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Technical Memorandum

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Subject: Concept Restoration Options for Lower Sidney Gulch in Lee Fong Park, Weaverville, California

Purpose of Memorandum

This technical memorandum (TM) provides a summary of conceptual restoration options developed for lower Sidney Gulch within Lee Fong Park, Weaverville CA. It also provides physical description of existing conditions, project goals and objectives, and the restoration design strategy. A draft of this TM was provided to the design review team and discussed at a meeting in Weaverville on May 17, 2012. Based on comments received, a third restoration option was developed and is included in this TM. This TM is intended for review by project stakeholders to assist in selecting a preferred restoration alterative to be developed to the 30% design level.

Introduction

Background

Sidney Gulch is a perennial stream with its headwaters originating near Weaver Bally on Shasta-Trinity National Forest. Sidney Gulch drains into West Weaver Creek within the town of Weaverville. Much of the stream and its tributaries flowing through town are highly urbanized. Like many of the creeks in the area, the streambed and banks were highly disturbed from historic hydraulic mining. Some sections of the stream have been placed in a concrete lined channel while others have riprap-lined banks. Invasive Himalayan blackberry persist in nearly all segments of the stream. Invasive Periwinkle and English ivy are also common riparian components.

Sidney Gulch supports coho salmon, a Federally listed threatened species. However, three migration barriers have been identified within the mainstem of Sidney Gulch that limit the usage of the watershed by coho salmon. The furthest downstream is a concrete lined channel within the US Forest Service (USFS) compound. At the upstream end of the concrete channel is a Caltrans concrete box culvert under Highway 299. The furthest upstream barrier is a corrugated metal culvert on the Weaver Bally Loop Road that has a perched outlet. It is approximately 1,200 feet upstream of the Highway 299 culvert.

Coho have been consistently observed within Sidney Gulch over the last two decades. Presence surveys have been conducted by California Department of Fish and Game and the US Forest Service. Spot sampling in 1986, 1989, 1990, 2000, 2001 and 2002 found young of the year and one year old and older (1+) fish in the stream. Later surveys in 2006 and 2009 also confirmed presence of young of year fish. In 1986, 2001, and 2010, adult coho have been documented attempting to migrate through the USFS concrete channel segment. In the most recent 2010 survey, 10 coho salmon redds were observed from Lee Fong Park to just upstream of Highway 299, all but one of which were located downstream of the USFS compound. Many of those were washed out in winter storms. This is attributed to high velocity flows within a simplified, straight channel. However, some surviving coho fry were observed in the upper reach within Lee Fong Park just below the Bremer Street culvert.

Sidney Gulch Restoration Project Goals

The Sidney Gulch Restoration Project is envisioned as a multi-phased project encompassing the entire channel corridor from West Weaver Creek confluence to upstream of the Weaver Bally Loop Road crossing. The overall goals for the Sidney Gulch Restoration Project are to:

- Create and improve in-stream salmon habitat
- Improve flood conveyance
- Increase riparian cover and diversity of native plant species
- Provide for fish passage
- Create off-channel habitat
- Provide interpretive education about the project and the watershed

For the project area within Lee Fong Park, the project has the added requirement of maintaining the human-based recreation goals of the Weaverville-Douglas City Parks and Recreation District.

Phase 1 Project Need

There are no fish passage barriers within, or downstream of, Lee Fong Park. Due to barriers upstream, the channel reach within the park is the most utilized by spawning and rearing coho salmon. The existing channel conditions within the park are non-ideal for coho salmon. This reach was historically hydraulically mined and is characterized as relatively incised, producing high shear stresses that may coarsen the bed material and scour redds. The channel bed is comprised of very coarse gravels and cobbles that are larger than typically used by coho salmon for spawning, and larger than the bed material found upstream of Highway 299. The channel also has few deep pools due to its relatively simplistic morphology. Portions of the channel lack adequate riparian shade and invasive vegetation is dominant within the riparian areas.

The approximately 1,600-foot long reach of Sidney Gulch within Lee Fong Park provides an excellent channel restoration opportunity to improve geomorphic function and salmonid habitat suitability. The site is relatively unconstrained, with minimal infrastructure encroaching on the channel. This reach maintains perennial streamflow, unlike the urbanized reaches further upstream. The park setting also provides an opportunity for public education and involvement in restoration activities. For these reasons, phase 1 of the large Sidney Gulch Restoration Project focuses on restoring the reach flowing through Lee Fong Park

The Five Counties Salmonid Conservation Program (Five Counties) retained Michael Love & Associates, Inc. (MLA) to develop conceptual design options for restoring the Lee Fong Park reach. MLA has teamed with Graham Matthews and Associates (GMA) to accomplish this task.

Field Activities

Topographic Survey

A topographic survey of the project area was conducted by GMA in April of 2011. The survey consisted of data collection sufficient to create detailed topography of 1,600 feet of channel and approximately 100 feet width of overbank on both sides. The survey included channel thalweg and location and species identification of all trees larger than 4 inches in diameter. The survey also captured high water marks evident from a March 20, 2011 high flow event.

The survey was conducted using a combination of RTK-GPS and a total station. Vertical and horizontal control was obtained through an OPUS solution and checked against benchmarks on Highway 299. Survey data was prepared in horizontal datum California State Plane Zone 1 NAD83 in US feet, and NAVD88 vertical datum in US feet. The survey data was used to create a topographic basemap with a contour interval of one foot. Approximate property line locations where provided by Five Counties and are shown on the basemap.

Geomorphic Mapping

MLA performed a geomorphic assessment of the project area on June 23, 2011. The geomorphic assessment included a walk-through of the site, photo-documentation and measurements of the active channel and other geomorphic channel expression. The active channel was identified by a distinct break in vegetation from the annual herbaceous vegetation to perennial woody trees and shrubs and an associated break in slope. Channel bottom width ranged between 8 to 14 feet, averaging 10 feet. Active channel width at the vegetation break varied from 14.5 to 25 feet, averaging approximately 19 feet.

The streambed is composed of very coarse gravels to small cobbles with occasional small boulders. Pebble counts were conducted in three locations by GMA in October, 2011. The median grain diameter (D_{50}) increased from 38.8 mm upstream to 42.5 mm downstream. The D_{84} grain size (84% of all particles are smaller than this particle size) increased from a diameter of 62.4 mm upstream to nearly 90 mm downstream. Results of the pebble counts are presented in **Attachment 1**.

Hydrology

Sidney Gulch is a relatively small stream with its upper watershed in the transitional rain-snow elevations. It drains the lower southeast side of Monument Peak north of Weaverville and elevations within the watershed range from approximately 4,500 feet at its peak to 1,950 feet at the confluence with West Weaver Creek. The contributing drainage area to the project reach is 6.33 square miles, with the majority of the watershed is within Shasta-Trinity National Forest. The town of Weaverville encompasses about one square mile of the lower watershed.

There are no historical streamflow records available for Sidney Gulch or its tributaries. Investigations into the USGS gaged streams within the region found that they are all hydrologically dissimilar to Sidney Gulch, with dramatically different drainage areas or elevations, and not suitable for use in estimating flow frequencies for the project reach. Therefore, alternative indirect methods were used to provide a preliminary estimate of flows and associated return periods in Sidney Gulch.

Estimated Peak Flow Hydrology

Five Counties prepared an analysis of peak flows for Sidney Gulch at Lee Fong Park using the North Coast Regional Regression Equations (Waananen and Crippen, 1977) and the Rational Method. Watershed parameters for the regional equations included an altitude index of 2.71 and a mean annual precipitation of 38.4 inches. A runoff coefficient (K) of 0.45 was used for the Rational Method, with a time of concentration of 45 minutes and a 4-hour rainfall intensity of 0.94 inches per hour. Peak flows for a range of return periods are presented below (**Table 1**). With both the regional equations and the Rational Method there is a large amount of uncertainty associated with these flows.

A Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) were recently prepared for Trinity County by the Federal Emergency Management Agency (FEMA, 2010a and b). Sidney Gulch is designated in the FIS as Middle Weaver Creek with a drainage area of 6.43 square miles at the confluence with West Weaver Creek. The FEMA FIS used a 100-year flow of 2,110 cfs.

Table 1. Summary of peak flows for Sidney Gulch at Bremer Street computed using various methods for the 6.33 square mile drainage area of Sidney Gulch.

Method	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Regional Equations	298 cfs	508 cfs	716 cfs	991 cfs	1,308 cfs	1,582 cfs
Rational Method	-	-	-	-	-	1,713 cfs
FEMA (2010)	-	-	-	-	-	2,110 cfs

Streamflow Monitoring

As part of a separate contract, GMA has established two stream gaging stations on Sidney Gulch. One is located just upstream of the Bremer Street culvert and another is located upstream of Weaver Bally Loop Road. The stations were established in winter of 2012 and captured the peak flow of water year 2012, that occurred on March 27th and was approximately 200 cfs (Graham Matthews, personal communication).

In addition to the stream gaging station, Five Counties has installed and are maintaining five crest gages within the Lee Fong Park reach. These gages record peak water surface elevations associated with individual runoff events.

Results from these monitoring efforts are expected to substantially improve the accuracy of predicted flows and associated return periods for use in the next phase of project development. The crest gage data, combined with the gaged flows, will also assist in better defining the hydraulic roughness coefficients for the channel at various flows, which will be useful in developing final channel designs.

Existing Hydraulic Conditions

FEMA 100-year Flood Elevations

The project area is mapped in the FIRM as Zone AE, indicating that the water surface elevations are provided for the 100 and 500-year flood events. The modeled water surface profile and FIRMETTE of the project area are show in **Attachment 2**.

The inundation areas and water surface profiles associated with the FEMA 100-year flood (baseflood) are provided in the FIRMETTE and FIS, respectively. The FIRMETTE shows a designated floodway and floodplain within the park. The floodway includes the channel and riparian areas and some of the adjacent overbank areas. The baseflood causes floodplain inundation across much of the park on both sides of the channel. The baseflood also inundates the Verizon work-yard and fire station parking lot.

At the pedestrian bridge within the Park, the baseflood elevation is approximate 1,980 feet. The surveyed bottom elevation of the pedestrian bridge is 1,980.1 feet, providing effectively no freeboard between the bottom of the bridge and the baseflood elevation.

Because the project reach is mapped Zone AE, any stream channel improvements will likely require a FEMA map revision. The process of FEMA map revision must be initiated prior to implementation of the project.

Hydraulic Analysis of Existing Conditions for Geomorphic Assessment

Trinity County Department of Public Works prepared an existing condition steady-flow HEC-RAS hydraulic model of the project area. This model was prepared prior to location of the FEMA FIRM map prepared for the project area. The County-prepared model was developed using cross sections at riffles selected by MLA from the topographic survey. Cross sections were spaced 30 to 70 feet apart to reflect horizontal and vertical changes in the channel geometry. HEC-RAS cross sections are labeled based on channel centerline stationing.

MLA adapted the County-prepared hydraulic model to assess additional flows ranging from 110 cfs to 508 cfs, which is approximately the 5-year flow event predicted by the regional equations (Table 1). The purpose of the hydraulic analysis was to:

- Verify and supplement the geomorphic field measurements including flow widths, depths, width-to-depth and entrenchment ratios,
- Identify the flow associated with the field-measured active channel widths and depths,
- Identify the flow associated with the March 20, 2011 high water mark, and

- Quantify the flows that produce shear stresses sufficient to mobilize bed material within the channel.

Model Setup

Several changes to the County provided HEC-RAS model were made to make it suitable for evaluating frequently occurring high-flows used in the geomorphic analysis. This included moving the bank markers to the top of the active channel, where there is a distinct break in the presence of woody vegetation. The hydraulic roughness coefficients for the active channel were estimated using methods outlined by Thorne and Zevenbergen (1985) and Limerinos (1970). These methods account for the wetted channel geometry and water surface slope at a given flow and characteristic size of the bed material. The hydraulic roughness at 200 cfs was determined using the pebble count data. The predicted Manning's roughness coefficients between cross sections ranged from 0.034 to 0.040. The modeled channel roughness values were increased slightly to values of 0.045 in the upstream reaches and 0.050 in the downstream reaches to account for the presence of riparian vegetation within the flow area and occasional wood obstructions in the channel. Outside the limit of the active channel, roughness values were set at 0.08 to reflect light brush and trees in the riparian areas (Chow, 1959).

Levee markers were added to the model as appropriate to exclude flows from isolated swales adjacent to the channel and the bioswale near the parking lot. Contraction and expansion coefficients were set at 0.3 and 0.5 respectively, to reflect the abrupt changes in flow energy between cross sections (ACOE, 2010).

The model simulations used mixed-flow with upstream and downstream boundary conditions set to normal depth with a slope of 0.010 ft/ft. In addition to the 2 and 5-year flows computed using the regional equations, the model was run for a range of flows corresponding to the measured active channel widths and depths and the field surveyed high water marks.

Existing Conditions Model Results

Model results indicated that the flow that fills the field-measured active channel is approximately 110 cfs, which is only a third of the estimated 2-year peak flow computed using the regional equations. The high water marks from the March 20, 2011 event corresponded to a flow of approximately 300 cfs, approximately the predicted 2-year peak flow. The overall water surface slope associated with the high water marks was 1.4%. Flows of approximately 300 cfs begin to inundate the existing floodplain benches within the upstream reaches of the project area.

Detailed results of the HEC-RAS modeling are presented in **Attachment 3**. Select cross sections located across stable riffles were used to conduct a competency-based sediment transport analysis and to supplement the geomorphic analysis for this project.

Sediment Transport Analysis

The channel bed within Sidney Gulch is characterized by very coarse gravel and small cobbles, with increasing size in the downstream direction. Small gravels and sands are generally lacking on the surface of the channel bed.

A competence-based sediment transport analysis of the existing channel was conducted to:

- Estimate the flow which the streambed becomes mobilized, and
- Identify areas of excessively high shear stresses that may cause export of gravels, deep bed scour and redd scour.

Flow competence is a measurement of a flow's ability to mobilize or entrain a given size sediment particle and is typically evaluated using channel shear stress. If the shear stress is greater than the entrainment shear stress of the particle, it will be mobilized. The entrainment shear stress for a given particle can be estimated using the Shields Equation and an estimate of critical dimensionless shear stress. Channel shear stress was obtained from the HEC-RAS results at stable riffle cross sections. A critical dimensionless shear stress value of 0.05 was used, which reflects typical gravel bed conditions with a minimal amount of sand (Buffington and Montgomery, 1997).

The sediment transport analysis was conducted assuming the "Equal Mobility Theory," which postulates that once the median diameter (D_{50}) grain size is moved in a stream channel, the entire bed has mobilized, including the larger particles (Parker et al., 1982). The mobility of the D_{84} particle was also computed for comparative purposes.

The results of the sediment transport analysis are presented in **Attachment 4**. Flows of 110 cfs generate shear stresses that are close to, or just above, those needed to mobilize the D_{50} of the bed. Flows between 200 and 300 cfs have the competence to move the D_{50} particle and the D_{84} particle size. This is consistent with observations by Graham Mathews, who reported the bed was mobile during the approximately 200 cfs discharge measurement taken in March 2012.

Existing Channel Geomorphology

Field observations and the results of the geomorphic and hydraulic analyses indicate that the Lee Fong Park Reach can be divided into two channel segments. The upstream channel segment extends from the Bremer Street Culvert to approximately 650 feet downstream, ending at a downed tree spanning the channel adjacent to the fenced lot on the east side of the channel. Downstream of this location the channel becomes more confined and straighter. The downstream segment of the channel extends for approximately 900 feet, from the downed log to the downstream end of Lee Fong Park opposite Lower Mill Street.

A plan map of the existing channel, thalweg profile with surveyed baseflow and highwater marks, and summary of measured and modeled geomorphic parameters is provided in **Attachment 5**. The plan map shows species and diameter of the lager trees, which are defined as alders with a diameter at breast height (DBH) of 12 inches or greater, cottonwoods with a DBH of 10 inches or greater, and black locusts with a DBH of 12 inches or greater.

Upstream Channel Segment (Bremer Street Culvert to Station 9+00)

The planform of the upstream channel segment is slightly sinuous, with gentle meander bends and small floodplains on the inside of the bends. The channel segment has an overall slope of 1.6% and can be classified as a pool-riffle channel (Montgomery and Buffington, 1997). Channel bed material consists primarily of very coarse gravels with occasional cobbles and small boulders. Jams formed by downed trees are an infrequent feature within and adjacent to the stream channel. Small gravel depositional areas are associated with downed wood, overhanging trees and undulations in the streambank.

The channel planform consists of three alternating meander bends spaced 220 to 240 feet apart. The amplitude of the bends creates an overall channel corridor width ranging from 80 to 120 feet. Within the channel corridor, the channel top width is approximately 30 feet and bordered on one or both sides by a floodplain ranging from a few feet to 85 feet in width. Typical floodplain widths are 15 to 25-feet. The entrenchment ratios (5-year flow width divided by the 2-year flow width) range from 1.2 to 2.8, with an average of 1.7. These values indicate the flow expands out of the channel and onto the small floodplain during larger flows.

In this stream segment, the channel profile consists of a diversity of riffles, runs, pools, and glides. Much of the diversity is forced by standing trees and their roots, as well as occasional downed wood in the channel. Some of the deeper pools occur at sharp channel bends, where trees provide bank stability, forcing a scour pool. Pool lengths typically range from 30 to 100 feet with residual depths from 1 foot to greater than 2 feet.

A narrow riparian corridor is present along the channel and floodplain. Beyond the riparian corridor is a relatively flat terrace. The park is on the terrace to the west of the channel and a commercial parking lot on the east side. The riparian corridor consists of mature cottonwood, alder and non-native black locust trees. The understory is sparse and consists primarily of invasive blackberry bushes, vinca vine and English ivy on the floodplains.

The upstream channel segment is moderately stable, and provides both planform and channel profile diversity that is beneficial for fisheries habitat. Bank erosion was observed within the downstream section of the meander bend on the east side of the stream channel adjacent to the parking area for the fire station (near station 11+75). Bank erosion is also evident on the west side of the stream near Station 10+00 adjacent to the park walking path. Riprap has been placed in this location to protect the adjacent park path. The 18th hole for the disc golf course is located on the west streambank near station 11+25 and confines the floodplain width in this reach of channel.

Downstream Channel Segment (Station 9+00 to Lower Mill Street)

The downstream channel segment provides substantially less in-stream and riparian habitat diversity. It is much straighter than the upstream segment, containing only two meander bends within the entire 900-foot stretch of channel. The channel corridor width is substantially narrower than upstream, with widths ranging from 40 to 70 feet. The overall slope of this channel segment is approximately 1.3%. In comparison to upstream, the size of the channel bed material notably increases to include more cobbles and small boulders. There is little downed wood within or adjacent to the stream channel and few gravel depositional features.

Flow widths at the 2-year flow of 300 cfs are narrower than the upstream channel segment, and flow depths are deeper, resulting in smaller width-to-depth ratios than upstream. Five-year entrenchment values are also smaller than the upstream reach, with an average value of 1.3, indicating that the channel is highly entrenched with no available floodplain at higher flow events. This creates higher in-channel shear stresses and sediment transport competence at lower flows than the upstream channel segment. The observed increase in channel bed material size and lack of depositional features suggests that smaller gravels delivered from upstream are transported through this channel segment.

The channel profile is more uniform than upstream, with substantially longer riffle/run features and fewer pools that are shorter and shallower. There are two deeper pools within this segment associated with a meander bend and a wood jam across the channel.

The riparian corridor adjacent to this segment of stream channel is limited, and consists mainly of isolated black locust trees. The understory is sparse and consists of invasive Himalaya blackberry bushes on the banks, though low willows are present at the streambank toe along some portions of the channel. The terrace beyond the channel corridor is part of the actively used park. The park pathway runs along the western edge of the channel corridor.

Restoration Objectives and Strategies

Restoration of the Lee Fong Park reach of Sidney Gulch should aim to create and improve in-stream spawning and rearing habitat for coho salmon. This can be accomplished by increasing the geomorphic and riparian complexity within the channel corridor. Specific objectives include:

Adult Salmon

- Increase frequency and distribution of riffles that contain spawning-sized gravels

Rearing Juvenile Salmon

- Increase accessible slack-water habitat
- Increase pool frequency and size
- Increase bank complexity
- Increase riparian canopy where needed (reduce summer water temperatures)

The field investigations, geomorphic analyses and hydraulic modeling indicate the following actions will contribute to meeting project objectives:

- Increase width of channel corridor through the downstream channel segment
- Increase area and distribution of floodplains within the channel corridor
- Increase channel connectivity to existing floodplains within the channel corridor
- Increase floodplain complexity to support and maintain side channels and backwater alcoves
- Increase in-channel roughness, gravel retention, bed diversity, pool frequency, and bank complexity through:
    - Addition of large wood within the channel
    - Increased channel sinuosity
- Reduce fine sediment inputs through stabilization of eroding and oversteepened banks
- Increase native riparian vegetation, remove non-native vegetation, and increase riparian canopy within the channel corridor

The restoration strategies presented in this TM are intended to achieve project objectives while being compatible with Park use and property constraints and avoiding excessive short-term impacts to this important coho salmon stream. The design strategies included minimizing removal of mature riparian trees; especially native species and limit construction impacts to the active channel. This may be accomplished by focusing efforts on floodplain modifications and designing new channel segments so they can be constructed in the dry, away from the existing channel.

Conceptual Design Development

Reference Reach

The reference reach approach to channel design uses an appropriately selected stable channel reach within the project stream as a template to establish channel and floodplain geometry for the design reach. Use of a reference reach helps ensure the design channel is geomorphically stable and has the physical attributes to support the geomorphic processes that create the desired habitat diversity.

The upstream reach between the Bremer Street culvert and station 9+00 is more complex and was identified as the best reference reach for the project. The geomorphic analysis identified this reach as moderately stable and providing geomorphic variability that is lacking in the downstream reaches. Therefore, the geomorphic parameters measured in the reference reach were used as a starting point for determining channel size and floodplain widths for the proposed improvements.

Project Corridor Geometry

Channel and Floodplain Dimensions

In general, design channel dimensions are developed to contain a specific flow, usually the "bankfull flow". At bankfull flow, the channel bed is typically fully mobile. As flows increase above bankfull flow, water begins to inundate adjacent floodplain surfaces. This limits the degree to which channel shear stress and velocities increase with increasing flows. The return frequency of bankfull flows is commonly between 1.2 and 1.7 years, but can vary regionally (Leopold and Wolman, 1964). Although this approach oversimplifies the variability in the channel and overbank surfaces, it serves as a fundamental starting point for developing the channel design.

The bankfull flow selected for the conceptual design was based on the hydraulic conditions within the reference reach. As previously discussed, the channel bed becomes fully mobile at approximately 200 cfs. The return frequency for this flow is estimated to be approximately 1.5 years and will serve as the bankfull flow for conceptual design. This design flow may be adjusted as the project moves forward, more detailed hydraulic analysis are conducted, and data from the 2012 streamflow gaging activities become available.

Using 200 cfs for a bankfull flow will result in lower floodplain benches than are currently present in the reference reach. The reference reach does not experience incipient inundation of its floodplains until flows reach nearly 300 cfs, approximately the 2-year flow. Therefore, the design floodplain would be approximately 0.5 to 1.5 foot lower than the floodplains in the reference reach, resulting in more frequent inundation.

Channel dimensions for the 200 cfs flow and were obtained from the HEC-RAS model results for select cross sections within the reference reach. Because the floodplains in the reference reach fully inundate during a 5-year flow event, the 5-year flow top width was used to define the desired floodplain width within the channel corridor. The channel corridor width and planform geometry were obtained from the topographic map of the reference reach. The active channel bottom width was obtained from field measurements. **Table 2** summarizes the geomorphic parameters used to develop the conceptual design options for the Lee Fong Park reach of Sidney Gulch.

Table 2. Summary of geometric parameters for the bankfull channel and floodplain used to develop conceptual options.

Active Channel Bottom Width	10 feet
Bankfull Flow Width	25 feet
Maximum Channel Depth at Bankfull	2.5 feet
Flow Width at 5-Year Flow (Combination of Channel and Floodplain)	50 feet

Side Channel and Alcove Design

Side channels, or cut-off channels, can be located on existing and constructed floodplains where the planform and bedform of the channel are conducive to their formation. They often originate at heads of riffles on the outside of a meander bend and begin conveying water at flows substantially lower than the bankfull flow. The water flows across the floodplain in a small channel or swale. The side-channel is relatively straight, giving it a shorter length and therefore steeper overall slope than the main channel. The downstream end of the side channel joins the stream near the downstream end of the meander. During larger flood events, the side-channel concentrates floodplain flows. At its terminus, the steeper water surface slope provides the energy to scour a pool in the main channel and potentially scour an alcove extending into the floodplain. These processes can create desirable pools and backwater habitats for fish.

For the project reach, side channels could start conveying water at the active channel flow of approximately 100 cfs. A large wood structure would span the side channel near its head to help maintain this elevation and reduce the risk of channel avulsion (main channel capturing the side channel). Large wood features should also be placed along the length of the side channel to create roughness, slow the water, and create floodplain diversity. The addition of large wood cover structures along the edges of the alcove would be used to increase the value of fisheries habitat.

Large Wood Structures

In addition to the large wood used in the side channels and alcoves, large wood structures should be placed throughout the project area to serve multiple functions. Placed along streambanks and protruding into the main channel, they act as roughness elements that create flow diversity that leads to scour pools and eddies that sort and deposit gravels. These structures may also be designed specifically to deflect flow away from a steep bank. Large wood should also be placed as bank armoring at sharp bends in the channel to force pools and channel sinuosity.

Because the project is in a FEMA designated floodway and that there are residential properties downstream of the project, all wood structures would need to be designed to be secure and resist forces associated with buoyancy and water velocities. Much of the wood would likely be anchored to large rock buried into the floodplain or streambank. Other wood structures may be secured by burying enough of the wood to keep them from mobilizing. Anchoring using driven or drilled woodpiles may not be cost effective given the coarseness of the material in the banks and floodplain.

Restoration Recommendations

Based on results of the geomorphic and hydraulic assessments of existing conditions, restoration recommendations for Sidney Gulch were broken into three distinct reaches as follows:

Reach 1 extends from the Bremer Street crossing to station 9+00, encompassing the upstream segment described in the geomorphic assessment.

Reach 2 extends between station 9+00 to 6+00, ending just downstream of the Verizon work-yard.

Reach 3 extends from stations 6+00 to the downstream end of the park.

There are various restoration elements within each reach, such as floodplain grading, bank grading, and construction of side channels. Many of these restoration elements are independent of one other, allowing for a selective approach to the restoration components. For Reach 3 there are three distinctly different alternatives, with each alternative having multiple restoration elements.

Attachment 6 presents a plan view and typical cross sections for restoration recommendations at each of the channel reaches.

All Reaches: Invasive Plant Species Removal and Riparian Enhancement

It is recommended that the Park continue their efforts to eradicate invasive plants such as Himalayan blackberries, vinca vine, English ivy, scotch broom and black locust trees, while at the same time increasing the width and density of the riparian under- and over-story with native plants.

Implementation of the project will necessitate the removal of several large trees. Where possible, black locust trees were targeted for removal and larger alders and cottonwood trees should remain and be protected. Though invasive, not all black locusts should be removed because they provide considerable riparian canopy. Over time, when the new native riparian trees become more established, these invasive trees should be removed by the park and replanted with native species.

