provide background information that may be used to guide future actions in the watershed. A summary of the bibliography (Appendix F) is provided in Table 1.

Table 1: Summary of Previous Studies Grouped by Type of Study

General Type of Study	Number of Studies	Contents of Data	Summary and Limitations of Data Quality
Water Quality	13	Primarily grab samples, some automated sediment data	Limited to specific time and reach, most quality is good
Water Quantity	4	Daily average flows, high and low flow statistics	USGS daily flows are fair flood and low flows are good
Management Plans	8	One basin wide, the rest are specific to a town or reach	Basin wide is good, specific plans are limited in data
Descriptive, Trend, or Analysis	9	Thesis work, research reports, and agency reports	Information is good, but is often site and time specific
Informational or Data	10	Newspaper stories, historical accounts, and data reports	USGS data reports are good, other reports are fair
Fauna or Flora	8	Invertebrate assessments, fish surveys and inventories	Most information is good but is generally site specific

Notes:

1. Water quality reports are mainly Spokane Conservation District reports. The Idaho Department of Health and Welfare and the Benewah Soil and Water Conservation District completed three studies in the upper watershed in Idaho. The Washington State Department of Ecology has miscellaneous measurements.
2. Water quantity reports are USGS reports based on the gage maintained at the mouth of Hangman Creek.
3. Informational reports are generally newspaper stories, and the information could not be verified by checking the source or data.
4. Data reports generally present information such as drainage basin area, stream flow statistics, or drainage basin characteristics.

3.3.1 United States Geological Survey

The USGS has collected stream flow data and miscellaneous water quality data on Hangman Creek at the mouth since April 1948. The USGS gage is station number 12424000. The information has been published in the annual reports for Washington starting with water year 1961. Prior to the series, water resource data for Washington were published in U.S. Geological Survey Water-Supply Papers. Data on stream discharge and stage through September 1960 were published annually under the title “Surface-Water Supply of the United States, Parts 12, 13, and 14.” For the 1961 through 1970 water years, the data were published in two 5-year reports.

The current USGS gage is located near the mouth at Latitude 47° 39’ 10”, longitude 117° 26’ 55” in the NW ¼ of section 24, T25N, R42E, Spokane County, Hydrologic Unit 17010306. The gage is located at river mile 0.8 on the left bank (0.3 miles downstream from the bridge on Interstate 90 in Spokane). The drainage area is 689 square miles. The gage has been operated from April 1948 to September 1977; October 1977 to September 1978 (discharges above 20 cfs only), October 1978 to the current year. Prior to October 1958 the data were published as Latah Creek at Spokane. The records are considered fair by the USGS. There are no dams or structures regulating Hangman Creek, but there are some diversions upstream from the USGS station for irrigation that could effect the streamflow at the gage.

USGS Daily, Monthly, and Annual Average Stream Flows
The annual average discharge for the 51 years of record (water years 1948 through 2000) is 238 cfs, which is equivalent to 4.70 inches of rain or 172,700 acre-feet per year. The maximum discharge for the period was 21,200 cfs on January 1, 1997, and the minimum discharge was 0.74 cfs on September 5 and 14, 1992. The monthly mean data for the period of record are summarized in Table 2. Exceedance values for 10, 50, and 90 percent exceedance are shown in Figure 2.

Table 2: Hangman Creek USGS Statistics of Monthly Mean Data

	Flow by Month in Cubic Feet per Second, Water Years 1948 through 2000											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Mean	18.3	45.8	205	479	752	752	352	197	77.9	23.1	13.9	13.9
Max	48.5	216	1251	2097	1776	1914	928	1925	434	77.7	47.3	46.2
Min	2.30	10.4	10.9	24.0	39.5	44.1	27.0	15.1	6.21	2.43	1.29	1.01

USGS Low Flow Statistics
Low flow statistics for Hangman Creek were evaluated for the period of record from 1949 through water year 2001 (Table 3). The statistical analysis was provided by the USGS as provisional unpublished data. The low flow statistics provide a good estimate of the probability of future Hangman Creek low flow events.

Low flow statistics are generally presented as the mean value for a designated number of consecutive days. The consecutive number of days from the USGS report range from one to 183 days. The period of consecutive days for the low flow value may occur anytime throughout the water year. The values in the USGS report are the lowest mean values. Table 3 is a summary of the low flow values, and Table 4 is a summary of the probability for each duration.

Table 3: Hangman Creek USGS Lowest Mean Flow Statistics Summary

	Lowest Mean Flow for the Following Number of Consecutive Days (cfs)					
	7 Days	14 Days	30 Days	60 Days	90 Days	120 Days
Average	10.9	11.4	12.2	13.2	14.4	16.8
Maximum	43.7	44.7	45.2	46.0	47.0	65.8
Minimum	0.92	0.95	0.99	1.1	1.4	1.9

Notes:
1. Flow periods are for the year ending on March 31.
2. Statistics are preliminary computations for gage number 12424000 for years 1949 through 2001.

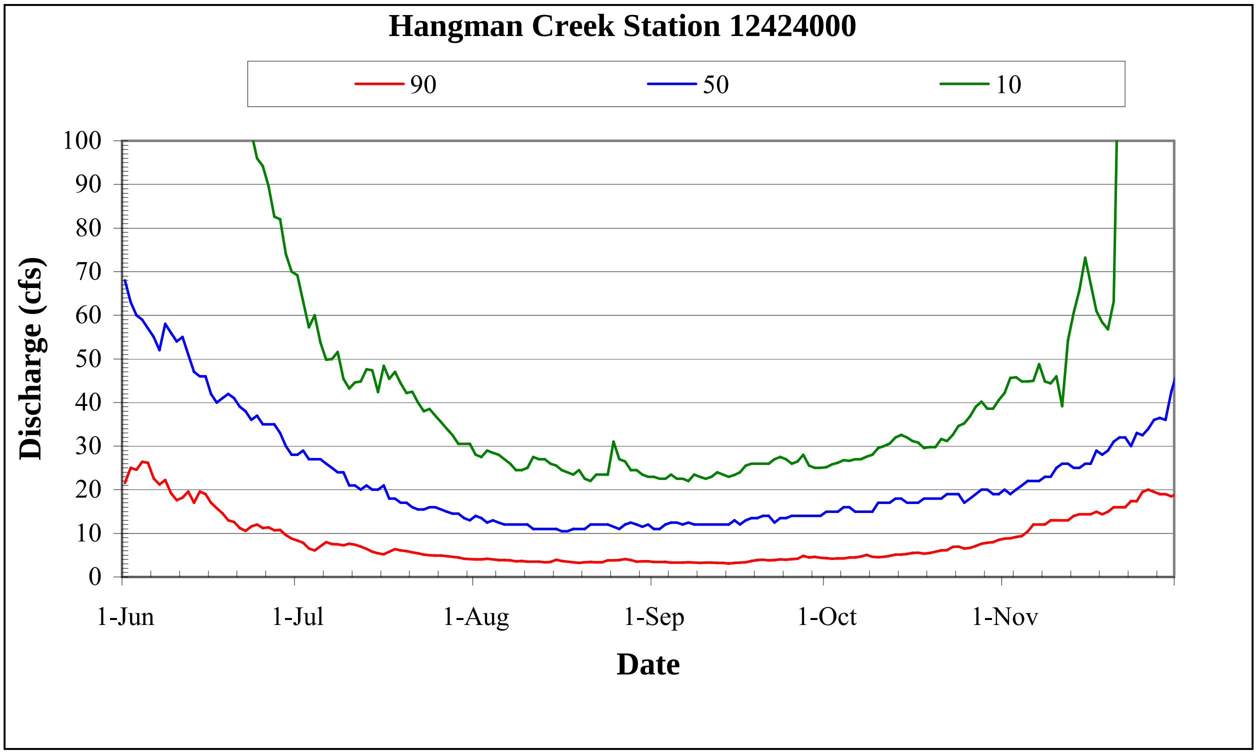

Figure 2: Exceedance Values in Percent During the Low Flow Period

<u>USGS Flood Flow Statistics</u>
The USGS completed flood frequency estimations for Hangman Creek at the mouth in 1998. The magnitude and frequency for various return period interval events are listed in Table 5.

Table 4: Hangman Creek USGS Lowest Mean Flow Non-Exceedance Probabilities

Probability	Recurrence Interval (years)	Lowest Mean Flow for Non-Exceedance Probabilities (cfs)					
		7 Days	14 Days	30 Days	60 Days	90 Days	120 Days
0.50	2	9.2	9.7	10.5	11.8	13.2	14.9
0.20	5	4.5	4.7	5.2	5.9	6.7	8.0
0.10	10	2.9	3.1	3.3	3.8	4.4	5.4
0.05	20	2.0	2.1	2.2	2.5	2.9	3.8
0.02	50	1.3	1.3	1.4	1.3	1.8	2.4
0.01	100	0.9	0.9	1.0	1.1	1.3	1.8

Notes:
1. Flow periods are for the year ending on March 31.
2. Statistics are preliminary computations for gage number 12424000 for years 1949 through 2001.
3. Probabilities based on Log-Pearson III analysis.

USGS Idaho Stations in the Hangman Watershed

The USGS maintained a discharge station on Hangman Creek in Idaho near the Washington State line from January 1981 through September 1982 and from October 1988 through September 1990. The gage was located at latitude 47° 11' 24", longitude 117° 01' 01" Benewah County, Idaho, Hydrologic Unit 17010306. The drainage area for the gage was 125 square miles. The average annual flow for the period of record was 64.7 cfs. The monthly mean of the stream flows are presented in Table 6.

Table 5: Flood Discharges in Cubic Feet per Second

Number of Peaks Used in Analysis	Indicated Exceedance Probabilities (Return Interval in Years)					Maximum Peak Used in Analysis
	0.5 (2)	0.1 (10)	0.04 (25)	0.02 (50)	0.01 (100)	
49	6,510	13,300	16,600	19,000	21,400	20,600

Notes:
1. Data are from the USGS report *Magnitude and Frequency of Floods in Washington, Water-Resources Investigation Report 97-4277.*
2. Prepared in cooperation with the Washington State Departments of Transportation and Ecology.
3. For station number 12424000.

Table 6: Statistics of Monthly Mean Data for Hangman Creek near Tensed, Idaho

	Flow by Month in Cubic Feet per Second											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Mean	1.26	5.41	27.8	148	299	220	123	63.5	71.1	2.18	2.57	0.63

Notes:
1. Station number 12422950 in operation from January 1981 through September 1982 and from October 1988 through September 1990.
2. Gage discontinued in 1988 due to lack of funding.
3. Gage discontinued in 1990 due to severe vandalism.
4. Miscellaneous measurements from September 1990 through 2002.

3.3.2 Spokane County Conservation District

Continuous Recording Discharge Data

The SCCD maintains five continuous discharge stations within the Hangman Creek watershed; the location for each is listed in Table 7. All stations were continuous recording stations. The maximum, minimum, and mean discharge values for each of the sites are shown in Table 8. The SCCD also completed miscellaneous measurements on Hangman Creek from October 1994 through September 1999 in conjunction with several water quality projects. The miscellaneous discharge measurements generally coincided with water quality grab samples.

Seepage Run Discharge Measurements

The SCCD completed 18 water quality measurements on September 5, 2001 and 18 discharges on September 6, 2001 to evaluate the ground water/surface water interactions along Hangman Creek. The measurements, known as a seepage run, provide estimations of the amounts of ground water flow to Hangman Creek and the losses from the surface water in Hangman Creek to the ground water system. Two other seepage runs (without water quality sampling) were conducted on July 18, 2002 and September 4, 2002 at 14 and 10 cfs, respectively. During the September 4, 2002 sampling, a seepage run was also conducted on California Creek.

Table 7: Site Characteristics and Years of Measured Flow for Gaging Sites

Location	Basin Area (square miles)	Approximate Elevation (feet)	Years of Measured Discharge
Hangman Creek near Tekoa	198	2,530	1999-Current
Rattler Run Creek (River Mile 0.1	13.7	2,300	1999-Current
Hangman Creek at Bradshaw Road	278	2,290	1999-Current
Rock Creek (River Mile 0.5)	179	2,010	1999-Current
Hangman Creek near Duncan	514	1,890	1999-Current

Notes:
1. SCCD drainage basin areas from Hangman Creek Watershed Management Plan, December 1994.
2. Elevations from USGS topographic maps.
3. The SCCD measured intermittent flows on Hangman Creek and its tributaries for water quality projects from October 1994 through September 1999.

Table 8: SCCD Summary Discharge Statistics

Parameter		Tekoa	Rattler Run	Bradshaw Road	Rock Creek	Duncan	Marne Bridge
Discharge (cfs)	Minimum	0.00	0.15	0.28	0.06	1.81	3.50
	Maximum	3130	81.8	3156	1900	4600	4370
	Annual Average	72.9	3.02	83.4	50.6	159	178
	Records Rated	Fair	Poor	Fair	Fair	Fair	Fair

Notes:
1. Annual average is the mean of the annual flows for water years 2000 and 2001.
2. Discharge measurements at the Marne Bridge site are from the USGS records for Water Years 2000 and 2002.
3. The annual average results for Tekoa, Rattler Run, Bradshaw Road, Rock Creek, and Duncan were skewed because of missing data.
4. Marne Bridge records rated fair by the USGS.
5. Rattler Run records rated poor based on flow measurement conditions. Rattler Run low flows were influenced by changes in vegetation during the growing season.

The September 6, 2001 seepage run was completed with the lowest flow for the three separate sampling dates (4.3 cfs). The 2001 seepage run shows the largest response to ground water interactions and is probably representative of Hangman Creek low flow hydrologic conditions. The September 6, 2001 sampling indicated that the ground water flow to Hangman Creek increased from zero just upstream of the state line (River Mile 58), to 4.3 cfs at the USGS gage (Station 12424000), but not in a steady manner (Figure 3). The stream flow increased from zero to 0.55 cfs throughout the upper reach of Hangman Creek before decreasing to 0.20 cfs at Keevy Road (River Mile 30). After Keevy Road, the flow increases to 1.7 cfs near Rock Creek. The flow steadily decreased through the lower watershed until Marshall Creek. The flow significantly increases after Marshall Creek to 4.3 cfs at the USGS gage. The discharge measurements for all sampling runs are tabulated in Table 9. Both sampling runs from 2002 show similar responses to the 2001 data (Table 9).

Table 9: Discharge Measurement Statistics for Seepage Run

Site	River Mile	Description	Sept. 6, 2001 Discharge (cfs)	July 18, 2002 Discharge (cfs)	Sept. 4, 2002 Discharge (cfs)
1	54.9	LHC at the State Line	0.23	0.15	0.16
2	54.8	Hangman Creek at Tekoa	0.29	1.48	0.72
3	47.3	Hangman Creek at Latah	0.55	2.19	1.21
4	47.2	Cove Creek at Latah	0.07	0.18	0.11
5	41.5	HC at Roberts Road	0.62	2.99	1.66
6	32.9	Rattler Run Creek	0.08	0.23	0.15
7	32.8	HC d/s Rattler Run Creek	0.59	3.75	1.43
7A	31.0	HC at Kentuck Trails Rd	NA	3.32	1.10
8	29.4	HC at Keevy Road	0.35	3.07	0.93
9	21.0	HC u/s of Rock Creek	1.62	5.62	2.31
10	20.2	Rock Creek	0.41	1.33	0.74
11	18.8	HC at Duncan	1.77	5.73	2.47
12	18.3	California Creek	0.04	0.59	0.12
13	13.5	HC d/s Hangman Valley Golf Course	1.42	7.07	3.72
14	10.2	HC two miles south of Hatch Road	1.33	8.21	2.80
15	8.8	HC at Yellowstone pipeline	1.33	8.85	2.40
16	4.6	HC u/s Marshall Creek	1.20	9.76	3.47
17	4.5	Marshall Creek	0.60	0.98	1.74
18	0.8	USGS gage site	4.30	14.0	10.0

Notes:

1. River miles are for main stem Hangman Creek only, and are measured from the mouth of Hangman Creek (RM 0.0) upstream. Measurements are from USGS 7.5 minute topographic maps.
2. No discharge was measured at the USGS site, the USGS rated flow was used.
3. LHC is Little Hangman Creek.
4. HC is Hangman Creek.
5. u/s is upstream.
6. d/s is downstream.
7. NA is not applicable.
8. cfs is cubic feet per second.

The stream flow measured during the seepage run is the total measured flow (which includes the ground water and surface tributary flow to Hangman Creek). To better understand the interaction of the ground water along the mainstem, the surface water flow from the tributaries was subtracted from the total flow for each mainstem station. The total measured flow along the main stem is compared to the ground water component of flow in Figure 4. Although the graph trends are similar, the graphs do differ below Rock Creek. Rock Creek increases the total measured flow at the first measurement site downstream, but this apparent increase in Hangman Creek flow is not from groundwater. The ground water component graph indicates that the stream reach immediately downstream from Rock Creek is losing water to the ground water system.

Overall, the seepage runs conducted by the SCCD illustrates that during low flow conditions, the flow in most of Hangman Creek is significantly less than the flow measured by the USGS at station 12424000. The seepage runs also demonstrate that significant reaches of Hangman Creek lose water to the ground water system. The flows in the upper watershed ranged from 6.7 percent (at Tekoa) to 41.2 percent (at Duncan) of the measured USGS flow.

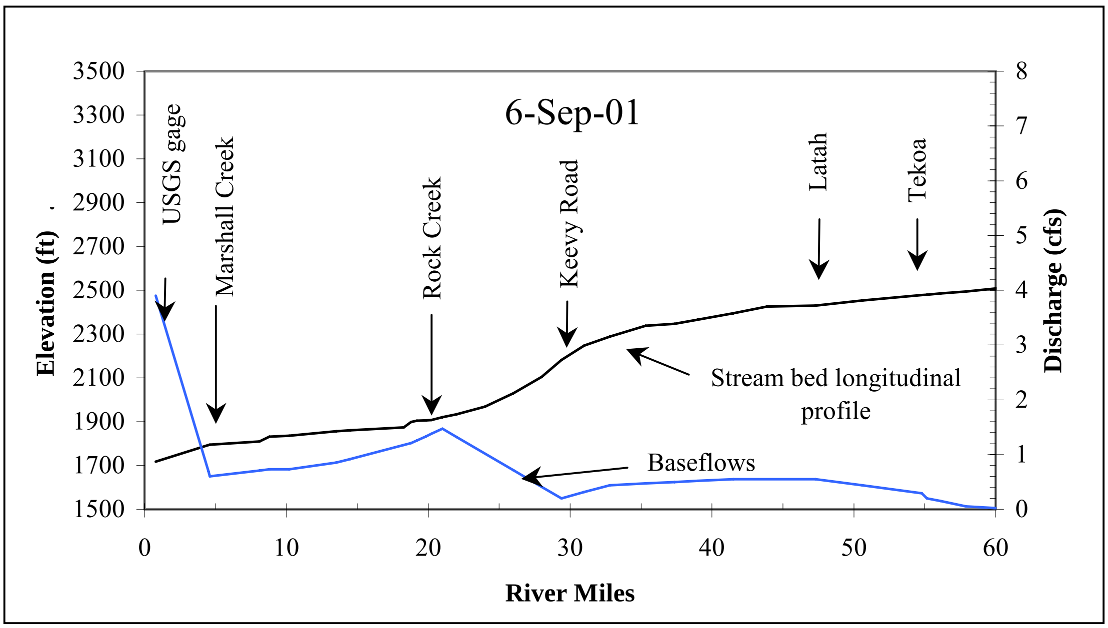

Figure 3: Ground Water Flow to Hangman Creek and Stream Longitudinal Profile

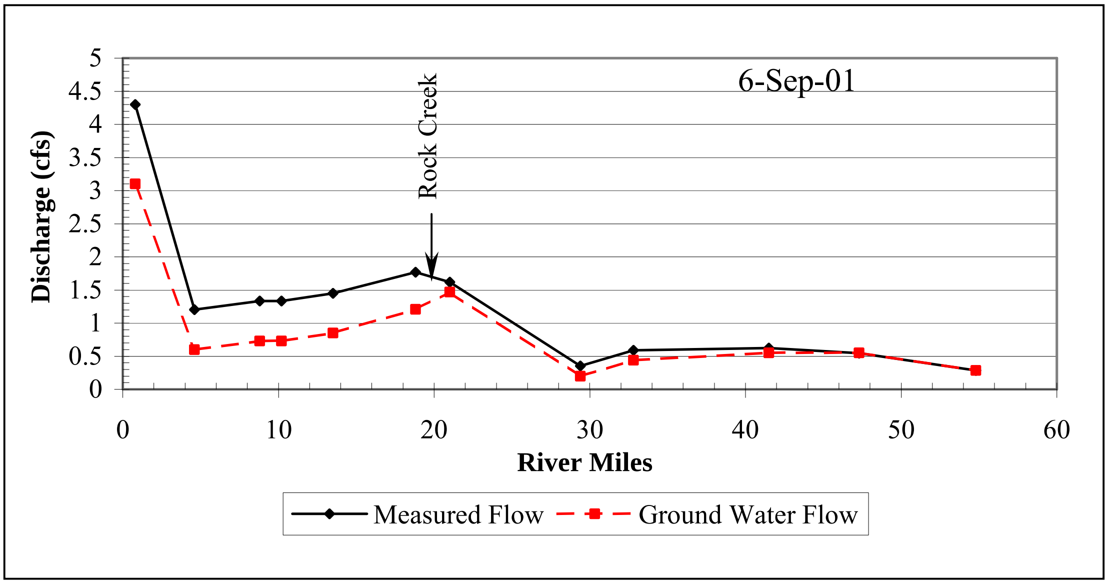

Figure 4: Hangman Creek Measured Stream Flow Compared to Ground Water Flow

3.3.3 Washington State Department of Ecology

The Washington State Department of Ecology has completed water quality sampling at both the mouth and near Bradshaw Road. Although the samples at the mouth have flow data listed, the discharge was not measured during the sampling. The rated discharge from the USGS gaging station was used. No other discharge records by Ecology were found for Hangman Creek.

3.4 Additional Studies

3.4.1 Pre-Development Base Flow Estimation

A pre-development base flow estimation was completed by the SCCD. This study evaluates the maximum historic flow that may have occurred during summer conditions. The pre-development estimation was based on September 6, 2001 flow measurements and watershed responses. This evaluation was completed to provide an upper summer time flow limit for the watershed. The estimation provides support for other work estimating pre-development stream flow detailed below in Section 4.2.2. The estimations used in this section are based flow measurements conducted on September 6, 2001for during a seepage run.

It is assumed that the climatic conditions that have existed for the past 50 years are similar to what existed prior to significant settlement and development. The summer conditions were hot and dry with little precipitation. These conditions provided extended periods in July, August, and September where the ground water base flow provided a majority of the flow in Hangman Creek. Native plant communities were significantly different based on early accounts and published Bureau of Land Management section line survey journals (see Section 4.2.2). Prior to settlement, the watershed was probably a mosaic of shrub/steppe and forest habitats. The habitats were intermixed based on aspect, elevation, and soil features, but covered a greater percentage of the watershed area than is seen today. Although differences in vegetation types, evapotranspiration rates, and coverage areas may be significant to historic stream flow estimations, they were not used in this evaluation (see Section 4.2.2).

The approximation summarized in this section uses measured flow from tributaries and estimates the tributary base flow in cubic feet per second per square mile (cfs/mi^2). The tributary data are then extrapolated for the entire watershed. The watershed was broken into two areas based on the results from the September 6, 2001 measurements. The first area is the majority of the watershed upstream of Marshall Creek, and the second area is Marshall Creek and Hangman Creek below the confluence of Marshall Creek. The reason for the split is the significant increase in flow from the ground water found downstream of Marshall Creek.

Area-1, Upstream of Marshall Creek

The highest expected base flow for the Hangman Creek watershed was estimated by applying the environmental conditions found at Indian Creek in Idaho. These conditions were applied uniformly for Area-1 of the watershed. Indian Creek is considered to be one of the more undisturbed sub-watersheds within the Hangman Creek basin, and because of this, the base flow for Area-1 was estimated using the base flow discharge from Indian Creek. The base flow discharge is the discharge divided by the basin area, or discharge in cfs per square mile. The base flow discharge from Indian Creek was multiplied by the number of square miles in Area-1 to estimate the Area-1 base flow. Several of the other tributaries (Table 10) were also evaluated for use in estimating the pre-development base flow, but no other sub-watersheds were found that provide watershed characteristics that are not heavily influenced by development and changes in the vegetative cover.

If the entire Hangman Creek watershed was similar in physical and vegetative character to the Indian Creek sub-watershed, and received the same amount of precipitation, the expected stream flow just above Marshall Creek would be approximately 16.5 cfs. This would be the maximum base flow expected under ideal conditions. This represents the probable maximum base flow for pre-development summer conditions.

Table 10: Tributaries Used to Evaluate Pre-Existing Base Flows in Hangman Creek

Stream Name	Area (mi^2)	Base Flow Discharge (cfs)	Unit Base Flow (cfs/mi^2)	Vegetation Coverage (percent)
Indian Creek	3.99	0.11	0.0276	95
California Creek	29.4	0.0423	0.0014	20
Marshall Creek	63.0	0.601	0.0095	45
Rock Creek	179	0.414	0.0023	20

Notes:

1. Basin areas based on NRCS figure provided in the Hangman Creek Watershed Management Plan, 1994.
2. Discharge measurements from September 6th, 2001.
3. Vegetation coverage from ocular estimation of USGS 1:24,000 topographic maps.
4. USGS measured flow was 4.3 cfs at the mouth of Hangman Creek.

Rock and California Creek flows were used as checks on extrapolating existing data. They represent conditions typical to what is found today. Based on the September 6, 2001 measured data, the Rock Creek flow per square mile estimates the flow just above Marshall Creek at approximately 1.37 cfs and the California Creek data estimates the flow at 0.84 cfs. The average of the two estimations is 1.10 cfs, very close to the measured 1.20 cfs flow.

Several of the watershed characteristics for Indian Creek may over or under estimate flow when used as an estimator for the larger Hangman Creek watershed. Table 11 contains a list of watershed characteristics and the probable effect on the estimated Hangman Creek pre-development base flow.

<u>Area-2, Marshall Creek to the Spokane River</u>

The lower area (approximately five miles) from Marshall Creek to the confluence with the Spokane River had the largest increase in flow on September 6, 2001. The increase in flow is due to both the flow from Marshall Creek and several large springs along Hangman Creek downstream from Marshall Creek. The flow just below the confluence of Hangman and Marshall Creeks was 1.80 cfs, and it increased to 4.30 cfs at the USGS gage. This represented the largest increase (2.5 cfs) and more than doubled the flow in Hangman Creek.

Table 11: Indian Creek Characteristics and Probable Effect on Estimated Flows

Watershed Characteristic	Hangman Estimation	Estimated Importance	Comments
Precipitation	Over	Major	Probably higher and more as snow
Elevation	Over	Moderate	Increases precipitation, cooler spring temperatures
Slope	Under	Moderate	Moves ground water to stream faster
Vegetation	Over	Major	Slows snow melt in spring, snow lasts longer into summer, cooler temperatures, but more interception and ET losses
Soils	Under	Moderate	Smaller basin may have less storage
Aspect	Neutral	Minor	Indian Creek trends north-northeast, Hangman trends north-northwest

To estimate the pre-development Marshall Creek flow, an average of the Indian Creek and Marshall Creek base flow discharges per square mile was used ([0.0276+0.0095]/2= 0.01855, Table 10). The base flow discharge per square mile (0.01855 cfs/mi^2) was multiplied by the basin area (63.1 mi^2). The estimated pre-development Marshall Creek flow is approximately 1.17 cfs.

The Hangman Creek base flow for the reach from Marshall Creek to the USGS gage was adjusted for the estimated higher ground water discharge rates and added to the Marshall Creek flow. The discharge per square mile for Indian Creek is approximately three times the discharge per square mile for Marshall Creek, therefore the September 6, 2001 Hangman Creek base flow from Marshall to the USGS gage was multiplied by three to adjust for pre-development conditions (2.5 cfs x 3 = 7.5 cfs estimated base flow to Hangman Creek). The estimated Hangman Creek base flow from Marshall Creek to the USGS gage would be approximately 7.50 cfs. The total discharge for Area-2 is approximately 8.67 cfs (1.17 cfs from Marshall Creek and 7.50 cfs from base flow).

<u>Estimated Pre-Development Low Flow Discharge at the USGS Gage</u>

The total probable maximum base flow discharge at the USGS gage site for pre-development conditions is approximately 25.2 cfs. The total pre-development maximum base flow discharge includes the estimated 16.5 cfs from Area-1 above Marshall Creek, the estimated 1.17 cfs from Marshall Creek, and the estimated 7.50 cfs from the adjusted base flow from Marshall Creek to the USGS gage site.

This estimation is based on uniform conditions throughout the Hangman Creek watershed similar to what is found today at Indian Creek in Idaho. It is unlikely that these uniform conditions existed, and this study only provides a maximum limit for estimating the historic summer low flows. Because of the variability in watershed conditions outlined in Table 11, the most likely historic summer low flows were probably significantly less than estimated by this procedure. This procedure was intended to provide an upper bracket for evaluating historic summer flow conditions using other methods.

3.4.2 Geologic Mapping of the Flood Hazard Management Area

Partial funding for the surficial geologic mapping of Hangman Creek was provided to the Department of Natural Resources. Hangman Creek was mapped between the confluences of the Spokane River and Rock Creek by Hamilton, Stradling, and Derkey, 2001. Hamilton, Stradling, and Derkey (2001) found that the Hangman Creek valley has experienced accelerated erosion and slope instability over the past several decades. They found three major factors that have contributed to the accelerated erosion and slope instability:

- Excavation of land causing slope instabilities and accelerated or redirected water runoff
- Additional surface water due to irrigation
- Rechanneling of Hangman Creek due to road construction (US 195)

Hamilton, Stradling, and Derkey (2001) state the removal of vegetation and rechanneling of Hangman Creek during the construction of U.S. 195 has left the valley unstable. They also mapped several silt/clay layers that act as barriers locally to water infiltrating from the surface. They found that the water tends to flow horizontally where it further reduces slope stability.

The initial focus of the mapping was to define the nature and extent of glacial flood deposits that comprise the Spokane Valley-Rathdrum Prairie Aquifer. Along with the flood deposits and surficial geology, Hamilton, Stradling, and Derkey (2001) inferred and mapped the Latah fault. The fault was mapped for the first time trending generally northwest to southeast along the trend of the main stem of Hangman Creek (Appendix G).

3.5 General Water Quantity Assessment and Water Balance Development

The water balance development was completed by Dr. John Buchanan, Professor of Geology, Eastern Washington University. The purpose of the data collection and assessment phase of this study was to establish a general water balance for the Hangman Creek watershed. The water balance was considered to "model" the flow in Hangman Creek on an annual basis. Ground water and surface water interaction were also examined during the critical flow period (July, August, and September). The study area included all of the land within the watershed.

The specific tasks/objectives in the scope of work were:

1. Delineation of watershed boundaries used for the water balance calculations
2. Determine ground water flow within and leaving the basin
3. Estimate direct recharge from precipitation
4. Determine the impact of irrigation on ground water recharge
5. Evaluate the potential for numerical modeling of the study area

3.5.1 Watershed Boundaries

The Hangman Creek watershed was divided into five smaller sub-watersheds (Figure 5). Three of the sub-watersheds are the major tributary basins of Rock Creek, California Creek, and Marshall Creek. The other two sub-basins are the Upper Hangman Creek sub-watershed above the confluence with California Creek and the Lower Hangman sub-watershed below California Creek. The sub-watersheds from largest in area to smallest are shown in Table 12.

Table 12: Hangman Creek Sub-Watershed Areas

Sub-Watershed	Area (square miles)	Area (acres)
Upper Hangman	334.9	214,383
Rock Creek	179.0	114,589
Lower Hangman	71.8	45,947
Marshall	63.1	40,359
California Creek	24.9	15,942

3.5.2 Ground Water Flow Dynamics

Ground water flow within and leaving the Hangman Creek watershed is dependent on the aquifer type and material. An unconfined aquifer exists in the lower portions of the Hangman Creek watershed, below Rock Creek. In the upper portions of the watershed, the main aquifer is contained in the Columbia River Basalts. These are multiple layers of stacked confined or semi-confined aquifers with limited recharge (Buchanan and Brown, 2003).

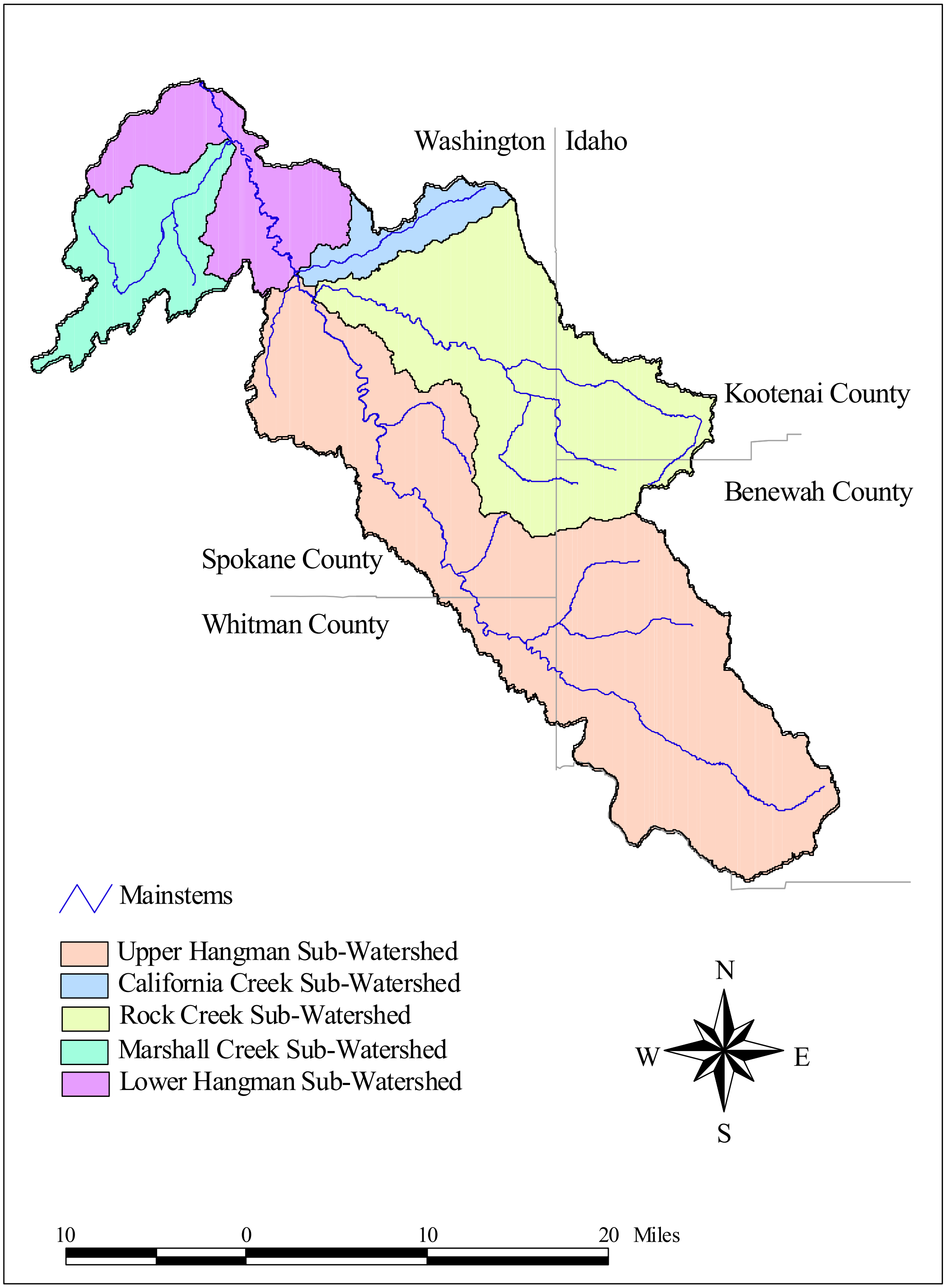

Figure 5: Hangman Creek Sub-Watersheds

In the lower portion of the Hangman Creek watershed, the unconfined aquifer exists in the sand and gravel deposits. The water table is in direct communication with Hangman Creek, and seismic reflection work done by Buchanan and McMillan (1997) suggests that the saturated thickness is more than 350 feet.

