Little Bridge Creek
Habitat Enhancement Project

Conceptual Design
Basis of Design Report

SUBMITTED TO
Yakama Nation Fisheries

December 31, 2018

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Yakama Nation Fisheries
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Toppenish, WA

PREPARED BY
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Table of Contents

Appendices

1. Preface

The Little Bridge Creek Fish Habitat Enhancement Project is between RM 0.7 to RM 2.0 on United States Forest Service Land. The goal of the project is to enhance instream and off-channel rearing habitat for ESA-listed endangered spring Chinook and threatened summer steelhead in accordance with the 2017 Biological Strategy (UCRTT 2017). Bull trout and west slope cutthroat will also benefit from the enhancement work. Little Bridge Creek enters the Twisp River from the North at RM 9.6.

1.1 NAME AND TITLES OF SPONSORS, FIRMS AND INDIVIDUALS RESPONSIBLE FOR DESIGN

The project is sponsored by Yakama Nation Fisheries (YN). Inter-Fluve is the engineering design firm. Mike McAllister (PE) is the licensed engineer of record and project manager. Mike Brunfelt (LG) has assisted with field and design work.

1.2 LIST OF PROJECT ELEMENTS THAT HAVE BEEN DESIGNED BY A LICENSED PROFESSIONAL ENGINEER

Mike McAllister (PE) is the licensed engineer of record for this project. Table 1 includes project elements, with BPA HIP IV activity and risk category:

Table 1. Activity categories and risk included in the project.

Description of Proposed Enhancement	Work Element	HIP IV Category	HIP IV Risk Level
Log structure construction to improve main channel habitat suitability and stability	Install habitat-forming natural material instream structures	2d	Low/Med

1.3 EXPLANATION AND BACKGROUND ON FISHERIES USE (BY LIFE STAGE – PERIOD) AND LIMITING FACTORS ADDRESSED BY THE PROJECT

Fish species known to utilize the project area include ESA-listed (endangered) spring Chinook Salmon, ESA-listed (threatened) summer steelhead and Bull Trout, and unlisted Westslope Cutthroat Trout, Pacific Lamprey, Mountain Whitefish, and non-native Brook Trout (Figure 1). Chinook Salmon, steelhead and Bull Trout are focal species for this habitat enhancement project, while the work is also expected to benefit all species present.

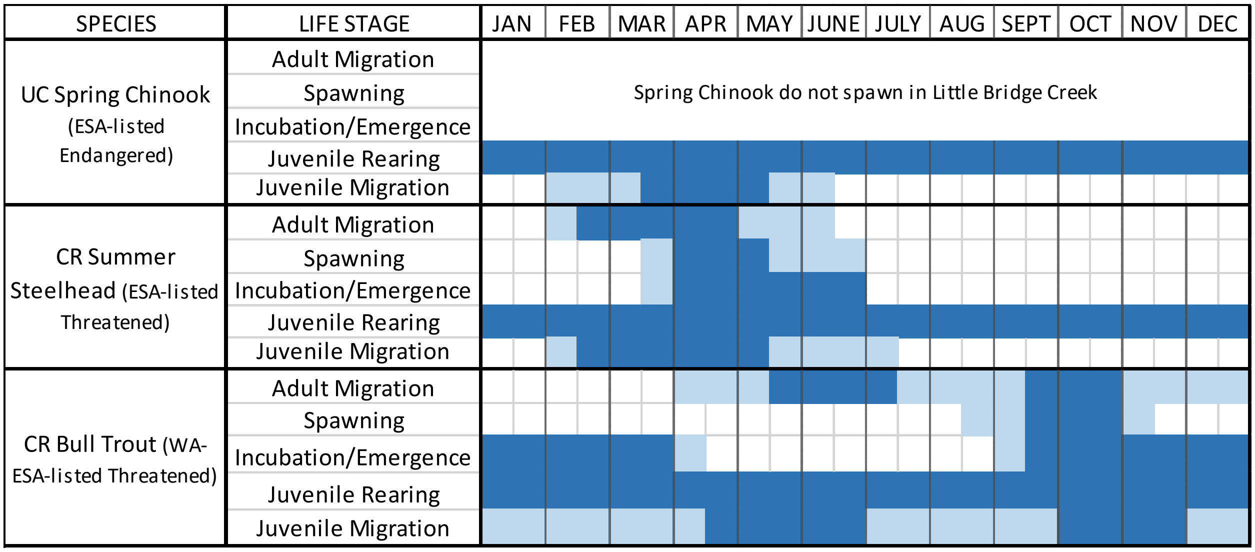

Figure 1. Life history timing of focal species in Little Bridge Creek within the project area.

1.3.1 Summer steelhead

Adult summer steelhead destined for Little Bridge Creek pass Wells Dam from July through May, with peak migration in September. Most adults overwinter in the Wells pool, while some hold in large pools in the mainstem Methow River. Adult summer steelhead enter the Twisp River and then Little Bridge Creek from February through May, holding in deep pools with overhead cover (NWPCC 2004). Spawning begins in late March, peaks in late-April, and lasts through May. Egg survival is highly sensitive to intra-gravel flow, temperature and is particularly sensitive to siltation earlier in the incubation period (Healy 1991). Fry emerge from the redds 6-10 weeks after spawning (Peven 2003).

Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and utilizing overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, US Fish and Wildlife Service 1995). Age-0 steelhead use slower, shallower water small boulder and large cobble substrate (Hillman et al. 1989). Older juveniles prefer faster moving water including deep pools and runs over cobble and boulder substrate (US Fish and Wildlife Service 1995). Juveniles out-migrate between ages one and four, though some hold over and display a resident life history form. Smolts begin migrating downstream from natal areas from April through mid-May (NWPCC 2004).

1.3.1 Spring Chinook

Spring Chinook enter the Twisp River from late May through early September, with peak spawning occurring in late August and early September (Inter-Fluve 2015). Fry emerge in the spring and seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). Near-shore areas with eddies, large woody debris, undercut tree roots, and other cover are very important for post-emergent fry (Hillman et al. 1989, Healy 1991). Age-1 parr move into deeper pools with resting cover in natal streams and migrate to smaller tributaries for extended periods of rearing. Spring Chinook express a stream-type life history where they rear for 1 year in freshwater before out-migrating as yearlings from late February through early May.

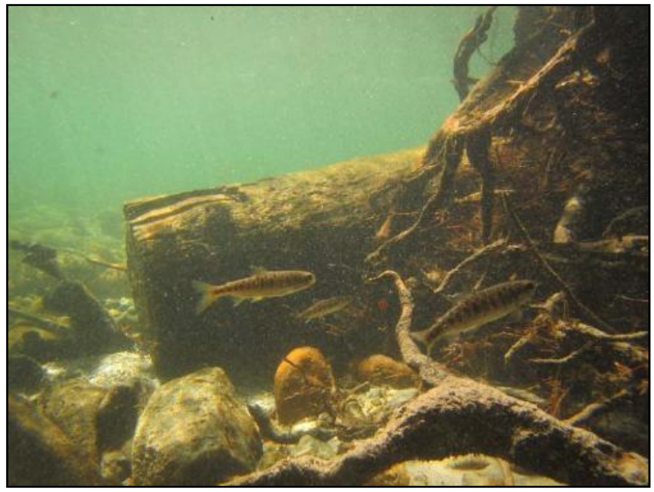

Figure 2. Chinook Salmon parr resting behind a constructed log jam in the Entiat River mainstem between feeding forays.

1.3.2 Bull trout

Little Bridge Creek supports a population of fluvial and adfluvial bull trout (NWPCC 2004). Fluvial populations of Bull Trout are known to exist in the Methow Basin and use the project area as a migration corridor on their way to spawning grounds in the upper watershed within the reach and in nearby tributaries. Bull Trout from the Columbia River migrate into the Methow subbasin from May through June (BioAnalysts 2002, 2003). Spawning occurs in headwater streams from mid-September through October. Bull trout juveniles rear in headwater streams for at least two years before migrating downstream as adults or sub-adults to express adfluvial life histories, or resident life histories in downstream reaches (McPhail and Baxter 1996).

1.3.3 Limiting factors for resident and anadromous fish

Ecological concerns for the Twisp River have been summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (UCRTT 2017). The Regional Technical Team (RTT) identified several ecological concerns or limiting factors affecting habitat conditions in the Twisp River and tributaries to the Twisp such as Little Bridge Creek. They are:

1. Peripheral and transitional habitats (side channel and wetland habitat conditions).
2. Channel structure and form (instream structural complexity).
3. Channel structure and form (bed and channel form).
4. Riparian condition (riparian condition and large wood recruitment).
5. Food (altered primary productivity or prey species competition and diversity).
6. Sediment (increased sediment quantity).
7. Species interactions (introduced competitors and predators).

The RTT also noted the need to better understand the interaction of other native species with Bull trout found in the Twisp River and Little Bridge Creek.

1.4 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

1.4.1 Large Wood

The project proposes to import logs with root wads to a nearby staging area, and place them in Little Bridge Creek and adjacent floodplain surfaces using a heavy lift helicopter. The project will enhance habitat and address ecological concerns 1, 2, 3 and 4 listed above. Each imported tree or log will have a minimum diameter of 18 inches diameter at breast height (dbh, measured at 4 feet from the base), a length of 40 feet, and have an attached rootwad. This wood specification has been determined to be naturally stable in Little Bridge Creek throughout the project reach. No ballasting or attachment hardware will be required. The wood structures will be "constructed" by directing the helicopter pilot to the placement and orientation of each large wood piece. The individual wood pieces will be concentrated in groups to enhance channel complexity, floodplain inundation, side channel development, gravel sorting and pool scour. The conceptual drawings in Appendix A show 175 imported logs to be installed in-channel, and 26 on the floodplain.

Figure 3. Heavy lift helicopter with large log

1.4.2 Culvert Removal

NF-030 Road crosses Little Bridge Creek at about stream mile 2.0 The crossing is a 40-foot span open bottom structural plate steel arch culvert (Figure 4). Width of culvert appears to appropriate and not a significant encroachment on the floodway. However, the road is closed by a push up berm approximately ¼ mile to the south, and Cow Creek fan has deposited sediment on the road and caused a deep washout that cannot be crossed by motor vehicles. If this road is to remain out of commission, then removing the culvert could improve tributary processes and mainstem debris passage.

Figure 4. NF-030 Road culvert. Road washout from tributary. From UAV, 2018.

1.5 DESCRIPTION OF PERFORMANCE/ SUSTAINABILITY CRITERIA FOR PROJECT ELEMENTS AND ASSESSMENT OF RISK OF FAILURE TO PERFORM, RISK TO INFRASTRUCTURE, POTENTIAL CONSEQUENCES, AND COMPENSATING ANALYSIS TO REDUCE UNCERTAINTY

1.5.1 Infrastructure and flood risk

Imported logs specified for the project would be self-stable. The bankfull channel width is roughly 25-35 feet. Hydraulic modeling indicates that even during the 100-yr flood, water depths are only 2-4 feet. Although each log could be expected to shift during a large flood, it would not move a significant distance from its original placement due to its length, weight, and root wad. The introduced wood is expected to increase overbank flow, side channel scour, and floodplain complexity over time. This is a desired condition for fish habitat on the project reach, which is entirely on USFS property. There are no structures near the project that would be at risk. Although there are forest roads along the adjacent valley wall, there is very low risk of erosion impacts due to the dense riparian forest on the floodplain and on valley slopes.

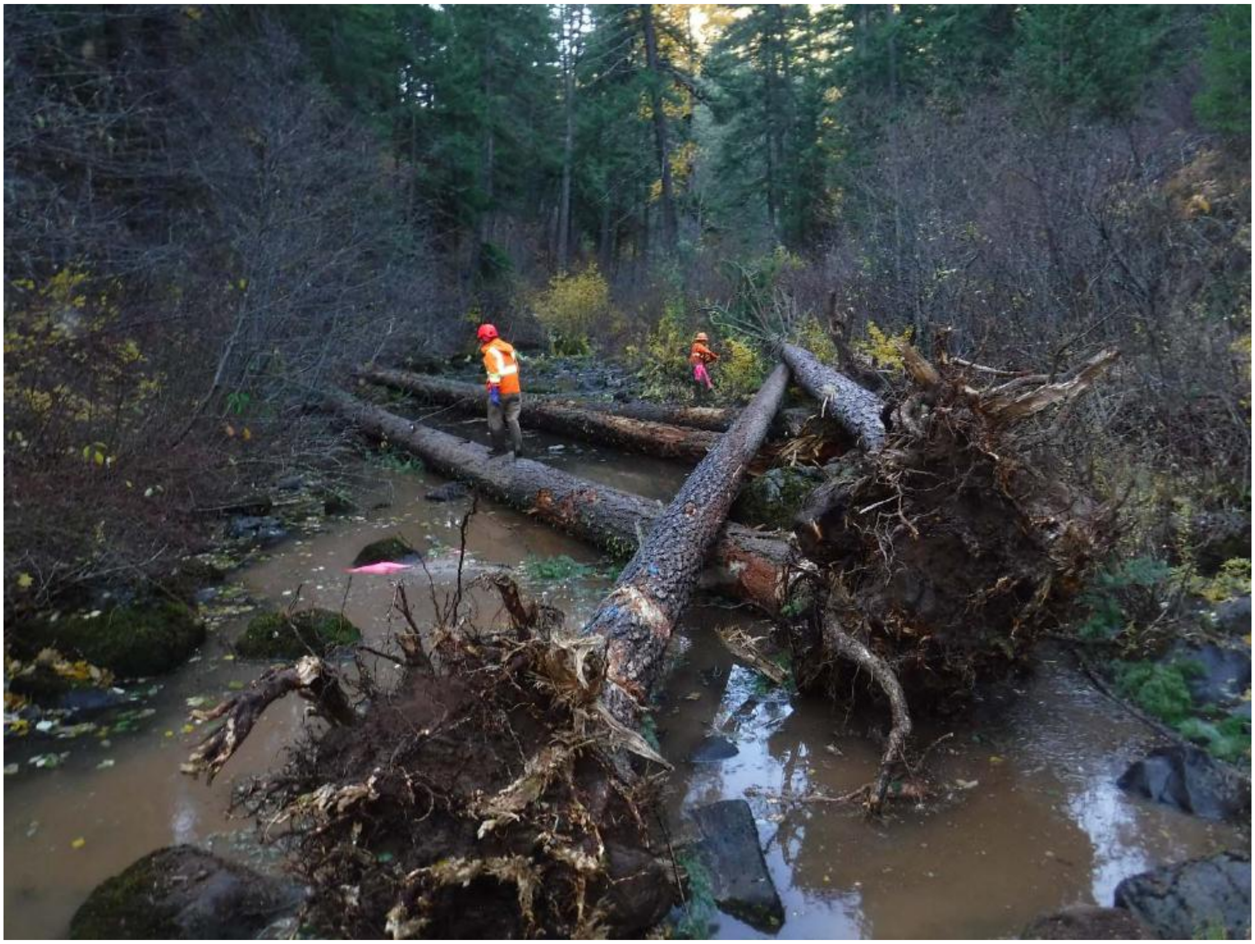

Figure 5. Ground crew removing chokers from helicopter placed logs

1.5.2 Design criteria

Design criteria for large wood and secondary channel habitat associated with the project are as follows:

- Wood used in this project will be naturally stable and will remain on site up to and beyond the 100-year return peak flow.
- Large wood habitat will be placed and oriented using a helicopter to be engaged with the creek, providing habitat year-round, and to provide sediment sorting and small woody debris capture during high water.