Reach 1 Improvements

The geomorphic and hydraulic analysis showed that Reach 1 is moderately stable and provides both planform and profile channel complexity for fisheries habitat. The observed bank erosion is from natural channel adjustments that are beginning to affect the land-use of the adjacent park to the west.

Improvements in this reach focus primarily on enhancing fisheries habitat by increasing channel and floodplain complexity and stabilizing eroding banks. This can be accomplished by lowering the existing floodplains, making new small floodplain benches, constructing floodplain side channels, swales, and alcoves, installing large wood features, and laying back eroding banks. Lowering the floodplains to increase their conveyance during more frequent flows will reduce the erosive pressure on the outside of the meander bends.

Floodplain and Side Chanel Enhancement

Station 11+50 to 13+00: The existing floodplain at meander bend 12+50 is approximately 40 feet wide. Though larger cottonwoods line the stream channel, the central portion contains grass and scattered trees, several of which are dead. A new side channel and floodplain area can be constructed through the grassed area without disturbance to adjacent large living trees. Construction of the side channel at 12+50 would necessitate the removal of two dead trees: a 14-inch cottonwood and a 12-inch alder. To form an alcove at the outlet of the side channel, a 12-inch alder would be removed.

18th Hole Disc Golf: The 18th hole for the disc golf is located on the west streambank near station 11+25 and confines the floodplain width in this reach of channel. Removing the stacked rock retaining wall and fill behind the wall would help to re-establish the floodplain within this area. It appears that the floodplain under the fill is at the desired elevation and would not need to be lowered.

Station 9+50 to 11+25: The back of floodplain at meander bend 10+50 is covered with a dense thicket of invasive blackberries. The central portion of the floodplain contains large cottonwood trees. A new side channel and lowered floodplain area can be constructed along the back of the existing floodplain without disturbance to the adjacent larger trees. Construction of the side channel at 10+00 would not require removal of any large trees, but may necessitate the removal of several small alders. The wood from these trees can be salvaged and reused for wood habitat structures.

Bank Grading and Stabilization

Meander Bend at 12+50: The bank erosion observed on the outside of the meander bend between stations 11+00 and 12+60 can be addressed by constructing a narrow floodplain bench and laying back the upper bank to support a riparian area. The bank erosion between stations 12+00 and 12+50 extends onto the adjacent private property. This area contains a paved and dirt parking area used by the fire station. To minimize loss of parking and maintain the existing asphalt, a 2H:1V slope may be necessary. Where the channel moves farther away from the parking lot, the upper bank side slopes can be laid back to a gentle angle more suitable for sustaining riparian vegetation. It is not expected that the floodplain and bank grading would affect an existing buried gravity sewer line in this area due to the depth of the line.

Trees along the channel margin would be retained within this area through minor adjustments in grading. The bank grading would require the removal of several large locust trees and several small alder trees.

Station 10+00: Stabilizing the oversteepened and eroding streambank near station 10+00 is constrained by the presence of several large cottonwood trees. This area has been partially riprapped to reduce bank erosion. Removal of this riprap and replacement with a wood revetment composed of logs and root wads placed along the channel toe would deflect the main flow away from the bank and protect it from erosion. The wood deflectors would also create local pools and cover for fish. The upper banks could be graded to a stable slope and planted with native riparian vegetation. The removed riprap can be salvaged to anchor large wood structures and for augmentation of the riprap around the abutments of the existing pedestrian bridge.

The installation of the large wood revetment and upper bank grading would require the removal of several large locust trees. It may also necessitate a slight relocation of 120 feet of graveled pathway.

Reach 2 Improvements

Upstream Portion of Reach 2 (Stations 7+50 to 9+00)

The upstream portion of Reach 2 is confined on both sides. The east side is confined by a chain link fence and Verizon work-yard. The west side of the stream is confined by the park pathway, several large cottonwoods and the historic orchard.

Improvements in this reach focus primarily on creating floodplains adjacent to the existing stream channel and widening the channel corridor as much as possible within the given constraints.

Western Streambank: A floodplain bench with widths ranging from 8 to 20 feet could be constructed adjacent to the existing stream channel. The pathway and orchard trees near the downstream end of this area limit the area available for grading.

Most trees can be retained along the channel margins and it is not expected that any large trees would be removed. It will be necessary to relocate approximately 130 feet of graveled pathway if grading is performed in this area.

Eastern Streambank: A floodplain bench with a width of approximately 5 to 10 feet could be graded adjacent to the existing stream channel. The upper streambank could be laid back at a 2H:1V to 3H:1V slope, ending at the fence line. This will slightly widen the channel corridor throughout Reach 2.

Most of the existing trees along the eastern channel margin can remain with minor adjustments in grading. It is not expected that any large trees would be removed for construction of the floodplain and bank grading.

Downstream Portion of Reach 2 (stations 6+00 to 7+50)

The downstream portion of Reach 3 is located in a small meander with a small floodplain on the western streambank that begins to inundate between the 2- and 5-year flow events. The eastern channel bank, located on the recently acquired park property, is unstable and covered with invasive vegetation.

Western Streambank: The existing floodplain could be lowered to increase the frequency of inundation and extended upstream to increase overall floodplain area. A side channel could be constructed within the lowered floodplain to create additional overbank flow conveyance and habitat diversity. The back of the enhanced floodplain can be located at the toe of the slope, preserving several large trees growing on the slope. Most of the existing trees along the eastern channel margin would remain with minor adjustments in grading of the floodplain.

Grading on the upper bank between stations 7+00 and 7+50 would increase the channel corridor width on the west side of the channel. To achieve the upper bank grading, removal of a locust clump a 16-inch locust and several small trees would be necessary. An existing orchard tree near the park pathway limited the extents of grading and path relocation in this area.

Eastern Streambank: On the eastern side of the channel, continuing from upstream, the oversteepened bank will be laid back to a 3H:1V side slope and revegetated. At Station 6+25, the channel currently makes a sharp bend, creating a deep pool and causing active bank erosion. To maintain the pool but stop the erosion, a large wood deflector with rootwads would be installed into this over-steepened bank. This will increase pool complexity and armor the bank.

Reach 3 Improvements

Reach 3 begins just downstream of the Verizon work-yard and ends at the downstream end of the park. The geomorphic assessment documented the over-simplified nature of this reach and lack of riparian canopy.

Reach 3 is less constrained by adjacent private properties or infrastructure. Relocation of the pedestrian bridge in the middle of Reach 3 was considered, but determined undesirable given cost and relative benefit. The existing bridge location did not dramatically affect the developed alternatives. The orchard and park pathway that run along the western side of the channel to the bridge, diverge away from the channel downstream of the bridge allowing more flexibility and variability with floodplain design and bank grading. The eastern side of the stream channel is also less constrained in the upper portion of this reach; however, private property in the downstream portion of this reach may limit restoration opportunities.

Restoration Alternatives

Because of the additional space available in Reach 3, three distinctly different restoration alternatives were developed

Restoration Alternative 1 focuses on improving the geomorphic function of the channel by providing floodplain flow access and widening the channel corridor while maintaining the existing channel. This alternative would continue the widening of the channel corridor from upstream and new floodplains would be constructed. Fisheries habitat would be improved by creating planform and channel profile diversity with the placement of large wood structures that create flow complexity, create scour pools and retain stream gravels.

The large wood would be placed to direct the flow and encourage lateral channel migration to increase sinuosity within this very straight section of channel.

Restoration Alternative 2 focuses on improving geomorphic function by restoring the channel and floodplains to a more stable geometry similar to the reference reach. This would involve realigning continuous segments of the channel to increase hydraulic diversity and roughness, leading to a more geomorphically stable channel planform, cross section, and profile. This alterative would include construction of new floodplains and continue the widening of the channel corridor from upstream. Large wood structures would be integrated into the reach to support the desired flow patterns, and create channel bed and bank complexity. The diversity of channel features (riffles, pools, alcoves) would provide productive fisheries habitat.

Restoration Alternative 3 contains similar elements as Alternative 2, but with the addition of a broad floodplain along the east side of the channel within the Park property. The floodplain will contain a side channel and alcove, large wood features and an extensive riparian area. The floodplain and side channel will increase the channel conveyance and reduce erosive pressure on the streambanks as well as create additional complex floodplain and side-channel fisheries habitat. The floodplain and side channel would extend around the eastern bridge approach, reducing the flow constriction created by the bridge crossing during large streamflows.

Restoration Alternative 1

The focus of restoration Alternative 1 is to substantially increase the amount of floodplain and channel corridor width while maintaining the existing stream channel.

Upstream of Pedestrian Bridge (Stations 6+00 to 3+00)

Eastern Streambank: A new floodplain with a width ranging from 15 to 40 feet can be constructed along the existing channel in this area. The upper bank can be laid back to a gentle slope, allowing establishment of riparian trees. To avoid an abrupt flow contraction and potential streambank instability near the pedestrian bridge, the floodplain width and upper bank grading would taper inwards to meet the exiting channel approximately 50 feet upstream of the bridge.

Most of the existing trees along the channel margin would remain with minor adjustments in grading. This would contribute to variability in the floodplain surface and along the channel margins. To achieve the floodplain grading, a 12-inch locust tree would likely be removed.

Western Streambank: The oversteepened streambank could be laid bank to support riparian vegetation and continue the riparian corridor widening from upstream. Near Station 5+50, an existing orchard tree near the park pathway limits the extent of grading and path relocation. Similar to the eastern bank, the grading would taper inwards to meet the existing channel approximately 50 feet upstream of the bridge.

To grade this bank, realignment of approximately 180 feet of park path and removal of several large locust trees at the top of the streambank will be required. The bank grading near the channel toe can be adjusted to protect the existing willows and alders that provide channel shade and bank stability.

Downstream of Pedestrian Bridge (Stations 6+00 to 3+00)

Eastern Streambank: A new floodplain with a width ranging from 10 to 20 feet could be constructed adjacent to approximately 100 feet of stream channel, extending from the pedestrian bridge downstream to the edge of the park property. The upper bank could be laid back to allow establishment of riparian vegetation. Similar to upstream, the floodplain and bank grading would begin approximately 50 feet downstream of the pedestrian bridge crossing to avoid an abrupt flow expansion and potential streambank instability near the bridge.

Most of the existing trees along the channel margin would remain with minor adjustments in grading. It will be necessary to relocate the existing disc golf hole downstream of the bridge.

Western Streambank: A new floodplain with a width ranging from 10 to 25 feet could be constructed adjacent to approximate 300 feet of stream channel, extending from the pedestrian bridge downstream through the existing meander bend. Lowering the floodplain within the existing meander bend at the downstream limit of the project area will reduce the erosive pressure on the eastern streambank. The upper bank at the back of the constructed floodplain could be laid back to allow establishment of a riparian area.

Most of the existing trees along the channel margin, including several cottonwoods would remain with minor adjustments in grading. Several larger locusts near the downstream portion of the project area would be removed. A slight relocation of an existing disc golf tee may also be necessary to move it away from the top of the new channel bank.

Restoration Alternative 2

The focus of restoration Alternative 2 is to improve geomorphic function by restoring the channel and floodplains to a more stable geometry similar to the reference reach. The restoration of natural geomorphic function and variability, along with installation of large wood structures, would create a wide variety of spawning and rearing habitat within this reach.

Upstream of Pedestrian Bridge (Stations 6+00 to 3+00)

Upstream of the pedestrian bridge a 150-foot section of new channel would be constructed to form a new meander bend. The meander bend would have a radius of curvature and amplitude similar to the meander bends in the reference reach. The proximity of the bridge and orchard would necessitate aligning the meander bend to the east and filling a portion of the existing channel to create a floodplain. To force the sharp bend in the channel at station 5+00, a sizable large wood deflector would be installed along the western bank to create a large scour pool. A swale and alcove could be incorporated into the floodplain behind the wood deflector.

Trees along the existing channel margin would remain and be incorporated into the streambank and floodplain, creating variability. The floodplain grading will terminate on the downstream end to avoid impacts to a large cottonwood tree.

The oversteepened streambank on the western bank could be laid bank to support riparian vegetation and continue the riparian corridor widening from upstream. Similarly to the east side of the channel, the grading would taper inwards to meet the existing channel approximately 50 feet upstream of the bridge.

The floodplain and bank grading would necessitate removal of three 12-inch locust trees. To grade the western bank, realignment of approximately 180 feet of park path will be required.

Downstream of Pedestrian Bridge (Stations 6+00 to 3+00)

Two meander bends, totaling 300 feet in length, would be constructed downstream of the pedestrian bridge using planform geometry similar to the reference reach. The meander geometry would create a new meander bend on the eastern side of the park, then reverse the direction in the downstream end of the project area, moving the channel away from the private property. The existing channel would be filled to create a floodplain inside of each bend. At the downstream end of the project, a portion of the existing channel could be maintained to create backwater habitat.

Grading of the new meander bends would involve constructing a new channel and filling approximately 200 feet of existing channel to create a floodplain. Trees along the existing channel and floodplain margin would remain and incorporated into the streambank and floodplain grading. Several alder clumps and large locust trees near the downstream portion of the project area would be removed. It will be necessary to relocate the existing disc golf hole downstream of the bridge. An existing disc golf tee at the downstream end of the project area would also need to be moved away from the top of the new channel bank.

Restoration Alternative 3

The focus of restoration Alternative 3 is to further expand improvements in geomorphic function and fisheries habitat within the channel by creating a broad floodplain, extensive side channel, backwater alcove, and broad riparian area in the eastern part of the Park adjacent to the pedestrian bridge. The larger floodplain will mimic the widest floodplains found in the reference reach and provide similar channel and floodplain complexity and flood conveyance.

The new floodplain will extend along the east side of channel starting at the Verizon property line, continue downstream past the existing pedestrian bridge, and then narrow to meet the channel upstream of the private property to the south. At is maximum width, the floodplain will be approximate 100 feet wide. A side channel will extend the length of the floodplain and end in an alcove at the confluence with the main channel. A large portion of the floodplain can be vegetated with a native riparian species.

If Alternative 3 is implemented, it will be necessary to construct a new trail from the pedestrian bridge to the lower-elevation floodplain surface. The trail can be extended across the floodplain and up the new slope to the current elevation of Park. It is recommended that the trail be constructed to provide handicap accessibility (See next section). The new trail can be constructed to cross over the new side channel in the floodplain using a small footbridge. The bottom of the bridge should be located a minimum of one foot above the surface of the floodplain to allow passage of flood debris that could jam under the crossing during annual flood flows.

The construction of the Alternative 3 floodplain will not result in additional removal of large trees. However, it will encroach into the play-area of several holes for the disc golf course. These holes would need to be relocated.

Pedestrian Trail Improvements

An existing rail-car bridge crosses Sidney Gulch in Reach 3. On both sides of the bridge, the trail rises steeply to the bridge deck. The slope of the trail does not meet the Americans with Disabilities Act (ADA) guidelines. Improving the trails to the existing bridge to meet ADA access guidelines may be a desired project component. Additionally, if Alternative 3 were implemented, it will be necessary to construct a new trail from the pedestrian bridge to the new floodplain elevation. Many funding sources for projects such as this require trail improvements meet ADA guidelines.

Accessibility guidelines for outdoor areas, including trails, are presented in draft guidelines prepared by the (United States Access Board, 2009), which is currently out for public comment. Upon acceptance, the Guidelines will be incorporated into the Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines (Unite States Access Board, 2004). The draft guidelines include the follow running-slope (grade) design standards for accessible trails:

- 5% Grade (1H:20V). Any distance.
- Up to 8.33% Grade (1H:12V). Resting intervals no more than 200 feet apart.
- Up to 10% Grade (1H:10V). Resting intervals no more than 30 feet apart.
- Up to 12.5% Grade (1H:8V). Resting intervals no more than 10 feet apart.
- No more than 30% of the total trail length may exceed a running slope of 8.33%.

There are numerous other guidelines for trails including minimum trail width, cross slope, handrails, signage etc. that are not enumerated, but would need to be addressed during design of the project.

The new trail alignments shown in Alternative 3 provide an example of trail alignments that meet the conditions of ADA accessible trail grade.

Hydraulic Performance of Conceptual Design

A primary project objective is to increase channel connectivity to the floodplain and increase floodplain size and flow conveyance to reduce channel shear stresses. The reduction of channel shear stresses, with the addition of channel complexity, is expected to decrease water velocities and increase retention of spawning sized gravel.

Hydraulic Analysis

A preliminary analysis of the hydraulic changes resulting from the proposed design was conducted using select channel cross sections from each reach. A normal-depth hydraulic analysis was performed for existing and proposed conditions at each selected cross section using the WinXSPro numerical model (USFS, 2005). For Reach 3, the analysis was performed for both Alternative 1 and 2 using a cross section in the southern end of the Park. For Alternative 3, the analyzed cross section spans the realigned channel, the new small floodplain on to the west and the larger new floodplain to the east side of the channel.

In WinXSPro, each cross section was subdivided into three segments to define the channel and overbank areas. Existing and proposed channel roughness values were set at 0.045 for Reach 1 and Reach 2 and 0.05 for Reach 3. Overbank roughness was set at 0.080. A water surface slope of 1.4% was used for both existing and proposed conditions in Reaches 1 and 2 and Reach 3 for Alternative 1. A slope of 1.3% was used for the assessment of design conditions for Reach 3, Alternatives 2 and 3. The lower slope is due to the added channel length created by the increased sinuosity. Hydraulic conditions were assessed for flows up to 800 cfs, which is slightly larger than the 10-year peak flow.

Detailed results for additional flows are presented in **Attachment 7**. In general, flow conditions are relatively unchanged up to the bankfull flow of 200 cfs. As flows increase above 200 cfs the proposed hydraulic characteristics begin to diverge from existing.

At the 5-year peak flow of 508 cfs the differences between existing and proposed are clearly illustrated (**Table 3**). Reach 2, the most constrained reach, shows the smallest change in wetted width and shear stress. Alternative 3 for Reach 3 shows the largest changes, with a 43.8% reduction in channel shear stress and nearly tripling of the wetted width.

Table 3. Wetted widths and channel shear stress at the 5-year peak flow of 508 cfs for existing and proposed conditions at selected cross sections in each reach.

Reach	Wetted Width		Channel Shear Stress		
	Existing	Proposed	Existing	Proposed	Reduction
Reach 1	35 ft	60 ft	2.2 lbs/sf	1.9 lbs/sf	13.6%
Reach 2	25 ft	48 ft	2.7 lbs/sf	2.5 lbs/sf	7.4%
Reach 3					
Alternative 1	27 ft	51 ft	2.8 lbs/sf	2.5 lbs/sf	10.7%
Alternative 2	27 ft	51 ft	2.8 lbs/sf	2.3 lbs/sf	17.8%
Alternative 3	27 ft	160 ft	3.2 lbs/sf	1.8 lbs/sf	43.8%

Construction Logistics

Earthwork

Table 4 summarizes the amount of material that will be excavated from the project area for the three alternatives presented. Project costs can be reduced substantially if the volume of material excavated from the project area can be disposed without transporting off-site. During the project design review meeting held on May 17 2012, members suggested that the excavated material could be placed in the recently acquired field accessible from Lower Mill Street to construct a more complex disc golf course. The area of the park accessible from Lower Mill Street is approximately 3 acres, excluding the area of the floodplain in Alternative 3. However, it appears that a substantial portion of the area may be wetland which cannot be disturbed. **Table 4** presents the depth of placement if the excavated material were placed in an approximate 1-area area. Rather than uniformly filling the area, playability of the disc golf course could be enhanced by using the excavated materials form a more complex terrain.

Table 4. Amount of material that would be excavated for the three alternatives and the depth of placement if the material were placed uniformly within a 1-acre area.

Alternatives Implemented	Material Excavated	Depth of Placement
Alternative 1, All Reaches	4,600 cy	2.9 feet
Alternatives 1 & 2	5,700 cy	3.5 feet
Alternatives 1 & 3	11,000 cy	6.8 feet

Placing more than approximately 11,000 cy of fill material within this area of the Park could become infeasible due to space limitations and would need to be hauled off-site. If excavated material requires hauling off-site, the costs to haul this material could be up to 2 or 3 time the cost of excavation. Therefore, construction of a larger floodplain than described in

Alternative 3 or additional floodplain areas adjacent to other reaches of the channel may become substantially more expensive if materials need to be disposed of off-site.

Construction Access

The concept designs aim to save native trees and minimize construction disturbance to the channel. This results in limited construction access and confined working areas for heavy equipment. In Reaches 1 and 2, construction access would be from the Park side of the stream channel. However, access from the opposite bank may be useful if permission can be obtained for use of the parking area next to the fire station. Construction accesses to the eastern side of the channel in Reach 3 could be from Lower Mill Street. However, this is a private residential road, so permission would be needed and use would likely be limited to mobilization and demobilization of equipment.

Temporary heavy equipment crossings will be required within each reach. Each crossing would span the bankfull channel and likely consist of a small culvert and fill placed across the channel. The fill could consist of washed gravel to minimize water quality impacts, and the gravel could be incorporated into the project once the crossing is removed. Alternatively, super sandbags could be used.

As part of final design, a thorough construction access assessment should be conducted, to improve constructability.

Water Management

The project will need to be constructed within the dry season when baseflows are low. Streamflow will need to be bypassed around the work area in a pipe during periods when grading activity is occurring adjacent to, or within, the active stream channel. The bypass is typically done using a small cofferdam and a gravity pipeline placed down the center of the active channel. The temporary stream crossings could also serve as cofferdams. Fish exclusion fencing would be placed upstream and downstream of the streamflow bypass and fish relocated prior to dewatering.

Pumping and dewatering of sediment-laden water from the work area will be necessary at times. Depending on the length of stream disturbed and the degree of baseflow and groundwater seepage into the project area, multiple pumps of various sizes may be necessary. The sediment-laden waters will be discharged away from the channel. Infiltration into the park lawn and/or orchard may be adequate. Alternatively, a gravity filter bag may be used to remove sediment from the water.

Comparison of Alternatives and Implementation Priorities

Table 5 provides a comparative summary of the different reaches and alternatives. The results of the geomorphic assessment indicated that Reach 3 is the least stable geomorphically and provides only marginal spawning and rearing habitat for coho salmon. Therefore, it should be the highest priority for restoration of Sidney Gulch within Lee Fong Park. Implementation of Alternatives 1, 2 or 3 in this reach would substantially increase flood conveyance and gravel retention, and create a more complex channel profile that includes riffles for spawning and pools for rearing. The increase in flow conveyance and expected habitat improvements would increase most substantially with implementation of Alternative 3.

The results of geomorphic assessment indicated that Reach 1 provides adequate geomorphic function and fisheries habitat. Small modifications to this 600-foot reach would increase the geomorphic variability and improve spawning and rearing habitat with minimal short-term impacts to the existing channel.

Reach 2, is confined and simplified with limited fisheries habitat. However, this reach is a short reach with the fewest restoration opportunities within the project area. If implementation funds are limited, delays in the restoration of this reach would not affect the benefits achieved with restoration of the upstream and downstream reaches.

Table 5. Schematic level comparison of project elements and construction impacts for the three channel reaches of Sidney Gulch.

Project Element	Reach 1	Reach 2	Reach 3		
			Alternative 1	**Alternative 2**	**Alternative 3**[2]
Constructed Floodplain Area	4,000 SF	4,275 SF	10,460 SF	9,670 SF	35,000 sf
Length of Side Channels Constructed	260 LF	85 LF	N/A	150 LF	500 ft
Length of Relocated Stream Channel	N/A	N/A	150 LF	300 LF	300 LF
Large Tree Removal [1]	7	2	5	7	7
Length of Park Path Relocated	120 LF	130 LF	180 LF	180 LF	300 LF

[1] Large trees defined by species: Alder DBH $\geq$ 12 inches, Cottonwood DBH $\geq$ 10 inches, Black Locusts DBH $\geq$ 12 inches.

Next Steps

After receipt and review of this technical memorandum, the next step is for the project team to meet with stakeholders to identity the preferred project direction. These can then be further developed to the 30% level for a more detailed review by the stakeholders and the general public.

GMA's continued monitoring of streamflow in Sidney Gulch will improve our understanding of flow magnitudes and frequencies occurring in Sidney Gulch. This information will support the future development of the restoration designs.