For the lower portion of the Hangman Creek watershed, Buchanan and McMillan (1997) estimated the ground water flow from the Hangman Creek watershed to be 12.7 cfs. Of that 12.7 cfs, they found that 6.6 cfs is from the Marshall Creek sub-watershed. Therefore, 12.7 cfs of ground water flow is occurring from Hangman valley to the lower Spokane aquifer (Buchanan and Brown, 2003). This 12.7 cfs is considered underflow from the basin and is not accounted for by the USGS gage at the mouth of Hangman Creek.

In the upper Hangman Creek watershed, the most prolific and important aquifer is contained within the Columbia River Basalts (Buchanan and Brown, 2003). Most ground water occurs within the vesicular zone at the top of a single basalt layer or flow. The potential yield of ground water from aquifers in the Columbia River Basalts ranges from 0.02 to 40.9 cfs (14.5 to 29,600 ac-ft/yr). Recharge to these aquifers is by either percolating downward through the vertical columnar jointing or by lateral ground water movement (Buchanan and Brown, 2003).

Occurrence and movement of ground water in the Columbia River Basalt hydro-stratigraphic units has been described regionally by Drost and Whiteman (1986). Within the Columbia River Basalts, the Grande Ronde flow forms the deepest hydrostratigraphic unit. Aquifers in the Grande Ronde unit are mostly confined. The uppermost significant water-bearing basalt aquifer is the Wanapum flow, and in many places in the watershed this flow crops out on the land surface or is covered by a thin veneer of soil, alluvium, or the Palouse Formation (Buchanan and Brown, 2003). The Wanapum hydrostratigraphic unit is responsible for flow to the small springs that occur naturally in the upper watershed. Generally, ground water flow is toward the main Hangman Creek valley, though it does not discharge to the stream itself (Buchanan and Brown, 2003). The ground water surface is graded toward the main stream valleys, but lies at a depth of more than 80 feet below the land surface in the upper part of the watershed (above the confluence of California Creek). Buchanan and Brown (2003) believe that the ground water in the basalt system is discharging to an underlying structure, either a suspected fault or a buried linear structure. The buried structure may convey the ground water to deeper strata or towards the north-northwest where it may eventually discharge into the alluvial reach in the lower Hangman sub-basin (Buchanan and Brown, 2003).

3.5.3 Direct Recharge Estimations

Direct recharge estimations, or infiltration estimates were supplied by Buchanan and Brown (2003) from previous regional work. The works cited by Buchanan and Brown (2003) were from studies done in the Idaho portion of the Hangman watershed (Ko and others, 1974) and from recent work in the Colville watershed (Kahle and others, 2002).

The Idaho study, by Ko and others (1974), concluded that only approximately 1.5 percent of precipitation infiltrated to recharge the aquifer in the area corresponding to the Upper Hangman sub-watershed. The study in the Colville watershed, by Kahle and others (2002), yielded similar results to the work done by Ko in 1974, according to Buchanan and Brown (2003). Kahle found that ground water flow comprises only about one percent of precipitation in their water budget.

To estimate the amount of precipitation that recharges the Hangman Creek aquifers, the recharge was considered to be a combination of the ground water underflow leaving the basin (12.7 cfs, see Section 3.5.2) and the base flow component of the surface water flow measured at the USGS gage. The base flow is the sustained or fair-weather flow of a stream that comes from ground water or spring contributions. The annual average base flow was estimated using the annual hydrograph (see below), and that amount was added to the ground water underflow out of the basin to estimate the total amount of water that infiltrated to the aquifers.

To estimate the average annual base flow for Hangman Creek, the annual hydrograph from Water Year 2001 was used. Water Year 2001 was used because it was a relatively low flow water year (83.7 cfs average annual flow versus the long term average annual flow of 235 cfs). A low flow water year was used to better separate the base flows from the storm hydrographs. After graphing the daily average flows for the water year, the storm hydrographs generally did not have complete recessional limbs. Because of this, it was not possible to separate the base flow for each storm event. A single base flow separation was done for the winter storm period based on projecting the fall base flow forward under the storm peaks and projecting the summer base flows back under the storm peaks (see Figure 6). The base flow was estimated by linearly extrapolating from day 125 (February 1, 2001, 48 cfs) to the base flow peak at day 192 (April 10, 2001, 62 cfs) and then back to day 243 (May 31, 2001, 38 cfs). For all other days the base flow was assumed to be equal to the recorded stream flow. The corrected daily average base flows for the water year were summed and divided by 365 to get an estimated average annual base flow of 33.7 cfs.

The estimated annual average base flow (33.7 cfs) was added to the 12.7 cfs ground water underflow out of the Hangman Creek watershed for a total ground water flow from infiltration of 46.4 cfs. This is equivalent to approximately 33,592 ac-ft per year. The final percentage of precipitation that infiltrates was estimated by dividing the total ground water flow (33,592 ac-ft/yr) by the total precipitated water (738,670 ac-ft/yr), or 4.5 percent of the precipitation infiltrates to the ground water system (Table 13).

3.5.4 Irrigation Impacts on Ground Water Recharge

Irrigation water rights and their impacts on the ground water system were evaluated by Buchanan and Brown (2003). They utilized the Washington State Department of Ecology's Water Right Tracking System and the Idaho Department of Water Resources databases to tabulate data on the basin water rights.

Buchanan and Brown (2003) found that the majority of water rights in the Hangman Creek watershed are ground water allocations (80 percent of all water use). They found that 16 percent of water use is derived from surface water rights, three percent from springs, and one percent from miscellaneous sources.

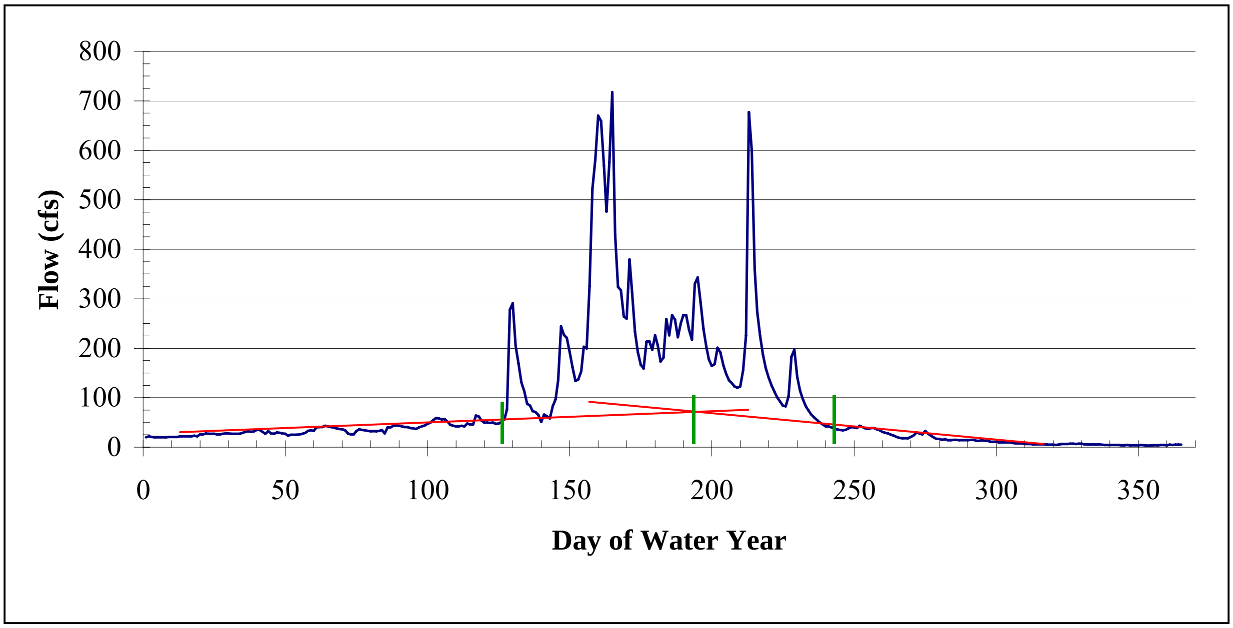

Figure 6: Hangman Creek Water Year 2001 Base Flow Separation Graph

Table 13: Available Sub-Watershed Precipitation and Infiltration

Sub-Watershed	Watershed Area (acres)	Precipitation		Evapotranspiration		Estimated Infiltration	
		(inches)	(ac-ft/yr)	(inches)	(ac-ft/yr)	(inches)	(ac-ft/yr)
Upper Hangman	214,383	22.3	398,395	14.9	266,192	1.01	18,119
Rock Creek	114,589	19.6	187,162	14.7	140,371	0.89	8,511
Lower Hangman	45,947	17.8	68,155	15.9	60,880	0.81	3,099
Marshall Creek	40,359	17.4	58,521	15.6	52,467	0.79	2,661
California Creek	15,942	19.9	26,437	19.5	25,906	0.90	1,202
Total Watershed	431,220	20.6	738,670	15.2	545,816	0.93	33,592

Notes:
1. Water balance surplus is precipitation minus the evapotranspiration, or 738,670 ac-ft/yr – 545,816 ac-ft/yr = 192,854 ac-ft/yr.
2. Watershed areas, precipitation, and boundaries are from Buchanan and Brown (2003).
3. Estimated infiltration rate is 4.5 percent.
4. ac-ft/yr is acre feet per year.
5. Infiltration values include both ground water underflow from the basin (12.7 cfs) and baseflow estimated using the USGS gage Station Number 12424000 (33.7 cfs).

Buchanan and Brown (2003) used GIS land use coverage to assess the potential irrigated acreage for each sub-watershed. Based on land use, they found approximately 6,194 acres were subject to irrigation. In addition to natural precipitation, Buchanan and Brown (2003) used the amount of water required by a crop for growth, (known as the crop irrigation requirement (CIR) to estimate irrigation requirements. The CIR used was 1.6 feet of water per acre. The volume of water necessary for crop growth is the product of the CIR and the area of the irrigated land. For the Hangman watershed, they found the amount of water required for irrigation to be 9,910 acre-feet (Table 14).

Table 14: Irrigation Water Rights Summary

Sub-Watershed	Irrigated Area (acres)	Annual Crop Irrigation Requirements (ac-ft/yr)	Irrigation Water Rights from Ground Water (ac-ft/yr)	Potential Recharge due to Over Irrigation (ac-ft/yr)
Upper Hangman	922	1,475	3,723	931
Rock Creek	419	670	2,617	654
Lower Hangman	232	371	5,236	1,309
Marshall Creek	3,180	5,088	3,039	760
California Creek	1,441	2,306	558	139
Total Watershed	6,194	9,910	15,173	3,793

Notes:

1. Crop irrigation requirements value of 1.6 feet per acre and irrigated areas for each sub-watershed are from Buchanan and Brown (2003).
2. Irrigation water rights from ground water are Ecology certificated water rights and Idaho statutory claims, decrees, and licenses.
3. Infiltration and direct recharge estimations based on 4.5 percent of precipitation infiltrating into each sub-watershed (see Section 3.6.4).
4. ac-ft/yr is acre-feet per year.
5. The potential over irrigation is estimated as 25 percent of the water rights from ground water.

Buchanan and Brown (2003) state that water appropriations in the Hangman Creek watershed have the potential to impact stream flows during the summer months, especially in the Lower Hangman and Marshall Creek sub-watersheds. They found a high potential for ground water mining, particularly in the California Creek and Marshall Creek sub-watersheds where water right allocations from ground water greatly exceed the recharge rate (Tables 16 and 17). They further suggest that pumping in these two sub-watersheds can affect stream flows, particularly in the summer months when streams are low and the irrigation and water demand is at a peak.

The ground water mining that may be occurring is mostly in the deeper basalt aquifers. Locally, irrigation supplied from deep aquifers may be recharging shallow unconsolidated aquifers more directly connected to Hangman Creek. Based on the number of irrigated acres and the CIR from Buchanan and Brown (2003), if the excess water that infiltrates to the shallow unconfined aquifer is approximately 25 percent of the pumped amount, then the amount that could infiltrate is approximately 3,793 ac-ft/yr. If the estimated irrigation use is fully used, then the recharge would be equivalent to approximately 5.2 cfs.

The results presented by both Buchanan and Brown (2003) assumes that all the water that is certificated is being fully used. Because of the high summer irrigation rates estimated (15,173 ac-ft/yr or 20.9 cfs (Table 14)), the results would suggest that not all the irrigation water is currently being used. Also, the results in Table 14 are only for irrigation ground water use. Other ground water uses could exacerbate any ground water mining that may occur. For the lower Hangman, Marshall, and California Creek sub-watersheds this could present a ground water mining problem. For the Rock Creek and upper Hangman Creek sub-watersheds, additional pumping will probably not be a problem on a sub-watershed wide scale.

3.5.5 Numerical Modeling

The numerical modeling potential for the Hangman Creek watershed was evaluated by Buchanan and Brown (2003). The following is an excerpt from their report.

Evaluation of Potential for Numerical Modeling

Software exists today that enables scientists and land managers to simulate the hydrologic cycle, and its component parts, within an entire watershed. A well implemented watershed model can be used to identify the important data needs within a basin and guide future research, as well as serve as a predictive tool to anticipate potential impacts in the basin under various land use scenarios.

Watershed modeling software exists in the public domain (free) and is available from the U.S. Geological Survey, the Environmental Protection Agency, or the U.S. Army Corps of Engineers, or it is commercially available for a licensing fee. All modeling software requires comprehensive datasets representing information for each component of the hydrologic and physical system, at the appropriate resolution, in the proper format, and usually as a time series to enable transient simulations.

Numerical modeling is typically very expensive and highly time consuming. Commercial software tends to cost several thousand dollars to license, and that fee does not include the added costs for training personnel to use the software, the time devoted to data entry, and the time for model calibration/verification and subsequent execution.

The latter aspect of modeling is typically underappreciated. All numerical models have to be calibrated and verified against field data to demonstrate their accuracy, prior to using the model as a tool to predict various scenarios and outcomes. In order to achieve this important goal, datasets have to span years of time (typically a minimum of 3 to 10 years) so that the model can be calibrated using one subset of the temporal data, and then verified against a second (separate) interval of time.

It is important that before any attempt is made to construct a watershed model of WRIA 56 there should be a consensus among all those involved in the planning process to clearly and specifically identify the primary purpose and objectives of the undertaking. The selection of the actual modeling code or software will depend on the expectations established by the planning process.

Numerous public domain codes exist for simple runoff and infiltration modeling. The models described there are not to be applied to an entire watershed, but rather to determine field values of runoff or infiltration on a local scale given the proper inputs. These models are free, are somewhat simple to operate, and can be instructive in understanding the hydrologic processes at work in various parts of a watershed.

However, more robust applications are required for full numerical modeling of a watershed system. The tool of choice being utilized for WRIA 55 and 57 is MIKE SHE, a very comprehensive code that can simulate all components of the hydrologic cycle (Golder Associates Inc., 2001). It appears the implementation for those basins will be achieved given the outstanding set of spatially and temporally distributed data that is available for model input, and the availability of qualified consultants to design and implement the working model. However, for WRIA 56, using that code would not necessarily yield equally reliable results, especially given the limited quantity of data that exists for the Hangman Creek watershed.

Modeling could ultimately be helpful in future water resource management in WRIA 56. A model development project would take at least a year or more in time to formulate the model framework and to calibrate against field data, provided that a comprehensive dataset already exists. The first objective of such a project would be to build the model to represent the hydrologic system as it exists today in the watershed. Once constructed, calibrated and validated, the model may be applied to helping choose among different management schemes as a solution to a particular problem.

Basic data requirements for watershed modeling (from Golder, 2001).

Watershed Geometry

- Boundaries of the watershed and all stream segments in a coordinate system
- Digital elevation model (DEM) of the watershed
- Specific site locations of all data, for example, locations of stream gages, water wells, stream withdrawals, etc.

Ground water

- Aquifer/aquitard properties – hydraulic conductivity, storativity, specific yield, etc
- Locations of ground water withdrawal or recharge
- Locations of water wells or monitoring wells

Soils

- Soil characteristics – profile information from land surface to ground water surface
- Distribution of soil types
- Physical properties of soils – water content, saturated hydraulic conductivity, etc.

Runoff and Overland Flow
- Land use coverage
- DEM data for slope/length information
- Meteorologic data – station data or PRISM data
- Storage sites on surface
- Runoff coefficients
- Flood maps

Channel Flow
- Surveyed river transects
- Manning's n – channel roughness coefficient
- Specific locations for gaining/losing reaches – interaction with ground water
- Specific locations for control structures, water input or abstraction, etc.

Snowmelt
- Climate data
- Temperature data
- Degree-day coefficients

Evapotranspiration
- Pan evaporation data
- Land use and vegetation cover – usually imported from GIS coverage

A working watershed model could explore the potential of gradually increasing ground water pumping in the select parts of the basin, and to predict whether it may eventually have an impact on stream flows. The model may also be used as a guide to further research, for example, in understanding the coupling of various stream reaches with the underlying ground water system. Short-term and long-term climatic cycles could also be simulated as more information becomes available in the Pacific Northwest region, with simulated stream hydrographs as the model output. Lastly, historical conditions in the watershed could be simulated in the model, prior to major land use modifications, in order to contrast the present day hydrology with that of the past.

3.6 Water Use Estimates

3.6.1 United States Geological Survey Estimates

The USGS conducted water use estimations for each WRIA in the state by conducting surveys and estimating water use (Table 15). The surveys were completed in the 1980s and revised in 1995 using population changes. The data are considered provisional by the USGS until it is published.

3.6.2 2000 Census Data Estimates

In addition to the USGS estimation of water use, the residential water use for the watershed was estimated using 2000 census tract information on population and housing units. The census tract information provides an estimation of domestic water use for exempt wells. Along with the census tract data, the City of Spokane and Washington State Department of Health estimates of household water use were used. Different per capita water use numbers were used depending on the location of the household (city versus county, Table 16). The water supplied by the city was also accounted for because it represents a net import of water to the watershed.

Table 15: USGS Water Use Data

	Withdrawal Ground Water (cfs)	Withdrawal Surface Water (cfs)	Consumptive Use (cfs)	Conveyance and Other Losses (cfs)
Total Public Water Supply	20.79	0.00	NA	2.21
Domestic	9.48	0.00	NA	NA
Commercial	6.53	0.00	NA	NA
Industrial	2.57	0.00	NA	NA
Self-Supply				
Domestic	1.56	0.00	1.32	NA
Commercial	1.50	0.00	1.61	NA
Industrial	1.58	6.84	2.2	NA
Livestock				
Stock	0.32	0.00	0.31	NA
Animal Specialties	0.02	0.00	0.02	NA
Irrigation (7,770 acres)	10.43	0.42	10.74	1.01
Mining	0.02	0.00	0.00	NA
Totals	60.51	7.26	16.20	3.22

Notes:

1. Data from USGS web site http://wwwdwatcm.wr.usgs.gov/wuse/main.huc8.95.tst.
2. cfs is cubic feet per second.
3. Public water supply is separated into domestic, commercial, industrial, and losses.
4. Data is provisional and from the USGS 1995 report.
5. NA is not applicable.
6. Public water supply served 49,850 people and self supply served 8,060 people.
7. Wastewater treatment returned 0.74 cfs from 14 facilities, three public and 11 other.

Table 16: Per Household Water Use

Area of Water Use	Indoor Water Use (gallons per day)	Outdoor Water Use (gallons per day)	Total Water Use (gallons per day)
City of Spokane	206	257	463
Spokane County	206	594	800

Notes:
1. City of Spokane data supplied by Reanette Boese, Spokane County.
2. Spokane County water use based on Health Department's estimate of 800 gallons per connection per day of water use.
3. Indoor water use for Spokane County is based on the City of Spokane indoor water use.

To estimate the water use with census tract data, the percentage of the households that are both within WRIA 56 and are supplied by the City of Spokane were estimated for each census tract (Table 17). The Hangman Creek watershed boundary and the city water supply limits were drawn over the census tract maps, and each census tract area adjusted for the percentage in the watershed to estimate the water use (Table 18).

Table 17: Census Tract Data and Area Adjustments

Census Tract or Location	Area in WRIA 56 (percent)	Water Supplied by City (percent)	Area supplied by the City (mi^2)	Population in WRIA 56	Population supplied by the City	Housing Units In WRIA 56	Housing Units supplied by the City
36	44.6	100	0.82	1,840	1,840	1,186	1,186
38	100	100	1.27	1,666	1,666	900	900
39	100	100	3.49	1,811	1,811	966	966
40	91.5	100	0.54	4,672	4,672	2,688	2,688
41	27.9	100	0.12	602	602	315	315
42	97.1	100	1.00	4,757	4,757	1,976	1,976
43	100	100	0.89	3,348	3,348	1,470	1,470
44	56.4	100	0.44	2,431	2,431	1,194	1,194
45	4.04	100	0.04	149	149	64	64
133	53.7	0.0	0.00	1,211	0	432	0
134.01	20.3	0	0.00	829	0	288	0
134.02	58.7	38.8	1.40	1,906	740	702	272
135	97.4	0	0.00	4,882	0	1,877	0
136	100	54.2	6.72	3,217	1,744	1,332	722
137	30.6	68.1	5.73	599	408	209	142
140.01	100	0	0.00	5,373	0	1,943	0
140.02	70.6	0	0.00	2,532	0	986	0
141	14.3	0	0.00	477	0	188	0
142	33.4	0	0.00	820	0	347	0
143P	68.5	0	0.00	977	0	407	0
Whitman County	NA	0	0.00	92^{e}	0	38^{e}	0
Fairfield	NA	0	0.00	494	0	194	0
Latah	NA	0	0.00	151	0	75	0
Rockford	NA	0	0.00	413	0	169	0
Spangle	NA	0	0.00	240	0	113	0
Waverly	NA	0	0.00	121	0	49	0
Tekoa	NA	0	0.00	826	0	363	0
Idaho	NA	0	0.00	$2{,}518^{e}$	0	$1{,}173^{e}$	0

Notes:
1. City is the City of Spokane.
2. e is estimated, based on 2000 census data.
3. Whitman County populations estimated using population densities from census tract 143.
4. Areas for percent in WRIA 56 and water supplied by the city are based on area percentages.
5. Housing units and populations from 2000 census.

Table 18: Estimated Water Use by Housing Units from Census Tract Data

Census Tract or Location	Housing Units in WRIA 56	Housing Units Supplied by City	Estimated Total Water Use based on Housing Units (mgal/yr)	Estimated Housing Units Indoor Water Use (mgal/yr)	Estimated Housing Unit Outdoor Water Use (mgal/yr)	Water Gain (+) or Loss (-) to the Watershed (mgal/yr)
36	1,186	1,186	200.5	89.2	111.2	+27.8
38	900	900	152.1	67.7	84.4	+21.1
39	966	966	163.3	72.7	90.6	+22.7
40	2,688	2,688	454.4	202.2	252.1	+63.0
41	315	315	53.2	23.7	29.5	+7.4
42	1,976	1,976	334.0	148.7	185.3	+46.3
43	1,470	1,470	248.5	110.6	137.9	+34.5
44	1,194	1,194	201.8	89.8	112.0	+28.0
45	64	64	18.7	4.8	13.9	+3.5
133	432	0	126.1	32.5	93.6	-70.2
134.01	288	0	84.1	21.7	62.4	-46.8
134.02	702	272	171.5	52.8	118.7	-63.5
135	1,877	0	548.1	141.2	406.9	-305.1
136	1,332	722	300.2	100.2	199.9	-82.2
137	209	142	43.6	15.7	27.8	-7.6
140.01	1,943	0	567.4	146.2	421.2	-315.9
140.02	986	0	287.9	74.2	213.7	-160.3
141	188	0	54.9	14.1	40.8	-30.6
142	347	0	101.3	26.1	75.2	-56.4
143P	407	0	118.8	30.6	88.2	-66.2
Whitman County	38	0	11.1	2.9	8.2	-6.2
Fairfield	194	0	56.6	14.6	42.1	-31.5
Latah	75	0	21.9	5.6	16.3	-12.2
Rockford	169	0	49.3	12.7	36.6	-27.5
Spangle	113	0	33.0	8.5	24.5	-18.4
Waverly	49	0	14.3	3.7	10.6	-8.0
Tekoa	363	0	106.0	27.3	78.7	-59.0
Idaho	1,173	0	342.5	88.3	254.3	-190.7
Watershed	21,644	11,895	4,865.1	1,628.3	3,236.6	-1,304

Notes:

1. City is the City of Spokane.
2. mgal/yr is million gallons per year.
3. Census tract 143P only includes non-incorporated housing units.
4. Idaho data only includes non-incorporated housing units.

Each housing units supplied by the City of Spokane uses 463 gallons per day, with 206 gallons per day as indoor use and 257 gallons per day for outdoor use (Reanette Boese, personal communication). The Washington State Department of Health's estimation of 800 gallons per connection per day was used for all housing units not supplied by the City of Spokane. For the county, the indoor use was assumed to be the same as the cities. This is approximately 594 gallons per day for outdoor lawn and garden use, reflecting the larger lots available in the county.

Water imported into the watershed by the city water system and used indoors is assumed to be removed from the watershed by the city sewer system. For lawn and garden use, it was assumed that 75 percent of the water applied was lost to evapotranspiration and that 25 percent was returned to the ground water system as over watering (Berg, Byrne, and Rogerson, 1996).

For each rural housing unit in the census tracts and small cities, the total water use, the total indoor water use, the total outdoor lawn and garden use, and the water supplied to the watershed was estimated (Table 18). The outdoor water lost by evapotranspiration from these housing units represent a consumptive loss.

The total estimated residential water use from single-family domestic housing units (Table 18) is 4,865.1 million gallons per year (mgal/yr; equivalent to 20.6 cfs). Of this total, 1,628.3 mgal/yr (6.9 cfs) is indoor use and 3,236.6 mgal/yr (13.7 cfs) is outdoor use. Of the outdoor use, 75 percent, or 2,427.4 mgal/yr (10.3 cfs) is lost as evapotranspiration. The total amount of estimated residential water use by census tract method is higher than the 1995 USGS residential water use estimate, 19.4 cfs versus 11.0 cfs, respectively.

3.6.3 Commercial and Industrial

Commercial and Industrial water use was estimated from Washington and Idaho State water right databases and personal contacts. A list of Washington water purveyors and Class A and B water systems in the Hangman Creek watershed was supplied by the county (Reanette Boese, personal communication). Each system or purveyor was contacted for water use information. The list of contacts and water use results is in Appendix H. Several water users were no longer in business or had connected to city water. Several of the smaller purveyors or water users do not collect water use data.

Although the information is approximate, the contacted commercial and industrial water users data estimate that 1,513 ac-ft/yr (2.09 cfs) of water is used annually. The contacted water users were for systems not supplied with City of Spokane water.

The USGS estimated the Hangman watershed commercial and industrial water use in 1995 at 8,832 ac-ft/yr (12.2 cfs). The USGS water use estimate is higher than the totals estimated using, the Washington and Idaho databases, personal contacts, and the City of Spokane water system.

3.6.4 Agricultural

Agricultural water uses were evaluated by the SCCD as a check on the work done by Buchanan and Brown (2003), see Tables 16 and 17. The SCCD evaluated both the Washington and Idaho water rights databases. Stock watering requests were generally low and the amounts were mostly associated with the irrigated water rights. The USGS estimates the stock water use for the Hangman watershed at 0.34 cfs, or approximately three percent of the 10.85 cfs estimated irrigation use. For the Washington and Idaho water rights databases, the certificated water rights for irrigation alone were 16,108 ac-ft/yr (22.2 cfs), for both irrigation and stock watering they were 2,955 ac-ft/yr (4.08 cfs), and for stock watering alone they were 289 ac-ft/yr (0.40 cfs).

The USGS estimates that there are 7,700 irrigated acres within the watershed. The Washington and Idaho water right databases have 7,117 acres listed for irrigation. Buchanan and Brown (2003) used 1994 GIS coverage supplied by the NRCS and estimated the irrigated acres at 6,194 acres for the entire watershed. These estimates would suggest that the number of irrigated acres is between 6,000 and 8,000 acres, or 1.4 to 1.8 percent of the watershed area.

Using the CIR method outlined by Buchanan and Brown (2003), the estimated volume of water necessary for crop growth is the product of the CIR (1.6 acre feet of precipitation) and the area of the irrigated land (6,000 to 8,000 acres). For the Hangman watershed, the total water needed for irrigation is between 9,600 ac-ft/yr (13.3 cfs) and 12,800 ac-ft/yr (17.6 cfs). Although this is on an annual basis, the irrigation requirements generally take place between June and October during the dry months (122 days). If the 9,600 to 12,800 acre-feet are used during the 122 days, the flow requirements would be between 39.7 cfs and 52.9 cfs.

These results would confirm that most irrigation water is from ground water sources that are not connected to the surface water of Hangman Creek, or that a significant amount of the area identified as irrigated land is not actually being irrigated.

3.7 Water Rights and Claims

A spreadsheet of water right certificates, permits, long form claims, and short form claims was obtained from Ecology. The spreadsheet had approximately 2,868 entries. The list was not checked for duplicate or incomplete entries. The list was sorted into separate groups of certificated water rights, permits, long form claims, and short form claims (Table 19). The certificates, permits and claims were further broken down by location. The water use amounts provided by Ecology (except for long form claims) were converted to equivalent stream flow in cfs. Long form claims were missing information on a significant amount of the entries (see Section 3.7.2 below).

3.7.1 Existing Washington Certificated Water Rights and Permits

Water rights generally are permitted and then certified. A permit is the first step towards securing a perfected (or certificated) water right. Until a water right is perfected, it is conditional (a permit) and the permit allows the construction of the water system and allows the water to be put to use. Water right permits remain in effect until either the water right certificate is issued, or the permit is cancelled. A water right certificate is issued from Ecology when Ecology confirms that the water right being developed under the permit is perfected. A Certificate of Water Right is the final legal record of the water right and is recorded at the county auditor's office.

Table 19: Water Rights, Permits, and Claims Summary

Type of Use		Total Water Certificated, Permitted, or Claimed (ac-ft/yr)			Equivalent Average Streamflow (cfs)		
		Surface	Ground	No Source	Surface	Ground	No Source
Certificated		7,579	27,225	0	10.5	37.6	0
Permits		3	2,278	0	<0.01	3.15	0
Short Form Claim		661	325	5,292	0.91	0.45	7.30
Long Form	Amount Claimed	3,755	36,551	2,248	5.19	50.5	3.10
	Amount Used	3,755	17,957	1,957	5.19	24.8	2.70
Total Certified, Permitted, and Claimed		**11,998**	**66,379**	**7,540**	**16.6**	**91.7**	**10.0**

Notes:
1. The amount used is based on the date of application. This was generally 1970 through 1975.
2. cfs is cubic feet per second.
3. ac-ft/yr is acre feet per year.
4. Short form claims were based on the exempt single family amount of 5,000 gallons per day.
5. No source indicates no source was identified on the claim form.
6. The total certified, permitted, and claimed is the total of all types of use excluding the Long Form amount used values.

The certificated water rights are predominantly for agriculture (irrigation and stock watering), municipal water supplies, and domestic water supplies. The certificated water rights, by location, are provided in Table 20.

Listed agriculture amounts are approximately 15,173 ac-ft/yr (21.0 cfs), municipal water supplies are approximately 10,324 ac-ft/yr (14.3 cfs), and domestic uses are approximately 3,063 ac-ft/yr (4.2 cfs). Other uses such as fish propagation, fire protection, commercial and industrial, recreation and beautification, power generation, and environmental quality totaled approximately 756 ac-ft/yr (1.0 cfs).

Several of the certificated water right database entries did not have any use amounts listed. These entries were generally for irrigation and the water use amounts were estimated using the number of irrigated acres or the instantaneous water use. The estimated water use for the incomplete entries was 5,325 ac-ft/yr (7.4 cfs). There were 35
water rights listed as being changed for a total allocation of 18,998 ac-ft/yr (26.2 cfs).

The changes usually represent a change in the water take point, the use, or a change to the service area listed on the water right. The changes were mostly for municipal water systems (mainly the City of Cheney). A summary of the permits is provided in Table 21.

Table 20: Certificated Water Rights by Location

Water Right Location	Total Use (ac-ft/yr)	Equivalent Average Streamflow (cfs)
Wells	27,225.0	37.61
Hangman Creek	3,619.2	5.00
Unnamed Springs	732.3	1.01
Cheney Sewage Lagoon	628.0	0.87
Marshall Creek	492.9	0.68
Hansen’s Pond	391.6	0.54
Meadow Lake	331.0	0.46
Unnamed Streams	274.6	0.38
Unnamed Ponds	271.6	0.38
Infiltration Trench	254.0	0.35
Stevens Creek	144.5	0.19
Minnie Creek	89.0	0.12
North Fork Hangman Creek	75.0	0.10
Crystal Springs Creek	75.0	0.10
Cove Creek	60.0	0.08
Maple Creek	42.0	0.06
Sump	40.0	0.06
Unnamed Lakes	20.0	0.03
Fish Lake	12.2	0.02
California Creek	12.0	0.02
Spring Creek	4.0	0.01
Rock Creek	3.9	0.01
Willow Springs Creek	2.0	<0.01
Jacob’s Spring	2.0	<0.01
Unnamed Source	1.5	<0.01
Queen Lucas Lake	1.0	<0.01
Garden Springs Creek	Unreported	Unreported
Hangman Watershed	**34,804.3**	**48.08**

Notes:

1. Water rights data are as of 1-23-01. Data obtained from the State Department of Ecology.
2. Water rights with no annual use listed were estimated first by multiplying the number of irrigated acres by three feet of water use. If the number of acres were not available, the total annual use in acre-feet was estimated from water rights in the same basin with similar instantaneous water use.
3. cfs is cubic feet per second.
4. ac-ft/yr is acre feet per year.
5. Garden Springs Creek did not have any information on total water use, instantaneous water use, or acres irrigated.

