Adopts a Lower Colgan Creek Restoration Conceptual Plan

November 19, 2002

RESOLUTION NO. 25475

RESOLUTION OF THE COUNCIL OF THE CITY OF SANTA ROSA ADOPTING A LOWER COLGAN CREEK RESTORATION CONCEPTUAL PLAN

WHEREAS, the Council initiated development of a restoration concept plan for lower Colgan Creek in December 1999; and

WHEREAS, the Lower Colgan Creek Restoration Concept Plan proposes restoration of natural channel dimensions and patterns, use of in-channel habitat features, establishment of a native riparian forest and increased flood conveyance between Victoria Drive and Bellevue Avenue; and

WHEREAS, a public meeting and walking tour was conducted on June 28, 2000; and

WHEREAS, the restoration concept plan would implement goals of the General Plan; and

WHEREAS, acquisition of land adjacent to Colgan Creek is proposed for a neighborhood park and for enhancement of the riparian corridor; and

WHEREAS, two alternative conceptual plans were presented to the Waterways Advisory Committee in November 2000 and the committee recommended one of the alternatives for final development and presentation to the Council; and

WHEREAS, on November 19, 2002, Council approved and adopted the Negative Declaration for the Lower Colgan Creek Channel Restoration Concept Plan.

NOW, THEREFORE, BE IT RESOLVED that Council adopts the Lower Colgan Creek Restoration Conceptual Plan.

BE IT FURTHER RESOLVED that Council directs staff to proceed with implementation of the Lower Colgan Creek Restoration Conceptual Plan.

BE IT FURTHER RESOLVED that Council authorizes staff to pursue acquisition of open space adjacent to the concept plan reach of Colgan Creek.

IN COUNCIL DULY PASSED this 19th day of November, 2002.
SUMMARY REPORT

Conceptual Design for Colgan Creek Stream Restoration

October 31, 2002

EXECUTIVE SUMMARY
The conceptual design for Colgan Creek stream restoration presents a vision of restoring Colgan Creek between Victoria Drive and Bellevue Avenue in southwest Santa Rosa. The overall purpose of the project is to enhance fish and wildlife habitat and the quality of life for local citizens. The plan includes converting 1.3 miles of straightened and denuded channel into a beautiful and more natural creek setting by restoring more natural channel dimensions and patterns, installing habitat features, and establishing a native riparian forest. Human elements of the plan include the incorporation of neighborhood parks, a meandering bicycle path, and increased flood conveyance in the creek.

INTRODUCTION
In the southwestern area of Santa Rosa, Colgan Creek flows westward for approximately 1.28 miles from near Victoria Drive to near Elsie Allen High School along Bellevue Avenue. The creek flows through fields east of Dutton Meadow before turning west to parallel Bellevue Avenue. This reach has been relocated and channelized for flood conveyance, and is owned and maintained by the Sonoma County Water Agency (SCWA).

A unique opportunity exists to restore natural channel functions and values to Colgan Creek before the southwest area of Santa Rosa is further developed. There is undeveloped land adjacent to the creek throughout much of the project. The creek passes along the southern edge of Elsie Allen High School, and the City has plans for a proposed bike and footpath along the creek.
Restoration planning done at this time may be able to take advantage of these conditions to go beyond the customary limits of creek restoration within an urban environment. Benefits of a restored creek and riparian corridor include providing aquatic and wildlife habitat, improving water quality, providing public access and recreational opportunities, and enhancing flood conveyance, if feasible.

Public participation in the planning process has included one public meeting and walking tour, a presentation to the Santa Rosa Waterways Advisory Committee, and a planning meeting with SCWA staff. One of two conceptual alternatives has been selected and herein revised.

This report presents a revised conceptual plan for restoration of Colgan Creek. (See Figures 1, 2, and 3.)