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Attachments:

Attachment 1: Pebble Counts

Attachment 2: FEMA and FIS Profile and FIRMETTE

Attachment 3: Existing Conditions HEC-RAS Model

Attachment 4: Sediment Transport Competence Analysis

Attachment 5: Existing Conditions Plan, Profile and Geomorphic Summary

Attachment 6: Design Condition Plan and Typical Cross Sections

Attachment 7: Comparison of Existing and Design Condition Hydraulics

Attachment 1: Pebble Counts

Version 1.0, October, 2010

GMA

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BED SURFACE PARTICLE SIZE ANALYSIS

Date collected:	10/6/2011	**Fieldbook #:**	
River:	Sidney Gulch	**Page #s:**	
Site Name:	Upstream sample	**Date Entered into Computer:**	10/06/11
Agency/group collecting data:	GMA	**Checked by:**	K. Barnard
Crew:	Keith Barnard	**Checked Date:**	
Pebble Count Location Description:	Near 2150018 N, 6301066 E. Existing channel station 14+14.	**Original Excel File Name**	
Cross Section Name:			
Historic Cross Section Name:		**Total pebbles counted n=**	106
Left Bank XS End Pin:			
XS start station (ft):		**Notes**	
XS end station (ft):			
Sampling width (ft):	10		
Distance up and downstream of XS sampled:	30		
Instrument:	Gravelometer		
Particle Measurement	mm		
Method of collection:	Heel/Toe		

PEBBLE COUNT DATA - NUMBER OF PARTICLES IN SIZE CLASSES - RULER OR GRAVELOMETER MEASUREMENTS

****These columns should be used for particles measurements recorded by size class.*

Size Class Percent Finer* than (mm)	Number of Particles	Rank	Chart Data: Sieve Size (mm)	Chart Data: Percent finer than
256	1	0.01	**256**	100%
180	4	0.04	**180**	99%
128	2	0.02	**128**	95%
90.5	8	0.08	**90**	93%
64	28	0.26	**64**	86%
45.3	23	0.22	**45**	59%
32	16	0.15	**32**	38%
22.5	9	0.08	**22.5**	23%
16	4	0.04	**16**	14%
11.2	2	0.02	**11.2**	10%
8	7	0.07	**8**	8%
5.6	2	0.02	**5.6**	2%
4	0	0.00	**4**	0%
2.8	0	0.00	**2.8**	0%
2	0	0.00	**2**	0%
<2	0	0.00	**1**	0%

RULER

*** The number of measured particles are placed in the cell corresponding to the ruler measurement in millimeters finer than. For example, *if you measured 10 particels* ≤64 mm and >45mm then you insert 10 in the cell adjacent to the 64mm category (same row).**

GRAVELOMETER

*** The number of particles are placed in the cell corresponding to the Sieve Size the particle passed through (Finer than the square hole) For example, if you passed 10 particels through the 64 mm size hole in the gravelometer, then you insert 10 in the cell in the same row as the 64mm sieve size.**

Selected Size Classes	
D5	6.6
D16	17.2
D25	23.8
D35	30.0
D50	38.8
D65	48.5
D75	55.4
D84	62.4
D90	77.2

Version 1.0, October, 2010

Hydrology | Geomorphology | Stream Restoration

BED SURFACE PARTICLE SIZE ANALYSIS

Date collected:	10/6/2011
River:	Sidney Gulch
Site Name:	Midstream sample
Agency/group collecting data:	GMA
Crew:	Keith Barnard
Pebble Count Location Description:	Near 2149535 N, 6301012 E. Existing Channel Sation.8+82.
Cross Section Name:	
Historic Cross Section Name:	
Left Bank XS End Pin:	
XS start station (ft):	
XS end station (ft):	
Sampling width (ft):	10
Distance up and downstream of XS sampled:	30
Instrument:	Gravelometer
Particle Measurement	mm
Method of collection:	Heel/Toe

Fieldbook #:	
Page #s:	
Date Entered into Computer:	10/06/11
Checked by:	K. Barnard
Checked Date:	
Original Excel File Name	

Total pebbles counted n= 102

Notes

PEBBLE COUNT DATA - NUMBER OF PARTICLES IN SIZE CLASSES - RULER OR GRAVELOMETER MEASUREMENTS

****These columns should be used for particles measurements recorded by size class.*

Size Class Percent Finer* than (mm)	Number of Particles	Rank	Chart Data: Sieve Size (mm)	Chart Data: Percent finer than
256	0	0.00	**256**	100%
180	1	0.01	**180**	100%
128	7	0.07	**128**	99%
90.5	15	0.15	**90**	92%
64	24	0.24	**64**	77%
45.3	24	0.24	**45**	54%
32	14	0.14	**32**	30%
22.5	8	0.08	**22.5**	17%
16	3	0.03	**16**	9%
11.2	2	0.02	**11.2**	6%
8	3	0.03	**8**	4%
5.6	0	0.00	**5.6**	1%
4	1	0.01	**4**	1%
2.8	0	0.00	**2.8**	0%
2	0	0.00	**2**	0%
<2	0	0.00	**1**	0%

RULER

*** The number of measured particles are placed in the cell corresponding to the ruler measurement in millimeters finer than. For example, *if you measured 10 particels* ≤64 mm and >45mm then you insert 10 in the cell adjacent to the 64mm category (same row).**

GRAVELOMETER

*** The number of particles are placed in the cell corresponding to the Sieve Size the particle passed through (Finer than the square hole) For example, if you passed 10 particels through the 64 mm size hole in the gravelometer, then you insert 10 in the cell in the same row as the 64mm sieve size.**

Selected Size Classes	
D5	9.6
D16	21.9
D25	27.9
D35	34.2
D50	42.5
D65	53.1
D75	61.7
D84	74.5
D90	85.6

Hydrology | Geomorphology | Stream Restration

Version 1.0, October, 2010

BED SURFACE PARTICLE SIZE ANALYSIS

Date collected:	10/6/2011	**Fieldbook #:**	
River:	Sidney Gulch	**Page #s:**	
Site Name:	Downstream sample	**Date Entered into Computer:**	10/06/11
Agency/group collecting data:	GMA	**Checked by:**	K. Barnard
Crew:	Keith Barnard	**Checked Date:**	
Pebble Count Location Description:	Near 2148956 N, 6301047 E. Existing Channel Sation 2+81.	**Original Excel File Name**	
Cross Section Name:			
Historic Cross Section Name:		**Total pebbles counted n=**	101
Left Bank XS End Pin:			
XS start station (ft):		**Notes**	
XS end station (ft):			
Sampling width (ft):	10		
Distance up and downstream of XS sampled:	40		
Instrument:	Gravelometer		
Particle Measurement	mm		
Method of collection:	Heel/Toe		

PEBBLE COUNT DATA - NUMBER OF PARTICLES IN SIZE CLASSES - RULER OR GRAVELOMETER MEASUREMENTS

****These columns should be used for particles measurements recorded by size class.*

Size Class Percent Finer* than (mm)	Number of Particles	Rank	Chart Data: Sieve Size (mm)	Chart Data: Percent finer than
256	2	0.02	**256**	100%
180	5	0.05	**180**	98%
128	9	0.09	**128**	93%
90.5	19	0.19	**90**	84%
64	11	0.11	**64**	65%
45.3	19	0.19	**45**	54%
32	13	0.13	**32**	36%
22.5	4	0.04	**22.5**	23%
16	11	0.11	**16**	19%
11.2	2	0.02	**11.2**	8%
8	2	0.02	**8**	6%
5.6	1	0.01	**5.6**	4%
4	0	0.00	**4**	3%
2.8	0	0.00	**2.8**	3%
2	3	0.03	**2**	3%
<2	0	0.00	**1**	0%

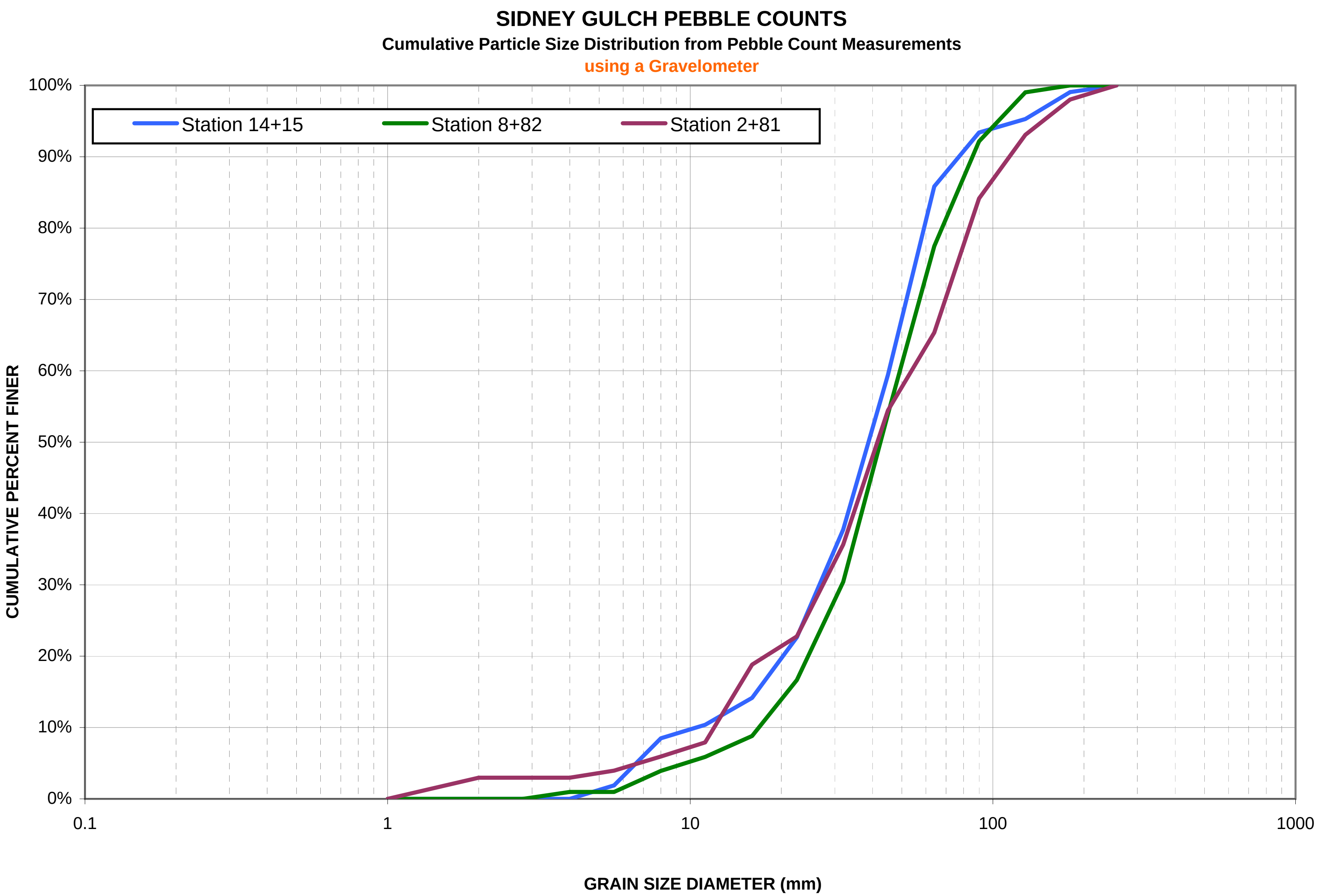
RULER

*** The number of measured particles are placed in the cell corresponding to the ruler measurement in millimeters finer than. For example, *if you measured 10 particels* ≤64 mm and >45mm then you insert 10 in the cell adjacent to the 64mm category (same row).**

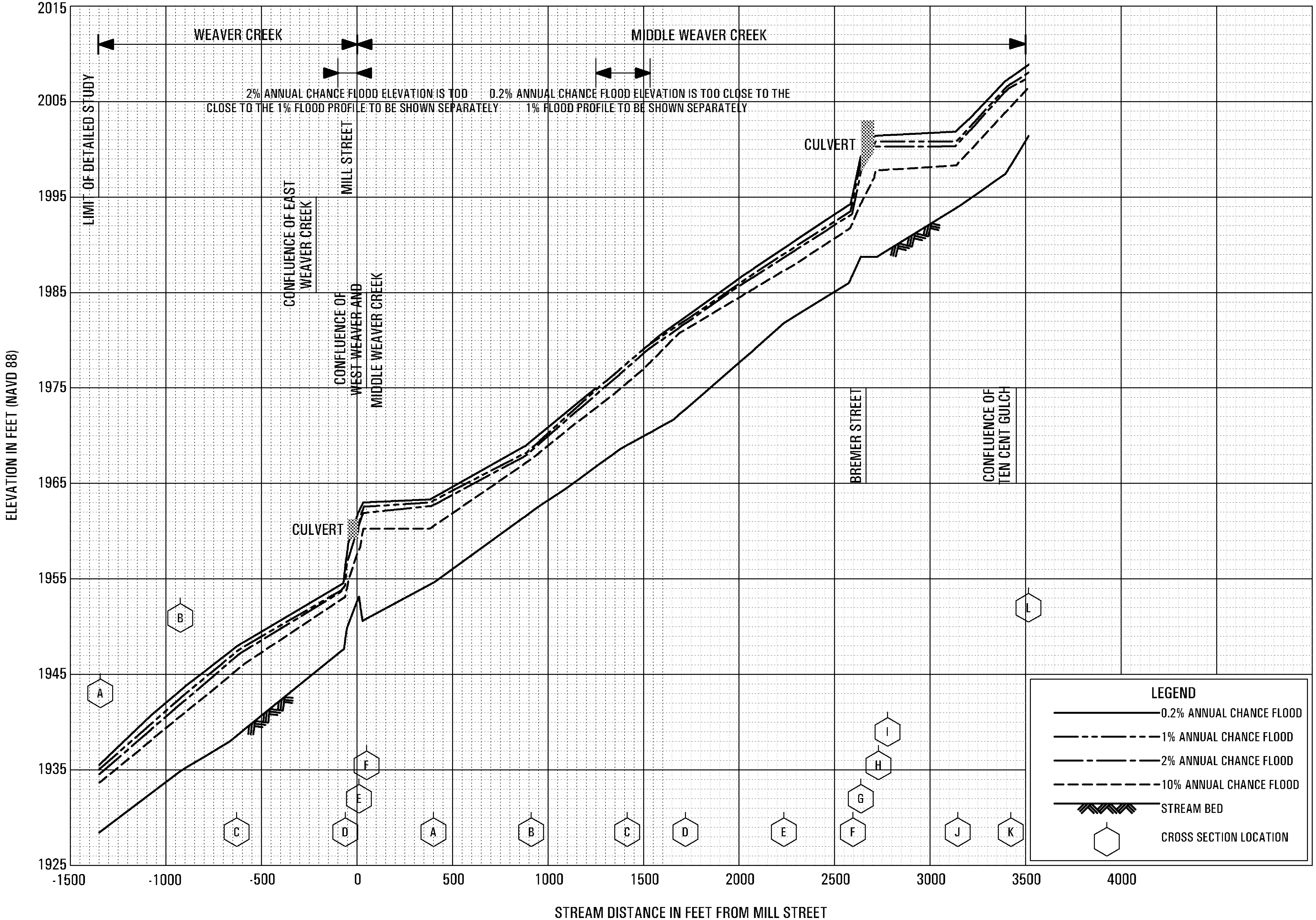
GRAVELOMETER

*** The number of particles are placed in the cell corresponding to the Sieve Size the particle passed through (Finer than the square hole) For example, if you passed 10 particels through the 64 mm size hole in the gravelometer, then you insert 10 in the cell in the same row as the 64mm sieve size.**

Selected Size Classes	
D5	6.8
D16	14.6
D25	23.9
D35	31.4
D50	41.5
D65	63.3
D75	76.2
D84	89.7
D90	113.4


SIDNEY GULCH PEBBLE COUNTS
Cumulative Particle Size Distribution from Pebble Count Measurements
using a Gravelometer
Station 14+15
Station 8+82
Station 2+81
CUMULATIVE PERCENT FINER
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.1
1
10
100
1000
GRAIN SIZE DIAMETER (mm)

Attachment 2: FEMA and FIS Profile and FIRMETTE

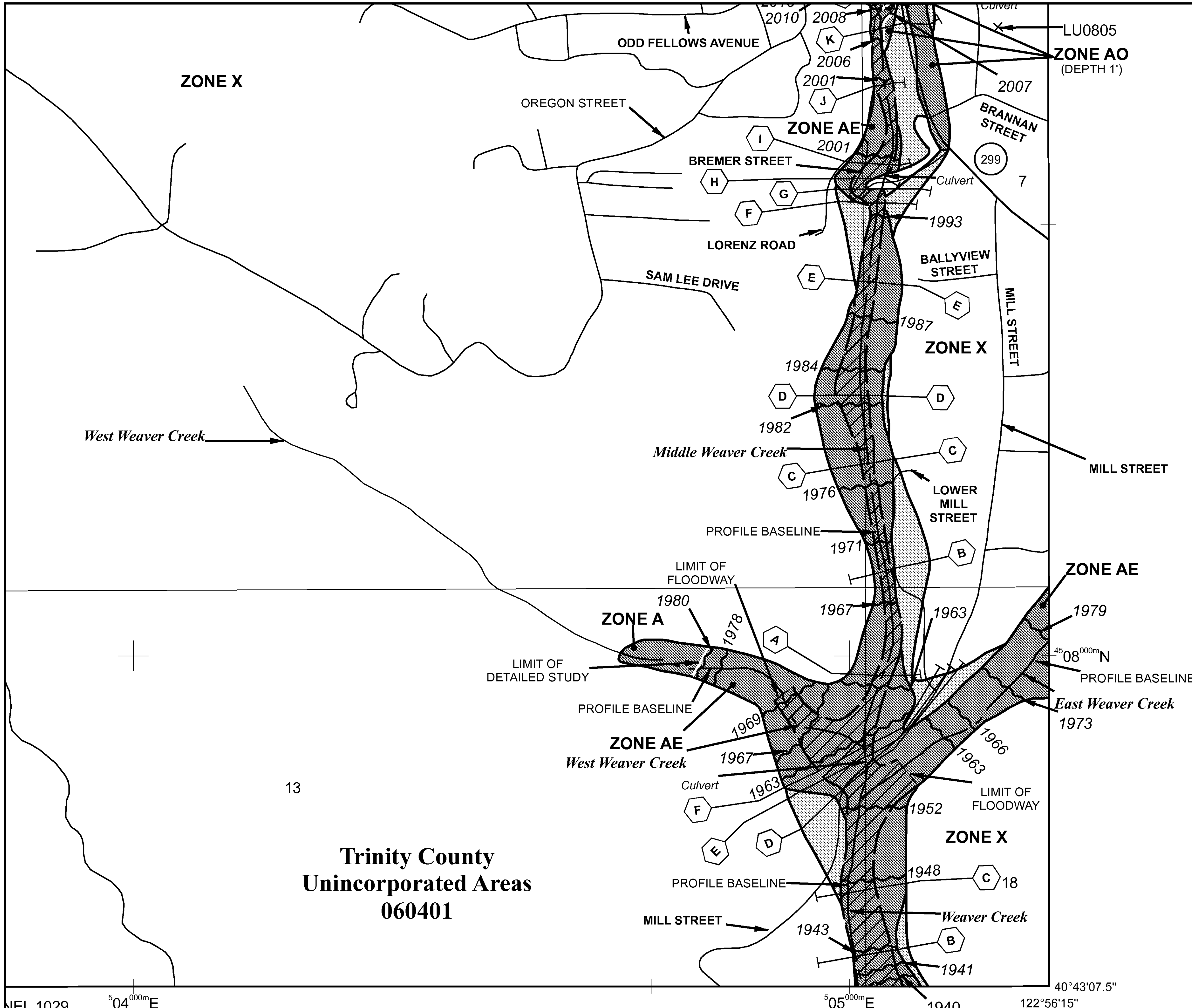


FLOOD PROFILES

WEAVER CREEK / MIDDLE WEAVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TRINITY COUNTY, CA
AND INCORPORATED AREAS



ational Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1027E

FIRM

FLOOD INSURANCE RATE MAP

TRINITY COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 1027 OF 2075

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
TRINITY COUNTY	060401	1027	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

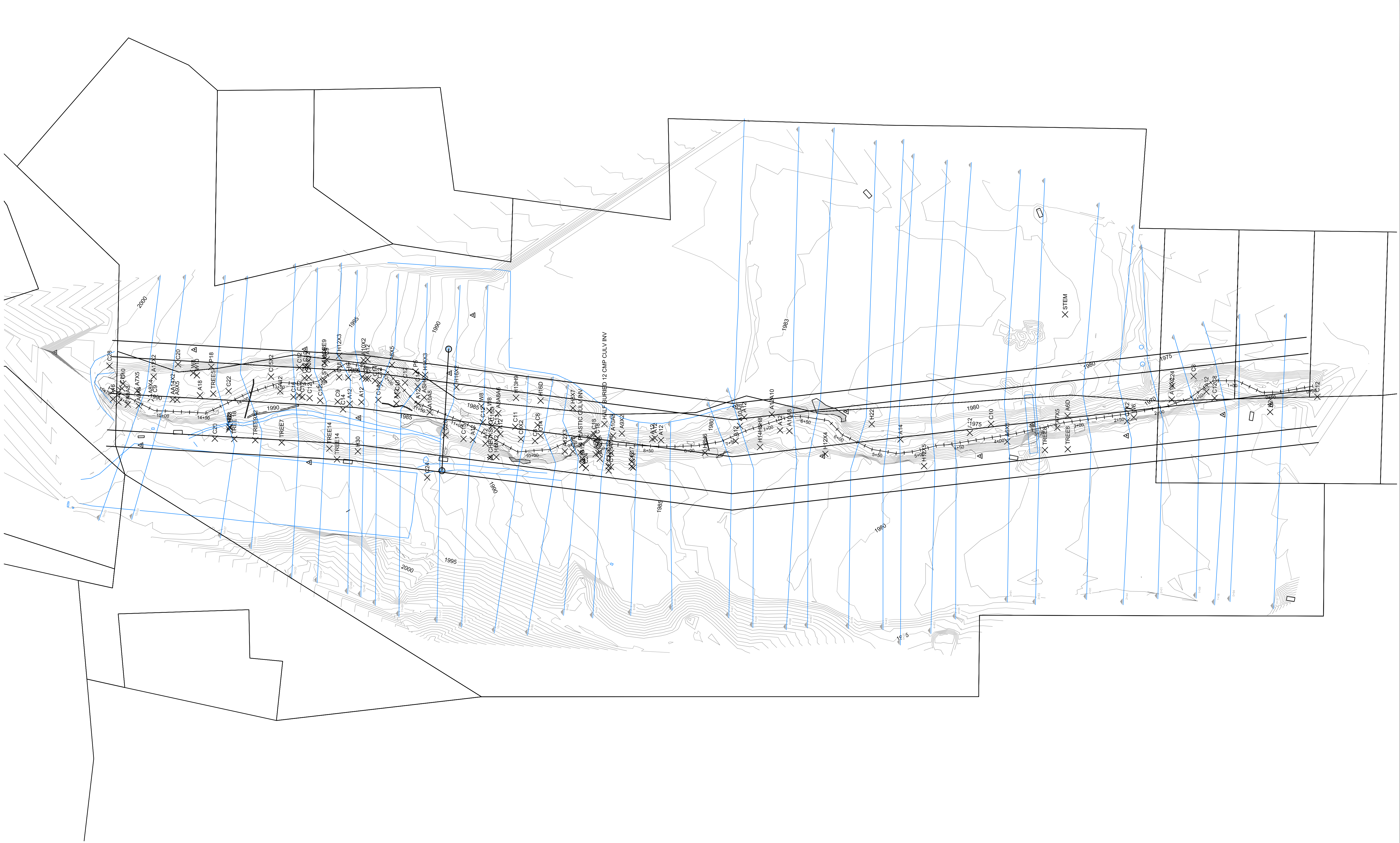
U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
06105C1027E

MAP REVISED
JANUARY 20, 2010

Federal Emergency Management Agency

Attachment 3: Existing Conditions HEC-RAS Model



SCALE, ft

50 0 25 50 100

SIDNEY GULCH TOPOGRAPHY

GMA
GRAHAM MATTHEWS & ASSOCIATES
Hydrology Geomorphology Stream Restoration
P.O. Box 1516 Weaverville, CA 96093-1516
(530) 623-0520 ph
graham@gmahydrology.com

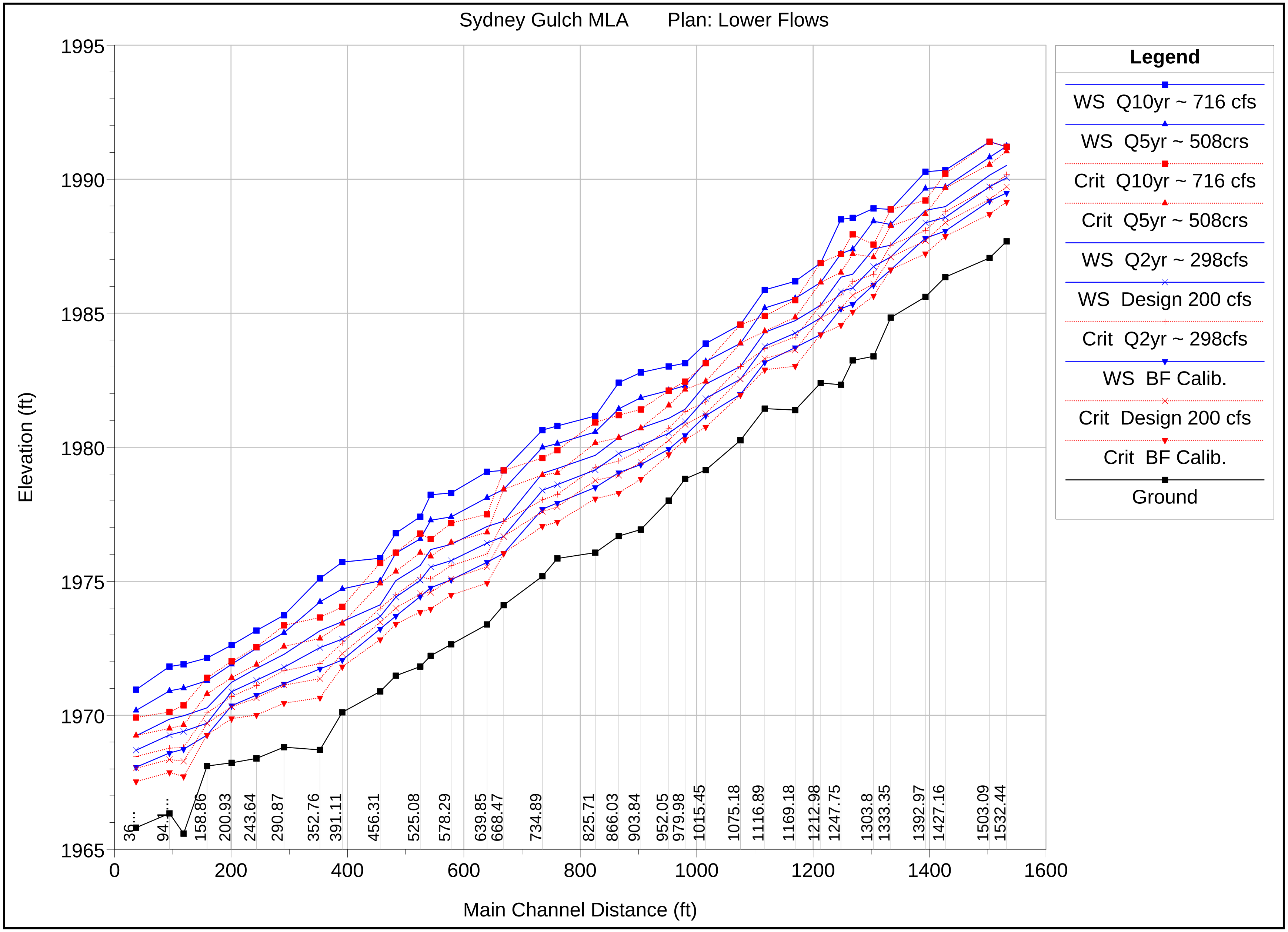
Reach	River Sta	Eliminated XS	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Depth (ft)	Max. Depth (Dmax) (ft)	Channel Shear (lb/sf)	Width/Dmax
Alignment - (MLA)		1532.44														
Alignment - (MLA)	1503.09		110	1987.06	1989.19	1988.7	1989.42	0.009937	3.91	28.16	19.96	0.58	1.41	2.13	0.8	9.37089202
Alignment - (MLA)	1427.16		110	1986.35	1988.07	1987.87	1988.4	0.018163	4.61	23.84	22.23	0.79	1.07	1.72	1.2	12.9244186
Alignment - (MLA)	1392.97		110	1985.61	1987.8	1987.22	1987.95	0.006853	3.04	36.15	30.43	0.49	1.19	2.19	0.5	13.8949772
Alignment - (MLA)		1333.35														
Alignment - (MLA)	1308		110	1983.39	1986.06	1985.65	1986.24	0.010074	3.44	31.97	28.98	0.58	1.1	2.67	0.67	10.8539326
Alignment - (MLA)	1267.86		110	1983.24	1985.34	1985.05	1985.72	0.017311	4.96	22.19	17.1	0.77	1.3	2.1	1.32	8.14285714
Alignment - (MLA)		1247.75														
Alignment - (MLA)		1212.98														
Alignment - (MLA)		1169.18														
Alignment - (MLA)	1116.89		110	1981.44	1983.17	1982.89	1983.4	0.013309	3.88	28.32	26.91	0.67	1.05	1.73	0.86	15.5549133
Alignment - (MLA)		1075.18														
Alignment - (MLA)	1015.45		110	1979.15	1981.18	1980.75	1981.41	0.010057	3.87	28.43	21.6	0.59	1.32	2.03	0.79	10.6403941
Alignment - (MLA)	979.98		110	1978.82	1980.44	1980.29	1980.86	0.020749	5.18	21.22	17.86	0.84	1.19	1.62	1.47	11.0246914
Alignment - (MLA)	952.05		110	1978.01	1979.93	1979.73	1980.29	0.018204	4.82	22.82	19.72	0.79	1.16	1.92	1.28	10.2708333
Alignment - (MLA)		903.84														
Alignment - (MLA)	866.03		110	1976.69	1979.05	1978.29	1979.27	0.007301	3.76	29.23	17.43	0.51	1.68	2.36	0.7	7.38559322
Alignment - (MLA)	825.71		110	1976.07	1978.5	1978.08	1978.85	0.013423	4.71	23.37	16.1	0.69	1.45	2.43	1.14	6.6255144
Alignment - (MLA)	760.62		110	1975.85	1977.92	1977.21	1978.11	0.007887	3.44	31.99	20.6	0.49	1.55	2.07	0.73	9.95169082
Alignment - (MLA)	734.89		110	1975.19	1977.69	1977.06	1977.89	0.008865	3.53	31.13	21.03	0.51	1.48	2.5	0.79	8.412
Alignment - (MLA)		668.47														
Alignment - (MLA)	639.85		110	1973.39	1975.71	1974.93	1975.89	0.007718	3.38	32.52	21.08	0.48	1.54	2.32	0.71	9.0862069
Alignment - (MLA)	578.29		110	1972.65	1975.06	1974.49	1975.3	0.01115	3.97	27.68	18.41	0.57	1.5	2.41	0.99	7.63900415
Alignment - (MLA)	543.03		110	1972.22	1974.76	1973.97	1974.94	0.007791	3.44	31.97	20.41	0.48	1.57	2.54	0.73	8.03543307
Alignment - (MLA)	525.08		110	1971.82	1974.43	1973.85	1974.73	0.013116	4.39	25.08	15.38	0.61	1.63	2.61	1.2	5.89272031
Alignment - (MLA)	483.09		110	1971.48	1973.7	1973.41	1974.06	0.019042	4.78	23.04	17.36	0.73	1.33	2.22	1.49	7.81981982
Alignment - (MLA)	456.31		110	1970.89	1973.23	1972.83	1973.57	0.016726	4.72	23.28	15.95	0.69	1.46	2.34	1.42	6.81623932
Alignment - (MLA)	391	391.11														
Alignment - (MLA)	352		110	1968.71	1971.73	1970.66	1971.91	0.006188	3.36	32.72	16.73	0.42	1.96	3.02	0.67	5.5397351
Alignment - (MLA)	290		110	1968.81	1971.17	1970.45	1971.41	0.009999	3.93	27.97	16.62	0.53	1.68	2.36	0.95	7.04237288
Alignment - (MLA)	243		110	1968.39	1970.75	1970.01	1970.94	0.008802	3.49	31.55	21.37	0.51	1.48	2.36	0.77	9.05508475
Alignment - (MLA)	200	200.93														
Alignment - (MLA)		158.86														
Alignment - (MLA)	118		110	1965.59	1968.74	1967.72	1968.88	0.00502	3.01	36.6	19.62	0.39	1.87	3.15	0.53	6.22857143
Alignment - (MLA)	94.18		110	1966.34	1968.6	1967.87	1968.74	0.006407	3.04	36.19	24.15	0.44	1.5	2.26	0.58	10.6858407
Alignment - (MLA)		36.81														