1.5.3 Risk of failure to perform

Current migration rate, planform condition and migration trend are conducive to the proposed project concept. The channel is well suited to intense wood treatments that will capture small woody debris, and induce lateral scour, overflow side channel development, gravel sorting, pool scour and associated channel and riparian complexity at low and high flows. There is very low risk that importing large wood will fail to improve channel and floodplain habitat.

1.6 DESCRIPTION OF DISTURBANCE INCLUDING TIMING AND AREAL EXTENT AND POTENTIAL IMPACTS ASSOCIATED WITH IMPLEMENTATION OF EACH ELEMENT

Disturbance will be very low. No entry by equipment, excavation, or access to the site will be required. Riparian areas will not be disturbed. Any disturbance to the channel will be limited to where the large wood is placed by the helicopter. Existing trees will be avoided, and if removed for safety, will be utilized (lifted and placed by helicopter) to supplement imported large wood placements. The timing of construction will be within the authorized in-water work period for Little Bridge Creek. Helicopter re-fueling and large wood staging areas have not been determined but are expected to be in an upland location provided by USFS, and will meet or exceed stream protection guidelines.

2. Resource Inventory and Evaluation

2.1 DESCRIPTION OF PAST AND PRESENT IMPACTS ON CHANNEL, RIPARIAN AND FLOODPLAIN CONDITIONS

Historical aerial photos show no significant anthropogenic or natural impacts to the riparian or floodplain; though poor photo resolution limits the effectiveness of this type of analysis. Recent drone aerial footage shown in the concept drawings, clearly shows a healthy riparian area and floodplain along most of the channel. Where the channel has migrated against the valley wall, hillside slope failures and sediment delivery has occurred. The volume and extent of the failures appear to be consistent with natural riverine processes and do not seem to burden the stream.

The project valley bottom appears to have been selectively logged decades ago (prior to earliest available aerial image). During filed observations, it was noted that large old stumps can be found along the valley bottom in areas that are now dominated by spruce trees. These large-tree removals appear to have been selective and not in significant numbers.

Riparian vegetation is robust. The channel is well shaded during the summer and where in-channel native large wood exists habitat complexity is improved. The floodplain is dominated by dense thickets of dogwood and willow, with red alder and cottonwood overstory. There is abundant small wood in the channel but large wood loading is relatively low, and there are relatively few sources of large standing trees that would provide significant loading of stable, enduring large wood over time (Figure 6).

Figure 6. Riparian area with willow, dogwood, red alder. Numerous small wood pieces.

2.2 INSTREAM FLOW MANAGEMENT AND CONSTRAINTS IN THE PROJECT REACH

Near the upstream end of the project reach, Aspen Meadows Irrigation Ditch diverts water from Little Bridge Creek for agricultural and domestic use. The water is diverted from the channel by a fish passable weir. The diversion enters a pipeline installed approximately 15 years ago to improve irrigation efficiency and instream flows.

2.3 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

Washington State geologic maps show the watershed is composed of Cretaceous sedimentary and volcanic rocks. During field work, andesite flows are observed on roadside hillslopes and shale and conglomerate bedrock exposures were found in small segments of valley toe eroded by Little Bridge Creek. Harder intrusive rocks exist in the adjacent watersheds to the north of the Little Bridge Creek watershed. These were carried over the watershed divide during alpine and continental glacial advance. During field work glacially transported intrusive granitic and metamorphic boulder lag deposits were observed in the channel. The same crystalline rocks were also observed within the smaller mobile bedload fraction in Little Bridge Creek. These are derived from glacially transported till and outwash deposited on top of the sedimentary and volcanic rocks. The majority of bedload observed in the channel is composed of sedimentary and volcanic rock origin.

Figure 7. Lag boulders in Little Bridge Creek

The project reach runs within a narrow valley 110-220 feet wide. Reach average grade is 2.9%. Local near surface bedrock, glacial lag, and old slope failures cause an alternating profile of localized steep areas interspersed by mild gradient areas.

In areas of near-surface bedrock and glacial lag deposits, the channel is generally steeper and straighter due to its inability to readily adjust into lateral boundaries. Steeper segments exhibit low width to depth ratio. The bed is armored, not eroding laterally, and holding steep banks.

Figure 8. Boulders in steep segment

In flatter channel segments, mobile cobble and gravel predominate and floodplain appears to be frequently active. In some low gradient areas, beaver dam activity has been successful due to the reduction in stream power.

There are frequent wood structures formed from single trees or groupings of small and medium sized wood, and a few jams supported by large wood. The stream appears to readily react to wood structures, storing and sorting gravels suitable for salmonid spawning, improving overhead cover, forming habitat through deposition, scour, and planform adjustments. Deep scour pools are associated with wood except in areas where depth is refused by lag boulders or bedrock.

Figure 9. Wood jam and bar formation in Little Bridge Creek

Figure 10. Fallen tree and bar formation in Little Bridge Creek

The channel is capable of laterally migrating and avulsing within wider flatter segments of the project reach, and where form is not controlled by near surface bedrock or lag boulder deposits. Within flatter segments of the project reach, large wood blockages play an important role of inducing healthy dynamic conditions. The wood causes direct lateral migration through flow redirection, as well as locally aggrading the channel to facilitate overbank flow, channel avulsion and side channel development.

2.4 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

There is little evidence of recent historical riparian impacts. Riparian conditions are excellent with extensive and dense thickets of willow and red osier dogwood on the floodplain, providing ample beaver food and dam construction material. Larger trees within the floodplain consist of mostly of early to mid-seral cottonwood. Fir and spruce trees intersperse the floodplain but predominantly occur on the adjacent hillslopes.

Two very large beaver dams have recently failed but are in the process of being repaired (Figure 11). Beaver activity appears to occur where local slope is flatter, floodplain connection is greater and stream power is lower. Observation of dam washouts and repair indicate presence of a local beaver population. Increased instream wood complexity will likely improve habitat suitability for beavers by attenuating in-stream energy and increasing floodplain inundation.

Figure 11. Partially washed out beaver dam and recent repair efforts in Little Bridge Creek

2.5 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Aside from evidence of historical selective logging, there are no known recent historical floodplain impacts within the project reach. As explained in previous sections, floodplain connectivity is strongly dependent on local slope and valley bottom width. In mild slope areas and wider sections of the valley, woody debris jams and beaver activity provide excellent floodplain connectivity by creating hydraulic roughness and sediment deposition. These areas demonstrate that the system is very reactive to wood inputs. There is abundant small to medium size wood but the many of the fallen trees and wood structures appear to be short-lived (subject to decay and breakage) and transient. Tall timber flanks the valley bottom, and where the stream runs along the valley edge, fallen trees can contribute to stream and floodplain complexity, but the stream corridor has relatively few large trees capable of providing enduring large wood structures to impose long-term and significant channel response on the reach scale. Additional large wood structures would increase the frequency and duration of overbank flows, expand the extents of floodplain inundation, and increase complexity of flow patterns across the valley bottom.

2.6 TIDAL INFLUENCE IN PROJECT REACH AND INFLUENCE OF STRUCTURAL CONTROLS (DIKES OR GATES)

Not applicable to this project.

3. Technical data

3.1 INCORPORATION OF HIPIV SPECIFIC ACTIVITY CONSERVATION MEASURES FOR ALL INCLUDED PROJECT ELEMENTS

HIP IV conservation measures will be met through the project design, and variances will be submitted for any conservation measures that cannot be met. The proposed design is a low risk very low impact strategy to enhance salmonid habitat in the reach.

3.2 SUMMARY OF SITE INFORMATION AND MEASUREMENTS (SURVEY, BED MATERIAL, ETC.) USED TO SUPPORT ASSESSMENT AND DESIGN

3.2.1 Elevation data

Project survey was completed in November, 2018. The project area was walked to identify and survey potential treatment sites, and to survey cross sections for hydraulic modeling. Survey was completed using total station survey equipment and relative datum. Temporary control points were established.

3.2.2 Fish use

Fish presence and life-stage timing data were taken from the 2017 Biological Strategy (UCRTT 2017), Methow Subbasin Plan (NWPCC 2004), Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007), Middle Twisp Reach Assessment, and empirical PIT tag and screw trap data from Columbia River Data Access in Real Time (DART 2018). Habitat preference information was taken from the primary literature.

3.2.3 Aerial images

Aerial images were taken using a licensed drone in November 2018.

3.2.4 Wood Loading

Each piece of wood with the specified dimensions provides approximately 2.2 cubic meters of wood volume. Fox and Bolton (2007) examined undisturbed streams 0-30 meters wide within the Douglas -fir-ponderosa pine (DF-PP) forest zone similar to the forest zone of Little Bridge Creek. Their research showed that for streams in DF-PP zones (n=14), wood volume ranged from 0 to 23 cubic meters per 100 meters of stream length.

The Upper Twisp River and Tributaries Habitat Assessment (Tetra Tech 2017) inventoried wood numbers and sizes in Little Bridge Creek. The assessment survey found that Little Bridge Creek Reach 2, where the project is proposed, contains 130 small, 50 medium, and 26 large wood pieces.

For comparison to Fox and Bolton, the assessment survey results are converted to metric units. The volume of wood in Reach 2 was roughly 359 cubic meters over 3,700 meters of stream. This scales as 282 cubic meters of wood within in the project length of 2,900 meters, or approximately 10 cubic meters per 100 meters of stream. To approach the maximum volume of 23 cubic meters per 100 meters found by Fox and Bolton, the project could hold a total of 667 cubic meters of wood. With 282 cubic meters of existing wood on site, adding 385 cubic meters, or 175 logs (2.2 cubic meters each) would comport with the maximum loading reported in DF-PP streams by Fox and Bolton.

3.3 SUMMARY OF HYDROLOGIC ANALYSES CONDUCTED, INCLUDING DATA SOURCES AND PERIOD OF RECORD INCLUDING A LIST OF DESIGN DISCHARGE (Q) AND RETURN INTERVAL (RI) FOR EACH DESIGN ELEMENT

Little Bridge Creek does not have a stream gage so peak discharges for given return intervals were calculated using indirect methods. The Upper Twisp and Tributaries Habitat Assessment (Tetra Tech 2017) summarized the predicted peak flows from USGS regional regression equations (Mastin et al. 2016), and the USBR Methow Subbasin Geomorphic Assessment hydrologic analysis (USBR 2008) that was based on a combination of gage data and regression analysis. Peak discharge estimates are reported for the outlet of the creek to the Twisp River. The project reach is a short distance upstream at RM 0.7 to RM 2 so results are slightly conservative due to not reducing results by weighted area. Results are summarized in Table 2. The greater magnitude discharges from the USBR study were used in the hydraulic model to provide a conservative evaluation of the hydraulic forces and water depth.

Table 2. Peak Discharge Estimates for the Little Bridge Creek Project Reach (cfs).

Flow Event	USGS	USBR
2-year	90	188
10-year	241	349
25-year	346	439
50-year	442	508
100-year	544	580

3.4 SUMMARY OF SEDIMENT SUPPLY AND TRANSPORT ANALYSES CONDUCTED, INCLUDING SEDIMENT SIZE GRADATION USED IN STREAMBED DESIGN

General observations of bedload and supply were noted and presented in section 2.3. No streambed design/grading is proposed for this project.

3.5 SUMMARY OF HYDRAULIC MODELING OR ANALYSES CONDUCTED AND OUTCOMES – IMPLICATIONS RELATIVE TO PROPOSED DESIGN

A one-dimensional (1D) hydraulic model was developed for existing conditions to determine flood stage and large wood transport potential. Creek stage and velocity results during modelled flood flows were compared with field observations, floodplain resilience, and specified large wood sizes to determine mobility risk.

3.6 HYDRAULIC MODEL

The U.S. Army Corps of Engineers' Hydraulic Engineering Center River Analysis System (HEC-RAS 5.0.3; USACE 2016) was used to run the steady-state, one-dimensional (1D) model for hydraulic computations to predict stage and velocity of floods in the project area. The existing conditions HEC-RAS model was developed using the 2018 survey data, which was collected along a representative reach of the stream and floodplain.

The upstream and downstream model boundary conditions were set to normal depth since they are located on riffles. Manning's 'n' or roughness values correspond with various types of land cover and channel characteristics. A roughness value of 0.04 was applied to the main channel, and 0.12 was applied to the overbank/floodplain regions. These values are consistent with field observations as well as published guidelines for channel types and vegetation conditions (Arcement & Schneider 1989). The peak flows for floods listed in Table 2 were run in this model.

3.1 MODEL RESULTS

The model predicts that in-channel flow depths vary 2-4 ft and velocities vary 5-13 ft/s, with the greatest depth and velocity occurring during the 100-yr flood. The velocity on the floodplain is much lower, varying 0.9-2,6 ft/s (Figure 12).

Detailed output of the hydraulic model is in Appendix B.

