TAMMANY CREEK
Sediment TMDL

SUBBASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOAD ANALYSIS

Prepared for:

Idaho Department of Environmental Quality
Lewiston Regional Office
1118 "F" Street
Lewiston, Idaho 83501
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GLOSSARY

Aerobic: Describes life or processes that require the presence of molecular oxygen.

Alevin: Newly hatched salmonid still dependent on yolk sac; remains in streambed gravel until yolk sac is absorbed.

Algae: Small aquatic plants that occur as single cells, colonies, or filaments.

Anaerobic: Describes processes that occur in the absence of molecular oxygen.

Aquatic: Growing, living, or frequenting water.

Assimilative capacity: An estimate of the amount of pollutants that can be discharged to and processed by a waterbody and still meet the state water quality standards. It is the equivalent of the Loading Capacity which is the equivalent of the TMDL for the waterbody.

Basalt: A fine-grained, dark-colored extrusive igneous rock.

Bedload: Material, generally of sand size or larger, carried by a stream on or immediately above (3") its bed.

Beneficial uses: Any of the various uses which may be made of the water of an area, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics.

Benthic organic matter: The organic matter on the bottom of the river.

Benthic: Pertaining to or living on the bottom or at the greatest depths of a body of water.

Benthos: Macroscopic (seen without aid of a microscope) organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the substrate.

Best management practice (BMP): A measure determined to be the most effective, practical means of preventing or reducing pollution inputs from point or non-point sources in order to achieve water quality goals.

Bioaccumulation: Accumulation of substances over time, such as pesticides, in an organism.

Biochemical oxygen demand (BOD): The rate of oxygen consumption by organisms during the decomposition (= respiration) of organic matter, expressed as grams of oxygen per cubic meter of water per hour.

Biomass: The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often measured in terms of grams per square meter of surface.

Biomass accumulation: A measure of the density and lateral and downstream extent of plant growth across a waterbody.

Biota: All plant and animal species occurring in a specified area.

Cfs: Cubic feet per second, a unit of measure for the rate of discharge of water. One cubic foot per second is the rate of flow of a stream with a cross section of one square foot which is flowing at a mean velocity of one foot per second. It is equal to 448.8 gallons per minute, 0.646 million gallons per day, or 1.98 acre-foot per day.

 Coliform bacteria: A group of bacteria predominantly inhabiting the intestines of man and animal but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms.

Colluvium: Material transported to a site by gravity.

Decomposition: The transformation of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and non-biological processes.

Dissolved oxygen: Commonly abbreviated D.O., it is the amount of oxygen dispersed in water and is usually expressed as mg/L (ppm). The amount of oxygen dissolved in water is affected by temperature, elevation, and total dissolved solids.

Effluent: A discharge into the environment, often used to refer to discharge of untreated, partially treated, or treated pollutants into a receiving waterbody.

Environment: Collectively, the surrounding conditions, influences, and living and inert matter that affect a particular organism or biological community.

Epilimnion: The upper, well-mixed, well-illuminated, nearly isothermal region of a stratified lake

Erosion: The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Culturally-induced erosion is that caused by increased runoff or wind action due to the work of man in deforestation, cultivation of the land, overgrazing, and disturbance of the natural drainage; the excess of erosion over that normal for the area.

Eutrophic: From Greek for "well-nourished," describes a body of water of high photosynthetic activity and low transparency.

Eutrophication: The process of physical, chemical, and biological changes associated with nutrient organic matter, and silt enrichment and sedimentation of a body of water. If the process is accelerated by man-made influences, it is termed cultural eutrophication. Eutrophication refers to natural addition of nutrients to waterbodies and to the effects of artificially added nutrients.

Existing beneficial use or existing use: Those beneficial uses actually attained in waters on or after November 28, 1975, whether or not they are designated for those waters in Idaho Department of Health and Welfare Rules, Title 1, Chapter 2, "Water Quality Standards and Wastewater Treatment requirements. "

Fecal Streptococci: A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.

Feedback loop: A component of a watershed management plan strategy that provides for accountability on targeted watershed goals.

Flow: The quantity of water that passes a given point in some time increment.

Flushing Rate: The rate at which water enters and leaves a lake relative to lake volume, usually expressed as time needed to replace the lake volume with inflowing water.

Granitic: Derived from granite; coarse to medium grained intrusive igneous rock

Groundwater: Water found beneath the soil's surface; saturates the stratum at which it is located; often connected to surface water.

Growth rate: The amount of new plant tissue produced per a given time unit of time. It is also a measure of how quickly a plant will develop and grow.

Habitat: A specific type of place that is occupied by an organism, a population or a community.

Headwater: The origin or beginning of a stream

Hydrologic basin: The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area. There are 6 basins described in the Nutrient Management Act (NMA) for Idaho -- Panhandle, Clearwater, Salmon, Southwest, Upper Snake, and the Bear Basins.

Hypolimnion: The poorly illuminated, dense, colder lower region of a stratified lake that is protected from wind action.

Influent: The flow into a process, facility, or larger body of water

Inorganic: Materials not containing carbon and hydrogen, and not of biologic origin.

Limiting factor: A chemical or physical condition that determines the growth potential of an organism, can result in less than maximum or complete inhibition of growth, typically results in less than maximum growth rates.

Load allocation: The amount of pollutant that non-point sources can release to a waterbody.

Loading: The quantity of a substance entering a receiving stream, usually expressed in pounds (kilograms) per day or tons per month. Loading is calculated from flow (discharge) and concentration.

Loading Capacity- The maximum amount of pollutant a waterbody can safely assimilate without violating state water quality standards. It is also the equivalent of a TMDL.

Loam: Moderately coarse, medium and moderately fine textured soils that include such textural classes as sandy loam, fine sandy loam, very fine sandy loam, silt loam, silt clay loam, sandy clay loam and silty clay loam.

Loess: Is defined as a uniform eolian (wind-blown) deposit of silty material having an open structure and relatively high cohesion due to cementation by clay or calcareous material at the grain contacts. A characteristic of loess deposits is that they can stand with nearly vertical slopes (ASCE P1826). Erosion potential is highly dependent on topography; ranges from low to very high within the Northwest.

Macrophytes: Rooted and floating aquatic plants commonly referred to as waterweeds. These plants may flower and bear seed. Some forms, such as duck-weed and coontail *(Ceratophyllilm),* are free-floating forms without roots in the sediment.

Margin of safety: An implicit or explicit component of water quality modeling that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody.

Mean: The arithmetic mean is the most common statistic familiar to most people. The mean is calculated by summing the entire individual observations or items of a sample and dividing this sum by the number of items in the sample. The geometric mean is used to calculate bacterial numbers. The geometric mean is a back-transformed mean of the logarithmically transformed variables.

Meter: The basic metric unit of length; I meter = 39.37 inches or 3.28 feet.

Milligrams per liter (mg/L): Concentration equal to.001 grams in substance weight per liter capacity.

Million gallons per day (MGD): A unit of measure for the rate of discharge of water often used to measure flow at WWTPS. It is equal to 1.55 cubic feet per second.

Monitoring: The process of watching, observing, or checking (in this case water). The entire process of a water quality study including: planning, sampling, sample analyses, data analyses and report writing and distribution.

Mouth: The location where a waterbody flows into a larger waterbody.

Nitrogen: A nutrient essential to plant growth, often in more demand than available supply.

Nonpoint source: A dispersed source of pollutants such as a geographical area on which pollutants are deposited or dissolved or suspended in water applied to or incident on that area, the resultant mixture being carried by runoff into the waters of the state. Nonpoint source activities include, but are not limited to irrigated and non-irrigated lands used for grazing, crop production and silviculture; log storage or rafting; urban areas; construction sites; recreation sites and septic tank disposal fields.

Nuisance: Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient: An element or chemical essential to life, such as carbon, oxygen, nitrogen, and phosphorus.

Organic matter: Molecules manufactured by plants and animals and containing linked carbon atoms and elements such as hydrogen, oxygen, nitrogen, sulfur, and phosphorus.

Orthophosphate: A form of soluble inorganic phosphorous which is directly utilizable for algal growth.

Oxygen demanding materials: Those materials, usually organic, in a waterbody that consume oxygen during decomposition or transformation. Sediment can be an oxygen-demanding material.

Parameter: A variable quantity such as temperature, dissolved oxygen, or fish population that is the subject of a survey or sampling routine.

Pathogen: Any disease-producing organism.

pH: A measure of the concentration of hydrogen ions of a substance, which ranges from very acidic (pH = 1) to very alkaline (pH = 14). pH 7 is neutral, and most lake waters range between 6 act 9. pH values less than 7 are considered acidic, and most life forms cannot survive at pH of 4.0 or lower.

Phased TMDL: A TMDL which identifies interim load allocations with further monitoring to gauge success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a waterbody. Under a phased TMDL, the TMDL has load allocations and wasteload allocations calculated with margins of safety to meet water quality standards.

Phosphorus: A nutrient essential to plant growth, typically in more demand than the available supply.

Phytoplankton: Microscopic algae and microbes that float freely in open water of lakes and oceans.

Point source pollution- The type of water quality degradation resulting from the discharges into receiving waters from sewers and other identifiable "points." Common point sources of pollution are the discharges from industrial and municipal sewage plants.

Reach: A stream section with defined characteristics.

Respiration: Process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process releases energy, carbon dioxide, and water.

Riparian: Associated with aquatic (streams, rivers, takes) habitats. Living or located on the bank of a waterbody.

Runoff: The portion of rainfall, matted snow, or irrigation water that flows across the surface or through underground zones and eventually runs into streams.

Sediment: Bottom material in a body of water that has been deposited after the formation of the basin. It originates from remains of aquatic organism, chemical precipitation of dissolved minerals, and erosion of surrounding lands.

Stream segments of concern (SSOC): Stream segments nominated by the public and designated by a committee whose members are appointed by the Governor.

Sub-basin: Smaller geographic management areas within a hydrologic basin delineated for purposes of addressing site specific situations.

Suspended solids: Fine mineral or soil particles that remain suspended by the current until deposited in areas of weaker current. They create turbidity and, when deposited, can cover fish eggs or alevins.

Thermocline: Zone in stratified lake where temperature changes rapidly with depth.

Total Maximum Daily Load (TMDL): TMDL = LA + WLA + MOS. A TMDL is the Total Maximum Daily equivalent of the Loading Capacity that is the equivalent of the assimilative capacity of a waterbody.

Total suspended solids (TSS): The material retained on a 2.0-micron filter after filtration.

Tributary: A stream feeding into a larger stream or lake.

Trophic state: Level of growth or productivity of a lake as measured by phosphorus content chlorophyll a concentrations, amount of aquatic vegetation, algal abundance, and water clarity.

Turbidity: A measure of the extent to which light passing through water is scattered due to suspended materials. Excessive turbidity may interfere with light penetration and minimize photosynthesis, thereby causing a decrease in primary productivity. It may alter water temperature and interfere directly with essential physiological functions of fish and other aquatic organisms, making it difficult for fish to locate a food source.

Waste load allocation: A portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. It specifies how much pollutant each point source can release to a waterbody.

Water column: Water between the interface with the atmosphere at the surface and the interface with the sediment layer at the bottom. Idea derives from vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water pollution: Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state which will or is likely to create a nuisance or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to fish and wildlife, or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water quality limited segment (WQLS): Any waterbody, or definable portion of waterbody, where it is known that water quality does not meet applicable water quality standards, and/or is not expected to meet applicable water quality standards.

Water quality management plan: A state or area wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water quality modeling: The input of variable sets of water quality data to predict the response of a lake or stream.

Water table: The upper surface of groundwater, below this surface the ground is saturated with water.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or take at a lower elevation. The whole geographic region contributing to a waterbody.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have the following 3 attributes (1) at least periodically, the land supports predominately hydrophytes; (2) the substrate is predominately undrained hydric soil; and (3) the substrate is on soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Zooplankton: Microscopic animals that float freely in lake water, graze on detritus particles, bacteria, and algae, and may be consumed by fish.

Acronyms and Abbreviations

AFO	Animal Feeding Operation
ARS	Agricultural Research Station
ASCE	American Society of Civil Engineers
BAG	Basin Advisory Group
BMP(s)	Best Management Practice(s)
BOD	Biological Oxygen Demand
BURP	Beneficial Use Reconnaissance Project
C	Degrees Celsius
CAFO	Confined Animal Feeding Operation
CBOD	Carbonaceous Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response Compensation and Liability
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony forming units
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
DMR	Discharge Monitoring Report
EHS	Extremely Hazardous Substances
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
EPT	Ephemeroptera, Plecoptera, Trichoptera Insect Orders
ESA	Endangered Species Act
ft	Feet
FY	Fiscal Year
GIS	Geographic Information System
ha	Hectare
HI	Habitat Index
HUC	Hydrologic Unit Code
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDHW	Idaho Department of Health and Welfare
IDL	Idaho Department of Lands

IDWR	Idaho Department of Water Resources
kg	Kilogram
l	Liter
LA	Load Allocation
lbs.	Pounds
LC	Load Capacity
m	Meter
mg	Milligrams
mg/l	Milligrams per liter
ml	Milliliter
MOS	Margin of Safety
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
SAWQP	State Agricultural Water Quality Program
SCD	Soil Conservation District
t/yr.	Tons per Year
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorous
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WBAG	Waterbody Assessment Guidance
WLA	Waste Load Allocation
WMP	Watershed Management Plan
WQLS	Water Quality Limited Segment
yr	Year

Tammany Creek at a Glance (Errata)

LOWER-SNAKE-ASOTIN
4th Field Hydrologic Unit
17060103
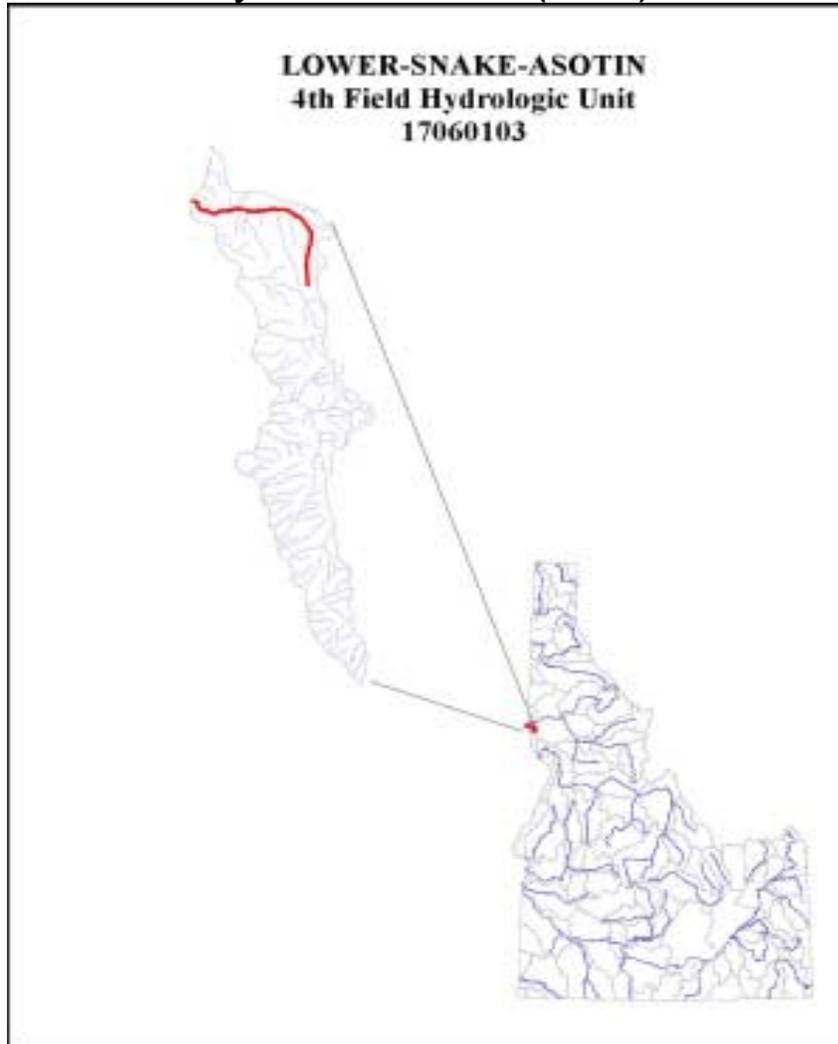
Subbasin	Lower Snake-Asotin
Hydrologic Unit Code	17060103
1998 303(d) Listed Stream Segment	Tammany Creek
Listed stream miles	13.79
Beneficial Uses Affected	Cold water biota Secondary Contact Recreation
Pollutants	Sediment
Major Pollutant Sources	Non-point Sources: Predominantly Agriculture, grazing and cropland uses, rural development.
Public participation	7/3/2001 – 8/3/2001 32 Comments recieved

1.0   EXECUTIVE SUMMARY – (Errata December 10, 2001)

The federal Clean Water Act (CWA) requires that states restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC § 1251.101). States, pursuant to section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States must publish a priority list of impaired waters that is known as the "303(d) list," currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses a waterbody in the Lower Snake-Asotin Subbasin that was placed on the "303(d) list" in 1994.