**EXISTING CONDITIONS**

Colgan Creek originates in the foothills on the north side of Taylor Mountain, flows northwesterly along Kawana Springs Road until it passes under U.S. 101 near Hearn Avenue, then turns and flows southwesterly until it meets the Laguna de Santa Rosa near the intersection of Todd Road and Highway 116. With exception of the headwater area along Kawana Springs Road, Colgan Creek is entirely confined to an artificially straightened flood channel. From Petaluma Hill Road east of 101 to Victoria Drive south of Hearn Avenue (the upper limit of the project zone), the channel is mostly constructed of concrete, including a flat bottom. From Victoria Drive to the Llano Road crossing (a distance of roughly four miles, including the project zone), the flood channel has mainly soil banks, supplemented with riprap or concrete in some areas, and a permeable, semi-natural bottom (i.e., silt or clay streambed, but unnaturally flat).

Throughout the project zone the stream is almost fully exposed to the sun, as there is essentially no functioning riparian tree corridor, although scattered immature valley oaks have been planted along the access road above the channel in some areas. A near-absence of shade persists downstream from the lower end of the project zone at Bellevue Avenue to Llano Road. Downstream from Llano Road, Colgan Creek continues as an artificially straightened flood channel, but a dense riparian strip of large, older cottonwood, willow, and other trees has been allowed to remain, both within and above the channel. These trees provide a nearly closed canopy shading the stream, and completely alter the stream habitat in beneficial ways.
Within the project reach, the water temperature in Colgan Creek near the Bellevue Avenue bridge on May 3, 2000 at 3:00 PM was 31°C (88°F). Higher stream temperatures are expected in summer, where water remains in this reach. The upper lethal thermal limit for steelhead or coho salmon is generally considered to be about 24°C (75°F), so temperature alone rules out any possibility of steelhead or coho juvenile rearing within the project zone under the existing conditions.

In addition to emergent grasses and weeds, the stream contains large amounts of thick, filamentous green algae, the growth of which is enhanced by the absence of shade, which would normally be provided by riparian trees and shrubs. The streambed throughout most of the project reach is either hard clay or clay overlain by silt. There is no gravel or cobble, and the only boulders appear to be isolated chunks of riprap that have fallen from the banks and been moved downstream at high flows. Aside from the few boulders and occasional shopping carts, there is very little instream structure available to provide shelter or living space for aquatic animals. The deepest water found was about three feet deep, in a short (10-foot long), narrow channel where the clay had been eroded to that depth. Most pools and glides were less than one foot deep. Two concrete and grouted riprap drop structures within the project reach represent significant barriers to upstream migration by fish, turtles, and other aquatic animals at all but the highest winter flows.

The stream fauna in the project zone are relatively impoverished. Only three species of fish were found, in small numbers: mosquito fish, threespine stickleback, and California roach. The latter two are native species; the mosquito fish are exotic species introduced to control mosquito larvae. Each of these are small-sized fish, the biggest of which is the roach, which may reach about five inches in length. These species are tolerant of high temperatures and poor water quality, and adapt to hide within algae and submerged vegetation. The only other aquatic vertebrates found were Pacific treefrog juveniles. Among the algae and emergent vegetation, invertebrates typical of ponds and sluggish streams were observed, including dragonfly larvae, dytiscid beetles, water striders, backswimmers, corixids, snails, and a few introduced swamp crawfish. Notable by their absence were the types of insect larvae (stoneflies, caddisflies, mayflies) associated with highly productive, rocky streams. Also absent were flatworms and leeches, which are common in perennial streams in this area, but cannot survive in streams that go dry in summer, and are slow to colonize new areas (unlike flying insects or good swimmers such as fish). Very few water-associated birds were observed during field reconnaissance on May 3, 2000 (one green heron, one kildeer, one pair of mallards).
The stream within the project zone lacks structural habitat diversity, is unshaded and subject to large fluctuations in temperature, dries up in the summer, and is relatively unproductive (lacks nutrients provided by decomposing leaves and twigs, which usually serve as the base of the food chain in small streams). As a result of these factors, aquatic life is poorly represented.