Table 21: Water Permits by Location

Permits	Total Use (ac-ft/yr)	Equivalent Average Streamflow (cfs)
Wells	2,278.2	3.15
Marshall Creek	Unknown	Unknown
Unnamed Spring	3	<0.01
Hangman Watershed	2,281.2	3.15

Notes:
1. Water permit data are as of 1-23-01. Data obtained from the State Department of Ecology.
2. cfs is cubic feet per second.
3. ac-ft/yr is acre feet per year.
4. Marshall Creek did not have any information on total water use, instantaneous water use, or acres irrigated.

3.7.2 Existing Washington Claims

A water right claim is a statement of claim to a water use that began before the State Water Codes were adopted and is not covered by a permit of certificate. A claim may represent a valid water right if it describes a surface water use that began before 1917 or a ground water use that began before 1945. A water right claim had to be filed with the state during an open filing period designated under RCW 90.14 (the Water Rights Claim Registration Act), or is covered by the ground water exemption. The initial statewide opening for filing water right claims ended June 30, 1974. The registry was opened three more times, with the last opening from September 1, 1997 through June 30, 1998.

There were two types of claim forms, a short form for claims less than 5,000 gallons per day and a long form for all other claims. Short and long form claims were evaluated separately. The current Ecology water right record summary for the Hangman Creek watershed has 1,121 short form claims. All short form claims were tallied and listed by location in Table 22. Short form water use estimations were based on 5,000 gallons per day (5.6 ac-ft/yr or 0.0077 cfs).

The current Ecology water right records summary for WRIA 56 has 1,080 long form claims. Of these, 779 records (72 percent) had no claimed amount of water indicated. The 779 records were checked at the Ecology office using their microfilm files. Of the 779 records, 83 (11 percent) were incomplete and the amount of water claimed could not be determined. Of the remaining 696 records, 573 (82 percent) were claims for less than 5,000 gallons per day, the use amount for a single family domestic exempt well. These claims probably did not need to be filed since they were less than the standard 5,000 gallons per day domestic right. Of the remaining long form claims, several of the larger claims appear to be filled out without any understanding of the quantity of water the claimant requested. For example, one long form claimed 11,520 ac-ft/yr (15.9 cfs), yet the rate of water claimed is only eight gallons per minute (gpm). At a flow rate of eight gpm, the annual water use is only 12.9 ac-ft/yr (0.02 cfs). So either the applicant does not understand the actual flow rate, the total amount of water wanted, or the quantity requested is in units other than the stated acre-feet per year. This applicant is requesting the water for domestic uses and to irrigate one acre. All application claim amounts were assumed to be in acre-feet per year as stated on the application, unless other units were specified.

Table 22: Short Form Claim Locations and Use Amounts

Claim Location	Number of Claims	Total Use (ac-ft/yr)	Equivalent Average Streamflow (cfs)
Source Not Identified	945	5,292.0	7.31
Springs	80	448.0	0.62
Wells	58	324.8	0.45
Unknown Ponds	13	72.8	0.10
Unknown Springs	5	28.0	0.04
Marshall Creek	4	22.4	0.03
Fish Lake	4	22.4	0.03
Unknown Streams	3	16.8	0.02
Mica Creek	2	11.2	0.02
California Creek	1	5.6	0.01
Hobbs Spring	1	5.6	0.01
Hangman Creek	1	5.6	0.01
Muskrat Creek	1	5.6	0.01
Rock Creek	1	5.6	0.01
Stevens Creek	1	5.6	0.01
Unknown Lake	1	5.6	0.01
Hangman Watershed	1,121	6,277.6	8.67

Notes:
1. Water short claim data are as of 1-23-01. Data obtained from the State Department of Ecology.
2. Water claims were estimated as 5,000 gallons per day water use per claim.
3. cfs is cubic feet per second.
4. ac-ft/yr is acre feet per year.

The total annual long form water claimed for Washington portion of the Hangman watershed (including the example 11,520 ac-ft/yr (15.9) cfs detailed above) is 42,554 ac-ft/yr (58.8 cfs). According to the claim forms reviewed, the current use at the time of application was 23,669 ac-ft/yr (32.7 cfs). A summary of the long form identified sources is provided in Table 23, and a summary of the long form clam data is provided in Table 24.

Table 23: Long Form Claim Sources

Claim Location	Number of Claims
Wells	487
Not Identified	422
Unknown Springs	104
Unknown Creeks	19
Ponds	13
Hangman Creek	12
Marshall Creek	5
Sump	5
Fish Lake	3
Minnie Creek	2
Unknown Lakes	2
Hangman Watershed	1,074

Notes:
1. Water long claim data are as of 1-23-01. Data obtained from the State Department of Ecology.
2. Water claims data did not have any water use amounts listed.

Table 24: Long Form Claim Data Summary

	Amount Claimed	Amount Used
Total (ac-ft/yr)	42,554	23,669
Mean (ac-ft/yr)	42.8	23.8
Median (ac-ft/yr)	3.0	2.0
Mode (ac-ft/yr)	2.0	2.0
Minimum Single Claim (ac-ft/yr)	0.01	0.0
Maximum Single Claim (ac-ft/yr)	11,520	8,640
Total (cfs)	56.2	32.7

Notes:
1. Amount used is based on the date of application. This was generally 1970 through 1975.
2. The mean is computed as the sum of all the data values divided by the sample size.
3. The median is the 50th percentile, or the central value of the distribution when the data are ranked in order of magnitude.
4. The mode is the most frequently observed value.
5. Statistic values do not include the records where claim and use amounts could not be determined.

3.7.3 Idaho Water Right Database Summary

The Idaho water right database was evaluated for the Hangman Creek Watershed (Idaho Basin 93). The database has 111 records broken down as follows: four applications, 73 Statutory Claims, Decrees, or Licenses, and 38 permits (of which only two are active). Of the 36 inactive permits, they have either lapsed, been cancelled or relinquished, or are listed as other, such as no point of use was found. Table 25 provides a summary of water rights for the Idaho portion of the Hangman Creek Watershed.

Table 25: Idaho Water Rights Database Summary

Type of Use	Ground Water ac-ft/yr	Ground Water cfs	Surface Water ac-ft/yr	Surface Water cfs	Unknown Source ac-ft/yr	Unknown Source cfs	Total All Sources ac-ft/yr	Total All Sources cfs
Domestic	712	0.98	1,326	1.83	4.2	0.01	2,042	2.82
Municipal	702	0.97	NR	NR	NR	NR	702	0.97
Commercial	14.1	0.02	NR	NR	NR	NR	14.1	0.02
Industrial	7.24	0.01	NR	NR	NR	NR	7.24	0.01
Irrigation	3,818	5.27	46.2	0.06	29.2	0.04	3,893	5.37
Stockwater	NR	NR	125	0.17	1.4	0.00	126	0.17
Other	NR	NR	3.8	0.01	NR	NR	3.8	0.01
Idaho Total	5,253	7.25	1,501	2.04	34.8	0.05	6,788	9.37

Notes:
1. ac-ft/yr is acre feet per year.
2. cfs is cubic feet per second.
3. NR is none recorded.
4. Unknown source was listed as "unknown" in the database source list column.
5. Number of records for Basin 93 (WRIA 56) is 111.

3.7.4 Water Use Estimation for Domestic Exempt Wells

The number of domestic exempt wells was estimated using the housing units in the watershed from the census tract information developed in Section 3.6.1. The total number of Washington housing units from Table 18, not served by a water system (such as the City of Spokane (census tracts 36, 38-45, 134.02, 136, and 137) or Cheney (census tracts 140.01 and 140.02)) were assumed to be the number of domestic exempt wells. After the total number of housing units was estimated for the watershed, known housing units or connections supplied by other water purveyors (Table 26) within the watershed were subtracted.

The total number of Washington housing units in the Hangman Creek watershed that are not supplied by the Cities of Spokane and Cheney is approximately 4,684. The estimated number of Washington housing units supplied by small water purveyors is approximately 565 units. Therefore, the number of Washington housing units in the unincorporated areas of the watershed is approximately 4,119 units. Using the State Department of Health's estimate of 800 gallons per connection per day, this would be an annual water use of approximately 3,691 ac-ft/yr (5.10 cfs). If all the single-family units use the maximum allowable 5,000 gallons per day, the annual water use would be approximately 23,069 ac-ft/yr (31.9 cfs).

3.7.5 Impacts of Peak Use

The peak use is defined as the use that would result if all certificated water rights, permits, and claims were exercised to their fullest extent; along with all domestic exempt wells being pumped at the maximum 5,000 gallons per day. Two peak uses were estimated: 1) an average annual peak use that would result if all uses were consumptive and if all water was used uniformly throughout the year, termed the Average Annual Peak

Use and 2) the most likely peak use that would occur during the summer taking into account seasonal irrigation uses and that a significant portion of the uses are not consumptive, termed the Average Peak Summer Use.

Table 26: Hangman Creek Watershed Small Water System Purveyors

Name of Water Purveyor	Number of Connections
Mullen Hill Terrace	40
Hangman Hills Water District	203
Ridge at Hangman	70
Hayford Village	63
Hidden Hills Estate	15
Marshall Community Water System	30
Patterson Addition Trailer Park	14
Valley of Horses Water District 12	20
Hideaway Trailer Park	60
Hilltop Mobile Home Park	38
Shady Pines Trailer Court	12
Washington State Total	**565**
Tensed, Idaho	58
Worley, Idaho	105
Watershed Total	**728**

Notes:

1. The number of connections for Tensed and Worley, Idaho were estimated using 2000 census data.

The Average Annual Peak Use for the Hangman watershed would happen if all certificated water rights, permits, and claims were exercised to their fullest extent 85,917 ac-ft/yr (119 cfs) from Washington and 6,788 ac-ft/yr (9.38 cfs) from Idaho; along with all domestic exempt wells being pumped at the maximum 5,000 gallons per day (22,857 ac-ft/yr (31.6 cfs)). On an annual basis this would be approximately 115,562 ac-ft/yr (159 cfs). The estimated average annual moisture surplus from the water balance (Table 13) is 192,854 ac-ft/yr (266 cfs). If the estimated ground water underflow out of the Hangman Creek basin remained 12.7 cfs, the average annual flow in Hangman Creek would be reduced to approximately 94.3 cfs (266 cfs – 159 cfs – 12.7 cfs = 93.3 cfs). This would be significantly less than the current average annual surface flow of 235 cfs. This scenario is considered unlikely, but provides some insight if all water presently allocated or claimed was utilized.

An Average Peak Summer Use for the summer irrigation months (June through October) was estimated using the total irrigation water rights, but taking into account that irrigation would return some water back to the ground water system by over watering (25 percent). The total irrigation water rights are approximately 20,704 ac-ft/yr (15,173 ac-ft/yr Washington ground water irrigation from Table 14, 1,638 ac-ft/yr Washington surface water irrigation from Ecology data base, and 3,893 ac-ft/yr from combined Idaho surface and ground water irrigation water rights form Table 25). Along with the over watering (both irrigation and domestic lawn and garden), a portion of the 5,000 gallons per day for indoor household use was also considered non-consumptive. The household water use generally goes to a septic system and then to the ground water system through the drain field. The non-consumptive water uses were adjusted based on the City of Spokane non-consumptive uses (58.4 percent).

The estimated Average Peak Summer Use (June through October) would be equivalent to a flow of approximately 133 cfs through the summer irrigation season. This flow takes into account the seasonal variations of the irrigation water uses and the non-consumptive uses outlined above. Since this is significantly greater than recorded Hangman Creek summer flows, the creek would probably go dry with this amount of use.

3.8 Estimation of Current and Future Water Use Amounts

The Hangman Creek Valley portion within the City of Spokane limits has a varied history of land use and zoning. For the most part, the valley has a history of rural and agricultural uses. The valley has maintained a low key, semi-rural ambiance, despite the fact that a four-lane highway bisects the neighborhood. The northern portion, known as Vinegar Flats, is characterized by smaller urban-size lots with older homes and is interspersed with family gardens, larger field farming, and nursery activities.

The zoning of the valley today reflects historical uses and zoning designations from two major planning activities: the 1983 Land Use Plan and the 1993 Hangman Creek Specific Plan. The major zoning category for the valley is low density residential, which is represented by the CR Zone (country residential), RS Zone (residential suburban), and R1 Zone (one-family residence). The low-density residential zoning ranges from seven housing units per acre down to one housing unit per five acres.

Currently, the valley has large areas zoned for agriculture. However, little of the land zoned for agriculture is actually used for agricultural activities. The Washington State Growth Management Act (GMA) requires that lands designated and zoned for agriculture must contain prime agricultural soils that have long-term commercial significance. Many of the areas zoned for agriculture do not have the required attributes to be designated as agricultural in the City's new comprehensive plan. The areas not meeting the criteria will be designated as low density residential and eventually will probably be zoned R1.

Other zoning categories in the valley include B1 (local business) and B2 (community business). The B1 and B2 zoned areas are primarily historic designations that are not currently used for business. The uses originally included gas stations, small grocery stores, and motels that served the neighborhood and travelers using Inland Empire Way prior to completion of US 195. The Hangman Creek Specific Plan did designate a new B2 zone, which is where the new grocery store, bank, and gas station is located. This land is located between the Cheney-Spokane Road and US 195. No additional commercial areas are expected in the new comprehensive plan.

Overall, land use in the Spokane County portion of Hangman Valley is not expected to change significantly over the next 20 years (SCCD, 2000a). The Hangman Creek watershed, from the Spokane City limits, has historically been used for agriculture and rural residential development. The 1981 Spokane County Generalized Comprehensive Plan designation for the Hangman Valley is Rural. Land uses within the rural designation are intended to be "very large lot residential with agricultural uses or open areas." The maximum net density for residential development is one unit per ten or more acres. The zoning designation that implements the Rural Comprehensive Plan category is General Agriculture.

3.8.1 Current Water Use Estimates

Monthly total instantaneous water use values were developed for each sub-basin. For each sub-basin, the monthly water use was estimated for irrigation, domestic indoor use, domestic irrigation (lawn and garden), commercial/ industrial use, and livestock use.

The irrigation use numbers are from Table 6 in Buchanan and Brown (2003). The domestic indoor and irrigation values are from Table 18 of this report. The census tracts were assigned to one of the sub-basins if the census tract was in two of the sub-basins, the water use was proportioned using the weighted area within each sub-basin. The values (or partial values in split census tracts) for the water use were summed and converted to monthly use.

The commercial/industrial water use is from the USGS values detailed in Table 15 of this report. The total commercial/industrial water use was proportioned to the sub-basins as follows:

Upper Hangman	15 percent
Rock Creek	20 percent
California Creek	5 percent
Marshall Creek	20 percent
Lower Hangman	40percent

The livestock water use values were also from the USGS as detailed in Table 15 and were proportioned as follows:

Upper Hangman	35 percent
Rock Creek	30 percent
California Creek	20 percent
Marshall Creek	10 percent
Lower Hangman	5 percent

Monthly water use estimates by sub-basin are in Table 27. The total current water use for the watershed is estimated to be 38,555 ac-ft/yr (53.2 cfs). Because several census tracts near Spokane actually use water imported to the watershed, the amount of water currently used from the Hangman basin is estimated to be 31,682 c-ft/yr (43.8 cfs).

Table 27: Current Monthly Water Use Estimates

	Monthly Water Use (ac-ft)											
Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper	238	215	238	231	238	964	996	996	964	238	231	238
Rock	247	223	247	239	247	498	515	515	498	247	239	247
Calif.	82	74	82	80	82	252	261	261	252	82	80	82
Marsh	329	297	329	318	329	1659	1714	1714	1659	329	318	451
Lower	714	645	714	691	714	2973	3072	3072	2973	714	691	714
Hangman Total	1611	1455	1611	1559	1611	6346	6557	6557	6346	1611	1559	1733
Qi (ac-ft/day)	52	50	52	52	52	212	212	212	212	52	52	56
Qi (cfs)	26	25	26	26	26	107	107	107	107	26	26	26

Notes:

1. Qi is the instantaneous discharge.
2. ac-ft is acre-feet.
3. cfs is cubic feet per second.

3.8.2 Population Increases and Related Development

Table 28 summarizes past and projected populations for Spokane County, the City of Spokane, and the Hangman Creek area. Overall growth in the city has been approximately 3.5 percent per year with most of this growth being concentrated in certain areas, such as the Hangman Corridor (SCCD, 2000b).

Table 28: Past and Projected Population

	1970	1980	1990	2010
Spokane County	287,487	341,835	361,364	522,022
City of Spokane	170,516	171,300	177,165	189,783
Hangman Creek	2,667	5,957	7,830	12,020

According to the Spokane Regional Transportation Council's (SRTC) report, *Methodology for the Development of 2010 and 2020 Forecast Residential Land Use in Spokane County for Transportation Planning* (SRTC, 1997) the City of Spokane is expected to grow by 54,000 people between the years of 1995 and 2010. This equates to 42.7 percent of regional growth. It is foreseen that the southwest quadrant of Spokane, which contains the project area, will absorb 50 percent of city growth (SRTC, 1997). Most of this growth will occur in the proximity of Hangman Creek, mainly north of Thorpe Road, west of US 195, and between the Cheney-Spokane and Hangman Valley roads (Table 29). City planners have projected the locations of seven areas that will most likely feel the affects of city population expansion; two of these High Growth Areas (HGA) lie within these bounds. The Hangman and Qualchan HGAs are expected to grow by a combined total of 5,262 single-family units, and 2,388 multi-family units, with 270 undeveloped lots remaining (SRTC, 1997). Current City of Spokane population projections and water demands are detailed in Table 30 (Bill Rickard, personal communication).

Table 29: Future Growth for Spokane City High Growth Areas

High Growth Area	Vacant Lots	Single Family Units	Multi-Family Units	Commercial Acres
Hangman Creek	220	2,936	790	None Allowed
Qualchan	50	2,326	1,598	20

Growth in the unincorporated areas of Spokane County, within the project area, is not projected to be significant (SCCD, 2000). Planned Interim Urban Growth Areas (IUGA) and Joint Planning Associations (JPA) are not located in this area.

Table 30: City of Spokane Population and Future Water Use Projections

Development Name (except water use data)	Population (except water use data)		
	1998	2006	2020
Eagle Ridge	355	1,715	7,951
Cedar Hills	NP	150	300
Development above Eagle Ridge	NP	250	1,500
Development below Eagle Ridge	NP	100	150
Mission Springs	NP	600	3,500
Miscellaneous Residential Development	NP	100	800
Projected Water Use (ac-ft/yr)	NA	958	5,180
Projected Water Use (cfs)	NA	1.32	7.15

Notes:
1. Data supplied from the City of Spokane, Environmental Programs.
2. ac-ft/yr is acre feet per year.
3. cfs is cubic feet per second.
4. NP is not provided.
5. NA is not applicable.

Census data for small towns (excluding Cheney) and the southern rural area in the Hangman watershed are outlined in Table 31. For most of the rural towns, the population has remained fairly constant. When totaled, the town populations have decreased approximately 1.4 percent from 1900 to 2000. The only significant increase in population in the last twenty years was in the 1990 to 2000 population for census tract 143P, the southern Spokane County rural (excluding towns) tract. This area increased 79.8 percent in the past ten years from a

1990 population of 1,581 to a 2000 population of 2,842. This increase reflects the increasing trend of single-family homes on small 10+ acre lots south of Spokane.

Water availability for future growth was a factor considered by the PU. A water rights summary for Hangman Washington communities (excluding Spokane) was provided by Ecology (Table 32) along with current annual water use. Using the 2020 population projections, Rockford Latah, Tekoa, and Cheney appear to have adequate water rights for estimated water use through 2020. Waverly, Spangle, and Fairfield should evaluate the population projections used, current water rights, and water systems for future needs.

Table 31: Census Tract Data for the Hangman Watershed (Washington)

Census Tract or Town	1980 Population	1990 Population	2000 Population	Change 1980 to 1990 (percent)	Change 1990 to 2000 (percent)
143P	1,544	1,581	2,842	(+) 2.40	(+) 79.8
Fairfield	582	519	494	(-) 10.8	(-) 4.82
Latah	155	203	151	(+) 31.0	(-) 25.6
Rockford	442	481	413	(+) 8.82	(-) 14.1
Spangle	276	229	240	(-) 17.0	(+) 4.80
Waverly	99	99	121	0.00	(+) 22.2
Tekoa	854	750	826	(-) 12.2	(+) 10.1
Total	3,952	3,862	5,087	(-) 2.28	(+) 31.7
Town Totals	2,408	2,281	2,245	(-) 5.27	(-) 1.58

Notes:

1. Population data from Spokane County 2000 census data.
2. Census tract 143P is the southern rural census tract excluding all towns.
3. Cheney census tract data are not included because of changes in census tract boundaries between 1990 and 2000 census.

3.8.3 Water Conservation and Re-Use Impacts

Water conservation and re-use can have significant impacts on water use amounts both for large purveyors and single-family systems. Efficient water use can have major environmental and economic benefits by improving water quality, quantity, and maintaining aquatic ecosystems.

The number and amount of water utilities across the United States that have a water conservation and reuse program has increased dramatically over the last 10 years (EPA, 2003). In many cities, the programs have increased to include not only residential customers, but commercial, institutional, and industrial customers as well (EPA, 2003). The EPA (2003) has documented several case studies where water savings have generally been between 10 and 20 percent; with Gallitzin, Pennsylvania realizing an 87 percent drop in unaccounted for water and a 59 percent drop in production.

In the Seattle case study presented by the EPA, Seattle's steady growth, dry summers, and lack of long-term storage forced Seattle to choose between reducing use or developing new water sources. Seattle instituted a water conservation program that included a seasonal rate structure, leak reduction, changes to plumbing codes, incentives for water-saving products, and public education. Seattle found that per-capita water consumption dropped by 20 percent in the 1990s. They found that the seasonal rate structure, changes to the plumbing codes, and efficiency improvements were major factors in the success of the program.

Table 32: Small Town Water Rights, Use, and Excess Capacity Summary

City	Water Rights (ac-ft/yr)	Current Annual Water Use (ac-ft/yr)	Current Excess Capacity (ac-ft/yr)	2020 Projected Water Use (ac-ft/yr)	2020 Excess Capacity (ac-ft/yr)
Waverly	52	33.5	18.5	61	(9.0)
Rockford	296	243	53	247	49
Spangle	135	67	68	212	(77)
Latah	100	5.66	94.3	89	11
Tekoa	800	334	466	326	474
Fairfield	208	135	73	261	(53)
Cheney	5,729	1,455	4,274	4,242	1,487

Notes:

1. Projected water use data is from Spokane County Water Quality Program (Reanette Boese, personal communication).
2. Projected water use is without water conservation in place, and is from water system plans and population projections.
3. ac-ft/yr is acre-feet per year.
4. Water right information supplied by the Washington Department of Ecology (Doug Allen, personal communication, 2003).
5. Annual water use for Rockford and Spangle were supplied by the Washington Department of Ecology, water use for Waverly was supplied by Spokane County, and the communities supplied all others.
6. Tekoa projected water use based on City of Tekoa 2020 population estimations.

There are several water saving ideas and programs that could be implemented throughout the Hangman Creek watershed. Below is a recommended list of possible water conservation ideas to save water on a residential, commercial, industrial, and municipal wide basis. Each water system should be evaluated and a program developed to implement the proper water conservation and reuse procedures necessary.

- Public education on water uses and waste.
- Equip homes with high-efficiency plumbing fixtures and appliances. This saves about 30 percent of indoor water use.
- Ensure that utility rate structures encourage water efficiency.
- Increase irrigation efficiencies with incentives for different application nozzles, timers, and distribution systems.
- Make retrofit kits for residences and businesses available free or at cost.
- Promote water efficient landscape practices.
- Educate and involve employers, residents, and school children in water efficiency efforts.
- Repair leaks and implement a water-loss management program
- Use metering to account for water use and waste throughout the water systems.

- Consider a reclaimed wastewater distribution system for non-potable uses.
- Ensure that fire hydrants are tamper proof.
- Offer incentive programs (rebates/tax credits) to homeowners and businesses to encourage replacement of plumbing fixtures and appliances with water-efficient models.
- Conduct water-use audits of homes, businesses, and industries.
- Develop water efficiency plans for each purveyor or town.
- Have all water distribution systems (residential, irrigation, water purveyor, or municipal) in a leak detection and repair program.

Most of the significant water savings outlined above are from repairs to water purveyors systems. Some of the smaller communities may want to consider instituting a plan to prevent shortages in the future. Waverly, Spangle, and Fairfield are projected to not have enough water in 2020 (Table 32).

4.0 PHASE II: WATER QUALITY OPTIONAL ELEMENT

4.1 Existing Data and Studies

Water quality sampling has been conducted by several agencies to evaluate Hangman Creek for violations of Washington State water quality standards or EPA guidelines (Table 33). Violations of the water quality standards may cause a stream or river segment to be listed on the state 303(d) list.

Table 33: Washington Class A and EPA Water Quality Standards

Parameter	Washington Class A Waters	EPA
Temperature (°C)	≤ 18	NA
Dissolved Oxygen (mg/l)	>8.0	>5.0
Fecal Coliform (geometric mean of all samples is less than the stated number of colonies/100ml) (less than 10 % of the samples exceed the stated number of colonies/100ml)	100 200	200 400
pH (units)	6.5-8.5	NA
Turbidity Background <50 NTU Turbidity Background >50 NTU	< 5 NTU increase < 10 % increase	Less than 10 % reduction in depth of photosynthetic zone 1.45 NTU
Total Phosphorus (mg/l)	NA	0.030
Nitrate + Nitrite (mg/l)	NA	0.072
Nitrite (mg/l)	NA	0.06 or 1, see Notes
Ammonia (mg/l)	Varies with Temperature and pH [8,9]	Varies with Temperature and pH [8,9]

Notes:
1. NA is not applicable.
2. NTU is Nephelometric Turbidity Units.
3. The EPA criteria for dissolved oxygen, turbidity, and the lower nitrite standard are the recommended limits for cold water fisheries (1976 Criteria).
4. The EPA criteria for fecal coliform is the recommended limit for swimming and bathing (1976 Criteria).
5. The EPA criteria for total phosphorus is the recommended limit to prevent eutrophication.
6. Ecoregion 10 reference conditions for turbidity, total phosphorus and nitrate + Nitrite are based on the 25th percentile for all seasons (USEPA, 2000).
7. The EPA upper nitrite criteria and nitrate criteria are the recommended limits for drinking water.
8. Ammonia acute criteria shall not exceed a 1-hour average concentration once in every three years calculated as: Maximum = $0.275/(1 + 10^{7.204-pH}) + 39.0/(1 + 10^{pH-7.205})$.
9. Ammonia chronic criteria shall not exceed a four day average concentration once every three years calculated as: Maximum = 0.80/[(FT)(FPH)(RATIO)], where $FT = 10^{[0.03(20-T)]}$ when $0 \le T \le 15$; FT = 1.4 when $15 \le T \le 30$. FPH = 1 when $8 \le pH \le 9$. $FPH = (1+10^{7.4-pH})/1.25$ when $6.5 \le pH \le 8$. RATIO = 13.5 when $7.7 \le pH \le 9$, and $RATIO = [(20.25)10^{7.7-pH}]/(1+ 10^{7.4-pH})$ when $6.5 \le pH \le 7.7$.

To comply with Section 303(d) of the federal Clean Water Act, Washington State must periodically prepare a list of all surface waters in the state for which beneficial uses of the water, such as for drinking, recreation, aquatic habitat, and industrial use, are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Hangman Creek is listed on the 1998 303(d) list for temperature and pH near the mouth in Spokane County, and for dissolved oxygen and fecal coliform bacteria in Whitman County (Figure 7) (Ecology, 2003a).

4.1.1 United States Geological Survey

The USGS has collected miscellaneous surface water quality samples at two areas, one near the mouth of Hangman Creek and the second at a station near the Stateline. Along with the miscellaneous surface water samples, the USGS has collected sediment samples, ground water samples, and suspended sediments at the gage near the mouth (Station 12424000). The suspended sediment results are published in the USGS annual Water Resources Data for Washington reports. The other miscellaneous sampling results are available from the USGS web site: http://waterdata.usgs.gov/wa/nwis/qwdata.

The Hangman Creek water samples from near Tensed, Idaho, were collected from September 1976 through May 1989. The samples were field data that consisted of air and water temperature and conductivity. Of the 35 samples collected, eight exceeded the Ecology standard of 18 ºC, with the maximum value at 27.0 ºC on August 10, 1981.

Hangman Creek near Station 12424000 was sampled at three different locations, Hangman Creek near Spokane, WA; Hangman Creek at Spokane, WA; and Hangman Creek at mouth at Spokane, WA. Hangman Creek near Spokane had two samples collected from February 1968 through June 1968. Hangman Creek at Spokane had 18 samples collected from April 1977 through August 2000. Hangman Creek at mouth at Spokane had 108 samples collected from October 1972 through October 1980. Not all parameters were analyzed for every sample.

The USGS grouped their samples into the following categories (1968 through 2000):

- Information – agency and laboratory codes
- Biological – bacteria and other biological samples
- Nutrients – ammonia, phosphate, etc.
- Organic – generally pesticides and fertilizers
- Major inorganics – Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}, K^{+}, Na^{+}, HCO_3^{-}
- Minor and trace inorganics – mostly trace metals, etc.
- Physical property – temperature, conductivity, DO, etc.
- Radiochemicals - radioruthenium
- Sediment - turbidity

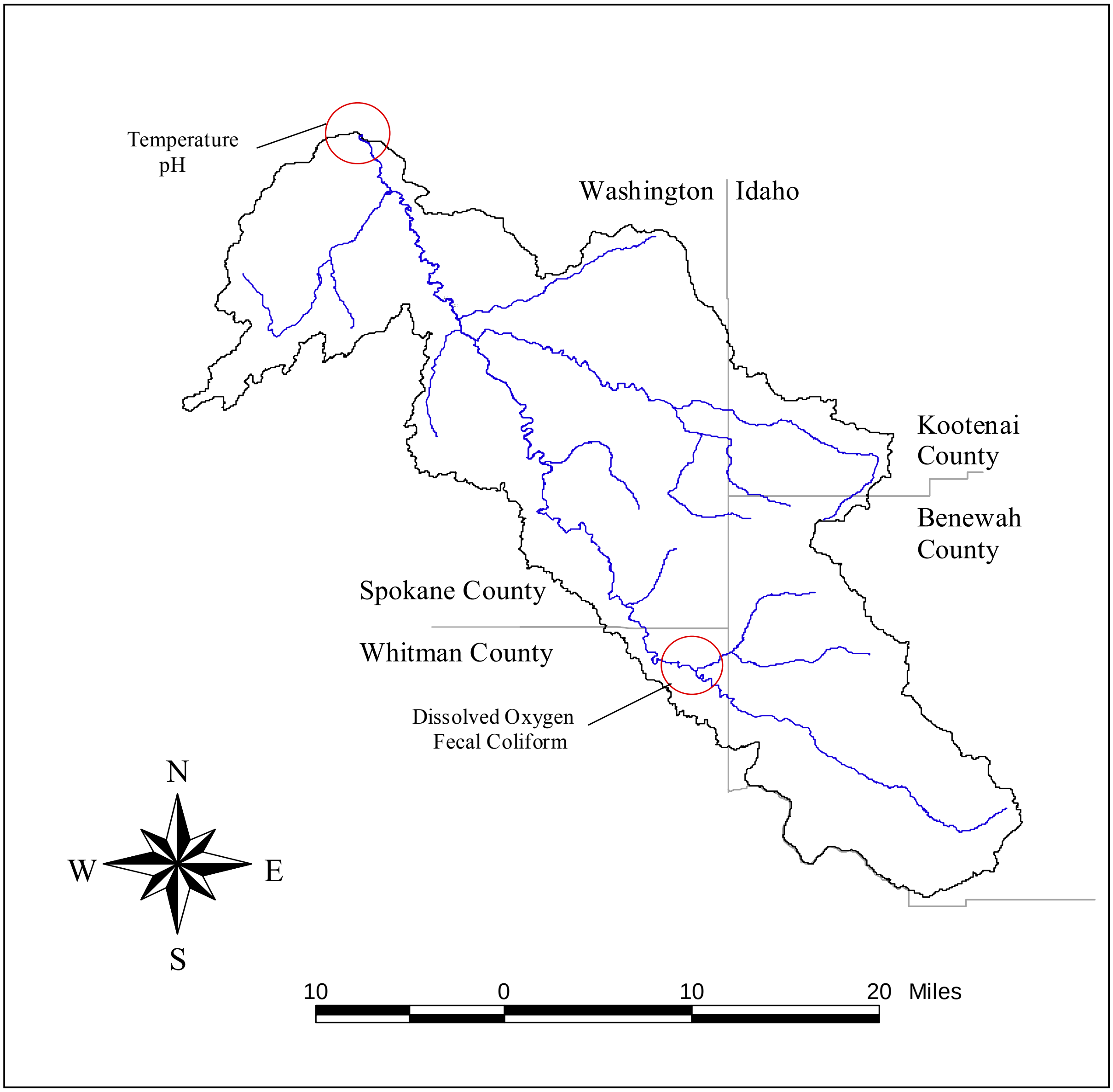

Figure 7: Ecology Designated Hangman Creek Reaches on the 303(d) List

The number of samples for each of the parameter groups varies along with the number of parameters analyzed (Table 34). For all surface water samples, four parameters exceeded Washington State water quality standards; temperature (27 exceedances), pH (14 exceedances), turbidity (14 exceedances), and dissolved oxygen (two exceedances).