This subbasin assessment and TMDL analysis has been developed to comply with Idaho's court ordered TMDL schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Lower Snake-Asotin Subbasin located in northern Idaho. The first part of this document, the subbasin assessment, is an important first step in developing the TMDL. The subbasin assessment portion of this document examines the current status of this 303(d) listed waterbody, and defines the extent of impairment and causes of water quality limitation throughout the subbasin. In the TMDL portion of this document, the loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

1.1   Tammany Creek

Tammany Creek is located in the Lower Snake-Asotin subbasin, hydrologic unit code 17060103. Tammany Creek, from its headwaters to the Snake River, is

listed on the State of Idaho Water Quality Impaired Water Body §303(d) list in 1994 by the Environmental Protection Agency (EPA) for excessive sediment levels. Due to the extensive rural and agricultural development within the Tammany Creek watershed, surface and stream bank erosion have been determined to be the dominant source of sediment loading to Tammany Creek.

This TMDL has been developed to provide protection to existing beneficial uses for Tammany Creek. The beneficial uses are secondary contact recreation and cold water biota.

The Tammany Creek TMDL has been developed through the combination of field surveys, water quality data analysis, modeling of hydrologic and erosional processes and application of State of Idaho water quality standards. A comparative erosion prediction analysis was conducted to estimate background and current land surface sheet and rill erosion levels within the Tammany Creek watershed. Stream bank stability surveys were conducted to provide bank erosion estimates within the watershed. From these surveys and analyses it is estimated that 11% of the current sediment loading within the Tammany watershed is representative of background levels. Using the 11% background value, a floating background allocation is used to account for natural processes in which sediment loading increases during high flow events.

The applicable State of Idaho aquatic life sediment standard is expressed as a maximum allowable turbidity above naturally occurring background levels. A surrogate Total Suspended Solids (TSS) level of 48 mg/l was created by extrapolating mass per volume units from turbidity nephlometric turbidity units (NTUs) for application in the TMDL loading. Through comparative analysis of turbidity and TSS concentrations, the TSS surrogate level used in this TMDL process is considered equivalent to the required 25 NTU value for turbidity in the Idaho Water Quality rules.

The monthly load allocations (LAs) for Tammany Creek is shown in table 1 below. The LAs were calculated by first multiplying the monthly average TSS concentrations by the 11% background value to equal a monthly average background concentration for TSS. Next the surrogate TSS level of 48mg/l, was added to the background TSS concentrations to equal the maximum monthly mean for TSS.

The TSS maximum monthly mean is then multiplied by the mean monthly flow to equal the monthly capacity. A 10% margin of safety is subtracted from the capacity to equal the maximum monthly load capacity shown in table 1.

Table 1. Sediment Loading Summary (Errata)

Tammany Creek Sediment Loading Summary												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
Load Capacity lbs./day	173.5	227.9	351.5	425.5	682.0	926.6	1156.7	682.0	318.1	173.5	121.9	121.9
Current Loading lbs./day	108.5	188.5	497.0	774.8	2191.8	3958.3	5812.8	2191.8	394.7	108.5	57.4	57.4
Necessary reductions	-	-	29%	45%	69%	77%	80%	69%	19%	-	-	-

A Margin of Safety (MOS) for TMDL LAs is required under the Clean Water Act. It has recently been required by EPA to establish an explicit MOS for every State of Idaho TMDL. A 10% MOS for Tammany Creek was chosen to be conservative and is representative of average conditions.

Point Source Waste Load Allocations for Tammany Creek equal zero since there are no point sources contributing to the stream within the Tammany Creek Watershed. There is an Animal Feeding Operation (AFO) within the watershed however, the AFO does not meet the definition of a National Pollution Discharge Elimination System (NPDES) regulated Confined Animal Feeding Operation (CAFO) since the operation does not exceed 1000 animal units and does not

discharge to Tammany Creek. AFOs are not regulated under the NPDES permitting program and are not considered point source dischargers.

Monthly load allocations were chosen rather than average annual loading rates to better address seasonal variation in flow. The monthly load allocations indicate that there is a 7-month window during high flow periods (generally from December to June) when sediment loading must be reduced to bring Tammany Creek into compliance with state water quality standards to restore and protect full support of its designated beneficial uses.

During the TMDL investigation, nutrients and pathogens were also examined as pollutant sources. Results for nutrient monitoring indicate that high nitrogen levels occurred in Tammany Creek. High nitrogen levels were not correlated with changes in flow or seasonal variation which indicates that nitrates are originating from a constant source, such as groundwater recharge. Phosphorous levels remained relatively low for most of the year and were found to be the limiting factor to nuisance aquatic growth. Phosphorus levels did increase during high flow events indicating that phosphorous transport occurs in relation with increased sediment transport in the watershed. Nutrient reductions for Tammany Creek will be addressed through this TMDL since phosphorus levels will reduce when sediment levels are reduced as part of TMDL implementation. Initial pathogen monitoring results indicate that pathogen loading within Tammany Creek exceeds the Idaho Water Quality standards. Upon analysis, concentrations of pathogen loading appear to be somewhat random and unpredictable. Further monitoring will be conducted by DEQ in the next data collection cycle to determine if a pathogen TMDL is warranted. Evaluation of pathogens and nutrients as pollutant sources within Tammany Creek will occur during the next 305(b) and 303(d) assessment and listing process.

The Soil Conservation Commission and the Nez Perce Soil Water Conservation District and the Watershed Advisory Group provided comment and involvement

through the development of the Tammany Creek TMDL. Two public meeting were held and two public comment periods were provided for additional input. The last public comment period ended August 3, 2001. During the public comment period, 32 comments were received and addressed. The primary commentors were the Nez Perce Tribe, the Nez Perce Soil Water Conservation District, the City of Lewiston, and EPA Region 10, as well as land owners within the watershed.

The implementation plan for the Tammany Creek TMDL is underway and includes inclusion of this project into an existing PL-566 watershed project. The PL-566 watershed project is a water quality improvement and water conservation project implemented by the USDA Natural Resources Conservation Service (NRCS) and the Nez Perce Soil Water Conservation District. The Idaho Association of Soil Conservation Districts will be monitoring the effectiveness of best management practices (BMPs) implemented as part of the PL-566 project and the TMDL and will report information generated to the watershed advisory group. DEQ will also continue to monitor the watershed to determine the support status of beneficial uses on a periodic basis and results will be reported to the public and EPA through the states 305(b) and 303(d) reporting process.

1.0 EXECUTIVE SUMMARY

Tammany Creek was listed on the State of Idaho Water Quality Impaired Water Body §303(d) list in 1994 by the EPA for excessive sediment levels. Due to the extensive rural and agricultural development within the Tammany Creek watershed, surface and stream bank erosion have been determined to be the dominant source of sediment loading to Tammany Creek. As required by the Clean Water Act, this TMDL develops the maximum sediment loading that is allowable by State of Idaho water quality criteria. The TMDL analysis focuses on the Idaho water quality standards that are intended to provide protection of all designated beneficial uses for the water body. The beneficial uses for Tammany Creek are secondary contact recreation and the support of cold water biota.

The Tammany Creek TMDL has been developed through the combination of field surveys, water quality data analysis, modeling of hydrologic and erosional processes and application of State of Idaho water quality standards. A comparative erosion prediction analysis was conducted to estimate background and current land surface sheet and rill erosion levels within the Tammany Creek watershed. Stream bank stability surveys were conducted to provide bank erosion estimates within the watershed. This TMDL also utilizes an analysis of field data that demonstrate strong relationships between creek flows and sediment concentrations and between turbidity and fine suspended sediment (total suspended solids, TSS). The applicable State of Idaho aquatic life sediment standard is expressed as a maximum allowable turbidity above naturally occurring background levels. These relationships allow for the comparison of the State of Idaho cold water biota turbidity standard to TSS concentrations, which permits the calculation of loads in the form of mass per unit time required by the Clean Water Act. From these surveys and analyses it is estimated that 11% of the current sediment loading within the Tammany watershed is representative of background levels. Using the 11% background value, a floating background allocation is used to account for natural processes in which sediment loading increases during high flow events. The analysis

results, shown in Table 1, indicate that there is a 7-month window during high flow periods when sediment loading must be reduced to bring Tammany Creek into compliance with state water quality standards to restore and protect full support of its designated beneficial uses.

Table 1. Sediment Loading Summary

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Necessary reductions	-	-	29%	45%	69%	77%	80%	69%	19%	-	-	-

2.0   SUBBASIN ASSESSMENT - CHARACTERIZATION OF WATERSHED

2.1   Watershed Characterization

2.1.1 Watershed Description

Tammany Creek is a second order tributary to the Snake River within the impact zone of the city of Lewiston in Nez Perce County, Idaho. The creek originates in the farm lands southeast of Lewiston and flows in a predominately northwesterly direction to where it joins the Snake River within Hells Gate State Park. The main stem is approximately 13 miles long and includes intermittent and perennial channels. The watershed is approximately 35 square miles and is predominately agricultural land including both cultivated crop and livestock range uses. Tammany Creek begins near the western boundary of the Nez Perce Indian Reservation in slightly rolling agricultural crop lands and continues in a northwesterly direction for approximately 5 miles (Picture 1). In this region the creek is ephemeral and flows only during rainfall and snow melt events. The creek then turns west where it enters the Tammany area of mixed land uses including range, crop and significant suburban development. In this reach, the creek is intermittent and flows in a concrete channel (Picture 2). As the creek exits the concrete channel to the west it becomes perennial, as springs appear, and flows in a westerly direction paralleling the southern Lewiston city limits through mixed agricultural lands and interspersed private residences (Picture 3). Four miles from the mouth the creek flows through a region of high impact development that includes a commercial indoor riding arena, livestock feeding operations, grazing areas and several private residences (Picture 4). Upon leaving this area, the creek flows through more mixed agricultural lands for two miles before entering another high impact area that includes an animal feeding operation (AFO) which houses approximately 600-800 livestock (Picture 5). The creek then continues west entering more mixed agricultural lands for approximately 1 mile before descending over 200 feet through a narrow canyon to meet the Snake River at Hells Gate State Park (Picture 6).

Picture 1. Upper Tammany Creek Watershed

Picture 2. Tammany Development Area

Picture 3. Downstream of Tammany Area

Picture 4. Lucky Acres Development Area

Picture 5. Livestock Bank Damage

Picture 6. Tammany Creek Lower Reach
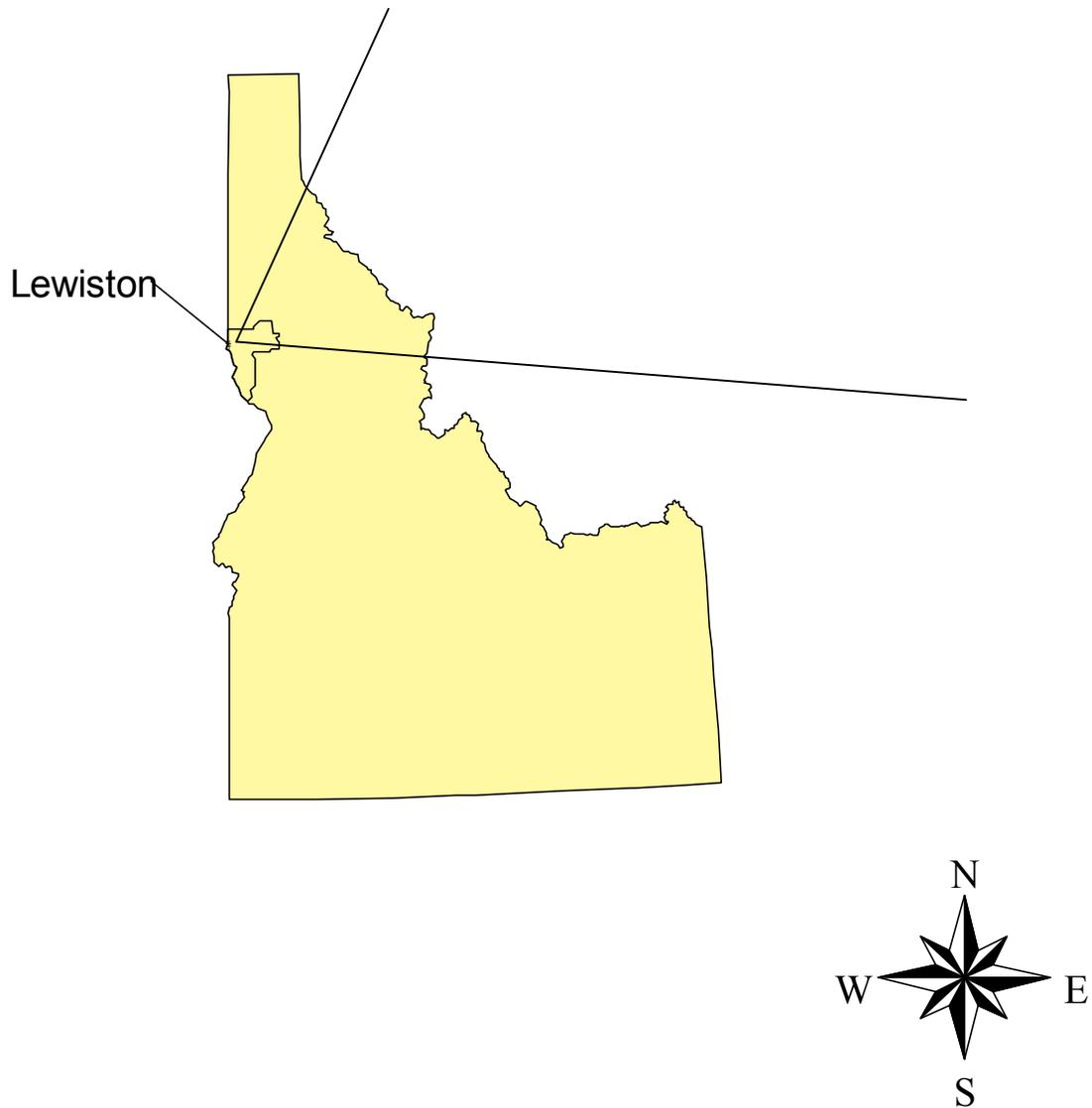
Tammany Creek Watershed

Lewiston

N
W   E
S

Figure 1. Tammany Creek Watershed Location

2.1.2 Watershed Hydrology

Tammany Creek is a second order tributary to the Snake River and is comprised of several minor ephemeral and intermittent stream segments and springs that join to form the creek's mainstem. The upper reaches, above the Barr Road crossing in the Tammany area, are intermittent and ephemeral and flow only during heavy precipitation or infrequent snowmelt run off events.