**Special Status Species**

Several special status species occur within the project area or within the vicinity of Colgan Creek. The California tiger salamander (federally-listed as endangered under emergency listing) occurs within close proximity to the project site. There are known breeding sites within one mile of the project site. The tiger salamander uses vernal pools for breeding and small mammal burrows in upland habitats for estivation.

Within the Russian River and some of its tributaries Coho salmon, chinook salmon, and steelhead are known to occur. Western pond turtle, Russian River tule perch, California roach, hardhead, river lamprey, and pacific lamprey are also found in the Laguna de Santa Rosa and/or the Russian River. The California Roach is the only special status species known to be currently present within the project reach. Western pond turtles, foothill yellow legged frogs, and northern red legged frogs likely inhabited the project area historically.

The yellow-breasted chat (California Department of Fish and Game Species of Special Concern) is one of many riparian bird species that have suffered population declines in Sonoma County as a result of the loss of riparian woodlands in and around the Laguna de Santa Rosa. Chats are known to nest in dense riparian growth along waterways in isolated pockets of the county. Restoration of Colgan Creek will encourage the return of this and other riparian bird species.

The restoration of Colgan Creek will provide cover and create foraging and nesting opportunities for both resident and migratory birds, as well as resident amphibians and reptiles. The restoration will also have downstream affects to the special status species found within the Laguna de Santa Rosa and the Russian River. Restoration will have a positive impact on the survival of special status species by providing woody debris and food (insects, invertebrates, etc.).

Wetland delineation confirmed by the U.S. Army Corps of Engineers shows wetlands in the area immediately north of the Colgan Creek corridor between Burgess Drive and Dutton Meadow Road. Special status plant species that frequently are present in vernal pools within the Santa Rosa Plain include
PUBLIC PARTICIPATION
Public participation in the preparation of the conceptual plan included a meeting with the SCWA, a public meeting and walking tour of the project reach, a City Council study session, review by the Santa Rosa Waterways Advisory Committee and presentation to a class at Elsie Allen High School.

The public meeting and creek walk were held on June 28, 2000. Approximately 20 people attended the meeting. Overall, people were in favor of the project. Issues and questions raised by the public are listed below. City or consultant responses to questions are in italics.

- **Bike path, public access, and neighborhood safety.** This proposed configuration of the bike path is a big concern for neighbors, especially those in the Victoria Drive area. Of particular concern are vandalism, burglary, and police response. Are there comparison studies with the Santa Rosa Creek bike path regarding safety concerns? The Victoria Drive neighborhood is a County pocket within the City. Will City police respond to this area? Victoria Drive residents asked whether backyard fences would be redone as part of the project.

  The bike path should be blended with the creek restoration project. One suggestion was to put the path, or just the upper part of the path, along the west side of the creek. It was noted that the bike path should be accessible by road and follow existing or planned transportation patterns (such as the road planned with Marv’s Meadows subdivision), and be less disruptive to wildlife corridors.

  Subsequent to the public meeting, Canine Companions for Independence objected to the proposal to put the bike path on the east bank of the creek.

  **Note:** In the revised conceptual plan, the bike path is planned for the west bank of the creek upstream (north) of Bellevue Avenue, terminating at the intersection of the creek and Dutton Avenue.

- **Level of flood protection.** Will the level of flood protection be the same in both alternatives? The conceptual channels are both designed to accommodate a 100-year storm event as determined using current SCWA hydrology. The current channel was designed to accommodate a 25-year storm event. Subsequent to the preparation of the concept plan, the hydrology for the Colgan Creek watershed is being reviewed. The level of flood protection that will be achieved with the restoration project will need to be determined after the new hydrological analysis is completed.
• **Taking private property.** It is not the intent of the City or the plan to “take” private property. Rather it is the intent of the plan to work with private property owners to improve their property as well as the creek through creative design alternatives and observance of creek setbacks. If, for any reason, no design solutions are available, and it is necessary for private property to be taken, landowners should be compensated at market value.