Table 34: Parameter Group Summary of USGS Data near the Mouth

Parameter Group	First Date	Last Date	Number of Samples			Number of Values		
			HCA	HCN	HCM	HCA	HCN	HCM
Information	10-10-78	8-30-00	17	NR	32	117	NR	63
Biological	10-10-72	4-3-00	NR	NR	33	NR	NR	64
Nutrients	2-20-68	4-3-00	11	2	91	55	2	695
Organic	10-10-72	4-3-00	NR	NR	22	NR	NR	22
Major inorganics	2-20-68	4-3-00	10	2	36	62	24	215
Trace inorganics	2-20-68	4-3-00	10	2	5	95	4	176
Physical Property	2-20-68	8-30-00	18	2	108	123	19	782
Radiochemicals	9-23-80	9-23-80	NR	NR	1	NR	NR	1
Sediment	5-19-80	9-23-80	NR	NR	10	NR	NR	46

Notes:
1. HCA is USGS sample site 12424000, Hangman Creek at Spokane, WA.
2. HCN is USGS sample site 12423980, Hangman Creek near Spokane, WA.
3. HCM is USGS sample site 12434003, Hangman Creek at Mouth at Spokane, WA.
4. NR is not reported.

4.1.2 Spokane County Conservation District

The SCCD has conducted extensive water quality sampling in the Hangman Creek watershed since 1994. In 1994, the SCCD completed a watershed management plan for Hangman Creek that has guided SCCD water quality sampling programs. In order to address water quality problems associated with Hangman Creek, the management plan included a Water Quality Monitoring Plan to:

1. document existing levels of suspended sediment, selected nutrients, bacterial contamination, and other water quality parameters in the Hangman Creek watershed,
2. quantify the effectiveness of erosion-reducing BMPs on water quality, and
3. compare water quality samples collected during different seasons to help quantify the contribution of bank erosion versus agricultural runoff to water quality impairment.

All of these aspects of the water quality-monitoring plan have been completed by the SCCD along with project specific sampling efforts. The SCCD has recently included water quality sampling to evaluate the ground water/surface water interactions along the main stem. The details of the water quality projects are provided below.

The SCCD has conducted two biological studies of Hangman Creek. One was an evaluation of the cumulative effects of human disturbance on the watershed using benthic macro-invertebrates, and the other was a chronicle of land use and fisheries in the watershed.

Hangman Creek Management Plan (SCCD, 1994)

In 1994, the SCCD completed a watershed management plan for Hangman Creek. The plan provides information on the watershed characteristics, soils, general land uses in the watershed, land ownership, flow data, fauna and flora, water quality problems, and best management practices. In order to address water quality problems associated with Hangman Creek, the management plan included a Water Quality Monitoring Plan to:

1. document existing levels of suspended sediment, selected nutrients, bacterial contamination, and other water quality parameters in the Hangman Creek watershed,
2. quantify the effectiveness of erosion-reducing BMPs on water quality, and
3. compare water quality samples collected during different seasons to help quantify the contribution of bank erosion versus agricultural runoff to water quality impairment.

The first of the objectives was completed in 1999 with the publication of the *Hangman (Latah) Creek Water Quality Monitoring Report, Water Resources Public Data File 99-01*. The second objective was completed in 2000 with the publication of the *Hangman Creek Subwatershed Improvement Project Report*. The third objective was completed in 2002 with the publication of *The Hangman Creek Water Quality Network: A Summary of Sediment Discharge and Continuous Flow Measurements (1998-2001)*.

Hangman (Latah) Creek Water Quality Monitoring Report (SCCD, 1999)

The water quality report completed in 1999 summarizes water quality monitoring at six stations over a three-year period from October 1, 1994 through September 30, 1997. The stations monitored were:

1. Hangman Creek at the Idaho State Line
2. Little Hangman Creek
3. Rattler Run Creek at the mouth
4. Hangman Creek at Bradshaw Road
5. Rock Creek at Jackson Road
6. Hangman Creek at Keevy Road

Routine water quality samples were taken at five sites, along with selected samples during high flow events to characterize the water quality of the Hangman Creek watershed (Tables 35 and 36). A sixth site, Hangman Creek at Keevy Road, was moved to Bradshaw Road, and only had a minimal number of samples taken. Discharge measurements, or discharge values estimated from stage measurements, were routinely taken along with the water quality sample. All monitored stations exceeded one or more of either the Washington State Class A Water Quality standards or EPA recommended standards (Table 37).

Table 35: Summary Laboratory Statistics for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
Total Suspended Solids (mg/l)	Minimum	2	2	<2	2	<2
	Maximum	810	4,640	10,540	3,170	7,565
	Mean	124	833	626	378	632
	Median	24.0	208	29.0	42.5	84.8
Turbidity (NTU)	Minimum	1.1	1.5	0.4	0.6	0.3
	Maximum	195	900	850	750	885
	Low Median	12.5	5.6	3.6	3.6	4.0
	High Median	50.0	129	92.0	90.0	116
Fecal Coliform (colonies/ 100 ml)	Minimum	3	3	<1	6	<1
	Maximum	2,400	1,400	14,300	3,800	1,700
	Geometric Mean	53	58	87	69	63
	% > 200	16	24	30	15	27
Nitrate NO_3 (mg/l as N)	Minimum	0.05	0.09	0.27	0.14	0.08
	Maximum	5.68	13.4	15.5	5.76	12.0
	Mean	1.71	2.70	5.88	1.91	3.22
	Median	1.32	0.95	4.65	1.22	1.70
Nitrite NO_2 (mg/l as N)	Minimum	0.001	<0.001	<0.001	0.001	<0.001
	Maximum	0.015	0.098	0.083	0.020	0.028
	Mean	0.004	0.010	0.016	0.005	0.009
	Median	0.003	0.006	0.011	0.005	0.008
Ammonia (mg/l as N)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum	0.10	0.10	3.24	0.18	0.46
	Mean	0.03	0.04	0.32	0.03	0.06
	Median	0.01	0.01	0.09	0.01	0.01
Total Phosphorus (mg/l)	Minimum	0.04	0.04	0.15	0.04	0.04
	Maximum	0.80	0.96	10.5	4.27	5.70
	Mean	0.15	0.17	0.72	0.48	0.42
	Median	0.10	0.13	0.42	0.10	0.12

Notes:

1. Mean and median values include samples from high flow events, which may skew the results. The number of high flow events sampled was not uniform for all stations.
2. For turbidity, the low median is for flows less than 100 (10 for Rattler Run Creek) cfs and the high median is for flows greater than 100 (10 for Rattler Run Creek) cfs. Only turbidity values that were paired with discharge measurements were used in the low/high flow evaluation. At some sites, turbidity measurements were taken without any discharge estimation.
3. NTU is Nephelometric Turbidity Units.

Table 36: Summary Field Statistics for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
pH (units)	Minimum	6.63	6.50	6.49	7.53	6.52
	Maximum	7.86	8.15	8.84	9.52	8.70
	Mean	7.34	7.41	7.96	8.25	7.79
	Median	7.39	7.38	8.05	7.16	7.79
Conductivity (µS)	Minimum	45.1	97.0	120	82.9	94.6
	Maximum	247	316	532	339	357
	Mean	104	212	352	198	219
	Median	120	199	374	173	202
Dissolved Oxygen (mg/l)	Minimum	4.9	3.5	7.6	6.0	6.7
	Maximum	11.7	13.2	13.7	14.0	18.5
	Mean	8.6	8.4	10.7	9.6	10.5
	Median	8.7	9.0	10.5	9.5	10.5
Temperature (°C)	Minimum	-0.5	0.4	-0.6	0.3	-0.7
	Maximum	22.8	21.9	19.3	23.8	24.7
	Mean	10.6	9.1	7.9	12.0	8.1
	Median	8.0	7.1	6.5	12.8	5.2

Notes:
1. Values include samples from high flow events, and may skew the results. The number of high flow events sampled was not uniform for all stations.
2. Temperature data are for grab samples only. Continuous temperature recorders were installed at some sites, but the data recorded by the continuous temperature recorders are not included here.

Routine water quality samples were taken at the two subwatersheds, along with selected samples during high flow events to characterize the water quality of the two small tributaries to Hangman Creek (Tables 38 and 39). The data were evaluated using the U.S. EPA paired watershed study design, as outlined in EPA circular 841-F-93-009. The data from the study suggest that the BMPs used did reduce the total suspended sediment concentration by more than 10 percent. Even with the improvement in total suspended sediment data, all monitored stations exceeded one or more of either the Washington State Class A Water Quality standards or EPA standards (Table 40).

Hangman Creek Sediment Discharge Reports (SCCD, 2000b, 2002)

To evaluate sediment sources and loads from the Hangman Creek watershed to the Spokane River, a suspended sediment and bedload measurement project was completed. The SCCD, in conjunction with the USGS, monitored both suspended sediment and bedload at the mouth of Hangman Creek from water year 1998 through 2001.

The stream stations monitored by the SCCD were:

1. Hangman Creek at the mouth near the Marne Bridge

2. Hangman Creek at Bradshaw Road
3. Rock Creek at Jackson Road

Table 37: Summary of Exceedances for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
Turbidity Low Flows	Exceedances	NA	7	7	1	6
	Number of Samples	NA	19	41	16	44
Turbidity High Flows	Exceedances	NA	6	6	14	46
	Number of Samples	NA	10	10	23	63
Fecal Coliform	Percent > 200 col/100 ml	16	24	30	15	27
Nitrate NO_3	Exceeds EPA Limit	0	1	14	0	3
	Number of Samples	25	25	57	27	59
Nitrite NO_2	Exceeds EPA Limit	0	1	2	0	0
	Number of Samples	25	25	57	27	59
Ammonia	Exceedances	0	0	4	0	0
	Number of Samples	24	24	47	19	50
Total Phosphorus	Exceeds EPA Limit	10	18	57	14	34
	Number of Samples	25	25	57	29	61
pH	Exceedances	0	0	8	5	3
	Number of Samples	25	25	53	23	58
Dissolved Oxygen	Exceedances	7	8	1	6	7
	Number of Samples	19	20	51	25	57
Temperature	Exceedances	7	5	1	11	14
	Number of Samples	25	30	76	33	88

Notes:
1. NA is not applicable. Turbidity values from Hangman Creek at the Idaho State Line were used as background values to establish the limits for the rest of the sample sites.
2. For turbidity, the low flows are less than 100 (10 for Rattler Run Creek) cfs and the high flows are greater than 100 (10 for Rattler Run Creek) cfs.
3. The number of temperature exceedances is for grab samples only. Continuous temperature recorders were installed at some sites, but the exceedances recorded by the continuous temperature recorders are not included here, see the original report Section 4.1.4.
4. For nitrate, nitrite, and total phosphorus, the EPA recommended limits are used. No Washington State Standards for these parameters are presently contained in the Water Quality Standards for Surface Waters of the State of Washington.

The USGS determined the average daily suspended-sediment load at the Marne Bridge site near the confluence of Hangman Creek and the Spokane River. The SCCD estimated the average daily bedload discharge at the Marne Bridge site. The annual total bedload and suspended sediment discharged for water years 1998 through 2001 ranged from 4,740 to 189,000 tons per year (Table 41). Along with the sediment sampling, a low flow water quality sampling run was completed at 18 sites within the watershed to characterize the base flow water type along the Hangman Creek main stem.

Table 38: 2000 Subwatershed Improvement Report Laboratory Summary Statistics

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
Total Suspended Solids (mg/l)	Minimum	<2	<2	<2	<2
	Maximum	3,568	2,923	5,105	3,408
	Mean	193	151	471	244
	Median	22	18	37	13
Turbidity (NTU)	Minimum	1.8	0.6	1.4	0.8
	Maximum	768	825	760	638
	Mean	81	88	112	58
	Median	18	45	50	7
Fecal Coliform (colonies/ 100 ml)	Minimum	5	0	0	<1
	Maximum	1,410	61	11	1,400
	Geometric Mean	37.4	5.4	7.7	11.6
	% > 200	15	0	0	14
Nitrate NO_3 (mg/l as N)	Minimum	0.45	0.74	1.00	0.60
	Maximum	16.2	8.74	8.74	8.72
	Mean	3.77	3.13	3.67	3.24
	Median	2.99	2.31	3.41	1.76
Nitrite NO_2 (mg/l as N)	Minimum	<0.001	<0.001	<0.001	0.001
	Maximum	0.026	0.015	0.015	0.024
	Mean	0.005	0.005	0.005	0.007
	Median	0.005	0.005	0.005	0.006
Ammonia (mg/l as N)	Minimum	<0.01	<0.01	<0.01	<0.01
	Maximum	0.41	0.08	0.08	1.03
	Mean	0.04	0.02	0.02	0.09
	Median	0.02	0.01	0.02	0.02
Total Phosphorus (mg/l)	Minimum	0.09	0.06	0.08	0.04
	Maximum	1.50	0.54	0.54	2.44
	Mean	0.35	0.18	0.21	0.25
	Median	0.27	0.14	0.17	0.16

Notes:

1. Mean and median values include samples from high flow events, which may skew the results. The number of high flow events sampled was not uniform for all sites.
2. NTU is Nephelometric Turbidity Units.

Bedload discharge samples from the upper reaches of the watershed were insignificant. At the Rock Creek Jackson Road site, the bedload sediment discharge was 24 grams at a discharge of 540 cfs. Sampling at Rock Creek and Hangman Creek at Bradshaw Road suggest that there is little bedload discharge from the upper watershed at low and moderate flows. In the lower reach (Hangman Creek at Marne Bridge), both moderate and high flows had significant bedload sediment discharges. The data suggest there is little bedload movement for flows less than approximately 216 cfs at the mouth of Hangman Creek. The highest bedload sediment discharge was 15,212 grams at a discharge of 5,300 cfs.

Table 39: 2000 Subwatershed Improvement Report Field Summary Statistics

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
pH (units)	Minimum	6.80	6.90	6.89	7.50
	Maximum	8.29	8.46	8.55	8.25
	Mean	7.78	7.80	7.98	7.76
	Median	7.85	7.81	8.07	7.75
Conductivity (μS)	Minimum	64	69	66	130
	Maximum	422	417	381	419
	Mean	305	284	269	314
	Median	326	324	304	334
Dissolved Oxygen (mg/l)	Minimum	4.5	6.1	9.3	4.5
	Maximum	12.2	13.6	12.8	12.7
	Mean	9.4	10.3	11.2	9.8
	Median	10.0	11.1	11.3	10.1
Temperature (°C)	Minimum	0.1	0.0	0.0	0.0
	Maximum	15.8	14.1	14.1	13.7
	Mean	6.3	5.5	5.4	5.1
	Median	5.5	4.3	4.2	3.9

Notes:
1. Values include samples from high flow events, and may skew the results. The number of high flow events sampled was not uniform for all sites.

The suspended sediment accounted for the majority of the total sediment discharged from the watershed. Generally, the higher the average annual flow rate, the higher the suspended sediment percentage. The suspended sediment is derived from both stream bank and agricultural field erosion. However, it is suspected to be primarily from field, road, and ditch erosion. The suspended sediment concentrations, as opposed to the bedload samples, were significant in the upper reaches of the watershed.

Water quality samples were taken at 18 sites on a single day along the main stem of Hangman Creek. The water samples were taken to evaluate low flow water quality (Table 42) and to characterize the ground water input to the creek.

Table 40: Summary of Exceedances for the 2000 Subwatershed Improvement Report

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
Turbidity > 50 NTU	Exceedances	21	19	19	11
	Number of Samples	56	40	38	33
Fecal Coliform	Percent > 200 col/100 ml	15	0	0	14
Nitrate NO_3	Exceeds EPA Limit	1	0	0	0
	Number of Samples	31	13	12	23
Nitrite NO_2	Exceeds EPA Limit	0	0	0	0
	Number of Samples	31	13	12	23
Ammonia	Exceedances	0	0	0	0
	Number of Samples	26	7	6	23
Total Phosphorus	Exceeds EPA Limit	34	13	14	18
	Number of Samples	35	17	16	23
pH	Exceedances	0	0	1	0
	Number of Samples	35	19	17	20
Dissolved Oxygen	Exceedances	6	3	0	2
	Number of Samples	32	17	15	19
Temperature	Exceedances	0	0	0	0
	Number of Samples	53	27	24	35

Notes:
1. Turbidity values were considered an exceedance if greater than 50 NTU. Background turbidity values are not known for the project watersheds. The 50 NTU limit value was assumed for exceedances and is not based on any regulatory limit.
2. The temperature values are for site visits only. Continuous temperature recorders were not installed at any site.
3. For nitrate, nitrite, and total phosphorus, the EPA recommended limits are used. No Washington State Standards for these parameters are presently contained in the Water Quality Standards for Surface Waters of the State of Washington.

Table 41: Bedload and Suspended Sediment Annual Summary

Year	Annual Bedload (tons)	Annual Suspended Sediment Load (tons)	Total Annual Sediment Load (tons)	Average Annual Discharge (cfs)
1998	5,100	35,200	40,300	166
1999	14,000	175,000	189,000	315
2000	12,300	83,000	95,300	273
2001	1,310	3,430	4,740	83.7

Notes:
1. Suspended sediments were estimated by the USGS from automated samples.
2. Bedload estimations were by the SCCD using regression equations developed from sample results and USGS flow data. The regression equation uses USGS daily average flow as the predictive input.

Trilinear diagrams were used to evaluate trends in the composition of the streamflow at the sampling points along Hangman Creek (Figure 8). The trends evaluate changes in the major dissolved cations (calcium, magnesium, and sodium plus potassium) and the major anions (chloride, sulfate, and bicarbonate). The diagrams illustrate the major dissolved ionic constituents in milliequivalents expressed as the percentages of the total cation or anion milliequivalents.

Table 42: Summary of Exceedances for the 2001 Low Flow Sampling

	Total Phosphorus (μg/l)	Fecal Coliform (colonies /100ml)	pH (units)	Dissolved Oxygen (mg/l)	Temperature (°C)
Stateline	63	59	7.21	7.14 e	12.6
HC at Tekoa	79	28	7.94	11.49	16.3
HC at Marsh Rd	64	46	7.70	10.05	16.0
Cove Creek	100	190	7.65	10.32	13.1
HC at Roberts Rd	77	16	7.86	9.41	17.6
Rattler Run Creek	256 e	310 e	7.81	9.24	13.8
HC at Bradshaw Rd	97	16	8.00	7.61 e	18.4 e
HC at Keevy Rd	58	2	8.64 e	11.55	19.2 e
HC u/s Rock Ck	72	7	9.23 e	16.64	20.4 e
Rock Creek	35	790 e	9.15 e	8.37	19.9 e
HC u/s California Ck	74	4	8.93 e	10.21	18.8 e
California Ck	95	290 e	8.34	10.23	16.0
HC at HV Golf Course	32	19	8.52 e	13.90	20.7 e
HC at Grunte Home	41	17	8.18	10.86	20.3 e
HC at Yellowstone	29	3	8.29	10.75	21.2 e
HC u/s Marshall Ck	32	2	7.83	10.58	20.5 e
Marshall Ck	65	1600 e	7.56	7.56 e	17.5
USGS Gage site	22	65	8.17	12.56	18.2 e

Notes:

1. Total Phosphorus is not listed on the 1998 Ecology 303(d) list, but exceedances of EPA recommended levels have been documented in previous SCCD sampling within the Hangman Creek watershed.
2. Fecal coliform was considered an exceedance if greater than 200 colonies per 100 ml sample. Not enough samples were obtained to adequately characterize the geometric mean for exceedances.
3. HC is Hangman Creek.
4. u/s is upstream.
5. HV is hangman Valley.
6. e indicates an exceedance of Ecology water quality standards, except for total phosphorus which is an EPA recommended limit.
7. There were no exceedances for nitrate, nitrite, or ammonia.
8. Two ammonia samples had corresponding pH values greater than 9.00. The exceedances criteria are dependent on pH, and the pH limit used in the calculation of exceedances is 9.00. For the samples with pH values greater than 9.00, extrapolations were used to estimate the limits.

The trilinear plot uses two equilateral triangles, one for cations and the other for anions. Each vertex represents 100 percent of a particular ion or group of ions. The composition of the water with respect to cations is indicated by a point plotted in the cation triangle, and the composition with respect to anions by a point plotted in the anion triangle. The coordinates at each point add to 100 percent.

The trilinear diagram constitutes a useful tool in water-analysis interpretation. Applications of the diagram are used to evaluate whether a particular water may be a mixture of others, or if two solutions of different concentrations are mixed. The results of this sample set indicate that the water in Hangman Creek is predominantly a calcium-bicarbonate water type. Sodium plus potassium quantities were estimated based on the other major ion concentrations and the field conductivity by the EWU Limnology Laboratory. No significant mixing trends were apparent using the major ions (Figure 8).

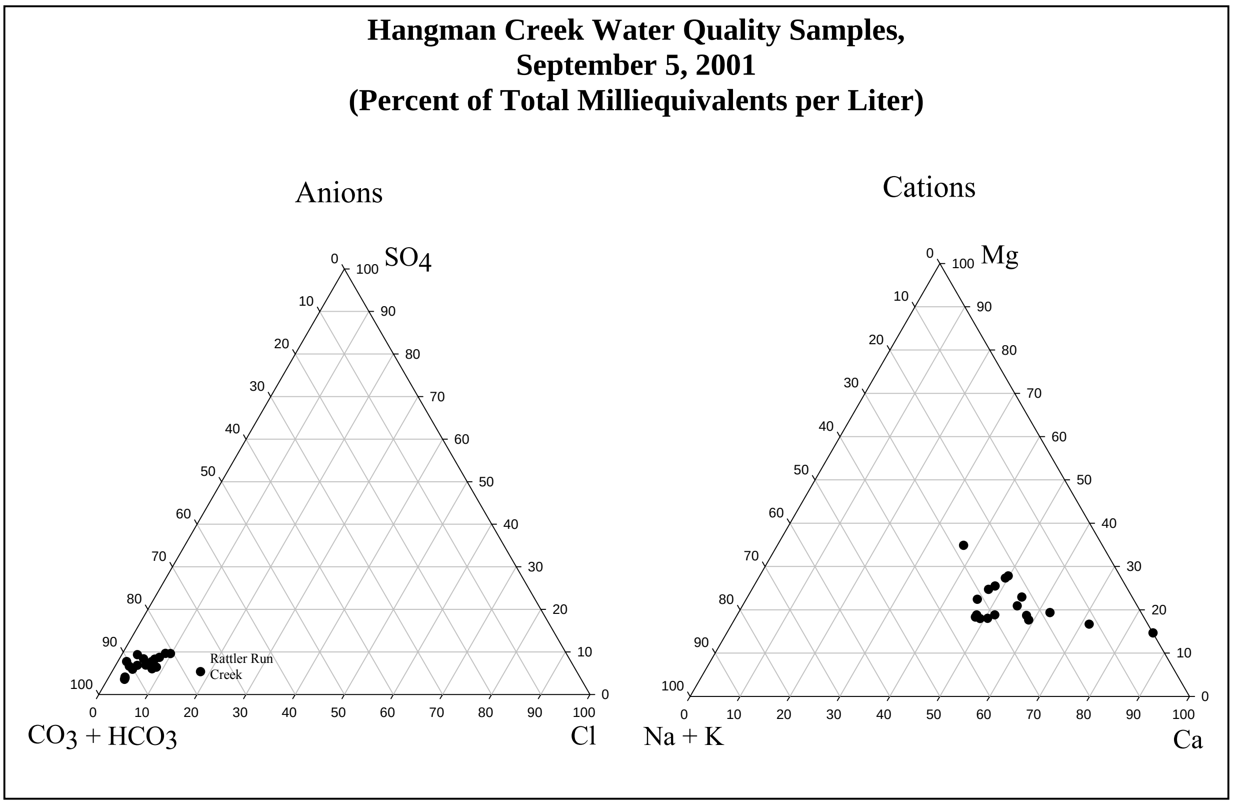

Figure 8: Hangman Creek Major Ion Percentages

<u>Biological Assessment of Hangman (Latah)Creek Watershed (SCCD, 1998a)</u>

The goal of the study was to collect macro invertebrate data to determine if the health of the stream could be related to the local land uses. Sample sites were selected to represent a range of conditions from heavy to moderate disturbance. An overall index score was calculated by assigning scores to the biological metrics developed in the study. High index scores indicate a healthy stream site capable of supporting a variety of invertebrates. A correlation of index scores for two years was able to distinguish the best from the most degraded sites (Table 43).

A Chronicle of Latah (Hangman) Creek: Fisheries and Land Use (SCCD, 1998b)

The chronicle of fishery resources in the watershed documents early accounts of the creek and fish from Native Americans, exploration journals, and local historians and residents. From the early accounts, it suggests that Hangman Creek was once a highly productive salmon rearing stream and home to native cutthroat and rainbow trout.

Table 43: Multimetric Index Scores for Hangman Creek

Site Name	Index Score	
	1996	1997
Marshall Creek	31	33
Rattler Run Creek	21	27
Hangman Creek at High Bridge Park	23	21
Rock Creek	17	21
Hangman Creek at Bradshaw Road	19	25
Hangman Creek at Roberts Road	17	13

Notes:
1. Correlation of index scores for two years was $r = 0.78$ for $p<0.07$.
2. Scores are for riffle sites.
3. Higher scores indicate better stream and water quality conditions.

The species composition of Hangman Creek has changed significantly over the last 100 years according to the report. Native trout, steelhead and salmon populations have suffered great losses due to loss of habitat and water quality degradation. Native species that could tolerate the changes in stream flow, temperature, and channel configuration have adapted over the years. Sculpin and redside shiners have apparently expanded their distribution and increased their population in the upper part of the watershed. Overall, the fish populations in Hangman Creek may have increased over the years, but most species are undesirable as sportfish and are adapted to warmer, slower stream flows (Table 44).

4.1.3 Washington State Department of Ecology Data

Ecology samples two sites on Hangman Creek for their River and Stream Water Quality Monitoring network. The sites are sampled for fecal coliform bacteria, DO, pH, TSS, temperature, total persulfate nitrogen, total phosphorus, and turbidity. The two sites are located at the mouth (station 56A070) and near Bradshaw Road (station 56A200). The first sampling at the mouth was on 10-10-72 and is ongoing. The Bradshaw Road site was first sampled on 10-5-98 and was last sampled on 9-13-99. The data are available from the Ecology web site, www.ecy.wa.gov.

4.2 Habitat and Land Use

Three significant habitat and land use studies were completed as part of the Water Quality Optional Element. The three studies were a riparian evaluation of the Hangman Creek main stem, a historic evaluation of watershed vegetation and soil loss, and identification of potential point and non-point source pollution sites along the main stem (the potential point and non-point pollution sources are discussed in Section 4.4 below.

In the early 1870s, prior to heavy settlement of the Hangman Creek watershed, the condition of the stream, riparian area, and floodplain are assumed to have been relatively pristine (Edelen and Allen, 1998). Salmon were present in sufficient numbers to support a fishery for the Coeur d' Alene Tribe upstream near where the town of Tekoa, Washington is located (Scholz et al. 1985). However, the majority of salmon and trout were captured at the mouth of Hangman Creek, where it enters the Spokane River. Tribes would congregate at the mouth with weirs, spears, and nets to catch salmon and trout in the fall. One weir at the mouth of Hangman Creek was reported to catch 1000 salmon a day for a period of 30 days a year (Scholz et al. 1985).

Table 44: Fisheries Species Composition and Changes, 1893 to 1993

		Near Tekoa, WA			Near Sanders, ID	
Species	Genus, species	1893	1971	1993	1971	1993
Rainbow Trout	*Oncorhynchus mykiss*	NF	NF	NF	F	F
Eastern Brook Trout	*Salvelinus fontinalis*	NF	NF	NF	NF	F
Chiselmouth	*Acrocheilus alutaceus*	NF	F	F	NF	NF
Brown Bulhead	*Ictalurus nebulsus*	NF	NF	F	NF	F
Longnose Sucker	*Catostomus catostomus*	NF	NF	F	NF	F
Bridgelip Sucker	*Catostomus columianus*	NF	F	NF	F	NF
Largescale Sucker	*Catostomus macrocheilus*	F	F	NF	NF	F
Sculpin spp.	*Cottus spp.*	F	NF	NF	F	F
Squawfish	*Ptchocheilus oregonensis*	F	F	F	NF	NF
Longnose Dace	*Rhinichthys cataractae*	NF	NF	F	NF	F
Speckled Dace	*Rhinichthys osculus*	F	NF	NF	F	F
Redside Shiner	*Richardsonius balteatus*	NF	F	F	F	F

Notes:
1. F is found.
2. NF is not found.
3. The 1893 study was done by Gilbert and Evermann.
4. The 1971 study was done by Laumeyer and Maughan.
5. The 1993 study was done by the Coeur d' Alene Tribe.

In general, little is known about the historic conditions of Hangman Creek. Early records were not kept and anecdotal evidence is inconsistent. The Coeur d'Alene harvest of

Chinook and steelhead in the area of what is now Tekoa, Washington (Scholz et al. 1985) suggests a clear, clean flowing stream. Stream conditions started to change in the 1880s and 1890s as an influx of settlers moved into the Hangman Creek. But even then, the farms were small due to the technology of the time. The gold mining in nearby communities had declined, so settlers were looking for suitable farmland. As a result, settlers and Indians cleared the watershed of trees and tilled the fertile soils (Edelen and Allen, 1998). In 1893, Gilbert and Evermann classified Hangman Creek as "an unimportant stream … found to be a small, rather filthy stream, not suitable for trout or other food-fishes." These observations were made in Tekoa, Washington near the Idaho-Washington state line.

The degraded state of Hangman Creek in 1895 was most likely the result of the strong influx of settlers and consequential land use activities, which was not described by Gilbert and Evermann (1893). Several of the land uses, such as timber harvest, agriculture, and a sugar beet processing plant near the town of Fairfield, Washington discharged pollutants directly into the stream (Leitz 1999). Other historical accounts of the flow in Hangman Creek vary from seasonally dry (original Public Land Survey Notes) to almost as high in low water time as it was in high water time. The scant and contradictory evidence of the historic condition of Hangman Creek only highlights the lack of information as to its true potential.

Current Conditions

Hangman Creek watershed has been significantly altered through past and present land uses including but not limited to agriculture, urban development, wetland/riparian destruction, forestry practices, and road construction (Table 45). Agriculture constitutes 64 percent of the land use, and is most prevalent in the upper and middle reaches of Hangman Creek. The lower portion of the Hangman Creek watershed is expected to undergo 50 percent of the City of Spokane's urban growth in the next ten years (SRTC 1997). Agriculture, in the form of dryland farming and grazing, is prevalent throughout the watershed. Most croplands are plowed to the edge of the streams. Riparian zones have been severely impacted causing increased width-to-depth ratios from increased bank erosion. Channelization and vegetation removal (upland and riparian), combined with steep slopes, fine Palouse derived soils, and high runoff conditions, have made the watershed more susceptible to streambed and upland agricultural erosion (Edelen and Allen 1998). Livestock have unrestricted access to riparian areas, tributaries, and the main channel in the watershed. Grazing impacts are not isolated to large operations in the watershed. Small "Hobby Farms", having too many head of livestock confined in a small area, also results in barren riparian areas. Forestry practices have cleared much of the upper watershed creating higher peak flows and sediment loading, while decreasing summer low flows. High road densities (1.7-4.7 miles/square mile) in the lower portions and moderate road densities (0.7-1.7 miles/square mile) in the upper portions of the watershed also contribute significantly to sedimentation. Land use activities have reduced the quantity and quality of in-stream habitat complexity, such as natural meander patterns and large woody debris (LWD) recruitment. The cumulative effects of land use activities (agriculture, forestry) have changed the natural hydrograph, impaired downstream water quality, increased the sediment load, and degraded fish and wildlife habitat in Hangman Creek.

Hangman Creek is one of the largest contributors of bedload and suspended sediments into the Spokane River. Bedload and suspended sediments originating from Hangman Creek are transported to and deposited behind Nine Mile Dam and eventually settle out in Lake Spokane. Soletero et al. (1992) estimated Hangman Creek contributes 77 percent of the total annual sediment load to Lake Spokane. The annual suspended sediment load from Hangman Creek was estimated to be 52,000 tons in 1998 and 211,000 tons in 1999 (SCCD 2000). The increased sediment load has also more locally resulted in embedded substrate and unsuitable spawning habitat for salmonids. The principal source of suspended solids comes from non-point sources (roads, annual cropland, eroding streambanks (SCCD 1994).

Aquatic habitats in Hangman Creek have been degraded physically and biologically with respect to the fisheries community requiring high environmental quality conditions. Hangman Creek flows are flashy, streambanks are unstable, and water quality is substandard. Results from an invertebrate inventory conducted throughout the Hangman Creek watershed found very few taxa requiring high environmental quality conditions (environmentally sensitive species) (Celto et al. 1998). These taxa were only found in two tributaries, Marshall and Rock creeks, and only found in one year (Celto et al. 1998). These biotic data reinforce the observations on degraded physical habitat conditions observed throughout the watershed. In the lower and middle region of Hangman Creek, six reaches are on Washington State's 1998 303(d) list for exceeding EPA water standards for the following parameters: fecal coliform, pH, dissolved oxygen, and temperature. According to Washington State water criteria (WDOE), Hangman Creek also exceeds in parameters set for nutrients (nitrate, ammonia, nitrite, total phosphorus) and turbidity. The upper reaches of Hangman Creek are located in Idaho and are also listed on Idaho's 1998 303(d) list exceeding water quality criteria set for habitat alteration, sediment, nutrients, and pathogens. Low flows, high temperatures, and low dissolved oxygen concentrations also impair the upper reaches (Peters et al., 2003).

Wildlife

Woody vegetation is often scattered and sparse along the riparian corridors in Hangman Creek. Wild mammals observed or commonly reported in these corridors include white-tailed deer, Rocky Mountain elk, moose, coyote, river otter, beaver, meadow vole, and deer mice. Birds commonly found in riparian habitats include great blue heron, kingfisher, yellow warbler, mallard, cinnamon teal, green-winged teal, wood duck, common merganser, western bluebirds, red-winged blackbirds, magpies and Canada geese. The American Bald eagle is a federally listed Threatened species that migrates through Hangman Creek, but no known nesting sites has been reported. The Washington Department of Fish and Wildlife (WDFW) list parts of the project area as white-tailed deer winter range.

Fisheries

The species composition of Hangman Creek has changed significantly over the last 100 years. Native trout, steelhead, and salmon populations have suffered great losses due to dams, loss of habitat, and water quality degradation. The relative abundance and distribution of resident non-migratory species, such as rainbow trout, have also changed dramatically. Other native species, which could tolerate the changes in stream flow, temperature, and habitat, have adapted or even prospered over the years. Sculpin and redside shiners have apparently expanded their distribution and increased their population. Redside shiners may be the most abundant fish throughout the system. Suckers and other bottom-feeding fish continue to dominate throughout the lower reaches. Overall, the fish populations may have increased in number, but most are undesirable as sportfish and are adapted to warmer, slower water (SCCD, 1998b).