Historically the watershed was primarily rolling grasslands with large woody species such as cottonwoods and willows occupying the stream banks and riparian zones. This perennial vegetation cover could have allowed for the capture of precipitation, minimizing surface runoff and promoting the incorporation into the shallow groundwater system. These waters could then be available to contribute to the creek base flow throughout the drier seasons. This pre-agricultural development system could represent a more moderate flow system with lower peak flows and higher base flows during dry periods resulting in greater bank stability, higher water quality and a healthier aquatic ecosystem. Modern land use modifications have resulted in the loss of perennial vegetation through agricultural development, grazing land conversions and roadway and structure construction. This loss in permeability from agricultural and rural development and field drain installations has resulted in larger and accelerated peak flows and reduced base flows in the drier seasons. This has increased sediment delivery to the creek channel and reduced the quality of the aquatic ecosystem.

2.1.3 Stream Channel Assessment

The channel conditions of Tammany Creek vary widely from shallow and wide with well-developed flood plains to highly entrenched with no flood plain. More specifically, the channel classifications according to Rosgen (1994) range from type A6 to C6 in the extreme upper and lower reaches of the creek to type G6 to F6 in the middle reaches. The G6 channel type is representative of a highly entrenched channel with no functioning flood plain and relatively low bank

stability. These highly entrenched channels present particularly difficult problems for the control of instream sediment loading and restoration and protection of riparian ecological health. The causes of channel downcutting and entrenchment are difficult to isolate and often result from a combination of factors.

Stream channels in their natural state are predominately in a dynamic equilibrium energy state. The available energy within the stream is balanced through frictional losses and the movement and deposition of sedimentary material. Channel incision is often initiated through a disruption of this energy balance. Actions such as channel straightening are often linked to the initiation of channel incision as the effective gradient is increased when the channel flow length is decreased (Parker and Andres, 1976). Livestock grazing has also been linked to channel incision as the land surface infiltration capacity is reduced from compaction and perennial vegetation is removed which results in increased runoff, greater channel flows and energy and decreased channel stability (Cooke and Reeves, 1976). Wildlife activities may also contribute to channel incision in certain cases.

Channel incision also occurs both downstream and upstream near dams (Darby and Simon, 1999). Investigations revealed that near the early 1900's there was a dam constructed on Tammany Creek to provide water for the operation of a dairy farm. Exact dates of the construction, operation and eventual removal of the dam are not available but it appears that it was in place in the early 1900's (Rasmussen, 2001). The downstream incision was stimulated through the removal of sediment through settlement in the reservoir pool. When the reservoir water is released the excess energy is balanced through the degradation of the channel bed resulting in increased channel incision. Fluctuating reservoir levels cause upstream incision and in the event of dam removal, the loss of bed elevation control initiates stream incision as the channel evolved to its new equilibrium. While many sections of the Tammany Creek channel are deeply incised, they are relatively stable. Schumm (1984) details the evolutionary

stages of channel incision that occur in stream systems. Many of the incised segments within the Tammany watershed appear to be at or near the final stable stage with the mean flow channel occupying a small portion of the incised channel bed, with large woody vegetation established within the incised channel floor. The evolution from the initiation of incision to the current relatively stable stage has been reported to take about 40 to 50 years in the southeast USA (Schumm et al. 1984) to over 100 years in the arroyos of the southwest USA (Gellis et al., 1995). Ultimately, the channel incision within the Tammany watershed most likely occurred as a result of a combination of factors including intensive agricultural development, road construction, channelization activities, dam construction and removal and livestock grazing. The complete recovery of the incised channels of Tammany Creek is expected to be a slow process that can take many years after corrective actions are taken.

2.1.4 Watershed Geology and Geomorphology

The underlying geology of the Tammany Creek watershed is primarily comprised of silty-loam soils overlying the Lolo flow of the Priest Rapids member of the Wanapum Basalt of the Columbia River Group. Within the drainage there are also exposures on the canyon walls of the Elephant Mountain members of the Saddle Mountain Basalt and associated sedimentary interbeded formations. The creek has eroded into the Lolo basalt and has deposited a bed of alluvium around the creek channel. In various locations throughout the lower extremity of the watershed fluvial deposits of historic meandering of the Snake River and deposition that occurred during the Lake Missoula Flood events that occurred during the last ice age can be observed (Heins, 2001). The upper reaches of the watershed are of low relief topography with a distinct high flat plateau representing the large planar basalt flows that inundated the region. Drainage patterns in the upper region are shallow, have little developed channel structure with most depositing erosional material upon agrading lowland areas. In this region the main stem ephemeral channel of Tammany Creek demonstrates little natural channel development and is primarily a county road drainage ditch.

Channel gradients within this region are less than 2%. The middle reach is gently sloping terrain with limited subdrainage development. The majority of the subdrainages deposit colluvium and alluvium materials upon the agrading lowlands and do not have developed channel delivery to the creek. Channel gradients in this reach vary between 3-5%. The lower reach of the creek exhibits greater channel development and features exposed down-cut basalt along with alluvial deposits from both the creek and historic meanders of the Snake River. The steepest slopes within the drainage are present within this reach with the most comprised of steep and shear basalt exposures. The main channel gradients through this reach range between 5-8% as it descends to the Snake River. All together the watershed is represented by a high plateau which transitions into a low sloping valley that descends more rapidly during the final mile before it reaches the Snake River. Overall this contributes to a very low runoff response to precipitation events with the creek flow dominated by groundwater discharge from the shallow basalt aquifer.

2.1.5 Watershed Climate

The Tammany watershed climate is classified under the Köppen global climate classification system as a Bsk category climate, which can be described as mid-latitude semi-arid, cool steppe regions. The cool classification is on a global scale and yet represents one of the warmest regions within the state of Idaho. More generally, the climate can be characterized as warm and arid with a long growing season. Average annual maximum and minimum temperatures are 63.1 and 41.7 degrees Fahrenheit respectively with an average annual precipitation of 12.5 inches which occurs primarily during the fall through spring seasons with isolated summer thunderstorms. Precipitation is relatively evenly distributed throughout the period between November and June with a monthly average total precipitation of 1.2 inches which commonly occurs in short duration and low intensity precipitation events. The 10-yr. 24-hour precipitation event is estimated to be between 1.7-1.9 inches (NOAA 1975).

2.1.6 Watershed Soils

Soils within the Tammany Creek watershed were developed in a moderately low precipitation area under grassland conditions. Topsoil depths are estimated to have been in the range of 20-25 inches, but have been reduced by 30-60 percent by erosion under current land practices (SCS 1986). The soils generally have an infiltration restrictive layer at depths of 40 inches, but mechanical cultivation has resulted in shallower restrictive zones in many areas. The soils can be divided into 3 general categories depending upon the slopes that they form upon.

1. The Chard silt loam is commonly present on low stream terrace and foothill slopes of 0-4 percent grade and are generally characterized as well and moderately well drained, moderate to moderate slow permeability, a silt loam surface texture and are commonly sodium affected. This group has a current common topsoil depth of 20 inches. Sheet and rill erosion is generally low within this group as the lower slope angles produce less erosion, but gully erosion can occur from concentrated flow originating on higher slopes.

2. The soils of the plateau top regions are characterized as silt loams on slopes of 2-8 percent grade that are moderately deep, well drained, have moderate or moderate slow permeability and are commonly sodium affected. Common current topsoil depths within this group are around 14 inches.   These areas experience slightly higher erosion potential than that of the drainage bottom or foothill slope soils. Representative soils of this group are the Endicott and Bryden silt loams.

3. The soil of the transition slopes between the plateau tops and the drainage bottom soils occur on slopes from 10 and greater percent grade. These soils are also silt loams that are well drained with moderate to moderately slow permeability and experience the greatest erosion through sheet, rill and gully erosion. Representative soils of these areas are the Oliphant, Broadax and Chard silt loams (SCS, 1986).

Within these soil groups, the group three soils present the greatest erosion potential. Within the watershed these group 3 soils represent 44% of the soils within the watershed with groups 1 and 2 representing 10% and 46% respectively. The long and low gradient slopes most often present within groups 1 and 2 minimize potential erosion within these regions. Consequently, the greatest sediment contribution from land surface erosion occurs within the group 3 soils.
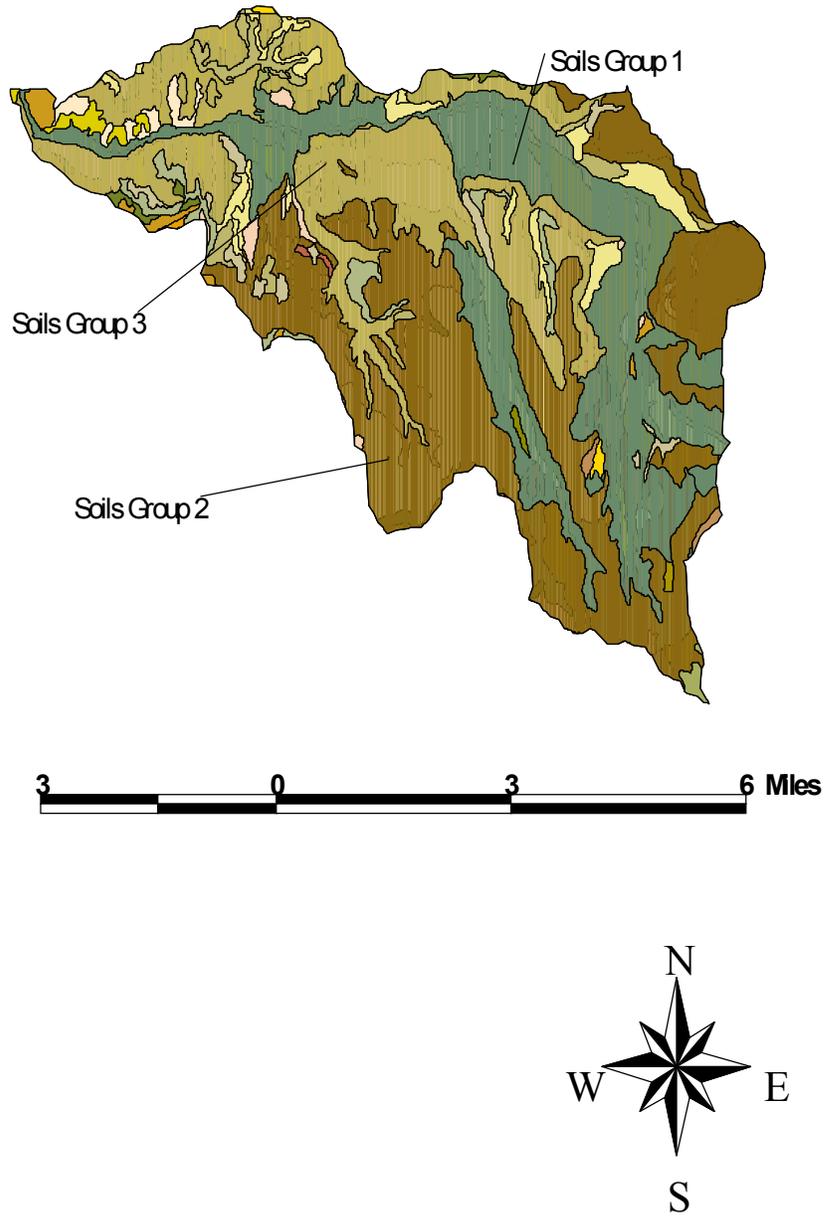
Tammany Creek Watershed
General Soils Map

Soils Group 1

Soils Group 3

Soils Group 2

3   0   3   6 **Miles**

N

W   E

S

Figure 2. Tammany Creek Watershed General Soils Map

2.1.7 Watershed Land Uses

The dominant land uses within the Tammany watershed are dryland agricultural crop production, livestock grazing and rural and urban development. Agricultural crop production accounts for approximately 89% of the watershed area of 22,332 acres with range and suburban following with 5% and 6% respectively.   Slopes range from 0-40 percent throughout the watershed with slopes between 0-7 percent constituting over 55% of the watershed with slopes greater than 27 percent representing only 5% of the watershed. The dominant agricultural practice is dry land farming of spring and winter wheat and other grain crops. In addition, several small irrigation operations and water rights exist within the watershed.

2.2   Water Quality Concerns and Status

2.2.1   Designated Beneficial Uses

At this time, Tammany Creek's designated beneficial uses are not codified in the Idaho water quality standards. Consequently, in accordance to the rules of the Department of Environmental Quality *IDAPA 58.01.02.101.01.a,* regarding non-designated surface waters, this TMDL will be developed with the assumed beneficial uses of secondary contact recreation and cold water biota. Throughout the remainder of the TMDL the use of the term beneficial uses will mean the non-designated default uses of secondary contact recreation and cold water biota.

Secondary contact recreation is defined as recreational activities during which the ingestion of raw water is not likely to occur. These activities may include but are not limited to wading, fishing, boating or infrequent swimming. Pollutants that most often affect this beneficial use are pathogens and excess nutrients that result in nuisance slimes or aquatic growths.

Cold water biota designation refers to water quality appropriate to the protection and maintenance of a viable aquatic life community for all cold water aquatic

species. Pollutants that most often affect this beneficial use include excess sediment loading, temperature or heat loading and excess nutrients that can be detrimental to aquatic organisms.

2.2.2 Water Quality Concerns

Tammany Creek was listed on the 1994 State of Idaho Water Quality Limited List by the EPA. This TMDL addresses the current sediment loading and the reductions necessary to bring the creek into full support of its beneficial uses.

According to IDAPA 58.01.02.070.07, water quality standards are to apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. Optimum flows are defined as 5.0 cfs for recreation and water supply uses and 1.0 cfs for aquatic life uses. Examinations of the available flow data indicate that the recreation optimum flows are only reached during precipitation events of very high intensity and short duration characteristic of summer thunderstorms and snow melt events which are assumed to not represent suitable times for recreational uses. Based on IDAPA 58.01.02.070.07, recreation-specific water quality criteria do not apply to intermittent reaches of Tammany Creek due to the non-attainment of the required optimum flows. The recreation-specific water quality criteria do apply over all perennial reaches of the creek. The cold water biota water quality standards are assumed to apply over the entire perennial reach of the creek. This reach has an annual mean flow equal to or greater than 1 cfs for over 8 months of the year.

According to the State of Idaho Water Quality Standards for sediment (IDAPA 58.01.02.250.08), sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities that impair beneficial uses. With the beneficial use of cold water biota, Idaho Water Quality Standards IDAPA 58.01.02.250.02.d specify that turbidity shall not exceed background turbidity by more than 50 NTU instantaneously or more than 25 NTU for more than 10 days. This standard reflects the fact that excess sediment

loading and its surrogate measure of turbidity reported in Nephelometric Turbidity Units (NTU), has been shown to be harmful to aquatic organisms at levels in excess of 25 NTU for prolonged periods (IDEQ 1989).

2.2.3 Available Data

The data used for the development of this TMDL was provided by the Nez Perce Soil Conservation District (NPSCD 1999) and contains biweekly measurements during the time period between December 16, 1999 and November 21, 2000. The constituents sampled include temperature, flow, pH, dissolved oxygen, turbidity, total suspended solids (TSS), total and ortho-phosphorous, nitrates and ammonia. The four sample sites (TC1-4) are shown in Figure 3. They include sites near both the origin of the perennial portion of Tammany creek and the mouth with two additional sites located in between.

