UPPER TRUCKEE MARSH SEWER FACILITIES ADAPTIVE MANAGEMENT PLAN

2017 ANNUAL REPORT

Prepared for:

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EXECUTIVE SUMMARY

The South Tahoe Public Utility District (District) is implementing an Adaptive Management Plan (AMP) to protect existing sewer facilities in the Upper Truckee Marsh. Two District sewer pipelines are located along the northern margin of the marsh in an easement over property owned by the California Tahoe Conservancy (Conservancy). The need for the plan was initiated by a channel avulsion in the vicinity of the easement following the record snowmelt year of 2011. The objective of the plan is to reduce inundation of the sewer easement and reduce the potential for stream channel development and erosion that would expose or damage the sewer lines and potentially lead to a sewage spill into the marsh and Lake Tahoe. The development of the plan is described in *Upper Truckee Marsh Sewer Facilities Adaptive Management Plan* (NHC, 2014). The plan envisioned up to 5 years of adaptive management activities to reduce risks to the sewer facilities and improve maintenance conditions. Annual reporting summarizing Year 1 (2014) and Year 2 (2015) post-construction monitoring and measures implemented in Year 3 (2016) has previously been prepared (NHC, 2015 and 2017). This Annual Report summarizes Year 3 post-construction monitoring and the measures implemented by the District in Year 4 (2017).

Baseline Information

Baseline information was previously presented in the 2015 Annual Report, and is briefly reviewed in this report for purposes of comparison. Baseline conditions included inundation of the STPUD easement near Bellevue Avenue in all flow conditions, and an imminent threat of new channel formation directly over the two sewer lines installed in the easement. Baseline surveying, water level and turbidity measurements, and vegetation transects provide the basis for project comparisons.

Year 3 Construction

The proposed Year 3 construction work was described in the 2016 annual report. Only minor work was considered necessary in the area near Bellevue Avenue in Year 3, pending further monitoring of pilot channel development and vegetative growth. Year 3 improvements were focused on installing hummocks and planting in areas upstream of Bellevue Avenue where increased inundation due to beaver activity presented a problem for access to District manholes. In addition, Year 3 improvements included a measure to address beaver activity at the head of the secondary channel in the center of the marsh, which reduces flows into the secondary channel that was activated in Year 2.

Year 3 plans were developed to include:

- Additional planting of wetland plugs in the right overbank near the end of Bellevue Avenue;
- Reinforcement and extension of an existing coir log at the head of Hummock H4 to encourage flow into Pilot Channel 1;
- Installation of a double marsh mat hummock near Manhole BV18, downstream of Hummock H6 in the District's easement;

- Slight modification of coir logs around the south side of Hummock H6 to lower top elevations to the level of the adjacent marsh to allow free drainage of overbank flows and reduce ponding in the easement;
- Installation of a marsh mat and willow mattress hummock and short pilot channel near Manhole BV19;
- Installation of a hummock near Manhole BV21;
- Installation of a double marsh mat hummock between Manholes BV21 and BV22 in a low spot within the easement;
- Installation of a double marsh mat hummock near Manhole BV22;
- Installation of a pond leveler at the head of the secondary channel in the center of the marsh to maintain an estimated 3 cfs minimum flow through the channel.

With the exception of the installation of the pond leveler, Year 3 improvements required no heavy equipment access and no significant grading activities.

Plans were included as an Appendix to the 2016 Annual Report and reviewed with the permitting and resource agencies in early October 2016. Construction was implemented in late October through a change order with V&C Construction.

Year 3 Post-Construction Monitoring

The 2017 water year was an exceptionally high water year in terms of peaks flows, late summer flow duration, and annual runoff volume. Winter-time peaks of 409 cfs and 483 cfs occurred on January 9 and February 9, respectively, at USGS Gage 10336780 near Tahoe Valley upstream of the site. Flows remained at or above 100 cfs for almost four months in April-July and the recession limb of the annual hydrograph never descended below about 28 cfs in late October. The channel capacity prior to the 2011 avulsion was believed to range between 25 and 50 cfs. The USGS reported average annual flow was 112 cfs, the largest in the historical record, exceeding even other large water years such as 1997 and 2011 by at least 50 percent. No calculations have been performed for sediment transport for the year, but flow characteristics suggest that WY 2017 was likely one of the largest years, and possibly the largest year, on record for transport of sediment. Due to the long duration of flows in excess of the channel capacity and the influence of beaver activity, much of the marsh, including the right overbank near Bellevue Avenue, remained inundated through the summer and fall months.

No significant topographic or channel changes were made in Year 3 construction, and topographic monitoring was limited to measurement of pilot channel geometry and visual observations. Visual observations in the Bellevue Avenue in August and October 2017 indicated that sediment had accumulated in the vicinity of the coir logs placed in Year 2 construction and the active portion of the overbank flow had narrowed due to increased vegetation. Minor accumulation of sediment was also noted in the hummocks placed in Year 1 and 2 construction, especially deposition of sand at Hummock 3.

During the snowmelt period, the District implemented a management measure to encourage flow into the upstream end of one of the pilot channels (Pilot Channel 3, PC-3) for the purpose of encouraging further natural development of pilot channel capacity. Pilot channels were observed in March, August, and October 2017. In March, all of the pilot channels were flowing over their banks and sand deposits were noted in several areas due to overflow of the channels in vegetated areas. Approximately 30 cfs was estimated to be passing through the pilot channel system, with 10-15 cfs on the right overbank. In August, approximately 25 cfs was estimated to be passing through the pilot channel system with about 3 cfs on the right overbank. Flows were generally contained in the channel banks. In October, flows in the pilot channel system were estimated at about 15 cfs with almost no flow in the right overbank. Flows at the USGS gage upstream of the site were about 85, 75, and 30 cfs for the March, August, and October observation dates, respectively.

Pilot Channel 3 was observed to carry the majority of the flow in all three observations. Measurements of the pilot channel geometry indicated that the outlet channel for the pilot channel system and Pilot Channel 3 expanded slightly in width and in depth since Year 2 measurements. Pilot Channels 1 and 2 remained active, but are not increasing in capacity.

In spite of increased capacity in PC-3, inundation of the overbank area continued through the fall of 2017. This inundation can partly be attributed to higher than normal flows and overflow of the main channel upstream of Bellevue Avenue due to beaver dams in the main channel. In addition to higher flow capacity, active bed load transport and bed form development (scour, ripples, dunes) were evident in the pilot channel system. The main pilot channel beds are now observed to have little vegetative growth and are characterized by sand in gradual transport along the bed.

The pressure transducers installed at the beginning of the project continued to operate following Year 3 construction. The water levels are intended to supplement observations on easement inundation and pilot channel performance in conjunction with survey data. The water level data for 2016 and 2017 appear to have some inaccuracies which may be attributed to overpressure of the pressure transducers during ice build-up in Trout Creek. Manual measurements were used to identify potential problems with the sensors and verify collected data. Stages recorded at the pressure sensors varied 1.5 to 2 feet.

Vegetation replanted on the road fill removal area and planted in the hummocks was surveyed in September 2015 by Western Botanical Services and results were reported in the 2015 Annual Report (NHC, 2015). Vegetation on the road fill removal met success criteria in the first year and has not been resurveyed, but was observed in 2016 to be in good condition with nearly 100% cover. Hummock transects surveyed in 2015 were resurveyed in 2016, and results showed that percent cover criteria were met and native plant criteria were nearly met. The 2016 annual report noted that native cover criteria were expected to be met in the following year, but inundation during the summer prevented resurveying the transects. Similarly, vegetation planted in Year 3 could not be accurately observed or surveyed. In observations from previous years, lowest establishment rates were associated with areas that had long inundation, and this may affect Year 3 plantings. If the planted areas are accessible in summer or fall 2018 the transects will be resurveyed to determine success in meeting cover and native plant criteria and observations of survival for Year 3 plantings will be made.

Turbidity measurements continued to be made upstream and downstream of the work area near Bellevue Avenue for Years 3 and 4. There are considerable gaps in operation of the turbidity sondes, and the available records generally do not correspond to periods of project activity. Both Year 3 and Year 4 records show periods of spikes in downstream turbidity but the cause of these increases is unknown and they do not correspond to dates of project activity. One purpose of the turbidity monitoring is to determine if the project activities from the previous year increase turbidity during high runoff periods, and the observed spikes are not consistent with a general increase in erosion or sediment transport in the pilot channels. Outside of the periods with spikes in downstream turbidity, the plots do not show a general increase in turbidity from upstream to downstream and may be more indicative of a decrease in turbidity from upstream to downstream under typical conditions. The turbidimeter equipment is currently being repaired by the District for re-deployment.

Photos were collected at photo points established in the baseline condition and are included in an appendix to the report.

Beaver activity upstream of the Bellevue work area increased in 2017, resulting in long duration overbank flooding of the District's easement and several of the manholes on the gravity sewer. The increase in flooding in 2017 appears to be related to construction of an extensive system of auxiliary beaver dams on flow paths that would otherwise return overbank flows to the main channel. The blockage of these return flows causes overbank flows near the District's Manhole BV-22 to continue down the right overbank and flood other manholes in the easement. Several areas of ponded water were evident in this area in August 2017, including areas near Manholes 18, 19, 21, and 22. Beaver activity in the main channel resulted in sediment deposition in the main channel upstream and at the location of the Pond Leveler installed in Year 3. Sediment deposition upstream of the pond leveler reduces main channel capacity and increases left and right overbank flows. Right overbank flows generally accumulate near the District's manhole BV-22 because they are prevented from re-entering the main channel due to the auxiliary beaver dams along the banks of the channel. A second dam on the main channel was also noted in 2017, close to BV-22.

Inundation by beaver activity was a primary cause of flooding in the easement in the fall of 2016 and 2017, and effectively prevents typical maintenance access along the easement. Year 3 improvements were designed to slightly raise ground levels and plant vegetation in areas around the manholes and other low points, but were expected to provide limited benefits against inundation by beaver activity.

Year 4 (2017)Activities

Year 4 activities were limited to maintenance actions to reduce the hydraulic changes occurring in the marsh resulting from beaver activity. These actions were implemented in an attempt to mitigate overbank flooding conditions and restore a portion of the channel capacity on the main channel and in the secondary channel in the center of the marsh.

Year 4 activities included:

- Woody debris removal from two locations on the main channel upstream of BV22 corresponding to the locations of channel obstructions. The woody debris removal extended to approximately 2.5 feet below the top of bank.
- Woody debris removal from 4 locations on the secondary channel, corresponding to locations of channel obstructions. Woody debris removal extended to the channel invert and bank locations upstream and downstream.

Plans for maintenance activities were reviewed with the permitting and resource agencies in October 2017 and were implemented in November 2017 through a change order with V&C Construction. All work performed in Year 4 was completed with hand crews, and no heavy equipment was used.

A field review of conditions was conducted in June 2018 and pilot channels were found to generally be operating as expected, with an estimated 30 cfs passing through the system. A flow of approximately 47 cfs was being recorded at USGS Gage 10336780 at the time of the field visit. A small flow of less than 1 cfs was estimated in the right overbank near Bellevue with only a fraction of that amount in the easement area. Gradient through the pilot channel system remains higher than the average gradient for the adjacent stream reaches, indicating that some incision and increase in capacity in the pilot channels may occur over time. Upstream of the Bellevue area, inundation on the right overbank and in the District's easement persisted although the creek channel was flowing at or below bankfull in some areas. The inundation is likely due to a combination of hydraulic control at the pilot channels and beaver activity. Hydraulic controls at the pilot channels are related to the size of the channels and inlet conditions. Although Pilot Channel 3 continues to slowly enlarge, the other two pilot channels have relatively low capacity due to a combination of channel size and vegetative growth. The combined capacity of the pilot channels remains less than the upstream main channel, resulting in backwater effects. Stages near bankfull in the main channel are slightly higher than ground elevations in some areas of the District's easement (i.e., channel is slightly perched), and thus ponding in these areas appears to persist well after overbank flow ceases. Overbank flows at higher discharges earlier in the year and a water table near the surface of the marsh result in ponding and very low flows in and through topographic depressions. Flows on the right overbank are directly influenced by beaver activity near and upstream of BV22.

Inundation of the right overbank by beaver activity is expected to continue and may change in location or severity from time to time. Beaver activity has also caused the main Trout Creek channel to fill with sand, increasing the probability for a new avulsion. The extensive overbank flooding due to beaver activity may also contribute to generally higher groundwater levels, filling topographic depressions in and near the easement. The measures developed in the Adaptive Management Plan did not specifically target this source of inundation and a change in management appears to be needed to ensure access to the sewer line upstream of Bellevue for maintenance. One option would be to raise the entire easement

area slightly. This option was originally considered, but not selected by the District due to the size of the potential work area, potential effects on the wetland, and difficulty in ensuring that areas to the right (north) of the raised area, including private property, would drain by gravity. A second option is to develop access points from the right upland margin of the marsh to specific manholes (i.e, not every manhole would have maintenance access). This option is similar to the existing contingency plan for access in case of a problem or blockage in the line. This option would potentially require crossing a wetland area with planned access routes to specific manholes, and therefore would likely require small hydraulic structures (mini-bridge, culverts, etc.) to maintain drainage patterns.

Coordination with the Conservancy and other agencies is recommended to select and develop a plan that provides reliable maintenance access upstream of Bellevue Avenue in the context of existing and potential future changes in beaver activity and stream behavior.

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1 INTRODUCTION

1.1 Purpose

The South Tahoe Public Utility District (District) is implementing an Adaptive Management Plan (AMP) to protect existing sewer facilities in the Upper Truckee Marsh. Two District sewer pipelines are located along the northern margin of the marsh in an easement over property owned by the California Tahoe Conservancy. The need for the plan was initiated by a channel avulsion in the vicinity of the easement following the record snowmelt year of 2011. The objective of the plan is to reduce inundation of the sewer easement and reduce the potential for stream channel development and erosion that would expose or damage the sewer lines and potentially lead to a sewage spill into the marsh and Lake Tahoe. The development of the plan is described in *Upper Truckee Marsh Sewer Facilities Adaptive Management Plan* (NHC, 2014). This annual report summarizes post-construction monitoring for Year 3 construction (2016), and describes the measures implemented in Year 4 (2017). Post-construction monitoring for prior years was previously reported (STPUD, 2015 and 2017).

1.2 Scope of Monitoring

The scope of the monitoring includes flow conditions and water surface elevations (including flow outside the main channel in the sewer easement area); topographic changes; turbidity; and vegetation. The complete monitoring plan is included in the AMP and is summarized in Table 1-1. The purpose of the Annual Report is to provide permitting agencies and other stakeholders with information related to the success of the project so that they may continue to be engaged in the adaptive management process. The permits for the project cover the entire expected 5-year implementation period and thus there is no specific agency approval or action required in response to the Annual Report. Completion of Year 3 monitoring was delayed in 2017 due to inundation associated with beaver activity, which is described in more detail below.

Table 1-1. Monitoring Plan Summary

Monitoring Component	Performance Standard	Frequency	Duration
Baseline Conditions			
Topography	Baseline 2014	Once	NA
Inundation of Easement	Baseline 2014	Once	NA
Trout Creek Water Levels	Baseline 2014	Continuous recorders installed 3 locations	NA

Table 1-1. Monitoring Plan Summary

Monitoring Component	Performance Standard	Frequency	Duration
Groundwater Levels	Baseline 2014	Continuous recorder in well at end of Bellevue Ave	NA
Wetland Extent	Baseline 2014	Once	NA
Woody Riparian	Baseline 2014	Once	NA
Herbaceous Cover and Natives Composition	Baseline 2014	Once	NA
Pre-Construction and During Construction			
Willow Flycatcher Surveys	Establish buffers or other measures to avoid disturbance, if present	Annually, if construction within nesting season	NA
Yellow Warbler, Long-Eared Owl, Waterfowl, and Northern Harrier Surveys	Establish buffers or other measures to avoid disturbance, if present	Annually, if construction within nesting season	NA
Fisheries	Fish rescue and relocation as needed; reporting if endangered species present	During dewatering and in-channel operations	Years 1-7
Cultural Resources	Observations during ground disturbance; avoidance of unknown cultural resources	Daily during ground disturbance	Years 1-7
Sediment Discharge	Turbidity below 20 NTUs except temporary periods during in channel work and pilot channel activation	Periodic field measurements plus logging turbidimeter at 15 minute intervals	During construction operations
Trout Creek Turbidity	Turbidity below project area shall not exceed turbidity above project area by more than 10 percent except temporary periods during in channel work and pilot channel activation	Periodic field measurements plus logging turbidimeter at 15 minute intervals	During construction operations

Table 1-1. Monitoring Plan Summary

Monitoring Component	Performance Standard	Frequency	Duration
Pilot Channel Width	NA	Twice per week	During construction operations
Post-Construction			
Topography	NA – Repeat of topographic surveys or cross sections for information	Annually	Years 2-7
Right Overbank Flows	No more than 10 percent over right overbank at flows less than bankfull	Up to 3 times during snowmelt season	Years 2-7
Inundation of Easement	No inundation of easement at flows less than 50 cfs	Annually in snowmelt season	Years 2-7
Pilot Channels and Left Bank Pathways	NA – Information on channel development	Annually	Years 2-7
Trout Creek Water Levels	NA – Information for inundation extents and channel behavior	Continuous, reported annually	Years 2-7
Groundwater	NA – Information for vegetation survival	Continuous, reported annually	Years 2-7
Planted Herbaceous Vegetation	70 percent of baseline cover after 2 years; 90 percent of baseline after three years; vigor comparable to surrounding marsh areas	Annually	Years 2-7
Planted Woody Vegetation	80 percent survival and exhibit good vigor	Annually	Years 2-7
Turbidity	Turbidity below project area shall not exceed turbidity above project area by more than 10 percent	Continuous, reported annually	Years 2-7

Table 1-1. Monitoring Plan Summary

Monitoring Component	Performance Standard	Frequency	Duration
Photo Points	NA – Information to support channel and vegetation conditions	Annually	Years 1-7
Wetland Extent	No loss in jurisdictional wetland	Once	At completion
Final Topography	NA – for information	Once	At completion

1.3 Report Organization

This Annual Report is generally organized to follow the monitoring plan categories of baseline, pre-construction/construction and post-construction monitoring in Sections 2, 3, and 4, respectively. Baseline conditions and Year 1 and 2 monitoring were previously reported (NHC,2015 and 2017). Table 1-2 provides a general timeframe for these monitoring categories.

Table 1-2. Schedule of AMP monitoring categories

AMP MONITORING	START	END
Baseline	October 2013	September 2014
Year 1 Construction	September 2014	October 2014
Year 1 Post Construction	November 2014	July 2015
Year 2 Construction	October 2015	November 2015
Year 2 Post Construction	November 2015	September 2016
Year 3 Construction	October 2016	November 2016
Year 3 Post Construction	November 2016	November 2017
Year 4 Activities[1]	October 2017	June 2018

[1]No new construction was completed in Year 4; see description of maintenance activity in Section 3

2 BASELINE CONDITIONS

Baseline conditions were previously reported in the 2015 Annual Report (NHC, 2015). A brief description is provided here for purposes of comparison.

2.1 Topography

The project area, as described in the AMP, is shown in Figure 2-1. The District retained Tri-State Surveying to set survey control and produce a topographic survey of the area near Bellevue Pump Station where the channel avulsion occurred and where the Year 1 improvements were focused (Tri-State Surveying, 2013). The survey included five cross sections previously surveyed by the California Tahoe Conservancy and nine new transects. The base map and cross section plots from the survey were included in appendices to previous annual report. In addition to the field survey, LiDAR-based mapping completed by TRPA (TRPA, 2010) provides general topographic information for the Upper Truckee Marsh. Figure 2-2 shows the LiDAR-based mapping. Note that this figure does not show topographic changes associated with the 2011 channel avulsion due to the date of the mapping.

2.2 Inundation of Easement

Inundation of the sewer easement near Bellevue Avenue was mapped in October 2013 as part of the field survey and observed prior to Year 1 construction operations in the spring and summer of 2013 and 2014. Figure 2-3 shows the area inundated on the baseline survey date, which had a recorded flow of 11 cfs at the USGS Gage 10336780 Trout Creek at Tahoe Valley. In the baseline condition, a section of the main channel was entirely blocked as a result of the 2011 channel avulsion, and most all of the creek flow was passing over the right overbank and sewer easement. Thus, regardless of flows in the creek or season, the sewer easement was continuously inundated in the area near Bellevue Pump Station. Figure 2-4 shows a photo of inundation in the easement near Bellevue Avenue in May 2013 at a flow of approximately 40 cfs. Figure 2-5 shows a photo of inundation during April 2014 at a flow of approximately 20 cfs.

2.3 Water Levels

NHC and the District installed three pressure transducers in the project area near Bellevue Avenue along the Trout Creek channel in November 2013. The pressure transducers record data on a set 30-minute time interval for later download. Figure 2-6 shows the location of the stream water level sensors and Figure 2-7 shows the water level data plotted against flows at the USGS gage. The baseline water level conditions reflect discontinuous channel conditions – the Trout Creek channel between the middle and downstream gages was completely filled with sediment and the entire flow was occurring on the right overbank. In addition to the transducers along the stream channel, the District installed a transducer in an existing monitoring well (MW4) near the end of Bellevue Avenue in July 2014. Groundwater levels prior to September 2014 (beginning of Year 1 construction) are shown in Figure 2-7.