• **SCWA participation.** People asked about SCWA’s support of the conceptual designs and commitment to maintenance. SCWA will be reviewing the conceptual designs. On other creek restoration projects within the City, SCWA has performed hydraulic maintenance and the City has maintained bike paths, benches and other amenities. (The SCWA subsequently reviewed and supports the conceptual designs).

• **Will neighboring properties drain to the creek?** Yes.

• **Wetland impacts.** Will any Corps jurisdictional wetlands be impacted? Can the new channel be considered mitigation for any wetlands destroyed? If wetlands are impacted, we anticipate that mitigation wetlands would need to be created just as if the new channel were a development project. While the new channel would be waters of the U.S., it’s unlikely that the Corps would accept it as mitigation for wetland impacts.

  What about impacts to subsurface water and vernal pools and their special status species? The new channels will not be deeper than the existing channel. Vernal pools receive very little water from subsurface flow and should not be affected.

• **Community volunteers.** Can volunteers help with the project? Yes. The City is already working with the Community Development Academy and Elsie Allen High School. The school has a greenhouse that isn’t being used. Volunteers could help collect acorns and assist with planting.

• **Hearn Avenue recharge area.** It was noted that residences in the vicinity of Hearn Avenue have shallow wells. It’s important to consider that flood conveyance can decrease groundwater recharge.

• **Downstream Effects.** What happens downstream of this project and further downstream to the Laguna? This project could be a pilot project for future restoration along Colgan Creek.

• **Bridges.** It was noted that existing bridges would need retrofitting.

• **Spoils.** Are there any plans for the spoils? It could be used for the planned developments.
• **Conceptual plan park areas in Alternative #1.** Will the parks be depressed to increase flood storage? They could, although the storage would be minimal.

**PROPOSED CREEK RESTORATION**
The objectives for the Colgan Creek Conceptual Stream Restoration are to:

- Develop approximate bankfull channel dimensions that will maintain sediment transport through the project site with in-stream enhancements such as pools and riffles.
- Create flood plains to contain the 100-year storm and help minimize channel erosion.
- Restore the riparian corridor to improve water quality while providing aquatic and wildlife habitat enhancement.
- Provide a bike path and public access for recreational opportunities.
- Provide an educational opportunity for Elsie Allen High School.

**Channel Geometry**
Bankfull geometries for the conceptual stream channel were derived from field measurements of several stream reaches in the Santa Rosa Plain. Bankfull indicators were examined along Colgan Creek in the natural reach above Petaluma Hill Road (above development), the middle channelized reach, and the lower vegetated but modified reaches below Todd and Llano Roads. Roseland Creek was also measured below Llano Road in both the modified and natural reaches. Matanzas, Spring and Copeland Creeks were also investigated with less conclusive results. In addition, Dunne and Leopold’s regional curve for the San Francisco Bay region at 30 inches annual precipitation was consulted to determine an appropriate range for bankfull width, depth and cross sectional area. Plan view geometries were measured from historic aerial photographs of the Santa Rosa Plain from 1942. These measurements were used to develop acceptable ranges for meander length, amplitude, belt width and radius of curvature and fell mostly within the ranges reported throughout the United States by Leopold in “A View of the River.” The proposed new channel stream length is 7,281 linear feet vs. the existing pre-project length of 6,523 linear feet.

**Bankfull Hydrology**
Bankfull flows were analyzed using several methods for the project reach. The first method was the intensity formula from Plate No. B-2 of the SCWA Flood Control Design Criteria manual for the 1.4 year storm that resulted in 675 cubic feet per second (cfs) at the Bellevue Avenue bridge. The second method was Dunne and Leopold’s equation from “Water in Environmental Planning,” page 616, for the San Francisco Bay region for bankfull discharge to drainage area. This gave a bankfull flow of 185 cfs at the Bellevue Avenue Bridge. U.S. Geological Survey’s “Magnitude and Frequency of Floods in California” by
Waananen and Crippen for the 2-year storm computed to 535 cfs at the Bellevue Avenue bridge with much higher flows using the urbanization factors. A near bankfull storm occurred on February 13, 2000. Velocity and cross section were measured on site. A flow of 228 cfs was calculated for that event. Bankfull flow rates used for the conceptual design are presented at the end of this summary report.