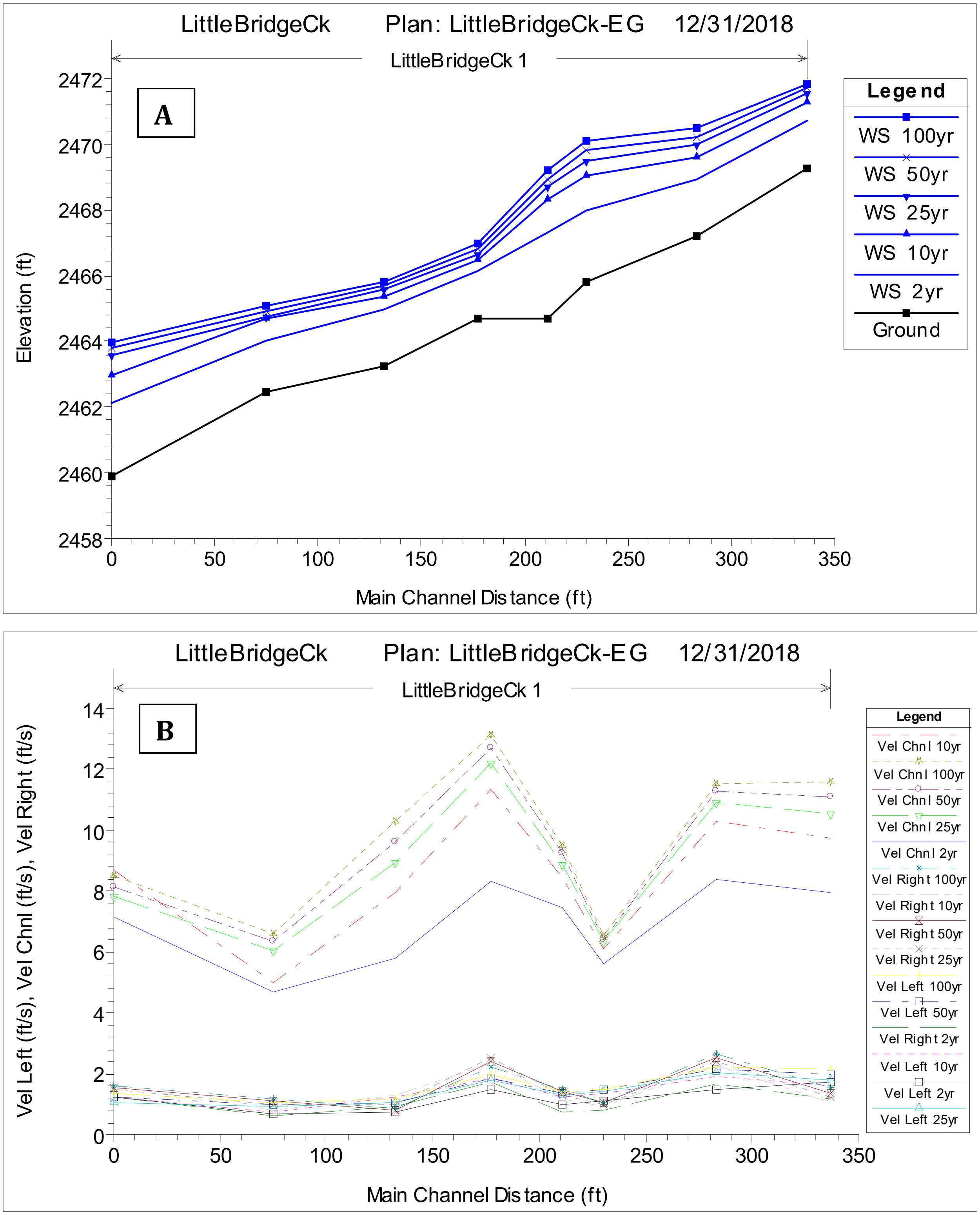

Figure 12. Long profile (A) and velocity plot (B) from HEC-RAS

3.2 STABILITY ANALYSES AND COMPUTATIONS FOR PROJECT ELEMENTS, AND COMPREHENSIVE PROJECT PLAN

Based on the conceptual design shown in the Appendix A, the model results predict that large wood will remain relatively stable during floods. It is possible that a 40-foot log with roots could move by partial buoyancy, rotation, or translation. However, due to bankfull channel width of 25-35 feet, moderate flood depth, and dense riparian vegetation, a matrix of intermingled and stacked logs is not expected to move more than minor adjustments. In the event that a log does become dislodged from a jam, it would not be transported significant distances in the channel without encountering other stabilizing resistance from vegetation, debris, sediment, boulders, and changes in stream form.

As the design progresses, stability analysis and computations for project elements will follow professional practice guidelines for large wood design (Knutson and Fealko 2014 and USBR and ERDC 2016), stream habitat restoration (Cramer 2012), Stability of Ballasted Woody Debris Habitat Structures (D'Aoust and Millar 2000) and institutional knowledge combined with professional judgment for the design of specific project elements.

3.3 DESCRIPTION OF HOW PRECEDING TECHNICAL ANALYSIS HAS BEEN INCORPORATED INTO AND INTEGRATED WITH THE CONSTRUCTION – CONTRACT DOCUMENTATION

The preceding analyses provide the basis for the attached conceptual designs. Moving forward, the concept drawings will be edited as needed to address stakeholder input and apply for permits. Design documents for permitting and construction will consider the method of implementation (field directed helicopter wood loading). Construction plans will be based on stability calculations for logs and log structures, and will depict stockpile/staging/fueling areas, general log structure locations that are geomorphically appropriate for producing a favorable response in channel and floodplain. However, the actual log placements will be fit in the field. Logs may be allocated to other sites in order to optimize each site for the actual materials being delivered. The final installed log structures may differ from the plans while still adhering to the design context of stability and function.

This project does not require detailed design drawings. Rather, it requires careful consideration of appropriate sites and sizes of log structures to provide a level of confidence that the channel will soon respond with favorable habitat forming results, and without impacting roads or culverts. The plans will show the general log structure locations and configurations, as well as specifications for stockpiling materials, helicopter transportation routes and fueling point, public safety, and site safety.

Figure 13. Before and after photos of Abernathy Creek, helicopter placed logs

3.4 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A LONGITUDINAL PROFILE OF THE STREAM CHANNEL THALWEG FOR 20 CHANNEL WIDTH UPSTREAM AND DOWNSTREAM OF THE STRUCTURE SHALL BE USED TO DETERMINE THE POTENTIAL FOR CHANNEL DEGRADATION

Not applicable to this project.

3.5 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A MINIMUM OF THREE CROSS-SECTIONS – ONE DOWNSTREAM OF THE STRUCTURE, ONE THROUGH THE RESERVOIR AREA UPSTREAM OF THE STRUCTURE, AND ONE UPSTREAM OF THE RESERVOIR AREA OUTSIDE OF THE INFLUENCE OF THE STRUCTURE) TO CHARACTERIZE THE CHANNEL MORPHOLOGY AND QUANTIFY THE STORED SEDIMENT

Not applicable to this project.

4. Construction – contract documentation

4.1 INCORPORATION OF HIPIV GENERAL AND CONSTRUCTION CONSERVATION MEASURES

Conservation measures will be included in future design drawing updates as they relate to helicopter operations, refueling, and staging. Variances will be submitted as required for conservation measures that are not met by the project design.

4.2 DESIGN – CONSTRUCTION PLAN SET

Following conceptual design approval, permit level design drawings will be completed and submitted. Construction design drawings will be updated as necessary to the level required for field directed helicopter wood loading.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES

Final large wood numbers (volume) will be included in future permit design phases. Imported and placed large wood/trees is the only proposed material for the project.

4.4 DESCRIPTION OF BEST MANAGEMENT PRACTICES THAT WILL BE IMPLEMENTED AND IMPLEMENTATION RESOURCE PLANS INCLUDING:

- Helicopter Site access staging and sequencing plan
- Work area isolation upland (helicopter re-fueling)
- Erosion and pollution control plan as needed near wood staging
- Site reclamation and restoration plan as needed near wood staging

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES

In water work will be required to take place in July.

4.6 SITE OR PROJECT SPECIFIC MONITORING TO SUPPORT POLLUTION PREVENTION AND/OR ABATEMENT

To be completed in future design phases.

5. Monitoring and adaptive management plan

To be completed in future design phases.

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Appendix A: 30% Conceptual Design Drawings

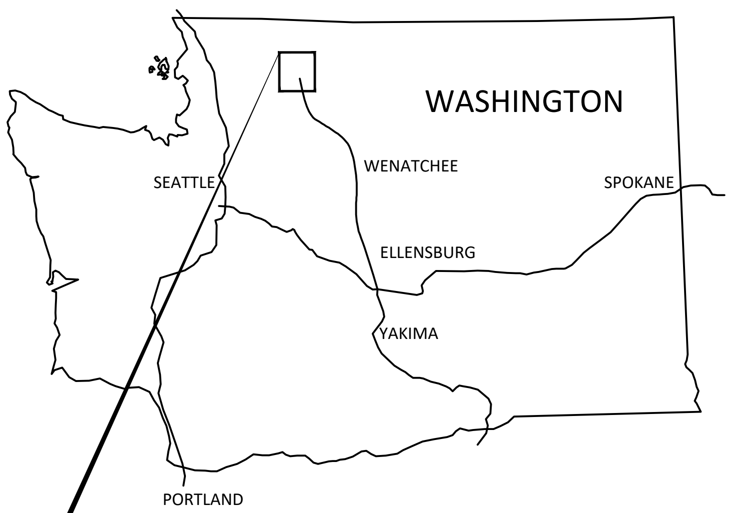
LITTLE BRIDGE CREEK

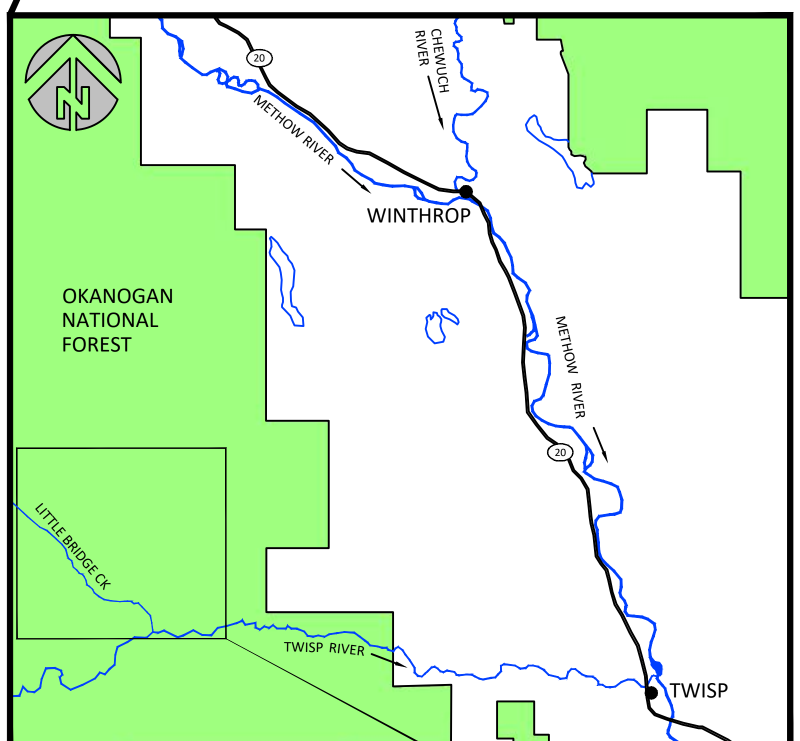
FISH HABITAT ENHANCEMENT PROJECT

Conceptual Design

Yakama Nation Fisheries

YAKAMA NATION FISHERIES
2 JOHNSON LANE
WINTHROP WA, 98862

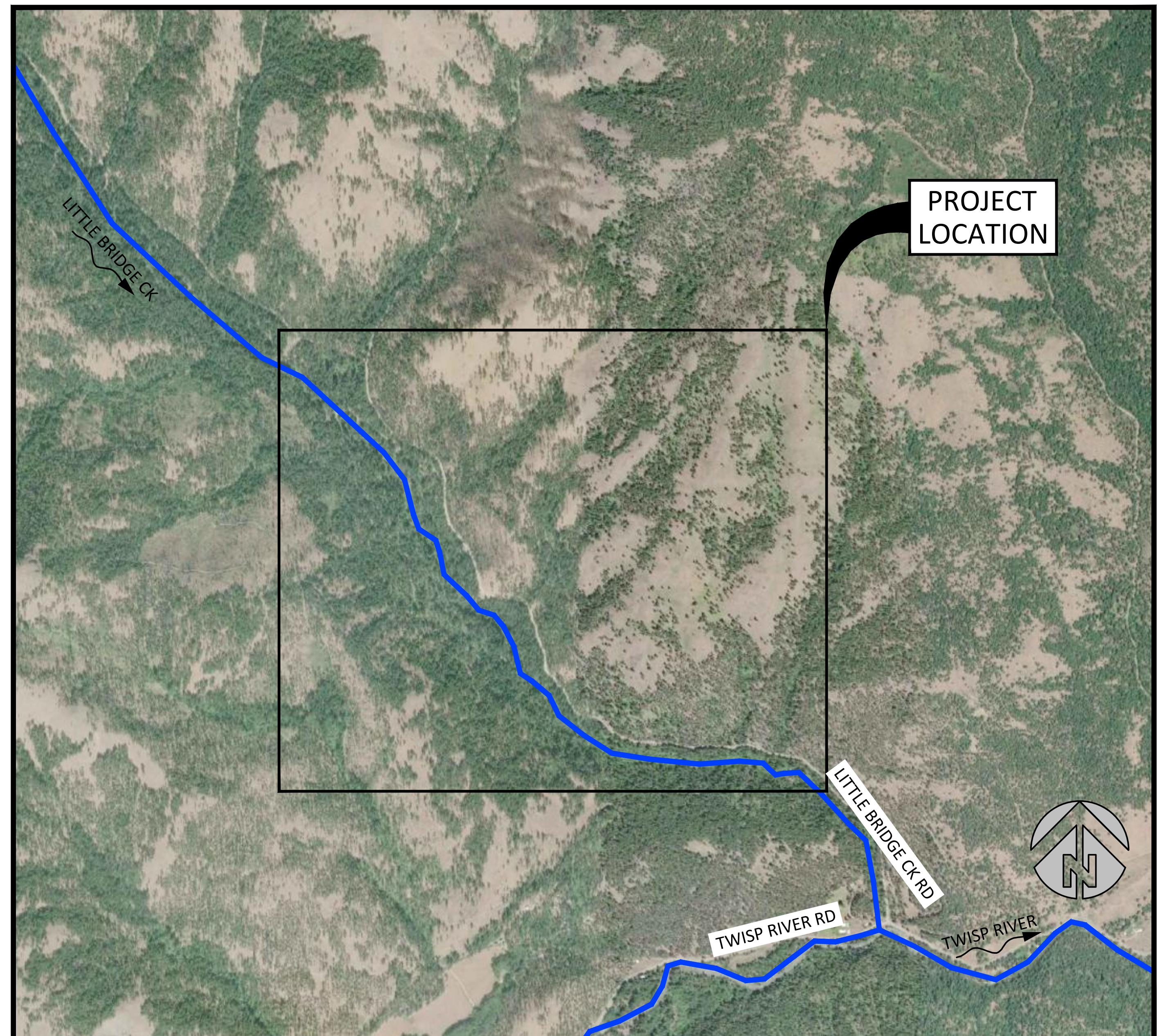




VICINITY MAP

COORDINATES:
LATITUDE: 48°23'16.80"N
LONGITUDE: 120°18'12.83"W

SECTION 2, TOWNSHIP 33N, RANGE 20E



SITE MAP

SHEET INDEX

TRIBUTARY OF: TWISP RIVER

NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
ZS	MB	MB
APPROVED	**DATE**	**PROJECT**
MM	12/14/18	17-02-59