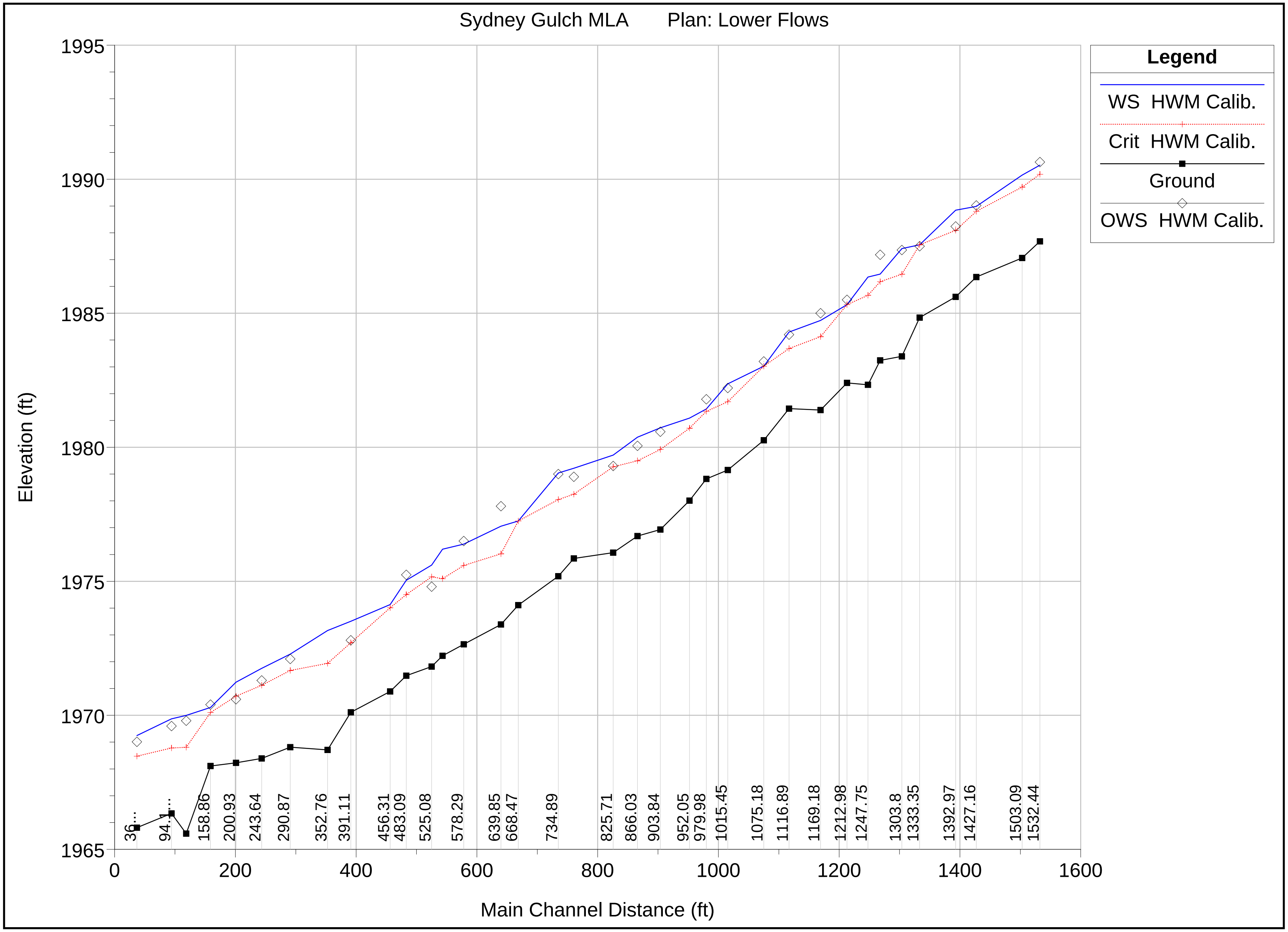
Reach	River Sta	Eliminated XS	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Depth (ft)	Max. Depth (Dmax) (ft)	Channel Shear (lb/sf)	Width/ Dmax
Alignment - (MLA)		1532.44														
Alignment - (MLA)	1503.09		200	1987.06	1989.72	1989.25	1990.13	0.0114	5.12	39.36	21.91	0.65	1.80	2.66	1.25	8.24
Alignment - (MLA)	1427.16		200	1986.35	1988.58	1988.38	1989.05	0.0174	5.54	36.30	26.49	0.81	1.37	2.23	1.56	11.88
Alignment - (MLA)	1392.97		200	1985.61	1988.38	1987.71	1988.58	0.0063	3.65	55.55	37.17	0.50	1.49	2.77	0.65	13.42
Alignment - (MLA)		1333.35														
Alignment - (MLA)	1308		200	1983.39	1986.74	1986.10	1986.97	0.0066	3.81	53.31	33.11	0.51	1.61	3.35	0.70	9.88
Alignment - (MLA)	1267.86		200	1983.24	1985.94	1985.67	1986.51	0.0159	6.06	33.59	20.24	0.78	1.66	2.70	1.75	7.50
Alignment - (MLA)		1247.75														
Alignment - (MLA)		1212.98														
Alignment - (MLA)		1169.18														
Alignment - (MLA)	1116.89		200	1981.44	1983.77	1983.31	1984.07	0.0102	4.43	45.19	29.20	0.62	1.55	2.33	0.98	12.53
Alignment - (MLA)		1075.18														
Alignment - (MLA)	1015.45		200	1979.15	1981.82	1981.26	1982.17	0.0090	4.69	42.87	23.45	0.60	1.83	2.67	1.03	8.78
Alignment - (MLA)	979.98		200	1978.82	1980.96	1980.85	1981.60	0.0218	6.42	31.49	21.77	0.90	1.45	2.14	2.06	10.17
Alignment - (MLA)	952.05		200	1978.01	1980.53	1980.27	1981.03	0.0152	5.69	35.71	23.36	0.77	1.53	2.52	1.57	9.27
Alignment - (MLA)		903.84														
Alignment - (MLA)	866.03		200	1976.69	1979.77	1978.96	1980.12	0.0075	4.72	42.82	20.17	0.55	2.12	3.08	1.00	6.55
Alignment - (MLA)	825.71		200	1976.07	1979.15	1978.77	1979.67	0.0136	5.74	35.04	19.30	0.73	1.82	3.08	1.55	6.27
Alignment - (MLA)	760.62		200	1975.85	1978.61	1977.78	1978.89	0.0078	4.29	46.97	23.12	0.51	2.03	2.76	1.02	8.38
Alignment - (MLA)	734.89		200	1975.19	1978.40	1977.60	1978.69	0.0080	4.33	47.43	27.87	0.52	1.70	3.21	1.04	8.68
Alignment - (MLA)		668.47														
Alignment - (MLA)	639.85		200	1973.39	1976.43	1975.54	1976.69	0.0073	4.12	49.40	26.47	0.49	1.87	3.04	0.94	8.71
Alignment - (MLA)	578.29		200	1972.65	1975.77	1975.09	1976.13	0.0102	4.82	42.08	21.73	0.58	1.94	3.12	1.29	6.96
Alignment - (MLA)	543.03		200	1972.22	1975.53	1974.59	1975.79	0.0068	4.08	50.67	27.76	0.48	1.83	3.31	0.91	8.39
Alignment - (MLA)	525.08		200	1971.82	1975.04	1974.54	1975.54	0.0151	5.71	36.75	23.77	0.68	1.55	3.22	1.84	7.38
Alignment - (MLA)	483.09		200	1971.48	1974.41	1974.00	1974.89	0.0156	5.55	36.38	20.41	0.70	1.78	2.93	1.78	6.97
Alignment - (MLA)	456.31		200	1970.89	1973.69	1973.47	1974.33	0.0229	6.45	31.22	18.48	0.84	1.69	2.80	2.46	6.60
Alignment - (MLA)	391	391.11														
Alignment - (MLA)	352		200	1968.71	1972.53	1971.37	1972.81	0.0072	4.27	46.87	18.98	0.47	2.47	3.82	0.99	4.97
Alignment - (MLA)	290		200	1968.81	1971.79	1971.12	1972.20	0.0123	5.14	39.12	19.35	0.62	2.02	2.98	1.50	6.49
Alignment - (MLA)	243		200	1968.39	1971.31	1970.65	1971.63	0.0101	4.55	44.34	24.15	0.57	1.84	2.92	1.19	8.27
Alignment - (MLA)	200	200.93														
Alignment - (MLA)		158.86														
Alignment - (MLA)	118		200	1965.59	1969.41	1968.29	1969.65	0.0061	3.99	50.52	22.38	0.45	2.26	3.82	0.86	5.86
Alignment - (MLA)	94.18		200	1966.34	1969.27	1968.35	1969.49	0.0062	3.78	53.32	26.73	0.46	1.99	2.93	0.80	9.12
Alignment - (MLA)		36.81														

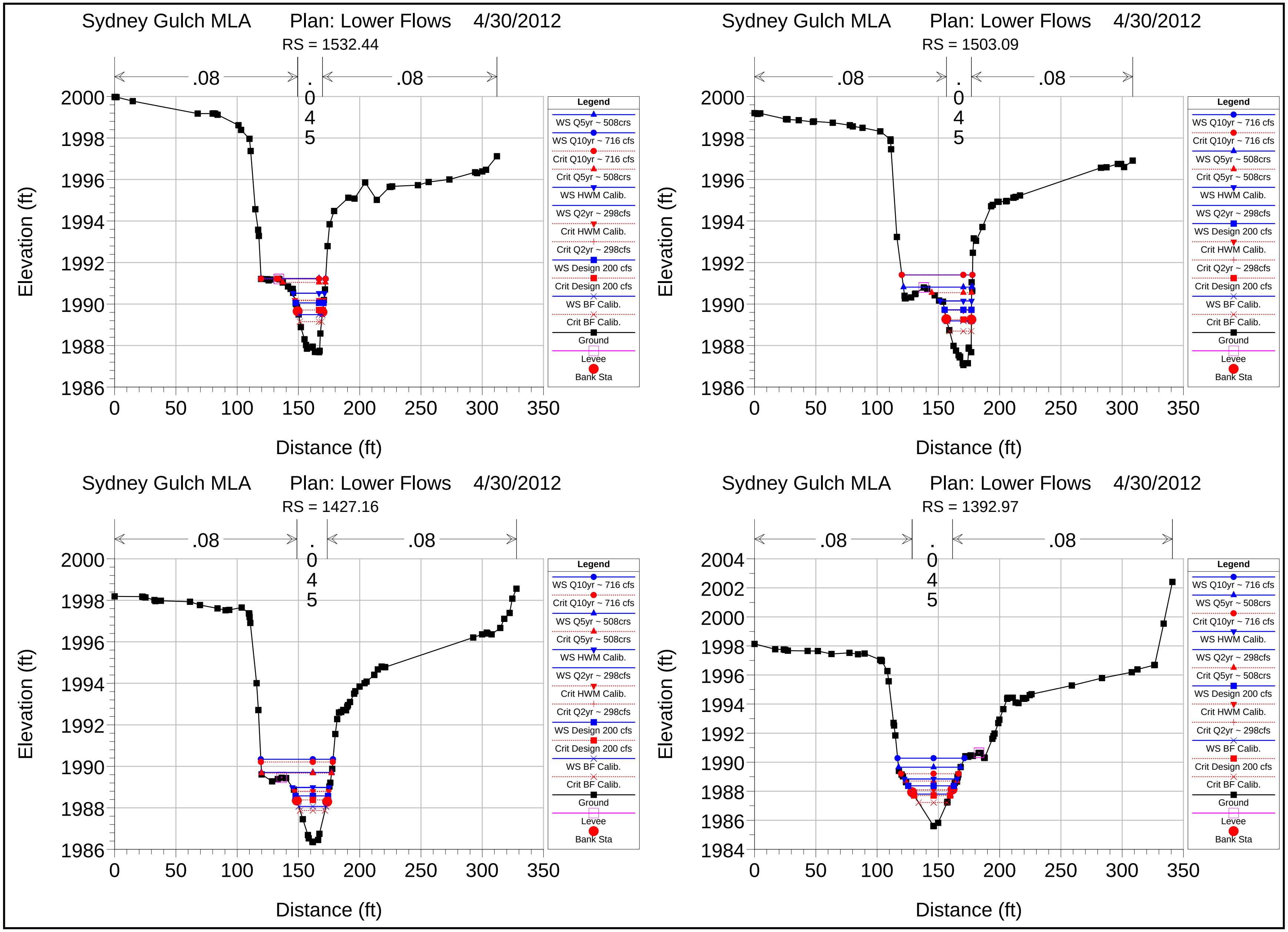
Reach	River Sta	Eliminated XS	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Depth (ft)	Max. Depth (Dmax) (ft)	Channel Shear (lb/sf)	Width/ Dmax
Alignment - (MLA)		1532.44														
Alignment - (MLA)	1503.09		298	1987.06	1990.15	1989.70	1990.75	0.0129	6.23	49.03	25.26	0.72	1.94	3.09	1.72	8.17
Alignment - (MLA)	1427.16		298	1986.35	1988.98	1988.79	1989.62	0.0170	6.44	47.56	29.98	0.83	1.59	2.63	1.94	11.40
Alignment - (MLA)	1392.97		298	1985.61	1988.84	1988.08	1989.11	0.0060	4.21	74.23	43.17	0.51	1.72	3.23	0.79	13.37
Alignment - (MLA)		1333.35														
Alignment - (MLA)	1308		298	1983.39	1987.40	1986.45	1987.66	0.0050	4.10	76.12	36.61	0.46	2.08	4.01	0.73	9.13
Alignment - (MLA)	1267.86		298	1983.24	1986.46	1986.18	1987.21	0.0155	7.02	44.62	23.77	0.80	1.88	3.22	2.16	7.38
Alignment - (MLA)		1247.75														
Alignment - (MLA)		1212.98														
Alignment - (MLA)		1169.18														
Alignment - (MLA)	1116.89		298	1981.44	1984.29	1983.68	1984.67	0.0087	4.96	60.83	30.94	0.60	1.97	2.85	1.11	10.86
Alignment - (MLA)		1075.18														
Alignment - (MLA)	1015.45		298	1979.15	1982.36	1981.69	1982.82	0.0088	5.44	55.83	25.12	0.61	2.22	3.21	1.28	7.83
Alignment - (MLA)	979.98		298	1978.82	1981.42	1981.34	1982.25	0.0206	7.34	42.28	25.17	0.91	1.68	2.60	2.48	9.68
Alignment - (MLA)	952.05		298	1978.01	1981.08	1980.71	1981.69	0.0130	6.33	49.70	28.15	0.74	1.77	3.07	1.77	9.17
Alignment - (MLA)		903.84														
Alignment - (MLA)	866.03		298	1976.69	1980.36	1979.49	1980.84	0.0077	5.56	55.63	23.10	0.58	2.41	3.67	1.28	6.29
Alignment - (MLA)	825.71		298	1976.07	1979.70	1979.26	1980.38	0.0131	6.65	46.13	21.48	0.74	2.15	3.63	1.91	5.92
Alignment - (MLA)	760.62		298	1975.85	1979.21	1978.24	1979.59	0.0077	4.99	61.37	24.66	0.53	2.49	3.36	1.27	7.34
Alignment - (MLA)	734.89		298	1975.19	1979.03	1978.04	1979.39	0.0072	4.87	67.98	36.41	0.51	1.87	3.84	1.21	9.48
Alignment - (MLA)		668.47														
Alignment - (MLA)	639.85		298	1973.39	1977.04	1976.02	1977.38	0.0068	4.70	66.96	30.46	0.50	2.20	3.65	1.13	8.35
Alignment - (MLA)	578.29		298	1972.65	1976.38	1975.58	1976.85	0.0097	5.53	56.72	25.66	0.59	2.21	3.73	1.57	6.88
Alignment - (MLA)	543.03		298	1972.22	1976.18	1975.09	1976.50	0.0062	4.60	70.83	33.53	0.48	2.11	3.96	1.07	8.47
Alignment - (MLA)	525.08		298	1971.82	1975.59	1975.16	1976.24	0.0148	6.58	50.66	27.16	0.70	1.87	3.77	2.27	7.20
Alignment - (MLA)	483.09		298	1971.48	1975.03	1974.49	1975.62	0.0135	6.22	49.79	22.96	0.69	2.17	3.55	2.04	6.47
Alignment - (MLA)	456.31		298	1970.89	1974.12	1974.00	1975.04	0.0248	7.72	39.76	20.57	0.90	1.93	3.23	3.28	6.37
Alignment - (MLA)	391	391.11														
Alignment - (MLA)	352		298	1968.71	1973.15	1971.93	1973.56	0.0076	5.09	59.45	21.18	0.50	2.81	4.44	1.31	4.77
Alignment - (MLA)	290		298	1968.81	1972.28	1971.67	1972.88	0.0137	6.23	48.97	21.16	0.67	2.31	3.47	2.05	6.10
Alignment - (MLA)	243		298	1968.39	1971.75	1971.11	1972.22	0.0115	5.54	55.22	25.79	0.63	2.14	3.36	1.64	7.68
Alignment - (MLA)	200	200.93														
Alignment - (MLA)		158.86														
Alignment - (MLA)	118		298	1965.59	1969.98	1968.80	1970.34	0.0067	4.78	64.36	25.60	0.48	2.51	4.39	1.15	5.83
Alignment - (MLA)	94.18		298	1966.34	1969.86	1968.78	1970.16	0.0061	4.40	69.69	28.92	0.47	2.41	3.52	0.99	8.22
Alignment - (MLA)		36.81														

Reach	River Sta	Eliminated XS	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Depth (ft)	Channel Shear (lb/sf)	Entr. (Top/200 cfs top)
Alignment - (MLA)		1532.44													
Alignment - (MLA)	1503.09		508	1987.06	1990.82	1990.55	1991.78	0.0152	8.00	75.81	55.86	0.81	1.36	2.61	2.21
Alignment - (MLA)	1427.16		508	1986.35	1989.71	1989.68	1990.57	0.0153	7.61	78.77	57.30	0.83	1.37	2.43	1.91
Alignment - (MLA)	1392.97		508	1985.61	1989.65	1988.70	1990.03	0.0056	5.04	112.78	50.69	0.52	2.22	1.02	1.17
Alignment - (MLA)		1333.35													
Alignment - (MLA)	1308		508	1983.39	1988.43	1987.09	1988.73	0.0038	4.54	138.49	87.04	0.43	2.20	0.79	2.38
Alignment - (MLA)	1267.86		508	1983.24	1987.39	1987.21	1988.31	0.0129	8.01	85.81	65.72	0.78	1.31	2.52	2.76
Alignment - (MLA)		1247.75													
Alignment - (MLA)		1212.98													
Alignment - (MLA)		1169.18													
Alignment - (MLA)	1116.89		508	1981.44	1985.20	1984.33	1985.72	0.0075	5.83	91.65	37.44	0.59	2.45	1.36	1.21
Alignment - (MLA)		1075.18													
Alignment - (MLA)	1015.45		508	1979.15	1983.20	1982.46	1983.92	0.0094	6.85	78.80	31.96	0.67	2.47	1.84	1.27
Alignment - (MLA)	979.98		508	1978.82	1982.30	1982.16	1983.37	0.0169	8.47	67.50	32.80	0.88	2.06	2.92	1.30
Alignment - (MLA)	952.05		508	1978.01	1982.12	1981.56	1982.86	0.0097	7.07	82.90	34.47	0.69	2.41	1.94	1.22
Alignment - (MLA)		903.84													
Alignment - (MLA)	866.03		508	1976.69	1981.44	1980.36	1982.11	0.0074	6.71	86.00	32.80	0.59	2.62	1.68	1.42
Alignment - (MLA)	825.71		508	1976.07	1980.57	1980.16	1981.61	0.0135	8.25	66.38	25.06	0.79	2.65	2.66	1.17
Alignment - (MLA)	760.62		508	1975.85	1980.14	1979.04	1980.71	0.0080	6.17	94.07	41.76	0.56	2.25	1.76	1.69
Alignment - (MLA)	734.89		508	1975.19	1979.99	1978.96	1980.47	0.0069	5.80	104.97	40.16	0.53	2.61	1.55	1.10
Alignment - (MLA)		668.47													
Alignment - (MLA)	639.85		508	1973.39	1978.12	1976.83	1978.59	0.0062	5.60	105.61	46.40	0.50	2.28	1.43	1.52
Alignment - (MLA)	578.29		508	1972.65	1977.40	1976.45	1978.06	0.0092	6.66	85.45	30.44	0.60	2.81	2.05	1.19
Alignment - (MLA)	543.03		508	1972.22	1977.27	1975.93	1977.70	0.0056	5.41	110.90	40.09	0.48	2.77	1.33	1.20
Alignment - (MLA)	525.08		508	1971.82	1976.58	1976.07	1977.42	0.0135	7.72	80.05	32.37	0.70	2.47	2.82	1.19
Alignment - (MLA)	483.09		508	1971.48	1976.05	1975.37	1976.87	0.0122	7.39	74.71	25.64	0.69	2.91	2.57	1.12
Alignment - (MLA)	456.31		508	1970.89	1975.02	1974.93	1976.30	0.0227	9.23	59.84	24.32	0.91	2.46	4.19	1.18
Alignment - (MLA)	391	391.11													
Alignment - (MLA)	352		508	1968.71	1974.23	1972.87	1974.86	0.0081	6.38	84.36	24.89	0.55	3.39	1.87	1.18
Alignment - (MLA)	290		508	1968.81	1973.08	1972.57	1974.06	0.0160	8.03	67.37	24.84	0.76	2.71	3.12	1.17
Alignment - (MLA)	243		508	1968.39	1972.50	1971.89	1973.27	0.0132	7.11	75.44	27.96	0.70	2.70	2.48	1.08
Alignment - (MLA)	200	200.93													
Alignment - (MLA)		158.86													
Alignment - (MLA)	118		508	1965.59	1971.01	1969.64	1971.55	0.0070	5.94	94.20	32.56	0.52	2.89	1.61	1.27
Alignment - (MLA)	94.18		508	1966.34	1970.91	1969.51	1971.34	0.0057	5.31	103.32	36.78	0.48	2.81	1.30	1.27
Alignment - (MLA)		36.81													