**Bankfull Hydraulics**

Once bankfull geometry ranges and hydrology were developed for the project reaches, Manning’s equation was used to analyze channel hydraulics and develop conceptual bankfull channel design dimensions. Bankfull cross-sections were developed for four reaches with bankfull widths of 29.5 feet (Sta. 204+87 to 205+90), 28.5 feet (Sta. 205+90 to 224+21), 27.5 feet (224+21 to 233+30) and 26.5 feet (Sta. 233+30 to 269+40). Shear stress and bed material mobilization using the modified Shields curve were also considered. Further refinement should be made in the final design phase including detailed analysis of streambed core (core samples) and streambed surface composition (pebble counts). The Manning’s roughness used for the bankfull channel hydraulic calculations was 0.032.

**Floodplain Hydrology and Hydraulics**

Floodplain analysis was done for the 10, 25 and 100-year storms using SCWA flood control hydrology and by using the Manning’s equation on the reaches with 28.5 feet and 26.5 feet bankfull widths. Reaches with 29.5 feet (very short reach) and 27.5 feet bankfull widths have some of the floodplain dimensions assumed. Numerous cross section and flood plain dimensions were analyzed. Minimum floodplain widths were developed that would contain the 100-year storm, with a minimum freeboard of 2 feet. The floodplain widths vary throughout the design where room permits. A Manning’s roughness of 0.060 was used for vegetated floodplain and banks above bankfull.

An additional 100-year storm analysis was conducted using an over-estimated Manning’s roughness of 0.060 for the bankfull channel and 0.150 for the vegetated floodplain and banks above bankfull. The analysis showed the 100-year storm still passed through the project area with 0.5 foot of freeboard.

Philip Williams & Associates, Ltd. performed a hydraulic analysis for Colgan Creek as part of the restoration concept plan project. Their report is titled Lower Colgan Creek: Hydraulic Analysis and dated May 14, 2001. The analysis assessed the hydraulic capacity of the channel with the implementation of the concept plan, including the effects with and without existing bridge street crossings in place. The report concluded that under the proposed restoration concept plan, with the assumption of reasonable vegetation management in the enlarged

Prunuske Chatham, Inc.
channel, removal of the private driveway bridge and replacement of the Dutton Meadow bridge, channel conveyance in the study reach will increase to carry the 100-year, ultimate development condition peak flow.

Any new hydrologic flood flow data available for the 10, 25 and 100-year storms should be used for modeling in the final design phase.

**Bridges**

It was assumed that the bridges throughout the project reach are undersized and would have to be modified in the final design stage. No backwater condition was assumed for the conceptual channel hydraulic analysis.

**Channel Gradient**

For purposes of this conceptual design, an average stream slope (riffle crest to riffle crest) of 0.002 ft/ft was used. This is a simplification of the existing channel gradient variations. The channel gradient of 0.002 ft/ft used between boulder drop structures works for the conceptual design as one possible scenario. It may not be the finished gradient used for the final design phase. For example, the average gradient could be steeper through the upper reaches where the channel is confined by development. Achieving the 0.002 ft/ft gradient in the lower reaches will require modifying the 3 feet concrete drop control structure at the bottom of the site to an 18-inch drop. This allows additional flood conveyance through the laterally constricted lower reaches along Bellevue Avenue and keeps the channel bottom below storm drain outlets.