LITTLE BRIDGE CREEK CONCEPTUAL HABITAT ENHANCEMENT PROJECT

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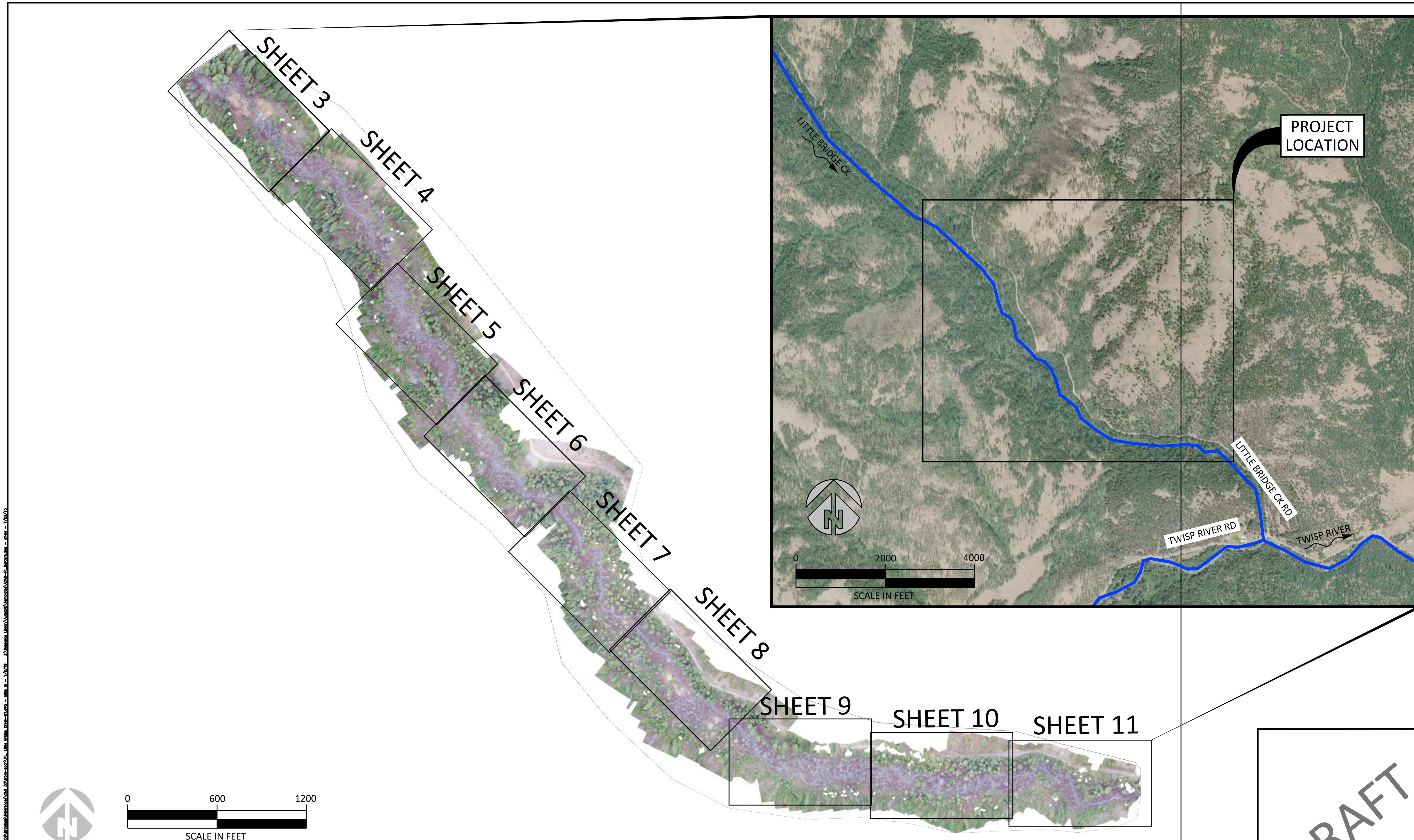
COVER, SHEET INDEX, SITE MAPS



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NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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OVERVIEW MAP

AERIAL VIEW 1

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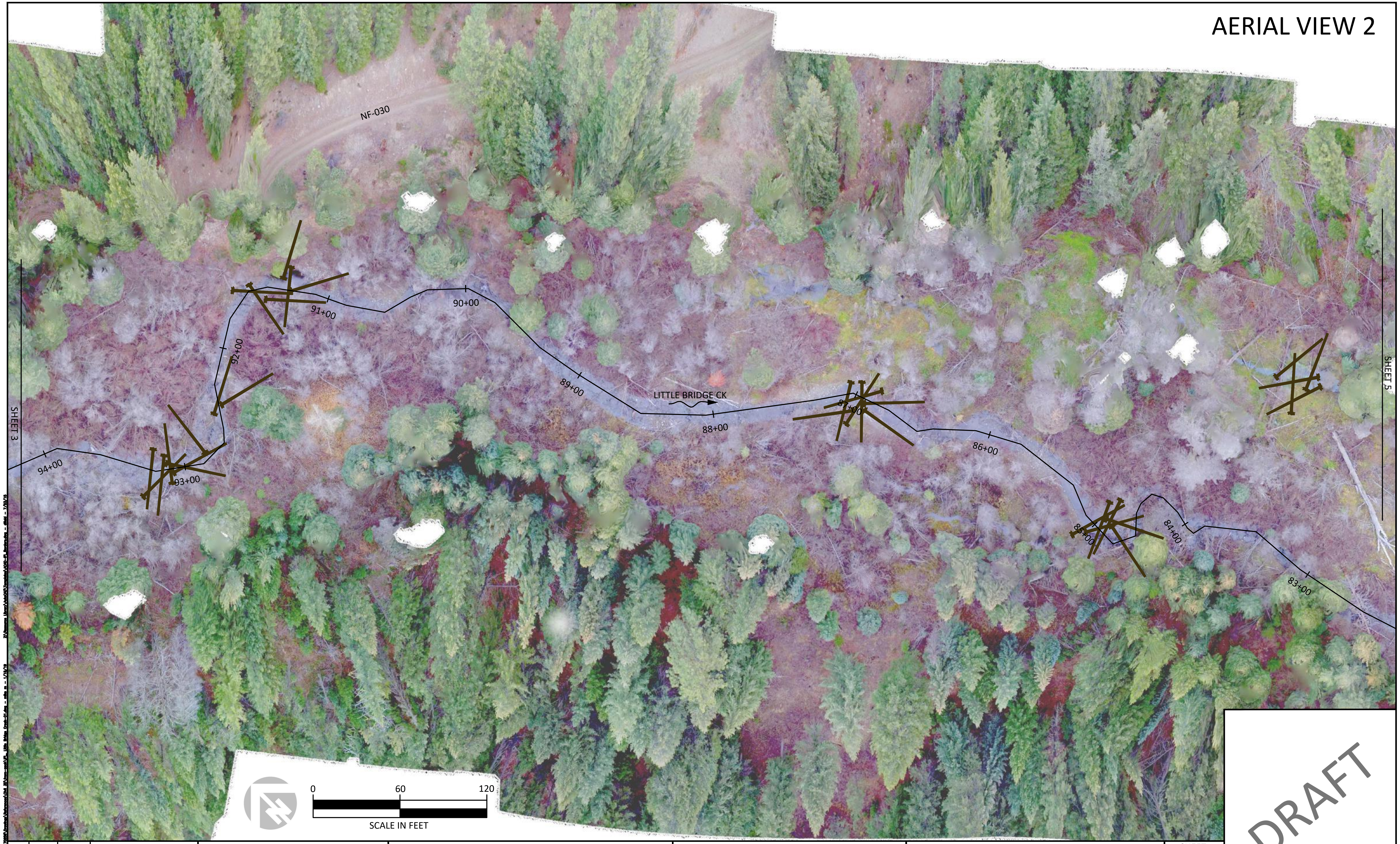
AERIAL VIEW 1 - LOG PLACEMENTS

SHEET 3 OF 11

DRAFT

AERIAL VIEW 2



DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
ZS	MB	MB
APPROVED	**DATE**	**PROJECT**
MM	12/14/18	17-02-59

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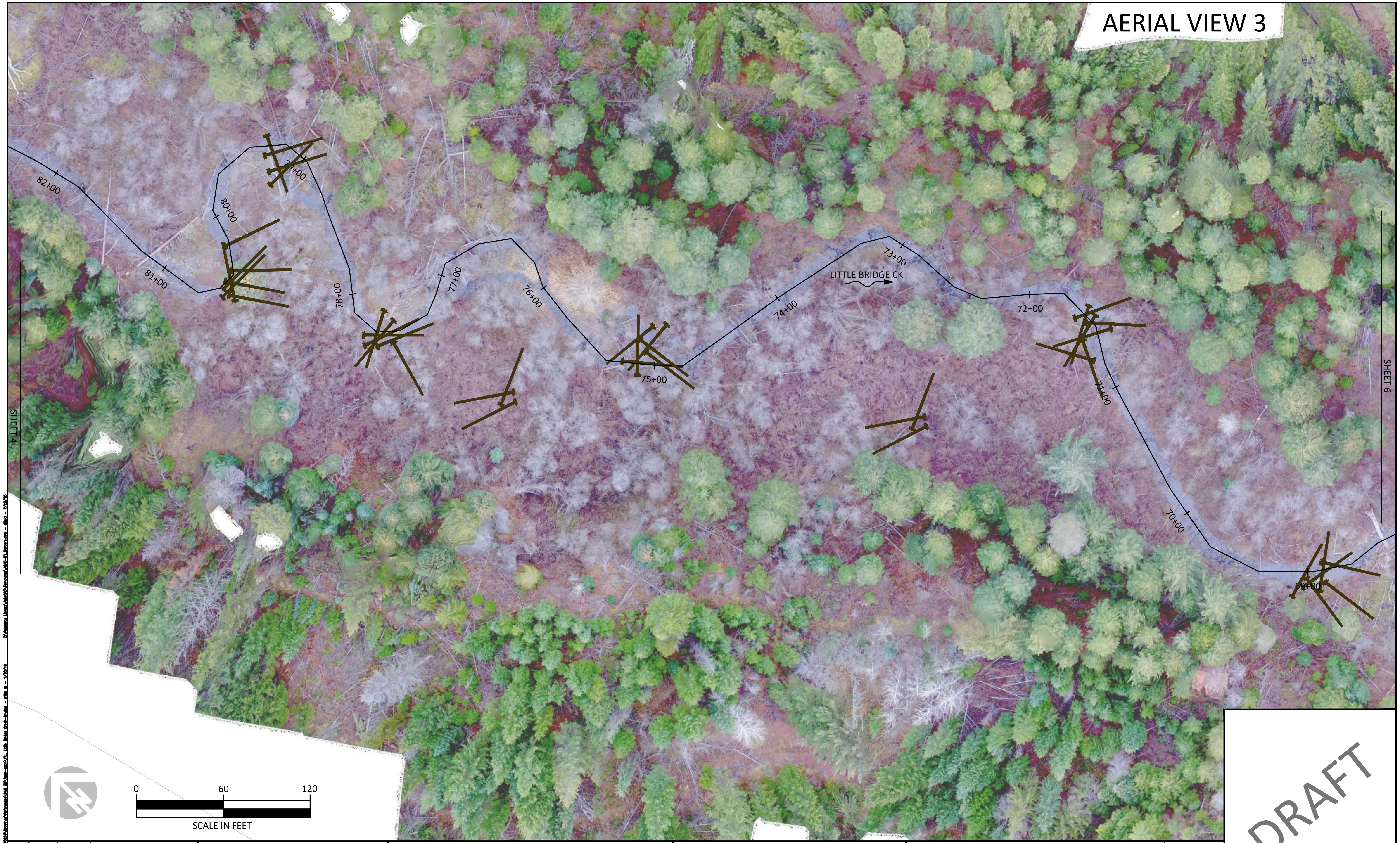
AERIAL VIEW 2 - LOG PLACEMENTS

SHEET 4 OF 11



NO.	BY	DATE	REVISION DESCRIPTION

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MM APPROVED	12/14/18 DATE	17-02-59 PROJECT

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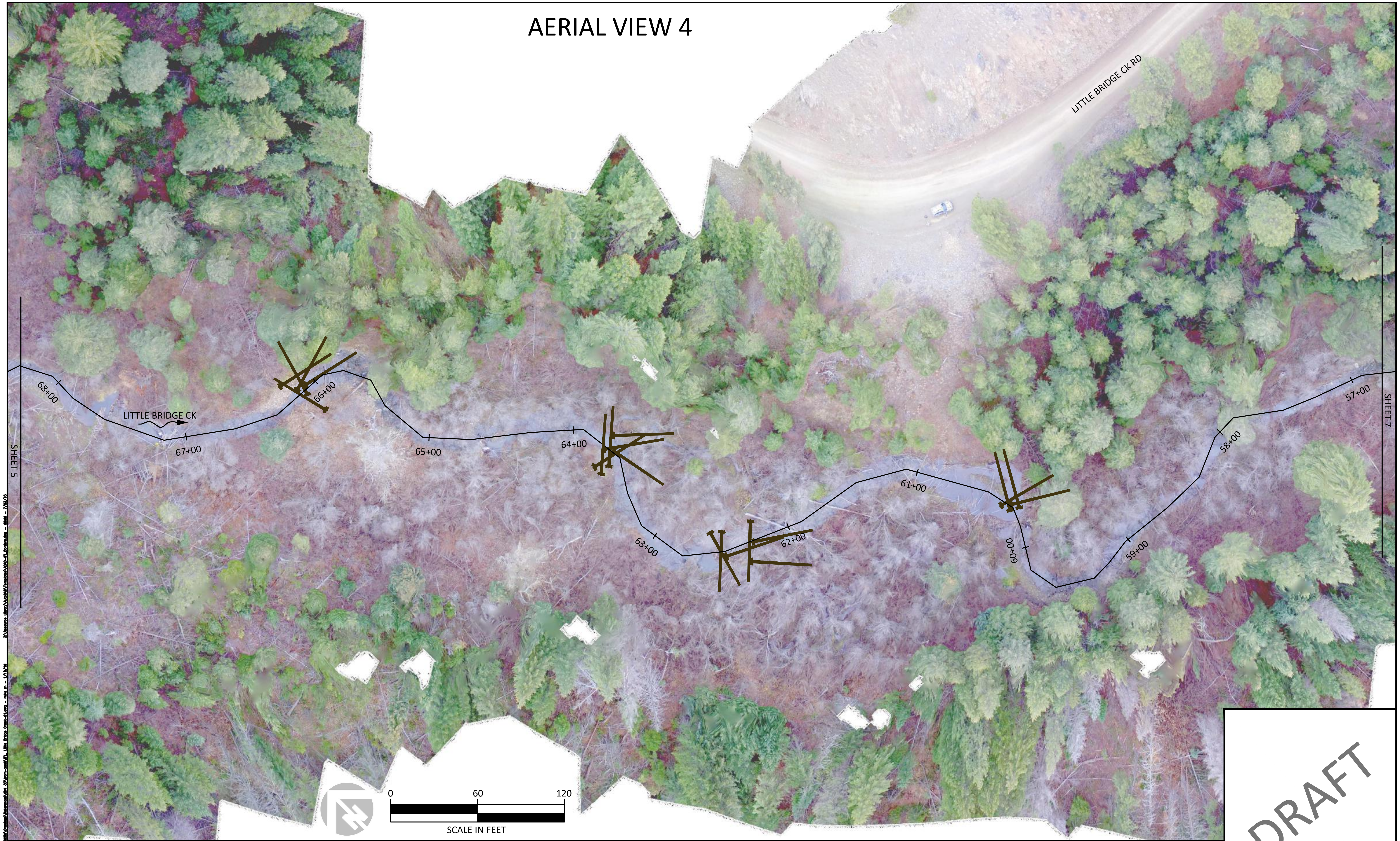
AERIAL VIEW 3 - LOG PLACEMENTS