Reach	River Sta	Eliminated XS	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Depth (ft)	Channel Shear (ft)	Entr. (Top/200 cfs top) (lb/sf)
Alignment - (MLA)		1532.44													
Alignment - (MLA)	1503.09		716	1987.06	1991.40	1991.40	1992.47	0.0143	8.74	109.01	57.62	0.81	1.89	2.94	2.28
Alignment - (MLA)	1427.16		716	1986.35	1990.34	1990.21	1991.24	0.0127	8.02	115.53	58.91	0.79	1.96	2.51	1.96
Alignment - (MLA)	1392.97		716	1985.61	1990.28	1989.21	1990.75	0.0056	5.70	145.66	54.63	0.53	2.67	1.22	1.27
Alignment - (MLA)		1333.35													
Alignment - (MLA)	1308		716	1983.39	1988.91	1987.56	1989.32	0.0046	5.44	170.04	96.12	0.48	2.41	1.09	2.63
Alignment - (MLA)	1267.86		716	1983.24	1988.56	1987.94	1989.10	0.0061	6.73	178.04	114.41	0.56	2.11	1.61	4.81
Alignment - (MLA)		1247.75													
Alignment - (MLA)		1212.98													
Alignment - (MLA)		1169.18													
Alignment - (MLA)	1116.89		716	1981.44	1985.87	1984.90	1986.54	0.0073	6.61	118.65	42.49	0.61	2.79	1.64	1.37
Alignment - (MLA)		1075.18													
Alignment - (MLA)	1015.45		716	1979.15	1983.87	1983.14	1984.70	0.0089	7.55	119.67	57.18	0.67	2.09	2.10	2.28
Alignment - (MLA)	979.98		716	1978.82	1983.14	1982.45	1984.24	0.0131	8.80	106.68	56.76	0.80	1.88	2.90	2.26
Alignment - (MLA)	952.05		716	1978.01	1983.02	1982.11	1983.81	0.0079	7.48	124.43	55.69	0.64	2.23	2.01	1.98
Alignment - (MLA)		903.84													
Alignment - (MLA)	866.03		716	1976.69	1982.41	1981.20	1983.16	0.0064	7.24	122.67	40.55	0.57	3.03	1.81	1.76
Alignment - (MLA)	825.71		716	1976.07	1981.17	1980.93	1982.59	0.0150	9.72	82.16	27.54	0.86	2.98	3.49	1.28
Alignment - (MLA)	760.62		716	1975.85	1980.80	1979.89	1981.52	0.0085	7.08	122.34	44.05	0.60	2.78	2.20	1.79
Alignment - (MLA)	734.89		716	1975.19	1980.64	1979.60	1981.27	0.0075	6.71	131.82	42.55	0.56	3.10	1.97	1.17
Alignment - (MLA)		668.47													
Alignment - (MLA)	639.85		716	1973.39	1979.09	1977.50	1979.57	0.0051	5.88	157.93	58.54	0.47	2.70	1.47	1.92
Alignment - (MLA)	578.29		716	1972.65	1978.30	1977.17	1979.08	0.0084	7.35	114.26	33.73	0.60	3.39	2.33	1.31
Alignment - (MLA)	543.03		716	1972.22	1978.23	1976.57	1978.70	0.0049	5.88	153.37	47.61	0.47	3.22	1.46	1.42
Alignment - (MLA)	525.08		716	1971.82	1977.41	1976.78	1978.41	0.0128	8.57	108.78	40.52	0.71	2.68	3.25	1.49
Alignment - (MLA)	483.09		716	1971.48	1976.79	1976.07	1977.86	0.0125	8.48	94.63	28.17	0.72	3.36	3.18	1.23
Alignment - (MLA)	456.31		716	1970.89	1975.86	1975.68	1977.33	0.0194	9.99	81.91	28.12	0.88	2.91	4.54	1.37
Alignment - (MLA)	391	391.11													
Alignment - (MLA)	352		716	1968.71	1975.11	1973.65	1975.92	0.0083	7.33	107.46	27.84	0.57	3.86	2.31	1.31
Alignment - (MLA)	290		716	1968.81	1973.73	1973.36	1975.05	0.0173	9.36	84.58	27.94	0.81	3.03	4.00	1.32
Alignment - (MLA)	243		716	1968.39	1973.16	1972.54	1974.17	0.0136	8.19	94.57	29.80	0.74	3.17	3.08	1.16
Alignment - (MLA)	200	200.93													
Alignment - (MLA)		158.86													
Alignment - (MLA)	118		716	1965.59	1971.90	1970.37	1972.53	0.0066	6.57	132.84	46.95	0.52	2.83	1.85	1.83
Alignment - (MLA)	94.18		716	1966.34	1971.82	1970.13	1972.33	0.0052	5.87	137.88	39.50	0.48	3.49	1.48	1.37
Alignment - (MLA)		36.81													


Sydney Gulch MLA Plan: Lower Flows
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
Crit Q5yr ~ 508crs
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Elevation (ft)
Main Channel Distance (ft)
1995
1990
1985
1980
1975
1970
1965
0
200
400
600
800
1000
1200
1400
1600
36...
94...
158.86
200.93
243.64
290.87
352.76
391.11
456.31
525.08
578.29
639.85
668.47
734.89
825.71
866.03
903.84
952.05
979.98
1015.45
1075.18
1116.89
1169.18
1212.98
1247.75
1303.8
1333.35
1392.97
1427.16
1503.09
1532.44


Sydney Gulch MLA Plan: Lower Flows
Legend
WS HWM Calib.
Crit HWM Calib.
Ground
OWS HWM Calib.
Elevation (ft)
Main Channel Distance (ft)
1995
1990
1985
1980
1975
1970
1965
0
200
400
600
800
1000
1200
1400
1600
36...
94...
158.86
200.93
243.64
290.87
352.76
391.11
456.31
483.09
525.08
578.29
639.85
668.47
734.89
825.71
866.03
903.84
952.05
979.98
1015.45
1075.18
1116.89
1169.18
1212.98
1247.75
1303.8
1333.35
1392.97
1427.16
1503.09
1532.44



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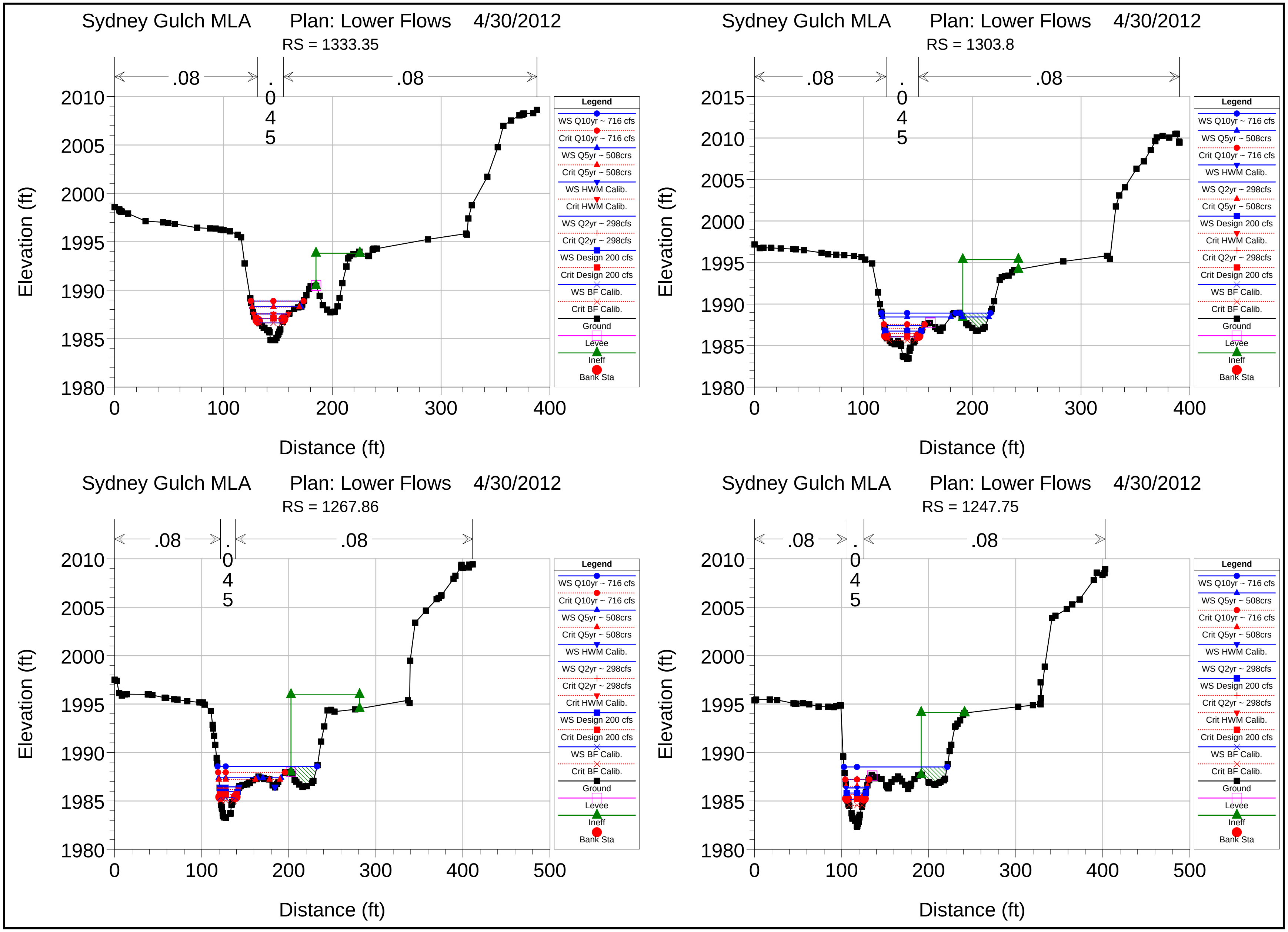
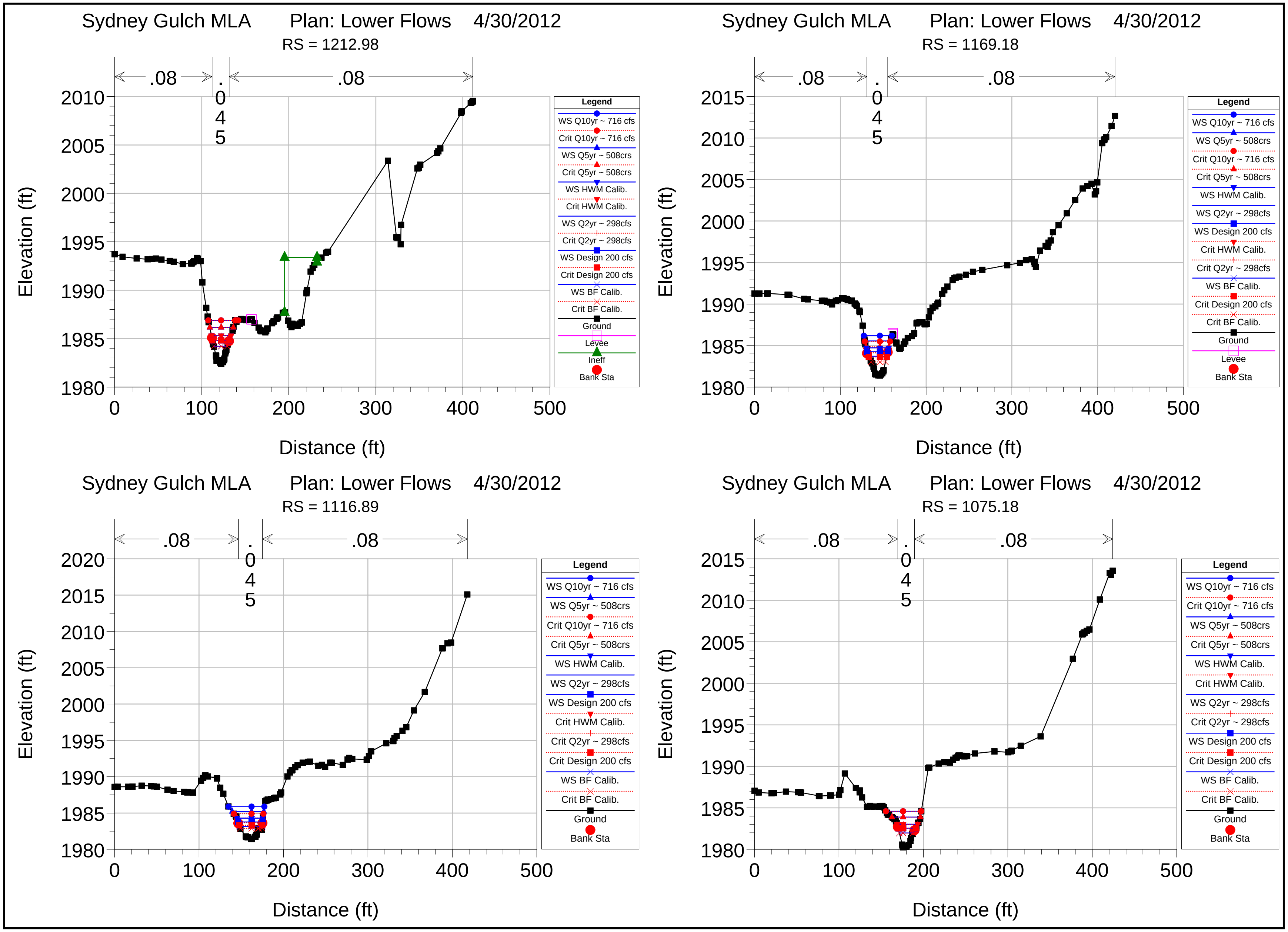
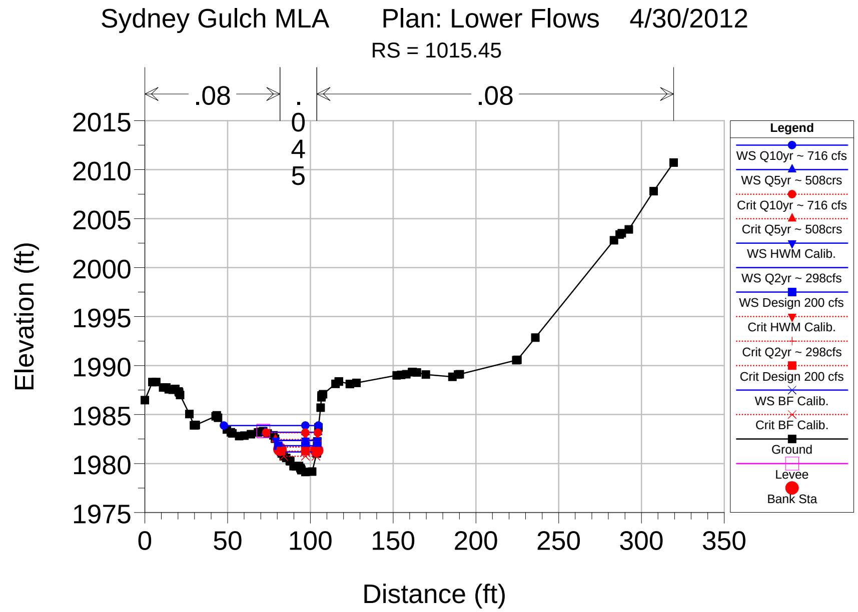
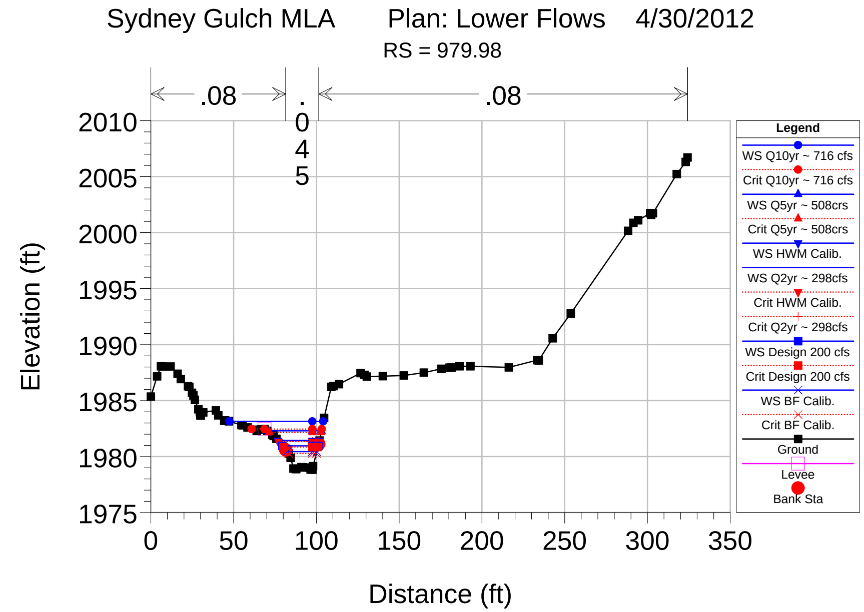
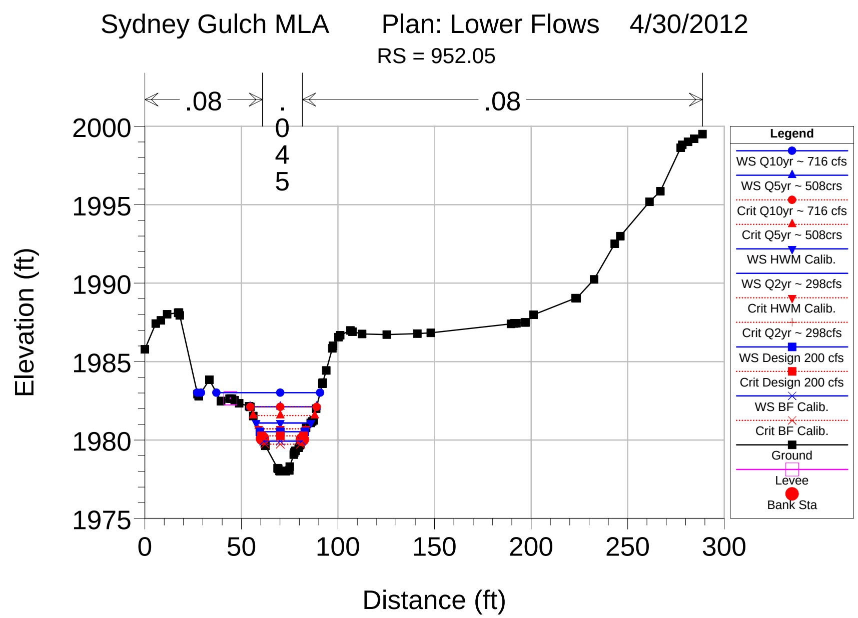
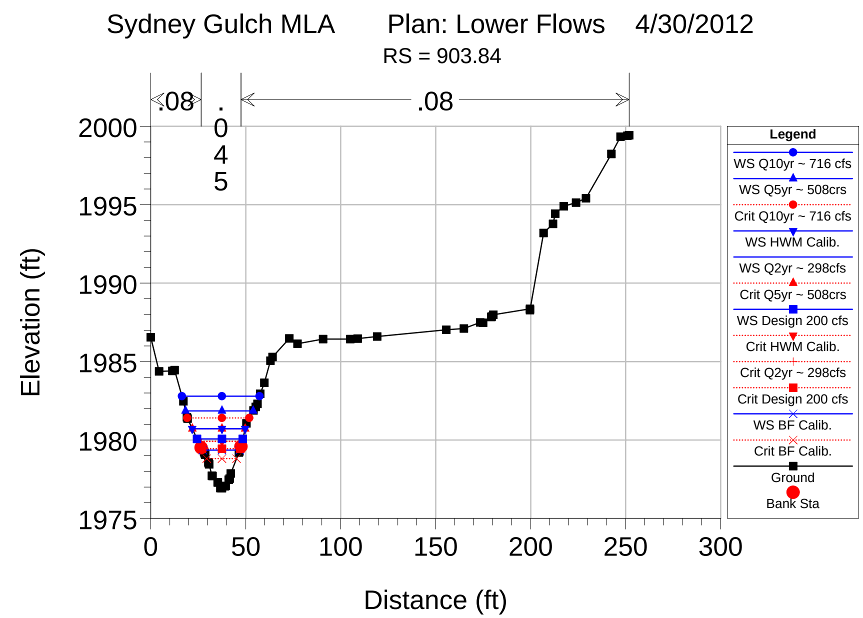

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1333.35
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
Crit HWM Calib.
WS Q2yr ~ 298cfs
Crit Q2yr ~ 298cfs
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Levee
Ineff
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1303.8
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Levee
Ineff
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1267.86
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q2yr ~ 298cfs
Crit HWM Calib.
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Levee
Ineff
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1247.75
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit Q2yr ~ 298cfs
Crit HWM Calib.
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Levee
Ineff
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1212.98
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
Crit HWM Calib.
WS Q2yr ~ 298cfs
Crit Q2yr ~ 298cfs
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Levee
Ineff
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1169.18
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Levee
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1116.89
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Bank Sta
Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 1075.18
.08
.045
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
Crit HWM Calib.
WS Q2yr ~ 298cfs
Crit Q2yr ~ 298cfs
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Bank Sta









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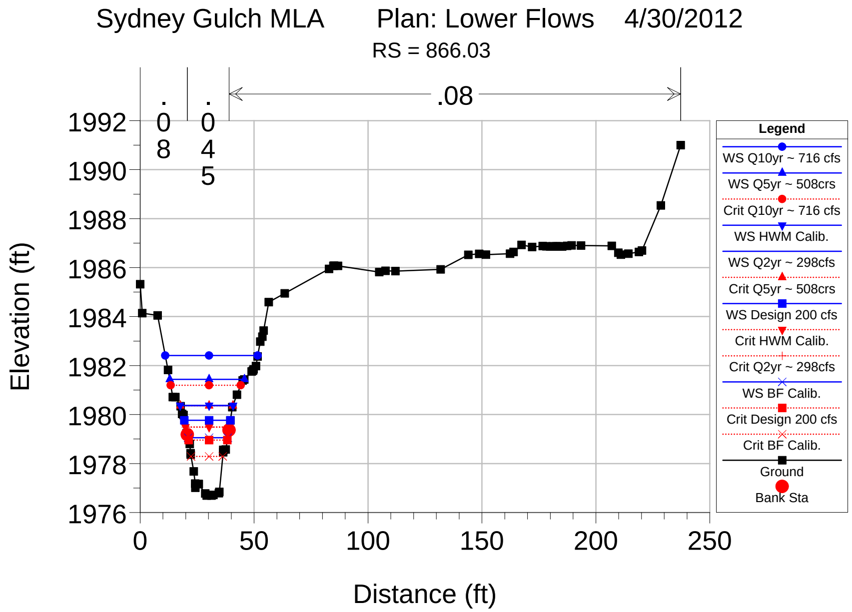
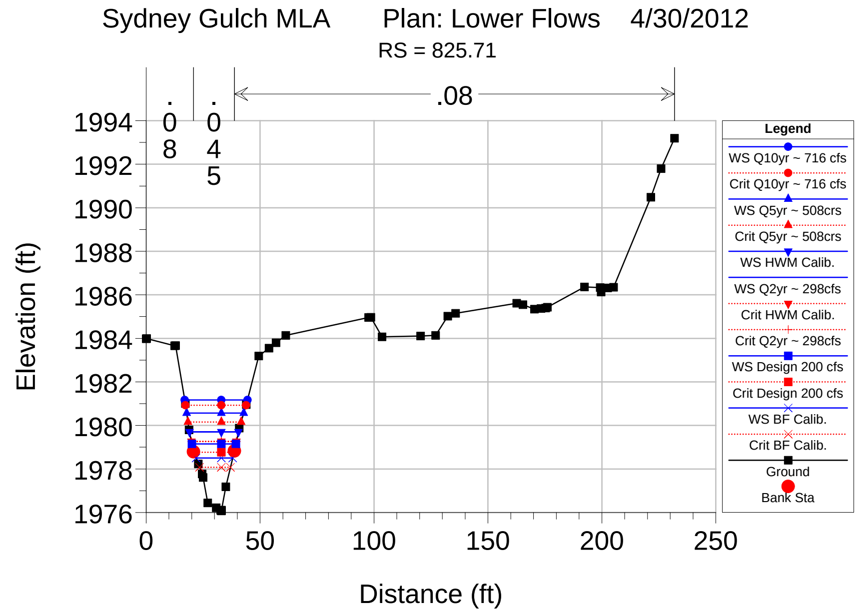
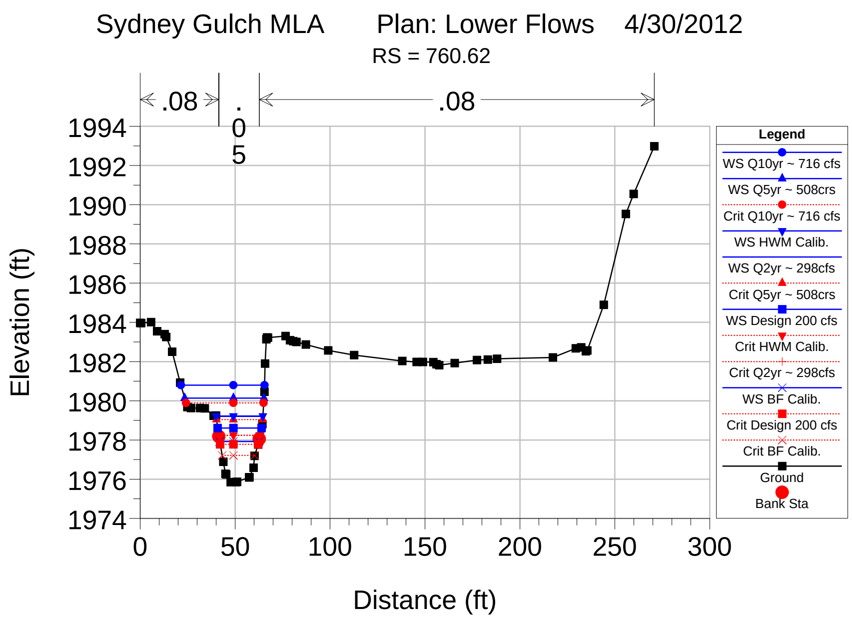
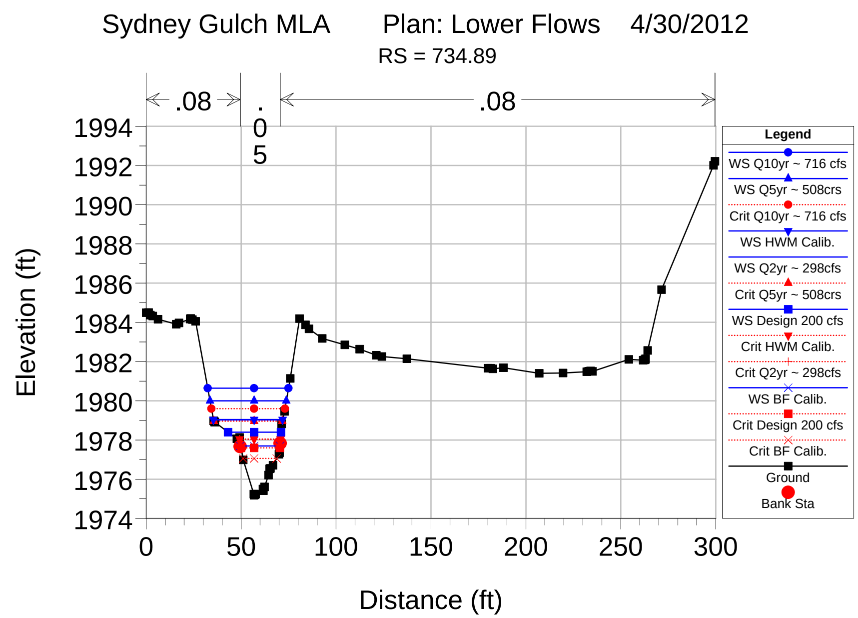
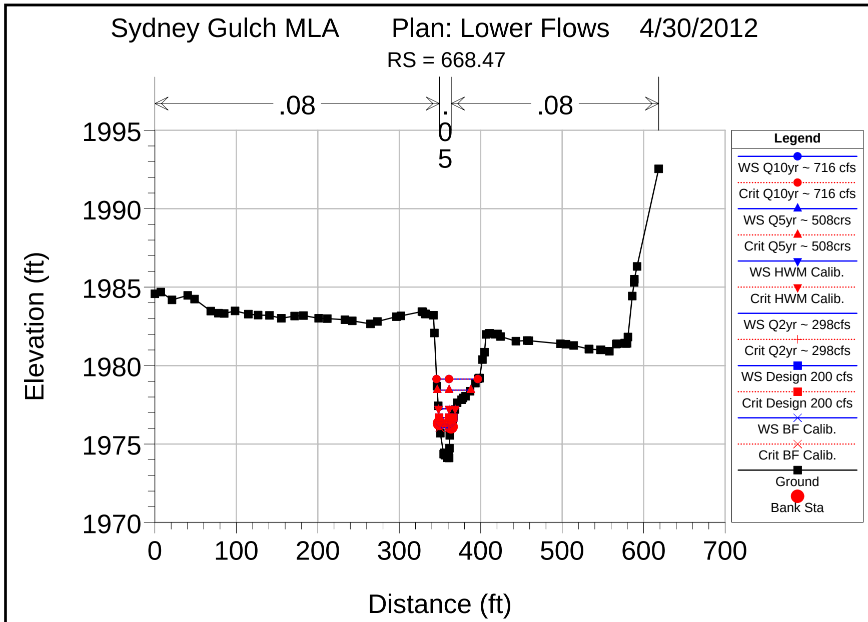
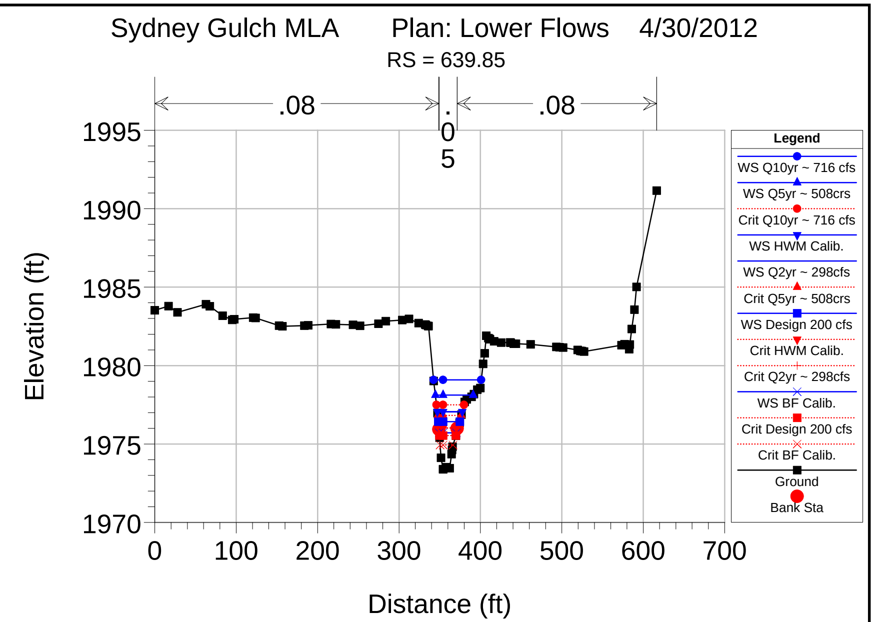