Native Plant Communities

Prior to settlement, the Hangman Creek watershed was a mosaic of shrub/steppe and forest habitat types (h.t.). Daubenmire and Daubenmire (1968) have described these habitat types. Forest types and steppe types were intermixed based on aspect, elevation, and soil features. Forest types (ponderosa pine series, Douglas fir series, and western hemlock series) occupied the higher elevations and northern aspects. Steppe types (Idaho fescue/snowberry h.t., Douglas hawthorn/snowberry h.t., and Douglas hawthorn/cow parsnip h.t.) occupied the lower elevations and remaining aspects. Both of the types were divided into phases based on soil features. Few of the original habitat types exist as they were converted to small grain production in the late 1800s (SCCD 1994).

Riparian Vegetation

Reed canarygrass and introduced pasture grasses are dominant in most of the project area, but stands of black cottonwood and mixed shrubs can be found in certain reaches. Woods rose, coyote willow, Douglas hawthorn, golden willow, and snowberry are common shrub species. Common tansy and other weedy forbs have also invaded much of the area. Grazing and urban encroachment have limited riparian plant growth. The stream has been channelized through much of this area to accommodate the road systems.

Tile drainage has depleted many of the wetlands in the area so that they could be farmed. Many of the former meanders have been cut off and the stream gradient has increased. As a result, streambanks are very unstable and it is difficult for riparian vegetation to reestablish. Riprap has been placed on a number of areas near roads. This also discourages the establishment of riparian vegetation.

Table 45: Land Use and Ownership Summary

Land Use Summary		Land Ownership Summary	
Type of Land Use	Acres	Ownership	Acres
Cropland	212,880	Private	368,180
Timber	119,490	Coeur d' Alene Tribe	52,121
Grassland/CRP	62,850	U. S. Forest Service	3,378
Brush	13,749	State of Washington	2,891
Developed	12,565	State of Idaho	1,732
Hobby Farms	9,225	U.S. Bureau of Land Management	47
Other	461		

Notes:
1. Data is from Natural Resources Conservation Service.
2. Information is from 1994.

4.2.1 Hangman Creek Main Stem Riparian Evaluation

In the spring of 2003, the Spokane County Conservation District conducted an inventory to assess the functional status of riparian-wetlands along the main stem of Hangman Creek. The extensive assessment evaluated over fifty-eight river miles within the Washington State portion of the watershed.

The assessment process followed the Bureau of Land Management's Proper Functioning Condition (PFC) methodology developed by the BLM, USDA Forest Service, and others (1993). The methodology is qualitative, but is based on quantitative science. A multi-discipline PFC team was formed to inventory and evaluate stream reaches based upon the interaction of vegetation, landform/soils, and hydrology. The PFC methodology evaluates 17 factors that take into account hydrology, vegetation, and sediment erosion and deposition. A functioning rating was determined for each reach. The functioning ratings were:

- Proper Functioning Condition
- Functional at Risk
- Nonfunctional

A riparian-wetland area is considered to be in a proper functioning condition when, according to the BLM (1998), adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and ground water recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity.

Riparian-wetland areas that are functional at risk are areas that are in functional condition, but an existing soil, water, or vegetation attribute makes them susceptible to degradation.

Riparian-wetland areas that are nonfunctional are areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, or providing diverse vegetation.

The assessment determined that Hangman Creek has extensive riparian-wetland problems magnified by years of human perturbation. Approximately 3.3 miles (6 percent) of the main stem were rated as nonfunctional. Only 15.2 miles (26 percent) were considered to be proper functioning, and 40.0 miles (68 percent) of the main stem were classified as functional-at-risk (Table 46). For functional at risk reaches, the reach trend was estimated (upward, downward, or not apparent).

Table 46: Properly Functioning Condition Summary

Reach Number	Reach Start River Mile	Reach Length (miles)	Functional Rating	Trend
1	58.5	4.7	Functional at Risk	Not Apparent
2	53.8	0.4	Functional at Risk	Not Apparent
3	53.4	2.6	Functional at Risk	Not Apparent
4	50.8	0.5	Functional at Risk	Not Apparent
5	50.3	3.6	Functional at Risk	Downward
6	46.7	5.3	Functional at Risk	Downward
7	41.4	1.4	Proper Functioning	NA
8	40.0	2.0	Functional at Risk	Not Apparent
9	38.0	1.5	Functional at Risk	Downward
10	36.5	1.1	Functional at Risk	Not Apparent
11	35.4	1.2	Functional at Risk	Downward
12	34.2	2.1	Functional at Risk	Not Apparent
13	32.1	7.4	Proper Functioning	NA
14A	24.7	1.9	Proper Functioning	NA
14B	22.8	1.1	Functional at Risk	Not Apparent
15	21.7	2.3	Functional at Risk	Not Apparent
16	19.4	0.8	Proper Functioning	NA
17	18.6	0.7	Proper Functioning	NA
18	17.9	3.3	Nonfunctional	NA
19	14.6	4.1	Functional at Risk	Downward
20	10.5	2.4	Functional at Risk	Not Apparent
21A	8.1	1.3	Functional at Risk	Upward
21B	6.8	1.0	Proper Functioning	NA
21C	5.8	3.8	Functional at Risk	Not Apparent
22	2.0	2.0	Proper Functioning	NA

Notes:
1. Reaches 14 and 21 were re-evaluated by the PFC team and split to better represent portions of the original reaches.
2. River mile is the distance measured from the mouth along Hangman Creek in miles.
3. Functional rating is based on the Bureau of Land Management Proper Functioning Condition methodology.
4. NA is not applicable for proper functioning and nonfunctional reaches.

Each reach evaluated was documented with pictures and written descriptions. The detailed reach descriptions are provided in Appendix I. Each reach description includes:

- Geographic description
- Riparian vegetation description
- Wildlife activity noted
- Geomorphic character
- Agricultural influences
- Anthropogenic influences
- Reach summary
- Reach rating

4.2.2 Historic Evaluation of Hangman Creek Vegetation and Soil Loss

The water quality degradation documented throughout the watershed raises questions regarding the historical conditions of the watershed. The problems of high peak flows and low summer flows brings added attention to water quantity issues in the watershed. There is a common perception that historic water levels were significantly higher, but have fallen due to human impacts in the watershed. This investigation provides an assessment of the historic condition of the native vegetative cover and estimates how changes in land use throughout the watershed have influenced the overall water availability and soil loss.

Pre-settlement watershed conditions were evaluated using historic plant community cover as described in early section line surveys. The section line surveys were part of the Public Land Survey System (PLSS) conducted under standards set forth in the 1785 Land Ordinance (BLM, 2003). The rectangular survey system, also know as the cadastral survey, subdivided public lands into townships, ranges, and sections across the western United States.

The original land surveys of Washington were conducted by the Surveyor General's Office in Olympia, WA during the late 19th Century. Similarly, surveys of the Idaho portions of the watershed were supervised by the Surveyor General's Office in Boise, ID in the early 20th Century. Copies of the surveyor notes and plats (maps) are stored at the Cadastral Survey's office on microfiche at Bureau of Land Management regional offices throughout the United States.

Surveys established each Township into six-mile squares. Each township has 36 square miles, and each square mile is called a Section. Surveyors walked each six-mile township boundary line and each one-mile section line. They recorded observations in their field notes, drew plats, and designated boundaries along the line walked. In general, most surveyors' field notes included descriptions of vegetation, landforms, soil type, water availability, and suitability for settlement. These qualitative descriptions of vegetation found in the field notes, along with the hand drawn plats, were used to estimate the historic vegetation cover for the Hangman Creek Watershed. The information from the original PLSS was gathered and processed in ArcView 3.2 GIS

Assumptions necessary to use the PLSS

The information contained in the PLSS is qualitative and sometimes difficult to interpret. Surveyors often used different terminology to describe common plant species and other observations. The vegetative communities and individual species listed in the notes often-required professional judgment because surveyors did not use uniform methods of recording vegetative information. The surveyors did not typically provide detailed accounts of species abundance or use scientific names. Loose terminology, and/or vernacular were often used to describe vegetation. Similarly, handwriting on both the plats and in the notes was sometimes not very clear.

The interpretation of observed species was based on plant names provided by the surveyors and referenced to their occurrence for a given habitat type found in the area as described by Daubenmire (1970). A species list, interpretation of terms used for the plant observed by surveyors, and comments relating to the plants observed is in Appendix J.

The Washington State surveys ranged from 1869 to 1880, and are considered by the BLM to be the first official surveys for the area. It was assumed that the vegetation observed by surveyors was native and that the conversion to agriculture and the introduction of non-native plants was not yet widespread. Settlements were cited as early as 1870, but the largest farm recorded at that time was approximately 55 acres in T 25 N, R 42 E, sec. 23 & 26.

In Idaho, a select group of early surveyors were considered fraudulent (personal communication, Sandra Gourdin, Spokane BLM office, 2003). Therefore, the earliest reliable Idaho State surveys available for this project ranged from 1903 to 1906. Settlement was widely expanding into Idaho by this time. Inferences of historical vegetative communities were based on topography and available field notes describing the surrounding landform and plant species.

Vegetative Community Delineation

Vegetation types described by the surveyors were categorized into seven major groups based on plant communities and dominant landforms. The categories included:

- Bunchgrass prairie
- Open Ponderosa pine and grasses
- Open Ponderosa pine on rocky surface
- Wetland or lake
- Evergreen forest
- Cottonwood, alder, or willow groves
- Cultivated

In most cases, surveyors wrote a summary labeled “General Description” for each section. The general descriptions, notes, and plats were used to assign the plant community type for each section. The vegetative communities in each section were adjusted using the features and landforms on the surveyor’s plat. GIS tools were utilized to produce a historical vegetation map (Figure 9) and to calculate the area of each vegetative community. These areas were further divided into five sub-watersheds (Table 47) to re-calculate a historical water balance similar to the work conducted in Section 3.5 by Buchanan and Brown (2003).

The historical vegetative communities in the Hangman Creek watershed prior to settlement were significantly different than today (Table 48). The watershed was primarily covered with rolling hills of bunchgrass prairie that extended into scattered populations of Ponderosa pine (*Pinus ponderosa*) forests. The Ponderosa pine communities often included a shrub understory such as snowberry (*Symphoricarpus albus*) and wood's rose (*Rosa woodsii*).

Table 47: Historic Vegetation Coverage for the Hangman Creek Watershed

Vegetation Types	Vegetation Area by Sub-watershed (acres)					
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	Watershed Total
Bunch grass Prairie	110,236	13,650	8,999	33,257	662	166,803
Open Ponderosa Pine with grasses	32,295	24,175	22,798	40,365	8,554	128,186
Open Ponderosa Pine on rocky surface	3,583	4,058	6,546	239	449	14,875
Wetland or Lake	0	645	1,995	0	0	2,640
Evergreen Forest	67,976	2,734	0	39,821	6,276	116,796
Cottonwood, alder, or willow groves	172	570	0	908	0	1,650
Cultivated	135	114	22	0	0	271

Notes:
1. Several categories, such as wetlands and lakes, were not originally recorded within several sub-watersheds. This may be a result of details provided by different surveyors and does not infer that they did not exist.
2. The bunchgrass prairie vegetative cover included areas defined as shrub steppe.

The streams, springs and drainages were densely vegetated with various shrubs and small trees including; hawthorn (*Crataegus*) willows (*Salix*), aspen and cottonwood (*Populus*), alders (*Alnus*), serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*). Higher elevations, canyon lands, and northern aspects supported a mix of coniferous forest species including Western Larch (*Larix occidentalis*), Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmanni*), Western hemlock (*Tsuga heterophylla*), and Western red cedar (*Thuja plicata*).

Agriculture has become the dominant land use for the watershed at over 275,000 acres. This more than doubles the pre-settlement prairie and forested areas combined. Overall forest land cover reductions average between 50 to 75 percent for the sub-watersheds with the exception of Rock Creek (approximately 86 percent). The harvest and conversion of these of forested areas, especially in headwater tributaries, probably had significant impacts to the hydrology of the watershed.

The base flow of Hangman Creek may have been affected by the early land use conversions at the turn of the century. Actual increases of base flows following the removal of forested land have been reported in many different studies (Bates and Henry 1928; Troendle 1983; Van Haveren 1988). However in arid environments with high evapotranspiration rates, such as eastern Washington, these increases may be more dependent upon sufficient summer precipitation.

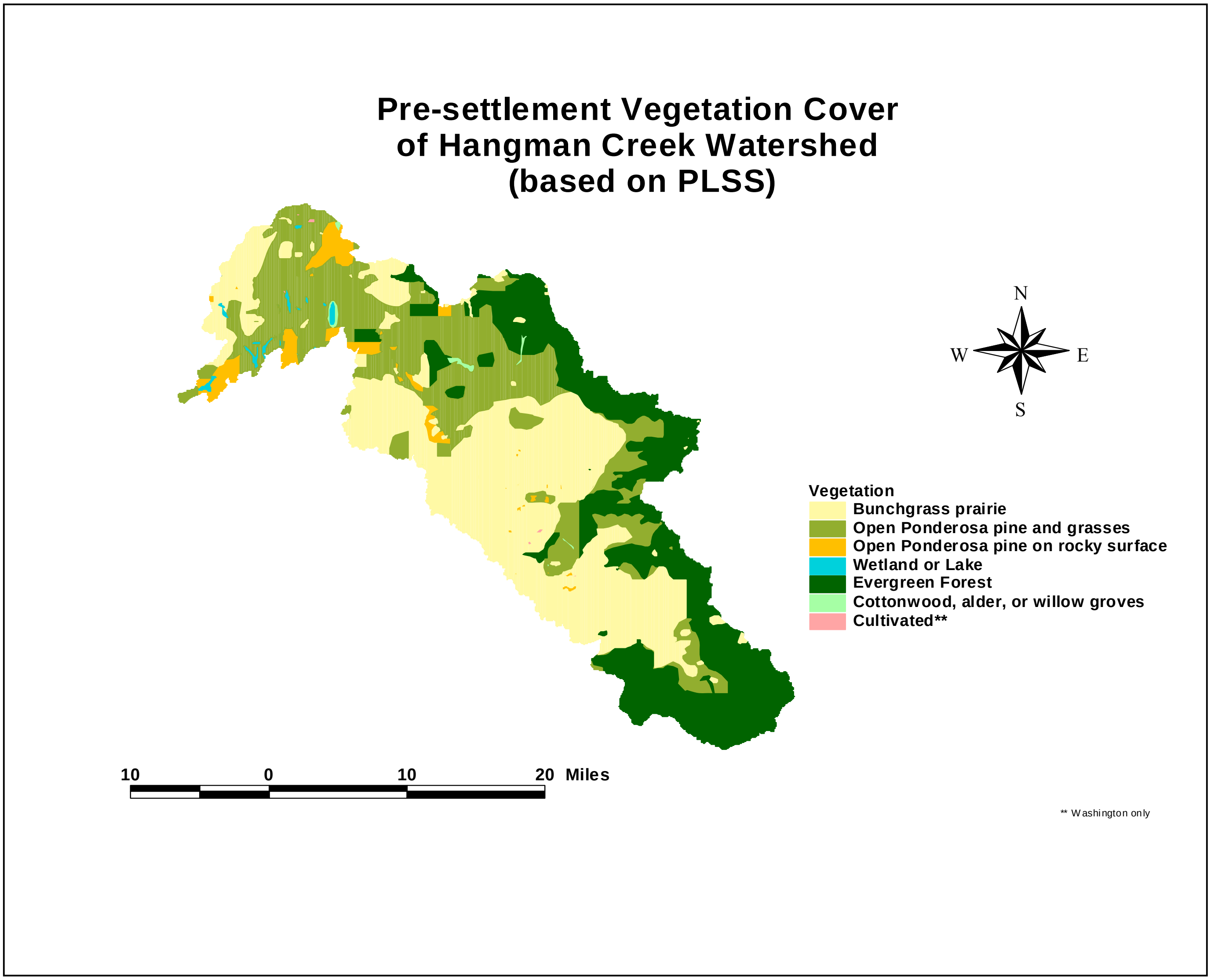

Figure 9 Pre-Settlement Vegetation Cover

Table 48: Land Use Changes in Hangman Creek (1870-2003)

Sub-watershed	Land Use	Land Uses (percent of sub-watershed area)		Net Change (pre-settlement to current, in percent)
		Pre-settlement	Current	
California Creek	Agriculture	0	55	55
	Developed	0	2	2
	Forested	96	23	-73
	Rock/Transitional	0	0	0
	Shrub/Steppe	4	19	15
	Wetland or Lake	0	0	0
Lower Hangman	Agriculture	0	30	30
	Developed	0	14	14
	Forested	67	18	-49
	Rock/Transitional	0	0	0
	Shrub/Steppe	29	36	7
	Wetland or Lake	3	0	-3
Marshall Creek	Agriculture	0	26	26
	Developed	0	6	6
	Forested	71	34	-37
	Rock/Transitional	0	1	1
	Shrub/Steppe	22	27	5
	Wetland or Lake	5	2	-3
Rock Creek	Agriculture	0	81	81
	Developed	0	1	1
	Forested	71	10	-61
	Rock/Transitional	0	0	0
	Shrub/Steppe	29	7	-22
	Wetland or Lake	1	0	-1
Upper Hangman	Agriculture	0	70	70
	Developed	0	1	1
	Forested	48	21	-27
	Rock/Transitional	0	1	1
	Shrub/Steppe	51	6	-45
	Wetland or Lake	0	0	0

Local watershed residents have reported that summer flows during the 1940 and 50s were much higher than what is currently observed (SCCD, 1998a). This may have been a response to the clearing of forest canopies throughout the watershed. The USGS records indicate that for the months of July through October (1948 – 1959), the average monthly flow never dropped below 12 cfs. However, based on the USGS seven-day low flow statistics, the critical base flow period (July – October) of Hangman Creek routinely reaches levels of 10 cfs and lower (at the mouth). Although these records indicate that there may be a slight downward trend in base flow, it is not considered significant.

Historical Water Balance

The historical water balance was developed through the application of the pre-settlement vegetative communities for each sub-watershed. The same methodology used by Buchanan and Brown (2003) in Section 3.5 was applied to calculate a new water balance. The most significant adjustment to the calculation, besides the vegetative cover, was the new evapotranspiration (ET) rates.

The ET rates of pre-settlement times were, on average, greater than the current rates due to the amount and density of vegetation. One of the major current vegetation land uses is small grains. Small grains have ET rates of approximately 11 inches per year, whereas the previously existing forested areas had ET rates ranging between 17 and 22 inches per year. This change in vegetation type results in an increased water surplus because less water is currently taken up and used by the vegetation than in historic times. The vegetation categories and the corresponding ET values that were used in the water balance are listed in Table 49.

Table 49: Historical Vegetation Evapotranspiration Rates

Vegetation Type	Evapotranspiration Rate (inches)
Bunchgrass prairie	11
Open Ponderosa pine and grasses	17
Open Ponderosa pine on rocky surface	17
Wetland or lake	47
Evergreen Forest	22
Cottonwood, alder, or willow groves	40
Cultivated	16

Notes:
1. Evapotranspiration rates based on information used in, and provided by, Buchanan and Brown (2003).

The historical water balance suggests that there was less water available as flow from Hangman creek during pre-settlement times than what is measured today. Buchanan and Brown (2003) reported a current watershed surplus of 192,854 acre-feet per year. The historical water balance calculations indicated a surplus of only 152,773 acre-feet per year (Table 50). Although a 40,000 acre-feet per year difference may reflect some error in the assumptions and estimations, the data suggests that the total water yield was about the same or lower in the past than what is currently measured. More importantly, the data suggests that historically there was not considerably more water in the watershed. Although the total water yield is probably greater now than pre-settlement, the availability of water for out-of-stream uses may be significantly less now during summer low flow periods. Pre-settlement base flows were probably higher and lasted longer into the dry summers due to longer retention of snow, greater wetland and riparian storage, slower surface runoff, and increased infiltration.

Table 50: Historic and Current Water Balance Parameters and Surplus

Water Balance Sub-Watershed Parameter	Sub-Watershed					Total Hangman Watershed
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	
Area (acres)	214,383	45,947	40,359	114,590	15,942	431,221
Precipitation (inches)	22.3	17.8	17.4	19.6	19.9	NA
Historic ET (inches)	15.5	16.2	17.1	17.2	18.7	NA
Current ET (inches)	14.9	15.9	15.6	14.7	19.5	NA
Historic Surplus (acre-feet per year)	121,168	6,051	860	23,125	1,569	152,773
Current Surplus (acre-feet per year)	132,203	7,275	6,054	46,791	531	192,854
Change in Surplus Historic to Current (acre-feet per year)	11,035	1,223	5,194	23,666	-1,037	40,081

Notes
1. ET is evapotranspiration.
2. NA is not applicable.
3. Evapotranspiration is a weighted value based on percentage of vegetation type for each sub-watershed.

The increased moisture surplus appears reasonable considering the land use changes that have occurred. In the Hangman Creek watershed, thousands of acres of forest canopy have been lost. This canopy loss likely resulted in a substantial reduction of snow and rain interception. However, the rate of snowmelt would be increased due to more direct exposure to solar radiation. Along with increased solar radiation, rain on snow events would melt the snow faster and substantially increase the size of peak flows in major flood events. It is during these major storm events that Hangman Creek currently suffers severe stream bank and channel damage along with significant sediment transport.

Sediment transport through the Hangman Creek system is significant, especially during extreme flood events. A cooperative study by the SCCD and USGS (1998-2001) recorded estimates of annual sediment discharge (suspended and bedload) ranging from 4,740 to 189,000 tons. The SCCD also estimated the total sediment load from 1906 to 1996 to be approximately 27.6 million tons.

Soil Erosion and Possible Changes in Erosion Rates

Historic pre-settlement soil erosion evaluations were done using the NRCS Revised Universal Soil Loss Equation (RUSLE) utilized in farm planning (NRCS Field Office Guide Book).

The soil loss equation predicts soil loss for different land uses, farm practices, and crop rotations. The final estimation of historic soil loss is based on a percentage of current estimated losses. A percentage was used because actual RUSLE soil losses for the entire watershed could not be estimated. The factors in the equation that would change, and how the predicted soil losses would be affected can be evaluated.

The soil loss equation is:

$A = RKLSCP$, where

A is the computed soil loss per unit area, usually expressed in tons per year
R is the rainfall and runoff factor
K is the soil erodibility factor
L is the slope-length factor
S is the slope-steepness factor
C is the cover and management factor
P is the support practice factor

Of the soil loss factors, R, K, L, and S should be approximately the same for both current and pre-settlement conditions. The only conditions that should significantly change based on historic and current land uses are the cover/management conditions and the support practice factors. When these factors were evaluated, it was assumed that the pre-settlement cover and management conditions would have been most like the no-till/low-till grass conditions and the support practice factor would be similar to, or better than contour farming. These assumed historic conditions are evaluated against current conditions of winter wheat, fallow, peas and spring grain crop rotations and strip cropping/cross-slope conservation practices.

For the cover and management factor C, the pre-development $C = 0.01$ (no till/low till grass) and the current $C = 0.10$ (small grain crop rotation). The percent decrease in soil loss is approximately:

Percent of current soil loss for C factor = $(0.01/0.10)*100 = 10$ percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

For the support practice factor P, assuming the pre-development conditions would be approximately half of the contour-farming factor $(0.50/2) = 0.25$. The current P factor is based on the average of up and down hill and contour farming (approximately 0.70). The percent decrease in soil loss is approximately:

Percent of current soil loss for P factor = $(0.25/.70)*100 \approx 37$ percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

The estimated historic soil loss would be approximately the reduction in C times the reduction in P. The historic soil loss is estimated as the percent of the current soil loss:

Historic soil loss = (10 percent)(37 percent)(current soil loss) = (0.10)(0.37)(current soil loss) $\approx$ 4 percent of the current soil loss from farmland. This represents a basin-wide historic soil loss that is approximately 96 percent less than the current basin-wide soil loss.

The current soil loss was estimated by the NRCS using the PSIAC model. The PSIAC model evaluated sediment yield in the Hangman basin. The factors included in the PSIAC model were: surface geology, soils, climate, runoff, topography, ground cover, land use, sediment transport, and upland and channel erosion. According to the PSIAC model, the estimated soil loss from farmland (SCCD, 1994) for the entire Hangman Creek watershed is 176,000 tons. The pre-settlement soil loss is estimated to have been approximately four percent of the total, or 7,000 tons per year.

4.3 Data Summary and Water Quality Implications

Although the Washington Department of Ecology has documented water quality violations of the state standards throughout the years, the number of reaches on the State's 303(d) list is only two (see Section 4.1 above). Past projects and studies were reviewed to evaluate the extent of water quality problems in Hangman Creek watershed. The sample locations from previous studies are shown on Figure 10, and a summary of the sample dates and parameters is provided in Table 51 (for the Idaho sites) and 55 (for the Washington sites). Details of the sampling are provided in Appendix K.

To evaluate the Hangman Creek main stem, it was divided into smaller reaches based on the results from the Proper Functioning Condition study conducted as part of this project. All major tributaries were evaluated as a whole, unless otherwise noted. Each reach and tributary was evaluated for water quality exceedances that would theoretically place it on the Ecology 303(d) list. Five categories of possible water quality actions were applied for each parameter to each main stem reach and/or tributary in the watershed:

1) **List** – One or more parameters exceed water quality standards within the reach or tributary that could require the reach or tributary to be placed on the 303(d) list or evaluated for TMDL listing,
2) **WOC** – Waters of Concern are sites with a single exceedance that may not provide enough statistical data and should be evaluated for listing.
3) **Sample** – There was a water quality violation immediately up or down stream, and the reach should be sampled short term and the results evaluated for placement on the 303(d) list or inclusion in a TMDL listing,
4) **Check** – There was no water quality violation near the reach – short term sampling is not required, and the reach should be monitored long term for trends,
5) **ND** - No data are available to evaluate the reach or tributary.

The main stem reaches evaluated are shown on Figure 11, and the township, range, and section are listed in Table 53. The water quality ranking for each reach and tributary is in Table 54.

Table 51: Idaho Water Quality Sampling Summary

Sample Location	Sample Dates	Parameters
Moctileme Creek	1998-2002	Field, TSS, TB, TKN, TP, Nutrients, FC
Indian Creek	1997-2002	Field, TSS, TB, TKN, TP, Nutrients. FC
Lolo Creek	2002	TSS, TB, TKN, TP, Nutrients, FC
Andrew Springs Creek	2000-2002	TSS, TB, TKN, TP, Nutrients
Mission Creek	2000	TSS, TB, TKN, TP, Nutrients
Smith Creek	2000	TSS, TB, TKN, TP, Nutrients
Hangman Creek at Sanders Road	2002	FC
Little Hangman Creek at Whistocken	1998-2002	Field, TSS, TB, TKN, TP, Nutrients
Little Hangman Creek at Agency	2002	Field, TSS, TB, TKN, TP, Nutrients, F C
North Fork Rock Creek at Hwy. 58	1998-2002	Field, TSS, TB, TKN, TP, Nutrients
North Fork Rock Creek at Railroad	1998-2002	Field, TSS, TB, TKN, TP, Nutrients
North Fork Rock Creek at Hatchery	1999-2002	Field

Notes:

1. Sample date ranges may not be annual sampling periods, see Appendix K for more detail.
2. Field parameters include some or all of temperature, dissolved oxygen, pH, and conductivity, see Appendix K for details.
3. TSS is total suspended solids.
4. TB is turbidity.
5. TKN is total Kjeldahl nitrogen.
6. TP is total phosphorus.
7. Nutrients is Cl, F, SO_4, NO_2, NO_3, and Ortho-Phosphate.
8. FC is Fecal Coliform bacteria.

There are 31 hydrologic segments within the watershed, six tributaries and 25 main stem reaches. The historic water quality sample results were used to evaluate these segments for possible listing on the Ecology 303(d) list or for inclusion in a TMDL listing. Of the 31 segments, only two (main stem reaches 1 and 22) are already included on Ecology's 303(d) list.

Sixteen segments (main stem reaches 6, 10, 12, 13, 14B, 15, 16, 19 20, and 21A-C, and Rattler Run Creek, Rock Creek, California Creek, and Marshall Creek) should be considered. for future listing or be reviewed (Table 52). Four segments (main stem reaches 3, 4, 8, and 9) should be checked and monitored long term. All reaches should be checked in the short term for temperature exceedances. Nine segments (main stem reaches 2, 5, 7, 11, 14A, 17, and 18, and Little Hangman Creek and Hangman Creek in Idaho) should have a sampling programs started to provide a more complete assessment of background conditions.

Table 52: Washington Water Quality Sampling Summary

Sample Location	Dates	Parameters
Hangman Creek at State Line	1994-2002	Field, TSS, TB, TKN, TP, Nutrients, NH_3
Hangman Creek at Tekoa	2001	Field, TKN, TP, N, Majors, FC
Little Hangman Creek at State Line	1994-2002	Field, TSS, TB, TKN, TP, Nutrients, Majors
Hangman Creek at Marsh Road	2001	Field, TKN, TP, N, Majors, FC
Cove Creek	2001	Field, TKN, TP, N, Majors, FC
Unnamed Tributary near Waverly, Southern	1995-1999	Field, TSS, TB, N, TP,
Unnamed Tributary near Waverly, Northern	1995-1999	Field, TSS, TB, N, TP,
Hangman Creek at Roberts Road	2001	Field, TKN, TP, N, Majors, FC
Rattler Run Creek Mouth	1994-2002	Field, TSS, TB, TKN, TP, FC, N, Majors
Rattler Run Creek above Fairfield	2001-2002	Field, TSS, TB, TKN, TP, FC, N, Majors
Rattler Run Creek u/s of Treatment Plant	2001-2002	Field, TSS, TB, TKN, TP, FC, N, Majors
Rattler Run Creek d/s of Treatment Plant	2001-2002	Field, TSS, TB, TKN, TP, FC, N, Majors
Rattler Run Creek at Darknell Road	2001-2002	Field, TSS, TB, TKN, TP, FC, N, Majors
Hangman Creek at Bradshaw Road	1995-2001	Field, TSS, TB, TKN, TP, FC, N, Majors, BL
Hangman Creek at Keevy Road	1995-2001	Field, TSS, TB, TKN, TP, FC, N, Majors
Hangman Creek u/s of Rock Creek	2001	Field, TKN, TP, N, Majors, FC
Rock Creek at Mouth	2001	Field, TKN, TP, N, Majors, FC
Rock Creek at Jackson Road	1994-1997	Field, TSS, TB, N, TP, FC, BL
Hangman Creek at Duncan	2001	Field, TKN, TP, N, Majors, FC
California Creek at Mouth	2001	Field, TKN, TP, N, Majors, FC
Hangman Creek d/s of H.V. Golf Course	2001	Field, TKN, TP, N, Majors, FC
Hangman Creek 2 miles south of Hatch Rd	2001	Field, TKN, TP, N, Majors, FC
Hangman Creek at Yellowstone Pipeline	2001	Field, TKN, TP, N, Majors, FC
Hangman Creek u/s of Marshall Creek	2001	Field, TKN, TP, N, Majors, FC
Marshall Creek at Mouth	2001	Field, TKN, TP, N, Majors, FC
Marshall Creek Headwaters (Site A)	1999-2000	Field, TP, N, FC, SRP
Marshall Creek at Horton's RR Bridge (Site B)	1999-2000	Field, TP, N, FC, SRP
Marshall Creek at Green's (Site C)	1999	Field, TP, N, FC, SRP
Marshall Creek at Shepard's Crossing (Site D)	1999	Field, TP, N, FC, SRP
Marshall Creek at Miller's Reach	2000	Temperature, DO
Marshall Creek at Fowler's Reach	2000	Temperature, DO
Marshall Creek at Cemetery Site (Site E)	1999-2000	Field, TP, N, FC, SRP
Hangman Creek at USGS Gage Site	1972-2002	Field, TSS, TB, TKN, TP, FC, N, Majors, BL

Notes:

1. Sample date ranges may not be annual sampling periods, see Appendix K for more detail.
2. Field parameters include some or all of temperature, dissolved oxygen, pH, and conductivity, see Appendix K.
3. TSS is total suspended solids.
4. TB is turbidity.
5. TKN is total Kjeldahl nitrogen.
6. TP is total phosphorus.
7. Nutrients is Cl, F, SO_4, NO_2, NO_3, and Ortho-Phosphate.
8. Majors are Cl, SO_4, HCO_3, Ca, Mg, K+Na
9. FC is Fecal Coliform bacteria.
10. SRP is soluble reactive phosphorus.
11. BL is bedload sediments.

Table 53: Hangman Reach Location using Township, Range, and Section

Reach Number	Location by Townships, Ranges, and Sections
1	T20N, R45E, Sections 11,12, and 13; T20N, R 46E, Sections 18,19, and 20
2	T20N, R45E, Section 11
3	T20N, R45E, Sections 10 and 11
4	T20N, R45E, Sections 4 and 9
5	T20N, R45E, Section 4; T21N, R44E, Sections 20,21,28, and 33
6	T21N, R44E, Sections 1, 2, 12, and 13; T21N, R45E, Sections 7, 17, 19, and 20
7	T21N, R44E, Section 2
8	T21N, R44E, Sections 2 and 3; T22N, R44E, Section 34
9	T22N, R44E, Section 33
10	T22N, R44E, Sections 28 and 33
11	T22N, R44E, Sections 21 and 28
12	T22N, R44E, Sections 16 and 21
13	T22N, R44E, Sections 5, 8, 16, and 17; T23N R44E, Sections 31 and 32
14A	T23N, R44E, Section 30; T23 N, R43E, Sections 24 and 25
14B	T23 N, R43E, Sections 13 and 24
15	T23 N, R43E, Sections 11, 13, and 14
16	T23N, R43E, Sections 2 and 11
17	T23 N, R43E, Sections 2 and 3
18	T23 N, R43E, Section 3
19	T24N, R43E, Sections 21, 27, and 28
20	T24N, R43E, Sections 8, 16, and 17
21A	T24N, R43E, Sections 5 and 8
21B	T24N, R43E, Sections 5 and 6
21C	T24N, R43E, Sections 5 and 6; T25N, R43E, Section 31; T25N, R42E, Sections 25 and 36
22	T25N, R42E, Sections 17, 23, 24, and 25

4.4 Sources of Water Quality Degradation

Potential point and non-point source pollution locations were documented for the main stem of Hangman Creek. Ground observations were completed using canoes to float the length of Hangman Creek from the State Line to the mouth. Aerial photos and global positioning system (GPS) units were used to locate and document sources and degree of degradation, as well as existing riparian vegetation and bedrock outcrops. Field notes were taken to accompany the GPS points.