Legend

- Stream Environment Zone
- State of California Property
- Project Area
- Bellevue Pump Station
- Sewer Easment
- Soft Coverage in Project Area

SCALE - 1:12,000

0 500 1,000 1,500 Feet

N

DATA SOURCES:
AECOM, ESRI, CTC

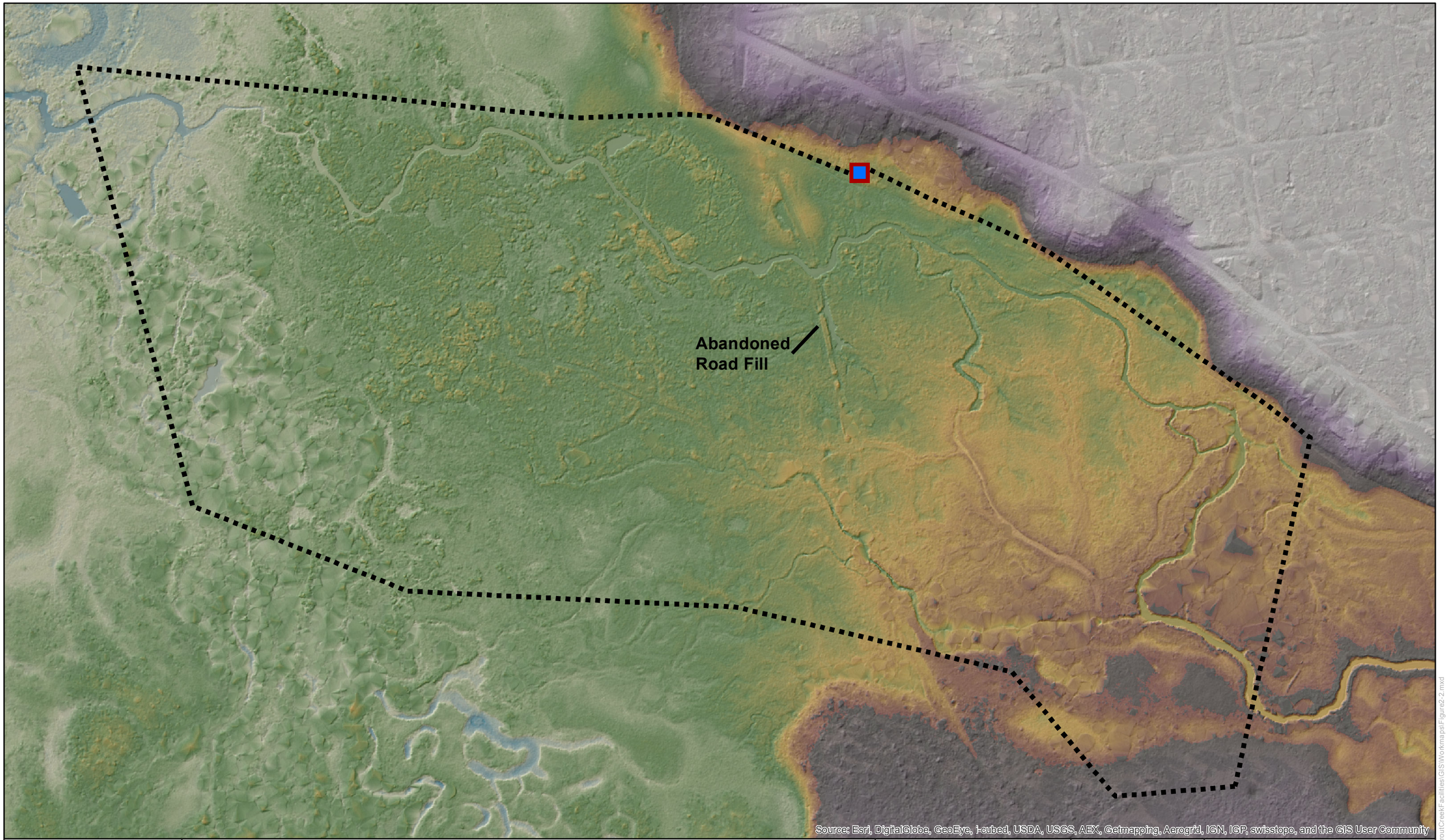
Job: 600035

JANUARY 2014

nhc
northwest hydraulic consultants

Figure 2-1

Project Area and SEZ Boundaries



nhc
northwest hydraulic consultants

Legend

Bellevue Pump Station

Project Area

UT Marsh Topo [ft]
Value
High : 6238
Low : 6230

South Lake Tahoe [ft]
Value
High : 6260
Low : 6238

SCALE - 1:3,000
0 100 200 300 Feet

N

DATA SOURCES: Tahoe Regional Planning Agency

Job: 600035

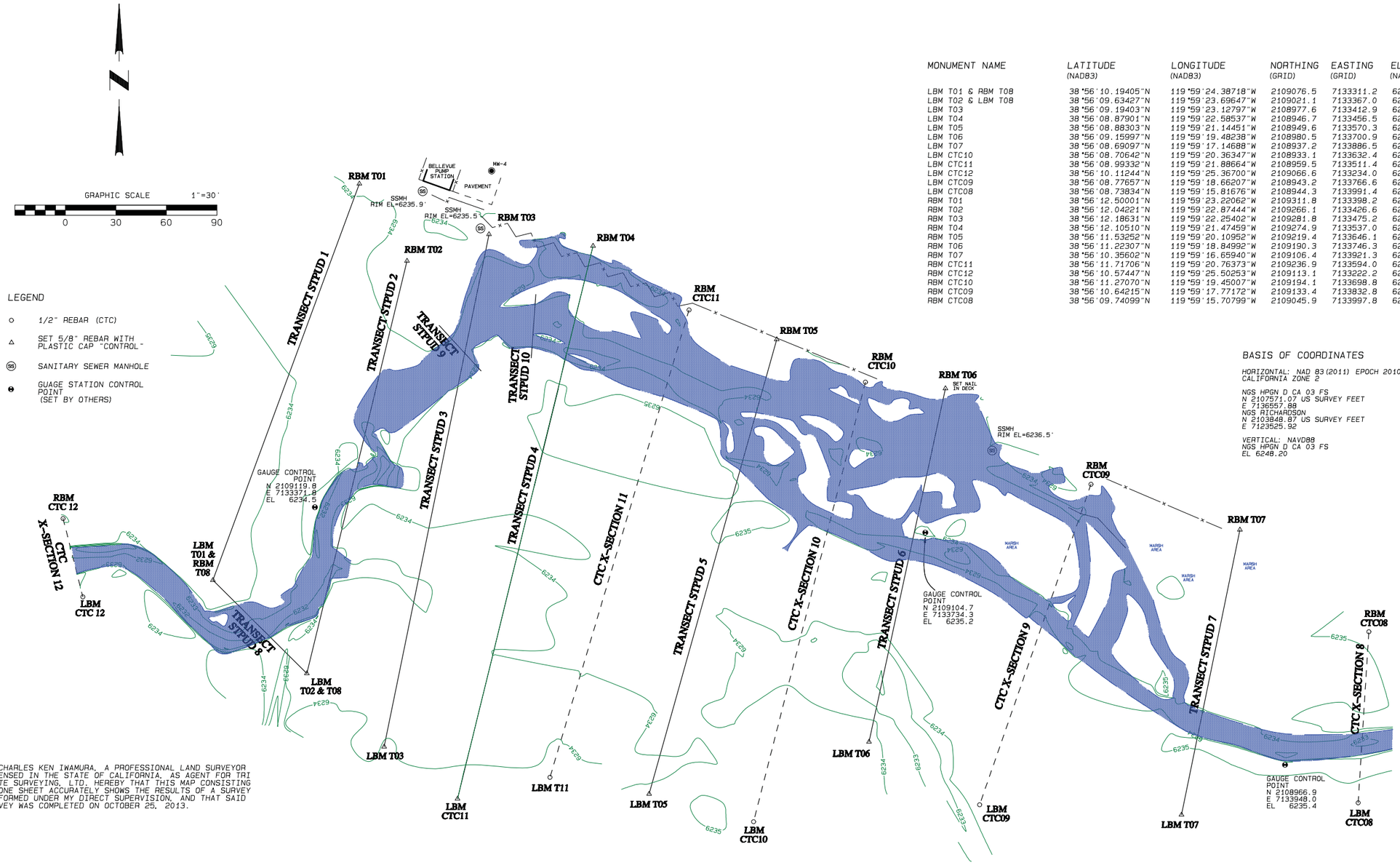
NOVEMBER 2015

FIGURE 2-2

2012 LiDAR Topography

ABC, L:\Old\Proj\600035_TroutCreek\Facilities\GIS\Workmaps\Figure2-2.mxd

TRUCKEE MARSH SEWER FACILITIES PROTECTION PROJECT FOR SOUTH TAHOE PUBLIC UTILTY DISTRICT



MONUMENT NAME	LATITUDE (NAD83)	LONGITUDE (NAD83)	NORTHING (GRID)	EASTING (GRID)	ELEV (NAVD88)	ELEV (NGVD29)
LBM T01 & RBM T08	38°56'10.19405"N	119°59'24.38718"W	2109076.5	7133311.2	6234.3	6230.3
LBM T02 & LBM T08	38°56'09.63427"N	119°59'23.69647"W	2109021.1	7133367.0	6233.9	6229.9
LBM T03	38°56'09.19403"N	119°59'23.12797"W	2108977.6	7133412.9	6234.2	6230.2
LBM T04	38°56'08.87901"N	119°59'22.58537"W	2108946.7	7133456.5	6234.4	6230.5
LBM T05	38°56'08.88303"N	119°59'21.14451"W	2108949.6	7133570.3	6234.2	6230.3
LBM T06	38°56'09.15997"N	119°59'19.48238"W	2108980.5	7133700.9	6234.6	6230.6
LBM T07	38°56'08.69097"N	119°59'17.14688"W	2108937.2	7133886.5	6234.5	6230.5
LBM CTC10	38°56'08.70642"N	119°59'20.36347"W	2108933.1	7133632.4	6234.6	6230.6
LBM CTC11	38°56'08.99332"N	119°59'21.88664"W	2108959.5	7133511.4	6234.4	6230.4
LBM CTC12	38°56'10.11244"N	119°59'25.36700"W	2109066.6	7133234.0	6233.9	6229.9
LBM CTC09	38°56'08.77657"N	119°59'18.66207"W	2108943.2	7133766.6	6235.2	6231.2
LBM CTC08	38°56'08.73834"N	119°59'15.81676"W	2108944.3	7133991.4	6234.9	6231.0
RBM T01	38°56'12.50001"N	119°59'23.22062"W	2109311.8	7133398.2	6234.3	6230.3
RBM T02	38°56'12.04221"N	119°59'22.87444"W	2109266.1	7133426.6	6234.4	6230.4
RBM T03	38°56'12.18631"N	119°59'22.25402"W	2109281.8	7133475.2	6234.4	6230.5
RBM T04	38°56'12.10510"N	119°59'21.47459"W	2109274.9	7133537.0	6234.3	6230.3
RBM T05	38°56'11.53252"N	119°59'20.10952"W	2109219.4	7133646.1	6235.0	6231.0
RBM T06	38°56'11.22307"N	119°59'18.84992"W	2109190.3	7133746.3	6236.5	6232.5
RBM T07	38°56'10.35602"N	119°59'16.65940"W	2109106.4	7133921.3	6234.9	6230.9
RBM CTC11	38°56'11.71706"N	119°59'20.76373"W	2109236.9	7133594.0	6235.2	6231.2
RBM CTC12	38°56'10.57447"N	119°59'25.50253"W	2109113.1	7133222.2	6234.3	6230.3
RBM CTC10	38°56'11.27070"N	119°59'19.45007"W	2109194.1	7133698.8	6235.1	6231.1
RBM CTC09	38°56'10.64215"N	119°59'17.77172"W	2109133.4	7133832.8	6235.0	6231.1
RBM CTC08	38°56'09.74099"N	119°59'15.70799"W	2109045.9	7133997.8	6235.6	6231.6

BASIS OF COORDINATES

HORIZONTAL: NAD 83(2011) EPOCH 2010.00
CALIFORNIA ZONE 2

NGS HPGN D CA 03 FS
N 2107571.07 US SURVEY FEET
E 7136557.88
NGS RICHARDSON
N 2103848.87 US SURVEY FEET
E 7123525.92

VERTICAL: NAVD88
NGS HPGN D CA 03 FS
EL 6248.20

I, CHARLES KEN IWAMURA, A PROFESSIONAL LAND SURVEYOR LICENSED IN THE STATE OF CALIFORNIA, AS AGENT FOR TRI STATE SURVEYING, LTD. HEREBY THAT THIS MAP CONSISTING OF ONE SHEET ACCURATELY SHOWS THE RESULTS OF A SURVEY PERFORMED UNDER MY DIRECT SUPERVISION, AND THAT SAID SURVEY WAS COMPLETED ON OCTOBER 25, 2013.

CHARLES KEN IWAMURA
PROFESSIONAL LAND SURVEYOR
CALIFORNIA CERTIFICATE NO. 8540

Figure 2-3. Baseline Topographic Survey near Bellevue Avenue (source: Tri-State Surveying; full survey in Appendix A)

TRI STATE SURVEYING, LTD
425 EAST LONG STREET
CARSON CITY, NEVADA 89706
(775) 887-9911 * FAX 887-9915

REVISIONS | NO. | DATE | MARK

BENCHMARK
DESIGNED BY
CHECKED BY JS
APPROVED BY
DRAWN BY CKI
DATE SURVEYED OCT 16, 2013

TRUCKEE MARSH SEWER FACILITIES PROTECTION PROJECT
PORTIONS OF THE N 1/2 OF SECTION 4, TOWNSHIP 12 NORTH, RANGE 18 EAST, M.D.M.
EL DORADO COUNTY CALIFORNIA

JOB NO 13120.01.CM
DATE 11-5-13
SHEET 1 OF 3

Figure 2-4. Inundation of the sewer easement near Bellevue Avenue at a flow of approximately 40 cfs, looking upstream, 20 May 2013

Figure 2-5. Inundation of the sewer easement near Bellevue Avenue at a flow of approximately 20 cfs, looking upstream, 1 Apr 2014

2.4 Wetland Extent

AECOM (2014) mapped jurisdictional habitat in the project area as shown in Figure 2-8. The area of the avulsed channel is mapped as a habitat and is evident as a gap in the Trout Creek open water habitat component near the center of the map. Nearly the entire project area is mapped as potential jurisdictional area with the exception of some higher ground mapped as Lodgepole Pine Meadow (LPM)along the north and south margins of the delineation area.

2.5 Vegetation

General vegetation characteristics in the study area have been described in environmental documentation for the Upper Truckee River and Marsh Restoration Project (California Department of General Services and California Tahoe Conservancy, 2013).

Woody Riparian Vegetation

Figure 2-8 includes mapping of willow scrub wet meadow habitat that is dominated by mature willows and primarily occurs along channel boundaries. In addition to the areas mapped as willow scrub, the channel avulsion area was colonized by willows. This area had numerous willow saplings that were 2 to 4 feet tall in the baseline condition.

Herbaceous Vegetation

Baseline vegetation surveys were conducted by Western Botanical Services in August 2014 and are summarized in a report provided in appendices to the previous annual reports. Three reference transects were established in the area proposed for abandoned road fill removal and three were established in areas proposed for hummock construction in Year 1. All transects were 100 feet long. Total cover, vegetative cover, and dominance by natives was determined by point-intercept method for the transects. Baseline vegetative cover varied from 84% to 98% (average 90%) in the road fill removal transects and from 58% to 98% (average 80%) in the proposed hummock area transects. Cover by native plants averaged 86% and 80% in the road fill removal and proposed hummock area transects, respectively.

Table 2-1. Cover in Baseline Vegetation Transects

Community at Road Fill	**Transect 1**	**Transect 2**	**Transect 3**	**Average**
Total Cover (including litter, gravel, rock)	100%	100%	100%	100%
Total Vegetative Cover	88%	98%	84%	90%
Vegetative Cover by Native Species	84%	90%	83%	85.7%
Community at Proposed Hummocks	**Transect 1**	**Transect 2**	**Transect 3**	**Average**
Total Cover (including litter, gravel, rock)	100%	61%	90%	83.7%
Total Vegetative Cover	95%	58%	88%	80.3%
Vegetative Cover by Native Species	93%	58%	88%	79.7%

MW-4

Stream Flow Cross Section #1

TC 003

TC 002

Down-Stream Turbidimeter

Up-Stream Turbidimeter

TC 001

Stream Flow Cross Section #2

TC 001 = Up-Stream Gage
TC 002 = Mid-Stream Gage
TC 003 = Down-Stream Gage

Pre-1968 Alignment
Crest Stage Gage

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

nhc
northwest hydraulic consultants

Legend

- Crest Stage Gauge
- Groundwater Elevation Gage
- Surface Water Elevation Gage
- Turbidimeter
- Streamflow Measurement Cross Sections

SCALE - 1:1,800
0 50 100 150 200 Feet
N

DATA SOURCES:
Google Earth

Job: 600035

NOVEMBER 2015

Figure 2-6

Streamflow Measurement Sites

ABC, L:\OldProj\600035_TroutCreekFacilities\GIS\Workmaps\Figure2-6.mxd

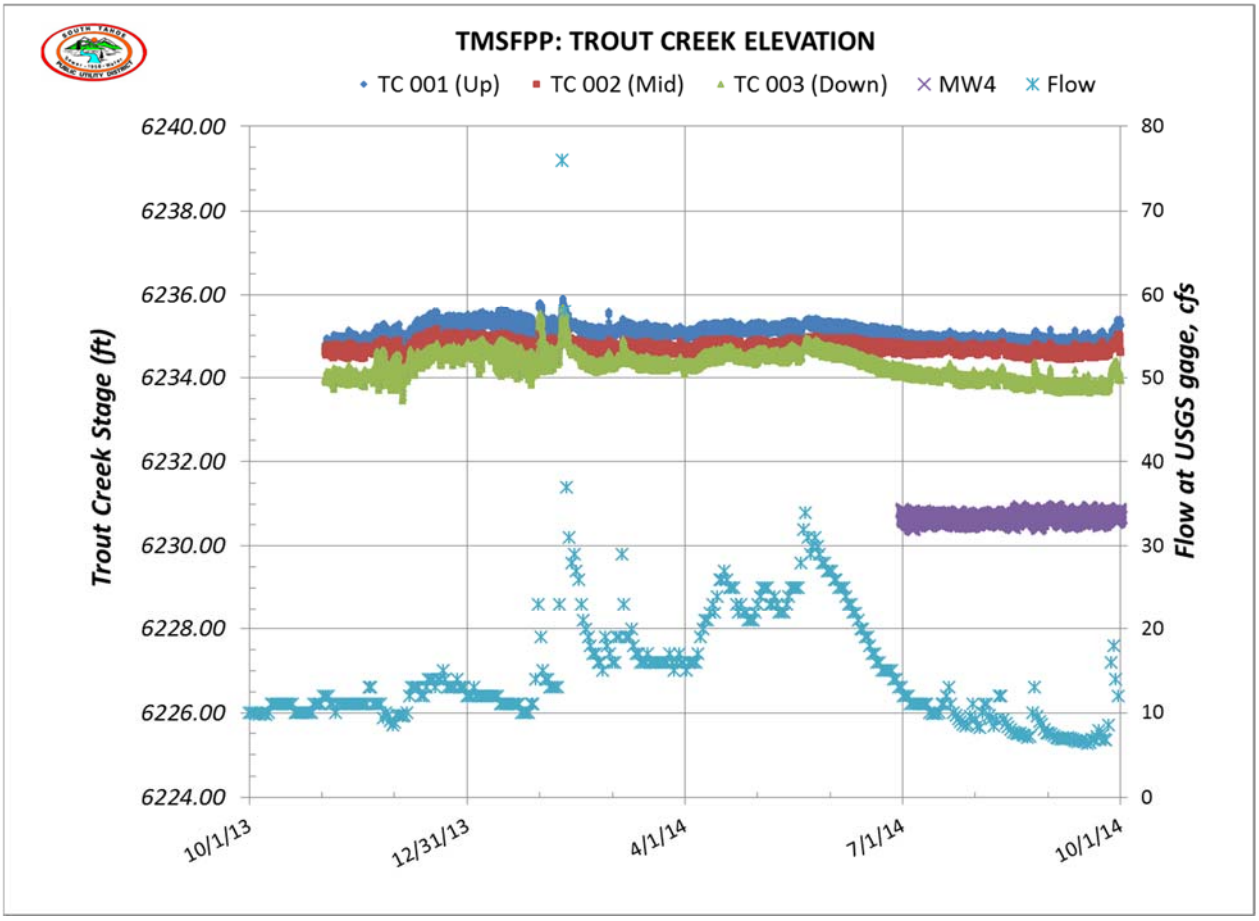


Figure 2-7. Water levels and flows at USGS Gage 10336780 prior to Year 1 activities

STPUD Trout Creek Upper Truckee Marsh Sewer Protection Project

Wetland Delineation Map

LEGEND

- Sample Points
- 1ft Contours
- Study Area Boundary *(233.78 acres)*
- Adaptive Management Action Area*(95.99 acres)*

Potentially Jurisdictional Habitats *(185.47 acres)*

Relatively Permanent Waters (RPWs) *(6.64 acres)*

- Main Channel *(3.41 acres)*
- Secondary Channel *(0.69 acre)*
- Distributary Channel *(1.83 acres)*
- Avulsed Channel *(0.71 acre)*

Wetlands Adjacent to or Abutting RPWs *(178.81 acres)*

- Lodgepole Pine Meadow *(4.89 acres)*
- Wet Montane Meadow *(126.50 acres)*
- Willow Scrub-Wet Meadow *(47.43 acres)*

Delineated by T. Beyerl and P. Valle on November 21 and 22, 2013.

Directions to Site:
U.S 50 to Los Angeles Ave to Bellevue Ave.