SHEET
5 OF 11

AERIAL VIEW 4



NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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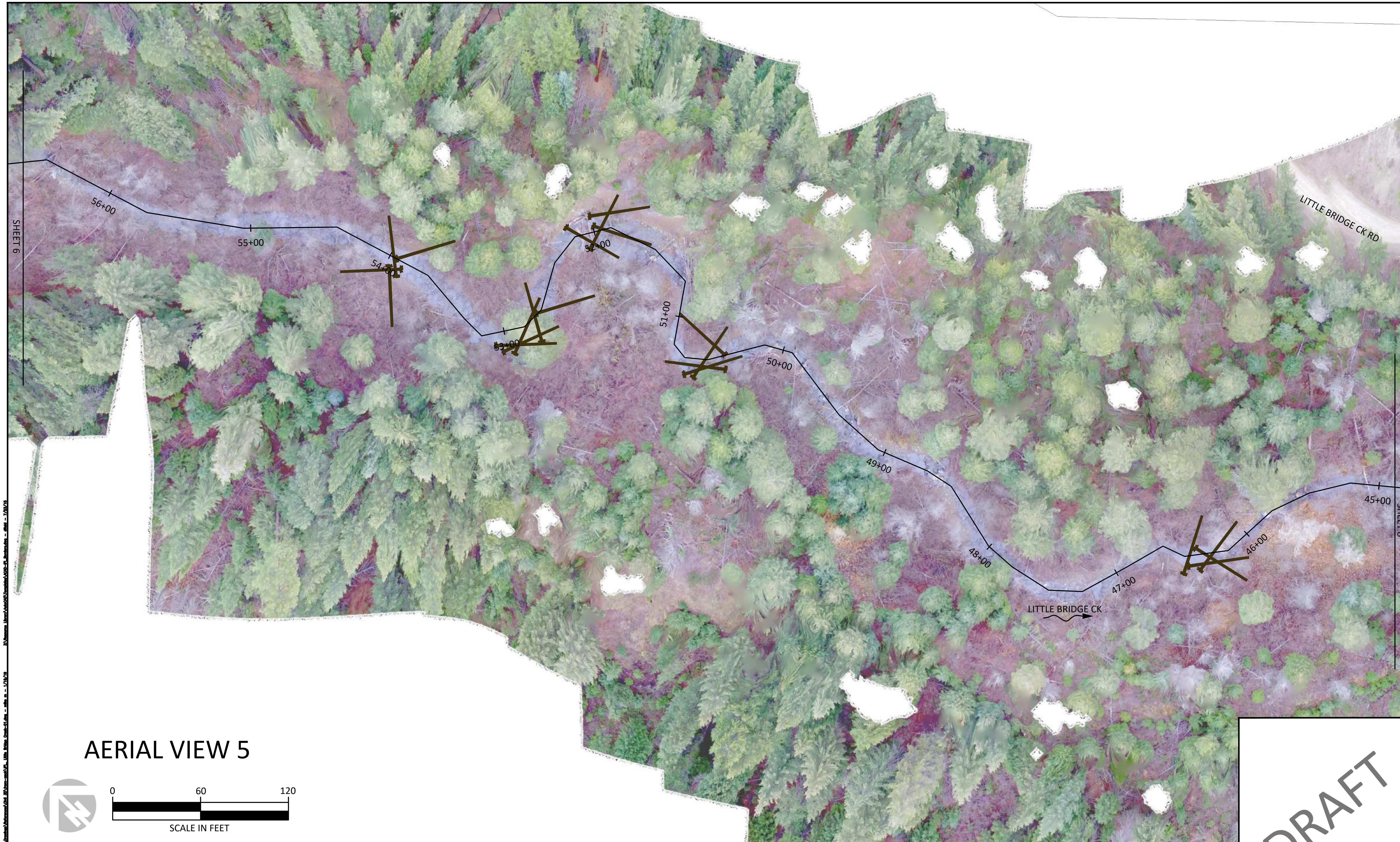
AERIAL VIEW 4 - LOG PLACEMENTS

DRAFT



AERIAL VIEW 5

0 60 120
SCALE IN FEET

DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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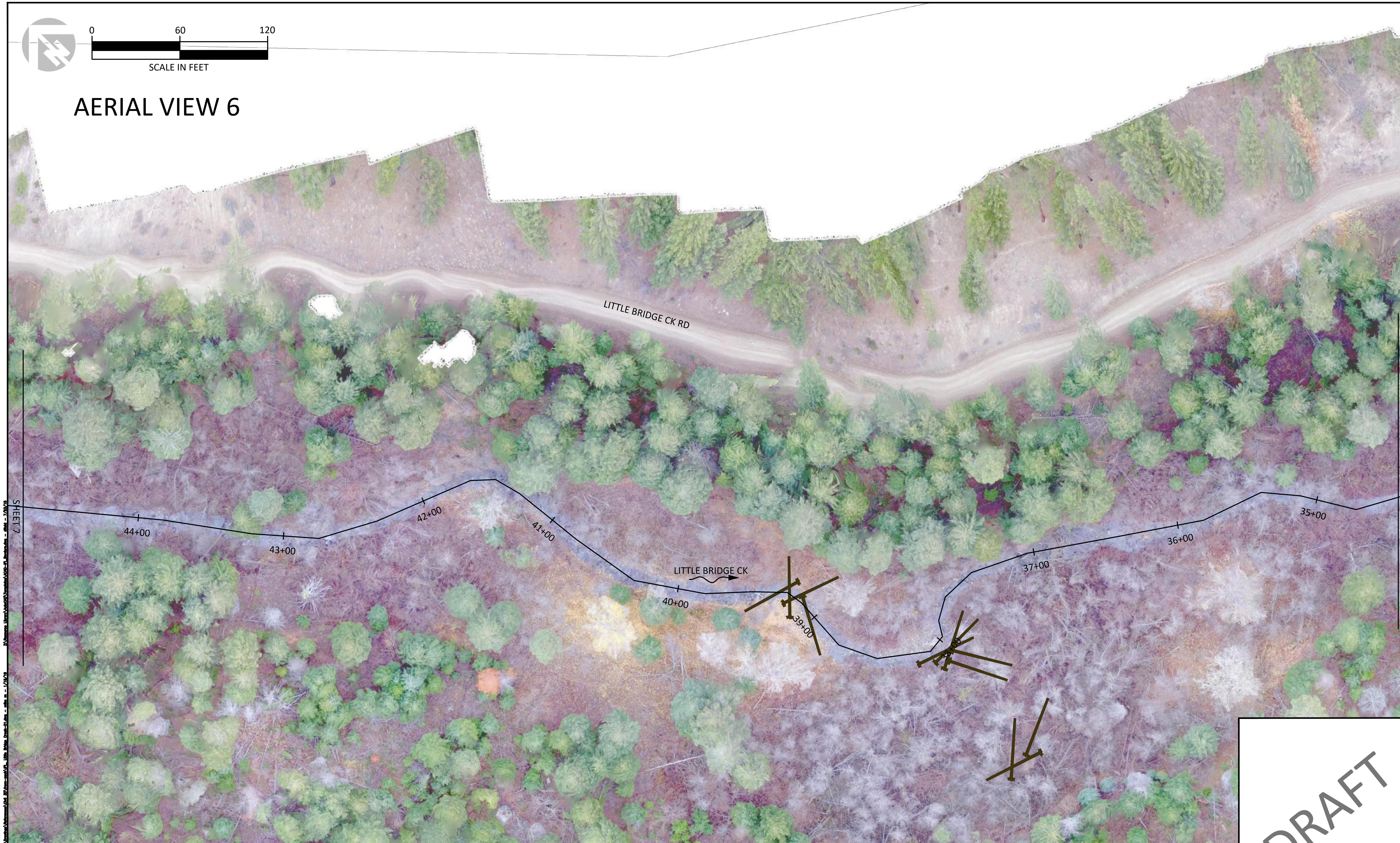
AERIAL VIEW 5 - LOG PLACEMENTS

AERIAL VIEW 6



DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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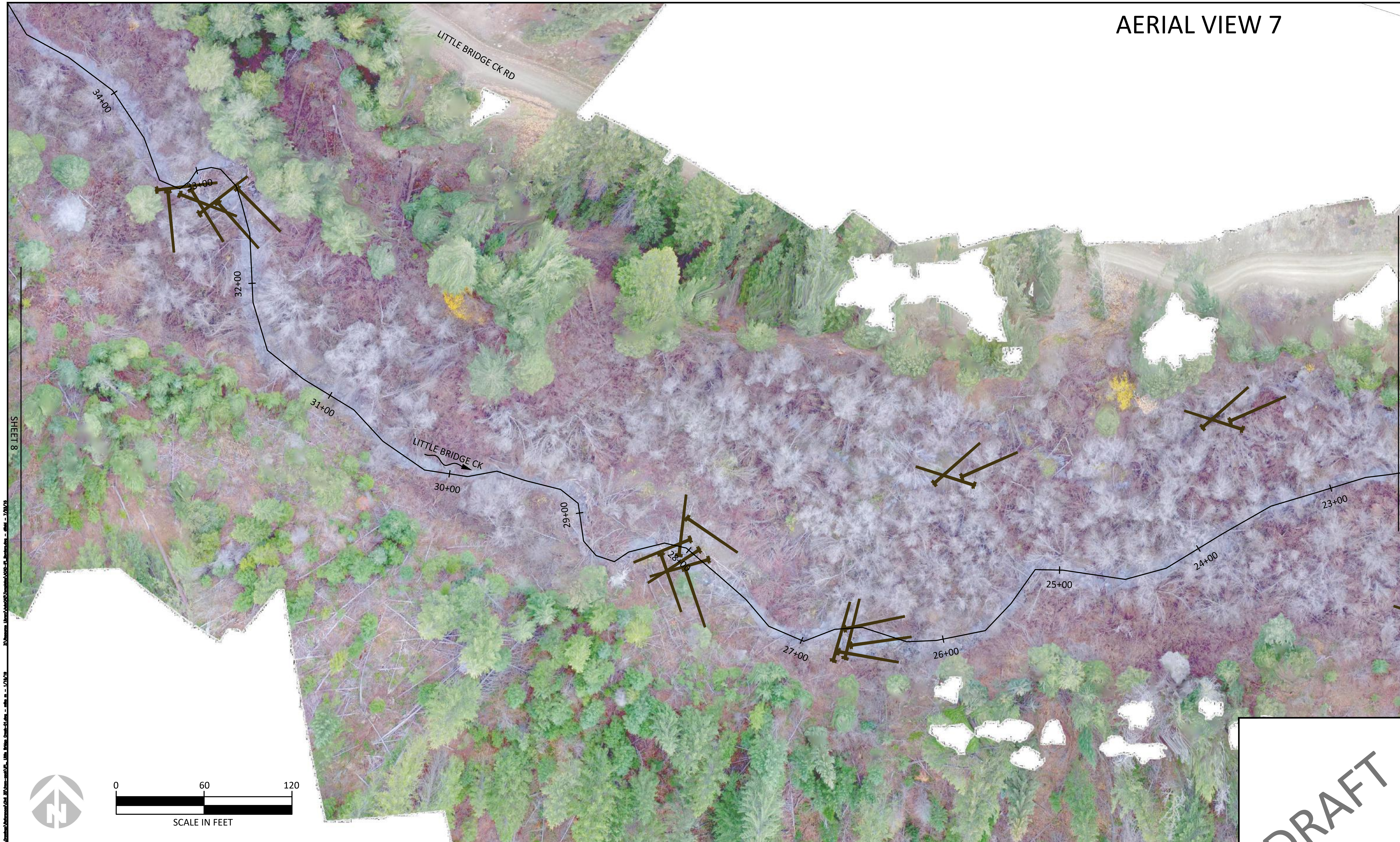
AERIAL VIEW 6 - LOG PLACEMENTS