Table 54: Hangman Creek Water Quality Rating by Reach and Tributary

Reach or Tributary	Water Quality Ranking for placement on 303(d) list or TMDL evaluation								
	Based on Washington State Standards						Based on EPA Standards		
	Temp.	Turb.	Fecal Colif.	pH	DO	Ammonia	Total Phos.	Nitrite	Nitrate
1	List	List	List	Check	List	ND	List	ND	ND
2	Sample	Sample	Sample	Check	Sample	ND	Sample	ND	ND
3	Sample	ND	ND	ND	ND	ND	ND	ND	ND
4	Sample	ND	ND	ND	ND	ND	ND	ND	ND
5	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sampl e	Sample
6	Sample	List	List	Check	List	Check	List	Sampl e	List
7	Sample	Sample	Sample	Check	Sample	Check	Sample	Sampl e	Sample
8	Sample	ND	ND	ND	ND	ND	ND	ND	ND
9	Sample	ND	ND	ND	ND	ND	ND	ND	ND
10	List	ND	ND	ND	ND	ND	ND	ND	ND
11	Sample	Sample	Sample	Check	Sample	ND	Sample	Check	Check
12	List	List	List	Sample	List	ND	List	Check	Check
13	List	Sample	Sample	WOC	Sample	ND	Sample	Check	Check
14A	Sample	Check	Check	Sample	Check	Check	Check	Check	Check
14B	List	Check	Check	Sample	Check	Check	Check	Check	Check
15	List	Sample	WOC	WOC	Sample	Check	Sample	Sampl e	Check
16	List	Sample	Sample	WOC	Sample	Check	Sample	Sampl e	Check
17	Sample	Sample	Sample	Sample	Check	Check	Check	Check	Check
18	Sample	Check	Check	Sample	Check	Check	Check	Check	Check
19	List	Check	Check	WOC	Check	Check	Check	Check	Check
20	List	Check	Check	Sample	Check	Check	Check	Check	Check
21A	List	Check	Check	Check	Check	Check	Check	Check	Check
21B	List	Check	Sample	Check	Check	Check	Check	Check	Check
21C	List	Sample	Sample	Sample	Sample	Sample	Sample	Sampl e	Sample
22	List	List	List	List	List	List	List	List	List
HC-I	Sample	Sample	Sample	Check	Sample	ND	Sample	ND	ND
LHC	Sample	Sample	Sample	Check	Sample	ND	Sample	ND	ND
RRC	List	List	List	List	List	List	List	List	List
RC	List	List	List	List	List	Check	List	Check	List
CC	ND	ND	WOC	ND	ND	ND	ND	ND	ND
MC	Sample	Check	WOC	Check	WOC	Check	Check	Check	Check

Notes:

1. Temp. is temperature.
2. Turb. is turbidity.
3. Colif. is coliform.
4. DO is dissolved oxygen.
5. Phos. is Phosphorus.
6. WOC is waters of concern.
7. HC-I is the portion of Hangman Creek main stem in Idaho.
8. LHC is Little Hangman Creek.
9. RRC is Rattler Run Creek.
10. RC is Rock Creek.
11. CC is California Creek.
12. MC is Marshall Creek.

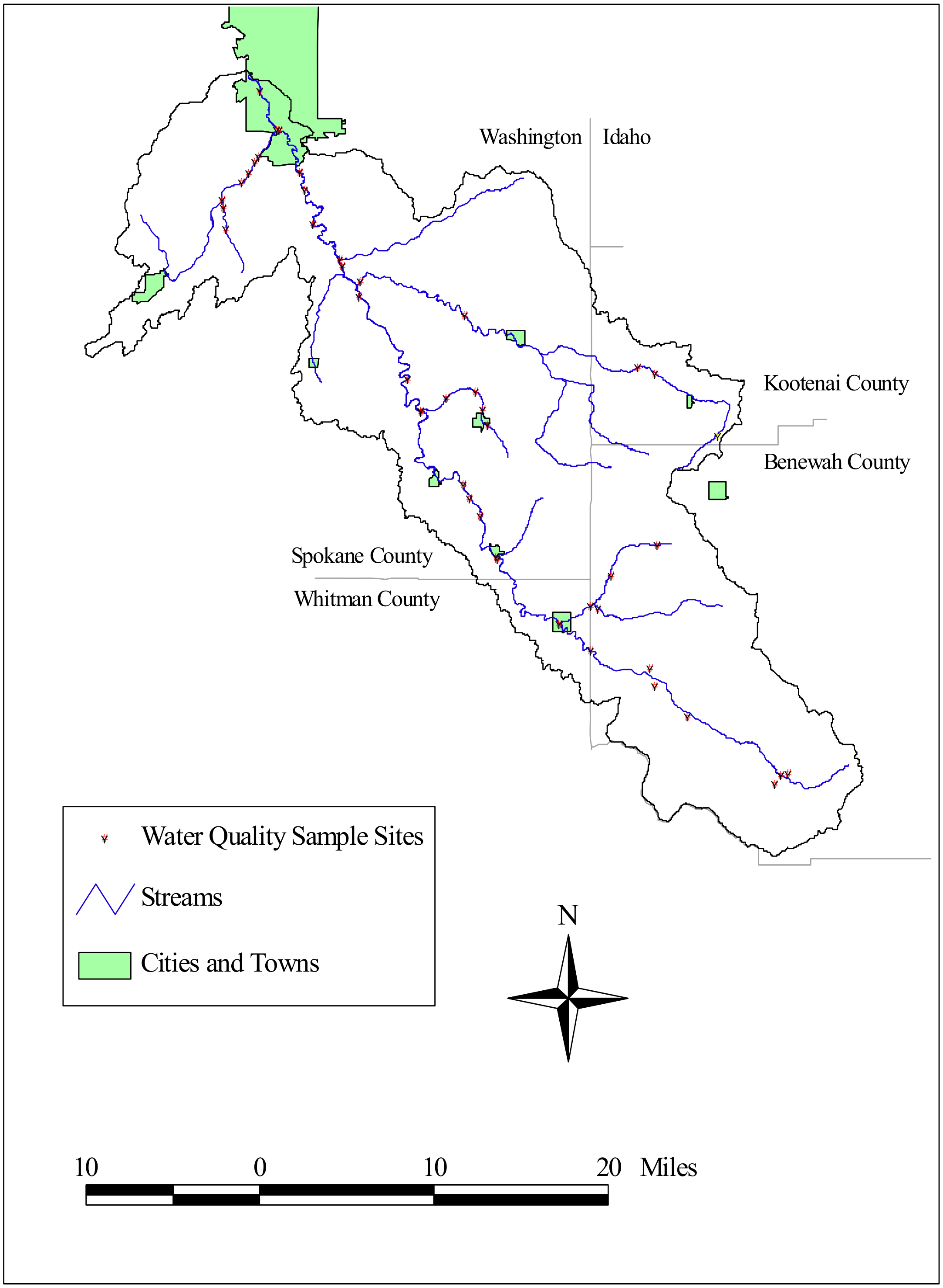

Figure 10: Water Quality Sample Sites

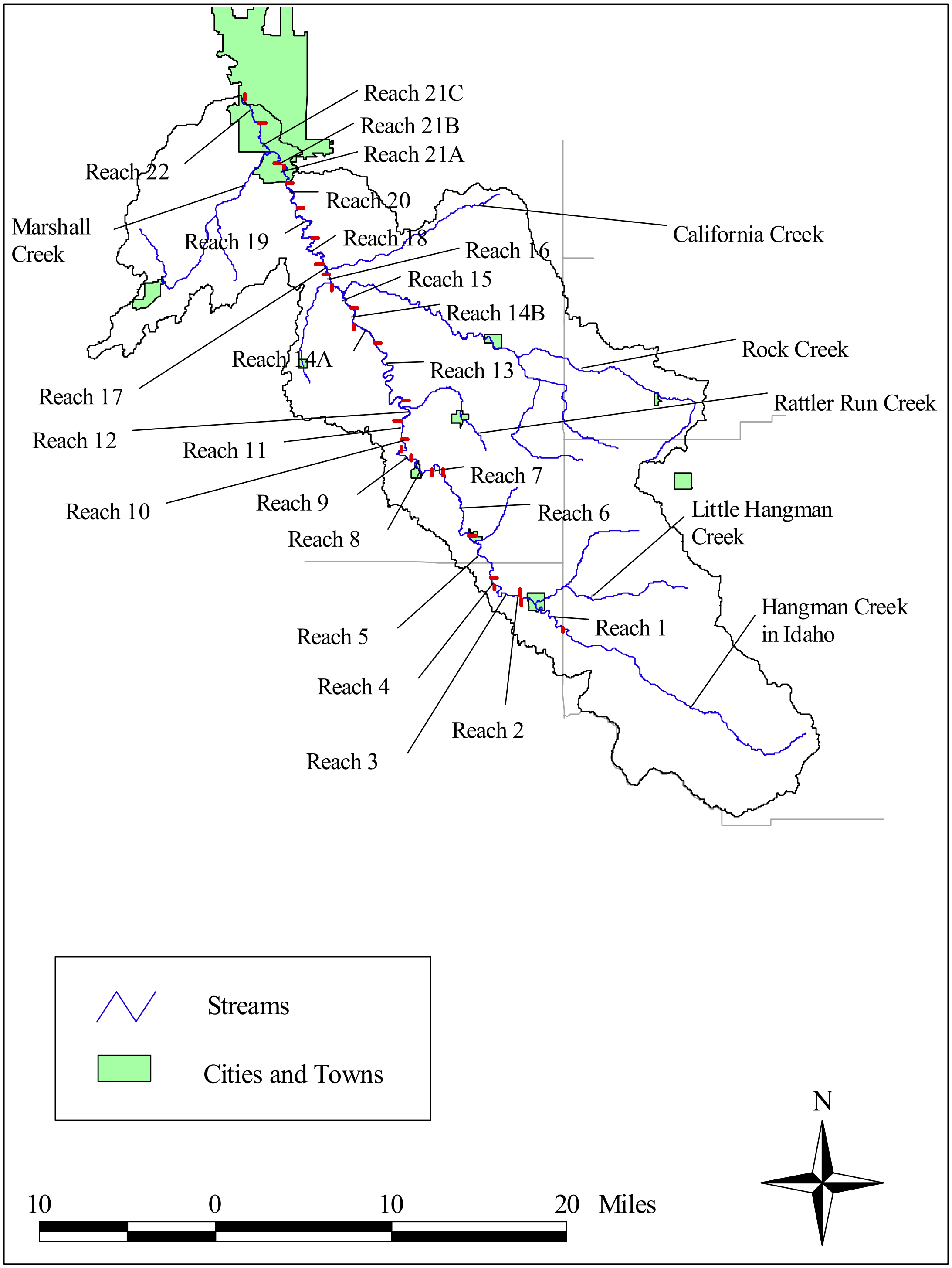

Figure 11: Hangman Creek Main Stem Reaches and Tributaries

Point sources included actively flowing ditches, culverts, pipes, tile drains, and stream crossings for the stream flow and weather conditions during the observation period (Table 54). However, ditches, culverts, and pipes that were inactive could be active during snowmelt or large rain events, therefore the number of point sources could vary from the number reported. Springs, tributary, and pump suctions were also noted.

Point sources were defined as:

- Crossing – a stream crossing that could cause some water quality degradation.
- Culvert – any culvert that discharged to Hangman Creek. The source for the culvert was not investigated, but they were generally small streams or ditches diverted under roads.
- Ditch – any drainage that was artificially channeled to Hangman Creek.
- Pipe – any pipe that, if flowing, would discharge to Hangman Creek. It is not known if the pipes are currently being used. Wastewater treatment facilities were included.
- Tile – discharges for field tile operations were marked when found.

Non-point sources were limited to stream bank erosion areas. The eroding banks were identified, and the length and average height of the erosion noted. Tall sediment banks or bluffs (typical in the lower third of the watershed) were evaluated for the erosion height using the scree slope. The scree slope is the material accumulating at the base of, and obviously derived from the cliff or bluff. It was assumed that the scree slope would erode similar to a cut bank. The erosion heights ranged from approximately four to 300 feet. The lengths of the erosion varied from approximately 50 to 1,450 feet (Table 55).

Pollution potential was estimated for each reach based on the number of point sources and/or the extent of non-point pollution sources. The pollution potential was considered high if there were more than 10 possible point source inputs, or if the average erosion height was greater than 30 feet. The pollution potential was considered low if the number of possible point source inputs was less than three, or the erosion length was less than 300 feet (except for Reach-7 that had an erosion length of 1,152 feet but no point source inputs or agricultural impacts). All other reaches were considered moderate for possible pollution potential.

4.5 Water Quality Issues Related to Stream Flow

Several water quality issues are related to Hangman Creek flow conditions. Both the extreme high and low flows found in Hangman Creek can exacerbate select water quality parameters. High flows tend to increase water quality problems related to sediment and low flows effect temperature, dissolved oxygen, and pH. For some parameters, such as fecal coliform bacteria, both high and low flows can effect the water quality, but in different ways.

Under low flow conditions, several sections of Hangman Creek and its tributaries become semi-stagnant. The stagnant pools result in extremely slow water velocities with low oxygen levels, higher water temperatures, and more algae and plant growth. Under low flows, the water entering the stream is generally base flow from ground water. As the base flow enters the large wide pools, the slow water velocity allows significant solar heating.

Table 55: Potential Pollution Sources Summary

Reach	Non-Point Sources			Point Sources					Reach Pollution Potential
	Erosion		Ag Impact	Crossing	Culvert	Drainage or Ditch	Pipe	Tile Drain	
	Total Length (ft)	Average Height (ft)							
1	456	7.0	AG,T,L	0	0	8	1	1	High
2	198	6.0	AG	0	0	1	0	0	Low
3	401	7.0	AG, T	0	3	2	0	0	Moderate
4	177	7.0	AG	0	0	2	0	0	Low
5	914	4.4	AG,T,L	1	2	1	0	0	Moderate
6	3,011	6.6	AG, L	0	6	10	1	3	High
7	1,152	5.0	None	0	0	0	0	0	Low
8	1,758	5.5	AG, L	0	1	1	0	0	Moderate
9	2,432	5.2	AG, L	0	0	0	0	0	Moderate
10	483	5.1	AG, T	0	1	1	0	0	Low
11	1,017	5.7	L	0	0	1	0	0	Low
12	1,298	5.0	AG, L	0	0	2	0	0	Moderate
13	3,735	5.2	None	0	0	5	0	0	Moderate
14A	1,802	7.1	AG, L	1	0	1	0	0	Moderate
14B	2,295	7.9	L	0	0	0	0	0	Moderate
15	4,731	11.4	AG, L	0	0	2	0	0	Moderate
16	0	0	L	0	0	1	0	0	Low
17	0	0	None	0	0	1	0	1	Low
18	5,105	40.3	AG, T	0	0	2	0	0	High
19	2,169	48.1	AG, T	0	0	1	0	0	High
20	1,673	38.2	None	0	0	1	0	0	High
21A	2,563	134	None	0	0	0	0	0	High
21B	249	15.2	None	0	0	0	0	0	Low
21C	4,091	139	None	0	1	2	2	0	High
22	903	80.2	None	0	2	2	0	0	Moderate

Notes:

1. Reaches are for the Hangman Creek main stem as described in the Proper Functioning Condition section.
2. Erosion lengths are the total of all erosion segments noted in the reach. The average erosion height is the weighted average for the erosion segments.
3. Agricultural impacts are AG if agriculture is predominant in the reach, T if tillage is to the stream bank edge, and/or L if livestock has access to the creek.

Under low flow conditions, several sections of Hangman Creek and its tributaries become semi-stagnant. The stagnant pools result in extremely slow water velocities with low oxygen levels, higher water temperatures, and more algae and plant growth. Under low flows, the water entering the stream is generally base flow from ground water. As the base flow enters the large wide pools, the slow water velocity allows significant solar heating.

During low flows, the water temperature tends to be high and the dissolved oxygen low. This is partly because of the solubility of oxygen in water at higher temperatures is lower. Also, as mentioned before, the velocity is significantly lower, increasing the time the water can solar heat. Plant decay in the slower waters can consume oxygen, further reducing the dissolved oxygen during low flow conditions. Extensive communities of Reed Canarygrass (*Phalaris arundinacea*) within the channels provide significant amounts of biomass. Both pH and fecal coliform bacteria parameters violate state standards during low flow conditions. The increased temperature and slower stream flows tend to provide a better environment for the bacteria to breed. The pH tends to violate water quality standards due to the decay of vegetation.

Moderate to moderately high flows generally have the best water quality. Under the higher flows, the water tends to be better oxygenated, cooler, and is able to flush out and dilute pollutants. Under the moderate to moderately high flows, the water entering the stream is a combination of both increased ground water flows with some overland flow. Generally, the ground water inflow has increased because of infiltration from precipitation. The overland flow is usually a small component of the total flow.

Under higher flood flows from heavy rains or snowmelt, the portion of overland flow is significant. The stormwater picks up a variety of pollutants as it moves over the soil surface and washes off roads. These pollutants include sediment, deicing chemicals, animal wastes, oil and grease, heavy metals, pesticides, and lawn and farm fertilizers.

Higher flood flows tend to increase water quality parameters that are more directly related to surface runoff and water velocity. Both turbidity and suspended sediment generally exceed the state standards during higher flows because of the increased carrying capacity of the water. Data collected by the SCCD show a weak correlation between increased stream flows, sediment, and nutrient parameters such as total phosphorus, nitrate, nitrite, and ammonia. Although the correlation between stream flow and nutrients is weak, nutrient exceedances tend to be higher during the fall and winter months. It is believed that the increase in eroded sediment from farm fields carries some of the applied nutrients into the water system. Fecal coliform bacteria tend to exceed state standards during high flows because it is washed off the ground by overland flow into Hangman Creek. The only exception to this is the Rattler Run watershed where total phosphorus exceeds the EPA standard during both low and high flows.

4.6 Recommendations (Short and Long Term)

The water quality evaluation was used to identify tributaries and reaches where future data collection efforts (both long term and short term) could be directed. The following tributary and reaches are recommended for future short-term sampling efforts:

- Nitrogen levels throughout the Vinegar Flats area.
- The entire length of Marshall Creek.
- California Creek above Highway 27.
- California Creek near the canyon mouth (including the IFIM site in the canyon).
- Rock Creek above Rockford, tie to samples at the confluence with Hangman Creek.
- PFC reaches and tributaries listed as "sample" and outlined in Table 53, above.
- Conduct TMDL assessment for watershed.

For long term monitoring, PFC reaches and tributaries listed as "check" and outlined in Table 53 above should be scheduled for monitoring to track trends. Currently, the long-term trends do not appear to be changing for temperature and dissolved oxygen. These water quality parameters may not be achievable. Other analyses that are low flow dependent, such as fecal coliform should also be evaluated. At this time, all parameters currently on the 303(d) list should remain on the list. Additional reaches and tributaries should be listed as detailed in Table 53.

4.7 TMDL Evaluation and Schedule Recommendation

The SCCD received a grant in 2003 to conduct a Total Maximum Daily Load (TMDL) project on Hangman Creek. The Hangman Creek TMDL process will be designed to complement ongoing TMDL and water quality work being done on the Spokane River. Hangman Creek is suspected to be the largest contributor of bedload and suspended sediment to the Spokane River. The majority of the bedload portion of the sediment load is transported downstream and deposited behind Avista's Nine Mile Dam. The suspended sediments continue through the dam's bypass system and settle out in Lake Spokane.

Both phosphorus and suspended sediment are known water quality issues for not only Hangman Creek, but also for both the Spokane River and Lake Spokane. The Department of Ecology's Dissolved Oxygen Draft Pollutant Loading Assessment for the Spokane River and Lake Spokane indicates that numerous historic studies have identified phosphorus loading to Lake Spokane to be directly responsible for low dissolved oxygen, excessive phytoplankton populations, and overall poor water quality during the summer period. The studies also indicate that the poor water quality can be directly related to upstream sources. The pollutant loading assessment also identifies higher nutrient concentrations in both Hangman Creek and the Little Spokane River, compared to the Spokane River at the Stateline.

A Use Attainability Analysis (UAA) may be appropriate for the Hangman Creek Watershed in
the future. The PU agrees that certain beneficial uses might not be achievable. The PU and WIT will continue to discuss the possibility of supporting a UAA process in Hangman Creek

and will monitor the current TMDL workgroup's progress and discussions. A UAA may or may not be supported from data collection and discussions resulting from the current TMDL process.

The TMDL project will initiate the first two phases of a stakeholder driven TMDL process for Hangman Creek. It will further identify and evaluate pollutant causes, develop TMDLs, and conduct whole farm planning in the watershed. The project will focus on the reduction of pollutants listed on the 1998 303(d) list and other parameters of concern as suggested in Table 53. This project is broken into two phases, and outlines a scope of work for Phase III. The development of the Hangman Creek TMDL Action Plan will strongly promote and reward voluntary stewardship efforts. It will result in water quality standards being met as soon as possible and have strong and widespread support.

Phase I:
Phase I will include the initiation of the working group and identify affected parties. The water quality conditions, data gaps, pollution sources, and loading capacity will be identified and evaluated.

Phase II:
Phase II will develop implementation and management recommendations for improving water quality along with a timetable for implementation and evidence of results. This phase will develop a monitoring plan to monitor effectiveness. Phase II funding is available to hire a farm planner to assist in developing farm plans and implementation of BMPs.

Phase III:
Phase III is not part of the current TMDL grant program, but will outline future action plan implementation funding. Cost-share funding, low-interest loans, and federal programs will be outlined. Water quality awareness and education programs will be continued. Monitoring programs will be setup to evaluate long-term water quality trends.

5.0 PHASE II: MULTI-PURPOSE STORAGE OPTIONAL ELEMENT

The purpose of the storage assessment was to identify a range of possible water storage options. Several selected options were evaluated in greater detail. The work presented in the Golder report was conducted in two steps. The first step consisted of characterizing the hydrology of the watershed from a perspective of water storage. A broad range of storage related options and concepts were considered for inclusion in a watershed plan. These included the following concepts (Golder, 2004a):

- Dams and surface water reservoirs;
- Wetland and riparian storage enhancement;
- Beaver ponds;
- Direct injection to groundwater;
- Enhanced surface water recharge to groundwater;
- Streamflow augmentation with groundwater;
- Snow fences;
- Distributed small-scale catchments;
- Public water system storage;
- Spreader structures;
- Vegetated filter strips;
- No-Till/direct seed agricultural practices;
- Water conservation;
- Agricultural best management practices;
- Erosion control models; and,
- Water marketing.
- Reforestation

Several of these options were considered to be adequately addressed through other programs (e.g., no-till/direct seed is being promoted by the Spokane County Conservation District). Others were considered adequately addressed by the work conducted to date (e.g., beaver ponds). The following options were retained for further evaluation in the second step:

- Streamflow augmentation with ground water;
- Wetland and riparian storage enhancement;
- Distributed small-scale catchments;
- Dams and surface water reservoirs; and
- Reforestation

Additional details were developed for many other options, and all findings from the first and second steps are contained in the Golder 2004a report (Appendix N). Along with storage options, the public water systems of the seven principle watershed communities were evaluated for storage, unaccounted losses, additional storage needed, fire storage capacity, and average per capita water use. The principal findings presented below are from the Golder, 2004 Draft Multi-Purpose Storage Assessment for Hangman (Latah) Creek Watershed report (October 2004).

5.1 Public Water Systems

Storage infrastructure needs and water use for seven public drinking water systems in the basin were inventoried. Information was obtained from available water system plans, the Washington Department of Health (DOH), and discussions with the representatives of the system owners/operators. Findings on water system storage needs are summarized in the following table:

Table 56: Summary of Water System Storage and Water Use

	Storage				
	Current (% above needed storage)	**Year When Additional Storage Needed**	**Fire Storage Capacity**	**Unaccounted Water Use**	**Average Per Capita Water Use** (gpd)
Cheney	Excellent (+143%)	>2020	OK	OK (11%)	159
Fairfield	Good (+18%)	Unknown	OK	OK (10%)	215
Latah	Good (+12%)	>2023	Very Minimal	High (27%)	257
Rockford	OK (+3%)	2014	OK	Moderate (<25%)	249
Spangle	Insufficient (-23%)	Unknown	OK	Very High (39%)	200
Tekoa	Excellent (+85%)	Unknown	OK	Moderate (<25%)	246
Waverly	Good (+14%)	2009	Very Minimal	Good (5%)	241

Notes:
1. Spangle unaccounted water use amounts may be an artifact of data reliability.

There are minimum storage requirements defined by DOH for public water systems, and additional guidelines are available from professional organizations (e.g., the American Public Works Association). Storage is needed for reliability of water supply and for public safety such as fire protection. How the storage is nominally accounted among the various components is subjective. Total available storage remains the same regardless to which water system component storage is assigned. For example, storage for the City of Spangle could be considered "OK" if less were assigned for fire protection, but then the amount assigned to fire protection would be considered "minimal."

Per capita water use varies from 159 gallons per capita per day (gpcpd) for the City of Cheney to 257 gpcpd for the Town of Latah. The daily per capita water use for the City of Cheney is anomalously low because of the seasonal nature of the college student population. Average per capita use excluding the City of Cheney is 235 gpcpd and is considered typical in this part of the state.

Less than 10% unaccounted water is considered acceptable. The City of Spangle has on the order of 40% unaccounted water. However this may be an artifact of the available data, and the City should evaluate the available data, and if substantiated, the cause(s) of unaccounted water. The communities of Latah, Rockford and Tekoa all have approximately 25% unaccounted water and further evaluate the causes of unaccounted water.

5.2 Streamflow Augmentation with Groundwater

The direct augmentation of streamflow by pumping of groundwater was evaluated at four localities. Individual well yields are estimated to range from 0.3 to 2.0 cfs. Actual well yields are quite variable and can only be determined upon installation of wells. Distributing the points of withdrawal along the length of the upper watershed avoids concentrating the stresses on the aquifer, and provides for a more natural gradual increase in streamflows along the reaches.

Two of these sites had flowing artesian conditions. Non-flowing conditions exist at all sites, depending on the ground surface elevation of the specific well site. Installation details for new wells were estimated for each site and range in cost from approximately $85,000 to $120,000. Annual pumping costs range from zero to $12,000 a year, assuming a three-month period of augmentation and depending on whether flowing artesian conditions are used to withdraw water or whether a pump is needed.

Water rights would be required for implementation, except at the Tekoa site where a municipal water right may be used for this purpose. Feasibility/pilot testing may be accomplished with a temporary (e.g., three month) or preliminary permit. JARPA permits would be required for the discharge of water to the stream. Additional ecological habitat may be built into the program in the form of wetland creation. Water quality considerations have not been evaluated, but any concerns may be partially if not completely addressed by delivery of water through wetlands. Pilot testing should be conducted. Water levels should be monitored for a full year, and flow monitoring should be monitored at least for the duration of the streamflow augmentation testing, and possibly for a full year if the well is also being used for domestic or other purposes.

A groundwater augmentation of streamflow program should also evaluate the sustainability from the perspective of a basin water balance. Such a program is fully sustainable if the augmentation rate is a negligible amount of total groundwater recharge, groundwater recharge is induced by the groundwater withdrawal, or there are other mitigating variables (e.g., concurrent artificial recharge, modification of current land use patterns, etc.). Groundwater recharge in the Hangman watershed is very low. Assuming an average annual recharge rate of one inch across the basin, total annual groundwater flux is on the order of 50 cfs. A proper assessment of this should be conducted as part of a feasibility study.

5.3 Wetland Restoration

Two wetland complexes were identified for restoration and water storage in WRIA 56. Wetland Complex A contains seasonal, palustrine emergent wetlands totaling 178 acres and could provide a maximum of 531 acre-feet of water storage capacity. Wetland Complex B contains 288 acres of restorable wetland and could provide a maximum of 694 acre-feet of water-storage capacity. Drained wetlands could be managed through water level control structures to store water during high flow periods and release water to streams during low flow periods. Only the lower, downstream reach of Hangman Creek would benefit from increased streamflows by these wetland restoration projects. Costs for restoring these two wetland complexes range from $25,000 to $150,000 per site.

Restoration of riparian areas in WRIA 56 could increase soil moisture storage and help attenuate high flows. Seventy parcels of high priority riparian areas for restoration in the upper Hangman Creek watershed have been identified in the Coeur d'Alene Tribes Habitat Prioritization Plan and efforts are ongoing to protect and restore these high quality riparian areas. These riparian parcels encompassed an estimated total 8,758 acres, with an average parcel size of 125 acres. Exact quantification of water storage that can be obtained by riparian restoration is unknown.

5.4 Catchment and Balancing Basins

Catchment basins are shallow excavations (< 4 feet deep) in areas adjacent to or near streams. They are designed to capture surface water runoff from adjacent hillsides and allow it to infiltrate to groundwater. Due to high sediment yields, catchment basins in the lower portion of the watershed have limited applicability. As a result of the high amount of sediment in this portion of the watershed, catchment basins would need to be very large or limited to relatively small watershed locations. If catchment basins were limited to locations with a contributing area of 1,000 acres or less, 82 catchment basins would be needed to attain the 600 acre-feet of water storage. The total cost for development of these catchment basins would be approximately $4,700,000 and the annual maintenance to remove sediments would be approximately $2,350,000.

Due to lesser amounts of sediment in the upper watershed, only 40 catchment basins would be needed in the upper watershed to attain the 600 acre-feet of water storage. Catchment basins in the upper watershed would enhance streamflows throughout the majority of the length of Hangman Creek. However, they would still need to be placed in areas with generally smaller contributing areas. The total cost for catchment basin development in the upper watershed for 600 acre feet of storage would be approximately $2,280,000, with an annual maintenance cost of $295,000.

Balancing basin are deep ponds designed to store runoff during peak periods and release the water slowly to the stream after the flood peak has passed. Balancing basins are connected to streams and are fed by streamflow during high flows. Water is returned directly to streams during low flows via an outlet structure. The total cost for six basins would be approximately $2,000,000.

5.5 New Dams

Potential new dam sites were identified in WRIA 56 based on appropriate geology (bedrock/basalt), topography and catchment size. Two sites near the town of Spangle and one on Smith Creek in the Upper Hangman watershed were identified as potential sites for placement of new dams in WRIA 56. The Courtney Canyon Dam site near Spangle could store between 55 and 991 acre-feet of water, the Spangle Creek Dam site near Spangle would store a maximum 495 acre-feet and the Smith Creek Dam site could store 534 acre-feet. A storage volume of 600 AF can sustain a streamflow augmentation of approximately 3 cfs for three months.

Dams would be designed to release stored water back to the stream during low flow period and provide a durable and efficient fishway according to Chapter 77.55.060 RCW. The two dam sites near Spangle would benefit the middle and lower portion of Hangman Creek, while a dam at Smith Creek in the headwaters of Hangman Creek would benefit the majority of the length of Hangman Creek. cost of each dam site to store approximately 600 acre feet of water (or its maximum storage capacity) ranges from approximately $900,000 to $7,000,000.

5.6 Reforestation

Reforestation of the Hangman Creek Watershed (WRIA 56) is being considered as a storage option for augmenting streamflow during summer low-flow periods. The analysis of the reforestation alternative was completed by Golder Associates (2004b). The analysis makes use of the U.S. Department of Agriculture Water Erosion Prediction Project (WEPP) hillslope model to determine the changes in runoff through reforestation of representative sub-basin areas. The WEPP hillslope model incorporates climate, hillslope, soil, and land use information to simulate daily water balance parameters such as runoff, soil evaporation, plant transpiration, deep percolation, and lateral subsurface flow. The model does not include a runoff routing component and is not capable of modeling subsurface flow. Golder (2004b) explored model simulations of eight representative hillslopes for the purpose of:

- determining if changes from current landcover to historic forest cover affect runoff,
- determining if it is possible to achieve an equivalent of 3 cfs additional streamflow in Hangman Creek through reforestation, and
- determining which sub-basins exhibit greater runoff benefit from reforestation.

Increased transpiration by trees makes reforestation in the Hangman Creek watershed for purposes of increasing stream flow during summer months generally undesirable. Rock Creek is the only sub-basin that shows promise for reforestation as a means of streamflow augmentation. Increased runoff of approximately three cfs a day occurs during May and June in the Rock Creek sub-basin because of delays in snowmelt runoff. However, in the same sub-basin, decreased runoff of up to three cfs per day occurs in August as a result of increased plant transpiration. Reforestation of the 67,500 historically forested acres in the Rock Creek sub-basin to obtain increased flows during the May (3.3 cfs) and June (4 cfs) time period would cost an estimated $33,750,000 to $168,750,000.

5.7 Alternative Storage Options

Additional water storage options investigation in this storage assessment include a variety of land management options that increase soil moisture and attenuate peak flows such as:
Beaver ponds;
Snow fences;
Spreader structures;
Vegetated filter strips;
No till/direct seed;
Water conservations; and
Other agricultural best management practices.

Storage Option Analysis

No one storage option will completely satisfy the wide range of physiographic features and needs of the Hangman watershed so multiple options may be the appropriate method to enhance the quantity of water for consumptive and in-stream needs. The conclusion of the Hardin-Davis Instream Flow Study (2003) stated that "Significant physical habitat gains could be produced with small increments of flow addition. Each cfs of additional water would add 5 percent or more to physical habitat value at flows below 20 cfs." This relates to the primary goal of this multi-purpose storage assessment – to increase summer low flow conditions.

To provide direct comparisons among water storage options in WRIA 56, the options were reviewed under the context of their ability to attain a standard value of 600 acre feet of water storage. A storage volume of 600 acre-feet can sustain a streamflow augmentation of approximately 3 cfs for three months.

The most cost-effective options for augmenting streamflow are the streamflow augmentation with groundwater option and wetland restoration. However, these options will only augment flows in the lower and middle portions of the watershed.

Only three major storage options provide streamflow augmentation to all areas of the watershed. These three options include catchment basins in the upper watershed, balancing basins in the upper watershed, and Smith Creek Dam development. These are however, significantly more costly options to implement.

Table 57: Summary of Storage Options

Option	Water Storage Capacity (acre-feet)	Locations of Increased Streamflow Benefit	Capital Cost Estimate ($1,000)	Annual O and M Costs ($1,000)
Streamflow Augmentation with Groundwater	600	Middle/Lower Hangman Creek	$85-$300	0-$12
Wetland Restoration Complex A	531	Lower Hangman Creek only	$25-$150	0 to 10% of installation
Wetland Restoration Complex B	694	Marshall Creek; Lower Hangman Creek	$25-$150	0 to 10% of installation
Catchment Basins	600 (82 basins)	Middle/Lower Hangman Creek	$4,500-$5,000	$2,350
Catchment Basins (Upper watershed)	600 (40 basins)	All of Hangman Creek	$2,000 - $2,500	$300
Balancing Basins	600 (6 basins)	All of Hangman Creek	$2,000-$2,500	$200
Courtney Canyon Dam	56-992	Lower Hangman Creek only	$94-$13,000	0 to 10% of installation
Spangle Creek Dam	30 – 496	Lower Hangman Creek only	$50 -$6,500	0 to 10% of installation
Smith Creek Dam	534	All of Hangman Creek	$900-$7,000	0 to 10% of installation

Notes:

1. A storage volume of 600 acre-feet can sustain a streamflow augmentation of approximately three cubic feet per second for three months.