0 200 400
FEET

NORTH

Aerial Image: NAIP 2012
X 60311654 002 2/14

Potentially Jurisdictional Features

Relatively Permanent Waters							**6.64**
	Trout Creek (Main Channel)	3.41	Trout Creek (Secondary Channel)	0.69	Trout Creek (Distributary Channel)	1.83	
	Trout Creek (Avulsed Channel)	0.71					
Wetlands Adjacent to or Abutting Relatively Permanent Waters							**178.83**
Wet Montane Meadow							126.50
	WM1	27.34	WM2	0.57	WM3	0.56	
	WM4	0.01	WM5	5.45	WM6	0.11	
	WM7	1.58	WM8	34.72	WM9	0.85	
	WM10	0.01	WM11	0.15	WM12	0.004	
	WM13	0.01	WM14	0.02	WM15	0.01	
	WM16	0.03	WM17	0.15	WM18	7.52	
	WM19	17.87	WM20	1.94	WM21	26.84	
	WM22	0.77	WM23	0.002			
Willow Scrub-Wet Meadow							47.43
	WSM1	0.18	WSM2	0.06	WSM3	4.45	
	WSM4	6.18	WSM5	0.18	WSM6	0.09	
	WSM7	0.17	WSM8	4.04	WSM9	0.14	
	WSM10	0.76	WSM11	0.04	WSM12	0.04	
	WSM13	1.06	WSM14	13.67	WSM15	3.98	
	WSM16	0.07	WSM17	0.49	WSM18	0.20	
	WSM19	0.34	WSM20	5.24	WSM21	0.27	
	WSM22	0.07	WSM23	0.07	WSM24	3.21	
	WSM25	1.26	WSM26	0.48	WSM27	0.72	
Lodgepole Pine Meadow							4.89
	LPM1	3.95	LPM2	0.93	LPM3	0.01	
					Total Potentially Jurisdictional Features:		**185.47**

Figure 2-8. Wetland Delineation Map (Source: AECOM, 2013)

2.6 Wildlife and Fish

Information on wildlife and fish in the project area was compiled for the Upper Truckee River and Marsh Restoration Project EIS/EIS/EIR (California Department of General Services and California Tahoe Conservancy, 2013). The Upper Truckee River marsh provides habitat for approximately 200 amphibian, reptile, bird, and mammal species.

Trout Creek, because of its lack of riffles and predominance of a uniform coarse sand bed, does not generally provide resident habitat for salmonids or most other species of fish. However, Trout Creek within the project area provides migratory habitat for rainbow and brown trout, and may also provide temporary migratory habitat for Paiute Sculpin, Tahoe sucker, mountain sucker, Lahontan redside, Lahontan tui chub, and mountain whitefish. California Department of Fish and Wildlife (CDFW) species of special concern include the Tahoe sucker, Lahontan Lake tui chub, and Lahontan redside, which have some potential for occurrence. Additionally, the Lahontan cutthroat trout (LCT) is a federally listed threatened species which has the potential to use the project reach for migration. Since 2002, the US Fish and Wildlife Service (USFWS) and US Forest Service Lake Tahoe Basin Management Unit (USFS-LTBMU) have implemented a project to reintroduce and restore LCT in the Fallen Leaf Lake Watershed, approximately four (4) miles west of Trout Creek. Additional information can be found at: https://eip.laketahoeinfo.org/Project/FactSheet/01.03.02.0001.

In 2011, two hatchery-raised Lahontan cutthroat were observed in the Upper Truckee River during a fisheries survey conducted by the U.S. Forest Service (USFS, 2011).

Monitoring of wildlife and fish populations is not a component of the AMP monitoring. However, mitigation measures were identified in the AMP to minimize construction impacts to wildlife and fish. These measures, and the data from pre-construction and construction monitoring are described in Section 3.

3 YEAR 3 CONSTRUCTION

3.1 Year 3 Construction

The proposed Year 3 construction work was described in the 2016 annual report. Only minor work was considered necessary in the area near Bellevue Avenue in Year 3, pending further monitoring of pilot channel development and vegetative growth. Year 3 improvements were focused on installing hummocks and planting in areas upstream of Bellevue Avenue where increased inundation due to beaver activity presented a problem for access to District manholes. In addition, Year 3 improvements included a measure to address beaver activity at the head of the secondary channel in the center of the marsh, which reduces flows into the secondary channel that was activated in Year 2.

Year 3 plans were developed to include:

- Additional planting of wetland plugs in the right overbank near the end of Bellevue Avenue;
- Reinforcement and extension of an existing coir log at the head of Hummock H4 to encourage flow into Pilot Channel 1;
- Installation of a double marsh mat hummock near Manhole BV18, downstream of Hummock H6 in the District's easement;
- Slight modification of coir logs around the south side of Hummock H6 to lower top elevations to the level of the adjacent marsh to allow free drainage of overbank flows and reduce ponding in the easement;
- Installation of a marsh mat and willow mattress hummock and short pilot channel near Manhole BV19;
- Installation of a hummock near Manhole BV21;
- Installation of a double marsh mat hummock between Manholes BV21 and BV22 in a low spot within the easement;
- Installation of a double marsh mat hummock near Manhole BV22;
- Installation of a pond leveler at the head of the secondary channel in the center of the marsh to maintain an estimated 3 cfs minimum flow through the channel.

With the exception of the installation of the pond leveler, Year 3 improvements required no heavy equipment access and no significant grading activities.

Plans were reviewed with the permitting and resource agencies in early October 2016 and are included in Appendix A. Construction was implemented in late October through a change order with V&C Construction.

3.2 Resource Protection

Willow Flycatcher and Nesting Bird Surveys

Willow flycatcher and nesting bird surveys were identified as measures to avoid potential impacts to bird species in the project area. Construction of Year 3 improvements did not commence until October,

outside of the nesting season. Pre-construction willow flycatcher and nesting bird surveys were therefore not conducted.

Fisheries

Year 3 work did not involve dewatering or excavation in any of the creek or marsh channels, and was completed without the need for fish exclusion, relocation, or rescue.

Cultural Resources

Year 3 work did not involve significant excavation and was completed without the need for archaeological monitoring.

3.3 Sediment Discharge and Trout Creek Turbidity

The District monitored Year 3 work visually to minimize turbidity discharged to the stream and made one to four turbidity measurements in the creek on each of six days that construction site observations were conducted. No dewatering or diversions were necessary to complete the work, and no excavation was performed in the channels. The potential for sediment discharge to the creek channels was therefore lower than in previous years of construction. However, due to upstream beaver activity, much of the overbank upstream of Bellevue Avenue had shallow inundation and work was conducted in wet conditions.

The Year 3 records for the upstream and downstream turbidimeters indicate that there were occasional spikes through the summer of 2016, but turbidity at both locations generally remained below about 10 NTUs and was commonly in the range of 4 to 8 NTUs during the summer months, with a decreasing trend in late fall. The records show no increase in turbidity associated with construction in the early October period. Turbidity records are presented in the subsequent section. The District also made field measurements of turbidity during the construction period, generally corresponding to the upstream and downstream turbidimeter locations. Twenty-one measurements were made over an eight day period. Average turbidity at the upstream turbidimeter location was 8.2 NTUs and at downstream location 6.6 NTUs. The maximum recorded turbidity during the construction period was 21 NTUs. Twenty of the twenty-one measurements were below 20 NTUs and seventeen of the measurements were below 10 NTUs.

4 YEAR 3 POST-CONSTRUCTION MONITORING

4.1 2017 Water Year Characteristics

The 2017 water year was an very wet water year in terms of peaks flows, late summer flow duration, and annual runoff volume. Winter-time peaks of 409 cfs and 483 cfs occurred on January 9 and February 9, respectively, at USGS Gage 10336780 near Tahoe Valley upstream of the site. These flows were associated with peaks on the Upper Truckee River and combined flows resulted in street flooding on the margins of the marsh. A snowmelt peak of 484 cfs occurred on June 23. The snowmelt peak is the fourth largest flow in the historical record for the gage (1961 to present), and the other winter-time peaks were larger than all but seven of the annual peaks since 1961. Flows remained at or above 100 cfs for almost four months in April-July and the recession limb of the annual hydrograph never descended below about 28 cfs in late October. The channel capacity prior to the 2011 avulsion was believed to range between 25 and 50 cfs. The USGS reported average annual flow was 112 cfs, the largest in the historical record, exceeding even other large water years such as 1997 and 2011 by at least 50 percent. No calculations have been performed for sediment transport for the year, but flow characteristics suggest that WY 2017 was likely one of the largest years, and possibly the largest year, on record for transport of sediment. Due to the long duration of flows in excess of the channel capacity and the influence of beaver activity, much of the marsh, including the right overbank near Bellevue Avenue, remained inundated through the summer and fall months. Figure 4-1 shows the mean daily flows in relation to median statistics.

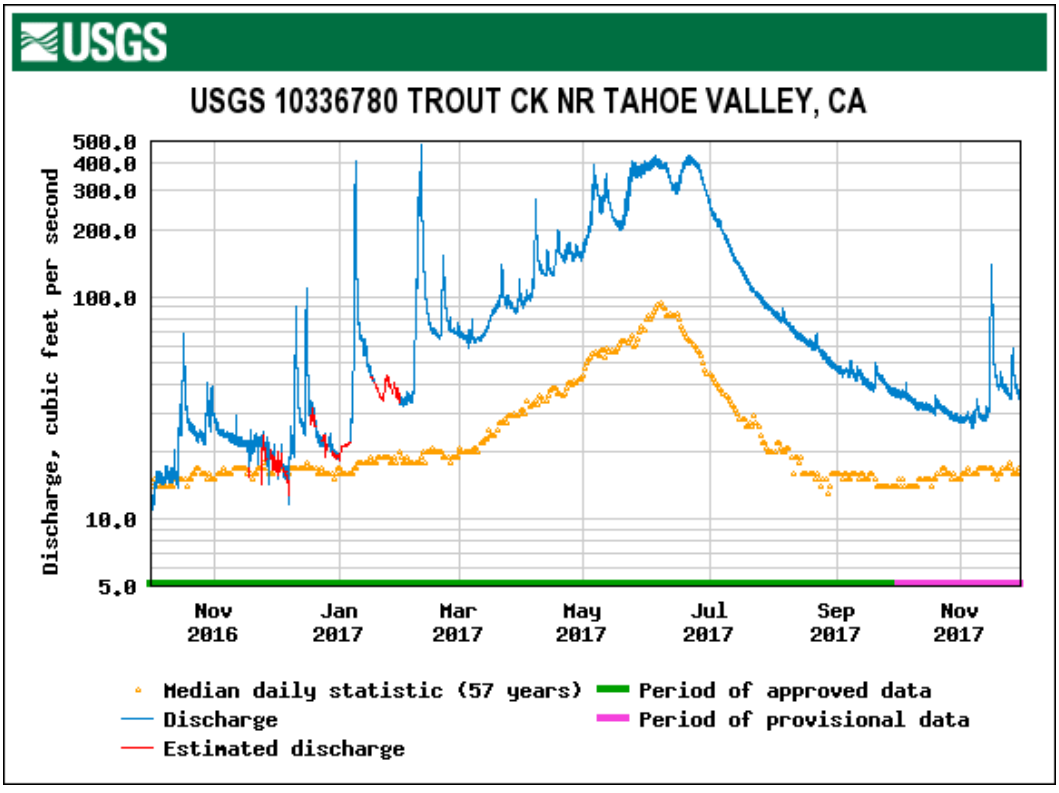


Figure 4-1. USGS mean daily flow hydrograph for WY 2017 with median statistics

4.2 Topography

The District re-surveyed the work areas near Bellevue Avenue and the head of the secondary channel in the center of the meadow in October 2015, following Year 2 construction. Topographic mapping from these surveys was reported in the 2016 Annual Report. No significant topographic or channel changes were made in Year 3 construction, and topographic monitoring was limited to measurement of pilot channel geometry and visual observations. Pilot channel observations are summarized in Section 4.3. Visual observations in the Bellevue Avenue in August and October 2017 indicated that sediment had accumulated in the vicinity of the coir logs placed in Year 2 construction and the active portion of the overbank flow had narrowed due to increased vegetation. Minor accumulation of sediment was also noted in the hummocks placed in Years 1 and 2, especially deposition of sand at Hummock 3.

4.3 Pilot Channels, Right Overbank Flows, and Inundation of Easement

During the snowmelt period, the District implemented a management measure to encourage flow into the upstream end of one of the pilot channels (Pilot Channel 3, PC-3) for the purpose of encouraging further natural development of pilot channel capacity. The measure involves a small (~ 10' long) flow diverter constructed in the Trout Creek channel to deflect flows at the head of the pilot channel (Figure 4-2). This measure was reviewed with the California Tahoe Conservancy and described to reviewing agencies prior to installation on the recession side of the snowmelt hydrograph in July 2017. Observations were made on performance of the deflector after installation, which appeared to encourage flow into the pilot channel without adverse effects on adjacent banks or on channel capacity.

Figure 4-2. PC-3 flow diverter at head of PC-3; flow in PC-3 is towards lower right of frame

Pilot channels were observed in March, July, August, September, and October 2017; and in June 2018. Flow distribution in the pilot channels was estimated in March and October 2017, and in June 2018.

In March 2017, flows were estimated at 30-35 cfs through the pilot channel system with a flow of approximately 10 cfs on the right overbank. All of the pilot channels were flowing over their banks and sand deposits were noted in several areas due to overflow of the channels in vegetated areas. Estimated flows in PC-1, PC-2, and PC-3 were 9, 4.5, and 20 cfs, respectively. At the outlet of the pilot channel system, the channel was measured at approximately 20 feet wide and 2.5 feet deep below the adjacent marsh surface. PC-3 was measured at approximately 6 feet wide by 2.5 feet deep, although depth varies substantially in areas of bed scour. Flows at USGS Gage 10336780 were about 85 cfs on the observation date. In October 2017, flows in PC-1, PC-2, and PC-3 were estimated at 3 cfs, less than 1 cfs, and 10 cfs, respectively, with only a trickle in the right overbank. Flows at USGS Gage 10336780 were about 30 cfs on the observation date.

In June 2018, flows were estimated at 30-35 cfs through the pilot channel system with a flow of less than 1 cfs on the right overbank. Flows were generally contained within the channel banks with the exception of the lower portion of PC-1 and the outlet of the pilot channel system downstream of PC-1, where flows were up to 0.5 feet deep in the overbanks. Estimated flows in PC-1, PC-2, and PC-3 were 2 cfs, less than 1 cfs, and 25-30 cfs, respectively. Some flow from the center of the marsh was joining the pilot channel system about 50 feet downstream of the head of PC-3. Flow at USGS 10336780 was measured at approximately 47 cfs on the observation date.

Measurements of the pilot channel geometry indicated that the outlet channel for the pilot channel system and Pilot Channel 3 expanded slightly in width and in depth since Year 2 measurements. PC-1 and PC-2 remained active, but are not increasing in capacity. Of the two channels, PC-1 is wider and has higher capacity and more active bed form development. The lower portion of the pilot channel system is 15 to 20 feet wide, which nearly matches the Trout Creek channel width in the adjacent reaches. The middle portion is 8 to 10 feet wide, and the upper portion is 5 to 6 feet wide. The middle and upper portions are deeper than the downstream section, with average depths of 1.5, 2.5, and 3 feet in the lower, middle, and upper portions, respectively. The width of the upper portion of PC-3 is not increasing, although the depth has increased slightly since 2016. In all of the observations, PC-3 was carrying the majority of the flow in the pilot channel system and is becoming the dominant channel.

In spite of increased capacity in PC-3, inundation of the overbank area continued through the fall of 2017. This inundation can partly be attributed higher than normal flows and overflow of the main channel upstream of Bellevue Avenue due to beaver dams in the main channel. In June 2018, with a flow of 47 cfs at USGS 10336780, less than 1 cfs was passing through the right overbank, and only a small portion of this flow was in the easement area. With further decrease in flows, inundation and flow in the right overbank near Bellevue Avenue is expected to cease later in the summer.

In addition to increased flow capacity, active bed load transport and bed form development (scour, ripples, dunes) were evident in the pilot channel system. The main pilot channel beds are now observed

to have little vegetative growth and are characterized by sand in gradual transport along the bed. Figures 4-3, 4-4, and 4-5 show pilot channel conditions in August 2016, October 2017, and June 2018.

A) 9 August 2016

B) 18 October 2017

C) 22 June 2018

Figure 4-3. Pilot channel flow looking downstream approximately 100 feet upstream of confluence with Trout Creek showing overbank deposition of sand during high flows on 9 Aug 2016 and expansion of channel on 18 October 2017 and 22 Jun 2018

A) 9 August 2016 **B) October 2017**

C) 22 June 2018

Figure 4-4. Pilot channel (PC-3) middle portion looking upstream on 9 August 2017, 18 October 2017, 22 June 2018 showing modest channel development

A) 9 August 2016

B) 18 October 2017

C) 22 June 2018

Figure 4-5. Pilot channel (PC-3) upper portion looking upstream on 9 August 2017, 18 October 2017, 22 June 2018 showing little change in channel width

4.4 Water Levels

The pressure transducers located as shown in Figure 2-6 continued to operate following Year 3 construction. Figure 4-6 shows the water level record through October 2017. The water levels are intended to supplement observations on easement inundation and pilot channel performance in conjunction with survey data. Communication difficulty between the datalogger and the computer was noted in the 2016 annual report, and water levels for TC 001 after December 2015 were considered suspect. The water level data for 2016 and 2017 also appear to have some inaccuracies. Water level data for TC001 differ from manual measurements (see Figure 4-7) by up to 1 foot from late 2015 to June 2016 and then reasonably match manual measurements in June 2016 and August 2017. However, level data trends in the winter of 2016/2017 do not match flow trends. During the winter, ice build-up typically forms along the reach of Trout Creek in the project area and has been observed at TC-001 and TC-003. Ice accumulation on the pressure transducers can overpressure the pressure sensor which may explain the discrepancies in the water level data recorded during the winter readings. Water level data for TC002 appear to reasonably match manual measurements through the period of record. Water level data for TC003 differ from manual measurements by 0.5 to 1 foot in 2016 and 2017. Stages recorded at TC 003 varied about 2 feet in 2016 and 2017, and varied about 1.5 feet at TC 002.

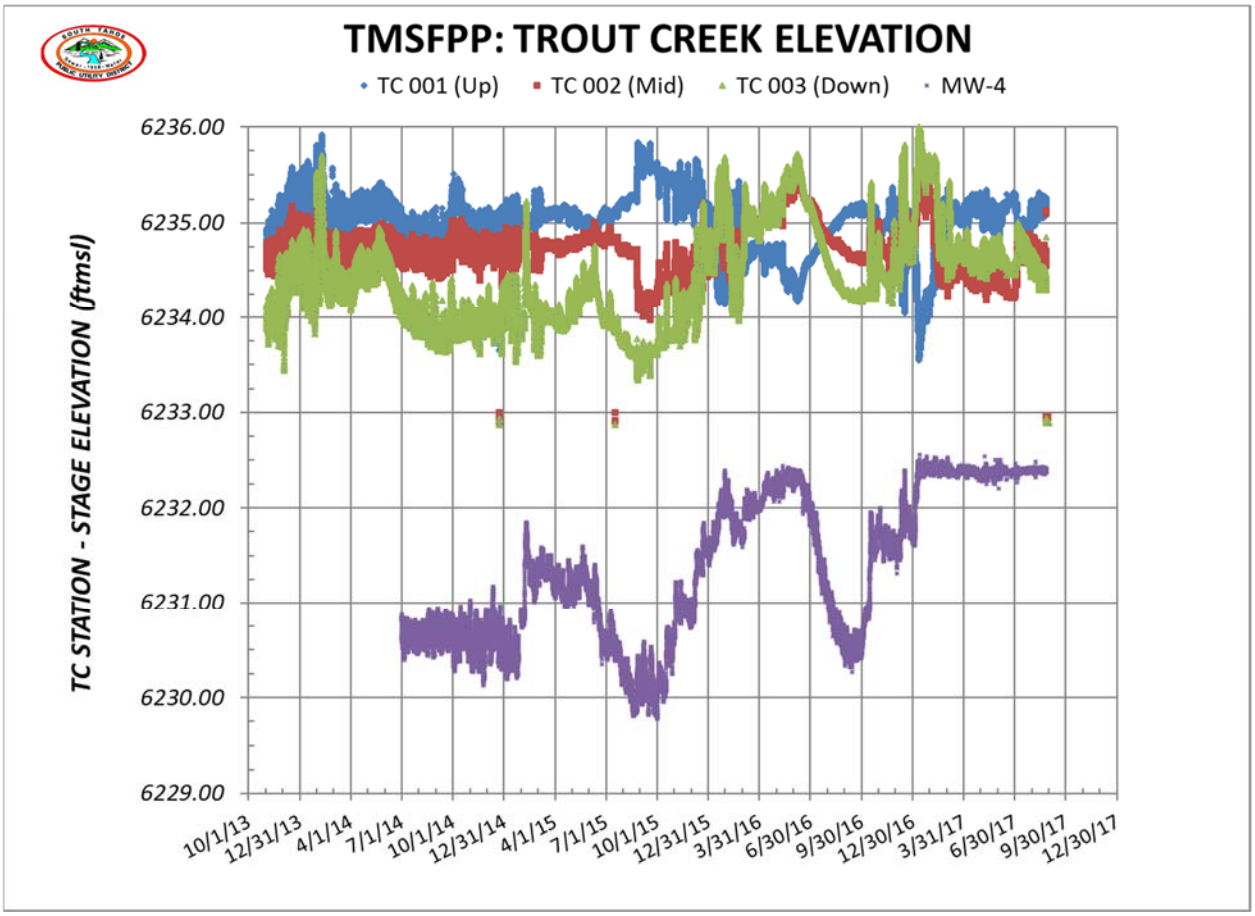


Figure 4-6. Water levels measured by pressure transducers through October 2017

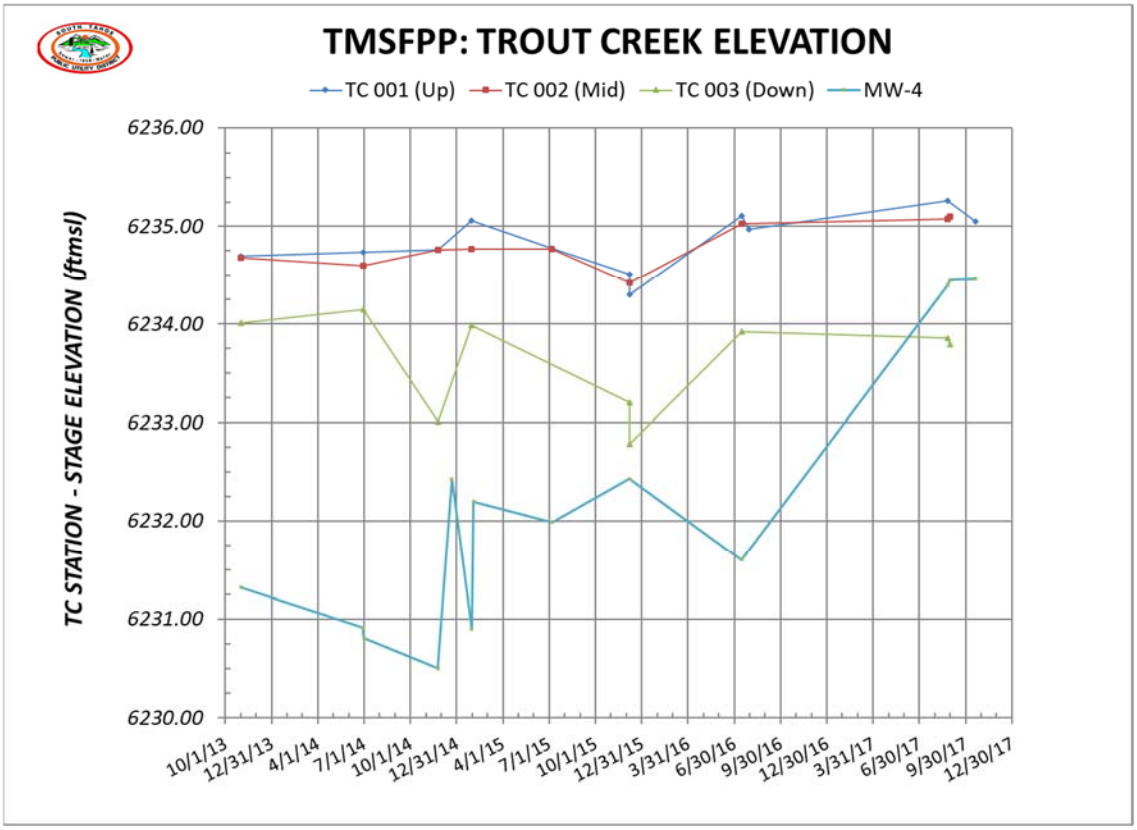


Figure 4-7. Water level manual measurements through October 2017 (note that lines connect intermittent measurements and may not be representative of intervening periods)

4.5 Planted Vegetation

Herbaceous Vegetation

Vegetation replanted on the road fill removal area and planted in the hummocks was surveyed in September 2015 by Western Botanical Services and results were reported in the 2015 Annual Report (NHC, 2015). Vegetation on the road fill removal met success criteria in the first year and has not been resurveyed, but was observed in 2016 to be in good condition with nearly 100% cover. Hummock transects surveyed in 2015 were resurveyed in 2016, and results showed that percent cover criteria were met and native plant criteria were nearly met. The 2016 annual report noted that native cover criteria were expected to be met in the following year, but inundation during the summer prevented resurveying the transects. Similarly, vegetation planted in Year 3 could not be accurately observed or surveyed. In observations from previous years, lowest establishment rates were associated with areas that had long inundation, and this may affect Year 3 plantings. If the planted areas are accessible in

summer 2018 the transects will be resurveyed to determine success in meeting cover and native plant criteria and observations of survival for Year 3 plantings will be made.