SHEET
8 OF 11

AERIAL VIEW 7



DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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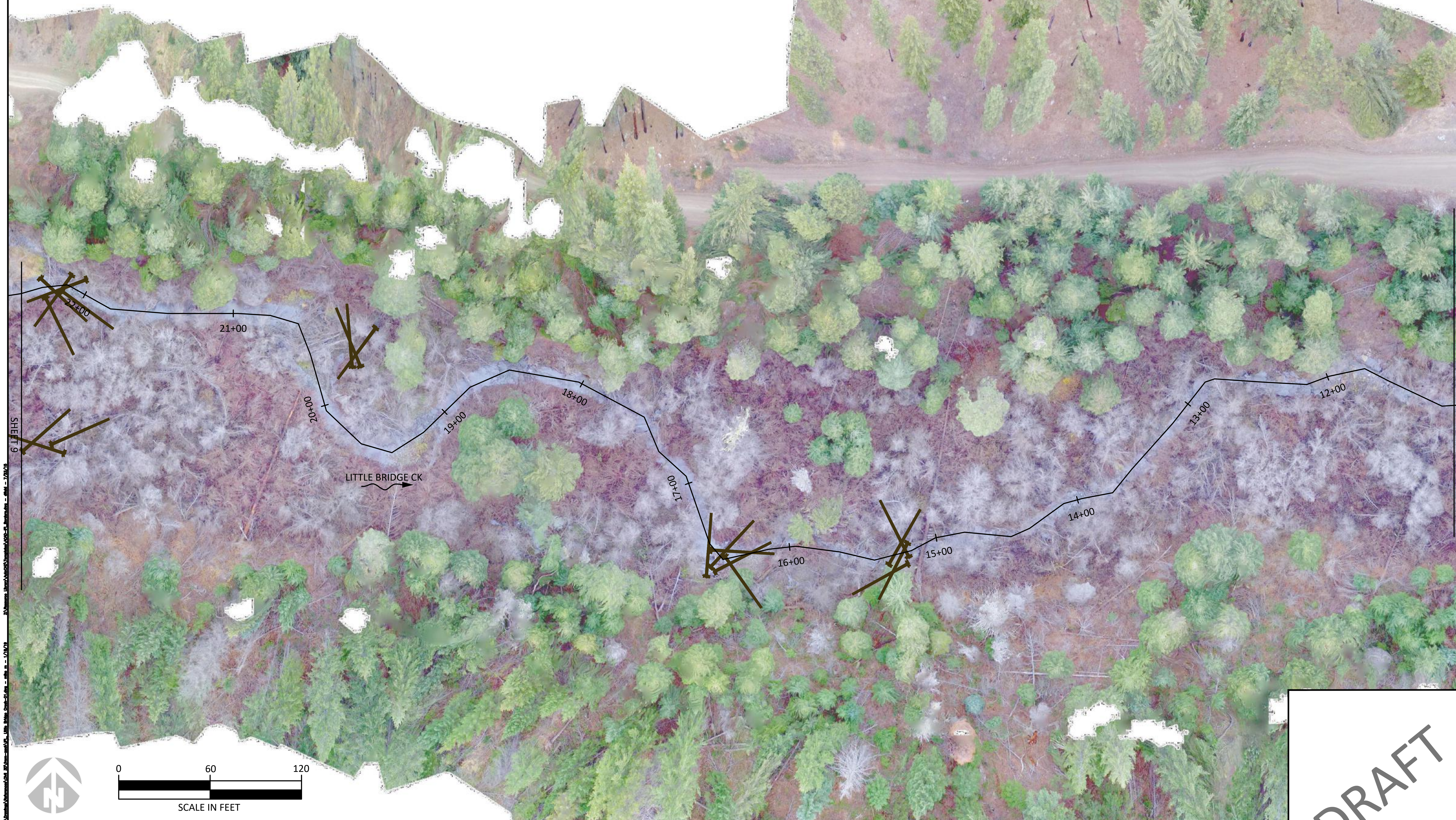
AERIAL VIEW 7 - LOG PLACEMENTS

SHEET 9 OF 11

AERIAL VIEW 8



DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

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MM — APPROVED | 12/14/18 — DATE | 17-02-59 — PROJECT

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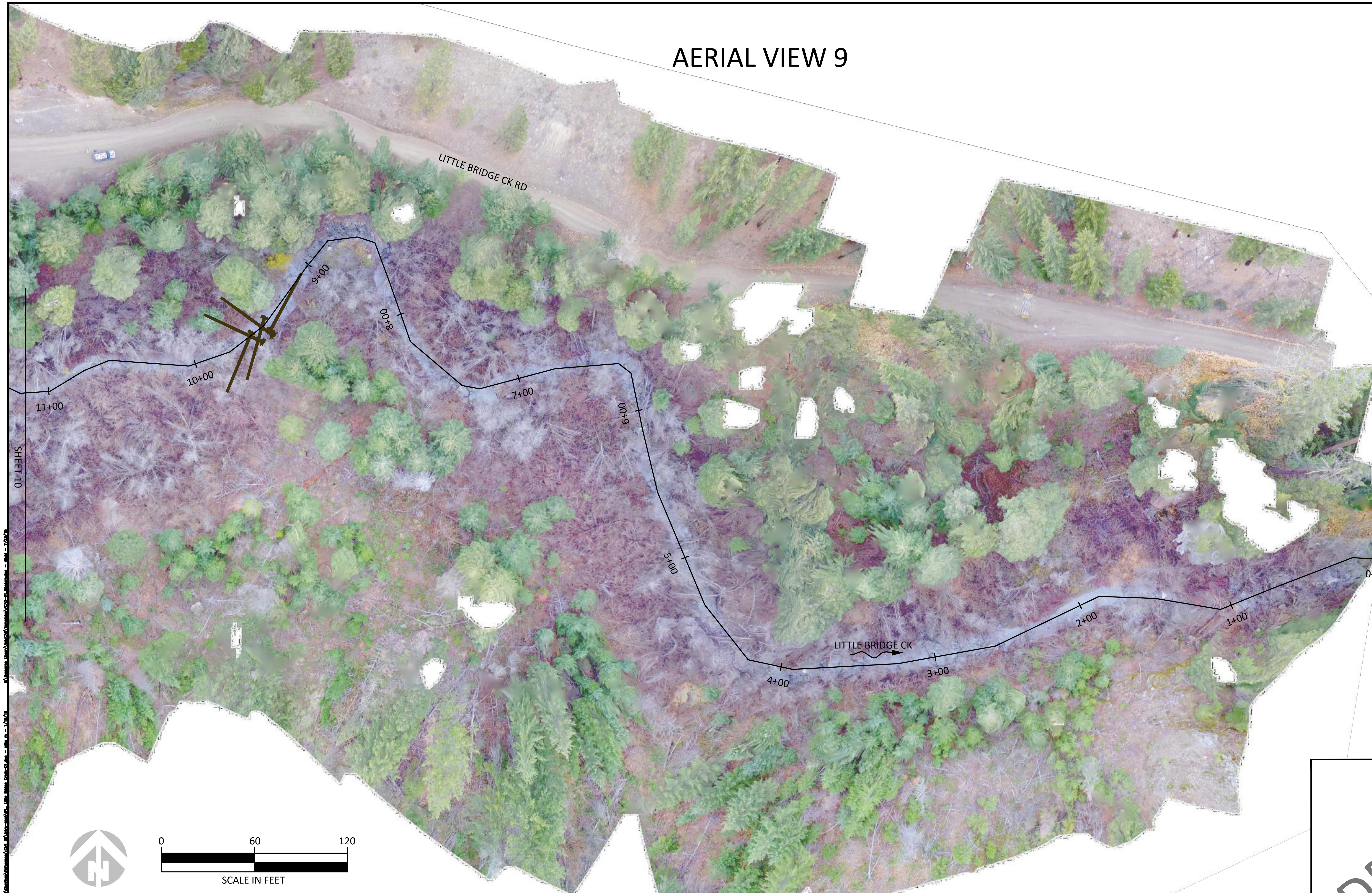
AERIAL VIEW 8 - LOG PLACEMENTS

AERIAL VIEW 9



NO.	BY	DATE	REVISION DESCRIPTION

ZS	MB	MB
DRAWN	DESIGNED	CHECKED
MM	12/14/18	17-02-59
APPROVED	DATE	PROJECT

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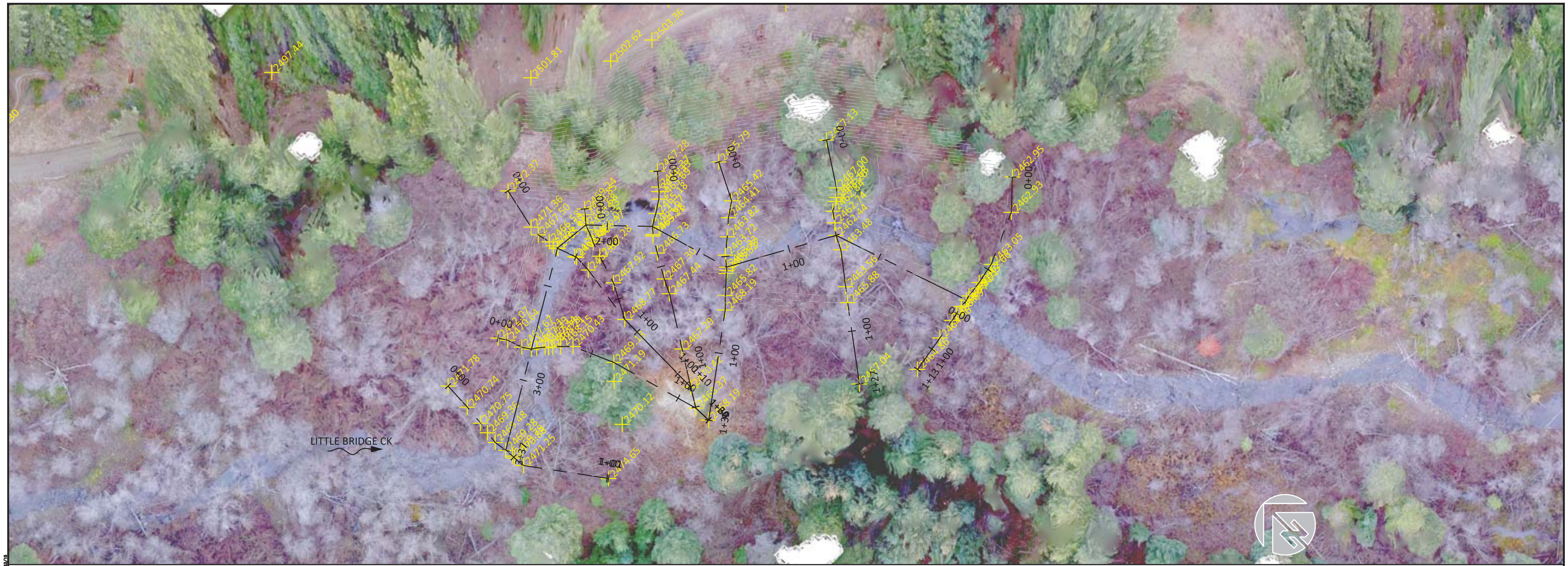
AERIAL VIEW 9 - LOG PLACEMENTS