2.3 Sediment Source Inventory

Sediment sources within the Tammany Creek watershed have been identified as sheet and rill erosion off of crop and grazing lands, pasture land surface runoff, unpaved roadway runoff, rural development activities, animal feeding operations, wildlife stream bank damage and direct stream bank erosion. The most significant sediment sources have been identified as sheet and rill erosion on agricultural lands, surface runoff from rural developments and stream bank erosion. Due to the difficulty in separating the exact source of overland flow sediment, rural development runoff and agricultural land runoff are combined in what will be termed land surface sheet and rill erosion. There are no point-sources in the watershed, therefore all pollutant sources are considered non-point sources.

Tammany Creek Sample Locations and Reach Designations

TC1 TC2 TC3 TC4

Reach 3

Reach 2

Reach 1

3   0   3   6 Miles

Perennial Channel
Ephemeral Channels
Roads
Land Use
COMMERCIAL AND SERVICES
CROPLAND AND PASTURE
MIXED RANGELAND
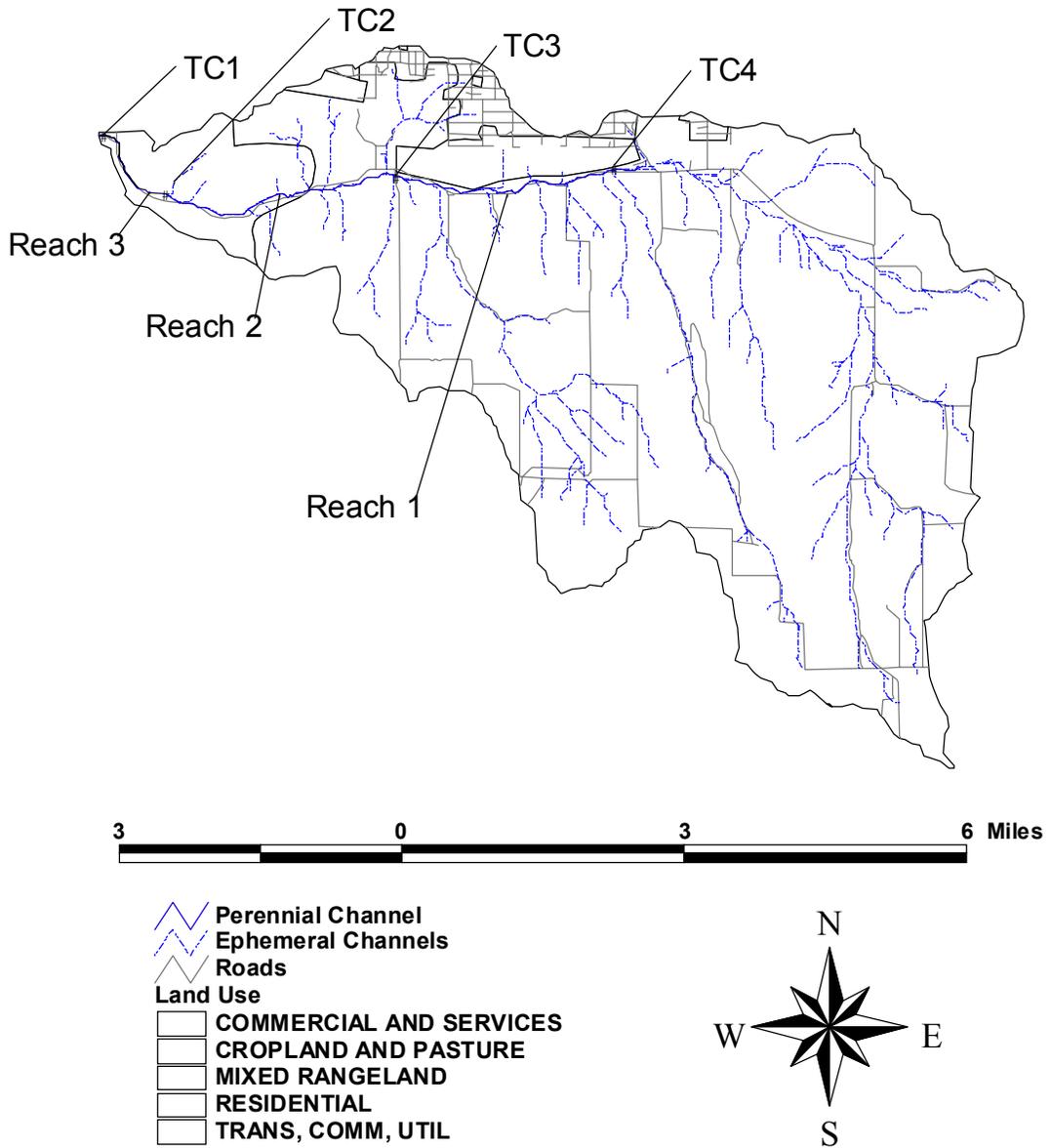**RESIDENTIAL**
TRANS, COMM, UTIL

N
W E
S

Figure 3. – Tammany Creek Sampling Locations

18

3.0   TAMMANY CREEK SEDIMENT LOADING ANALYSIS

3.1   Summary

Sediment loading analyses require an understanding of both the hydrologic and sedimentologic characteristics of the watershed. Of particular importance in regard to the hydrology of the watershed is the estimation of the watershed mean monthly flows. The use of long-term mean flows allows for estimations of current loading conditions without the biases present in the short-term data record. Once the representative mean flows have been estimated they are then applied to sedimentation characteristics of the watershed observed in field surveys and from available data to estimate the current loading that is occurring within the watershed.

In the absence of a suitable location within Tammany Creek for estimation of background sediment loads, a predictive erosion model was applied to compare erosion rates under what are considered "background" conditions and under current land practices. Comparisons between the two erosion rates allow the calculation of a percentage of current erosion that is considered natural. Natural erosional processes result in increases in sediment loading during higher flows.

The applicable State water quality criteria are in terms of a surrogate measure of sediment concentration that is termed turbidity. Turbidity is generally a measure of the clarity of the water, or more specifically, the ability of light to pass through the water. Linear regression analyses were conducted to correlate turbidity to measures of total suspended solids (TSS), which is a direct measure of fine suspended sediment. A correlation between turbidity and TSS measures (R^2=0.85) was observed and was applied to water quality criteria to determine the allowable load allocation above background levels which is termed the load capacity. The difference between load capacity and the current sediment loading provides the measure of reductions necessary to allow for the support of beneficial uses and compliance with State water quality standards. A diagram illustrating the complete methodology used for the development of this TMDL is

shown in Appendix A.1, with detailed descriptions of methods and calculations included in Appendices A.2-A.4.

3.2   Hydrology

The data provided by the NPSCD and described in section 2.2 consisted of biweekly instantaneous measurements of various water quality parameters and flow. Due to the dependence of loading calculations upon representative average flow values and the lack of long-term flow data, a linear regression analysis with a nearby gauged water body of similar characteristics was conducted.

A regression analysis between Tammany Creek and Lapwai Creek in Nez Perce County, Idaho was conducted and provided a correlation with an $R^2 = 0.69$. Detailed description of the analysis method is provided in Appendix A.2. The resulting regression equation was then used with the Lapwai Creek 24-year mean monthly flows (USGS 1999) to provide an estimate of monthly mean flows for Tammany Creek that will be used in the loading and target analysis of this TMDL. This process allows for the conversion of instantaneous measurements to representative longer term mean values. The regression predicted mean monthly flows for Tammany Creek are listed in Table 2.

Table 2. – Regression Predicted Mean Monthly Flows (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
0.68	0.98	1.30	1.52	1.96	2.34	2.50	2.00	1.22	0.68	0.48	0.55

3.3   Sedimentology

The Tammany creek watershed sedimentology characteristics were examined using the field data provided by the NPSWCD and field surveys. Linear regression analyses were conducted to correlate the measured TSS with measured turbidity levels. A correlation was found between TSS and turbidity with an average R^2= 0.85 for the four sampling locations. This correlation was nearly a 2:1 relationship with a turbidity value of 25 NTU approximately equal to 48 mg/L TSS. This relationship is very similar to that observed during the development of the Paradise Creek TMDL (DEQ 1998). This correlation allows for the application of the numerical turbidity water quality standard for the TMDL mass per unit time load calculations. A regression analysis was conducted to correlate the TSS measurements with flow and resulted in a correlation with an average R^2=0.656 for the four sampling locations. This regression equation was used to predict TSS concentrations at the estimated monthly mean flows. Example regression plots are shown in Appendix 6.3.

3.4   Applicable Water Quality Standard

General Sediment Standard (IDAPA 58.01.02.200.08)- *Sediment shall not exceed quantities which impair beneficial uses.*

Cold Water Biota Sediment Standard (IDAPA 58.01.02.250.02.d)- *Turbidity, below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days.*

3.5   Sediment Target Assessment

Introduction

Idaho Water Quality Standard 58.01.02.250.02.d provides guidance for the determination of the appropriate sediment target that will allow for the full support of the designated beneficial use of cold water biota support. This standard specifies that the water body turbidity shall not exceed background turbidity by more than 50 NTU instantaneously or more than 25 NTU for more than 10 days.

3.5.1   Background Designations

A comparative analysis was used to compare current erosion and sedimentation rates to that of expected background conditions. This study used the widely accepted Revised Universal Soil Loss Equation (RUSLE) (Renard et al. 1994) predictive erosion model within an ArcView Geographic Information System (GIS) environment to estimate erosion rates for both predevelopment and current land use conditions. RUSLE is an empirical equation that incorporates factors such as soil erodability, slope length, slope angle, vegetation cover, cropping practices and regional rainfall intensity to predict surface erosion rates. The background erosion rates were developed by representing the vegetation cover as a mixed grass prairie with 80% ground coverage within the RUSLE model.

In addition, stream bank stability surveys were conducted to assess the direct bank erosion potential and estimate the additional sediment load contributions from in-channel erosion. A mixed grass prairie environment with 80% of stream banks in stable (Overton et al. 1995), non-eroding conditions was used to represent background conditions. Sediment source contributions were estimated through bank erosion surveys and sheet and rill erosion estimates. It is estimated that on average 36% of the sediment loading is from direct bank erosion with the remaining 64% coming from overland sheet and rill erosion. Through comparisons of predicted total erosion under current land practices and that under background conditions, it is estimated that 11% of the current sediment loading is representative of background sediment loading. Therefore, a

floating background load allocation of 11% of the current loading will be applied to account for natural processes in which sediment load increases with increased flows.

3.5.2 Loading Calculations

Loading calculations involve the use of measurements of pollutants in both concentrations and loads. Concentrations are measures of pollutant mass per volume such as in mg/L. Loads are slightly different and represent a pollutant mass per unit of time such as in lbs./day. A simple load calculation involves the product of the flow and the concentration and some unit conversion factor to account for the different units of measure. Therefore, both flow estimates and sediment concentration estimates are necessary to calculate pollutant loads.

For this study, the correlation analysis and resulting regression equation between the flows of Lapwai Creek and Tammany Creek were used to estimate mean monthly flows for Tammany Creek shown in Table 2. These mean flow values are then used in conjunction with the TSS and flow regression equation obtained from the regression analysis described in section 3.2 to estimate the TSS concentrations that are predicted at these flow values. The predicted TSS concentrations are then multiplied by the mean monthly flows to calculate the average loading for each month.   This form of analysis allows the conversion from instantaneous measurements to continuous average values with which continuous load estimates can be derived. This allows the application of the 25 NTU above background continuous standard. The use of the flow correlation equation upon 24 yr. mean monthly flows and the regression of TSS verses turbidity and TSS verses flow allows for the generation of a continuous record of sediment concentration and load shown in Figures 4 and 5.

The target load is calculated by multiplying the existing monthly average TSS concentrations by 11%, the previously estimated background percentage (section 3.4), to generate the predicted background TSS value. Next, the 48

mg/L (the equivalent of 25 NTU turbidity, section 3.2) is added to the background TSS concentrations as the additional load allocation for all non-point sources. This generates the maximum monthly average TSS concentration allowed to comply with water quality standards. This value is then multiplied by the monthly mean flow to determine the monthly maximum loading capacity. An explicit 10% margin of safety, as required by federal law, is then subtracted from this maximum loading capacity to account for potential errors inherent in the loading analysis.

3.6   Loading Summary

The analysis previously detailed in section 3.4 provides a measure, in mass per time units, of the maximum allowable amount of sediment that the creek can contain and still comply with water quality criteria and maintain full support the creek's beneficial uses. The difference between the allowable load and the current load is the measure of sediment loading that must be reduced to attain the necessary water quality. This is illustrated in both Figure 4 in sediment concentrations and in Figure 5 in sediment loads. Table 3 summarizes the results of the analysis and the sediment loading reductions that have been determined necessary. The total required reductions have been divided into the three reach segments shown in Figure 3. These proportions were constructed from a distinct loading profile observed within the available data set, shown in Figure 6, which indicate that the greatest sediment loading was occurring between sample points TC-2 and TC-3. The loading profile also indicated that an actual reduction in sediment load occurs between sampling locations TC-1 and TC-2. These proportioned reductions are included to provide additional guidance to direct the best use of implementation efforts.
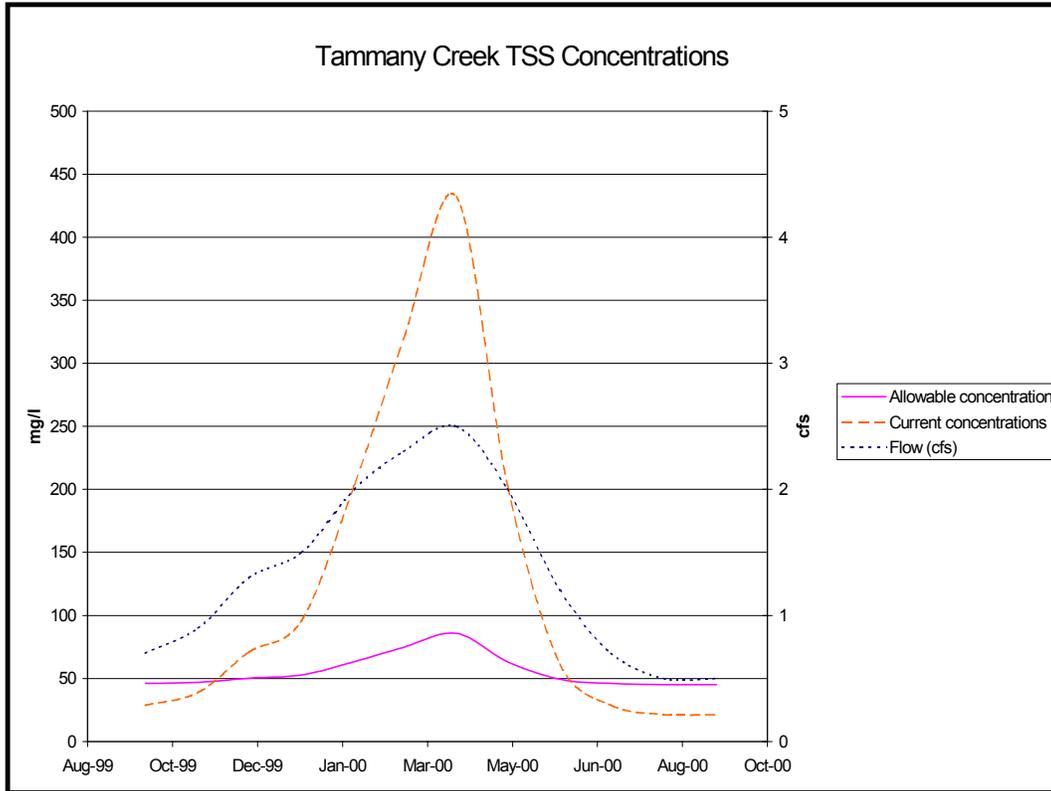
Figure 4. Tammany Creek TSS concentrations
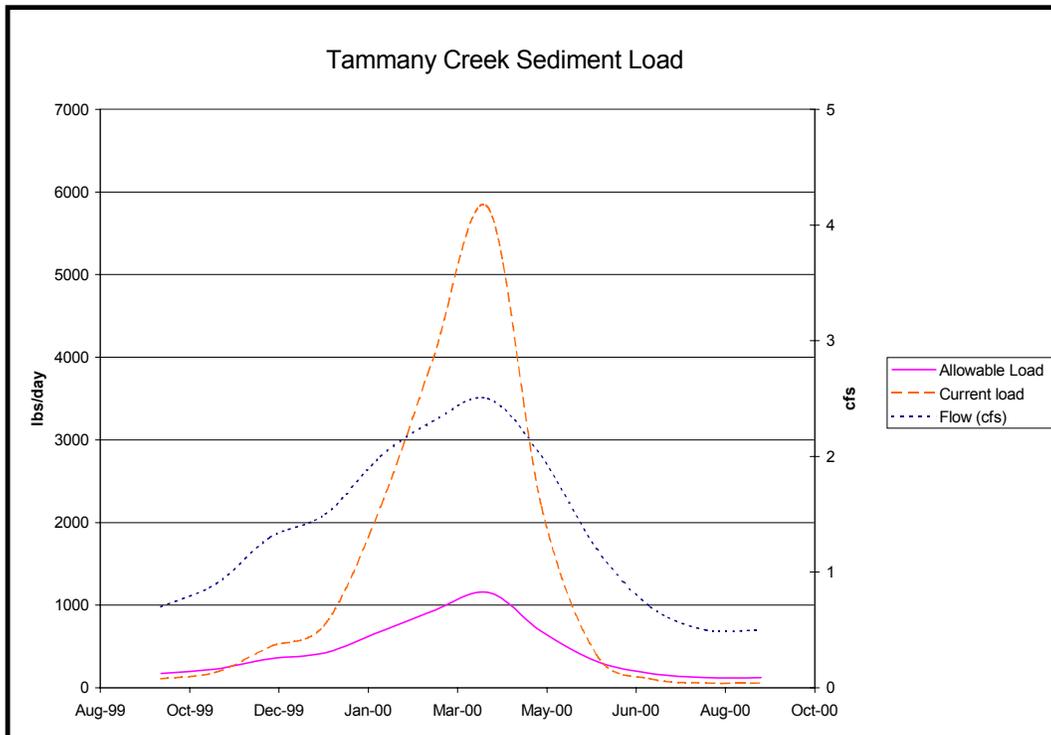
Figure 5. Tammany Creek Sediment Load