4.6 Turbidity

Figure 4-8 shows the turbidity measurements upstream and downstream of the work area near Bellevue Avenue for Year 3 and Figure 4-9 shows the measurements for Year 4. The records indicate no long-term trend for elevated turbidity at the downstream gage compared to the upstream location. In addition, no temporary impacts associated with Year 3 construction in October 2017 are evident. Year 4 records are unfortunately intermittent and there is a gap during the period of maintenance activities in November 2017. Both Year 3 and Year 4 records show periods of spikes in downstream turbidity but the cause of these increases is unknown and does not correspond to periods of project activity. Although one purpose of the turbidity monitoring is to determine if the project activities from the previous year increase turbidity during high runoff periods, the observed spikes are not consistent with a general increase in erosion or sediment transport in the pilot channels. Outside of the periods with spikes in downstream turbidity, the plots generally show that turbidity is in the range of 2 to 10 NTUs, with a slight trend for higher levels during summer months.

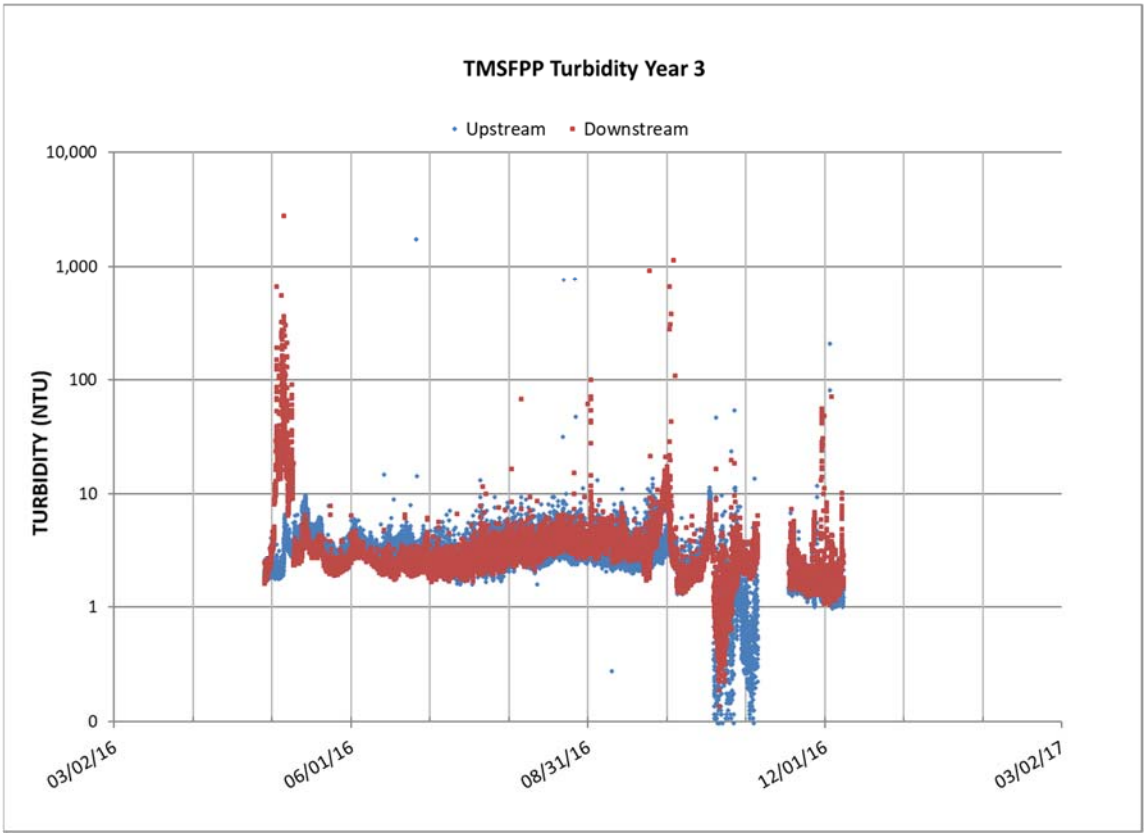


Figure 4-8. Turbidity upstream and downstream of work area near Bellevue Avenue in Year 3

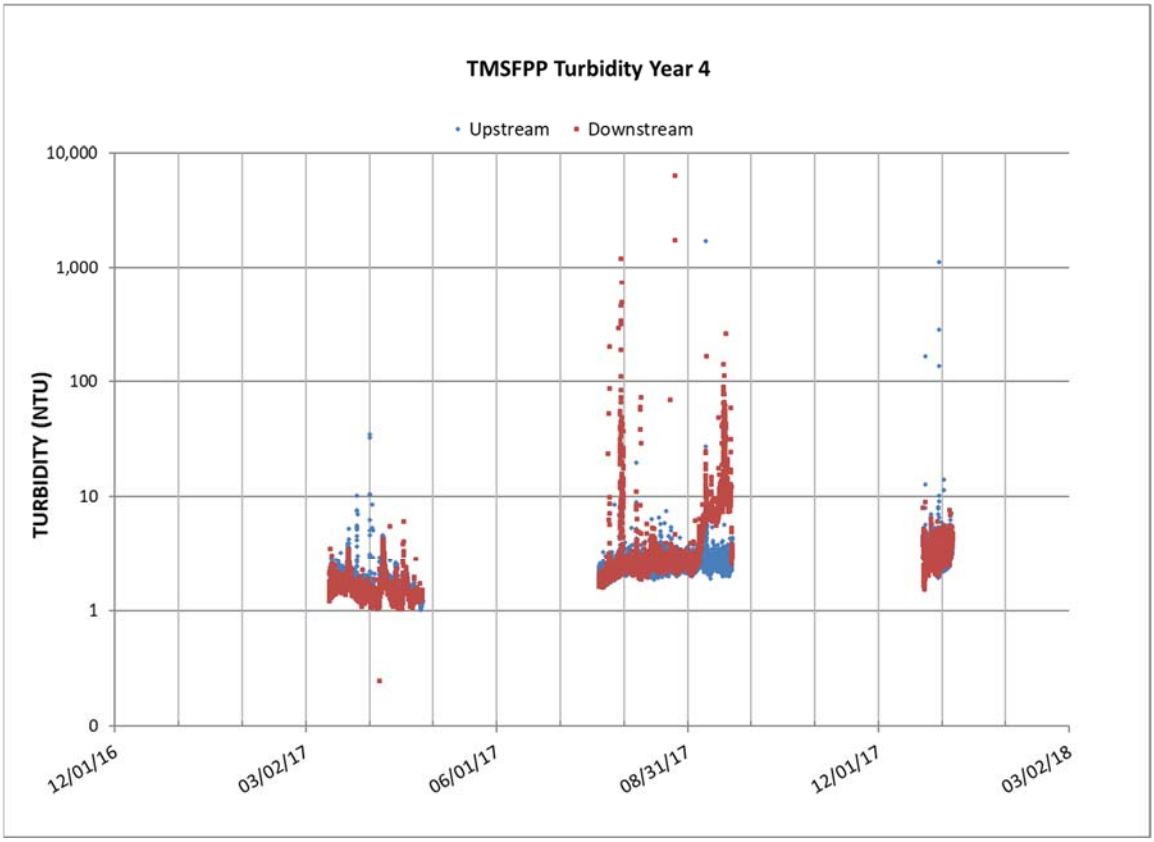


Figure 4-9. Turbidity upstream and downstream of work area near Bellevue Avenue in Year 4

4.7 Photo Points

Photos were collected at project photo points on 7 Oct 2015, 22 Nov 2016, and 23 Oct 2017. The photo point map and photos are included in Appendix B. Additional photos were collected as listed in the photo index in Appendix B, and are available from the District's files on request. In addition to ground photos, the District collected aerial views of the work area on 28 July 2017 using a small unmanned aerial vehicle (UAV). Figures 4-10 and 4-11 show two views collected using this method.

Figure 4-10. Upstream of Bellevue work area looking west, 28 July 2017, with pilot channels diverting flow to left)

Figure 4-11. Easement and avulsed channel area looking west, 28 July 2017 (hummocks in easement along fence on right side of photo)

4.8 Wetland Extent

This standard applies at the end of the project to ensure that AMP measures have not converted functional wetland and Stream Environment Zone (SEZ) jurisdictional areas into mesic or upland conditions. As evident in the aerial views, project features are still subject to shallow inundation and were constructed within the range of elevations for adjacent areas of the marsh.

4.9 Final Topography

This data will be compiled at the completion of the project.

4.10 Beaver Activity

Beaver activity upstream of the Bellevue work area began shortly after Year 1 improvements were constructed in 2014, and by 2015 overbank flooding had increased in the area upstream of Bellevue due to a beaver dam on the main Trout Creek channel in the area where the channel crosses the meadow

from left to right approximately 1,300 feet upstream of Bellevue Avenue. Figure 4-12 shows the inundation of the left overbank and center of the marsh in April 2015. Since 2015, beaver activity has increased, with a second dam on the main channel, auxiliary dams along the right and left overbanks, and dams in the secondary channel in the center of the meadow. The large snowmelt hydrograph in 2017 resulted in long duration overbank flooding of the District's easement and several of the manholes on the gravity sewer. The increase in flooding in 2017 appears to be at least partly related to construction of an extensive system of auxiliary beaver dams on flow paths that would otherwise return overbank flows to the main channel. The blockage of these return flows causes overbank flows near the District's Manhole BV22 to continue down the right overbank and flood other manholes in the easement and to occupy a low area along the margin of the marsh to the north of the easement between BV20 and BV22. Several areas of ponded water were evident in this area in August 2017, including areas near Manholes BV18, BV19, BV21, and BV22. Beaver activity in the main channel resulted in sediment deposition in the main channel upstream and at the location of the Pond Leveler installed in Year 3. Sediment deposition upstream of the pond leveler reduces main channel capacity and increases left and right overbank flows. Right overbank flows generally accumulate near the District's manhole BV22 because they are prevented from re-entering the main channel due to the auxiliary beaver dams along the banks of the channel. A second dam on the main channel was also noted in 2017, downstream of the location shown in Figure 4-12 and close to BV-22. Figure 4-13 shows an annotated aerial photo from 11 February 2017 indicating beaver dam locations and flow paths. Figure 4-14 shows a closer view of the area near BV22. Figure 4-15 shows a map of dam locations and inundation, focusing on right overbank flooding.

Inundation by beaver activity was a primary cause of flooding in the easement in the fall of 2016 and 2017, and effectively prevents typical maintenance access along the easement. Year 3 improvements (see Section 5 below) were designed to slightly raise ground levels and plant vegetation in areas around the manholes and other low points, but were expected to provide limited benefits against inundation by beaver activity. Maintenance activities in Year 4 (see next section) were designed to alleviate some of the flooding and temporarily restore channel capacity. However, it was recognized that continued beaver activity may again result in worsened overbank flooding, and a more comprehensive solution to inundation caused by beavers is still needed.

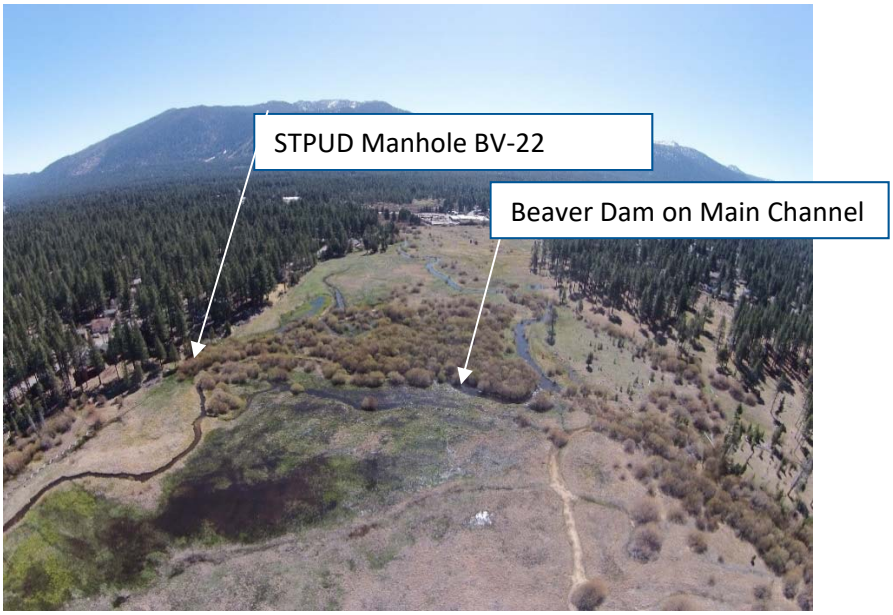


Figure 4-12. Inundation of meadow at low flow (approximately 25 cfs) due to beaver activity, as mapped in April 2015.

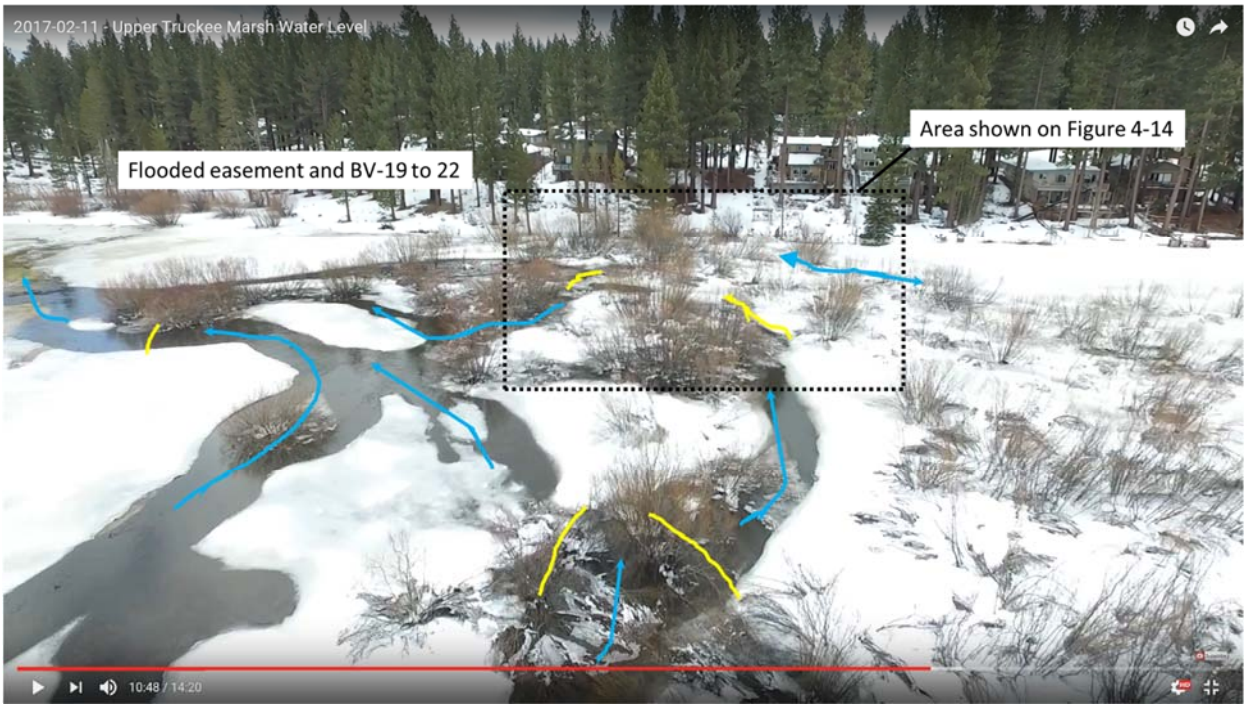


Figure 4-13. Aerial photo showing beaver dam locations and flow paths, February 2017. Yellow lines indicate dam locations and blue lines indicate flow paths

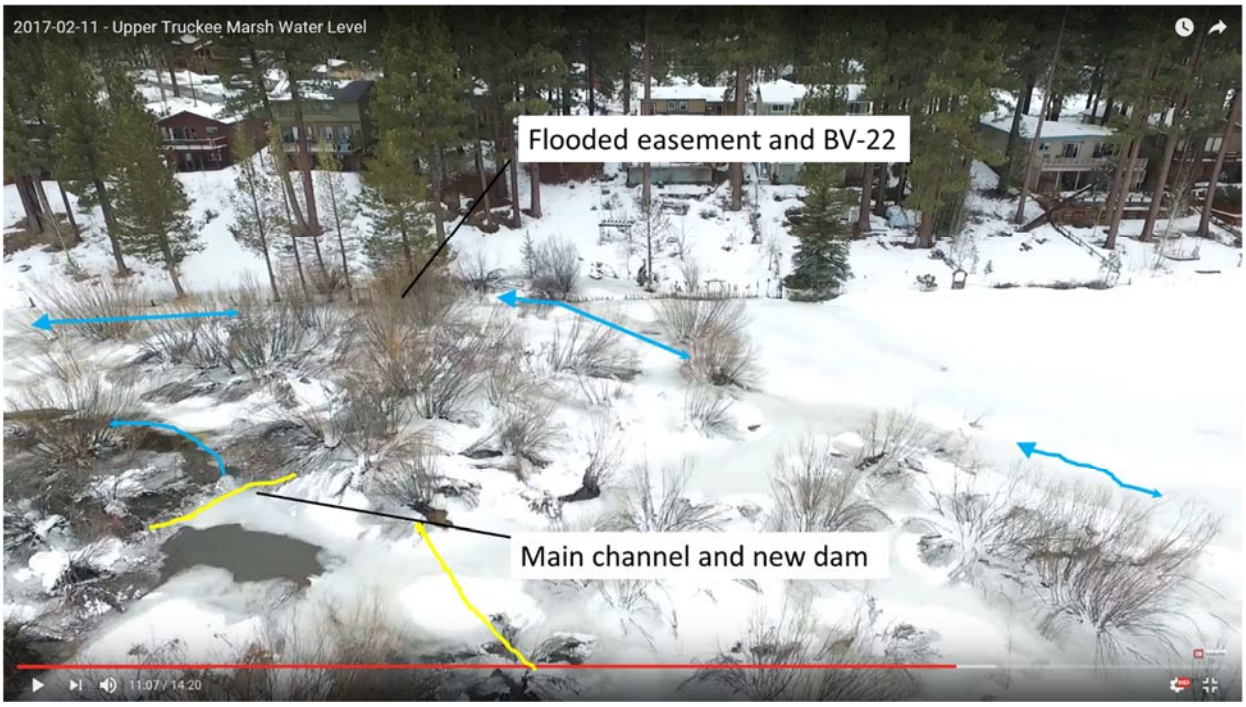
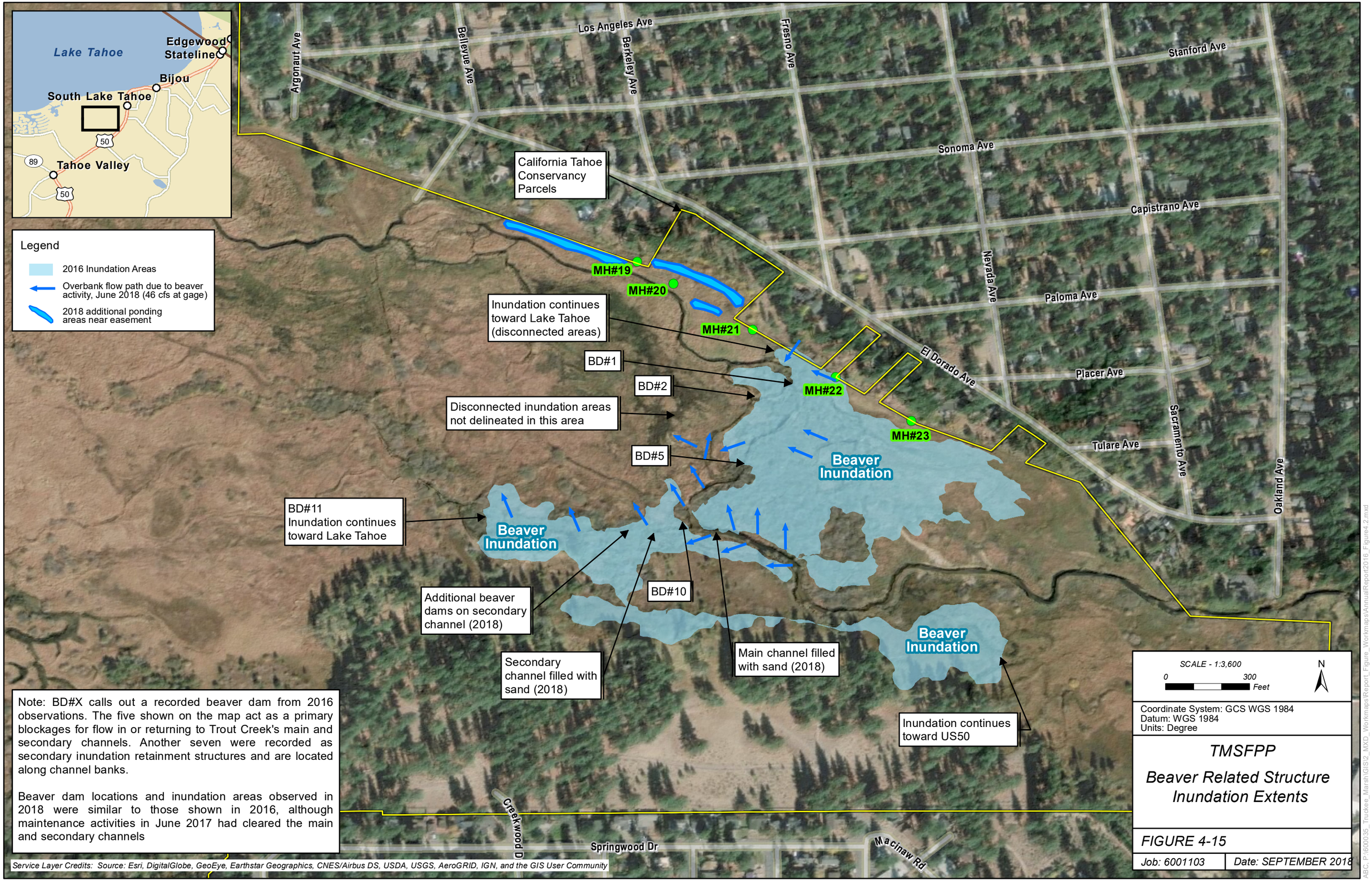