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 866.03
.08
.045
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta

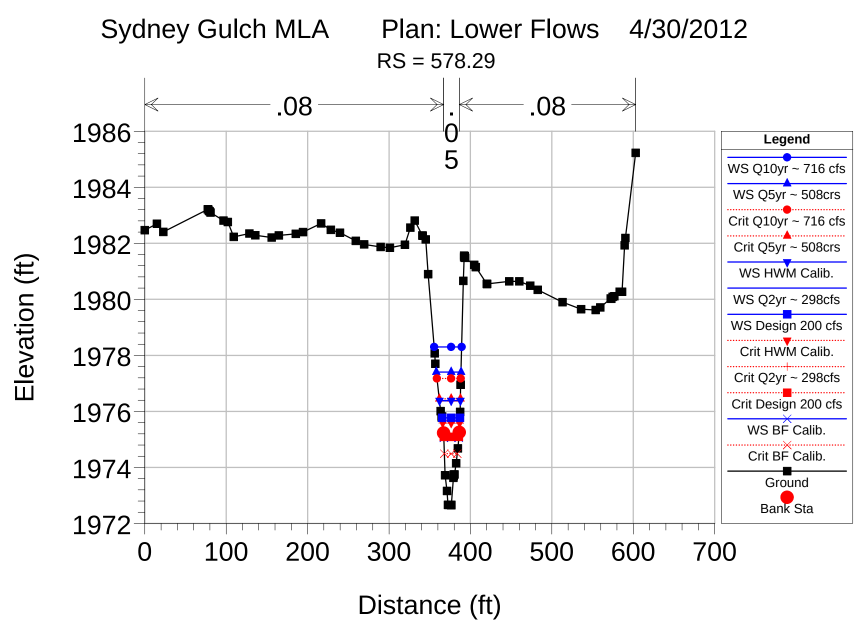

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 825.71
.08
.045
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Bank Sta

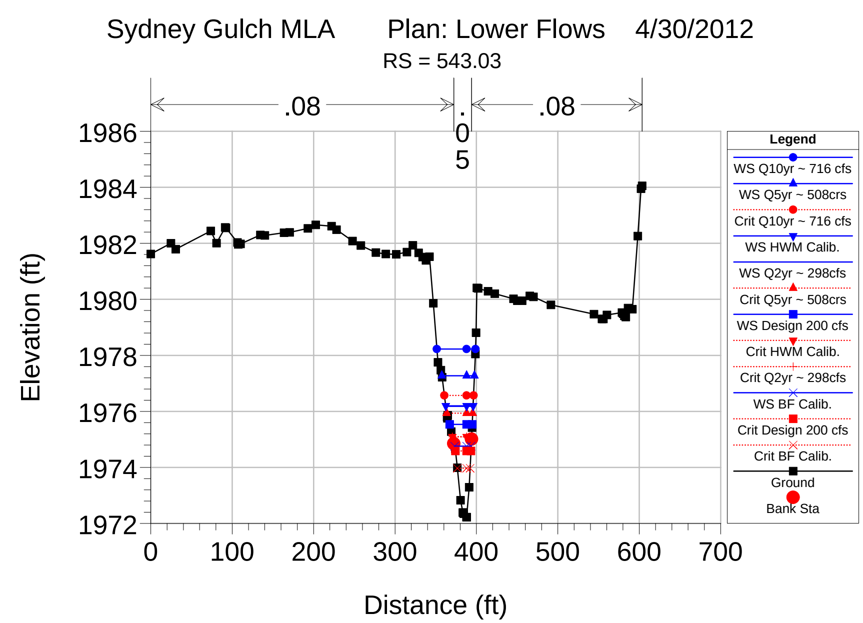

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 760.62
.08
.05
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 734.89
.08
.05
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta









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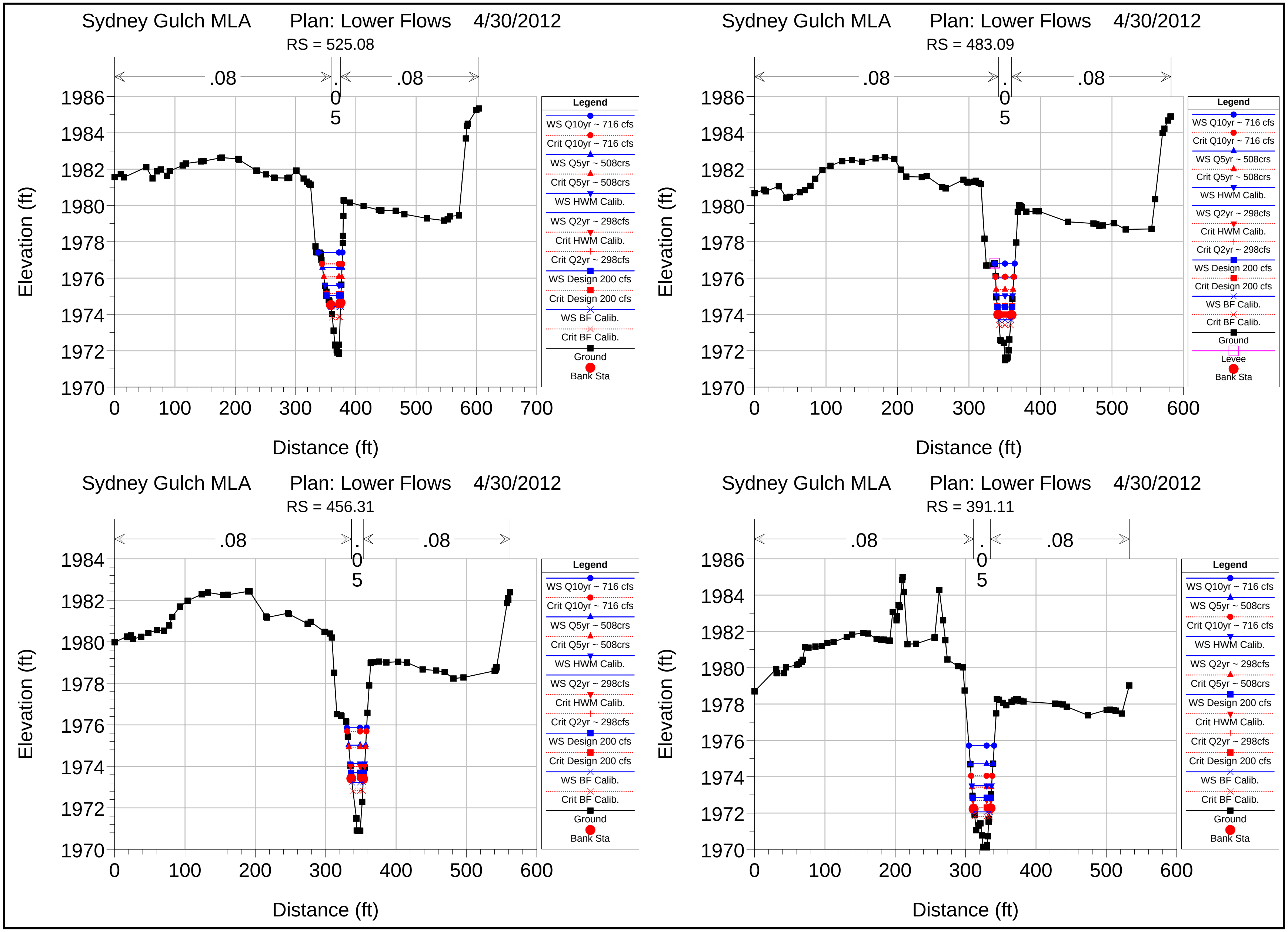

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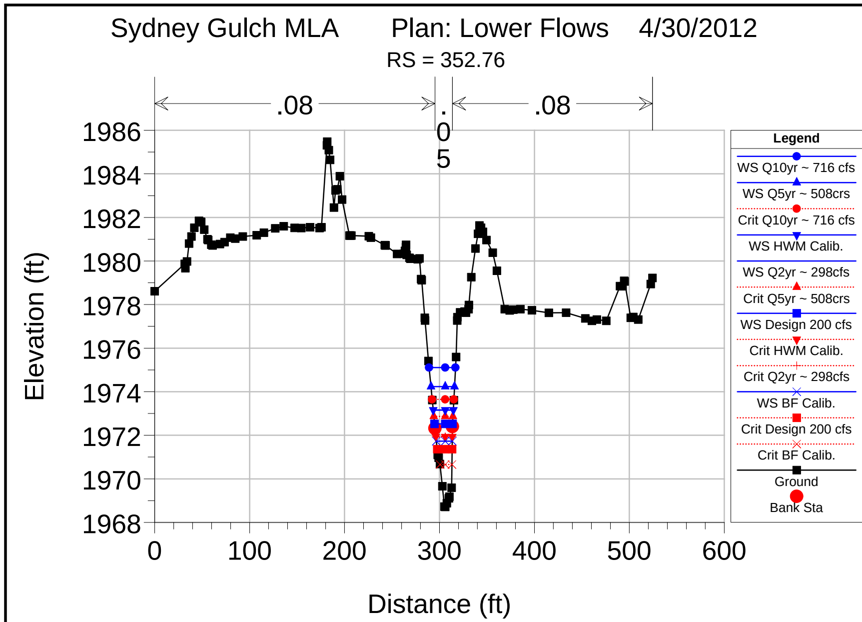
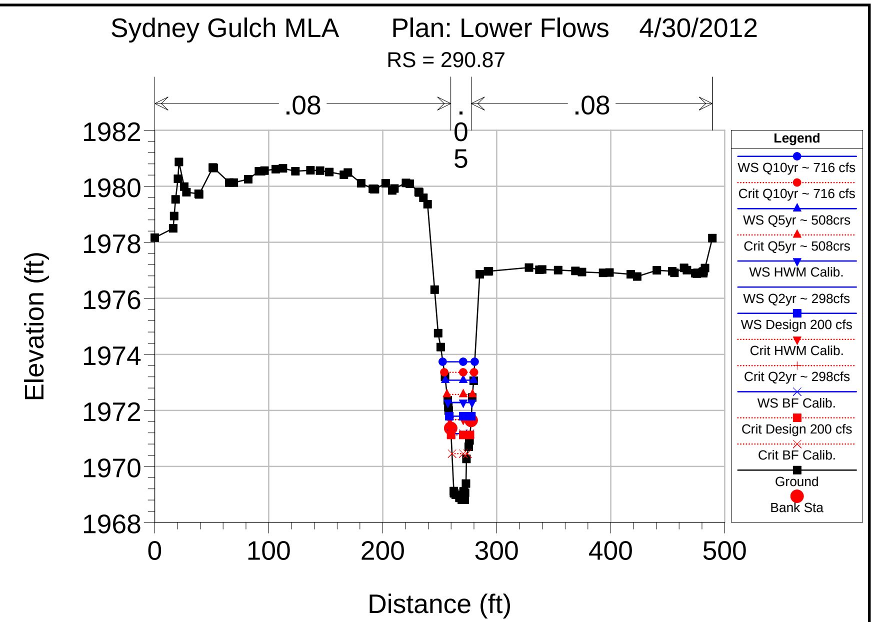
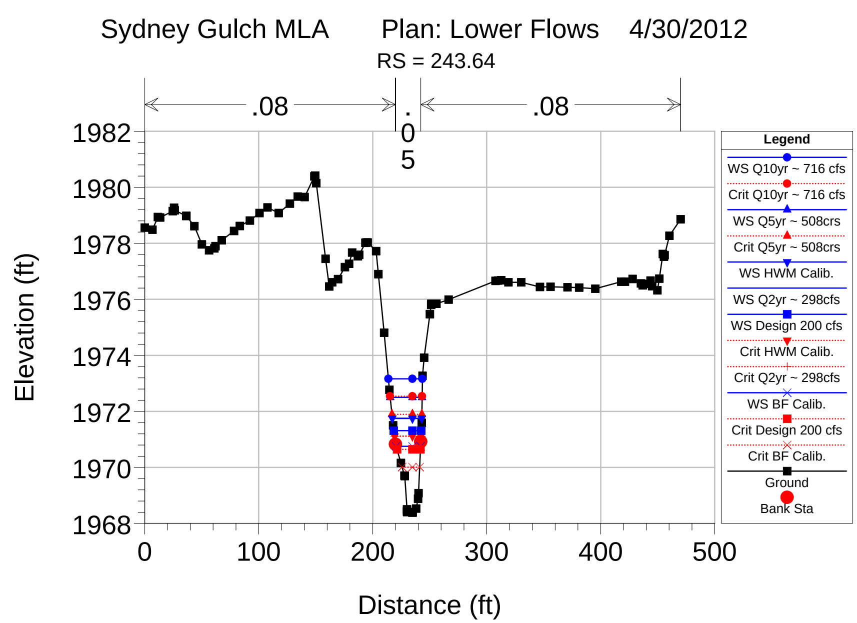
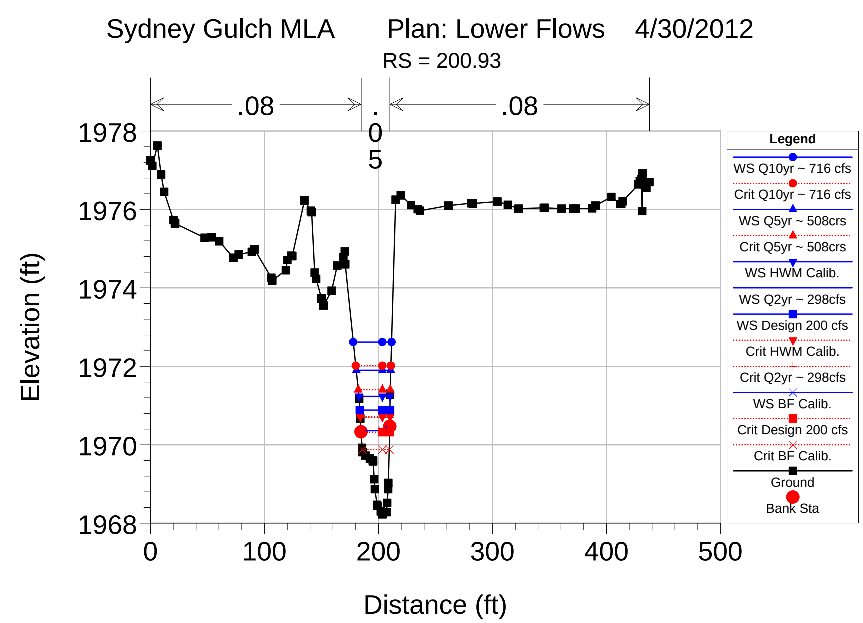
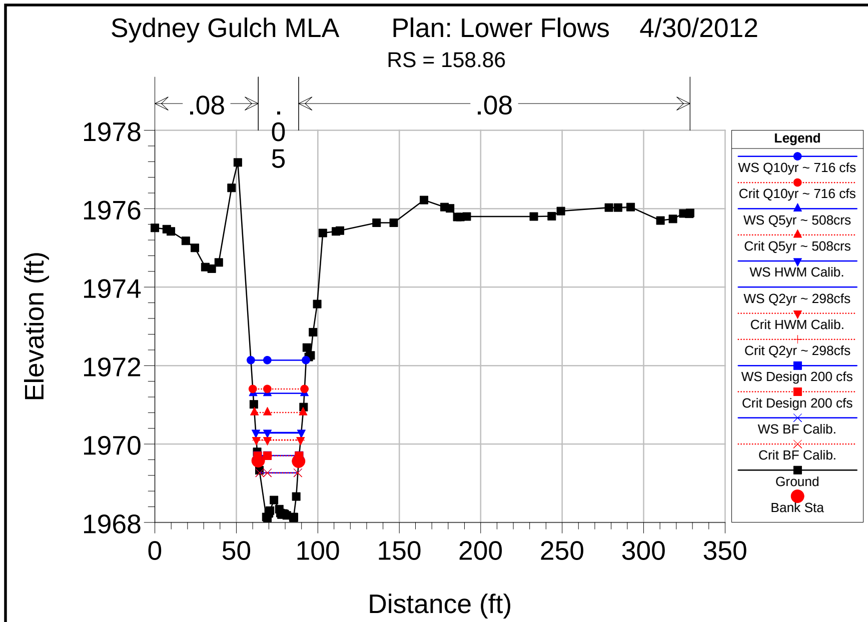
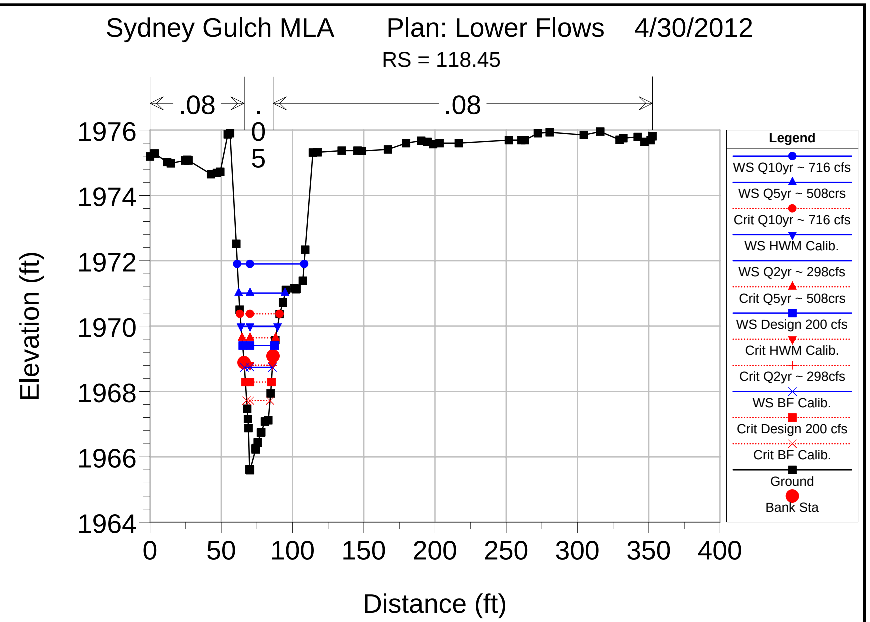

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 352.76
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta

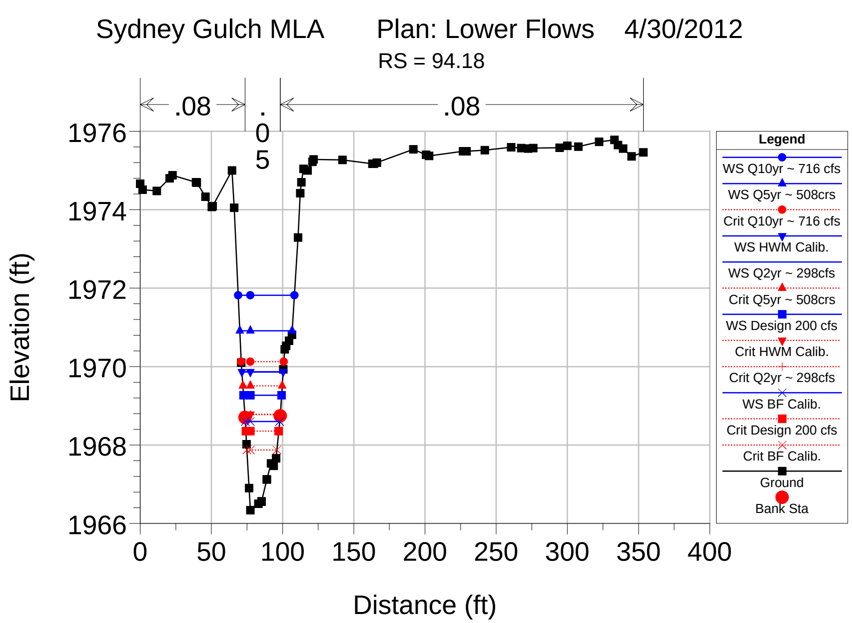

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 290.87
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta

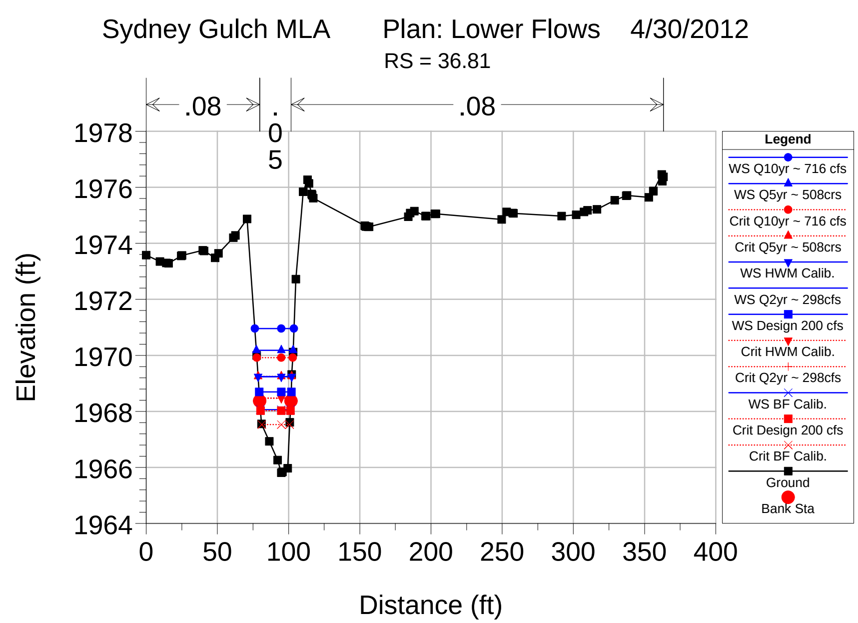

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 243.64
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 200.93
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta

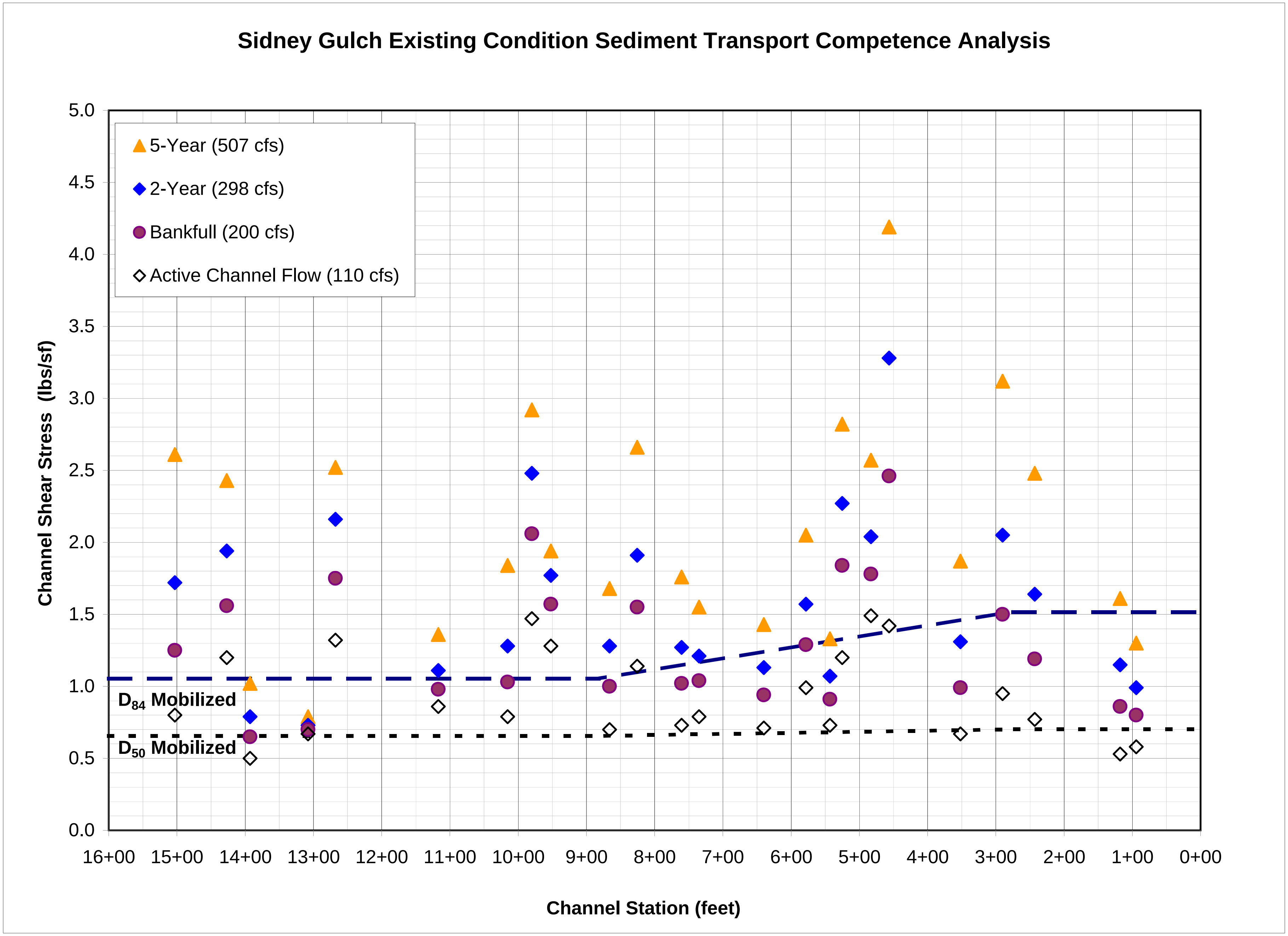

Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 158.86
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
Crit Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS Design 200 cfs
Crit Design 200 cfs
WS BF Calib.
Crit BF Calib.
Ground
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 118.45
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 94.18
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
WS HWM Calib.
WS Q2yr ~ 298cfs
Crit Q5yr ~ 508crs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta


Sydney Gulch MLA Plan: Lower Flows 4/30/2012
RS = 36.81
.08
.05
.08
Elevation (ft)
Distance (ft)
Legend
WS Q10yr ~ 716 cfs
WS Q5yr ~ 508crs
Crit Q10yr ~ 716 cfs
Crit Q5yr ~ 508crs
WS HWM Calib.
WS Q2yr ~ 298cfs
WS Design 200 cfs
Crit HWM Calib.
Crit Q2yr ~ 298cfs
WS BF Calib.
Crit Design 200 cfs
Crit BF Calib.
Ground
Bank Sta

Attachment 4: Sediment Transport Competence Analysis



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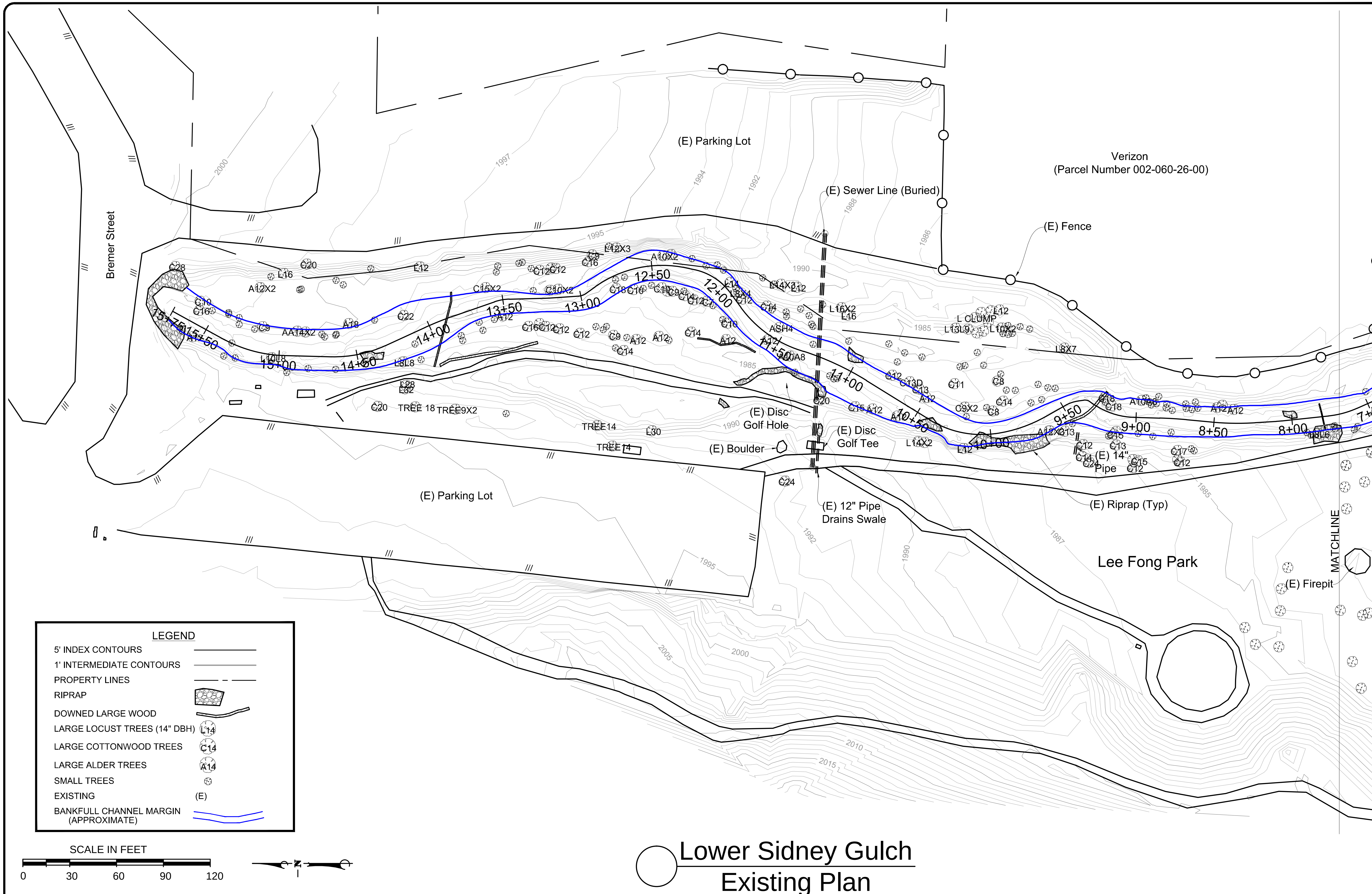
Attachment 5: Existing Conditions Plan, Profile and Geomorphic Summary



LEGEND

- 5' INDEX CONTOURS
- 1' INTERMEDIATE CONTOURS
- PROPERTY LINES
- RIPRAP
- DOWNED LARGE WOOD
- LARGE LOCUST TREES (14" DBH) L14
- LARGE COTTONWOOD TREES C14
- LARGE ALDER TREES A14
- SMALL TREES
- EXISTING (E)
- BANKFULL CHANNEL MARGIN (APPROXIMATE)

SCALE IN FEET

0 30 60 90 120

Lower Sidney Gulch
Existing Plan

Michael Love & Associates
Hydrologic Solutions

GMA
Hydrology | Geomorphology | Stream Restoration

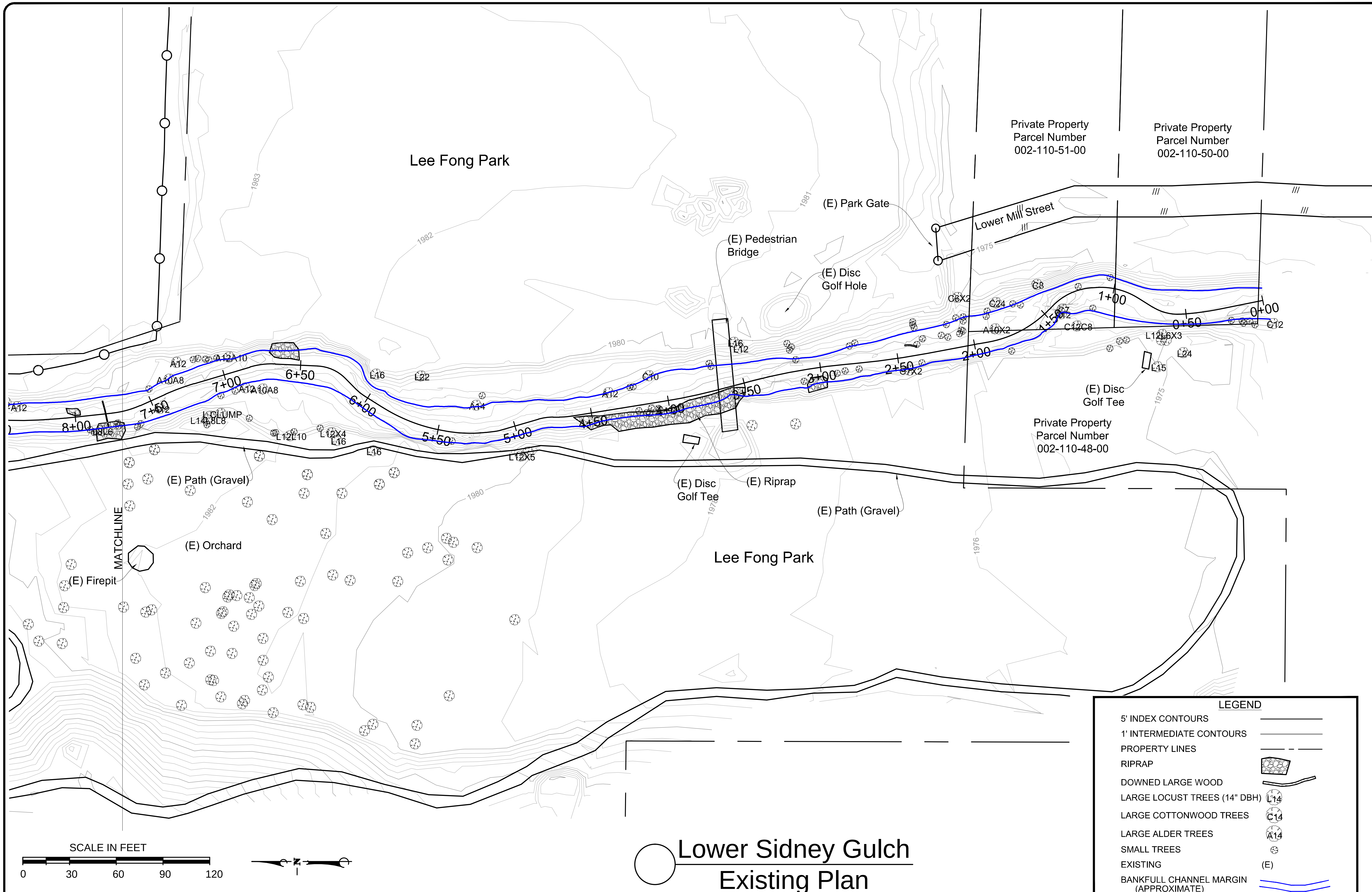
FIVE COUNTIES SALMONID CONSERVATION PROGRAM

Lower Sidney Gulch Stream Restoration, Phase 1

LOWER SIDNEY GULCH

EXISTING PLAN

DATE	May, 2012
SUBMITTAL	Concept
DESIGN	ML / RS
DRAWN	KB
SHEET	1 of 2



Lower Sidney Gulch
Existing Plan

Michael Love & Associates
Hydrologic Solutions
Hydrology | Geomorphology | Stream Restoration

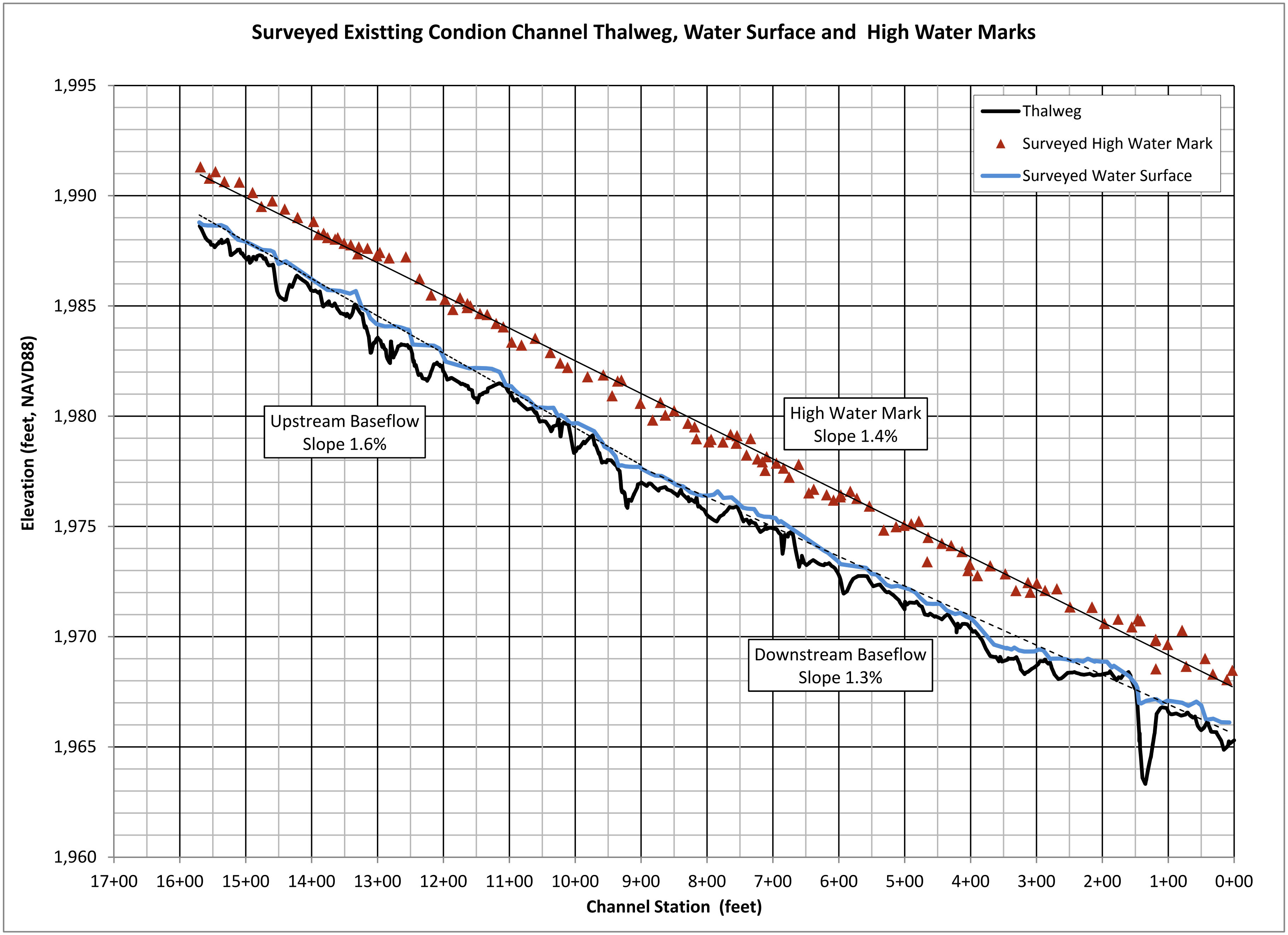
FIVE COUNTIES SALMONID CONSERVATION PROGRAM

Lower Sidney Gulch Stream Restoration, Phase 1

LOWER SIDNEY GULCH

EXISTING PLAN

DATE	May, 2012
SUBMITTAL	Concept
DESIGN	ML / RS
DRAWN	KB
SHEET	2 of 2



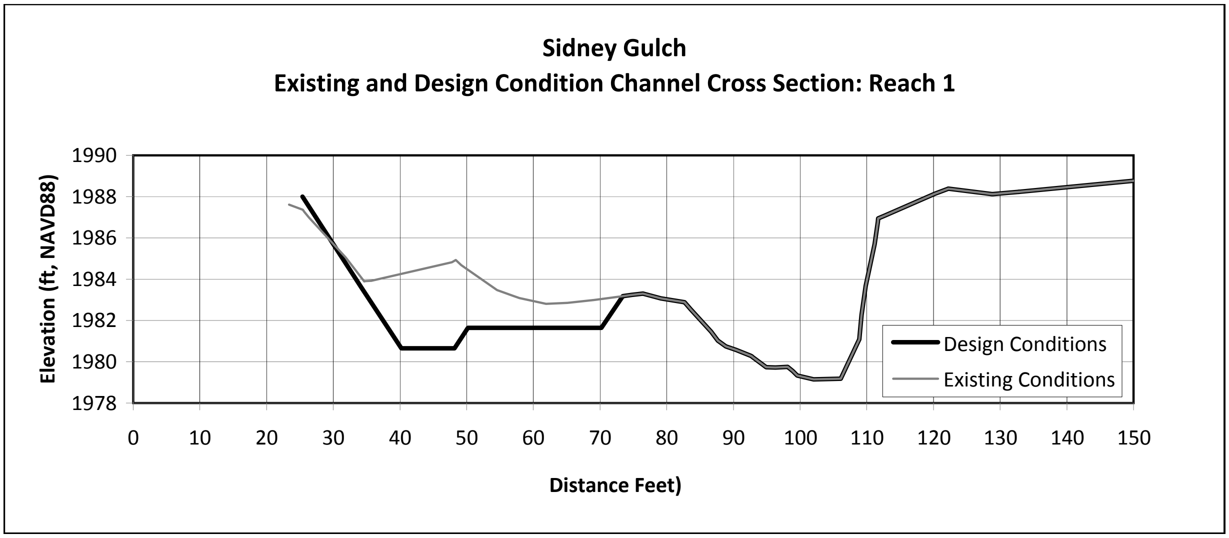
Surveyed Existting Condion Channel Thalweg, Water Surface and High Water Marks
Thalweg
Surveyed High Water Mark
Surveyed Water Surface
Upstream Baseflow Slope 1.6%
High Water Mark Slope 1.4%
Downstream Baseflow Slope 1.3%
Elevation (feet, NAVD88)
1,995
1,990
1,985
1,980
1,975
1,970
1,965
1,960
17+00
16+00
15+00
14+00
13+00
12+00
11+00
10+00
9+00
8+00
7+00
6+00
5+00
4+00
3+00
2+00
1+00
0+00
Channel Station (feet)

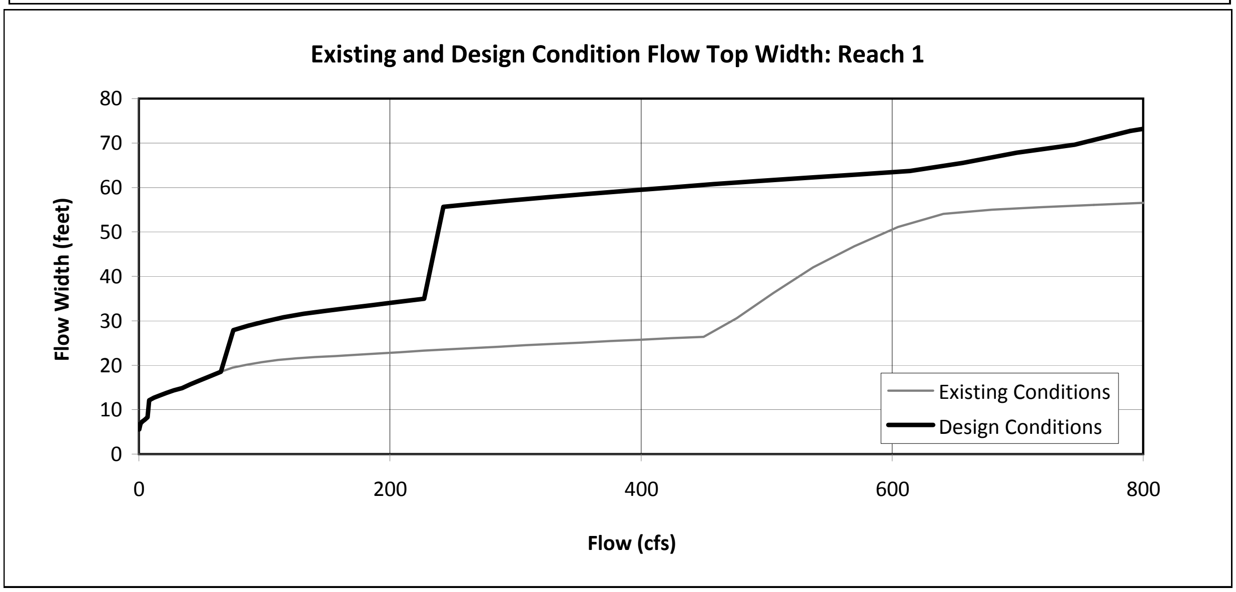
Summary of Geomorphic Parameters in the Lee Fong Park Reach of Sidney Gulch

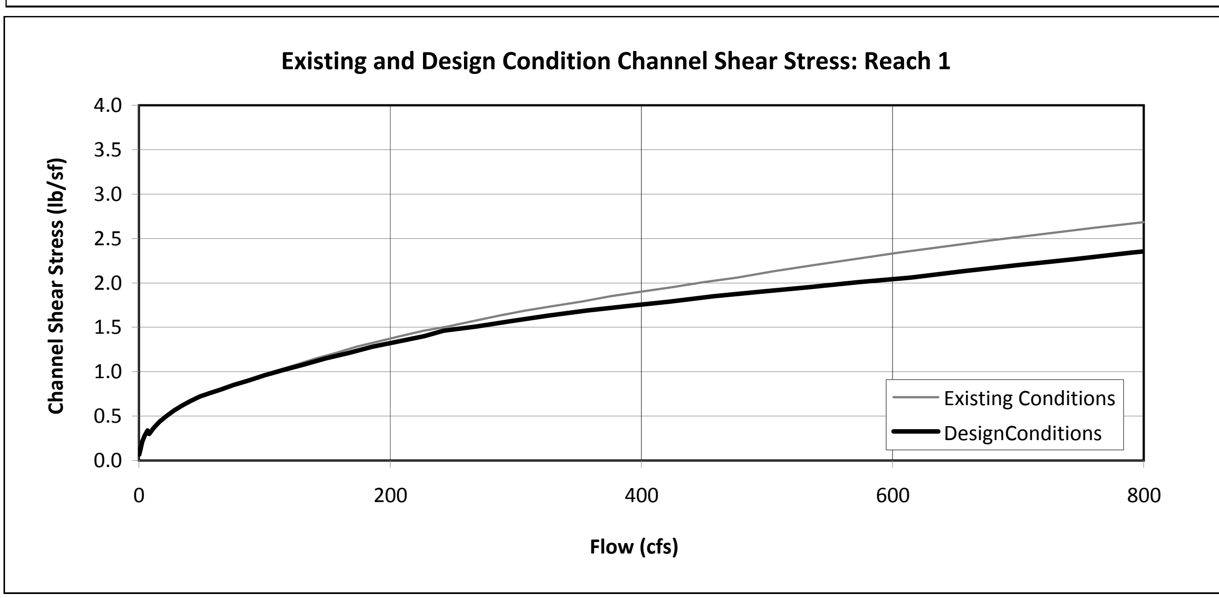
	Upstream (Stations 15+32 to 9+00)	Downstream (Stations 9+00 to 0+00)
Overall Slope	1.6%	1.3%
Field Measured Active Channel Width	7.8 to 12.5 feet **Average 10.1 feet**	7.0 to 13.5 feet **Average 10.3 feet**
Field Measured Active Flow Width	20.0 to 24.5 feet **Average 22.1 feet**	14.5 to 21.0 feet **Average 16.7 feet**
Field Measured Active Flow Depth	2-2.5 feet	-
Modeled Bankfull Flow Width	20.2 to 37.2 feet **Average 26.3 feet**	18.5 to 27.9 feet **Average 22.7 feet**
Modeled Bankfull Flow Depth	2.1 to 3.3 feet **Average 2.6 feet**	2.8 to 3.8 feet **Average 3.1 feet**
Modeled Bankfull Flow Width/Max. Depth Ratio	7.5 to 13.4 **Average 10.2**	5.0 to 9.1 **Average 7.3**
Modeled 2-Year Flow Width	23.8 to 43.2 feet **Average 29.8 feet**	20.6 to 36.4 feet **Average 25.9 feet**
Modeled 2-Year Maximum Flow Depth	2.6 to 4.0 feet **Average 3.1 feet**	3.2 to 4.4 feet **Average 3.7**
Modeled 5-Year Flow Width	32.0 to 87.0 feet **Average 50.4 feet**	24.3 to 46.4 feet **Average 32.4**
Modeled Entrenchment (5-Year Width/2-Year Width)	1.2 to 2.8 **Average 1.7**	1.1 to 1.7 **Average 1.3**
Mapped Channel Corridor Width	80 to 120 feet	40 to 70 feet
Bed Material Size	D_{50} 38.8 mm D_{84} 62.4 mm	D_{50} 42.5 mm D_{84} 90.0 mm

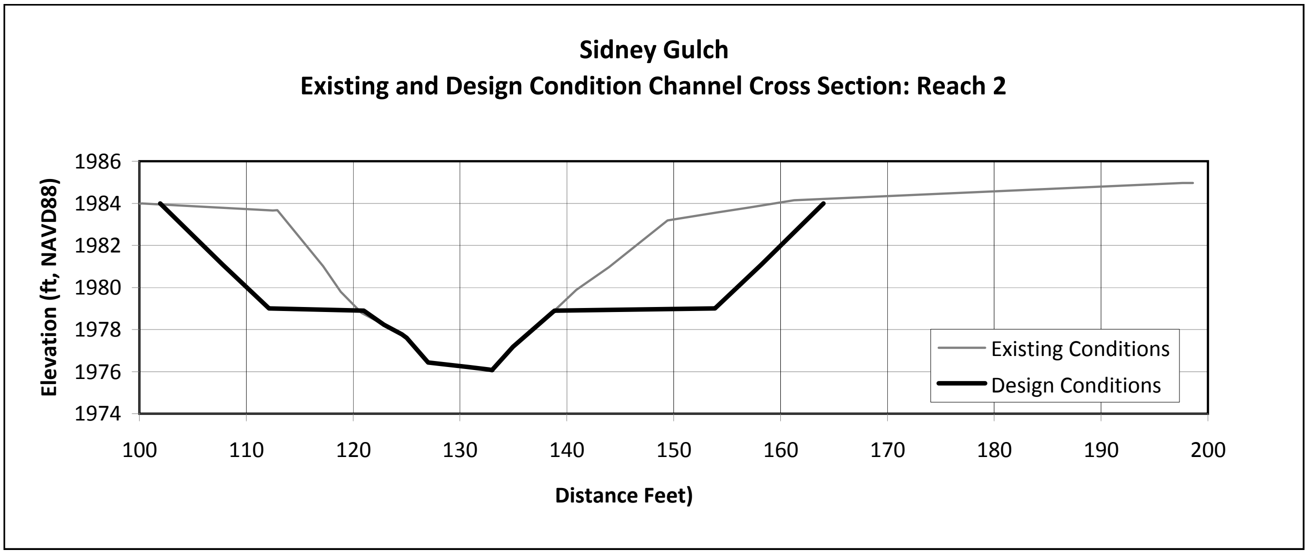
Attachment 6: Design Condition Plan and Typical Cross Sections

Attachment 7: Comparison of Existing and Design Condition Hydraulics

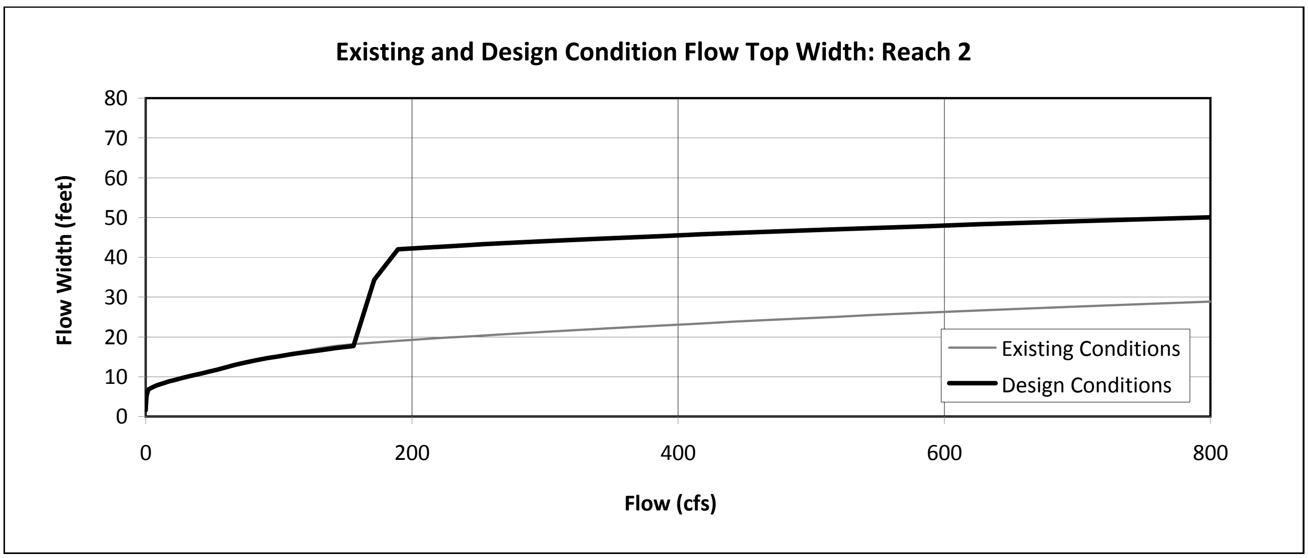

Sidney Gulch
Existing and Design Condition Channel Cross Section: Reach 1
Elevation (ft, NAVD88)
1990
1988
1986
1984
1982
1980
1978
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Distance Feet)
Design Conditions
Existing Conditions