25

Table 3.

Tammany Creek Sediment Loading Summary												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
Mean Monthly Flows cfs	0.7	0.9	1.3	1.5	2.0	2.3	2.5	2.0	1.2	0.7	0.5	0.5
Current Concentration TSS mg/L	28.8	38.9	71.0	96.0	203.6	319.8	432.0	203.6	61.1	28.8	21.3	21.3
Background Concentration mg/L (11% of current concentration)	3.2	4.3	7.8	10.6	22.4	35.2	47.5	22.4	6.7	3.2	2.3	2.3
Allowable Load Allocation mg/L 48 mg/L ~ 25 NTU	51.2	52.3	55.8	58.6	70.4	83.2	95.5	70.4	54.7	51.2	50.3	50.3
10% Margin of Safety mg/L	5.1	5.2	5.6	5.9	7.0	8.3	9.6	7.0	5.5	5.1	5.0	5.0
Maximum Allowable Concentration mg/L	46.1	47.1	50.2	52.7	63.4	72.2	85.9	63.4	49.2	46.1	45.3	45.3
Load Capacity lbs./day	173.5	227.9	351.5	425.5	682.0	926.6	1156.7	682.0	318.1	173.5	121.9	121.9
Current Loading lbs./day	108.5	188.5	497.0	774.8	2191.8	3958.3	5812.8	2191.8	394.7	108.5	57.4	57.4
Necessary reductions	-	-	29%	45%	69%	77%	80%	69%	19%	-	-	-
Reductions lbs./d	-	-	145.6	349.3	1509.8	3031.6	4656.1	1509.8	76.6	-	-	-
Reach 1 Reductions lbs./day (38% of total reductions)	-	-	382.9	382.9	382.9	1139.9	1670.2	438.7	438.7	-	-	-
Reach 2 Reductions lbs./day (62% of total reductions)	-	-	624.7	624.7	624.7	1859.8	2725.1	715.7	715.7	-	-	-

Tammany Creek Loading Profile
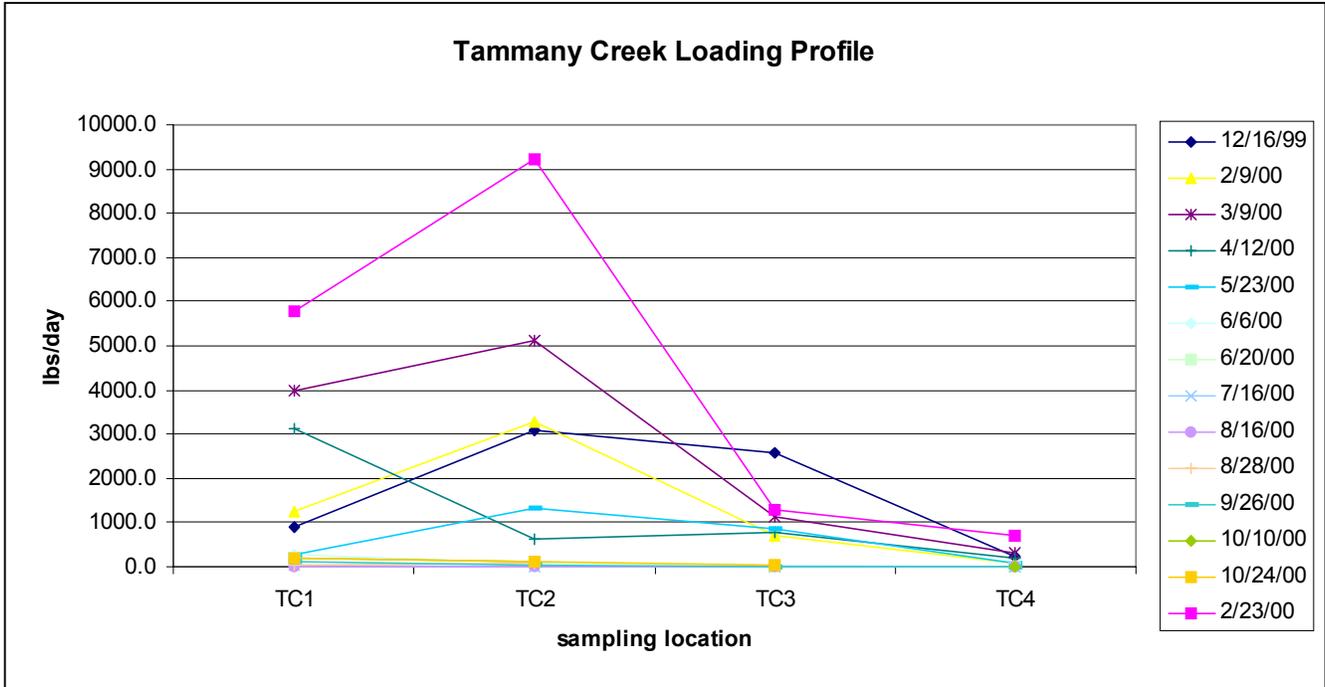
Figure 6. Tammany Creek Sediment Loading Profile

3.6.1 Load Allocations

There are no point sources within the watershed and source specific load allocations are not required upon non-point sources. In the case of sediment sources, the relative contributions vary both spatially and temporally and therefore are not well suited to specific allocation measures. Additionally, with regard to State of Idaho water quality standards, where the reductions are obtained is insignificant as long as they are obtained. It is estimated that 36% of the sediment loading occurs from bank erosion with the remaining 64% from sheet and rill erosion as previously stated in section 3.4. While no source-specific allocations will be designated, It is highly recommended that implementation efforts place emphasis upon the restoration of riparian areas that will function both to increase bank stability and reduce sediment delivery from sheet and rill erosion through filtration.

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5.0 PUBLIC PARTICIPATION AND COMMENTS

Comments

1.   Feedlot description in introduction should be AFO, not CAFO.

The description was changed to AFO from CAFO.

2.   Map in figure 2.11 shows streams that are completely dry. This map should be redrawn with added input from landowners.

[Figure 2.11 has been changed to Figure 3] This map has been redrawn to illustrate both the perennial and ephemeral channels within the watershed.

3.   Channel incision is also the result of wildlife. Where cattle have been fenced off the creek, muskrat and beaver are thriving.

It was noted that wildlife may also contribute to channel incision.

4.   NOAA 1975 quote on 10 year 24 hr. storm is inaccurate when compared with Asotin Creek data and data collected by the National Weather Service at the Nez Perce County Airport.

The value in the report was estimated from the 1975 NOAA atlas. A range will be given in the report instead of the single value to reflect the uncertainty of the estimate. This value was not used in any analysis and was provided as a description of the climate for outside readers.

5.   Report does not mention irrigation use. There are multiple water rights and more irrigation operations than recorded

Accurate data on irrigation uses is not available. A reference to the irrigation uses will be included in the report

6.   If recreation use is considered at flow of 5 cfs, then it should be noted that Tammany Creek does not flow at this level, except at flood stage. Thus, Tammany Creek should not be listed for secondary recreation use.

Further review of the State of Idaho Standards show that the 5-cfs optimum flow applies only to intermittent and ephemeral waters. For perennial streams there is no optimum flow that must be obtained for water quality standards to apply. It will be clarified that the

recreation specific standards do not apply in the intermittent reaches and do apply within the perennial reaches of the creek.

*7.	Please list stream bank erosion from wildlife activities (i.e. muskrats).*
This will be included in the report.

*8.	Based on past visual observations, flow estimates appear high July to September.*
Visual estimates are insufficient for the estimation of flow values. Comparison between the predicted and observed flow values during the measurement period show good agreement and thus are assumed to adequately represent average flows during July through September.

*9.	Should be noted that site TC2 was in water alley for cattle that is no longer in use. Data may be influenced by past use.*
This will be noted in the report.

*10.	Table 8.1 should be recalculated without "outlier" data. Each site shows one (1) high E Coli level reading. Per contact with Lloyd Knight of the Idaho Cattle Association, "outlier" readings should not be used to calculate averages, because these readings are often inaccurate and increase the margin of error.*
[Table 8.1 has been changed to Table C-1]The "outlier" in question was not used in the calculations of Table C-1. The mean of the two neighboring data points was used in place of the "outlier" to ensure against error from the questionable measurement.

*11.	Samples were taken around mid-day, when cattle are most likely to come to water in the water alley. A water alley is a restricted area where cattle are allowed to drink from the creek. Cattle are fenced away from the balance of the creek to protect stream banks.*
Sampling times varied between 10 am and 6 p.m. Water quality standards are not time-specific and thus apply at all time regardless of wildlife or livestock activities.

*12.	Regarding the use of qualitative descriptors of regression coefficients. In general, R2 values less than 0.90 are not very convincing of a linear relationship. While*

a coefficient of 0.85 may be acceptable for suggesting a trend, using the descriptive qualifier of "very good" implies a statistical confidence that the data does not support. In addition, it ignores the biological component of turbidity that probably exists in this nutrient-rich watershed.

It is agreed that the qualitative descriptions may be overstated and will be revised in the final document. These values reflect the use of all available data points and have not been selectively screened to indiscriminately increase the R^2 values. While confidence intervals are good descriptors of the range of values, max and min, they are not deemed necessary, as the mean value is what is used for the loading calculations.

13.   A reference is needed as to how the estimates were calculated for the distribution of background of 11%. Why switch to lbs/day instead of kg/day. I prefer consistent units.

Appendix A.4 details the methodology used to provide the 11% background estimation. This was the same methodology used by the EPA in the Winchester Lake TMDL. Units of lbs./day were used for familiarity for the reading audience.

14.   The wide variation in annual bank recession rates of 0.01 to 0.2 ft/yr. suggest that confidence intervals should be calculated for all related sediment mass loading to the stream instead of utilizing only the 788 tons/yr. value. The soil density is not given. The bottom portion of the last paragraph on page 39 is confusing and should be reworded.

Confidence intervals are not necessary for bank recession rates. The range cited in the report reflects the range of bank conditions between segments of the watershed, and not a variation within a segment as implied in the report.   The creek was segmented based upon bank conditions for the mass loading calculations to provide the best resolution in the mass loading estimations. The use of confidence intervals on an estimate of bank recession rates is unnecessary.   This will be reworded for clarity in the report.

15.   Are you saying that only 30% of the current loading estimates calculated with Eq. 6.44 is making it to the creek? If so, is this a valid use of the sediment delivery equation? The Palouse has also been extensively recontoured. What is the potential that a 10 yr design storm would recreate the rills needed to deliver sediment from recontoured fields to the creek?

[Equation 6.44 has been changed to Equation A-4-4] Only 30% of the watershed subbasins have delivery potential to the creek. Under the GIS analysis the subbasins without delivery potential are truncated, and the erosion rates are calculated for the remaining 30%. The sediment delivery equation is then applied to these subbasins to estimate the mass of sediment delivered to the creek channel from each of these subbasins. The sum of which is the sheet and rill derived sediment estimated to be delivered to the channel each year. Rills do not provide the means necessary to deliver sediment from great distances as in the case of the subbasins in the Tammany Creek watershed. The near channel slopes and flood plains were included in the calculations to account for short distance rill delivery. Significant gullies would be necessary to provide delivery from distant subbasins. A 10, 20 or 50 year storm could regenerate delivery but no observations or data from such an event it is available.

16.   Insufficient biological data is presented to conclude that the nutrients in the creek are not impairing the aquatic life. Streams with high concentrations of algae produce oxygen during the day through photosynthesis. However, at night these same streams may become oxygen deficient because of the high biological oxygen demand. The high numbers of pathogens described in later sections are probably related to the nutrients.
Diurnal dissolved oxygen swings do present the potential of lowered DO levels then is presented in the data set that is used in this analysis. This observation will be included in the final TMDL. If future monitoring indicates diurnal dissolved oxygen sags below water quality standards are occurring, a nutrient TMDL may be warranted. It is believed that the sediment reductions will reduce the potential for nutrient related water quality issues and provide additional protection against diurnal dissolved oxygen sags.

17.   It is not clear from reading the subbasin assessment and TMDL if the animal feeding operations are AFOs or CAFOs. If the operations are CAFOs they are considered point sources and require a waste load allocation (WLA) of zero to be consistent with federal regulations prohibiting discharge. In any event the document needs a statement concerning WLAs. If there are point sources in the watershed, the WLA will be zero.
On page 3 of the subbasin assessment the report states that there is an AFO within the watershed, not a CAFO. Therefore, there are no point sources within the watershed. This will be clarified within the document.

18.   On page 9 it is not clear by what is meant by "Wildlife activities may also contribute to channel incision" or on page 17 "wildlife damage to streambanks."
This was included at the request of a Watershed Advisory Group member who indicated that beaver and muskrat activities on his property had caused stream bank damages.

19.   On page 22, the Idaho Turbidity standard is cited incorrectly; it should be 58.01.02.250.02.d. We agree that this criteria should be cited in the TMDL.
Thank you, this has been corrected.