6.0 PHASE II: INSTREAM FLOW OPTIONAL ELEMENT

An outside consulting firm from Corvallis, Oregon, Hardin and Davis, Inc (HDI) studied habitat conditions in Hangman Creek and its tributaries. HDI used PHABSIM, SNTEMP, and hydrological investigations to evaluate instream flow conditions for fisheries. Most of the discussion in Section 5.0 is from the HDI, 2003 instream flow report. For more details, the entire report is contained in Appendix L.

Flow recommendations were developed for three levels of habitat protection for resident salmonids. The recommendations were based on weighted usable area (WUA) versus flow and the low-flow season hydrograph. Resident salmonids were determined to be the greater priority relative to other fish species and other life stages. The recommendations were classified as optimal, minimum, and critical flows for reaches above and below Marshall Creek. Optimal flows (providing 80 percent of maximum WUA) were 50 cfs below Marshall Creek and 26 cfs above Marshall Creek. Minimum flows (at which one cfs changed the WUA by five percent or more) were 15 cfs both below and above Marshall Creek. Critical flows (at which one cfs changed WUA by 10 percent or more) were six cfs below and seven cfs above Marshall Creek.

Recommended flows developed in the HDI study apply to the low-flow summer period. The minimum and critical levels signify flows below which physical habitat for salmonids is greatly reduced. Recommendations for overall ecosystem health may need to consider flows during other times of the year, and for other purposes.

Temperature, as measured directly and as HDI modeled using SNTEMP, appears to be a limiting factor for salmonids in most of Hangman Creek. Additional flow, if it could be provided, would provide only limited temperature reductions under present-day conditions, due to lack of shade. When existing shade conditions (approximately 20 percent shade) were increased in the simulation to 70 percent shade, a significant decrease (one to two ºC) in water temperature resulted.

HDI, 2003 found that low flows and high summer air temperatures make it difficult to bring high stream temperatures within state guidelines for salmonid-bearing streams. HDI, 2003 believes that restoration within the study area is unlikely to make the entire Washington portion of the main stem suitable for salmonids year-round. However, the PHABSIM study indicates that even small additions to flow during the summer period would result in WUA increases for resident salmonids, and each cfs increase may increase the WUA for non-salmonids at an even greater rate. The SNTEMP study indicates that shade restoration could significantly increase the usable stream length by salmonids compared to present conditions. Improving both conditions simultaneously would provide the greatest benefits. Further flow and temperature improvements might be possible with restoration in the tributaries and in the upper (Idaho) basin.

6.1 Data Analysis for Instream Habitat

Instream flows for fisheries are quantified by several methods. Among those in wide use in the state of Washington are the Tennant method, toe width, and IFIM; the latter two are commonly used by the state in making flow recommendations.

Tennant: The Tennant method is one of the simplest and most widely used. Briefly, flow recommendations follow directly from average flow data from a USGS gage. The recommendations can be summarized (Tennant, 1976) as:

Flow	Fishery condition
10 percent of average annual flow	minimum, short-term survival
30 percent of average annual flow	satisfactory fish habitat
60 percent of average annual flow	excellent to outstanding habitat

The Tennant method has value for making first-cut recommendations and for generating results when time and budget are lacking or non-existent. A major drawback to generalized application of the method is that two streams with very different natural hydrographs can have identical average annual flows. For example, a spring-fed stream can have a near-constant flow all year, while a desert stream may be nearly dry much of the time, with occasional flood flows. The Tennant method would recommend a flow far below natural low flows in the first case, and far above natural low flows in the second case.

Toe width: The Washington Department of Fisheries (WDF), Washington Department of Game (WDG, now known as the Department of Fish and Wildlife), and the U.S. Geological Survey (USGS) developed the toe-width method in the 1970s. The toe-width is the distance across the channel measured from the toe (location where bank angle and substrate change from terrestrial to aquatic) of one streambank to the toe of the other streambank. This width of the stream is used in a power function equation to derive the flow needed for spawning and rearing salmon and steelhead (Swift, 1976 and 1979). Washington Department of Fish and Wildlife (WDFW) and Washington Department of Ecology (Ecology) also use the criteria for rearing steelhead to estimate flow needs for resident trout.

IFIM: The Instream Flow Incremental Methodology (Bovee 1982) refers to a group of methods for studying the incremental effects of flows on microhabitat, water quality, sediment transport, and other parameters. The most widely used part of IFIM is the Physical Habitat Simulation (PHABSIM).

The basic premises of PHABSIM are that numbers of fish are positively correlated with the amount of physical habitat; that physical habitat is related to discharge; and that physical habitat can be quantified in terms of depth, velocity, substrate, and cover. The four principal components of PHABSIM are field measurements, a hydraulic model, habitat suitability criteria, and a habitat model.

Field measurements are used to quantify the matrix of depth, velocity, substrate, and cover combinations that occurs along representative transects at a particular flow. A hydraulic model is then used to simulate this matrix over a range of flows. Habitat suitability criteria (HSC) describe the value to a species of any combination of physical variables. A habitat model combines HSC with output from the hydraulic model to generate an index of habitat value, termed Weighted Usable Area (WUA), as a function of flow. Thus, for any given flow, PHABSIM sums all the usable habitat. When the model is used over a range of flows, it generates a WUA versus flow curve. This curve is used as a basis for recommending flows.

Because of its adaptability and general acceptance by resource agencies, the PHABSIM model was selected as the primary tool for assessing flows in Hangman Creek. The Tennant and toe-width models were also used in order to compare results.

The PHABSIM study of Hangman Creek followed procedures outlined by the Instream Flow Group (Bovee 1982). It also complied with guidelines established by the State of Washington (WDFW and Ecology, 2000). The PHABSIM study consisted of the following steps.

1. Mapping and transect selection
2. Model selection
3. Field data collection
4. Computer simulation of hydraulics
5. Development of habitat suitability criteria (HSC)
6. Determination of weighted usable area (WUA) as a function of flow
7. Interpretation of WUA results, and recommended flows

The habitat quantified by PHABSIM does not include temperature or other water quality parameters. SNTEMP, a stream temperature model developed for relating downstream temperatures to changes in flow and shade, is often applied concurrently with PHABSIM to evaluate the combined habitat value of physical space and temperature (Bovee 1982; Bartholow 1989).

6.2 Habitat Mapping

Measurements made at a study site must be put into the context of the entire reach being studied. Habitat was mapped in the vicinity of each of the study sites in order to quantify the percentages of habitat units (mesohabitats) near the site, and to have an estimate of the percentages in the entire study area.

The study area was subdivided into five reaches for the PHABSIM study. These five reaches - Denny (RM 35.4), Keevy (RM 29.2), Paintball (RM 2.5), Rock Creek, and California Creek -are shown in Figure 12. Within each reach, a two-person crew walked a length of stream (0.5 to 2.5 miles) in July 2002, making measurements at each habitat unit (habitat units were classified following definitions in W.T. Helm (1985)). The percentages of each habitat type within the reach were calculated, and these percentages were used to weight the PHABSIM transect measurements.

Toe width measurements were taken at appropriate sites (generally pool tail-outs) during the habitat mapping. The Hardin-Davis crew collected 22 toe width measurements near the five PHABSIM sites.

6.3 Temperature and Water Quality Studies

The Stream Network Temperature Model (SNTEMP) is a steady-state model that incorporates all of the significant sources of heat gain and loss in a moving stream (Theurer et al. 1984; Bartholow 1989). It was specifically designed to evaluate the downstream temperature impacts of changes in flow regime, but it can also be used to evaluate changes in shade.

SNTEMP is a DOS-based model that uses a group of interrelated input files, containing data on stream geometry, shade, discharge, and meteorology (Table 58). At each location in the stream network, SNTEMP predicts average water temperature for each time period of interest. For Hangman Creek, a weekly time step was used based on the estimated travel time.

The study length for SNTEMP modeling was from Hays Road to the mouth, a total of 35.4 river miles (RM). Flows in SNTEMP needed to be supplied at each location in the network. These flows were estimated based on the USGS gage (mouth of Hangman Creek) and SCCD gages at Bradshaw Rd. (RM 32.9), Duncan (RM 18.7), and Rock Creek. Data from the 2001-2 seepage runs (SCCD 2002) were also incorporated. Table 58 lists the site-by-site flow estimates, and the underlying data and assumptions.

Approximately 20 inputs are required in the SNTEMP model. Sources of data include field measurements, published data, and default values (Table 59). Default values were applied only for variables that generally have a negligible effect on model predictions (Bartholow 1989). The variables that generally exert the greatest influence on predicted water temperatures are beginning water temperature, discharge, air temperature, shade, and relative humidity. Stream width can also be important in some cases.

In order to calibrate the model, simulated verses measured weekly average stream temperatures were compared at 11 locations. Minor adjustments were made to the wind speed to improve the agreement between modeled and measured water temperatures.

Once calibrated, the SNTEMP results represented existing conditions. Three scenarios were evaluated and compared to existing conditions to estimate the potential benefits from different management options. It is important to note that the scenarios incorporate simplifying assumptions, and do not represent actual proposed alternatives. The model scenarios were created to evaluate the relative potential of changes in shade and streamflow. The three scenarios were:

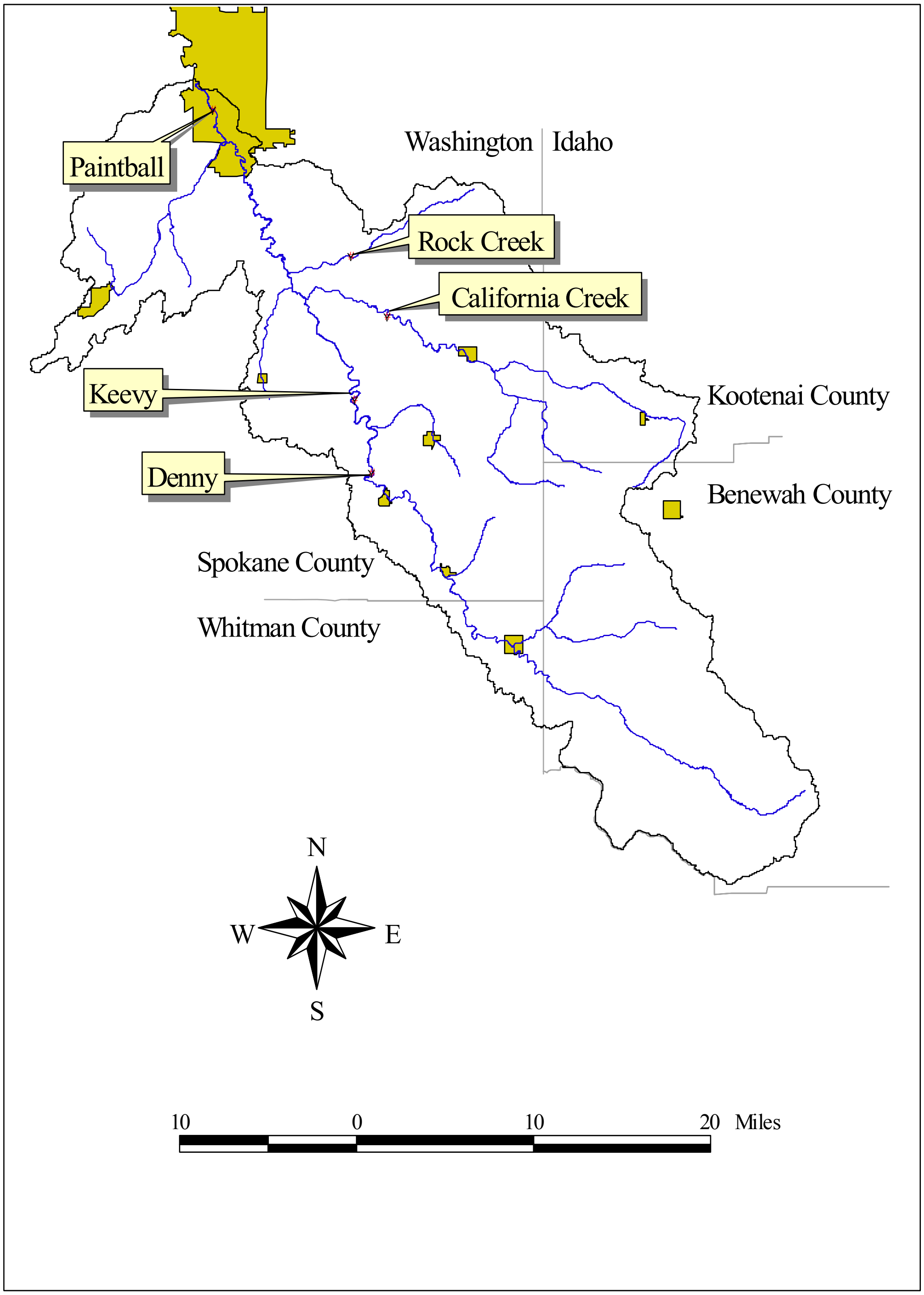

Figure 12: Instream Flow Sample Sites

Increased shade: The shade values at each site were increased to simulate 70 percent of the streambanks being lined with trees, compared to current conditions of about 20 percent. Natural shading conditions were not known; this simulation was intended to approximate restored conditions.

Increased flow: It was assumed for the purpose of the study that increased flow could take two general forms: surface water and ground water. Simulated additions were one, two, and three cfs. The additional inflow was simulated by increasing the flow at the top of the SNTEMP site (Hays Rd, RM 35.5).

Table 58: Flow Estimates for SNTEMP Model

River Mile	Creek	Location	Underlying Data and Assumptions	August Flow (cfs)
35.4	Hangman	Hays Rd	Assumed same as Bradshaw gage	1.41
32.9	Hangman	Bradshaw Rd	SCCD gage at Bradshaw	1.41
29.2	Hangman	Keevy Rd	Assumed same as Bradshaw gage	1.41
22.2	Hangman	Latah Rd	Bradshaw plus accretion	2.29
20.2	Rock	Near confluence	SCCD gage in Rock Cr	0.74
18.7	Hangman	Duncan	SCCD gage at Duncan	3.03
18.3	California	Near confluence	Estimate from seepage run and IFIM studies	0.46
18.2	Hangman	Valley Chapel Rd	Sum of Duncan gage and California Creek estimate	3.49
13.8	Hangman	HV Golf Course	Estimate for km 29.3, plus 1/3 of above-Marshall accretion estimate	4.55
8.8	Hangman	Yellowstone Pipeline	Estimate for km 22.2, plus 1/3 of above-Marshall accretion estimate	5.61
4.5	Hangman	Qualchan Golf Course	Estimate for km 14.2, plus 1/3 of above-Marshall accretion estimate	6.67
4.4	Marshall	Near confluence	Marshall ungaged; assumed to be 100% of remaining inflow	3.39
3.6	Hangman	Kampas Bridge	Assumed same as USGS gage	10.06
0.4	Hangman	Marne Bridge	Assumed same as USGS gage	10.06
0	Hangman	Mouth	USGS gage	10.06

Notes:

1. River Miles are from Hardin-Davis Inc. report and do not match USGS or SCCD river miles.
2. cfs is cubic feet per second.
3. Rd is road
4. For more detail, see HDI, 2003.

For surface water addition, the temperature of this added water was set to be the same as that of the flow already existing at the site (ambient water temperature). Additional ground water, if it could be provided, would enter Hangman Creek at more than one location. However, for the purposes of the simulation, the additional water was also treated as though it all entered at Hays Rd. Simulated additions were one, two, and three cfs. The temperature of the inflow water was assumed to be 5 ºC below ambient. Therefore, depending on the relative quantities, the resulting instream temperature at the Hays Road site was reduced by 0.25 to 3.5 ºC.

Increased shade plus flow: In this scenario, increased shade and increased flow were combined into the same simulations.

Table 59: SNTEMP Model Data Sources

Parameter	**Data Source**
Latitude	Topographic maps
Elevation	Topographic maps
Average annual air temperature	Spokane airport meteorological station
Mean weekly air temperature	Spokane airport meteorological station
Mean weekly relative humidity	Spokane airport meteorological station
Mean weekly wind speed	Spokane airport meteorological station
Mean weekly solar radiation	Based on weather station data
Stream width	On-site measurements
Discharge, weekly, per site	SCCD and USGS gages
Mean water temp, per validation site	SCCD data loggers
Topographic shade	On-site measurements
Vegetative shade	On-site measurements
Dust coefficient	Default value
Ground reflectivity	Default value

Notes:
1. Data and table from HDI, 2003.

Other water quality parameter changes with increased shade and flow

Other water quality parameters were reviewed, based on Ecology measurements. Parameters on the 303d list included temperature, as well as coliform bacteria, dissolved oxygen, and pH. Small increases in flow and decreases in temperature may have water quality benefits for the parameters on the 303(d) list. Pollutants such as coliforms could be slightly diluted by higher discharges. Dissolved oxygen would be slightly higher (other things being equal) with lower temperatures. The benefits would be minor compared to the benefits of reducing the sources of pollution (HDI, 2003).

6.4 Recreational Flow Requirements

In order to ascertain the recreational use of Hangman Creek, local boaters were consulted, and additional observations were made during habitat mapping and IFIM investigations. Hardin-Davis staff did not float the creek due to insufficient flows throughout the field season.

Compared to other creeks in the region, Hangman Creek receives limited use by recreational boaters. The predominantly agricultural character of the stream and its surrounding landscape limits its attractiveness to casual boaters. The canyon section between river miles 25 and 35 offers attractive scenery, but is generally too steep for casual boaters. Furthermore, flows necessary to float the creek generally exist during the winter and spring, when the weather, stream temperature, and turbidity are typically not conducive to leisurely paddling. Consequently, the greatest boating use of Hangman Creek is by whitewater enthusiasts, principally kayakers.

The two sections that are floated most commonly by whitewater paddlers are the canyon section and the lower section. Kayakers usually put in at the monument off North Kentuck Trails Road, and take out at the Valley Chapel Road bridge just downstream from the Rock Creek confluence. The flow range for best kayaking of this reach is approximately 2,000 to 5,000 cfs at the USGS gage, although it is considered runnable down to around 500 cfs. The put-in for the lower section is most often the Hatch Road Bridge, and the take-out at the Riverside Avenue bridge. The optimal flow range for this reach is approximately 1,000 to 2,000 cfs, but as in the upper reach is runnable down to around 500 cfs. The highest flow advised for experienced boaters is in the neighborhood of 8,000 to 12,000 cfs for either run.

The two sections favored by kayakers, as well as other parts of the creek, could conceivably be run at flows lower than 500 cfs in shallow-draft craft such as inflatable rafts and kayaks. However, a trip of any reasonable length at flows below 500 cfs would involve extensive boat-dragging over rocks and other debris.

The average number of days per year that provide flows sufficient for enjoyable whitewater boating is limited, particularly at the higher flows (Table 60). Optimal flows (1000-2000 cfs in the lower section, and 2000-5000 cfs in the canyon section, based on the USGS gage) occur most frequently from January to April, and are generally of short duration. A flow at the gauging station of 500 cfs is considered to be the lowest runnable flow, and would involve considerable rock-scraping in many of the riffle and cascade sections of the creek. Finally, the warmer months of the year (June-September) have an average of less than one day per year where the flow is greater than 250 cfs.

In addition to boating, other recreational uses occur on Hangman Creek such as fishing, swimming, and wading. Fishing occurs on a limited basis in the spring months, and is hindered by high flows and turbidity during the winter. High water temperatures limit summer fishing for trout. Swimming occurs in the study area in some locations. Large swimming holes are heavily used by local teenagers in summer months. Wading is a frequent use by local residents.

Table 60: Average Number of Days per Year for Hangman Creek Flow Ranges

Daily Average Flow (cubic feet per second)	Average number of days per year
500 - 1000	23.6
1000 - 2000	12.5
2000 - 5000	5.9
Notes: 1. Table from HDI, 2003. 2. Flow and days per year from USGS data.	

The lack of flows adequate for boating during summer months makes Hangman Creek an unpopular choice for most boating enthusiasts. Winter flows attract some whitewater enthusiasts during the few days of higher (near flood stage) flows. Incremental gains in summer base flow would not alter these circumstances.

6.5 Instream Flow Recommendations

Flow recommendations are not directly generated by PHABSIM, as with the Tennant or toe width methods. Factors that are generally considered in developing flow recommendations from PHABSIM data are: key species and life stages, the raw WUA results, the natural hydrograph, and the percentage change in WUA per unit change in flow.

Rainbow trout adults are the primary life stage of interest, thus the PHABSIM flow recommendations that follow are based on this life stage alone. If the WUA curves are considered by themselves, without reference to the hydrograph, it would appear that the recommended flow for salmonids would be at or above the maximum flow modeled by PHABSIM. In other words, in the absence of other information, this would yield a flow "recommendation" of 40 cfs or more in the study area above Marshall Creek, and over 80 cfs below Marshall Creek.

For management purposes, it is important to know not only the raw WUA values, but also the rate of change in WUA per unit of flow. When the PHABSIM results are plotted as the percentage increase in WUA per unit (cfs) of water added, the results show that the effect on habitat of adding one cfs depends greatly on the existing flow level. When flows are low, a high percentage of WUA is gained per one cfs addition.

Recommended flows are given for two different parts of the Hangman Creek main stem, below and above Marshall Creek. The portion below Marshall Creek, where tributary and ground water inflow significantly increase the late-summer flows, is represented by the RM 2.5 (Paintball) site. The portion above Marshall Creek to the Idaho border is represented by the combined results from RM 29.2 and RM 35.4 (Keevy and Denny) sites. Based on the longitudinal profile, the relative weighting of these two sites was estimated at 0.28/0.72.

Flow recommendations are presented for the June to October period. For each time period, three different recommended flow levels are possible:

Optimum:	The flow providing 80 percent of the maximum WUA
Minimum:	The flow at which the change in WUA per one cfs is five percent
Critical:	The flow at which the change in WUA per one cfs is 10 percent

For each recommended flow level (Table 61), and each time period, the flow exceedances is given. Since flows are significantly higher in June compared to the other four months, exceedances values were calculated separately for June.

Flow exceedances at the RM 2.5 site were taken directly from the USGS records for 1948 to present. Exceedance values for flows upstream of Marshall Creek were estimated based on SCCD flows measured in 2002 at RM 33 (temporary Bradshaw gage). The relationship between average weekly flows at the Bradshaw and USGS gages from June to September 2002, was approximately:

Flow at USGS gage	Percent of USGS flow at River Mile 33
<12 cfs	20
12-40 cfs	30
>40 cfs	35

According to HDI (2003), the flows presented in Table 61 can be interpreted as follows. When the existing flow falls below 26 cfs in the main stem upstream of Marshall Creek, any additional flow withdrawal will adversely affect habitat conditions, reducing the habitat from optimum to minimum. Withdrawals will adversely affect minimum and critical habitat conditions if additional withdrawals cause existing flows to fall below 15 and seven cfs, respectively. The same interpretation can be placed on flows of 50, 15, and six cfs in the section downstream of Marshall Creek.

Table 61: Hangman Creek Flow Recommendations and percent exceedance

Reach	Level	Flow (cfs)	June Exceedance (percent)	July – October Exceedance (percent)
Below Marshall Creek	Optimum	50	40	<5
	Minimum	15	90	50
	Critical	6	> 95	80
Above Marshall Creek	Optimum	26	25	0
	Minimum	15	55	5
	Critical	7	80	20

Notes:
1. Table from HDI, 2003.
2. Exceedance percents are the percent of time that the flow in Hangman creek is greater than the flow listed in the table.
3. Below Marshall Creek reach based on site at River Mile 2.5.
4. Above Marshall Creek reach based on sites at River Mile 29.2 and 35.4.
5. cfs is cubic feet per second

Flow recommendations are compared for various methods in Table 62. Agreement among the methods is relatively good. This is probably because all the methods are fundamentally based on the width and shape of the channel. PHABSIM gives more usable results than the other two methods, because any increment of flow change, for any species, can be evaluated.

It is important to note that the numbers given in Table 62 for PHABSIM are narrowly defined. They are low-flow period recommendations, below which physical habitats for salmonids are greatly reduced (See Appendix L). Recommendations for overall ecosystem health may need to consider additional purposes at flows during other times of the year (HDI, 2003).

Interaction of temperature and physical habitat

From the Idaho border to the mouth, Hangman Creek is approximately 58 river miles. During the summer, much of the creek has very low physical habitat (WUA) due to low flows with temperatures above published guidelines for salmonids. With increased flow, the physical habitat would increase substantially for each cfs of added flow during the low-flow period. Besides increased flow, the length of stream with suitable temperatures could be increased by shade restoration. Taken together, the increase in total habitat area (added length plus increased WUA) could be significant (Bovee 1982).

Table 62: Recommended Instream Flows for the Various Methods Used

Reach Location	Summer Flow Recommendations in cubic feet per second					
	PHABSIM (optimal)	PHABSIM (minimum)	PHABSIM (critical)	Toe Width	Tennant (minimum)	Tennant (good)
Hangman below Marshall Creek	50	15	6	25	24	72
Hangman above Marshall Creek	26	15	7	9 to 19	10	30
California Creek	NS	10	6	5	NA	NA
Rock Creek	27	14	6	14	NA	NA

Notes:
1. Table from HDI, 2003.
2. NS is not simulated for flows greater than 10 cfs.
3. NA is not applicable because there is no average annual flow established for these creeks.

6.6 Hydrological Analyses for Instream Flow

While many factors influence the response of a stream to rainfall, the subsurface storage capacity of a basin often exerts the strongest influence. Watersheds with limited subsurface retention cannot absorb large enough volumes of water to provide long-term base flow in the dry season. Surface conditions, such as vegetative cover and land use, have some impact on the rate of overland flow and infiltration, but cannot change the storage capacity of the aquifer.

Hangman Creek is incised into bedrock within the study area, and aquifer storage is limited to sediments deposited by the stream within the incised channel. Deeper upland sediments are generally perched and effectively isolated from the stream network. The limited bank storage capacity and volume of connected aquifer storage does not allow for retention of recharge, resulting in a ‘flashy’ hydrograph response to precipitation. Due to the physical limitations for retention of stream flow within the lower (Washington) portion of the Hangman Creek watershed, little opportunity exists to improve base flow with alternative land management activities. The hydrologic system is controlled by the physical characteristics of geology and storage capacity.

Artificial retention of high flows and engineered storage facilities would allow for dampening of the peak flood events, however the storage capacity of the underlying aquifer and stream banks would soon reach their physical capacity to store the surplus water. Consequently, a storage project would not add substantially to base flow. However, artificial storage could potentially allow for augmented flows throughout the low-flow season.

Dry-land farming is the predominant land use in the Palouse soils above Hangman Creek. If irrigated faming had been predominant, opportunities for water management could have been implemented to enhance stream base flow. Because the watershed is capable of sustaining dry-land farming, this suggests a hydrologic system in balance. Short of increased precipitation, little opportunity exists within the study area to improve base flow significantly (HDI, 2003).

The upper reaches of the Hangman Creek watershed (beyond the current study area) exhibit geologic conditions that may indicate the presence of a larger aquifer and greater storage capacity (HDI, 2003). Changes in land management activities within an aquifer with higher storage capacity could result in increased base flow.

6.7 Instream Flow Report Conclusions

The geology and climate of the watershed indicate that large increases in base flow are unlikely. However, significant physical habitat gains could be produced with very small increments of flow addition. Each one cfs of additional water in the main stem would add five percent or more to physical habitat values during the low-flow season.

Physical habitat increase alone may not improve salmonid potential, because stream temperatures are very warm over most of the distance. Even with a simulated additional inflow of cool water, stream temperatures were improved over only a short distance. Therefore, it appears that flow augmentation would need to be combined with temperature reduction to improve trout habitat significantly.

Simulations with SNTEMP indicate that shade restoration could significantly lower stream temperatures. Shade could thus increase the total length of the main stem available for salmonids, even without flow augmentation.

Shade restoration and flow augmentation, if combined, could yield the biggest improvement in the amount of habitat suitable for salmonids in Hangman Creek. There would be increases in WUA, and there would be an increase in the length of the creek with suitable temperatures. Flow and temperature improvement have a positive synergistic effect on fish habitat.

Improvements made in the major tributaries (Rock and California Creek) could contribute to better flow and temperature conditions in Hangman Creek. Improvements made in the upper watershed could also make such a contribution.

No single action (e.g. change of flow) will restore salmonid habitat conditions to its maximum potential. However, the combined effects of several projects (riparian restoration, upper watershed improvement, increased flows from tributaries) could significantly improve fish habitat in Hangman Creek.

6.8 Planning Unit Progress on Instream Flow Recommendation For WRIA 56

In June of 2003, the PU began a series of instream flow development meetings to discuss the results of the HDI report and continue progress towards a final recommendation for WDOE. The PU discussions revolved around the statutorily protected instream resources and values for the watershed. The PU also considered instream and out-of-stream water uses, and whether or not the recommended flow or range of flows would be scientifically defensible and hydrologically achievable. The PU followed the basic process described below.

The Instream Flow Process (as described in "A Guide to Instream Flow Setting in Washington State")

- Identify all statutorily protected instream resources and values present in the stream.
- Gather and evaluate existing watershed-specific information on instream resources, hydrology, diversions, existing water rights, applicable historical information, as well as other factors that may limit instream resources.
- Determine how to evaluate stream flows for the resources identified, including any additional information that is needed.
- Conduct studies, as needed, to determine what stream flows are needed to protect instream resources and to evaluate past, current, and the potential future hydrology in the basin.
- Review and evaluate study results to determine needs to protect and preserve the identified instream values and resources.
- Evaluate current and future water uses, including both in stream and out of stream uses.
- Consider management alternatives to meet instream and out of stream needs.
- Develop an instream flow recommendation, through the local evaluation and decision process, that protects instream resources.
- Develop and propose a rule to establish instream flow.

After months of discussion, the WRIA 56 PU could not come to consensus regarding an actual instream flow recommendation, but was able to agree on many components. The PU has agreed to continue discussion and work towards developing a recommendation for minimum instream flow(s) for the Hangman Creek Basin during Phase IV, Plan Implementation. A Final Project Completion Report (Grant # G0200292) was written and submitted to the Washington State Department of Ecology (Appendix L). This report provides information derived from the minutes of the WRIA 56 instream flow meetings held at the SCCD office. The written minutes and the actual tape recordings have been documented and archived at the SCCD.

7.0 PHASE III: ISSUES AND RECOMMENDATIONS

7.1 Issues

The Hangman (Latah) Creek Watershed has a myriad of water resource issues that cannot be easily reconciled over the short-term. Historical practices of logging, agriculture, and stream channel alterations created a difficult baseline situation. However, decades of poorly managed water rights and claims, continued population growth, dry climatic conditions, and relatively few changes in land use behavior have not improved the watershed conditions. Recommendations were developed for the following main categories and the key issues within each.

- Water Quantity
- Water Quality
- Habitat and Land Use
- Minimum Instream Flow Ruling

7.2 Water Quantity Recommendations and Strategies

For the Hangman Creek watershed, summer flow conditions do not generally provide adequate resources for the estimated uses in the watershed. Summer flows are generally in the range of approximately10-15 cfs. The ten-year drought summer flow would be approximately five cfs. The instantaneous low flow for Hangman Creek is 0.74 cfs.

The basin water use generally exceeds the recorded summer stream flow at the mouth of the creek. Several methods were evaluated to estimate the water use in the basin, and all exceeded the stream flows in the summer. Current water use estimates for the summer months are approximately 107 cfs (this includes both surface and ground water). The water rights data for certificated, permitted, and claimed water use are: 16.6 cfs from surface water, 91.7 cfs from ground water sources, and 10.0 cfs with no source identified.

All estimations supplied in this report generally indicate that water use in the Hangman creek watershed exceeds summer flows conditions. Summer flows almost always have a large number of days with the flow less than 10 cfs, exactly at the time when evapotranspiration, irrigation, and water use is highest.

7.2.1 Projected Future Growth

Water availability for future growth was considered by the PU. For most of the rural towns, the population has remained fairly constant to slightly declining. When totaled, the town populations have decreased approximately 1.4 percent from 1900 to 2000. The only significant increase in population in the last twenty years was in the 1990 to 2000 population for census tract 143P, the southern Spokane County rural (excluding towns) tract. This area increased 79.8 percent in the past ten years from a 1990 population of 1,581 to a 2000 population of 2,842. This increase reflects the increasing trend of single-family homes on small 10+ acre lots south of Spokane.

The City of Spokane is expected to grow by 54,000 people between the years of 1995 and 2010. This equates to 42.7 percent of regional growth. It is foreseen that the southwest quadrant of Spokane, which contains the project area, will absorb 50 percent of city growth.

A water rights summary for Hangman Washington communities (excluding Spokane) was developed by Ecology (Page 51) along with current annual water use. Using the 2020 population projections, Rockford Latah, Tekoa, and Cheney appear to have adequate water rights for estimated water use through 2020. Waverly, Spangle, and Fairfield should evaluate the population projections used, current water rights, and water systems for future needs.

Issue Statement 1:
According to current data collection efforts and reports, some municipal water systems may not have enough water to meet projected future growth.

Recommendation(s) and Selected Strategies:

R1.a. Evaluate the potential to purchase or lease, valid current water rights for municipal supply.

Strategy: The Watershed Implementation Team will work with Ecology to research and develop a mechanism for this process.

R1.b. Reclamation, conservation and reuse strategies shall be encouraged to increase water available for beneficial uses in the watershed.

Strategy: The Watershed Implementation Team will work with Spokane County and other potential stakeholders to further investigate opportunities.

7.2.2 Growth Management

Issue Statement 2:
Projected growth over the next 20 years could have severe impacts on the water resources in the basin. A majority of the growth is occurring within the lower portion of the basin (near or within the City of Spokane). Growth should be managed to minimize impacts to water

Recommendation(s) and Selected Strategies:

R2.a. Separate watershed management units may be identified and managed differently for water rights if future studies indicate a disparity between sub-basins and their groundwater/surface water relationships.

Strategy: Identify funding sources and develop studies to better understand groundwater/surface water interactions within the sub-basins of the watershed.

R2.b. All proposed changes in GMA Comprehensive Plans, that affect housing density, and require new withdrawals and/or issuance of new water rights from the watershed should be based on water availability.

Strategy: The Watershed Implementation Team will further develop water availability information to assist local jurisdictions with future land use planning.