Figure 4-14. Aerial photo showing beaver dam locations and flow paths, February 2017. Yellow lines indicate dam locations and blue lines indicate flow paths


Lake Tahoe
Edgewood
Stateline
Bijou
South Lake Tahoe
Tahoe Valley
50
89
50
Legend
2016 Inundation Areas
Overbank flow path due to beaver activity, June 2018 (46 cfs at gage)
2018 additional ponding areas near easement
Argonaut Ave
Bellevue Ave
Los Angeles Ave
Berkeley Ave
Fresno Ave
Stanford Ave
Sonoma Ave
Capistrano Ave
Nevada Ave
Paloma Ave
El Dorado Ave
Placer Ave
Tulare Ave
Sacramento Ave
Oakland Ave
California Tahoe Conservancy Parcels
MH#19
MH#20
MH#21
MH#22
MH#23
Inundation continues toward Lake Tahoe (disconnected areas)
BD#1
BD#2
Disconnected inundation areas not delineated in this area
BD#5
BD#11 Inundation continues toward Lake Tahoe
BD#10
Additional beaver dams on secondary channel (2018)
Secondary channel filled with sand (2018)
Main channel filled with sand (2018)
Inundation continues toward US50
Beaver Inundation
Beaver Inundation
Beaver Inundation
Creekwood Dr
Springwood Dr
Macinaw Rd
Note: BD#X calls out a recorded beaver dam from 2016 observations. The five shown on the map act as a primary blockages for flow in or returning to Trout Creek's main and secondary channels. Another seven were recorded as secondary inundation retainment structures and are located along channel banks.
Beaver dam locations and inundation areas observed in 2018 were similar to those shown in 2016, although maintenance activities in June 2017 had cleared the main and secondary channels
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
SCALE - 1:3,600
0
300
Feet
N
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
TMSFPP
Beaver Related Structure Inundation Extents
FIGURE 4-15
Job: 6001103
Date: SEPTEMBER 2018
ABC, P:\6000035_Truckee_Marsh\GIS\2_MXD_Workmaps\Report_Figure_Workmaps\AnnualReport2016_Figure4.2.mxd

5 YEAR 4 MAINTENANCE

5.1 Year 4 Work

Post-construction vegetation monitoring and Year 3 planning and design was delayed until fall by inundation upstream of the Bellevue project area. The Year 1 and 2 improvements were generally considered effective at treating conditions in the Bellevue work area, and only minor work was considered necessary in this area in Year 3, pending further monitoring of pilot channel development and vegetative growth. Year 3 improvements were focused on installing hummocks and planting in areas upstream of Bellevue Avenue where increased inundation due to beaver activity presented a problem for access to District manholes. In addition, Year 3 improvements included a measure to address beaver activity at the head of the secondary channel in the center of the marsh, which reduces flows into the secondary channel that was activated in Year 2. Year 4 activities were limited to maintenance actions to reduce the hydraulic effects occurring in the marsh from beaver activity. These actions were implemented in an attempt to restore the channel capacity on the main channel and in the secondary channel in the center of the marsh.

Year 4 activities included:

- Woody debris removal from two locations on the main channel upstream of BV22 corresponding to the locations of channel obstructions. The woody debris removal extended to approximately 2.5 feet below the top of bank.
- Woody debris removal from 4 locations on the secondary channel, corresponding to locations of channel obstructions. Woody debris removal extended to the channel invert and bank locations upstream and downstream.

Plans for maintenance activities were reviewed with the permitting and resource agencies in October 2017 and construction was implemented in November 2017 through a change order with V&C Construction. All work performed in Year 4 was completed with hand crews, and no heavy equipment was used. Timing of the work in late fall was intended to provide some chance that beaver dams would not be constructed/repaired after the maintenance activities for several months, due to reduced beaver activity in winter. The maintenance actions were recognized as temporary measures.

5.2 Observations after Year 4 Maintenance

A reconnaissance of the project area in June 2018 indicates that beaver dams in the main channel and secondary channel are rebuilt or partially rebuilt and that the Trout Creek channel upstream of the main dams near the head of the secondary channel is entirely filled with sediment. At a flow of 47 cfs at USGS 10336780, less than 15 cfs was estimated to be in the main channel near BV22 downstream of the dams and the remainder was passing through the overbanks. In addition, very little flow was occurring in the secondary channel at its divergence from the main channel due to filling of the secondary channel with sand. This deposition is related to a beaver dam approximately 100 feet downstream. The right overbank upstream of the reach of the main channel crossing the meadow from left to right was a large

area of shallow inundation. Inundation in this area may be a main focus for the beaver activity because inundation provides safe access to a large grove of willows appears to have become established since the 1997 flood event and that now spans nearly the entire meadow. Numerous breakouts to the left and right overbanks were occurring upstream of the bend to the right in the main channel at the head of the secondary channel because the old section of channel downstream of the bend is entirely filled with sand. Figure 4-15 (previous section) shows some of the overbank flow paths observed in June 2018.

6 DISCUSSION OF AMP EFFECTIVENESS

The area near the end of Bellevue Avenue (Bellvue area) was the main focus of initial work under the AMP because it was the location of the avulsion and the sewer lines were directly threatened in this location by potential new channel formation in the easement that could have exposed the lines or damaged the manholes. The work in the Bellevue area has been largely successful in reducing this threat and in establishing flow patterns in pilot channels toward the center of the marsh that are now the dominant flow paths. At a flow of 47 cfs at USGS 10336780, only a trickle of flow was in the easement near Bellevue in June 2018, and this flow is expected to cease later in the summer. This aspect of the project generally meets the objective of the AMP. However, shallow flooding is still present in the right overbank upstream of Bellevue Avenue (generally beginning near manhole BV19 and continuing to BV20, then with intermittent wet and dry areas between BV20 and BV22. BV22 is presently flooded continuously by beaver activity in this area of the channel, including an auxiliary beaver dam that connects to the manhole.

The right overbank flooding prevents maintenance access and thus the objectives of the AMP are not met upstream of Bellevue Avenue. The right overbank flooding appears to be due to a combination of long duration bankfull conditions in the creek upstream of PC-3 and right overbank flows at BV22 caused by beaver activity. The bankfull conditions are created because the pilot channel system still has a higher gradient than adjacent channel reaches, and thus acts as a hydraulic control to cause a full or nearly full Trout Creek channel upstream of PC-3 at flows of 25 to 30 cfs. Because much of the right overbank is slightly lower than the right bank of the channel (i.e., the channel is not located in the lowest area of the marsh), this condition contributes to seepage and shallow inundation in the right overbank. Beaver activity has increased inundation levels and durations upstream of BV22 and may be influencing groundwater levels in other areas downstream of BV22.

In the Bellevue area, the options that can be considered are to: 1) again increase the size of the pilot channels, and 2) open a low flow pathway on the right overbank to better drain very low flows through the overbank area along, but not in, the easement. The latter action was intended to be included in Year 4 maintenance activities but was not completed due to timing and weather considerations.

In the area upstream of Bellevue, these actions may not resolve flooding in the topographically low areas and measures beyond the scope of the original Adaptive Management Plan (AMP) may need to be considered. Beaver activity is expected to continue and inundated areas may become larger and may move as the channel upstream of the existing dams continues to fill and becomes unsuitable for lodge construction. In addition, channel filling behind the dams creates a higher chance for another channel avulsion, which could again significantly change the problem. The measures developed in the AMP did not specifically target this source of inundation and a change in management appears to be needed to ensure access to the sewer line upstream of Bellevue for maintenance. Options available to the District are limited – although management of flows through implementation of AMP measures on Conservancy

land has been supported by the Conservancy, the District is not in a position to manage future marsh evolution under the influence of beavers.

One option that could be considered is to raise the entire easement area slightly. This option was originally considered, but not selected by the District due to the size of the potential work area, potential conversion effects on the wetland, and difficulty in ensuring that areas to the north (right, looking downstream) of the raised area, including private property, would drain by gravity. A second option is to develop access points from the right upland margin of the marsh to specific manholes (i.e, not every manhole would have maintenance access). This option is similar to the existing contingency plan for access in case of a problem or blockage in the line. This option would potentially require crossing a wetland area with the access routes to specific manholes, and therefore would likely require small hydraulic structures (mini-bridge, culverts, etc.) to maintain drainage patterns. The most likely locations for access between Bellevue and BV22 are across a Conservancy parcel on El Dorado near manholes BV20 and BV21. Both of these access points would require crossing a wetland swale and therefore would require a structure of some type (multi-culvert, low bridge, causeway, etc.) on the Conservancy parcel to maintain flows. This area is currently outside the project limits defined in the environmental document for the AMP. There may also be some potential to reach BV21 via an upland route if access across private property adjacent to the Conservancy parcel could be obtained. For maintenance, access to BV20 is considered preferable, as this is the location of a junction on the gravity main with a sewer line running from El Dorado Avenue to the main. There is a topographic low between BV20 and BV21 that would currently restrict access from BV21 to BV20.

Coordination with the Conservancy and other agencies is recommended to discuss options and to develop a plan that provides reliable maintenance access upstream of Bellevue Avenue in the context of existing and potential future changes in beaver activity and stream behavior.

7 REFERENCES

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APPENDIX A

Construction Information

Year 3 Plans

SHEET INDEX

South Tahoe Public Utility District

CONSTRUCTION PLANS FOR

Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan - Year 3 Improvements

OCTOBER 2016

PROJECT MANAGER

Ivo Bergsohn, Hydrogeologist
South Tahoe Public Utility District
1275 Meadow Crest Road
South Lake Tahoe, California 96150

APPROVED BY:

Shannon Catulla, Assistant General Manager *(date)*
South Tahoe Public Utility District
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South Lake Tahoe, California 96150

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Western Botanical Services, Inc.
5859 Mt Rose Highway
Reno, Nevada 89511
(775) 849–3223
www.wbsinc.us

REGISTERED PROFESSIONAL ENGINEER — EDWARD E. WALLACE — No. 32301 — Exp: 12/31/16 CIVIL — STATE OF CALIFORNIA

4 oct 2016

Edward E. Wallace *(date)*
CALIFORNIA REGISTERED
PROFESSIONAL ENGINEER NO. # 32301
northwest hydraulic consultants

Vicinity Map

Project Location Map

Drawing Name: UT MARSH COVER YR3 (P:\600035_Truckee_Marsh\AC-600035\dwg\YR3)			Date: 4 OCTOBER 2016	
Drawing Status: Final Construction Documents	Designer: eew	Drafter: tvs	Checked: eew	Job Number: 6001103
Sheet 1 of 7				Sheet Number: T1

GENERAL NOTES

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING UTILITY COMPANIES TO DETERMINE THE LOCATION OF UNDERGROUND FACILITIES. THE LOCATION OF KNOWN EXISTING FACILITIES IN THE WORK AREA ARE SHOWN, BUT NO GUARANTEE IS MADE AS TO THE ACCURACY OF THIS INFORMATION.
2. THE CONTRACTOR SHALL PROTECT EXISTING SURVEY CONTROL POINTS AND SHALL BE RESPONSIBLE FOR CONSTRUCTION STAKING. IF EXISTING MONUMENT(S) MUST BE DISTURBED TO PERFORM THE WORK, THE CONTRACTOR SHALL NOTIFY THE DISTRICT FOR RELOCATION OF THE MONUMENT PRIOR TO BEGINNING TO WORK.
3. EXCESS MATERIAL IS TO BE REMOVED FROM THE SITE AND DISPOSED OF AT AN APPROVED SITE.
4. THE ENGINEER MAY MAKE MINOR CHANGES TO THE CONFIGURATION AND DESIGN GRADES OF PROJECT FEATURES AND TO REVEGETATION LAYOUTS TO SUIT FIELD CONDITIONS.
5. THE CONTRACTOR SHALL CONTACT THE DISTRICT IMMEDIATELY IF FIELD CONDITIONS ARE FOUND THAT CONFLICT WITH THESE PLANS. FIELD ADJUSTMENTS MUST BE APPROVED BY THE DISTRICT PRIOR TO CONSTRUCTION.
6. IF ANY ARTIFACTS OR OTHER MATERIALS ARE FOUND INDICATING POTENTIAL ARCHAEOLOGICAL OR HISTORICAL RESOURCES, WORK SHALL BE HALTED IMMEDIATELY AND THE CONTRACTOR SHALL CONTACT THE DISTRICT.
7. NO TREES ARE DESIGNATED FOR REMOVAL. IF FIELD CONDITIONS INDICATE THE NEED FOR TREE REMOVAL, PRIOR APPROVAL FROM THE DISTRICT AND TRPA IS REQUIRED.
8. NO GRADING SHALL OCCUR PRIOR TO INSTALLATION OF CONSTRUCTION BMPs AND APPROVAL BY TRPA AT A PRE-GRADE INSPECTION. BMPs TO BE INSTALLED PRIOR TO EQUIPMENT OR TRUCK USE OF ACCESS ROUTES IN PROJECT AREA.
9. WORK TO BE PERFORMED IS PART OF A MULTI-YEAR ADAPTIVE MANAGEMENT PLAN(AMP). PERMIT CONDITIONS FOR THE AMP APPLY TO THE PROJECT.
10. ON-SITE WORK SHALL BE PERFORMED FROM 8AM TO 6PM, MONDAY THROUGH FRIDAY. WORK OUTSIDE THESE HOURS MUST BE APPROVED BY THE DISTRICT A MINIMUM OF 48 HOURS BEFORE THE ABNORMAL WORKING HOURS ARE SCHEDULED TO BEGIN.
11. VEHICLE ACCESS RESTRICTED TO LOW GROUND PRESSURE UTILITY ATV (E.G., MULE), MAX WEIGHT 2000 LBS. ACCESS RESTRICTED TO MINIMUM NUMBER OF TRIPS REQUIRED FOR DELIVERY OF MATERIALS. AREAS OF WET GROUND TO BE PROTECTED, IF NEEDED TO AVOID RUTS OR OTHER DISTURBANCE OF THE MEADOW SURFACE.
12. CONTRACTOR TO PROVIDE SERVICES AS DIRECTED BY DISTRICT TO REMOVE DEBRIS AND MAINTAIN DRAINAGE IN EXISTING SECONDARY FLOW ROUTES FOR DEWATERING AND WATER MANAGEMENT AT THE SITE. CONTRACTOR TO DOCUMENT SERVICES PERFORMED ON A DAILY BASIS AND PROVIDE REPORTS TO THE DISTRICT WEEKLY.

AREAS & QUANTITIES - YEAR 3 IMPROVEMENTS

DISTURBANCE AREAS AND APPROXIMATE CUT/FILL QUANTITIES

COMPONENT	SURFACE AREA, SF	CUT (-)/FILL(+) CY
ACCESS ROUTES	14,200	0
PILOT CHANNELS	200	-5
DOUBLE MARSH MAT HUMMOCKS	1968	+5
MARSH MAT HUMMOCKS WITH WILLOW MATTRESS	352	0
PLANTED COIR LOGS	40	0
WETLAND PLUG PLANTINGS	200	0
HUMMOCKS	304	0
TOTALS	3078.2	0

[1]EXCLUDES AREAS WHERE ONLY PLANTING OCCURS

MONUMENT LOCATIONS					
NAME	LATITUDE (NAD83)	LONGITUDE (NAD83)	NORTHING (GRID)	EASTING (GRID)	ELEVATION (NAVD88)
RBM T01	38.936805560°N	119.989783506°W	2109311.8	7133398.2	6234.3
RBM T02	38.936678391°N	119.989687343°W	2109266.1	7133426.6	6234.4
RBM T04	38.936695860°N	119.989298498°W	2109274.9	713537.0	6234.3
RBM T05	38.936536812°N	119.988919311°W	2109219.4	7133646.1	6235.0
RBM T07	38.936210006°N	119.987960945°W	2109106.4	7133921.3	6234.9

LEGEND

EXISTING TREES	
EXISTING EDGE OF PAVED ROAD	
EXISTING TRAIL	
EXISTING CONTOURS (MAJOR)	60
EXISTING CONTOURS (MINOR)	61
EXISTING FENCE	
EXISTING EDGE OF WATER (10/25/13)	
EXISTING BUILDINGS & STRUCTURES	
SURVEY CONTROL POINT	
PROPOSED SLOPE	
CONSTRUCTION BASELINE	1+00
SILT BARRIER	
SAFETY PRESERVATION FENCE WITH SILT BARRIER	
PROPOSED CONTOURS (MAJOR)	80
PROPOSED CONTOURS (MINOR)	79
PROPOSED SPOT ELEVATIONS	83.2
HUMMOCK	
DIVERSION DAM	
STAGING AREA	

SURVEY
TOPOGRAPHY BASED ON FIELD SURVEY, 3 NOVEMBER 2013, BY TRI-STATE SURVEYING, LTD., AND 20 JANUARY 2015 AND NOVEMBER 2015 LUMOS & ASSOCIATES.