*20.   Total suspended solids are clearly elevated in Tammany Creek. We are concerned that the turbidity standard, intended primarily to address feeding behavior, is not adequately protective of TSS effects. In a document titled **Sediment Targets Used or Proposed for TMDLs**, Rowe, Essig and Fitzgerald, 1998, the target for TSS is proposed to be a monthly average concentration of 50 mg/l with a daily maximum of 80 mg/l to allow for natural spikes during flood events. In table 3.51 on page 26, most of the monthly Allowable Load Allocations appear to exceed this amount (range: 50.3-95.5 mg/l). We recommend IDEQ use their sediment targets document as a basis to establish TMDL targets of 50 mg/l (monthly average) and 80 mg/l (daily maximum), since it suggests that adverse effects would occur above these levels.*
[Table 3.51 has been changed to Table 3]. The sediment targets used in the loading calculations (ranging 45.3-85.9 mg/l) are consistent with the mentioned *draft* guidance document. This range was obtained from the application of Idaho State water quality standards that appear to align very well with the suggested targets.

21.   In table 3.51, page 26, in the bottom three rows the words "Load Allocations" should be substituted for "reductions".
[Table 3.51 has been changed to Table 3]. These rows are the reductions, not the allocations.

22.   In the nutrient discussion in pages 43 through 48, we disagree with the conclusion reached using the "limiting nutrient" method based on the N/P ratio. Simply put, the concentration of nitrogen and phosphorous in the system is more than adequate to support the growth of nuisance vegetation in the stream. It is likely that the turbidity due to the sediment in the stream is impairing light transmission in the water and

inhibiting photosynthesis and therefore algae production. There is some merit in the statement that controlling sediment will reduce phosphorous loads to the stream. However, since it is stated on page 43 that an average of 56%of the total phosphorous is in the form of orthophosphate (dissolved) from June to October, it appears that the majority of the phosphorous is not adsorbed onto sediment particles. We recommend further investigations of nutrients in Tammany Creek including diurnal dissolved oxygen measurements.

[Pages 43-48 are now pages 49-54] While it is unlikely that turbidity related light availability is limiting the algae production in a creek of this size with an average depth of less than 6 inches, we agree that further investigations are warranted and will be conducted in the next data collection cycle. A nutrient TMDL is beyond the scope of this analysis and not the purpose of this document.

23.   The section in the TMDL on pathogens is appreciated. Since the data clearly show exceedances of E. Coli criteria, we recommend that IDEQ consider completing a TMDL now while you're actively working in the watershed, rather that having to return at a later date. States have the option to write TMDLs for impaired waters not on the 303(d) list (and avoid listing), and EPA has approved such TMDLs in other states.
A pathogen TMDL was beyond the scope of this report. Further information for the completion of a pathogen TMDL will be collected in the next data collection cycle.

*24.   There is no mention of the **Supplemental Watershed Protection Plan – Environmental Assessment, Tammany Creek Watershed,** July 1998 in the TMDL document. Was this information used in the development of the TMDL?*
This document was reviewed prior to the TMDL development, but specific information was not cited from it.

25.   The only concern I have about Tammany Creek is the neighbor across the street (Allmon Drive) piling horse manure in a draw that eventually drains into the creek. During the summer this neighbor dumped at least 5 truckloads of manure in the draw that runs on his neighbor's property.
Any further actions such as this should be reported to the IDEQ for investigation.

*26.	The Watershed Land Uses discussed on page 15 appear to present existing land uses within the watershed. It may be appropriate to consider future or planned uses in the analysis, based on the nature of the planned usage and its location within the watershed. For example, those lands between Tammany Creek and the Lewiston City Limits, bounded by 6th Street and 21st Street, are included on the City's Annexation Plan. Annexation of these lands, and the anticipated increase in suburban residential uses, may adversely effect the sediment or pollutant loading within Tammany Creek. Based on rules established by the TMDL program, it may be a better use of resources to accommodate these changes with our initial efforts rather than revisit the analysis in the future. Conversely, if the program requires reassessment of the watershed at set intervals, future development will be accommodated by the adjusted TMDL limits.*

It is difficult to anticipate the rate and size of future growth and development that might occur in the watershed. The TMDL targets are set by State water quality standards and therefore will remain regardless of potential development in the future. In addition, individual load allocations are not required of non-point sources and are not assigned in this document. It is the responsibility of the City and developers to ensure that increased suburban residential use does not significantly impact the water quality of Tammany Creek and not the responsibility of the DEQ to lower water quality standards to accommodate future development.

*27.	The loading Profile discussed on page 24 indicates an apparent reduction in sediment load between two sample points located in the lower reaches of Tammany Creek. The analysis should address more specifically why this might occur and under what conditions. Such a reduction does not seem likely in high-flow situations when the stream has higher sediment load. In addition, if such a reduction can occur, such as that within a floodplain, does the analysis reflect the sediment loss?*

Sediment loading and transport is a dynamic process in which sediment is constantly suspended, deposited and resuspended. The reductions within the lower reach is due primarily to the lack of development, this area is the region within and just upstream from the Hells Gate Idaho State Park, and the presence of a functioning riparian zone within that reach. Yes, under a flood event such a reduction is unlikely to occur, at least to the degree that appears to occur under more moderate flow conditions. The analysis only reflects the sediment loss in the proportioning of the sediment load reductions within the watershed.

28.   We believe that the beneficial uses of Tammany Creek should be changed from secondary contact recreation and support of cold-water biota to primary contact recreation and cold-water biota. The rational for this change is because the creek discharges to the Snake River immediately upstream from Hells Gate State Park swimming beach.

This will be taken under advisement.

29.   The interpretation that the yearlong nitrate loading, and orthophosphate loading during the period August to October, is being contributed from groundwater inflow to the creek is troubling because these nutrient contributions are not being addressed by the TMDL. In addition, the presence of large concentrations of E. Coli bacteria suggests that septic tank effluent may be a potential source for these pollutants. Sample site TC-2 clearly violates the instantaneous E. Coli standard for secondary contact recreation. On this basis, we recommend that a bacteria TMDL be included at this time. EPA classifies septic systems and cesspools as Class V injection wells that must be operated in a manner which protects underground source of drinking water. In addition, large cesspools must be phased out by April 2005(EPA, 1999). The presumed high density of septic tanks in the Lewiston Orchards adjacent to Tammany Creek strongly suggest that septic tank influence on water quality should be considered

See responses to comments 22 and 23.

30.   The high levels of nitrate-nitrite (29 times the EPA guideline of 0.3 mg/l) indicate the need for reduction of this nutrient. If the system proves to be truly be phosphorous limited after further study, N reductions are needed to reduce the possibility of massive algae blooms related to the slightest increase in P.

See responses to comments 22 and 23.

31. Photographs of the Lucky Acres development area (Picture 4) and livestock ban k damage (Picture 5) document that livestock impacts are resulting in the degradation of the creek. A detailed discussion of these impacts is needed in the TMDL.

These impacts are discussed in the subbasin assessment. A detailed analysis of these impacts is beyond the scope of this document.

32.   The statement "In the absence of any documented nuisance aquatic growths on Tammany Creek…"(p. 46) does not mean that nuisance aquatic growths are absent. There is no mention in the text utilizing IDEQ's Beneficial Use Reconnaissance Program (BURP) on Tammany Creek. Insufficient biological data is presented to conclude that the nutrients in the creek are not impairing the aquatic life.

We do not believe that the few dissolved oxygen measurements presented in the text are sufficient to document the trophic status of the creek. Streams with high concentrations of algae produce oxygen during the day through photosynthesis. However, at night these same streams may become oxygen deficient because of the high biological oxygen demand. Diel oxygen levels should be sampled to rule out a nighttime sag in DO related to BOD, and chlorophyll samples should be evaluated to rule out excess algal production. Were any chlorophyll samples taken? Were algal mats or periphyton observed in stream?

In addition, recent work on nutrient dynamics has shown the Redfield ratio to be inaccurate (Lee, 2001). The approach is not valid unless the actual concentration of nutrients is at or below a growth limiting concentration. Growth rate limiting levels are on the order of 0.005 mg/l P for soluble orthophosphate, and about 0.02 mg/l for nitrate plus ammonia as N. If concentrations of soluble orthophosphate and available nitrogen are greater than these amounts, the rate of growth of algae is not limited by nutrients, but by other factors such as light. Concentrations of available N and P should be taken at the time of maximum algal biomass (Lee, 2001).

[Page 46 is now Page 52] See response to comment 22.

APPENDIX A   LOADING ANALYSIS METHODOLOGY

A.1   Sediment TMDL Analysis Process

Sediment TMDL Analysis Process

Hydrology Analysis
Regression Flow Analysis

↓

Predicted Average Flows

↓

Flow-TSS Regression Equation

↓

Predicted TSS Concentrations

X

Predicted Average Flows

↓

Current Average Daily TSS Load

↓

Target Load / Current Load

↓

Percent Reductions Necessary to Support Beneficial Uses

Water Quality Data Analysis
Field Data Analysis
Flow-TSS Regression, TSS-Turbidity Regression

Background Designation, Loading Analysis - RUSLE Comparative Study- Bank Erosion Survey

11% → Background TSS Average Concentration

+ **48 mg/L**

↓

Maximum Allowed Concentration

X

Predicted Average Flows

X 0.90 ← 10% Margin of Safety

Target Average Daily TSS Load

State Water Quality Standards
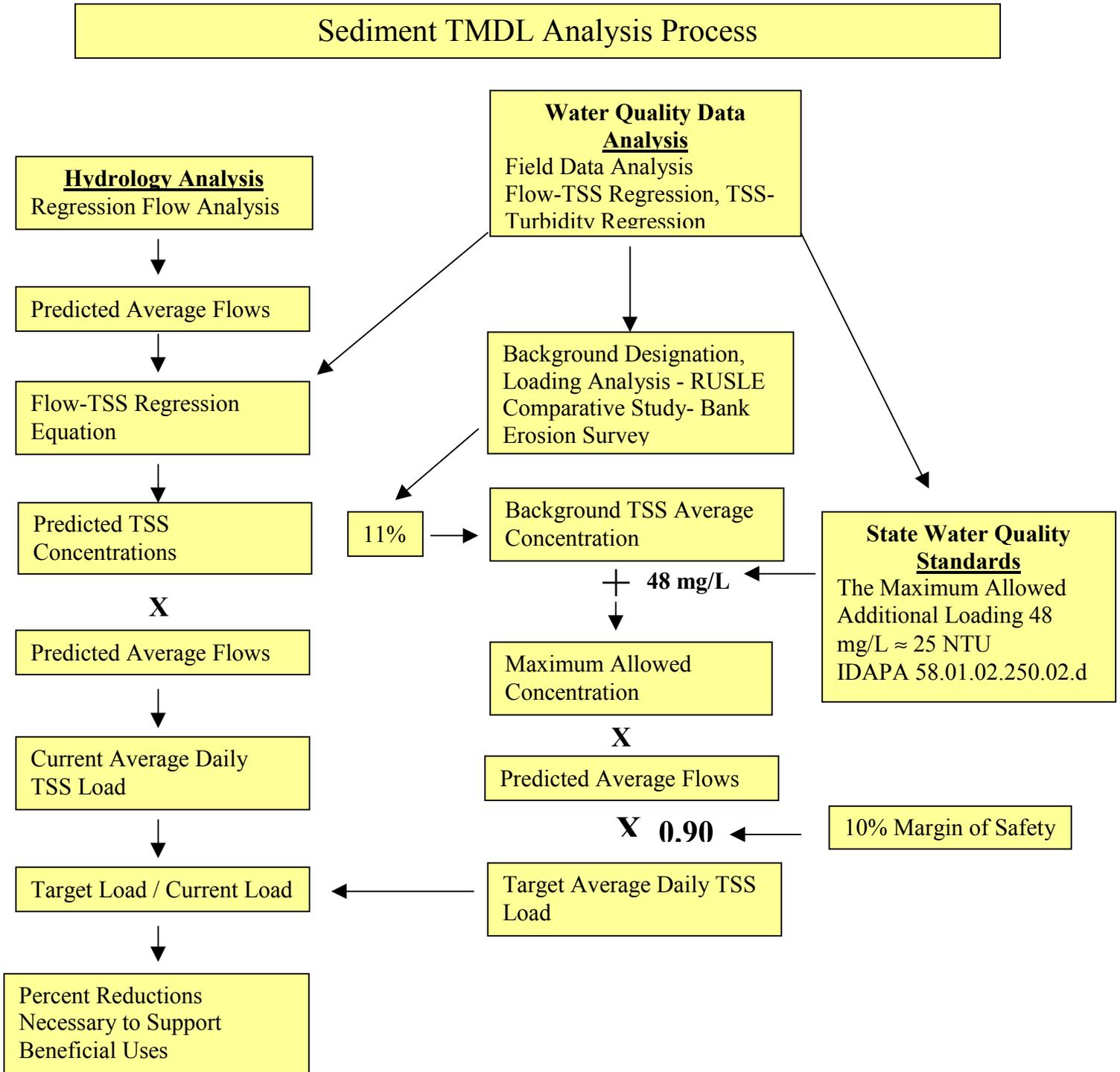The Maximum Allowed Additional Loading 48 mg/L ≈ 25 NTU
IDAPA 58.01.02.250.02.d

Figure A-1. Sediment TMDL Analysis Process

A.2 Hydrology Calculations

The data available, provided by the NPSCD, and described in section 2.2 consisted of biweekly instantaneous measurements of various water quality parameters and flow. Due to the dependence of loading calculations upon

representative average flow values regression analysis with Lapwai Creek in Nez Perce County, Idaho was conducted to estimate Tammany Creek mean monthly flows. The regression plot shown in Figure A-2 provided a correlation with an R^2 = 0.69. The resulting regression equation was then used with the Lapwai Creek 24-year monthly mean flows to provide an estimate of Tammany Creek monthly mean flows. The Lapwai Creek regression predicted flow values are assumed to be representative of the hydrology of the Tammany Creek watershed and will be used in the loading and target analysis of this TMDL. The regression predicted monthly mean flows are listed in Table A-1.
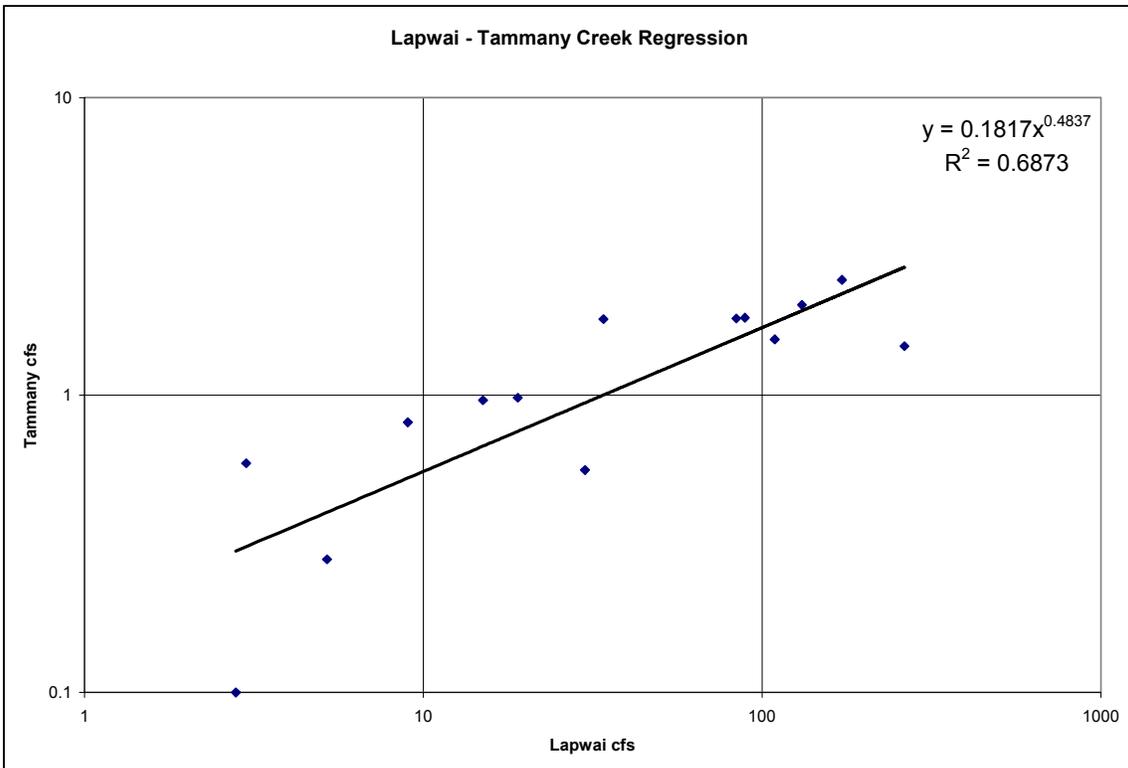