**Channel and Habitat Features**

The conceptual plan includes drawings of boulder bank protection, drop structures, vanes, and woody debris habitat structures to explore the possibilities that should be considered in the final design phase. The conceptual design assumes all 1:1 bank slopes will have vegetated boulder armoring to bankfull and vegetated fabric reinforced earth fills above. 2:1 slopes on outside bends may need boulder toe protection or biotechnical bank protection. Any slope 3:1 or flatter will be protected by native plant reforestation. Boulder armor at outside bends can be designed to enhance aquatic habitat.

**Next Phase of Planning and Design**

The plan shows a conceptual representation of how the stream may look after construction. It also shows the boundary lines for the restoration project. In order to develop a final set of construction plans, the following will be necessary:

- Obtain onsite hydrologic, geomorphic and biological monitoring data during at least two rainy seasons.
• Procure revised flood flow calculations (Q100, etc.) for Colgan Creek.
• Procure accurate topographic map with property lines.
• Prepare design and specifications.
• Obtain environmental regulatory permits for the project.
• Prepare a monitoring plan to gauge the success of the project and gather information for adaptive management.
APPENDIX A
GEOMORPHIC AND HYDRAULIC DESIGN DATA

Note: Station numbers refer to pre-project SCWA stationing. For a glossary of geomorphic and hydraulic design data terms, see Appendix B.

Bottom of site
Sta. 204+87 to 205+90

Qbf = 240 cfs  Q10=1,021 cfs  Q25=1,189cfs  Q100=1,501cfs

Bkf Width = 29.5'
Bkf Mean Depth = 2.31'
XS area = 68 ft2
W/ D = 12.7
Channel bottom width = 18'
Bkf Velocity = 3.53 ft/ sec.
Bkf shear stress = 0.27 lbs/ sq.ft.
Assumed slope=.002 ft/ ft.
Min. Entrenchment=2.2; flood prone width=65'

100yr width =64'
100yr. depth = 7.5'
100 yr. velocity = 5.5 ft/ sec
100 yr. shear stress = 0.55 lbs/ sq.ft.

Top of bank min. width = 76'
Top of bank height (existing) 10' free board = 2.5'
Meander length (10.9W1.01)= 333'  range (10-14 bkf widths) = 295' – 413'
Amplitude (2.7W1.1)= 112'
Radius of curvature (2.3BkfW) = 68' range to from field measurements (4BkfW) = 118'
Riffle to riffle (5-7W) = 147’-205.5’

Downstream Culverts to Dutton Meadows Road
Sta. 205+90 to 224+21 (along Bellevue)

Qbf = 230cfs  Q10= 979cfs  Q25=1,139cfs  Q100=1,437cfs

Bkf width = 28.5'
Bkf Mean Depth = 2.31'
XS area = 65.9 sq.ft.
W/ D= 12.3
Channel bottom width = 17'
Bkf Velocity = 3.52 ft/sec.
Bkf shear stress = 0.27 lbs/sq.ft.

100yr width = 62.5'
100yr. depth = 7.35'
100yr area = 272 sq.ft.
100 yr. velocity = 5.28 ft/sec
Shear stress = .54 lbs/sq.ft.
Assumed slope= 0.002 ft/ft.
Min. Entrenchment= 2.2; flood prone width= 62'

Top of bank min. width = 75'
Top of bank height (existing) = 10'

Meander length (10.9W1.01)= 321’ range (10-14 Bkf widths) = 285’ - 399’
Amplitude (2.7W1.1) = 107’
Radius of curvature (2.3 BkfW) = 65.5’ range to (4 BkfW) = 114’
Riffle to riffle (5-7W) = 142’-200’

Optimum belt width (using 10.9w=ML, 2.7w=A, 2.3w=Rc) = 140’
With 2:1 side slopes belt width = 176’ Range 120’ to 180’

**Dutton Meadows to 90-Degree Bend Outlets at Bellevue Ave.**
Sta. 224+21 to 233+30

Qbf= 214cfs  Q10= 910cfs  Q25=1,057cfs  Q100=1,334cfs

Bkf width = 27.5’
Bkf Mean Depth = 2.25’
XS area = 62.5 sq.ft.
W/ D= 12.3
Channel bottom width = 16.5’
Bkf Velocity = 3.46 ft/sec.
Bkf shear stress = 0.28 lbs/sq.ft.