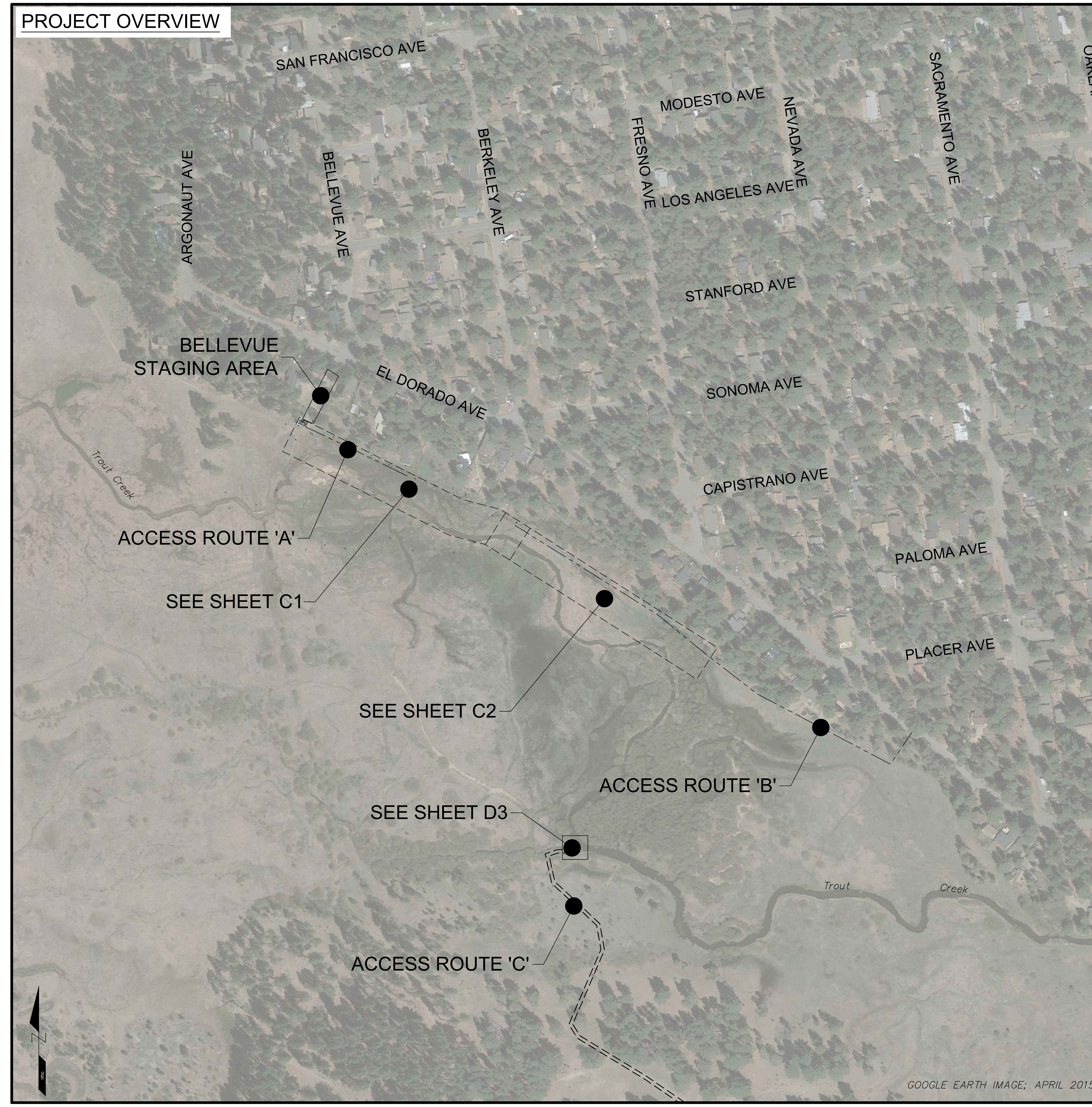
HORIZONTAL: NAD 83(2011) EPOCH 2010.00
CALIFORNIA STATE PLANE ZONE II, US SURVEY FEET

NGS HPGN D CA 03 FS
N 2107571.07 US SURVEY FEET-GRID
E 7136557.88

NGS RICHARDSON
N 2103848.87 US SURVEY FEET - GRID
E 7123525.92 GRID

VERTICAL: NAVD88
NGS HPGN D CA 03 FS
EL 6248.20

PROJECT OVERVIEW



PROJECT OVERVIEW
SCALE: 1"=200'

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REGISTERED PROFESSIONAL ENGINEER — EDWARD E. WALLACE — No. 32301 — Exp: 12/31/16 — CIVIL — STATE OF CALIFORNIA

Revisions		
No.	Date	Description

Drawing Information	
Date	4 October 2016 (09:13)
Status	Final Construction Documents
Designer	
Drafter	
Checked	
File Name	UT MARSH COVER YR3
Plotted Scale	0 1/2 1

Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan
Years 2-5 Improvements

General Notes

Job Number
6001103

Sheet Number
G1

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Revisions		
No.	Date	Description

Drawing Information	
Date	4 October 2016 (09:12)
Status	Final Construction Documents
Designer	eew/tvs
Drafter	tvs
Checked	eew
File Name	UT MARSH YR3
Plotted Scale	0 1/2 1

Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan
Years 2-5 Improvements
Plan Sheet

Job Number 6001103

Sheet Number

C1

Sheet 3 of 7

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Revisions		
No.	Date	Description

Drawing Information	
Date	4 October 2016 (09:12)
Status	Final Construction Documents
Designer	eew/tvs
Drafter	tvs
Checked	eew
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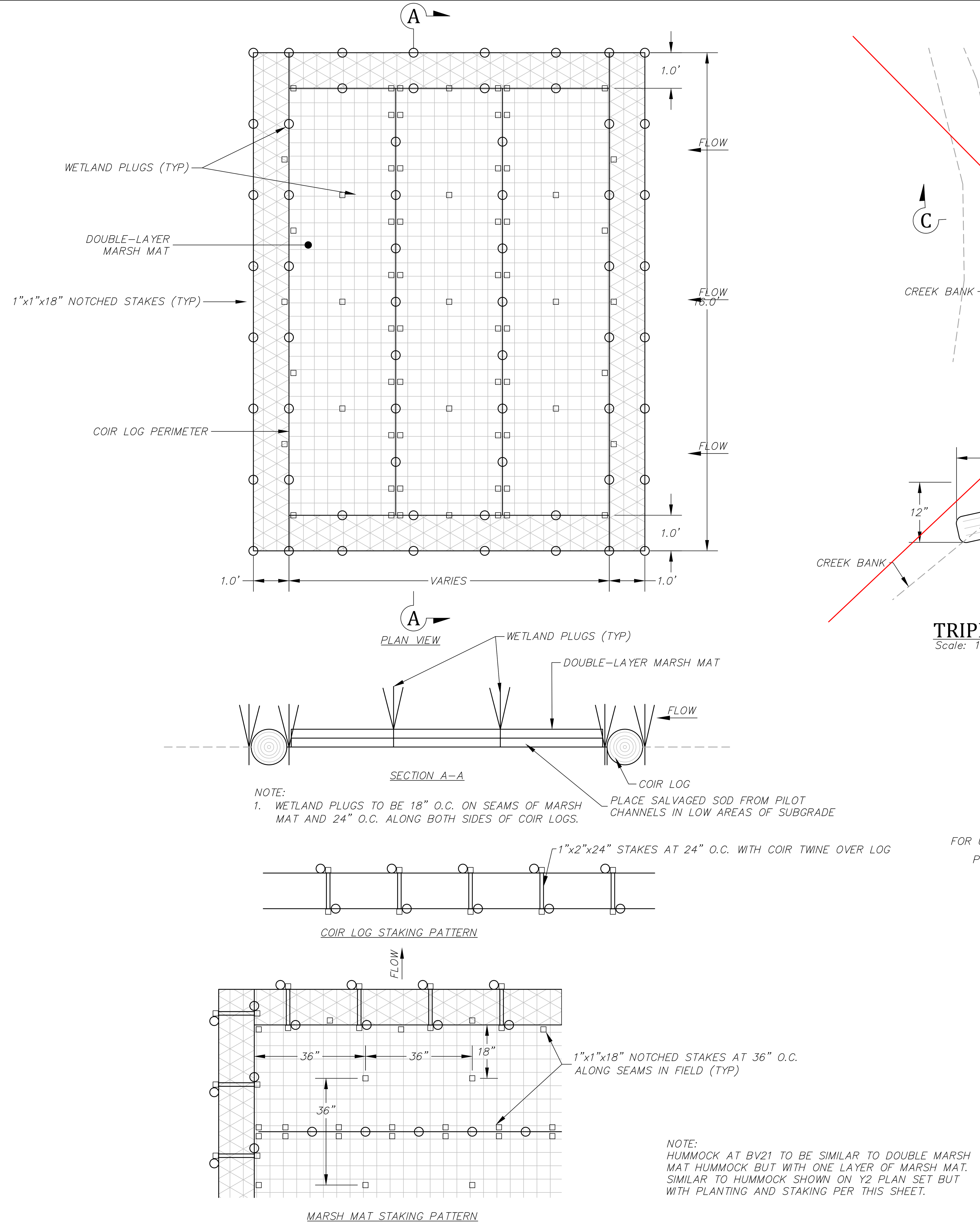
Plotted Scale	0 1/2 1

Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan
Years 2-5 Improvements

Plan Sheet

Job Number
6001103

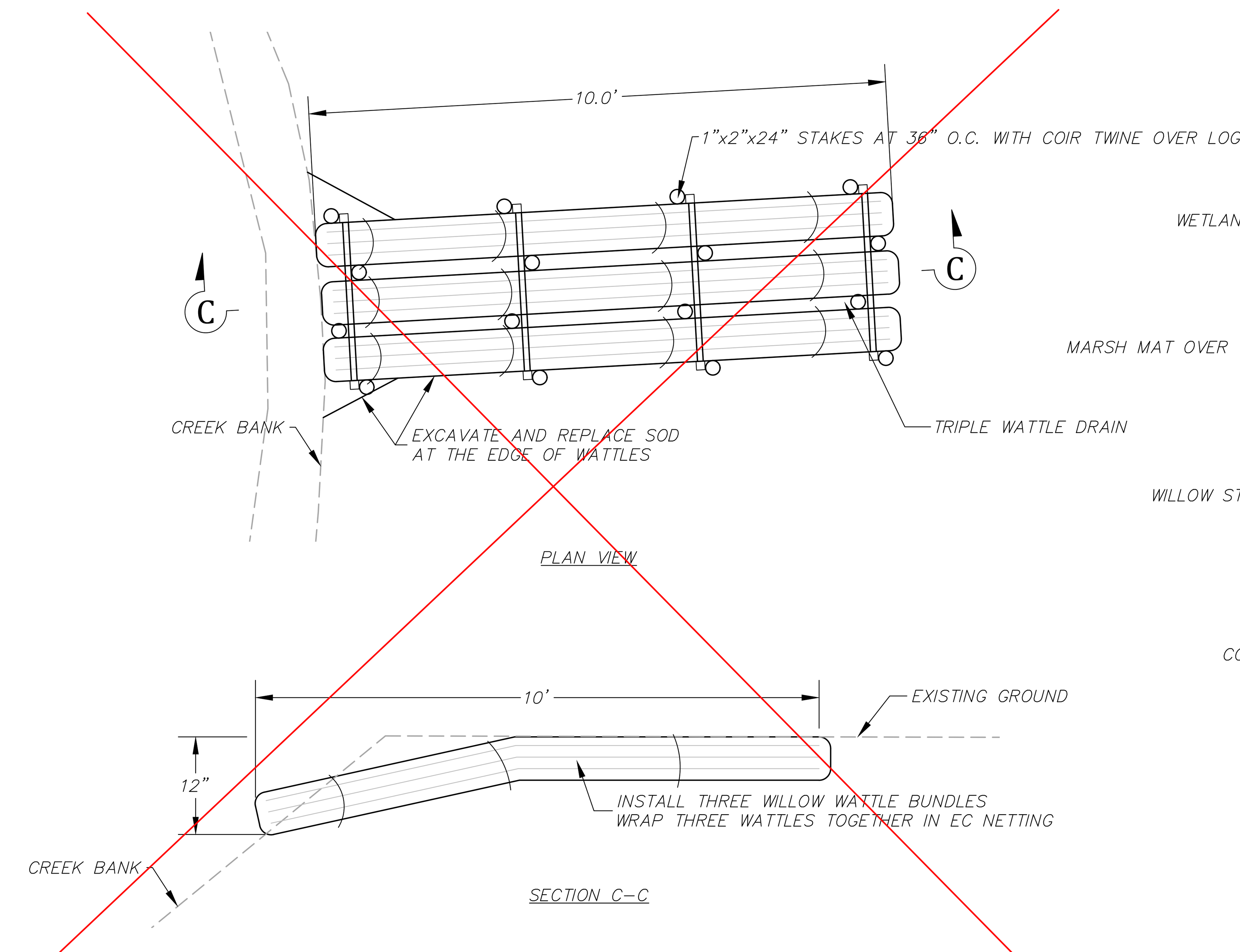
Sheet Number
C2



DOUBLE MARSH MAT

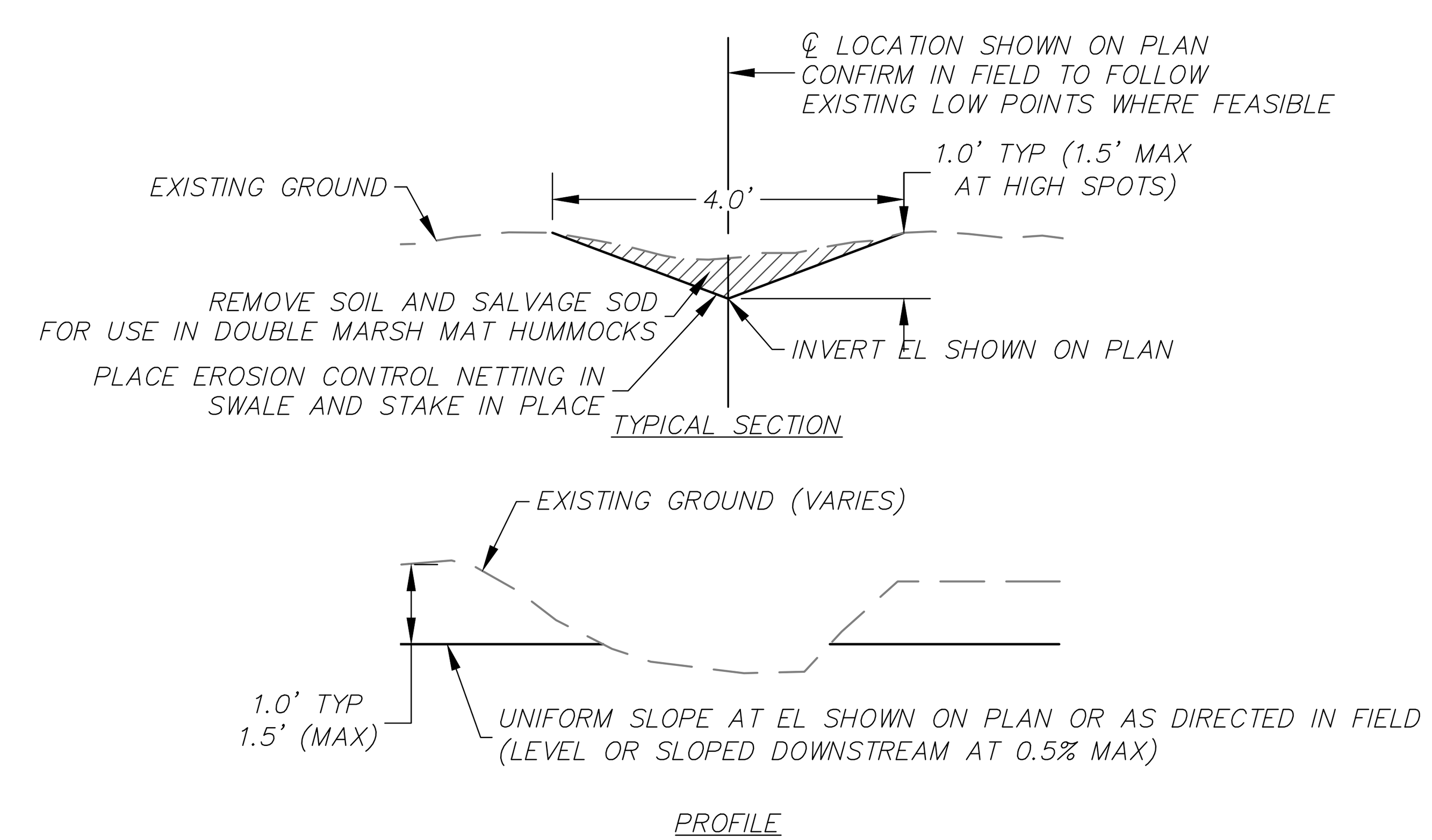
Scale: 1"=6"

NOTE:
HUMMOCK AT BV21 TO BE SIMILAR TO DOUBLE MARSH MAT HUMMOCK BUT WITH ONE LAYER OF MARSH MAT. SIMILAR TO HUMMOCK SHOWN ON Y2 PLAN SET BUT WITH PLANTING AND STAKING PER THIS SHEET.



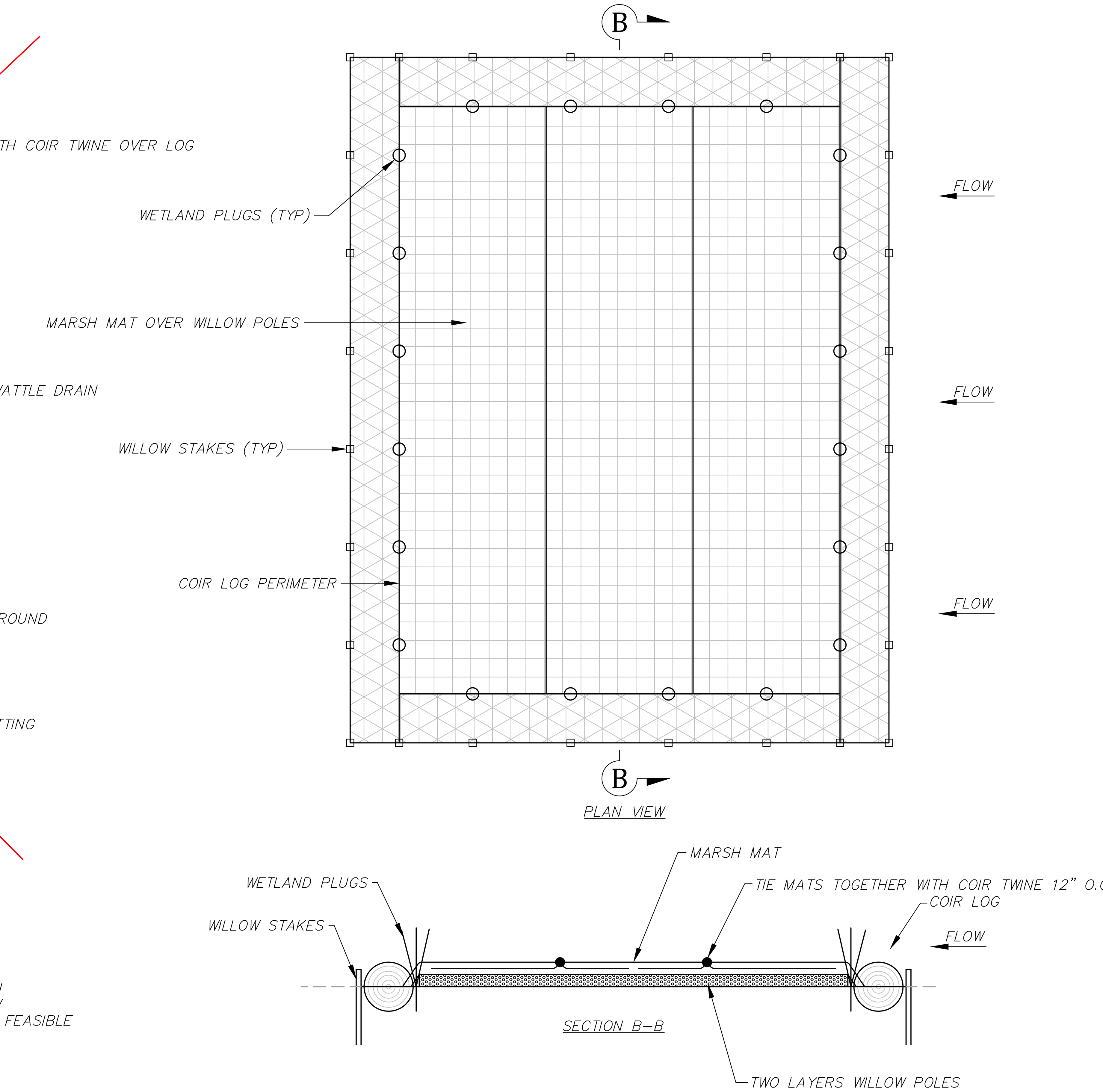
TRIPLE WATTLE DRAIN (NOT IN CONTRACT)

Scale: 1"=6"



PILOT CHANNEL

Not to Scale



HUMMOCK WITH WILLOW BRUSH MATTRESS

Scale: 1"=6"

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Revisions

No.	Date	Description

Drawing Information

Date	4 October 2016 (09:11)
Status	Final Construction Documents
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Drafter	tvs
Checked	eew
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Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan
Years 2-5 Improvements