Figure A-2.   Lapwai Creek Regression

Table A-1. – Lapwai Creek-Tammany Creek Regression Predicted

Mean Monthly Flows

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
0.68	0.89	1.30	1.52	1.96	2.34	2.50	2.00	1.22	0.68	0.48	0.55

A.3 Water Quality Data Regression Plots

TC-1

$$y = 0.6036x - 4.3302$$
$$R^2 = 0.8845$$
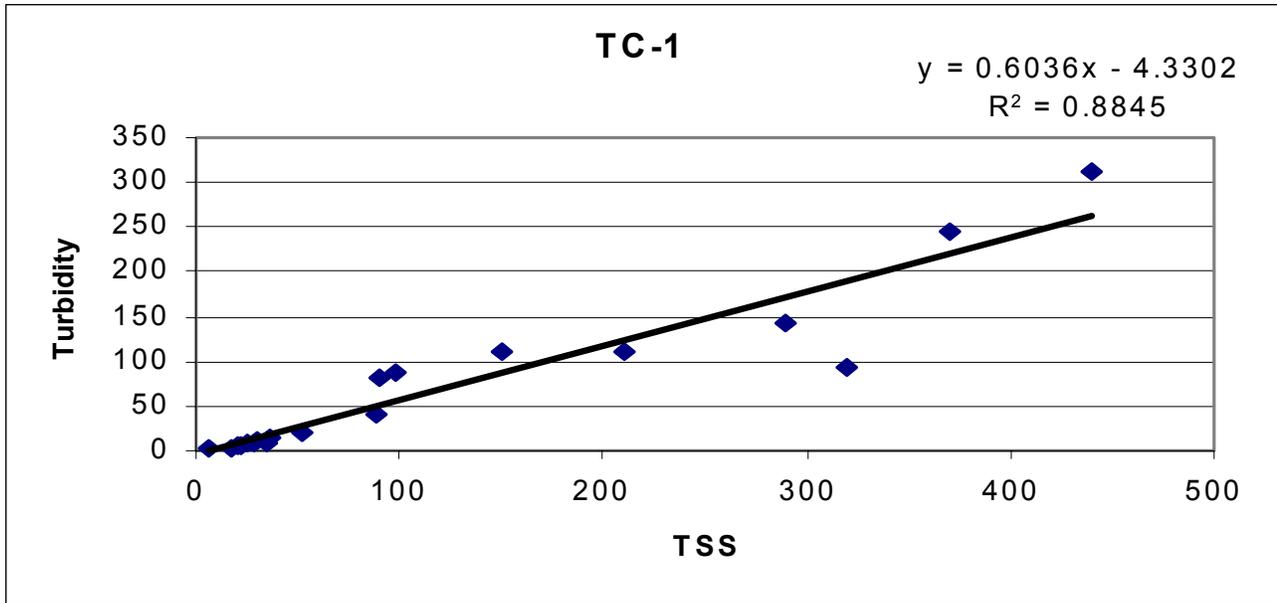
Figure A-3. Correlation of TSS and turbidity at site TC-1

TSS vs. Flow TC-1

$$y = 10.049e^{1.5044x}$$
$$R^2 = 0.6594$$
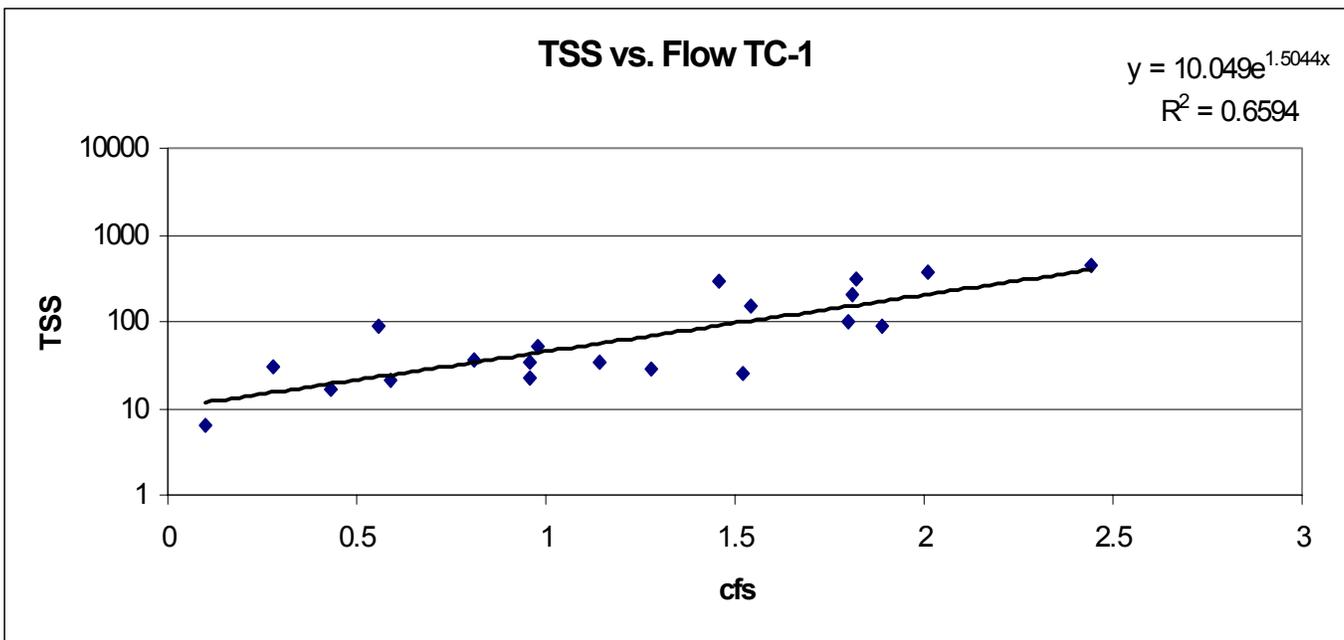
Figure A-4. Correlation of TSS and flow at siteTC-1

A.4   Erosion and Sedimentation Calculations

A.4.1 Direct Bank Erosion Methodology

Direct bank erosion was estimated through the use of a direct volume method based upon the NRCS (NRCS, 1983) stream bank erosion assessment protocol. During the stream bank surveys, 30% of the stream was surveyed over randomly selected stream segments. An average bank erosion rate was calculated based upon these sampled locations and extrapolated throughout the remainder of the stream to estimate total annual sediment contributions that result from direct bank erosion.

Field surveys were conducted over approximately 30% Tammany Creek. The bank annual recession rates varied from 0.01 ft/yr. to 0.2 ft/yr. between stream segments. The size of the eroding bank segments were measured and the

$$(A * L * d) / 2000 \text{ lbs/ton} = \text{tons/yr/feature} \qquad \text{(A-4-1)}$$

resulting annual erosion mass was calculated using equation 6.41 where A is the eroding area ft^2, L is the average annual lateral recession rate ft/yr., and d is the approximate soil density estimated within the Tammany Watershed for a silt loam as 90 lbs/ft^3. The sum of the lengths of all bank erosion features surveyed within the segment is divided by twice the total surveyed segment length, to account for both banks in the segment, to determine the percentage of the surveyed segment that was considered eroding. The total erosion mass, in tons, for all erosion features in the segment as calculated in equation A-4-1 is summed and divided by twice the segment length to calculate the erosion rate in tons/yr./bank length.

Results from the field surveys indicate that the proportion of banks eroding varies from 5-60% between surveyed segments with bank erosion sediment deposition rates varying from less than 2- tons/yr./bank mile to over 180- tons/yr./bank mile with an estimated total bank erosion of 788 tons/yr.

A.4.2 Sheet and Rill Methodology

The methodology for the estimation of sheet and rill erosion levels was through a mass balance approach using the Revised Universal Soil Loss Equation (RUSLE) within a GIS environment to predict erosion rates under current and

$$A = R * K*L*S*C*P \hspace{2cm} \text{(A-4-2)}$$

background conditions. The RUSLE equation (equation A-4-2) incorporates factors for rainfall erosivity (R), soil erodability (K), slope length (L), slope angle (S), vegetative cover (C) and land management practices (P) to estimate an annual average erosion rate (A) in tons/acre.

Through the use of ArcView Geographic Information System (GIS) Digital Elevation Model (DEM) data, the watershed was descretized into 30-meter square cells. Employing the method described by Engel (1999), involving the use of the ArcView spatial analyst extension, the LS factor of the RUSLE equation was estimated for each individual cell from flow accumulation and slope angle measurements from each cell. Because the RUSLE equation was not designed to estimate channel transport, the maximum flow length allowed within this calculation was 300 meters or 10 grid cells. An examination determined that this maximum flow length eliminated nearly all channel transport pathways from the RUSLE calculations. A GIS theme was constructed from the NRCS Soil Survey Geographic (SSURGO) database to allow for precise K-factor estimations through the watershed. An additional GIS theme for the P-factor was constructed using land use coverage and surveys of farming practices within the watershed. The C-factor GIS theme was constructed through the use of aerial photographs, GIS data and field surveys. Due to the low relief topography throughout the Tammany Creek watershed, a single R-factor value, obtained from consultation with the NRCS, was used in all subsequent calculations. The background scenario required different C and P factors that were chosen to represent a grassland prairie. All themes were converted to grid files and then

clipped within the basin boundaries. The RUSLE calculations were conducted within ArcView for each cell that were then summed to estimate total erosion rates under both conditions.

While these calculations allow for an estimation of soil detachment, they do not represent the amount of sediment that actually reaches the creek. Soil that becomes detached through rainfall impact or surface runoff processes can be stored within the watershed in various locations with only a fraction of the total mass reaching the creek. A literature search was then conducted to determine an appropriate sediment delivery ratio, which describes the ratio of sediment delivered to creek channels verses the total soil mass lost, to be applied to estimate the mass of sediment reaching the creek. This ratio has been studied extensively and has been determined to be exponentially inversely proportional to the watershed size, yet a universal ratio remains somewhat nebulous due to the dependence upon many watershed specific criteria including soil type, surface topography, land practices, climate and others. The general equation describing the sediment delivery ration is shown in equation A-4-3 where Sd is the annual sediment delivered to the creek, St is the total predicted sediment eroded in the watershed, A is the watershed area and $-\lambda$ is an exponent that ranges in the current literature from 0.10 to 0.35 depending upon the watershed under study. The result is a sediment delivery ratio that is inversely related to the watershed area. A study was conducted by Lee (1983)

$$S_d = S_t * A^{-\lambda} \qquad\qquad (A\text{-}4\text{-}3)$$

within several watersheds of the Palouse region to determine a sediment delivery ratio appropriate to the region. Lee found that the λ exponent that best described sediment delivery within the Palouse region was 0.201.

$$S_d = S_t * A^{-0.201} \qquad\qquad (A\text{-}4\text{-}4)$$

Using equation A-4-4 and the Tammany watershed area of 22,332 acres it is estimated that 13% of the total annual erosion is expected to reach Tammany Creek.

A.4.3 Current Loading Estimations

Land uses and development has significantly changed the shape and function of the watershed from its natural condition. Field surveys indicate that less than half the watershed sub-drainages have the potential for sediment delivery to the creek. Aside from the land area immediately surrounding the stream channel, the potential for sediment delivery requires concentrated flow from the sub-drainage. Such flow requires or will quickly develop a defined channel with discernable bed and bank features. In the absence of such features the sub-watershed has no potential for delivery to the stream channel and agradation of material occurs in the lower regions of the sub-drainage. Field surveys indicate that only 30% of the watershed sub-drainages contain delivery channels to the creek. Thus only erosion and sediment contributions from these sub-drainages and the land area immediately surrounding the creek are considered to be delivering sediment to the creek channel. The estimated sediment delivery to the creek channel, shown in Table A-2, from these contributing sub-watersheds is estimated at 2,535 tons/yr. Thus it is estimated that 3,323 tons of sediment, 788 tons from bank erosion and 2,535 tons from sheet and rill erosion, is delivered to the channel each year.

A-2. Estimated Sediment Loading

	Sheet and Rill Derived Sediment Loading tons/yr.	Direct Bank Erosion Derived Sediment Loading tons/yr.	Total Sediment Loading tons/yr.
Current Conditions	2,535	788	3,323
Background Conditions	290	98	388

APPENDIX B   Supplementary Nutrient Analysis

Introduction

Tammany Creek is currently listed on the State of Idaho 303(d) list for only excess sediment pollution. Water quality assessments during the course of this study indicate that nutrient levels are also of concern. It is expected that these additional pollutants will be added to the Tammany Creek 303(d) listing within the next listing cycle (expected out in 2002). Therefore, this supplementary nutrient analysis was conducted to proactively address this expected additional TMDL requirement.