100yr width = 60.5’
100yr. depth = 7.5
100 yr. velocity = 5.28 ft/sec
Shear stress = .54 lbs/sq.ft.
Assumed slope= 0.002 ft/ft.
Min. Entrenchment=2.2; flood prone width = 60.5’

Top of bank min. width = 73’
Top of bank height (existing) = 10’

Meander length (10.9W1.01)= 309’ range (10-14 bkf widths) = 275’ – 385’
Amplitude (2.7W1.1) = 103’
Radius of curvature (2.3W) = 63’ range to (4W) = 110’
Riffle to riffle (5-7W) = 137.5’-192.5’

90-Degree bend at Bellevue to top of Project
Sta. 233+30 to 269+40

Qbf= 200cfs Q10= 910cfs Q25=1,057cfs Q100=1,334cfs
Note: Q 10, 25, 100 were not provide by SCWA.

Bkf width = 26.5’
Bkf Mean Depth =2.21’
XS area = 58.82 sq.ft.
W/ D= 12.0
Channel bottom width = 15.5’
Bkf Velocity = 3.41 ft/ sec.
Bkf shear stress = 0.27 lbs/ sq.ft.

100yr width = 59.27
100yr. depth = 7.32
100yr area = 254 sq.ft.
100 yr. velocity = 5.23 ft/ sec
Shear stress = 0.5 lbs/ sq.ft.
Assumed slope=.002 ft/ ft.
Min. Entrenchment= 2.2; flood prone width = 58.3’

Top of bank min. width = 72’
Top of bank height (existing) = 10’

Meander length (10.9W1.01)= 298.5’ range (10-14 bkf widths) = 265’ – 371’
Amplitude (2.7W1.1) = 99’
Radius of curvature (2.3W) = 61’ range to (4W) = 106’
Riffle to riffle (5-7W) = 132.5’-185.5’
APPENDIX B
GEOMORPHIC AND HYDRAULIC GLOSSARY

aggrade, aggrading, aggradation — with relation to stream systems, to fill with sediment over time; the raising of a stream-channel bed over time due to the deposition of sediment that was eroded and transported from the upstream watershed or the channel.

amplitude — the distance, perpendicular to the valley, between the centers of the channel over one half of the wavelength. Related to the distance of meandering between two consecutive bends in the channel.

bankfull — stage at which sediment transport is most effective.

bankfull channel — channel formed by the dominant discharge (see definition below); also referred to as the active channel.

bankfull discharge — flow that results in the average morphic characteristics of the channel; see definition of dominant discharge below.

bankfull mean depth (Bkf Mean Depth) — the mean depth of the bankfull flow.

bankfull shear stress (Bkf shear stress) — the average shear stress exerted by the bankfull flow at a given location.

bankfull velocity (Bkf Velocity) — the average velocity of the channel at a given location during the bankfull flow.

bankfull width (Bkf Width) — the width at the top of the bankfull channel.

barrier — the stoppage of materials, energy, and organisms.

bed — bottom of a channel.

belt width — outside width of meandering of the bankfull channel.

channel — a natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks which serve to confine the water.

core samples — a sample of what lies below the bed of the stream. Can be used to determine the size and type of gravels that are moving through the system.

cross-sectional area (XS area) — the area of a stream, channel, or waterway opening, usually taken perpendicular to the stream centerline.

degrad, degrading, degradation — with relation to stream systems, to cut down or lower the channel bottom over time; the lowering of a stream-channel bed over time due to the erosion and transport of bed materials or the blockage of sediment sources.

dimension — in this document, refers to the cross section measurement of the bankfull channel and flood-prone area.

discharge — volume of water passing through a channel during a given time, usually measured in cubic feet per second.
**drop structure** — a structure in the bed of the stream where the flow drops vertically over it.