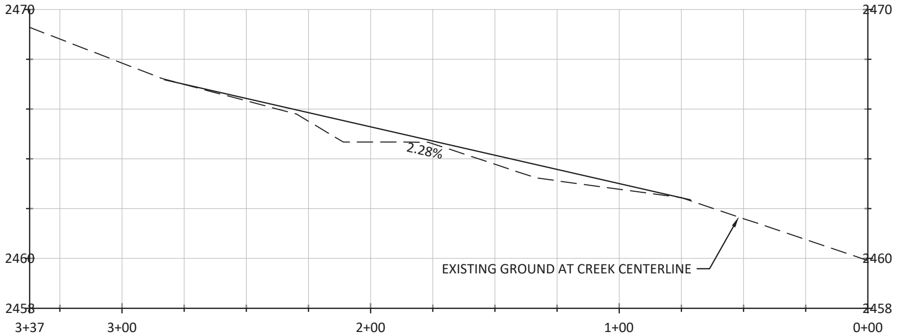
DRAFT

Appendix B: Hydraulic Model Output



PLAN VIEW

0 50 100
SCALE IN FEET



PROFILE VIEW

NO.	BY	DATE	REVISION DESCRIPTION

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APPROVED DATE PROJECT

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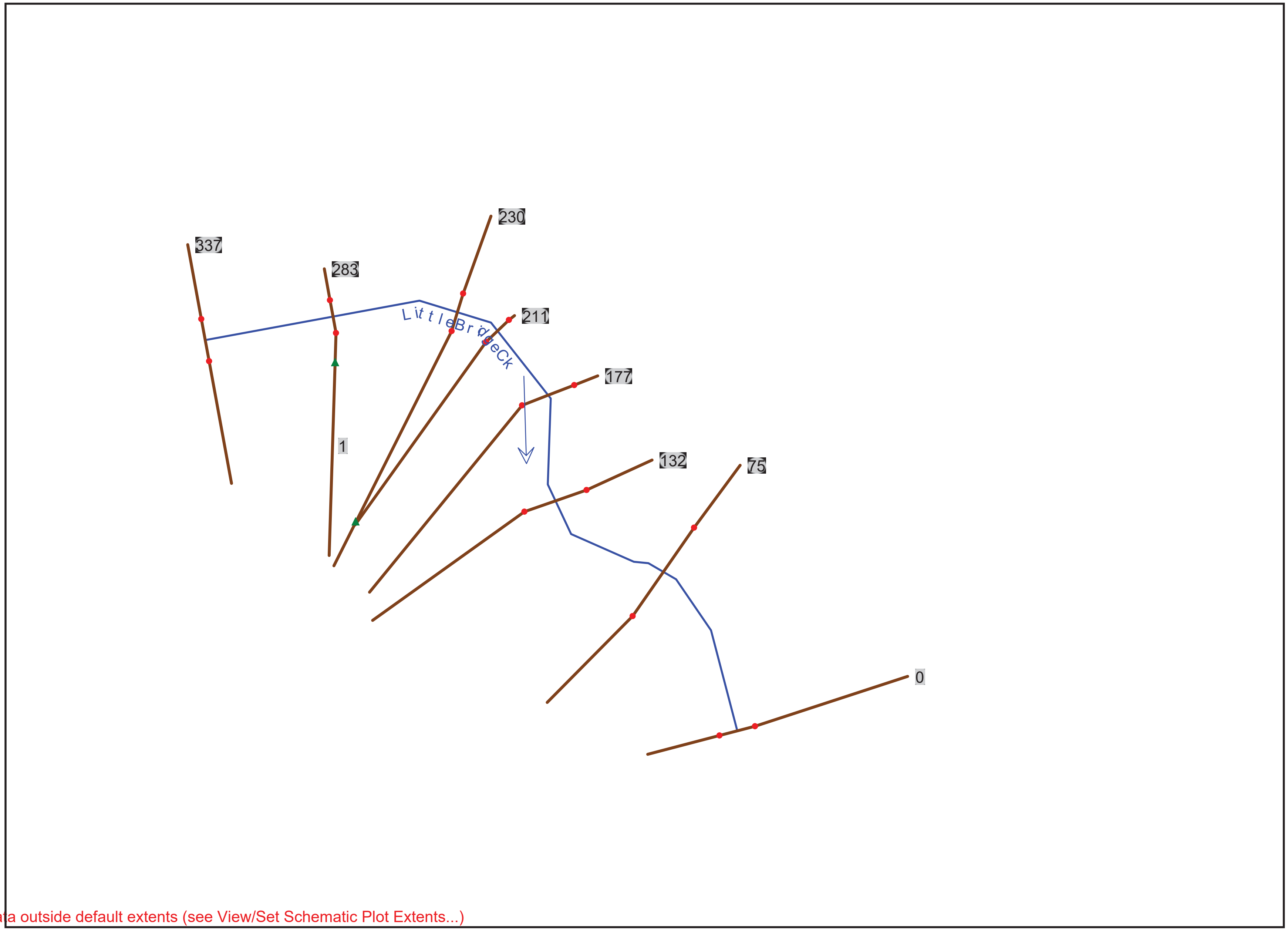
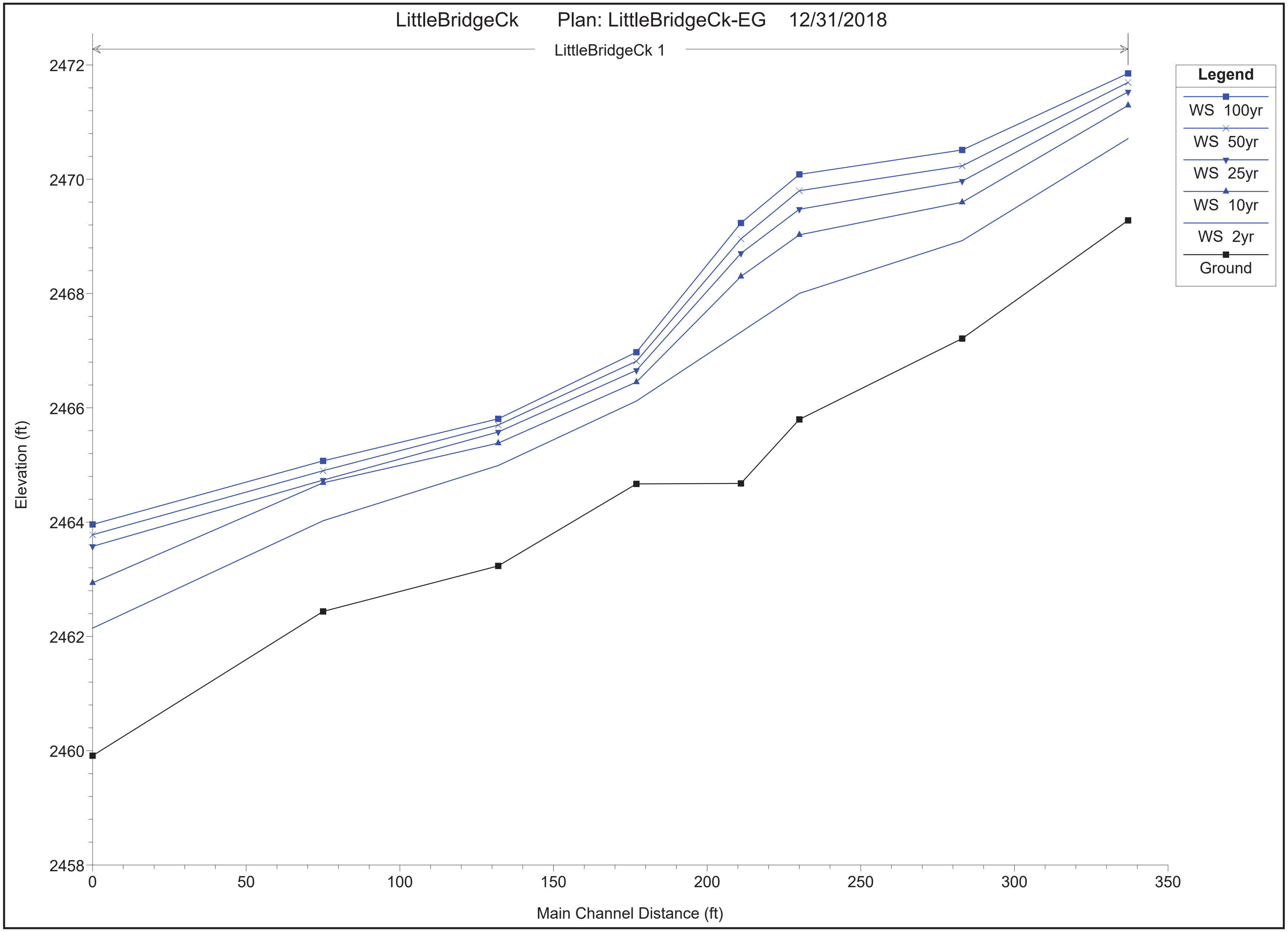
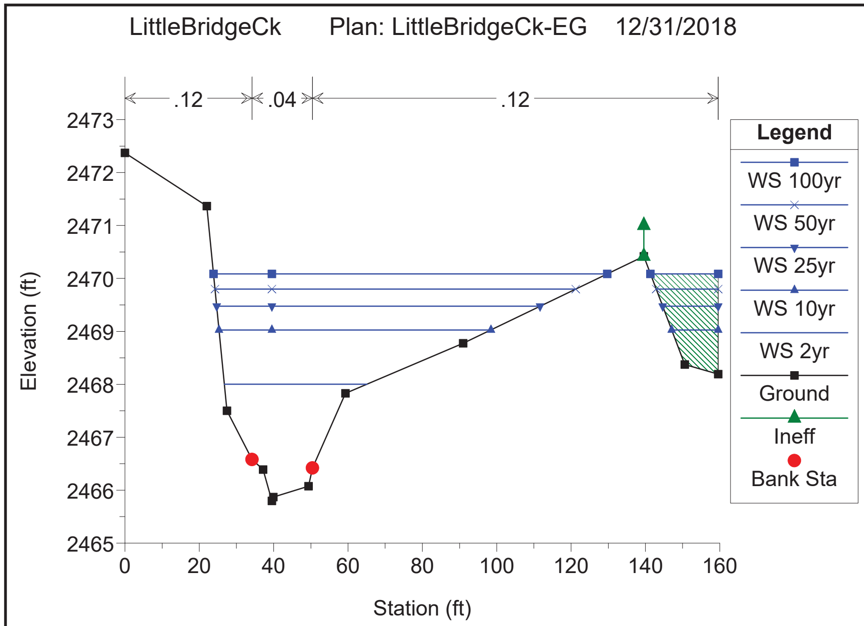
SURVEY

SHEET
OF

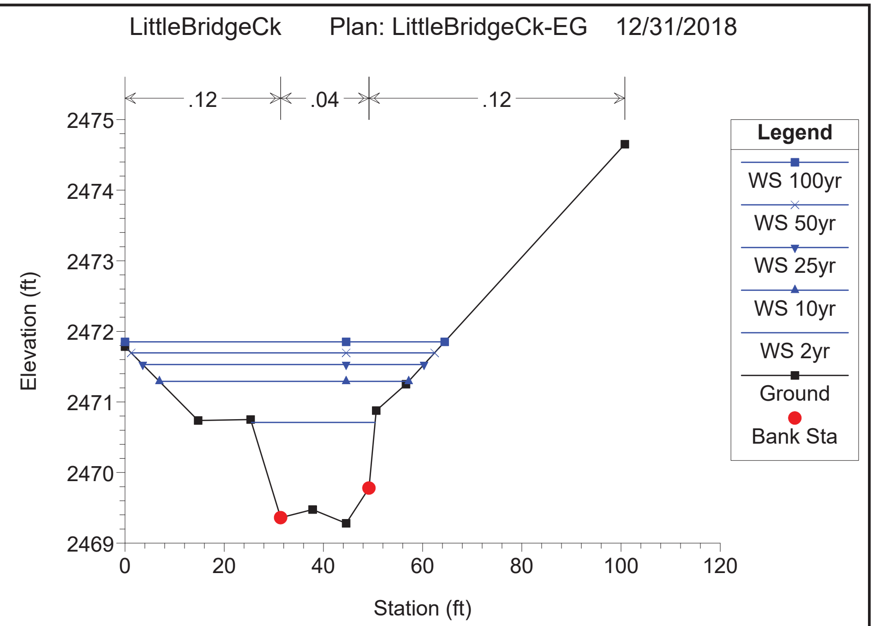


Some schematic data outside default extents (see View/Set Schematic Plot Extents...)

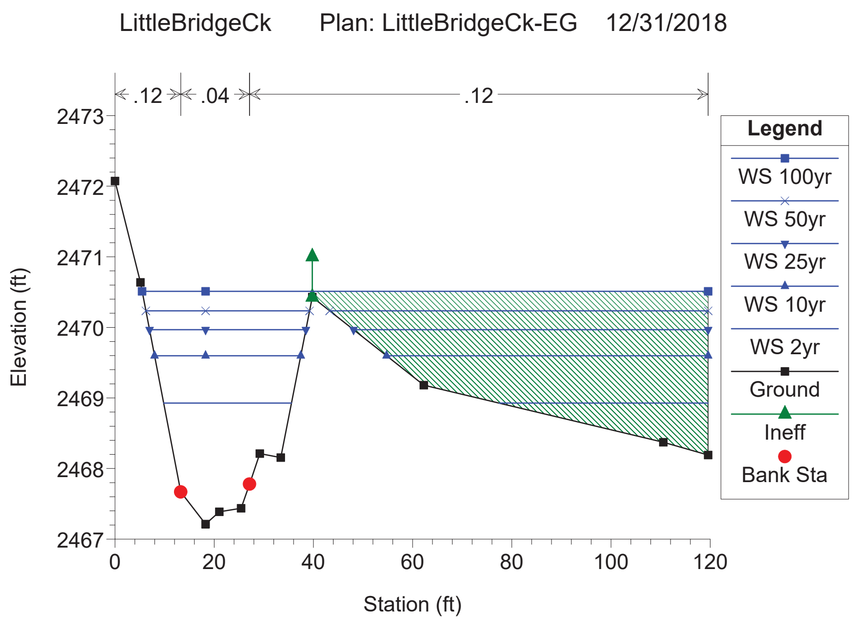

LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
LittleBridgeCk 1
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Elevation (ft)
2472
2470
2468
2466
2464
2462
2460
2458
0
50
100
150
200
250
300
350
Main Channel Distance (ft)



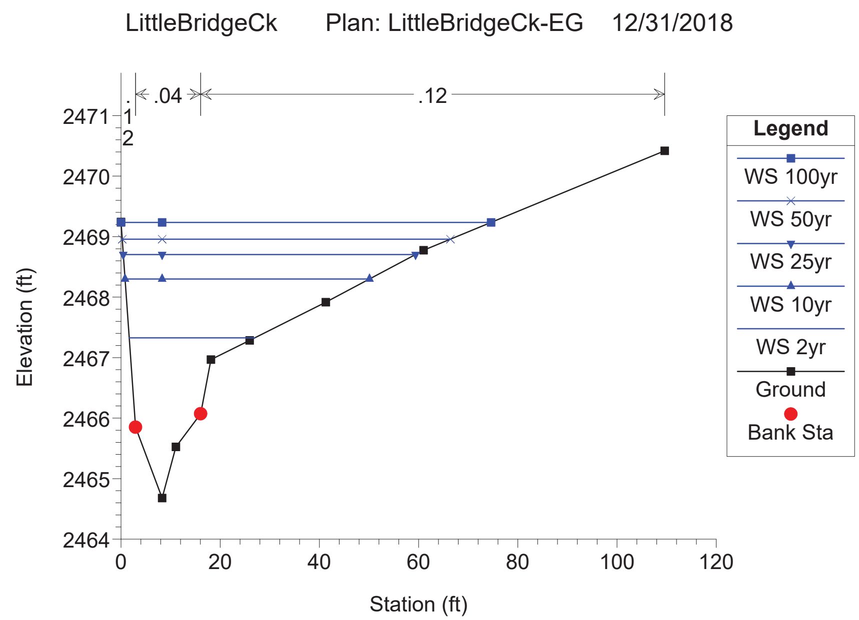
LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Ineff
Bank Sta



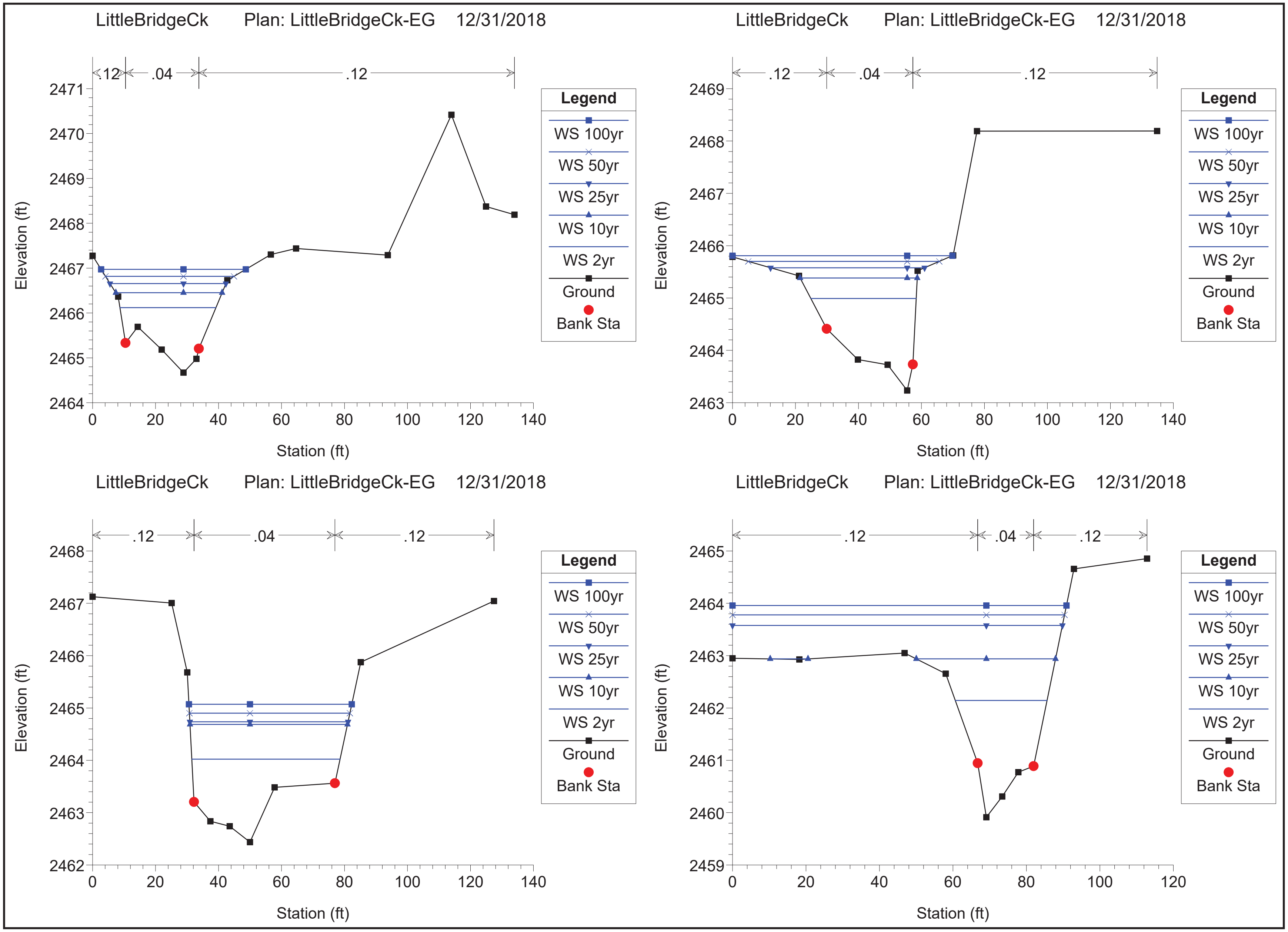
LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta

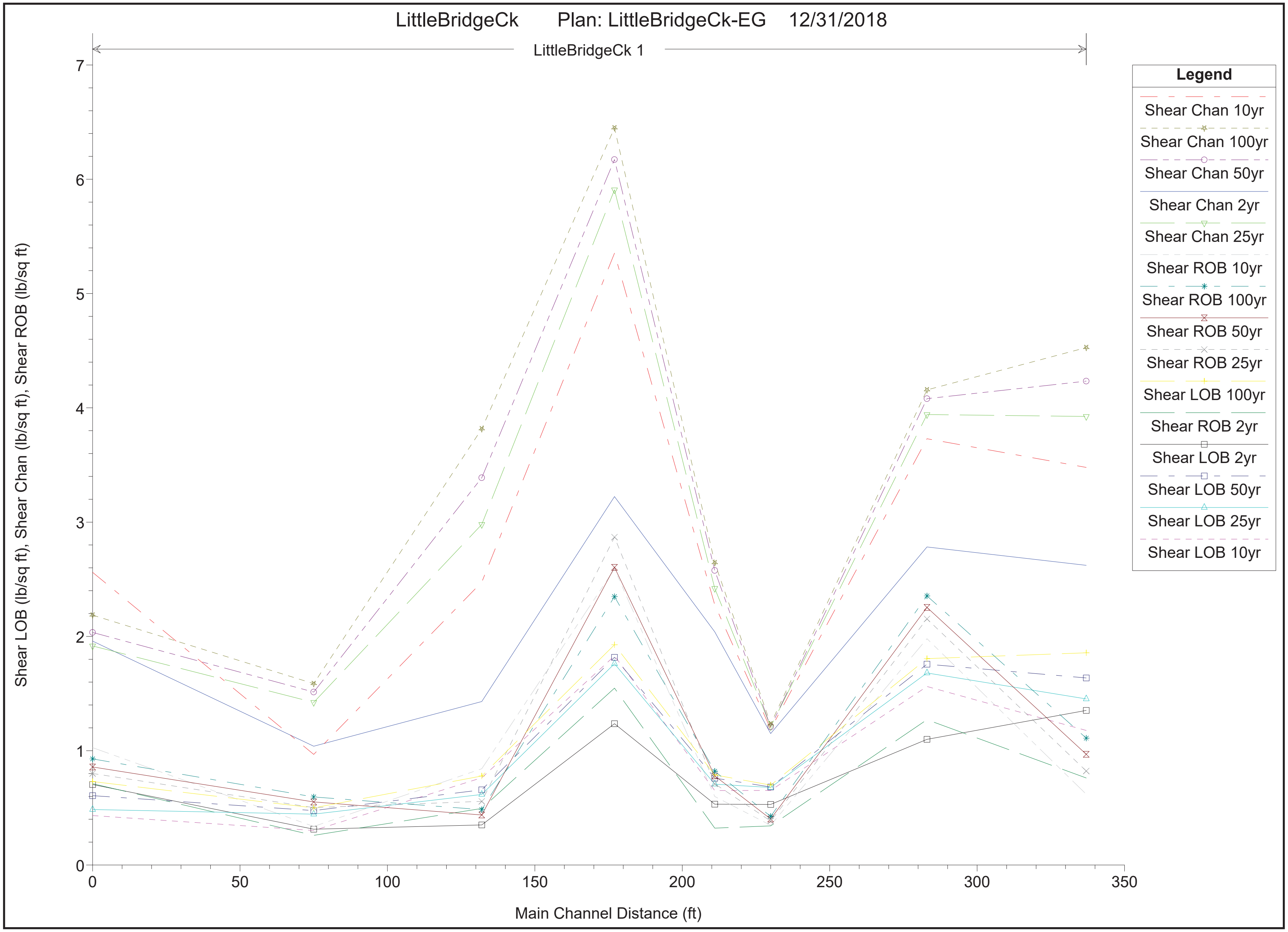


LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Ineff
Bank Sta

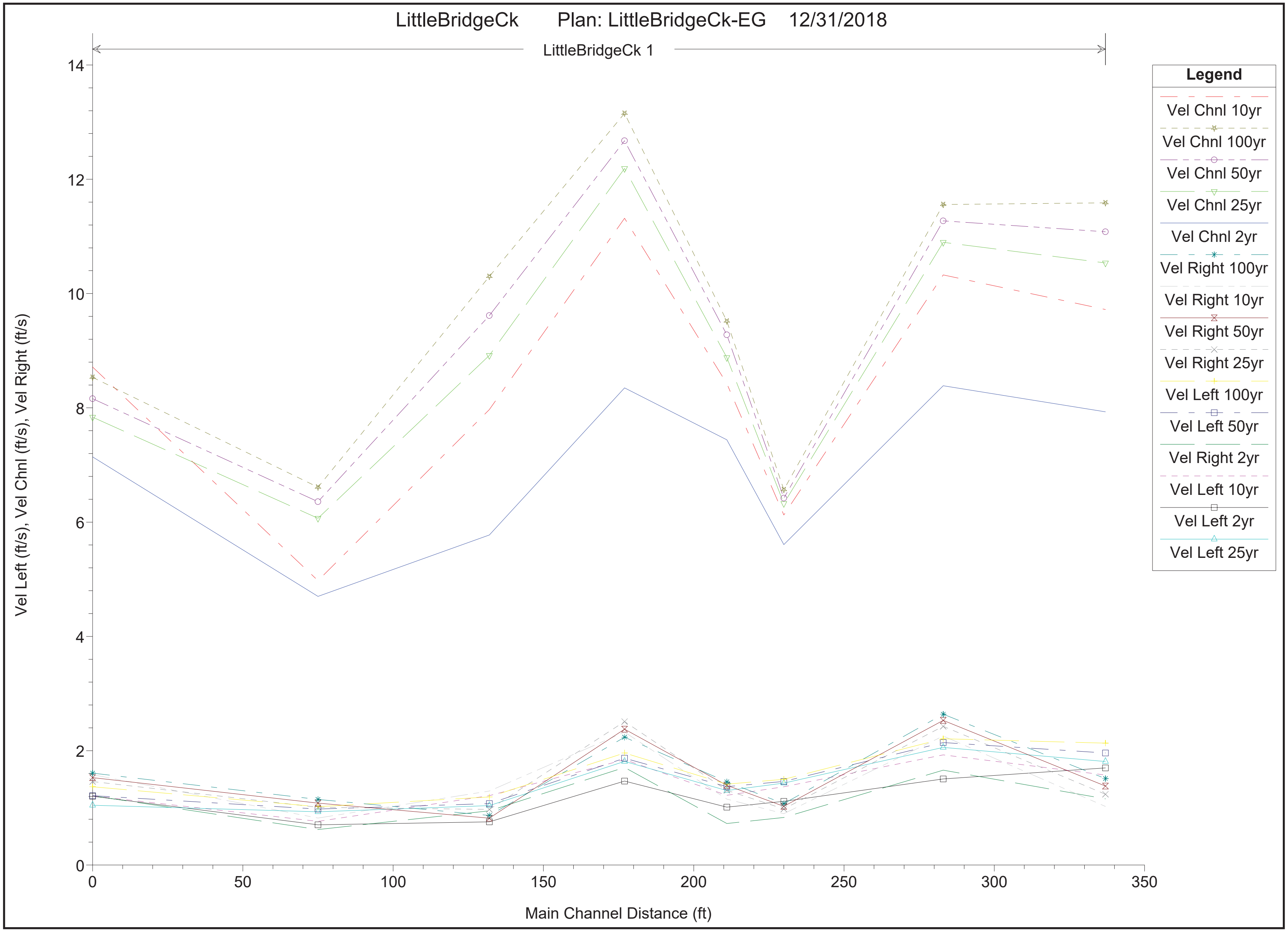


LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta


LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta
LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta
LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta
LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
.12
.04
.12
Elevation (ft)
Station (ft)
Legend
WS 100yr
WS 50yr
WS 25yr
WS 10yr
WS 2yr
Ground
Bank Sta



LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
LittleBridgeCk 1
Shear LOB (lb/sq ft), Shear Chan (lb/sq ft), Shear ROB (lb/sq ft)
Main Channel Distance (ft)
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300
350
Legend
Shear Chan 10yr
Shear Chan 100yr
Shear Chan 50yr
Shear Chan 2yr
Shear Chan 25yr
Shear ROB 10yr
Shear ROB 100yr
Shear ROB 50yr
Shear ROB 25yr
Shear LOB 100yr
Shear ROB 2yr
Shear LOB 2yr
Shear LOB 50yr
Shear LOB 25yr
Shear LOB 10yr


LittleBridgeCk Plan: LittleBridgeCk-EG 12/31/2018
LittleBridgeCk 1
Vel Left (ft/s), Vel Chnl (ft/s), Vel Right (ft/s)
Main Channel Distance (ft)
0
2
4
6
8
10
12
14
0
50
100
150
200
250
300
350
Legend
Vel Chnl 10yr
Vel Chnl 100yr
Vel Chnl 50yr
Vel Chnl 25yr
Vel Chnl 2yr
Vel Right 100yr
Vel Right 10yr
Vel Right 50yr
Vel Right 25yr
Vel Left 100yr
Vel Left 50yr
Vel Right 2yr
Vel Left 10yr
Vel Left 2yr
Vel Left 25yr

HEC-RAS Plan: EG River: LittleBridgeCk Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Hydr Radius C	SA Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(acres)
1	337	2yr	188.00	2469.28	2470.71	0.032891	7.93	27.33	24.93	1.24	1.28	0.18
1	337	10yr	349.00	2469.28	2471.29	0.030011	9.72	51.36	50.26	1.26	1.86	0.18
1	337	25yr	439.00	2469.28	2471.53	0.030015	10.54	64.10	56.71	1.28	2.09	0.18
1	337	50yr	508.00	2469.28	2471.70	0.030022	11.08	73.81	61.17	1.30	2.26	0.18
1	337	100yr	580.00	2469.28	2471.85	0.030018	11.59	83.72	64.46	1.31	2.42	0.18
1	283	2yr	188.00	2467.21	2468.93	0.029785	8.39	28.93	67.89	1.21	1.50	0.16
1	283	10yr	349.00	2467.21	2469.60	0.027595	10.33	47.48	94.32	1.23	2.16	0.16
1	283	25yr	439.00	2467.21	2469.97	0.024923	10.90	58.76	103.02	1.20	2.53	0.16
1	283	50yr	508.00	2467.21	2470.23	0.023354	11.27	67.37	109.29	1.19	2.80	0.16
1	283	100yr	580.00	2467.21	2470.51	0.021659	11.56	76.73	114.12	1.16	3.07	0.16
1	230	2yr	188.00	2465.80	2468.00	0.009763	5.61	45.94	38.39	0.72	1.89	0.15
1	230	10yr	349.00	2465.80	2469.03	0.006563	6.12	103.45	85.69	0.63	2.90	0.15
1	230	25yr	439.00	2465.80	2469.48	0.005793	6.33	139.30	101.96	0.61	3.35	0.15
1	230	50yr	508.00	2465.80	2469.80	0.005278	6.42	169.09	113.73	0.59	3.67	0.15
1	230	100yr	580.00	2465.80	2470.09	0.005002	6.57	198.14	124.14	0.58	3.95	0.15
1	211	2yr	188.00	2464.68	2467.33	0.017651	7.44	29.01	25.31	0.95	1.85	0.14
1	211	10yr	349.00	2464.68	2468.30	0.013007	8.42	65.47	49.29	0.88	2.80	0.14
1	211	25yr	439.00	2464.68	2468.70	0.012118	8.88	87.35	58.93	0.87	3.20	0.14
1	211	50yr	508.00	2464.68	2468.96	0.011976	9.28	103.14	66.17	0.87	3.45	0.14
1	211	100yr	580.00	2464.68	2469.23	0.011391	9.52	122.63	74.60	0.86	3.72	0.14
1	177	2yr	188.00	2464.67	2466.12	0.055124	8.35	25.05	30.46	1.52	0.94	0.12
1	177	10yr	349.00	2464.67	2466.45	0.067562	11.32	35.70	33.77	1.77	1.27	0.12
1	177	25yr	439.00	2464.67	2466.66	0.064285	12.19	42.89	36.80	1.77	1.47	0.12
1	177	50yr	508.00	2464.67	2466.82	0.060554	12.68	49.10	40.79	1.75	1.63	0.12
1	177	100yr	580.00	2464.67	2466.97	0.057761	13.15	55.87	45.95	1.73	1.79	0.12
1	132	2yr	188.00	2463.23	2464.99	0.019506	5.78	34.38	33.46	0.94	1.17	0.10
1	132	10yr	349.00	2463.23	2465.38	0.025320	7.97	48.25	37.21	1.12	1.57	0.10
1	132	25yr	439.00	2463.23	2465.58	0.027125	8.92	56.34	48.95	1.18	1.76	0.10
1	132	50yr	508.00	2463.23	2465.70	0.028863	9.61	62.99	60.68	1.23	1.88	0.10
1	132	100yr	580.00	2463.23	2465.81	0.030728	10.30	70.19	69.86	1.29	1.99	0.10
1	75	2yr	188.00	2462.44	2464.02	0.018716	4.70	40.57	47.10	0.88	0.89	0.05
1	75	10yr	349.00	2462.44	2464.69	0.009987	4.98	72.80	50.02	0.70	1.55	0.05

HEC-RAS Plan: EG   River: LittleBridgeCk   Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Hydr Radius C	SA Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(acres)
1	75	25yr	439.00	2462.44	2464.74	0.014243	6.07	75.25	50.24	0.84	1.60	0.05
1	75	50yr	508.00	2462.44	2464.90	0.013735	6.36	83.58	50.96	0.84	1.77	0.05
1	75	100yr	580.00	2462.44	2465.07	0.013132	6.61	92.34	51.71	0.84	1.94	0.05
1	0	2yr	188.00	2459.91	2462.14	0.019187	7.14	31.27	24.98	0.98	1.64	
1	0	10yr	349.00	2459.91	2462.94	0.016976	8.71	54.61	48.19	0.98	2.42	
1	0	25yr	439.00	2459.91	2463.58	0.010087	7.84	109.66	89.80	0.79	3.04	
1	0	50yr	508.00	2459.91	2463.78	0.010048	8.16	127.96	90.39	0.79	3.24	
1	0	100yr	580.00	2459.91	2463.96	0.010242	8.53	144.21	90.91	0.81	3.42	