Strategy: Local jurisdictions should develop a better understanding of the aquifer and water availability before conducting land use planning in the basin.

R2.c. Land use regulators should utilize water availability estimates described in the Watershed Management Plan. Minimum parcel size should be based on sub-basin estimates in areas where new exempt wells will be the main source of domestic water.

Strategy: All new domestic exempt wells should be regulated by any future Minimum Instream Flow Ruling developed by Ecology.

Strategy: Spokane County should evaluate policies that will limit the maximum daily withdrawals of domestic exempt wells to less than 5000 gallons per day.

Strategy: Request Counties, Cities, and/or Regional Health Districts to evaluate the quantity of water necessary (currently 1 gallon per minute,), from a domestic exempt well before a building permit is issued.

7.2.3 Priorities of Future Water Allocation

The Watershed Planning Act requires that Planning Units develop priorities for water allocations for each watershed. The Planning Unit utilized public input and developed a set of priorities for the Hangman Watershed. The agricultural (dryland) small towns and domestic residences represent the rural character of the watershed. Water must be available for human consumption and smaller livestock operations.

***Issue Statement 3*:**

It is important to ensure adequate water supplies for instream and out-of-stream uses within the basin. Priorities need to be set for the watershed.

<u>**Recommendation(s) and Selected Strategies:**</u>

R3.a. Future allocations of water rights should be apportioned accordingly.

1. Municipal
2. Domestic (group, domestic exempt)

3. Stock water (requiring less than 5,000 gallons per day for ranging cattle)
4. Light Industrial
5. Commercial (retail, commercial livestock)
6. Stock water (requiring greater than 5,000 gallons per day)
7. Agriculture (irrigated)
8. Heavy Industrial

It is understood that water right issuance is prioritized "first in time, first in right". This prioritization by the PU may be used in the future to designate water rights and other legislation.

R3.b. Initiate a watershed based negotiation to achieve a cooperative agreement to address cross state line availability of water (both surface and groundwater).

Strategy: The Watershed Implementation Team should initiate a process for collaboration between appropriate multi-state stakeholders and agencies.

7.2.4 Water Conservation, Reclamation, and Re-use

The dominant use of water in the watershed occurs within the last five miles of the lower watershed. The Cheney/Marshall Creek and the Qualchan areas represent approximately 60% of the water used. Water conservation throughout the majority of the watershed may not provide significant results to most of the watershed. However, a water conservation plan can save up to 20% of the water used and any additional available water may benefit future growth and instream flows. Most of the significant water savings will be from repairs to water purveyors systems.

Issue Statement 4:

The Planning Unit recognizes that the watershed may be fully allocated. Significant water savings may occur from implementing water conservation measures. Communities may want to consider instituting a plan to prevent shortages in the future.

Recommendation(s) and Selected Strategies:

R4.a. Work with water purveyors to implement conservation programs required by the Department of Health through the new Municipal Water Law (HB 1338).

Strategy: Spokane County should initiate this coordinated effort between the State Department of Health and the water purveyors. These agencies should facilitate a process to convene local purveyors to develop coordinated conservation provisions. These can take the form of individual plans.

Strategy: Assess the needs for additional conservation measures in the basin (aside from Municipal Water Law).

R4.b. Identify funding sources for small town infrastructure upgrades (*i.e.* leak detection, repair, storage, metering).

Strategy: The Watershed Implementation Team should work with the Department of Health to identify funding sources.

R4.c. Develop new legislation to prevent water saved by improved irrigation efficiency or conservation from being subject to relinquishment (systems who are not municipal water suppliers).

Strategy: The Watershed Implementation Team should draft and submit appropriate legislation

R4.d. Options for keeping current water rights and place of use in the watershed should be explored.

Strategy: The Watershed Implementation Team should pursue this idea and develop alternatives and options for the watershed.

R4.e. Request the legislature allocate funds to purchase or lease this saved water (from R4.d.).

Strategy: The Watershed Implementation Team should formally request funding from the Legislature

R4.f. The potential to utilize the Conservation Futures Program for purchasing water rights should be explored.

Strategy: The Watershed Implementation Team should explore this possibility.

R4.g. A coordinated water conservation education/information program should be developed and implemented. This program may be coordinated with a larger regional effort.

Strategy: The Watershed Implementation Team should develop this program. This program may also be developed in coordination with a larger regional program.

R4.h. Encourage the use of water conserving programs, actions, and technology (*i.e.* xeriscaping, low flow toilets and shower heads) for domestic (group, domestic exempt), light industrial, heavy industrial, commercial, agriculture, irrigation, and municipal uses.

Strategy: Spokane County should develop and coordinate this program with appropriate agencies and departments.

R4.i. A watershed drought management plan should be developed. This plan will initiate specific actions to be taken to conserve and preserve water in the basin.

Strategy: The Watershed Implementation Team should develop this plan. This plan may be coordinated with a larger regional effort.

7.2.5 Groundwater/Surface Water Interactions

According to Buchanan's work and the seepage data, the groundwater/surface water interactions can be further defined into three physiographic provinces. The first is upstream of Rattler Run Creek, the second is the bedrock canyon area from Rattler Run Creek to Duncan, and the third is downstream of Duncan to the confluence of the Spokane River.

For the province upstream of Rattler Run Creek, the major ground water aquifer is in the basalt bedrock and is generally 80 feet below the Hangman Creek streambed. There is a minor aquifer in the unconsolidated sediments overlying the basalt bedrock, but the amount of storage in this aquifer is minor. In the upper physiographic province, the unconsolidated sediments have both gaining and losing reaches.

The central province consists of bedrock with very minor unconsolidated deposits. The ground water surface in the basalt bedrock in this area is significantly above the streambed. This provides a gaining reach through the bedrock canyon.

The lower province consists of an unconfined aquifer connected to, and influenced by the flows in Hangman Creek. Duncan to Marshall Creek is a losing reach during low flow summer conditions. Below Marshall Creek the ground water surface is above the creek as indicated by the numerous springs found along Hangman Creek. The greatest gain in stream flow is in the last few miles from Marshall Creek to the confluence with the Spokane River (approximately 200 percent increase from upstream of Marshall Creek to the USGS gage).

Issue Statement 5:

Groundwater withdrawals from the deep basalt aquifer system in the upper basin do not have an immediate, direct impact on stream flows in the upper basin (Buchanan 2003). However, groundwater withdrawal in the upper basin may indeed have an impact on surface water flows in the lower basin, but it may be delayed by many years or decades. Furthermore, the impact may be so small that it may not be measurable in the lower basin.

Recommendation(s) and Selected Strategies:

R5.a. The groundwater connections between sub-basins should be studied and better defined.

Strategy: The Watershed Implementation Team should develop a scope of work and identify funding for this study.

R5.b. Groundwater levels need to be monitored to determine if aquifer mining is occurring within the basin.

Strategy: The Watershed Implementation Team should develop a scope of work and identify funding for this study.

R5.c. A study should be conducted to evaluate whether groundwater from adjoining watersheds is being utilized by municipalities on the edge of watershed (Tekoa, Cheney, Spangle). The addition of a dedicated monitoring station (well) should be established.

Strategy: The Watershed Implementation Team should develop a scope of work and identify funding for this study.

R5.d. A new permanent gaging station should be developed between the upper and lower watershed. This will help determine water interchange rates and provide better recreational information on water levels.

Strategy: The USGS should establish and maintain the real time gaging station. The Watershed Implementation Team should identify funding to help support this.

R5.c. Encourage the establishment of a new permanent gaging station near the stateline.

Strategy: The Coeur d'Alene Tribe should establish and maintain this station. This station may be implemented through joint entities/stakeholders.

7.2.6 Actual Water Use/Allocation in the Basin

Water use for the basin was evaluated for single family domestic, commercial/industrial, and agricultural uses. The total estimated residential water use from single-family domestic housing units is 20.6 cfs. The commercial and industrial water use is estimated as 12.2 cfs. The agricultural water use is estimated as 10.8 cfs. The total water use for the basin is 43.6 cfs equivalent stream flow.

Hangman Creek water is allocated by water rights (certificated, permitted, claimed, and single-family domestic exempt wells). If all the certificated, permitted, claimed, and single-family domestic exempt rights were used at the maximum allowable exent, the use would be approximately 159 cfs. The certificated water use is 48 cfs, but most of the use is for irrigation, significantly less than the estimated irrigation uses.

Issue Statement 6:

The total certificated water rights in the basin are approximately 48 cfs. However, the actual use in the basin is not known.

<u>**Recommendation(s) and Selected Strategies:**</u>

R6.a. Develop a strategy to address compliance and enforcement of water rights and claims. Required resources should be identified.

Strategy: The PU recognizes the need for additional enforcement regarding compliance and enforcement of water rights and claims in the watershed. However, the PU could not specifically identify the type or amount of resources required. Further discussion and investigation is needed to state required assistance.

R6.b. Determine the need and support for adjudication in the watershed. If supported, the appropriate sub-basins should be prioritized for adjudication.

Strategy: The Watershed Implementation Team should determine the need and support for adjudication and then prioritize sub-basins as needed.

R6.c. If appropriate, a petition should be filed with the State of Washington for general adjudication of water rights in the basin.

Strategy: The Watershed Implementation Team should file a petition if necessary.

7.2.7 Potential Augmentation and Storage Strategies

The Hangman watershed has low to moderate precipitation (19-40 inches) of which a significant portion is lost to evapotranspiration (e.g., >75%). Much of the precipitation falls during the winter as snow. The stream hydrograph is driven by rain on snow (and frozen ground) events and results in a flashy flow regime with flooding during the spring and low flows during the summer. Groundwater recharge and groundwater supported stream baseflows are low. There is little natural water storage capacity in the watershed. Land use patterns have modified the majority of the basin from natural bunchgrass prairie vegetation to dryland crop agriculture. The effect of these land use patterns has been to further reduce the intrinsic water storage capacity of the watershed and accentuate the flashiness of the hydrologic regime, causing higher peak flows and lower summer flows, along with accelerated sediment erosion.

Issue Statement 7:

The Hangman Creek Watershed is routinely impacted by low flows during the critical summer months of July through September. Improvements in storage and augmentation may prove to be beneficial to communities and stream flow levels.

<u>Recommendation(s) and Selected Strategies:</u>

R7.a. The Cities and Towns of Spangle, Rockford, Tekoa, and Latah should evaluate and investigate the causes for unaccounted water in their Public Water Systems.

Strategy: If necessary, a leak detection program should be developed for these towns. The Watershed Implementation Team and the local jurisdictions should coordinate efforts on this. Funding should be identified.

R7.b. A streamflow augmentation program should be developed and implemented for Hangman Creek.

Strategy: New and existing wells should be drilled and/or pumped to augment the streamflow with groundwater. This water may be purchased or leased. The Watershed Implementation Team should work with the local stakeholders, Department of Ecology, and local jurisdictions to determine feasibility, location, and operation of wells. A new well would require a water right. An applicant would need to be identified.

Strategy: Water rights should be purchased or leased from The City of Tekoa to augment streamflows. The City of Tekoa currently possesses large amounts of inchoate water rights. These rights could be utilized for augmentation. The Department of Ecology, the City of Tekoa, and the Watershed Implementation Team should discuss the potential of this strategy.

Strategy: Develop a system to utilize inchoate water rights, on a temporary basis, from cities and towns within the watershed. The Watershed Implementation Team should work with the The Department of Ecology and interested stakeholders to explore this possibility.

Strategy: Historic and current wetland sites should be acquired and restored. The Watershed Implementation Team should work with local jurisdictions and stakeholders to identify additional sites and funding sources.

Strategy: Catchment basins should be built to capture and store water. The Watershed Implementation Team should coordinate this effort with local stakeholders and jurisdictions. Funding sources and additional locations should be identified.

Strategy: Balancing basins should be built to capture and store runoff during peak periods. The Watershed Implementation Team should work with the local jurisdictions, stakeholders, Department of Ecology, and the Department of Fish and Wildlife

Strategy: Dams should be built in the upper watershed to capture and store water.

Strategy: Beaver ponds should be encouraged and protected throughout non-developed portions of the watershed. The Watershed Implementation Team should coordinate this effort with the Department of Fish and Wildlife and local stakeholders.

Strategy: An education program on storage activities and benefits should be regionally coordinated and implemented. The Watershed Implementation Team should coordinate this effort with local jurisdictions and other stakeholders in the region.

Strategy: A cost-share program for snow fencing should be developed and maintained. The Watershed Implementation Team should coordinate this program with the Spokane County Conservation District. Funding sources should be identified.

Strategy: Living and constructed snow fencing should be encouraged and supported throughout the watershed. The Watershed Implementation Team should support this effort with local jurisdictions, stakeholders, and the Spokane County Conservation District.

Strategy: Vegetated buffer strips should be encouraged and implemented throughout the watershed. The Watershed Implementation Team should support this effort with local jurisdictions, stakeholders, and the Spokane County Conservation District.

Strategy: No-till/Direct Seed tillage operations should be encouraged throughout the watershed. The Watershed Implementation Team should support this effort with local jurisdictions, stakeholders, and the Spokane County Conservation District.

Strategy: A No-till/Direct Seed Demonstration Program should be initiated and funded. The Watershed Implementation Team should support this effort with local jurisdictions, stakeholders, and the Spokane County Conservation District.

Strategy: The Rock Creek sub-watershed should be targeted for reforestation efforts. The Watershed Implementation Team should work with local stakeholders and jurisdictions, the Spokane County Conservation District, and the Natural Resources Conservation Service. Funding and properties should be identified.

R7.c. Encourage change of source for water rights from surface to ground water where feasible. Additional incentives may help involvement.

Strategy: This option should be further explored. The Watershed Implementation Team should work with the Department of Ecology on this strategy.

7.3 Water Quality Recommendations and Strategies

Hangman Creek is a well-studied watershed suffering from anthropogenic disturbance. It is often described as one of the most degraded waterbodies in eastern Washington State. It is designated as a Class A Washington waterway in the Washington Administrative Code (WAC) Chapter 173-201A. However, point and non-point pollution sources continue to degrade the watershed. The majority of the watershed has not been able to attain the necessary requirements for the Class A designation for decades.

The basin's growth and continued poor land management has led to environmental stresses that have reduced water quality. Hangman Creek was identified on the 1998 303(d) list for not achieving State water quality standards for fecal coliform, dissolved oxygen, pH, and temperature. Recent monitoring has identified several other water quality problems not acknowledged by the 303(d) list (sediment load, turbidity, ammonia, low flows, and total phosphorus).

Hangman Creek is suspected to be the largest contributor of bedload and suspended sediment to the Spokane River. The majority of the bedload portion of the sediment load is transported downstream and deposited behind Avista's Nine Mile Dam. The suspended sediments continue through the dam's bypass system and settle out in Lake Spokane. The impacts of sediment to Lake Spokane have not been thoroughly studied.

7.3.1 Water Quality (flow related) Parameters

Several water quality issues are related to Hangman Creek flow conditions. Both the extreme high and low flows found in Hangman Creek can exacerbate select water quality parameters. High flows tend to increase water quality problems related to sediment and low flows effect temperature, dissolved oxygen, and pH. For some parameters, such as fecal coliform bacteria, both high and low flows can effect the water quality, but in different ways.

Issue Statement 8

Hangman Creek is listed on the 1998 303(d) List of impaired water bodies for four flow related parameters (fecal coliform, pH, dissolved oxygen, and temperature).

<u>Recommendation(s) and Selected Strategies:</u>

R8.a. Participate in Lake Spokane D.O. TMDL process related to point and non-point sources in the Hangman Creek watershed.

Strategy: The Watershed Implementation Team should participate in the TMDL process for Lake Spokane as related to nonpoint source issues.

R8.b. Participate in the Hangman Creek TMDL project.

Strategy: The Watershed Implementation Team should participate in the TMDL process for Hangman Creek.

R8.c. The information (data) gaps for short and long-term water quality needs should be evaluated.

Strategy: The Watershed Implementation Team should evaluate the information (data) gaps in coordination with the Spokane County Conservation District.

R8.d. The long-term trends of sediment loads should be evaluated.

Strategy: The trend evaluation should be coordinated with the Watershed Implementation Team, The Spokane County Conservation District, the Hangman TMDL Workgroup, the USGS, and the Department of Ecology. Others may be involved.

R8.e. The stream gaging operation throughout watershed should be maintained to assist with the TMDL study. The stations will assist in the determination of pollutant load allocations.

Strategy: The Watershed Implementation Team should coordinate this with the Spokane County Conservation District and Hangman TMDL Workgroup.

R8.f. The installation of additional gaging stations to monitor the effects of BMP implementation should be supported. These BMPs should be recommended through the TMDL process.

Strategy: The Watershed Implementation Team should coordinate efforts with the Spokane County Conservation District and the Hangman TMDL Workgroup.

R8.g. Stock watering impacts to surface waters should be minimized throughout the watershed.

Strategy: The Watershed Implementation Team should coordinate efforts to develop an action plan to minimize livestock impacts. This effort should be coordinated with the Spokane County Conservation District, The Department of Ecology, and the Hangman TMDL Workgroup.

R8.h. Incentives should be developed to encourage off creek watering systems for livestock.

Strategy: The Watershed Implementation Team should coordinate efforts to develop incentives for off creek watering systems. This effort should be coordinated with the Spokane County Conservation District, The Department of Ecology, the Hangman TMDL Workgroup, and Spokane County.

R8.i. Incentives should be developed to improve riparian zones.

Strategy: The Watershed Implementation Team should coordinate efforts to develop an action plan to improve riparian zones. This effort should be coordinated with the Spokane County Conservation District, The Department of Ecology, the Hangman TMDL Workgroup, and the Spokane County Shoreline Workgroup.

7.3.2 Septic systems

Septic systems are on-site sewage disposal systems for single-family homes, small businesses and apartment buildings. Proper maintenance of septic systems is important to avoid system failure. Failed septic systems can allow untreated sewage to seep into wells, groundwater, and surface water bodies, where people get their drinking water and recreate

Contamination of water bodies by failed septic systems pollutes water supplies, closes shellfish beds and recreational areas, and creates offensive odors. High fecal coliform bacteria levels may be a result of failed or poorly maintained septic systems.

Issue Statement 9
Septic systems that are failing, improperly maintained or non-functioning can provide contaminants to surface and ground water.

Recommendation(s) and Selected Strategies:

R9.a. An education/information program should be initiated for septic system construction, care and maintenance.

Strategy: Spokane County and the Regional Health District should initiate and/or support this program.

R9.b. A septic maintenance program should be established. Inspections should take place every three years. Septic system pumping should occur every six years.

Strategy: The Regional Health District should initiate and maintain this program.

R9.c. Incentives should be developed for replacement and/or upgrades of substandard septic systems.

Strategy: The Watershed Implementation Team should coordinate with the Regional Health District to develop incentives.

7.3.3 Wellhead Protection

The purpose of a wellhead protection plan is to protect the public health, safety and welfare through the protection of the ground water resources underlying the municipality. The plan will also ensure a supply of safe and healthful drinking water for the present and future generations of local residents in the watershed. Areas of land surrounding each public community well, known as Well Head Protection Areas (WHPAs), from which contaminants may move through the ground to be withdrawn should be identified for all watershed residences.

Through regulation of land use, physical facilities and other activities within these areas, the potential for ground water contamination can be reduced. The purpose of the regulations contained in this ordinance is to prevent the migration of potential pollutants from areas within a WHPA into ground water that is withdrawn from a public community well.

Issue Statement 10

Wellhead protection is lacking in the smaller communities throughout the watershed.

Recommendation(s) and Selected Strategies:

R10.a. The needs for wellhead protection in smaller communities should be identified.

Strategy: The Watershed Implementation Team should identify the needs for wellhead protection in the smaller communities.

R10.b. Potential funding sources for wellhead protection in smaller communities should be identified.

Strategy: The Watershed Implementation Team should identify the potential funding sources for wellhead protection in the smaller communities. Evergreen Rural Water of Washington is a potential funding source.

R10.c. The impacts of storm water handling in smaller communities should be identified.

Strategy: The Watershed Implementation Team should identify the impacts of storm water handling in the smaller communities.

R10. d. Identify potential funding sources for storm water system plans with wellhead protection program.

Strategy: The Watershed Implementation Team should identify potential funding sources for storm water handling in the smaller communities.

7.4 Habitat and Land Use Recommendations and Strategies

Hangman Creek has many physical problems that can likely be attributed to ineffective past and current land use management practices. The initial development of agriculture in the watershed led to a significant reduction of riparian vegetation and extensive channel alterations. The majority of the watershed has remained rural in character, even with the addition of several small towns and golf courses along the mainstem and tributaries. These types of activities have removed and suppressed the regrowth of native riparian buffers. The result has been continuous water quality violations and significant reductions in wildlife and aquatic habitat.

7.4.1. Planning, Shorelines, and Development

The purpose of land use management is to provide guidance for growth and development while preserving the aesthetic and functional capability of the surrounding landscape. The State of Washington and designated federal agencies require counties and cities to adopt specific regulations concerning land use issues. Within Spokane County and the City of Spokane, development regulations include a comprehensive plan, zoning ordinance, subdivision ordinance, shoreline master program, critical areas ordinance, flood plain management ordinance, stormwater management ordinance, health ordinance, and building codes. These land use management regulations can positively affect the watershed (especially shorelines) if they are followed and enforced.

Issue Statement 11

The types and extents of land uses appropriate for the watershed should be compatible with the Watershed Management Plan's goals. These plans include both water quantity and water quality issues (future TMDL Plan). Riparian area and flood plain encroachment continues to occur throughout the basin (rural and urban).

Recommendation(s) and Selected Strategies:

R11.a. All development and construction proposals within the watershed should have a SEPA review and be reviewed by the Watershed Planning Team for compatibility with the watershed management plan.

Strategy: The Watershed Implementation Team should request to be on review lists of all relevant agencies.

R11.b. All County and City Land Use Planning intended for WRIA 56 should be reviewed/coordinated with the Watershed Implementation Team for compatibility with the watershed management plan.

Strategy: The Watershed Implementation Team should coordinate with local planning departments to review land use planning proposals within the Hangman Watershed.

R11.c. The local Shoreline Management Plans and/or Critical Areas Ordinance should include a restriction on commercial, residential, and industrial development along streams, within the 100-year flood plain, and the associated channel migration belts.

Strategy: The Watershed Implementation Team should coordinate with the current Shoreline Management Committee (consisting of local jurisdictions) and the City of Spokane to review policies and provide comments.

Strategy: The Watershed Implementation Team should make recommendations to land-use authorities for Shoreline Management Plans and Critical Area Ordinances.

R11.d. If new commercial, residential, and industrial development within the 100-year flood plain occurs, then mitigation should be required for fish and wildlife impacts.

Strategy: The Watershed Implementation Team should coordinate with the current Shoreline Management Committee (consisting of local jurisdictions) and the City of Spokane to review policies and provide comments.

R11.e. All streamside/shoreline land uses (eg. Agricultural, urban, residential) subject to the jurisdiction of local shoreline management regulations should implement Best Management Practices and establish appropriate riparian buffers to protect streamside habitat and water quality.

Strategy: Local jurisdictions should enforce local regulations to extent possible. An education and awareness program should be developed.

R11.f. Technical assistance should be available for landowner consultation

Strategy: The Spokane County Conservation District, the local jurisdictions, private consultants, and Ecology should provide technical assistance to landowners to the extent possible.

R11.g. Shoreline Management Plan regulations and Critical Area Ordinances should be enforced to the extent possible.

Strategy: All local jurisdictions required to regulate shorelines should maintain adequate staffing for enforcement.

R11.h. Greenbelts or conservancy corridors should be established to improve and enhance fish and wildlife habitat.

Strategy: The Watershed Implementation Team should coordinate, develop, and submit applications to the Spokane County Conservation Futures Program.

R11.i. A complete channel migration zone delineation project should be funded within the watershed and should be considered in future land use regulations.

Strategy: The Watershed Implementation Team should develop a scope of work and identify potential sources of funding for this study.

R11.j. The current delineation of the 100-year FEMA flood plain designations should be reassessed. New boundaries should be determined by a professional engineer.

Strategy: The Department of Ecology (Flood Control Assistance Account Program) should coordinate with Spokane County Flood Plain Management Department, FEMA, and the Watershed Implementation Team to conduct the work.

R11.k. Conduct feasibility study of a land acquisition/relocation program for structures within the 100-year flood plain.

Strategy: Local jurisdictions should conduct the feasibility studies. The Watershed Implementation Team should coordinate with local jurisdictions to help identify funding sources.

R11.l. Develop and maintain public awareness and education programs for riparian area function, benefits, and flood plain encroachment (This should be inclusive of residents, developers, and a broad range of stakeholders).

Strategy: The Watershed Implementation Team should coordinate this effort with the current Shoreline Inventory Committee, the current Shoreline Management Update Committee. This program should be maintained over the long-term.

R11.m. The local jurisdictions should develop a coordinated flood response plan in conjunction with a flood warning system.

Strategy: Spokane County Emergency Management Service should develop this plan in coordination with local jurisdictions.

R11.n. Establish a riparian restoration program for the watershed.

Strategy: The Watershed Implementation Team should coordinate with the Spokane County Conservation District, the Hangman TMDL Workgroup, and the current County Shoreline Management Update Committee to develop and implement the program.

R11.o. Pursue the reservation of a portion of the Conservation Futures Program to fund the acquisition of high priority riparian shorelines.

Strategy: The Watershed Implementation Team should coordinate with the Spokane County Parks and Recreation Program to discuss the potential and process.

R11.p. Identify high priority riparian habitat to submit for consideration in the Spokane County Conservation Futures Program.

Strategy: The Watershed Implementation Team should coordinate with the Spokane County Conservation District, the Natural Resources Conservation Service, the Department of Fish and Wildlife, and the current Shorelines Management Update Committee to identify high priority riparian areas for submission to the Conservation Futures Program.

R11.q. Coordinate and continue Riparian Buffer Cost-Share/and or loan programs.

Strategy: The Watershed Implementation Team should coordinate with the Spokane County Conservation District to coordinate and continue a riparian buffer program for the watershed.

7.4.2 Fisheries Habitat

Isolated resident populations of interior redband trout have been reported in several tributaries (Scholz, 2002). Fish are impaired by high suspended sediment concentrations in spring and high temperatures and low dissolved oxygen in summer. No known spawning surveys have been conducted to date. Low base flows and diminished vegetative cover have resulted in water temperatures exceeding the comfort zone of salmonid fish in local stream reaches. Water temperatures higher than 15.5° C impair the swimming ability of salmonids (USDA FS, 1985). Soltero et al. (1992) reported temperatures higher than the Class A WAC standard of 18° C. The Spokane Conservation District (1997, 2002) conducted studies reporting serious temperature excursions with maximums near 26° C. Recent fish surveys indicate depressed populations of trout and a dominance shift to fish better adapted to warmer water (Scholz, 2002).

Issue Statement 12

Fisheries within the Hangman watershed are stressed due to poor habitat, water quality and low water quantity issues.

<u>Recommendation(s) and Selected Strategies:</u>

R12.a. Fish barriers should be identified and mapped within the mainstem and tributaries. A feasibility plan to identify the benefits of removal of these barriers and an action plan to remove identified barriers should be developed.

Strategy: An action plan should be developed to identify, map, and evaluate potential fish barriers.

Strategy: Further action for identified fish barriers should be developed.

R12.b. Conduct Proper Function Condition Assessment (PFC) on the remaining tributaries in the Hangman Creek Watershed.

Strategy: The current Shoreline Inventory Committee (consisting of local jurisdictions) should work with the Spokane County Conservation District.

R12.c. Evaluate whether the current hydrology is capable of supporting flows required for returning migratory salmonids.

Strategy: The Watershed Implementation Team should coordinate this work with the Coeur d'Alene Tribe and the Department of Fish and Wildlife. A body of hydrological information should be gathered, analyzed, and reviewed.

7.5 Phase IV Plan Implementation Recommendations and Strategies

The Planning Unit has agreed by consensus to continue watershed planning through Phase IV funding. The first step will be to develop a new MOA between participating local governmental jurisdictions and other appropriate stakeholders. This new group will form the core of a decision-making body required to continue the watershed planning process. This interim body, called the Watershed Implementation Team would be responsible for detailing a Scope of Work and structuring a longer-term formal body responsible for future implementation measures. The Watershed Implementation Team will be a body similar to the Planning Unit and its' current stakeholder membership.

Issue Statement 13

The WRIA 56 Watershed Plan for Hangman (Latah) Creek should be implemented through Phase IV.

Recommendation(s) and Selected Strategies:

R13.a. An Implementation Plan MOA shall be developed between local governmental agencies and other required stakeholders.

Strategy: The Spokane County Conservation District shall undertake the development and completion of an Implementation Plan MOA.

R13.b. At such time as a Memorandum of Agreement between the Initiating Agencies is complete, a lead agency should be identified to develop the Phase IV grant application and assume administrative responsibility for the grant.

Strategy: The Spokane County Conservation District should be tentatively identified as the lead agency for plan implementation until such time as the Memorandum of Agreement formalizes this position.

Strategy: At such time as the Memorandum of Agreement between the Initiating Agencies is complete, the lead agency shall develop and submit the Phase IV grant application to the Washington State Department of Ecology.

R13.c. The current planning unit shall continue for no longer than one year under the current Operating Procedures or until such time as a completed MOA for Phase IV specifies otherwise.

R13.d. A Detailed Implementation Plan should be developed.

Strategy: A Detailed Implementation Strategy should be developed for this watershed. The plan may include milestones, timelines, funding mechanisms, and obligations of local stakeholders.

R13.e. The Watershed Implementation Team will work to develop and recommend a Minimum Instream Flow(s) for the Hangman Creek Basin.

Strategy: The Watershed Implementation Team will continue to work on the minimum instream flow(s). If a recommendation cannot be made, the Watershed Implementation Team will promptly notify Ecology that consensus could not be reached.

8.0 PHASE IV: IMPLEMENTATION STRATEGY

The Planning Unit has agreed by consensus to continue watershed planning through Phase IV funding. The first step will be to develop a new MOA between participating local governmental jurisdictions and other appropriate stakeholders. This new group will form the core of a decision-making body required to continue the watershed planning process. This interim body, called the Watershed Implementation Team would be responsible for detailing a Scope of Work and structuring a longer-term formal body responsible for future implementation measures. The Watershed Implementation Team will be a body similar to the Planning Unit and its' current stakeholder membership. The Spokane County Conservation District (SCCD) has been designated as the Lead Agency. The SCCD will submit and administer the Phase IV grant application. The Watershed Implementation Team will then select and hire a professional consultant to facilitate and develop the Detailed Implementation Plan.

Another important element of this management plan is that it should be considered a "working" document. It must be able to consider and accept new technology or advancement in areas that prove to be more effective and efficient (costs and strategies). This type of adaptive management promotes a need for periodic review of the plan. It is recommended that this plan be reviewed in 18 months after it is approved by the appropriate County Commissioners.

8.1 Phase IV Funding

House Bill 1336 provides the funding mechanism for Phase IV activities. Phase IV allows up to $400,000 in grant funds over a five-year period. Funding will be available for up to $100,000 per year for the first three years of implementation. A two-year extension may be available for up to $50,000 each year. These grants require a ten percent match which can include in-kind goods and services, cash, or through local agreements with participating governments, federal agencies, and other stakeholders.

This funding allocation may provide significant advancement towards the implementation of the plan. Initial estimated costs of the plan range from $500,000 to $1.8 million dollars. Additional funding sources will also be identified during the first year of Phase IV.

8.2 Obligations and Costs

The Watershed Planning Act does not allow local government agencies or other stakeholders to become unwillingly obligated by recommendations. To avoid this, each entity/government evaluated the recommendations, as they were being proposed and developed. Any concerns were addressed accordingly. All recommendations found to be unacceptable were deleted or modified. This approach allowed the entity to systematically decide if they could or would accept the outlined responsibility and potential commitment involved. However, it was difficult to confidently assess the size and scope of every commitment at this stage of the plan. Most of the recommendations are conceptual at this point. Therefore, general cost estimates of each strategy were proposed. Although every entity agreed with the proposed plan and recommendations, no entity was obligated to a future funding commitment at this time. It was decided that a more detailed scoping of the responsibilities and cost commitments would be identified through the first year of Implementation (Phase IV).

Phase IV allows up to $400,000 in grant funds over a five-year period. The grants require a ten percent match. This funding allocation may provide significant advancement towards the implementation of the plan. Initial estimated costs of the plan range from $500,000 to $1.8 million dollars. Additional funding sources will also be identified during the first year of Phase IV.

8.3 Early Action Items

The following Early Action Items have been developed by the WRIA 56 Planning Unit as interim actions to be implemented between approval of the Watershed Plan by the Planning Unit and finalization of the Implementation Agreement. These actions are not prioritized and will be implemented as opportunities provide. Funding will be limited to Phase III funds not otherwise utilized in the WRIA 56 Planning Process and/or funding volunteered by Planning Unit participants.

- The Planning Unit will pursue negotiations with the City of Tekoa, WA to pump additional water into Hangman Creek to augment flows during the critical summer period (July – September).
- The Planning Unit will investigate and implement a series of long-term monitoring wells to evaluate the ground-water level status in the Hangman Creek basin.
- The Planning Unit may provide technical assistance and/or financial assistance to the Tekoa Golf Course with changing or transferring its surface water right, if a right exists and is valid, from Hangman Creek to a more efficient alternate source.
- The Planning Unit may grant the Town of Tekoa financial assistance to partially fund the cost of the infrastructure needed to supply water to the Tekoa Golf Course. The granting of funds would be contingent upon meeting match and conservation requirements determined by the Planning Unit.
- The Planning Unit may fund restoration/acquisition of high priority riparian shorelines in the watershed.
- The Planning Unit will implement a water quality monitoring program to provide a baseline condition to help indicate potential long-term improvements within the basin.

8.4 Significant Archaeological and Cultural Resources

The Washington State Archaeological database (ARCHNET) has revealed several archeological or historical sites within the Hangman Creek watershed (SCCD 1994). These sites are recorded closer to the City of Spokane, but other sites may exist within the project area. The Coeur d'Alene and Spokane Indian Tribes utilized the corridor for many activities including hunting, fishing, and collecting important vegetation. These cultural and archaeological areas have been identified as campgrounds, burial sites, sweat baths, and a Mastodon fossil pit. Due to looting and potential vandalism, the sites are not available to the general public.

Since significant archaeological and cultural sites exist within the drainage, any future project activities should proceed with caution. Although the National Historic Preservation Act, Section 106 does not apply to this project (no federal funding), a formal review by parties with access to information concerning these sites should be conducted. If a site is suspected to contain artifacts, then it may be reasonable to have a staff member from the appropriate jurisdiction or Tribe present during construction activities.

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