B.1   Water Quality Concerns

During the development of the Tammany Creek sediment TMDL, high nutrient levels were observed in the available data set provided by the NPSWCD. Excess nutrient levels can cause nuisance algae growth that can impair beneficial uses and cause reduced dissolved oxygen levels that are detrimental to aquatic life. The two nutrients of concern are nitrogen and phosphorous. In surface waters nitrogen is present in the forms of nitrate (NO_3), nitrite (NO_2), ammonia and organic nitrogen. Of these four nitrogen compounds, NO_3+NO_2 constitute the great majority of the nitrogen available for plant uptake and therefore are used as the measure of available nitrogen within this study. Compared to the EPA guidelines of 0.30 mg/L of NO_3+NO_2 (U.S. EPA 1986), levels of up to 8.7 mg/L were observed within Tammany Creek. Phosphorous is present within aquatic systems in several forms. Typically, greater than 90% of the total phosphorous (TP) present in freshwater occurs in organic forms in the biota or absorbed to particulate matter (Wetzel, 1983). The remaining fraction is in the form of orthophosphate (OP: PO_4^{-3}) which is the inorganic, soluble form which is readably assimilated by plants and therefore is used as the measure of phosphorous available for plant uptake in this study. Within the available data, OP constituted from 21-86% of the TP with an average of 56% of TP present as OP. This indicates that the Tammany Creek is enriched in phosphorous and excessively enriched in nitrogen. The optimum nitrogen to phosphorous molar

ratio for plant uses has been estimated at 16:1 (USGS 1994). When addressing excess nutrient levels in surface waters it is often more cost effective to focus reduction efforts upon the limiting nutrient of the system. Within Tammany Creek phosphorous is the dominantly limiting nutrient. Figure B-1 illustrates the molar ratios observed in Tammany Creek. Molar ratios greater than 16 are termed phosphorous limited conditions and ratios below 16 are termed nitrogen limited conditions.
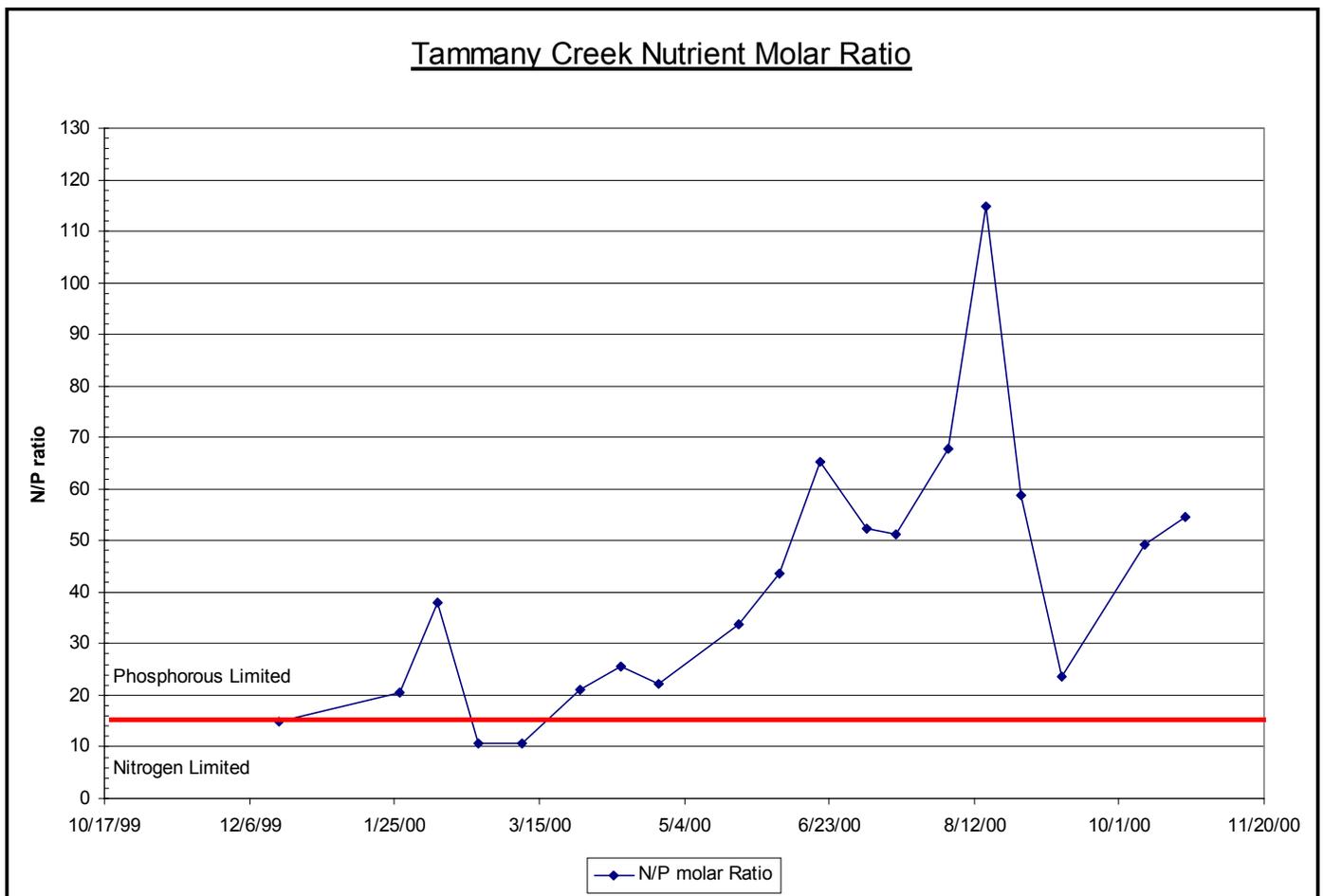

Figure B-1. Nutrient Molar Ratios

B.2   Pollutant Sources

Nutrients are a natural element within aquatic ecosystems. However, excess nutrient loading can cause excess algae growth, nuisance slime growth and depleted dissolved oxygen levels. There are several sources of excess nutrients to water bodies including agricultural chemical runoff, animal wastes and septic tank drain fields. These sources can have multiple modes of delivery to the water body including contaminated groundwater base flow, surface runoff transport and delivery and direct deposition within the water body.

B.3   Applicable Water Quality Criteria

General Surface Water Quality Criteria- *IDAPA 58.01.02.200.06 Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.*

The Idaho general surface water quality criteria states that "Surface waters must be free of excess nutrients that cause visible slime growth, or nuisance aquatic growth, which impairs beneficial uses." As a result, there are no explicit numerical targets and nutrient target loads are assessed on a case by case basis. The Tammany Creek beneficial uses that are impacted by excess nutrient loading include secondary contact recreation and cold water biota support. Secondary contact recreation can be impacted by excess visible slime and algae growth. Cold water biota can be impaired when excess alga growth is decomposed by aquatic microorganisms that results in depleted dissolved oxygen levels that are detrimental to aquatic life.

According to IDAPA 58.01.02.250.02.a, the Idaho general surface water criteria for aquatic life use designations, dissolved oxygen levels are to exceed 6 mg/L at all times. It is the widely accepted that excess nutrients and the associated aquatic growths are directly related to lowered dissolved oxygen levels. Therefore, dissolved oxygen levels will be used to assess the impact of nutrients

upon aquatic life and excess algae and slime growth is used to assess the impacts upon recreational uses. In the absence of any documented nuisance aquatic growths on Tammany Creek, the dissolved oxygen measures will also be used for assessment of nuisance aquatic growths impacting recreation uses.

B.4   Available Data

The data used for the development of this TMDL was provided by the Nez Perce Soil Conservation District (NPSCD) and contains biweekly measurements during the time period between December 16, 1999 and November 21, 2000. The nutrients sampled include total phosphorous, ortho-phosphorous, nitrite and nitrate, ammonia and total kjeldahl nitrogen in addition to other measured parameters including flow, sediment and dissolved oxygen.

B.5   Nutrient Loading Analysis

Tammany Creek can generally be described as having very high nitrogen levels that are not correlated to flow and do not vary appreciably during the year. This is indicative of a constant source, likely from shallow groundwater base flow containing elevated nitrogen levels. Phosphorous levels are fairly low with peak levels occurring during high flow events and correlate extremely well with TSS levels (average R^2=0.82) indicative of sorbed phosphorous being transported to the creek during high flow and/or precipitation events. During the higher flow periods, generally between December and May, over 50% of the total phosphorous is organic in nature indicating plant and/or animal waste sources. After this higher flow period, beginning in June, inorganic ortho-phosphate increasingly represents the majority of the total phosphorous present. This reaches a maximum of approximately 80% of the total phosphorous present in Tammany Creek from August to October. This is indicative of an inorganic source during the periods of low precipitation such as what might be expected in shallow ground water base flow containing inorganic phosphorous from fertilizers or septic drain fields.

Examinations of the molar ratios of nitrogen and phosphorous indicate that the system is typically phosphorous limited which appears to prevent any appreciable excess aquatic growths. Additional examination of the dissolved oxygen levels indicates that the lowest dissolved oxygen level recorded was 5.9 mg/L at sampling location TC-2 with sample locations TC-1, TC-3 and TC-4 recording values of 8.5, 7.8 and 8.2 mg/L respectively on the same day. Averaging the four samples of each sampling event results in minimum, mean and maximum values of 7.6, 9.6 and 11.5 mg/L respectively. There is the potential that dissolved oxygen levels lower during the night when photosynthetic activities are at there minimum. There is no available information regarding this cycle on Tammany Creek. From this information is appears that the excess nutrient loading is not significantly impairing the aquatic life beneficial use.

Current nutrient levels are not impairing beneficial uses therefore a nutrient TMDL has not been developed. Nevertheless, efforts to reduce the level to total phosphorous within Tammany Creek can provide the greatest benefit towards limiting potential nutrient related problems. Due to the significant correlation between sediment (TSS) and total phosphorous concentrations (illustrated in Figure B-2) it is reasonable to assume that if the recommended reductions in sediment loading specified in section 3.0 of this TMDL are implemented, significant reductions in the total phosphorous reaching the creek will also occur. Therefore, no nutrient specific reductions are deemed necessary at this time and it is assumed that the phosphorous level reductions needed to provide a reasonable margin of safety will occur as the required sediment reductions are implemented.
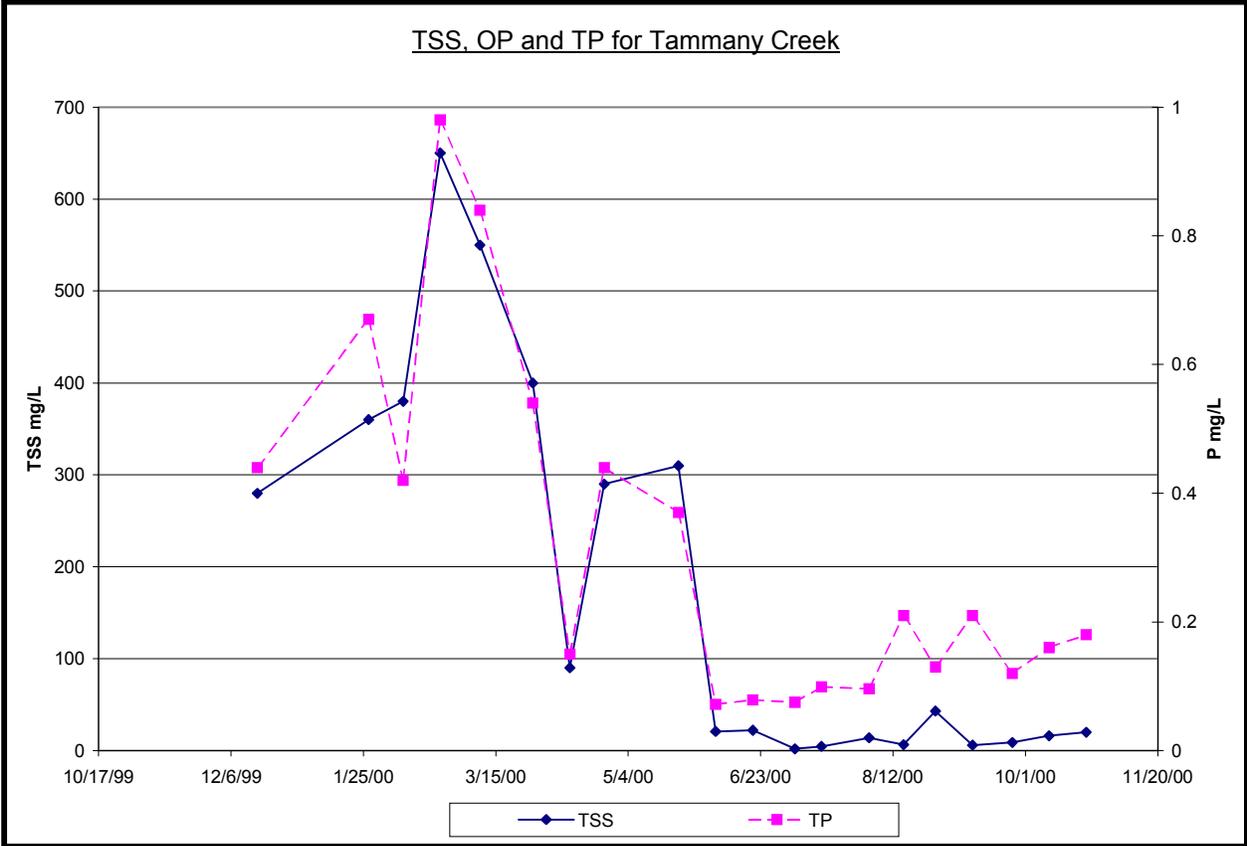
Figure B-2. Tammany Creek TSS and TP

APPENDIX C   Supplementary Pathogen Analysis

Introduction

Tammany Creek is currently listed on the State of Idaho 303(d) list for only excess sediment pollution. Water quality assessments during the course of this study indicate that pathogen levels are also of concern. It is expected that this additional pollutant will be added to the Tammany Creek 303(d) listing within the next listing cycle (expected out in 2002). Therefore, this supplementary pathogen analysis was conducted to proactively address this expected additional TMDL requirement.

C.1   Water Quality Concerns

The presence of pathogens in a water body may impair beneficial uses and pose a human health hazard. Pathogens are a subset of microorganisms, including certain bacteria, viruses and protozoa, which if entered into the body through ingestion or contact with the skin or mucous membranes can cause sickness or death. Pathogens are particularly difficult to measure do to their common low numbers of occurrence and unreliable analysis methods. Commonly non-pathogenic bacteria which are often associated with pathogens and which typically occur in greater concentrations are measured as a surrogate for pathogens. E. coli or fecal coliform are often used for this purpose. E. coli has become the preferred surrogate because it is less likely to give a false positive and more closely related to gastrointestinal illness. Pathogens are of particular concern because Tammany Creek has the designated beneficial use of secondary contact recreation in addition to the fact that Tammany Creek flows into the Snake River at the east end of the Hells Gate State Park swimming beach.

C.2   Pollutant Sources

Common pathogen sources include animal fecal matter, urban runoff and septic tank drain fields. Animal fecal matter contamination can result from direct runoff from animal feeding operations, land application of manure and direct contamination from animals with access to the water body. Urban runoff can also contribute to the pathogen concentrations as pet wastes are carried in surface runoff and through storm drains that often drain into the adjacent waterways. Failing septic systems that allow passage of wastes before sufficient degrading has occurred can also be a potential source for pathogens. Wildlife can also be potential sources of pathogens where significant populations exist.

C.3   Applicable Water Quality Criteria

Secondary Contact Recreation Criteria -*IDAPA 58.01.02.251.02 Waters designated for secondary contact recreation are not to contain E. coli bacteria significant to the public health in concentrations exceeding*

> a.   *A single sample of 576 organisms per 100 ml or*
> b.   *A geometric mean of 126 organisms per 100 ml based on a minimum of 5 samples taken every 3 to 5 days over a 30-day period.*

Idaho water quality standards provide a numeric maximum concentration for E coli. bacteria of 576/100ml for instantaneous measurements and 126/100ml for a geometric mean over 30 days.

C.4   Available Data

The data used for the development of this TMDL was provided by the Nez Perce Soil Conservation District (NPSCD) and contains biweekly measurements during the time period between December 16, 1999 and November 21, 2000. The pathogen indicators monitored include both E. coli. and fecal coliform in addition to other measured parameters including flow, nutrients, sediment and dissolved oxygen. The samples are representative of instantaneous measurements and

Figure C-1. E. Coli. col/100ml for sample site TC-2

there are no sampling periods which include the 5 samples in 30 day period to strictly apply the geometric mean pathogen water quality criteria. Nevertheless, a geometric mean was calculated for all the measurements over the course of the year for comparative use.

C.5   Pathogen Loading Analysis

E.Coli. concentrations in Tammany Creek for sample site TC-2 violate the instantaneous standard in 63% of the recorded samples and 100% of the samples violate the geometric average standard. Furthermore, the concentrations appear to be somewhat random demonstrating no predictable loading mechanism or correlation to flow. This reflects the spatial and temporal variations that can result from activities such as direct fecal deposition in the

stream by wildlife and livestock, land application of manure and precipitation events. Pathogen concentrations are integrated using mean flows and current concentrations to compare to the water quality standard concentrations integrated through the same flows. The results of the calculations are shown in Table C-1. The results indicate that pathogen loading must be reduced by 88% upon the application of the 126-col/100ml geometric mean standard.

Table C-1. Pathogen (E. Coli.) Loading Analysis

Standard	Current Load bcfu	Load Capacity bcfu	Required Reductions	Load Allocation bcfu
126 col/100ml 30-day Geometric mean standard	12,827	1,491	88%	1,491