Existing and Design Condition Flow Top Width: Reach 1
Flow Width (feet)
80
70
60
50
40
30
20
10
0
200
400
600
800
Flow (cfs)
Existing Conditions
Design Conditions

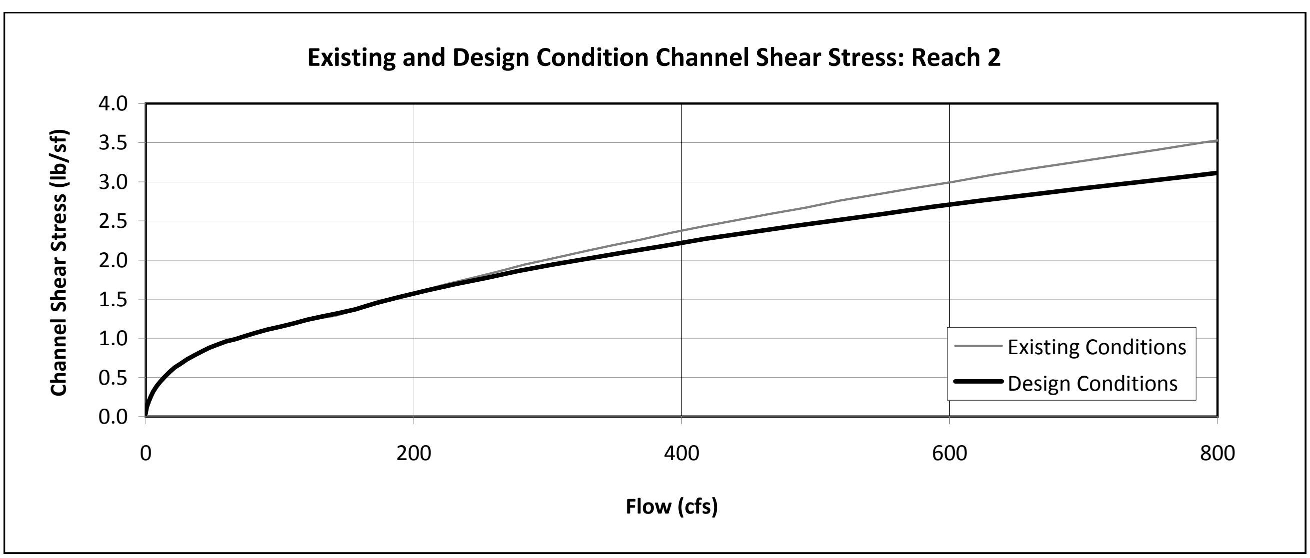

Existing and Design Condition Channel Shear Stress: Reach 1
Channel Shear Stress (lb/sf)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
Flow (cfs)
Existing Conditions
DesignConditions



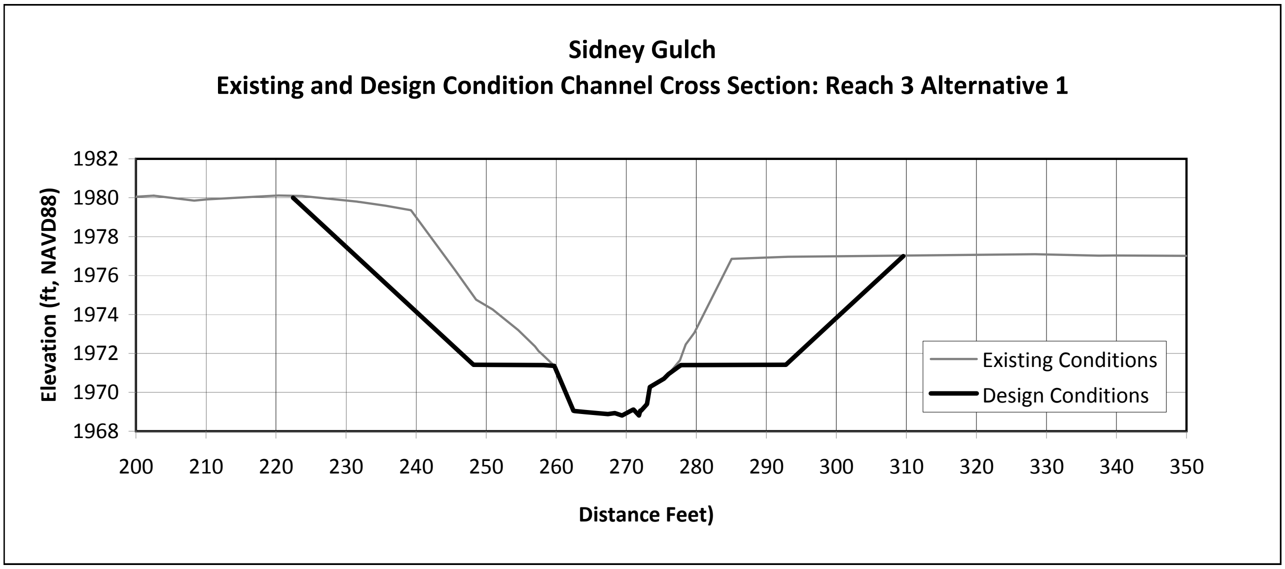
Sidney Gulch
Existing and Design Condition Channel Cross Section: Reach 2
Elevation (ft, NAVD88)
1986
1984
1982
1980
1978
1976
1974
100
110
120
130
140
150
160
170
180
190
200
Distance Feet)
Existing Conditions
Design Conditions

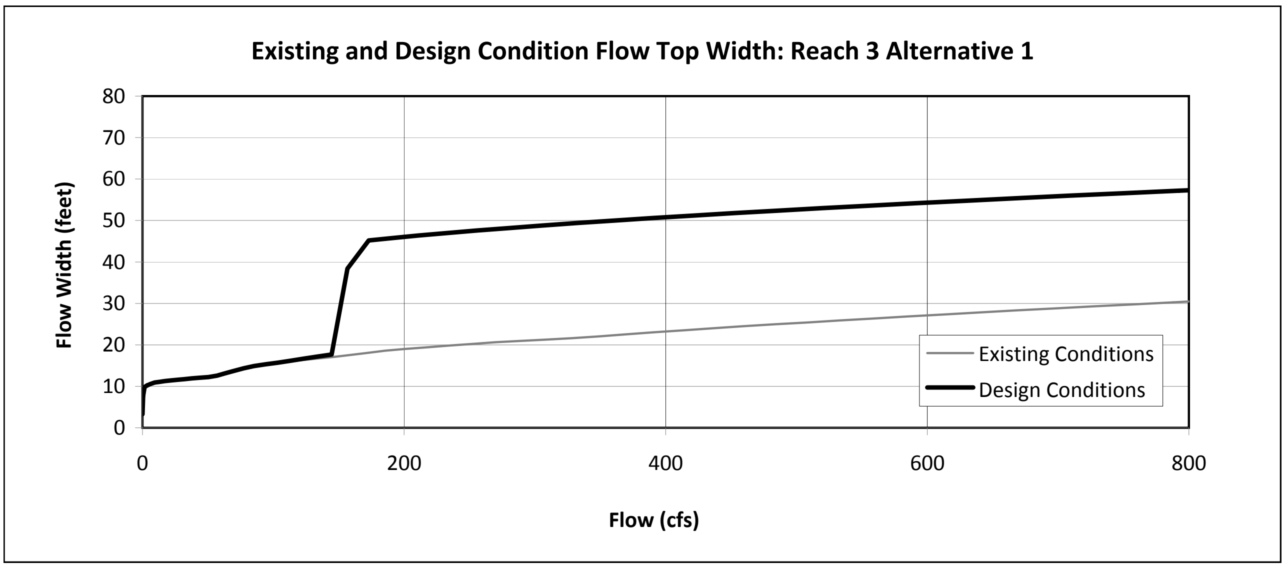


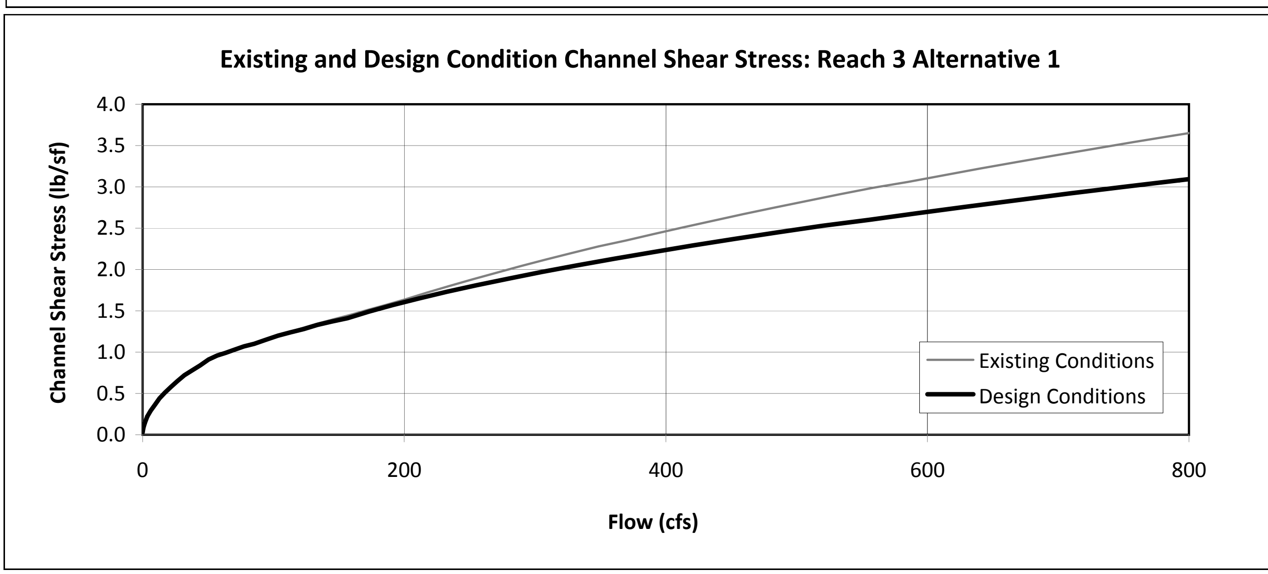
Existing and Design Condition Flow Top Width: Reach 2
Flow Width (feet)
80
70
60
50
40
30
20
10
0
0
200
400
600
800
Flow (cfs)
Existing Conditions
Design Conditions

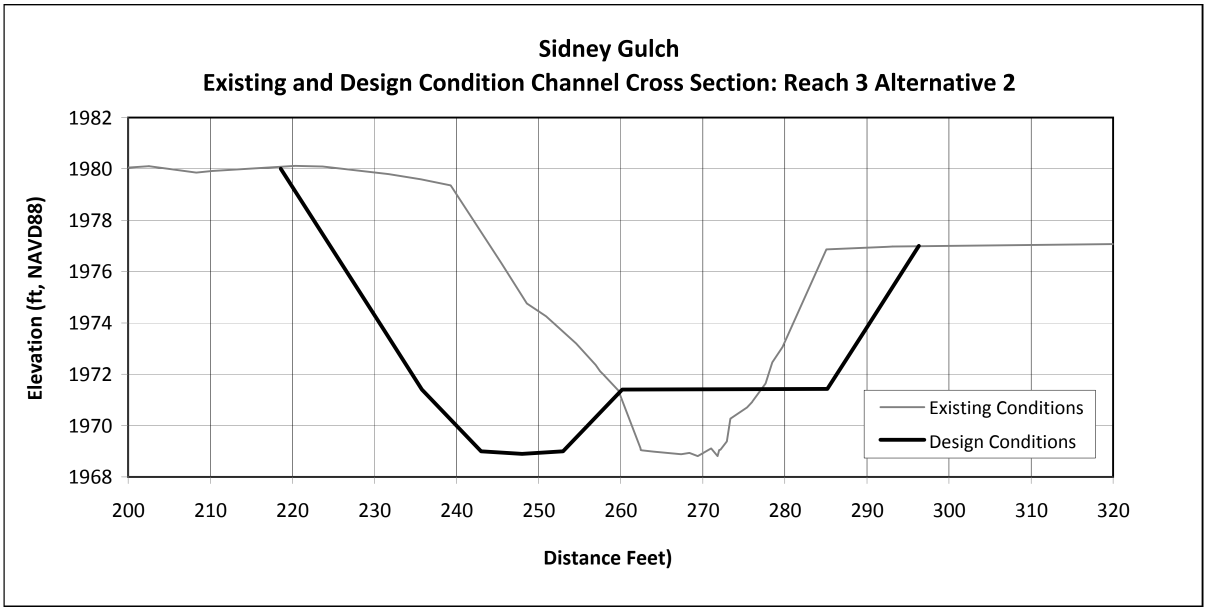


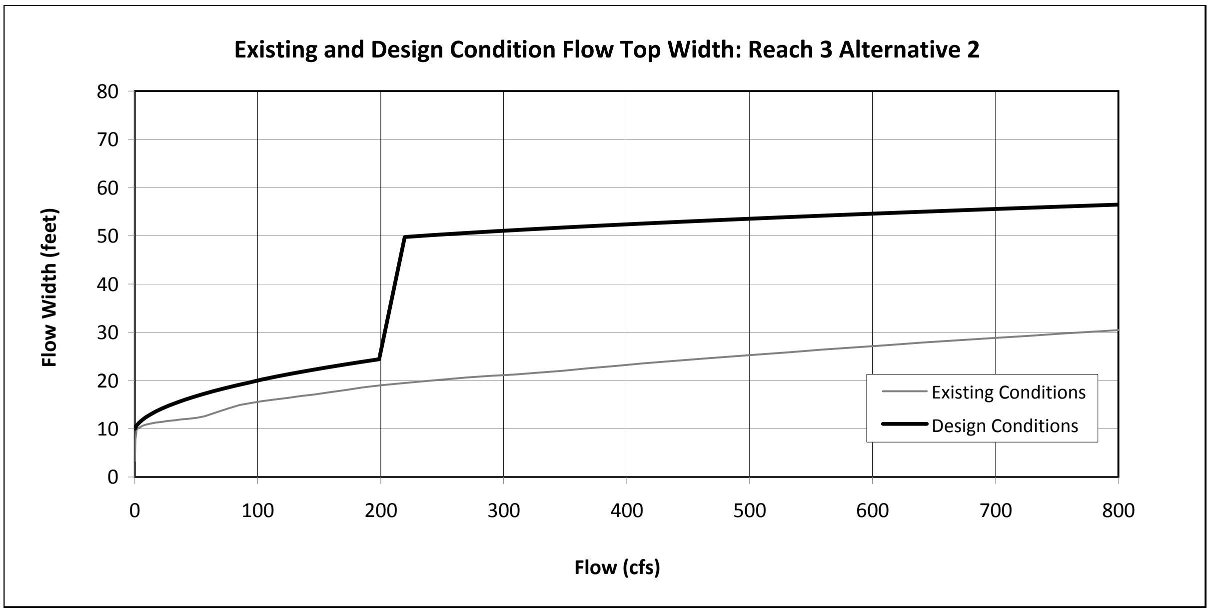
Existing and Design Condition Channel Shear Stress: Reach 2
Channel Shear Stress (lb/sf)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
Flow (cfs)
Existing Conditions
Design Conditions

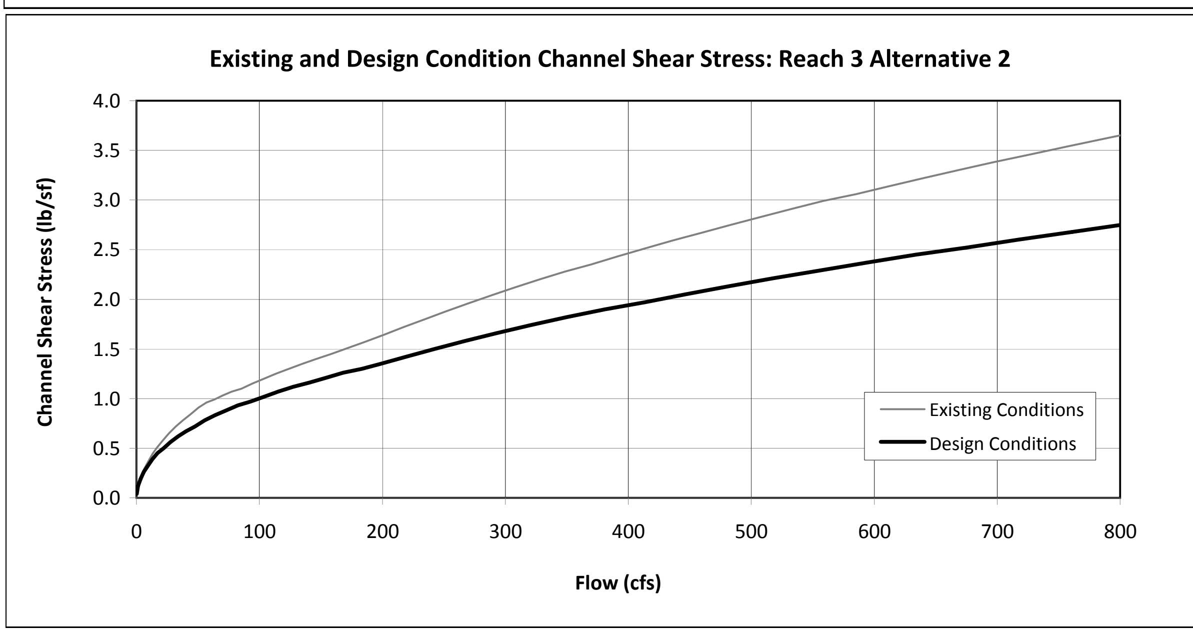

Sidney Gulch
Existing and Design Condition Channel Cross Section: Reach 3 Alternative 1
Elevation (ft, NAVD88)
1982
1980
1978
1976
1974
1972
1970
1968
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
Distance Feet)
Existing Conditions
Design Conditions

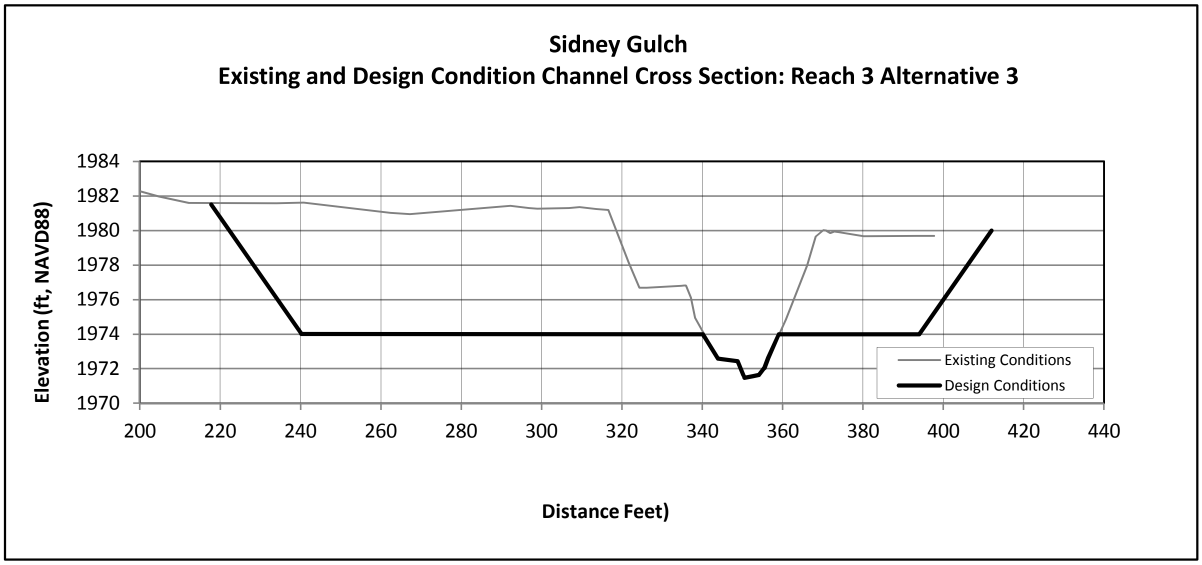

Existing and Design Condition Flow Top Width: Reach 3 Alternative 1
Flow Width (feet)
80
70
60
50
40
30
20
10
0
0
200
400
600
800
Flow (cfs)
Existing Conditions
Design Conditions

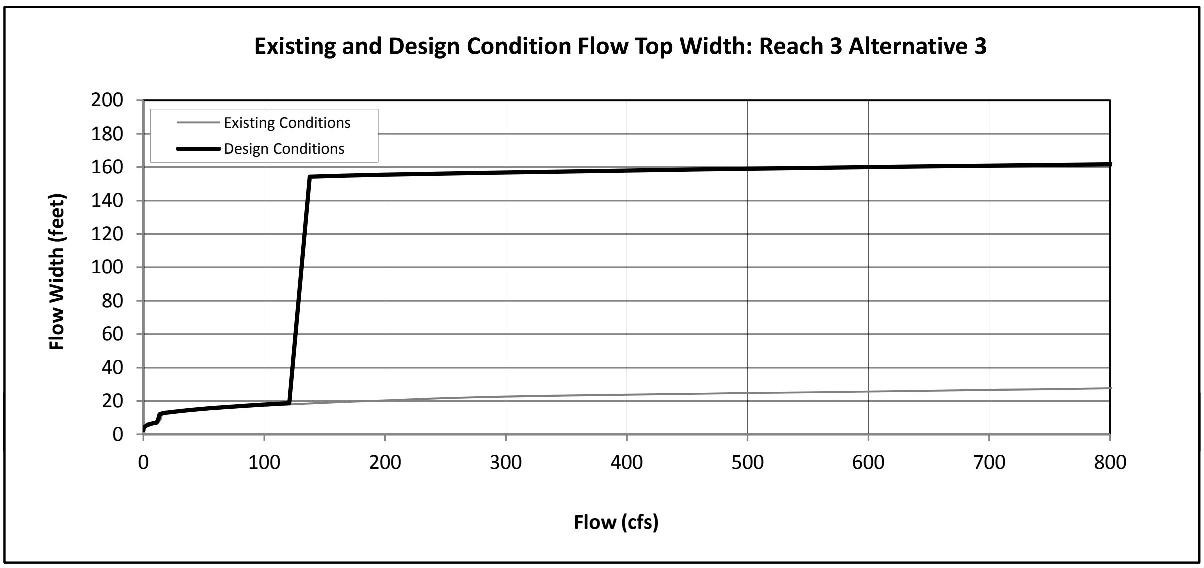

Existing and Design Condition Channel Shear Stress: Reach 3 Alternative 1
Channel Shear Stress (lb/sf)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
Flow (cfs)
Existing Conditions
Design Conditions

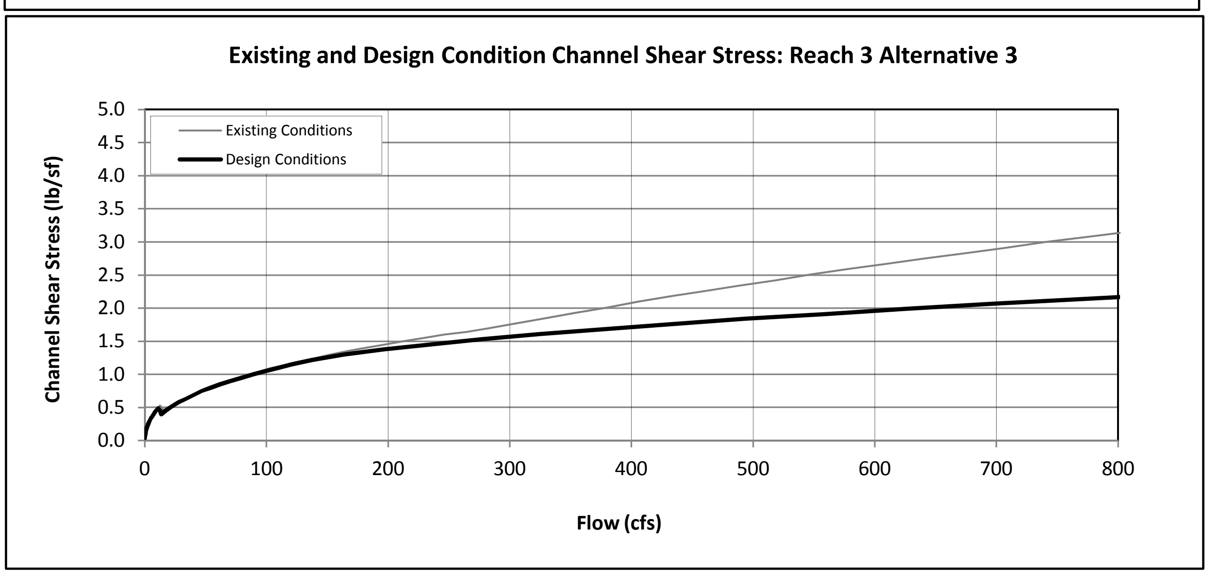

Sidney Gulch
Existing and Design Condition Channel Cross Section: Reach 3 Alternative 2
Elevation (ft, NAVD88)
1982
1980
1978
1976
1974
1972
1970
1968
200
210
220
230
240
250
260
270
280
290
300
310
320
Distance Feet)
Existing Conditions
Design Conditions


Existing and Design Condition Flow Top Width: Reach 3 Alternative 2
Flow Width (feet)
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
Flow (cfs)
Existing Conditions
Design Conditions


Existing and Design Condition Channel Shear Stress: Reach 3 Alternative 2
Channel Shear Stress (lb/sf)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
700
800
Flow (cfs)
Existing Conditions
Design Conditions


Sidney Gulch
Existing and Design Condition Channel Cross Section: Reach 3 Alternative 3
Elevation (ft, NAVD88)
1984
1982
1980
1978
1976
1974
1972
1970
200
220
240
260
280
300
320
340
360
380
400
420
440
Existing Conditions
Design Conditions
Distance Feet)


Existing and Design Condition Flow Top Width: Reach 3 Alternative 3
Flow Width (feet)
200
180
160
140
120
100
80
60
40
20
0
100
200
300
400
500
600
700
800
Existing Conditions
Design Conditions
Flow (cfs)


Existing and Design Condition Channel Shear Stress: Reach 3 Alternative 3
Channel Shear Stress (lb/sf)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
700
800
Existing Conditions
Design Conditions
Flow (cfs)