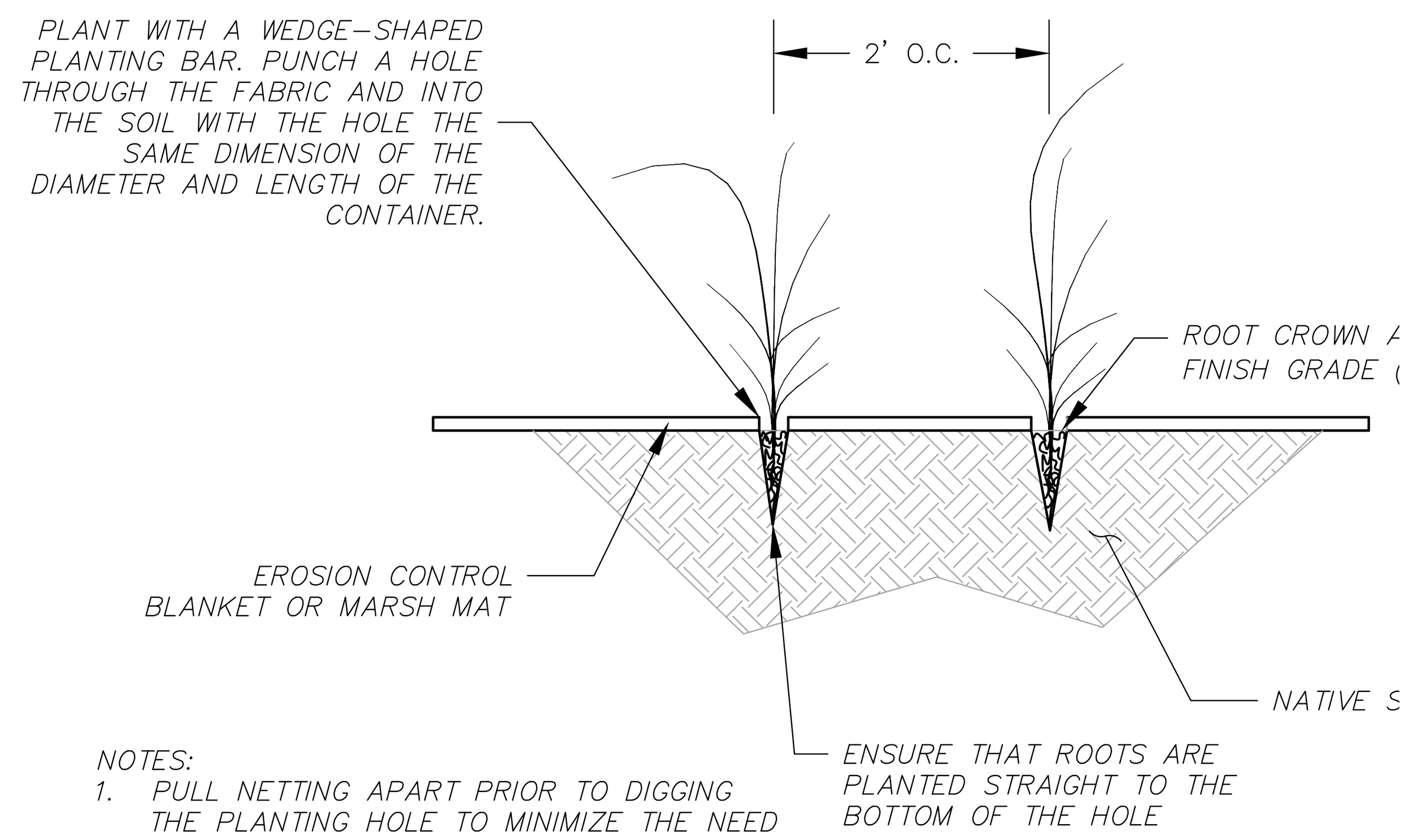
Details Sheet

Job Number 6001103

Sheet Number

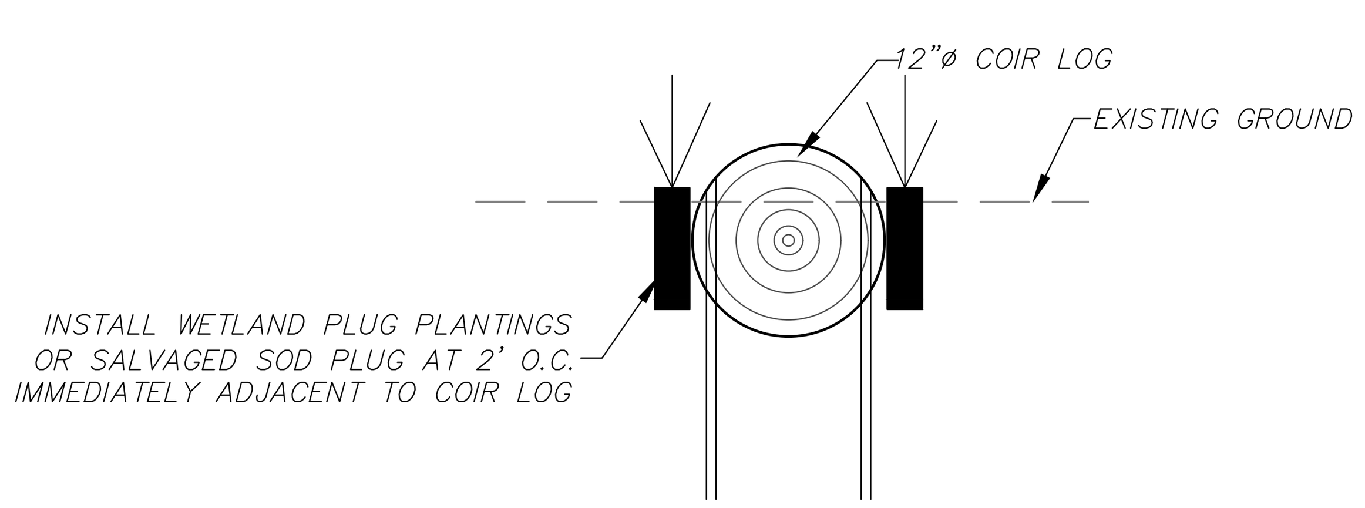
D1

Sheet 5 of 7

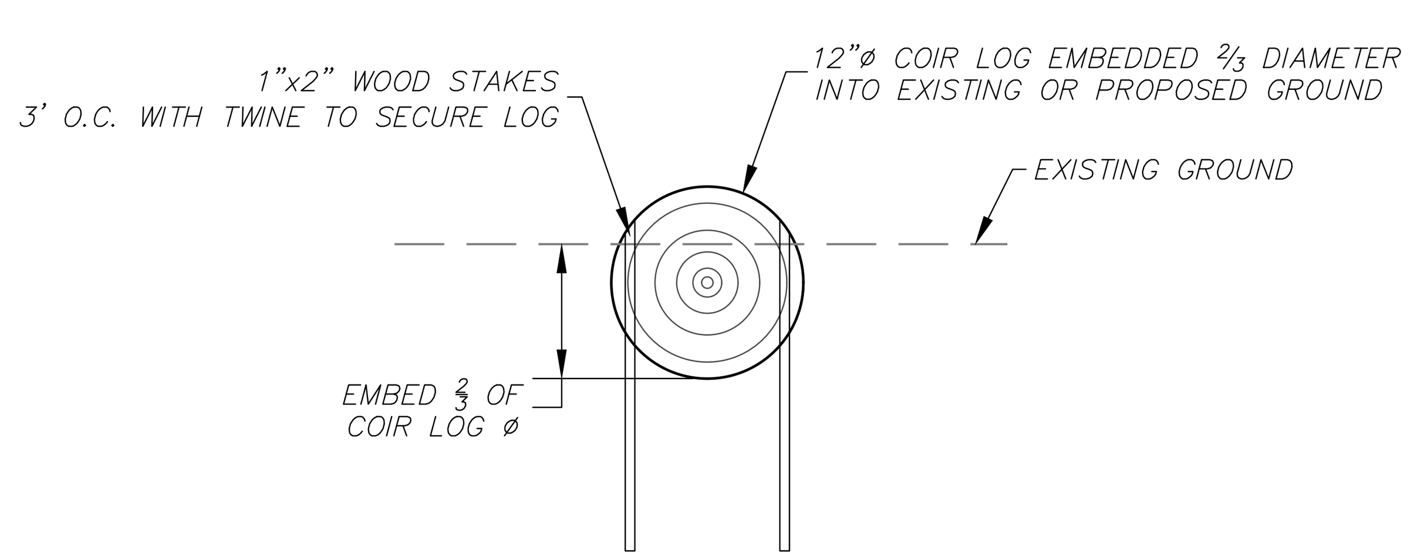


NOTES:
1. PULL NETTING APART PRIOR TO DIGGING THE PLANTING HOLE TO MINIMIZE THE NEED TO CUT THE FABRIC.
2. WETLAND PLUGS SHALL BE CAREX NEBRASCENSIS AND JUNCUS BALTICUS.
3. WETLAND PLUGS SHALL BE SUPERCELL 1.5 INCH WIDE AND 8 INCHES DEEP OR DEEPOTS (10-INCH DEPTH).
4. UP TO 45 WETLAND PLUGS WILL BE PLANTED AT LOCATIONS DIRECTED BY THE DISTRICT (NOT SHOWN ON PLANS)

WETLAND PLUG PLANTING
Not to Scale



PLANTED COIR LOG
Not to Scale



COIR LOG INSTALLATION
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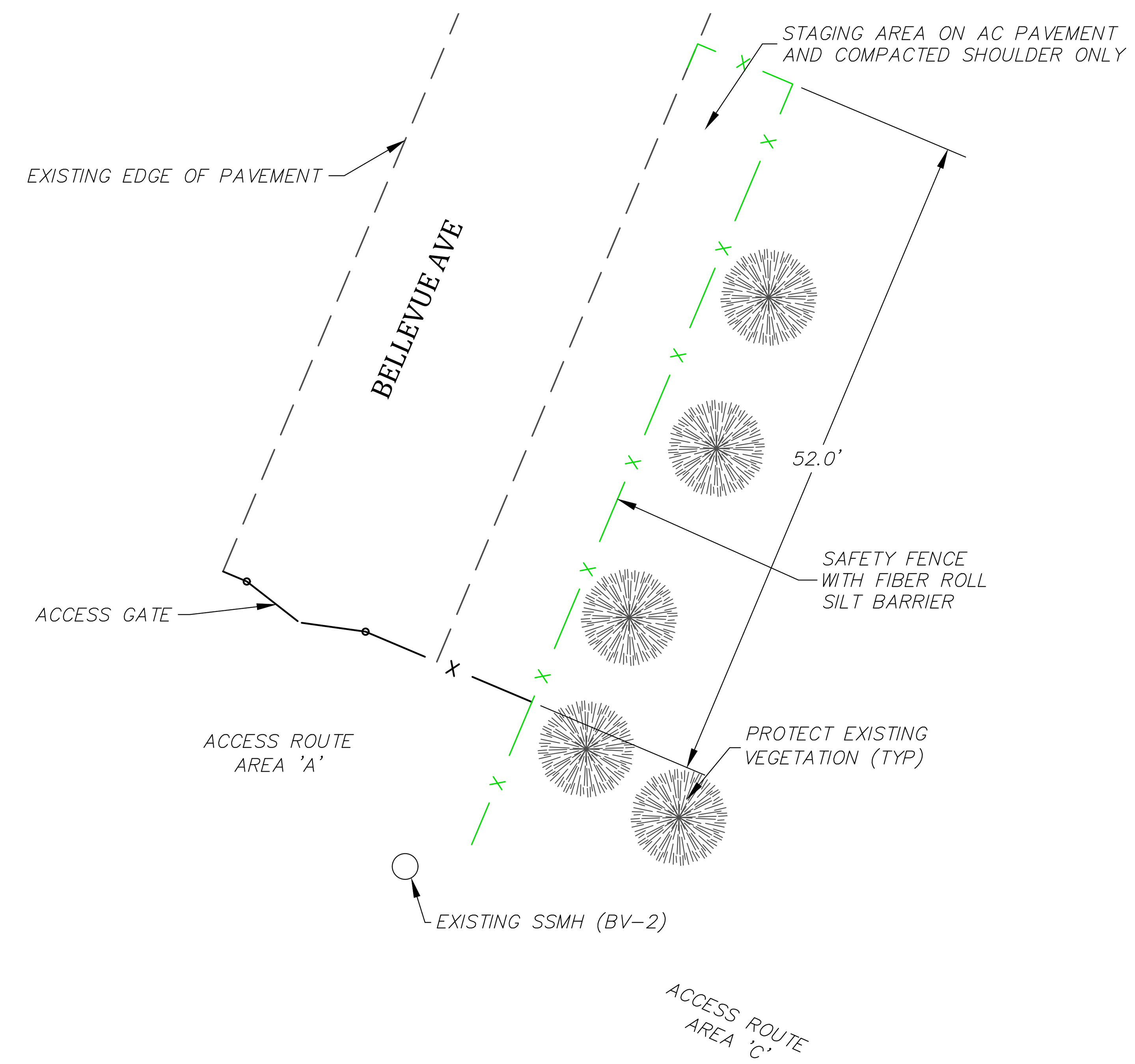
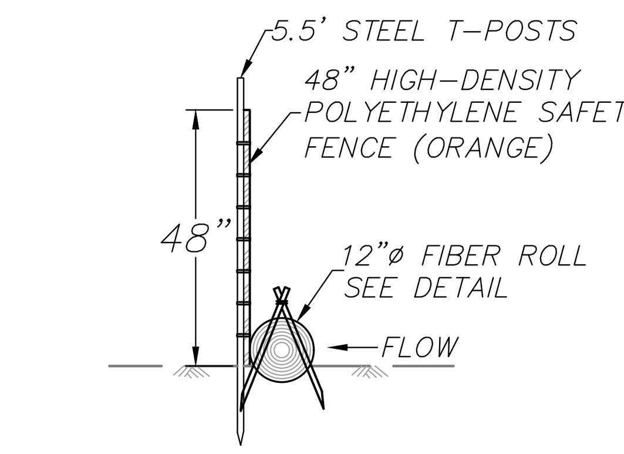
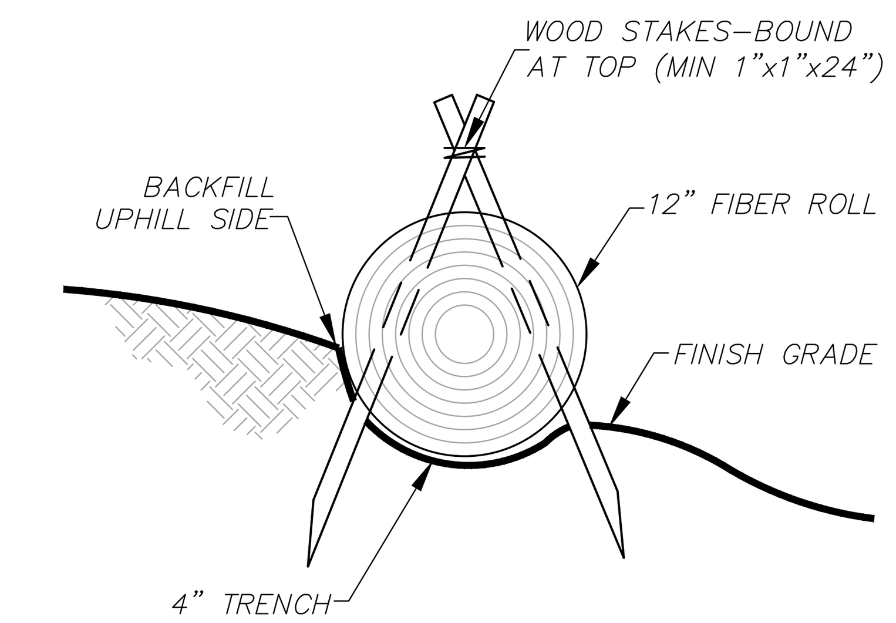


STAGING AREA BMPs
Not to Scale

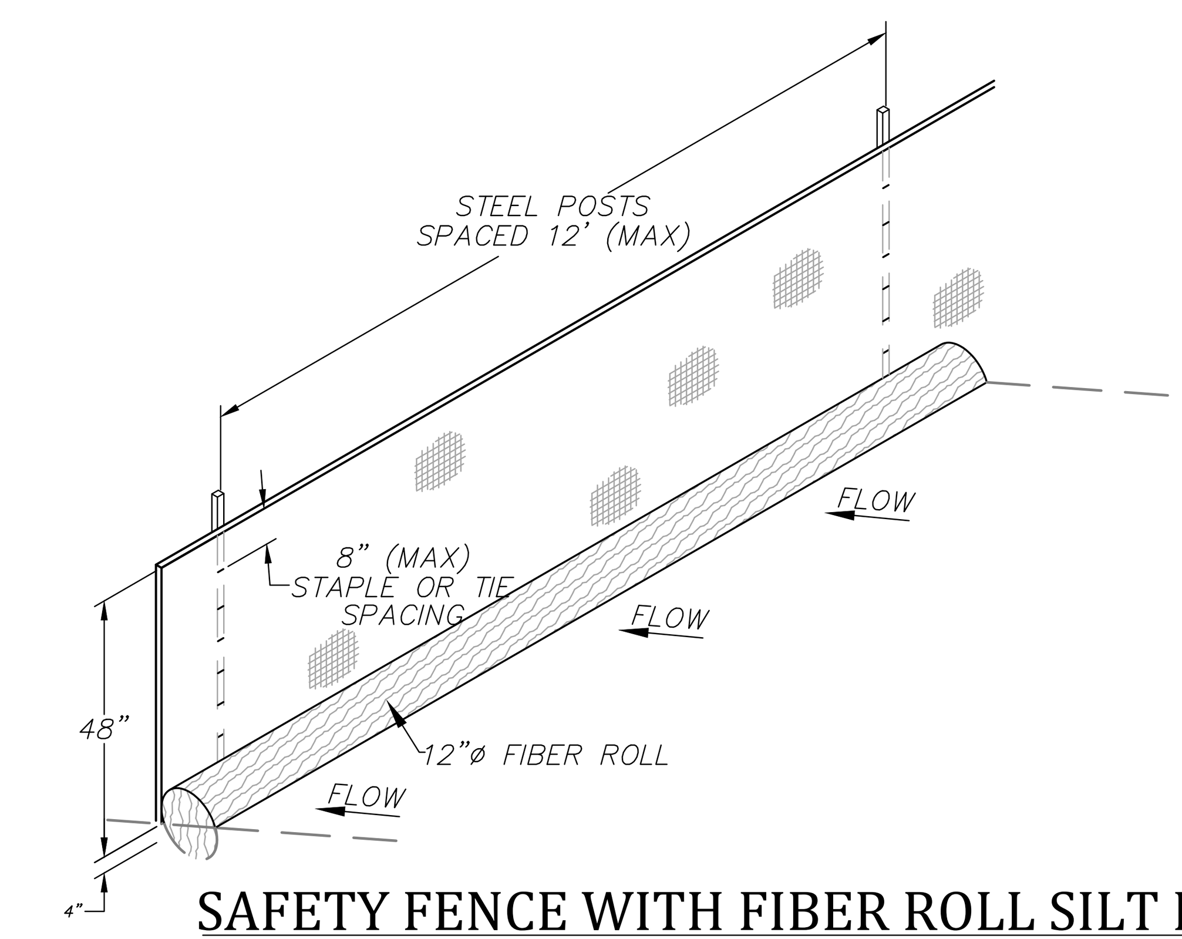
STAGING AREA BMP NOTES:
1. STAGING AREA TO BE MAINTAINED IN A CLEAN CONDITION
2. CONTRACTOR IS RESPONSIBLE TO MAINTAIN OR RESTORE EXISTING AC PAVEMENT TO A PRE-PROJECT CONDITION.



SECTION
FIBER ROLL SILT BARRIER AT SAFETY FENCE



FIBER ROLL SILT BARRIER
Not to Scale



SAFETY FENCE WITH FIBER ROLL SILT BARRIER
Not to Scale

NOTES:
1. FIBER ROLL SHALL BE MADE FROM 100% MATTRESS GRADE COCONUT FIBER AND BOUND BY HIGH STRENGTH COIR NETTING, AND HAVE A MINIMUM WEIGHT OF 5 LBS PER LINEAL FOOT.
2. ORANGE SAFETY FENCE SHALL BE HIGH DENSITY POLYETHYLENE WITH A MESH OPENING OF APPROXIMATELY 1 INCH BY 4 INCHES AND A MINIMUM HEIGHT OF 4 FEET.
3. FIBER ROLL SILT BARRIER SHALL BE INSTALLED ALONG CONTOUR AND ON SLOPES 5H:1V OR FLATTER UNLESS OTHERWISE APPROVED BY TRPA.
4. THE INSTALLATION CONFIGURATION SHALL PREVENT RUNOFF FROM LEAVING THE SITE OR ENTERING A WATERCOURSE WITHOUT PASSING THROUGH A SILT BARRIER.
5. THE MAXIMUM LENGTH OF SLOPE DRAINING TO THE SILT BARRIER SHALL BE 100 FEET.
6. FIBER ROLL SHALL BE INSTALLED BY SHAPING A 4 INCH DEEP FURROW TO MATCH THE SHAPE OF THE LOG, SECURING IN FURROW WITH WOOD STAKES, AND TAMPING THE GROUND AROUND THE FIBER ROLL TO FILL VOIDS BETWEEN THE LOG AND THE GROUND.
7. TRPA BMP-517

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REGISTERED PROFESSIONAL ENGINEER EDWARD E. WALLACE No. 32301 Exp: 12/31/16 CIVIL STATE OF CALIFORNIA

Revisions		
No.	Date	Description

Drawing Information	
Date	4 October 2016 (09:11)
Status	Final Construction Documents
Designer	eew
Drafter	tvs
Checked	eew
File Name	UT MARSH DETAIL YR3
Plotted Scale	0 1/2 1

Upper Truckee Marsh Sewer Facilities Adaptive Management Plan Years 2-5 Improvements