**entrenched stream** — a stream deeply incised or degraded, cut into bedrock or consolidated deposits, often with over-steepened banks and abandoned flood plains.

**entrenchment ratio** — an indicator of how entrenched, or vertically contained a stream is. Quantitatively, it is the ratio of the width of the flood-prone area to the surface width of the bankfull channel. The flood-prone area width is measured at the elevation that corresponds to twice the maximum depth of the bankfull channel.

**ephemeral stream** — one that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times above the water table.

**flood flow** — a flow above bankfull discharge.

**floodplain** — flat area adjacent to the bankfull channel at the elevation where flows overtop the bankfull channel; land adjacent to a channel at the elevation of the bankfull discharge, which is inundated on an average of about two out of three years.

**fluvial** — of, pertaining to, or inhabiting a river or stream; formed or produced by the action of flowing water.

**groundwater flow** — water that moves through the subsurface soil and rocks.

**habitat** — the spatial structure of the environment that allows species to live, reproduce, feed, and move; provide necessary elements of life including space, food, water, and shelter.

**hydrology** — study of flows resulting from rainfall; study of the properties, distribution, and effects of water and ice on earth’s land surfaces, in the soil and underlying rocks, and in the atmosphere.

**intermittent stream** — a seasonal stream; is in contact with the ground water table that flows only at certain times of the year as when the ground water table is high and/or when it receives water from springs or from some surface source such as melting snow in mountainous areas; it ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow.

**Manning’s “n” Roughness Coefficient** — an empirical coefficient for computing stream bottom roughness used in determining water velocity in stream discharge calculations.

**meander** — a sinuous channel form.

**meander amplitude** — the width of the meander measured at the center of the bankfull channel and measured perpendicular to the valley.
meander length — also called “wavelength.” The distance, along the creek, between two successive points in the wave that are characterized by the same phase of oscillation.

minimum entrenchment (min entrenchment) — the design minimum allowable value of entrenchment.

morphology — study of shape, form, or structure of, in the case of this report, streams.

100-year depth — the depth of flow at the peak of the 100-year storm.

100-year shear stress — the average shear stress exerted on the channel at the peak of the 100-year storm.

100-year storm — the storm event of such intensity that it occurs only once in one hundred years.

100-year velocity — The average velocity within the channel at the peak of the 100-year storm.

100-year width — The top width of flow during the peak of the 100 year storm.

pattern — as used in this report, the channel’s form as observed in plan view; the channel pattern is described in terms of its sinuosity, belt width, wave length, and related geometric relationships

pebble — stone ½ to 3 in. in diameter, including coarse gravel and small cobble.

pebble count — used to determine particle size distribution by measuring 100 bed particles at specified locations.

perennial stream — one that flows continuously throughout the year.

pool — location in an active stream channel where the water is deepest and has reduced current velocities.

radius of curvature — radius of the circle defining the curvature of an individual bend, measured between adjacent inflection points.

reach — a section of a stream’s length.

regional curve — a plot of bankfull channel dimensions by drainage area.

riffle — a shallow rapid.

riffle to riffle — the distance between consecutive riffles, generally five to seven bankfull widths.

riparian — pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

sediment — fragmental material that originates from weathering of rocks and decomposition and erosion of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

sediment transport — see definition of sediment above.

sinuosity — the amount of curvature in the channel
**stream bank** — side slopes of an active channel between which the stream flow is normally confined.

**streambed** — see definition of bed above.

**stream slope** — riffle crest to riffle crest

**toe** — break in slope at the bottom of a slope.

**top of bank minimum width** — minimum width of top of highest banks.

**top of bank height** — distance from lowest point in channel to top of highest bank.

**velocity** — the rate of motion of objects or particles

**watershed** — an area confined by topographic divides that drains a given stream or river.

**Width/depth ratio (W/D)** — the ratio of the bankfull surface width to the mean depth of the bankfull channel.

**woody debris** — woody material that is introduced into the stream channel.