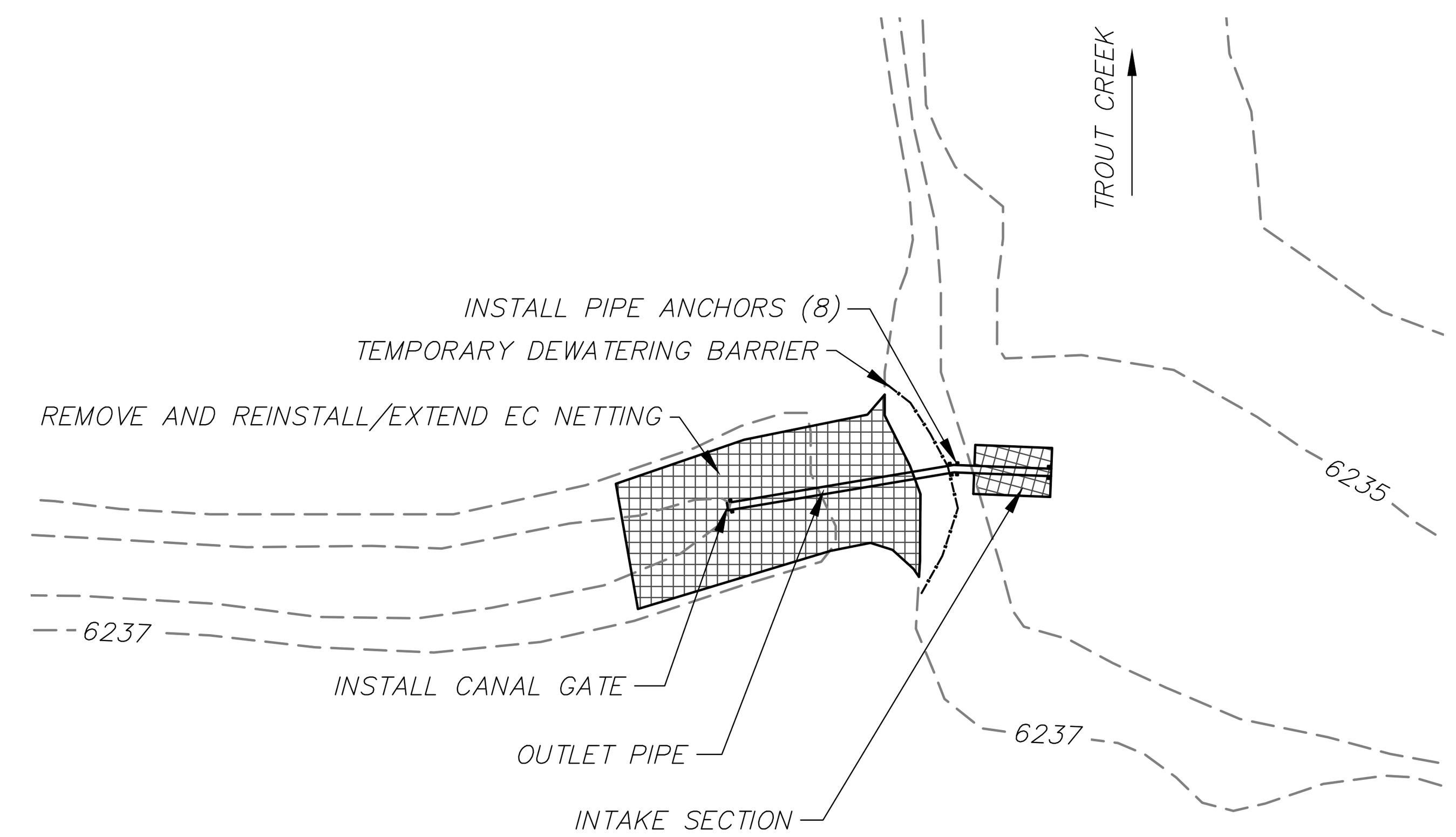
Details Sheet

Job Number 6001103

Sheet Number

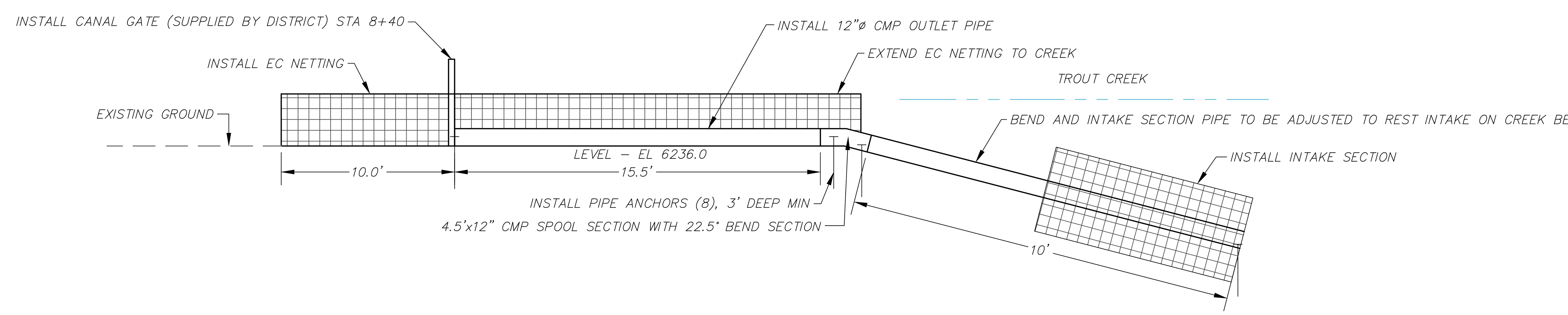
D2

Sheet 6 of 7

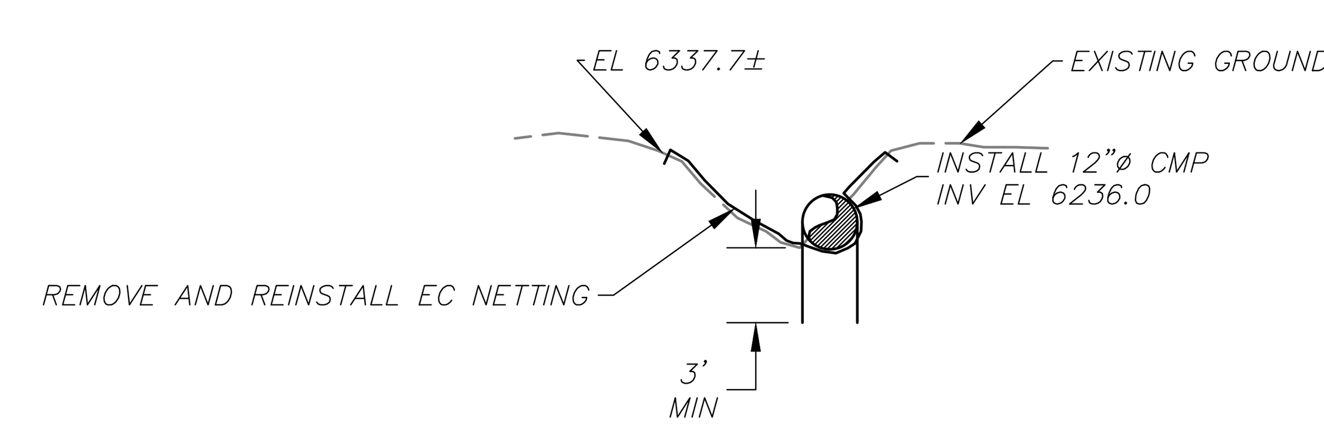


NOTES:
POND LEVELER TO BE INSTALLED IN THE FOLLOWING STEPS:
1. INSTALL TEMPORARY DEWATERING BARRIER AT HEAD OF SECONDARY CHANNEL TO STOP FLOW INTO SECONDARY CHANNEL
2. REMOVE EXISTING EROSION CONTROL FABRIC
3. EXCAVATE FOR PIPE BEDDING
4. REINSTALL AND EXTEND EROSION CONTROL FABRIC
5. INSTALL OUTLET PIPE AND CANAL GATE
6. REMOVE TEMPORARY DEWATERING BARRIER
7. INSTALL INTAKE SECTION IN TROUT CREEK

PIPE ANCHORS TO BE $\frac{3}{4}$" GALVANIZED PIPE WITH A TEE FITTING AT TOP AND $\frac{3}{8}$" POLYESTER ROPE STRAPS, TIGHTENED TO HOLD PIPE TO GROUND.



NOTES:
1. CONTRACTOR TO SCHEDULE DELIVERY OF POND LEVELER TO PROJECT SITE BY DISTRICT.
2. SECONDARY CHANNEL TO BE DEWATERED FOR INSTALLATION OF OUTLET PIPE. INSTALLATION AND CONNECTION OF INTAKE SECTION SHALL BE MADE IN THE WATER (TROUT CREEK).
3. OUTLET PIPE TO BE INSTALLED LEVEL AT EL 6236.0
4. BEND CONNECTION BETWEEN OUTLET PIPE AND INTAKE SECTION TO BE ADJUSTED TO REST INTAKE SECTION ON BED OF CREEK CHANNEL
5. EROSION CONTROL NETTING TO BE 0.3" 100% COIR NETTING WITH 50% OPEN AREA (70 OR 700 SERIES PRODUCT)
6. OUTLET PIPE TO BE INSTALLED ALONG RIGHT BANK (LOOKING DOWNSTREAM) OF SECONDARY CHANNEL AND BACKFILLED ALONG THE BANK WITH SOD SALVAGED AT LOCATIONS IDENTIFIED IN THE FIELD BY ENGINEER



LONGITUDINAL SECTION

POND LEVELER
Not to Scale

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REGISTERED PROFESSIONAL ENGINEER — EDWARD E. WALLACE — No. 32301 — Exp: 12/31/16 — CIVIL — STATE OF CALIFORNIA

Revisions		
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Drawing Information	
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File Name	UT MARSH DETAIL YR3
Plotted Scale	0 1/2 1

Upper Truckee Marsh Sewer Facilities
Adaptive Management Plan
Years 2-5 Improvements

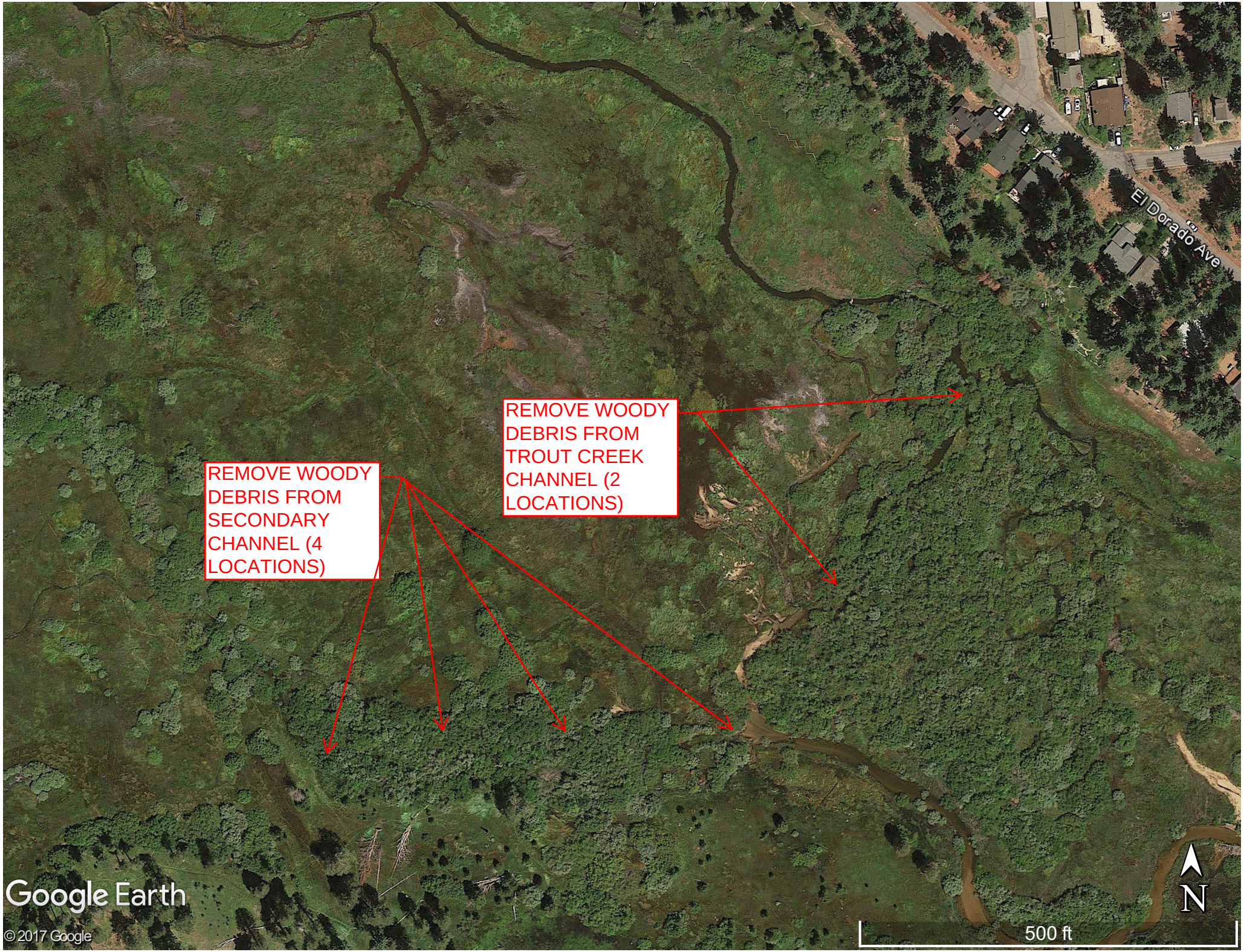
Details Sheet

Job Number
6001103

Sheet Number
D3

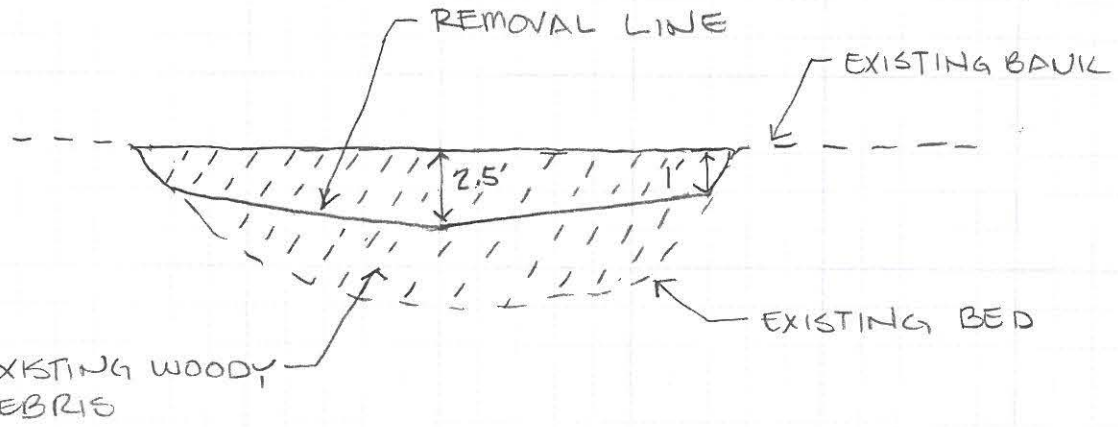
Sheet 7 of 7

Year 4 Maintenance Activities

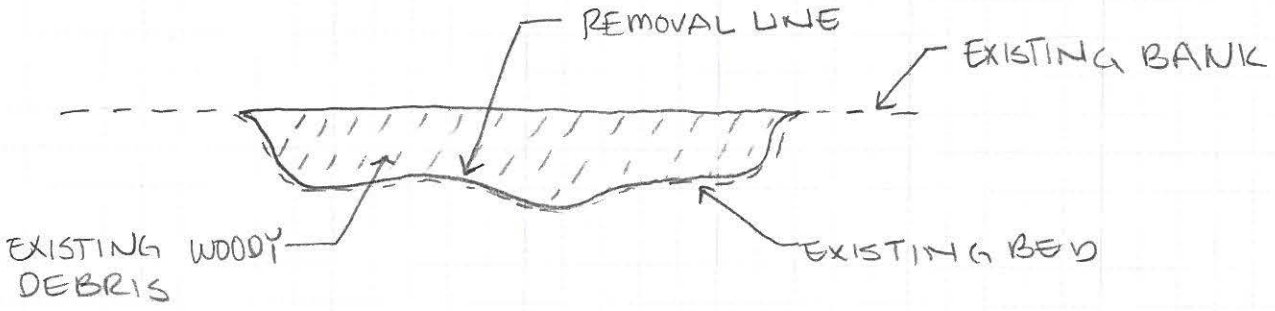

REMOVE WOODY DEBRIS FROM SECONDARY CHANNEL (4 LOCATIONS)
REMOVE WOODY DEBRIS FROM TROUT CREEK CHANNEL (2 LOCATIONS)
El Dorado Ave
Google Earth
© 2017 Google
N
500 ft

northwest hydraulic consultants inc.	DATE:	BY:	CHK:
PROJECT:		JOB NUMBER:	
SUBJECT:			SCALE:

NOTES:
1. DEBRIS WILL BE PARTIALLY REMOVED FROM OBSTRUCTIONS ON TROUT CREEK AND FULLY REMOVED ON SECONDARY CHANNEL
2. DISPOSE OF WOODY DEBRIS BY SCATTERING ON FLOODPLAIN
3. WORK TO BE PERFORMED BY HAND CREWS - NO EQUIPMENT ACCESS



TYPICAL SECTION
WOODY DEBRIS REMOVAL
TROUT CREEK CHANNEL
(NTS)



TYPICAL SECTION
WOODY DEBRIS REMOVAL
SECONDARY CHANNEL
(NTS)

APPENDIX B

Photo Points and Supplemental Photos

northwest hydraulic consultants

Legend

Photo Monitoring Stations

Survey Cross Sections

SCALE - 1:800

0 25 50 75 100 ft

N

DATA SOURCES: Google Earth

Job: 600035

JANUARY 2014

Locations of Photo Points

UPPPER TRUCKEE MARSH SEWER FACILITIES

ADAPTIVE MANAGEMENT PLAN

2017 ANNUAL REPORT

APPENDIX B

2014-2017 PHOTO MONITORING

UTMSFPP Adaptive Management Plan

Photo Point 1 – Looking SW across right overbank

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP PHOTO MONITORING

UTMSFPP Adaptive Management Plan

Photo Point 2 – Looking SW across right overbank

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP Adaptive Management Plan

Photo Point 3 – Looking SW across right overbank in avulsion area; LBO-1 at middle far right of view, FH-5A in foreground

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP Adaptive Management Plan

Photo Point 4 – Looking SW across right overbank in avulsion area; FH-3 at lower right

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP Adaptive Management Plan

Photo Point 5 – Looking SW across right overbank at downstream end of avulsion area

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP Adaptive Management Plan

Photo Point 6 – Looking SW across marsh towards Trout Creek, near downstream end of project area near Bellevue Avenue

Upper Left – Oct 2017

Upper Right – Oct 2015

Lower Left – Oct 2014

UTMSFPP Photo Monitoring
Updated: 28-Sep-18
Folder location: \6001103_TroutCreek_Year2\Images\2017.10.05&06

Abbreviations

PP#x	Photo Point
H-x	Hummock
FH-x	Fill Hummock
PC-x	Pilot Channel
LBO-x	Left Bank Opening
PCL-x	Planted Coir Log
RBP-x	Right Bank Plug

Left and Right are referenced looking downstream

Number	2017 Photo	Description	2016 Photo	Description	2015 Photo	Description
1	IMG_20171005_165345.jpg	PP1	IMG_20161126_144325.jpg	PP1	IMG_2320.JPG	Photo Point #1, looking SW across right overbank; LBO-5 center left.
2	IMG_20171005_165453.jpg	PP1	IMG_20161126_144327.jpg	PP1	IMG_2321.JPG	same as above
3	IMG_20171005_165457.jpg	PP1	IMG_20161126_144329.jpg	PP1	IMG_2322.JPG	same as above
4	IMG_20171005_165500.jpg	PP1	IMG_20161126_144331.jpg	PP1		
5	IMG_20171005_165502.jpg	PP1	IMG_20161126_144333.jpg	PP1		
6	IMG_20171005_165506.jpg	PP1	IMG_20161126_144334.jpg	PP1		
7	IMG_20171005_165329.jpg	PP2	IMG_20161126_144131.jpg	PP2	IMG_2323.JPG	Photo Point #2, View looking SW across right overbank.
8	IMG_20171005_165336.jpg	PP2	IMG_20161126_144133.jpg	PP2	IMG_2324.JPG	same as above
9	IMG_20171005_165338.jpg	PP2	IMG_20161126_144134.jpg	PP2	IMG_2325.JPG	same as above
10	IMG_20171005_165339.jpg	PP2	IMG_20161126_144136.jpg	PP2	IMG_2326.JPG	same as above
11	IMG_20171005_165345.jpg	PP2	IMG_20161126_144139.jpg	PP2		
12			IMG_20161126_143744.jpg	PP3	IMG_2327.JPG	Photo Point #3, looking SW across right overbank in avulsion area; LBO-1 at middle far right of view.
13	IMG_20171005_164218.jpg	PP3	IMG_20161126_143745.jpg	PP3	IMG_2328.JPG	same as above
14	IMG_20171005_164220.jpg	PP3	IMG_20161126_143746.jpg	PP3	IMG_2329.JPG	same as above
15	IMG_20171005_164224.jpg	PP3	IMG_20161126_143747.jpg	PP3	IMG_2330.JPG	same as above
16	IMG_20171005_164228.jpg	PP3	IMG_20161126_143748.jpg	PP3	IMG_2331.JPG	same as above
17			IMG_20161126_143749.jpg	PP3		
18	IMG_20171005_164011.jpg	PP4	IMG_20161126_143551.jpg	PP4	IMG_2332.JPG	Photo Point #4, looking looking SW across right overbank in avulsion area; FH-3 at lower right of view
19	IMG_20171005_164014.jpg	PP4	IMG_20161126_143553.jpg	PP4	IMG_2333.JPG	same as above
20	IMG_20171005_164017.jpg	PP4	IMG_20161126_143554.jpg	PP4	IMG_2334.JPG	same as above
21	IMG_20171005_164020.jpg	PP4	IMG_20161126_143556.jpg	PP4	IMG_2335.JPG	same as above
22	IMG_20171005_164028.jpg	PP4	IMG_20161126_143557.jpg	PP4		
23	IMG_20171005_164030.jpg	PP4	IMG_20161126_143558.jpg	PP4		
24	IMG_20171005_163757.jpg	PP5	IMG_20161126_142814.jpg	PP5	IMG_2336.JPG	Photo Point #5, looking SW across right overbank at downstream end of avulsion area
25	IMG_20171005_163802.jpg	PP5	IMG_20161126_142816.jpg	PP5	IMG_2337.JPG	same as above
26	IMG_20171005_163806.jpg	PP5	IMG_20161126_142817.jpg	PP5	IMG_2338.JPG	same as above
27	IMG_20171005_163808.jpg	PP5	IMG_20161126_142819.jpg	PP5	IMG_2339.JPG	same as above
28	IMG_20171005_163810.jpg	PP5	IMG_20161126_142821.jpg	PP5		
29			IMG_20161126_142822.jpg	PP5		
30	IMG_20171005_165453.jpg	PP6	IMG_20161126_142424.jpg	PP6	IMG_2340.JPG	Photo Point #6, looking SW across marsh toward Trout Creek, near downstream end of project area near Bellevue Avenue .
31	IMG_20171005_165450.jpg	PP6	IMG_20161126_142428.jpg	PP6	IMG_2341.JPG	same as above
32	IMG_20171005_165455.jpg	PP6	IMG_20161126_142433.jpg	PP6	IMG_2342.JPG	same as above
33					IMG_2343.JPG	same as above
34					IMG_2344.JPG	same as above
35					IMG_2345.JPG	same as above
36					IMG_2346.JPG	same as above

Upper Truckee Marsh Sewer Facilities Protection Plan (UTMSFPP)

Selected June 2018 Photos

Easement Near Bellevue Pump Station (white stakes are at MH

BV17)

Very low flow adjacent to easement (<1 cfs downstream of pilot channel inlets)

Looking downstream towards Bellevue in swale. Easement along right side of photo outside of low flow swale

Main pilot channel flow near discharge to pre-avulsion Trout Creek channel

Pilot Channel 3 looking upstream towards inlet

Pilot Channel 3 inlet with flow deflector

Easement between BV 20 and BV19 looking downstream; CTC parcel on right

Hummock constructed in Y3 near BV 19

Persistent inundation due to beavers near upstream end of hummock between BV 21 and BV 22

Auxiliary beaver dam blocking return flow from inundation area to creek near BV22

Beaver dam on main channel showing accumulation of sand behind dam, looking downstream

Beaver dam on main channel looking upstream

Sand nearly filling main Trout Creek channel upstream of two beaver dams

Sand in main channel upstream of bend to right near head of secondary channel

Sand in secondary channel near head due to beaver dams downstream