Final Report

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Prickly Pear Creek
Channel Stability Analysis and Engineering Design Report
Former East Helena Smelter Facility
East Helena, Montana

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1 INTRODUCTION

This Channel Stability Analysis and Engineering Design Report presents findings and recommendations of studies completed to support the Prickly Pear Creek (PPC) realignment project. The purpose of this report is to describe the preliminary engineering criteria developed for the realignment of PPC at the Former East Helena Smelter Facility near East Helena, Montana (Figure 1). This work was performed as part of the South Plant Hydraulic Control Interim Measure (SPHC IM), described in detail in the *Interim Measures Work Plan* (IM Work Plan) (METG, 2012a).

Chapters in this report detail the following:

- Existing Channel Geomorphology
- Hydrology
- Existing Channel Hydraulics
- Existing Conditions Sediment Transport and Channel Stability
- Supplemental Investigations
- Proposed Design Criteria
- PPC Realignment Conceptual Design (30% Preliminary Design)

This report includes calculation summaries that contain the previously completed detailed analyses (included as appendices to support each section), and conceptual-level (30% preliminary design) drawings and details developed to date.

1.1 *Project Location*

The project is located near and around the East Helena Smelter site in East Helena Montana (Figure 1). The project area includes the PPC corridor from the Kleffner Ranch boundary, northward through Upper and Lower Lakes, and terminates at the north end of the slag pile near U.S. Highway (Hwy) 12.

1.2 *Summary of South Plant Hydraulic Control Interim Measures*

The intent of the SPHC IM is to reduce the migration of contaminants in groundwater by modifying the hydraulic regime at the south end of the former American Smelting And Refining COmpany (ASARCO) East Helena Smelter Site. This modification will reduce both the mass and rate of inorganic contaminants (primary arsenic and selenium) contributed to groundwater leaving the former smelter site. The primary components of the SPHC IM are as follows (METG, 2012a):

- Construction of prefabricated bridge decking on Smelter Dam.
- Construction of a temporary PPC bypass to route creek flow away from the south portion of the former Smelter site and allow the Upper and Lower Lakes to drain.

- Removal of Smelter Dam.
- Relocation or decommissioning of utilities on the east bench east of PPC.
- Realignment of PPC to areas of the east bench potentially farther east of its current location.

The artificially elevated surface water from Upper Lake, Lower Lake, and PPC recharges and drives groundwater flow paths that significantly alter the existing hydraulic configuration at the site. This artificially elevated groundwater contacts more contaminated soils beneath the site than it would under natural conditions and contributes to contaminant transport via the groundwater. The SPHC IM components will reduce that recharge and lower groundwater elevations at the south end of the site, which will help achieve key cleanup goals of reducing groundwater/ contaminated soil interaction as well as reducing groundwater flow velocities and, in turn, will reduce contaminant export at the northern, down-gradient boundary of the site.

As stated in the IM Work Plan (METG, 2012a), measures incorporated in the SPHC IM include removal of bypass channel construction and PPC Realignment. A separate series of source control IMs includes the removal of Tito Park and Lower Lake, and regrading of Upper Lake. These source control IMs significantly affect the design and construction of the PPC realignment and thus must be fully coordinated with the SPHC IMs. The sections below summarize the various IM components that provide context for the PPC realignment design.

1.2.1 Prickly Pear Creek Bypass Channel

From approximately 1,000 feet (ft) upstream of Upper Lake Diversion to the toe of Smelter Dam, PPC will be routed through a bypass channel to dewater Upper Lake, Tito Park, and Lower Lake, and facilitate permanent channel realignment construction. The PPC temporary bypass layout is shown on the preliminary design drawings (Appendix G). The bypass low-flow channel was designed to pass the 5-year flood event, and the overall floodway of the bypass will provide the hydraulic capacity to pass the 25-year flood event. The PPC temporary bypass design was completed previously and construction is planned for 2013 (CH2M HILL\MMI, 2012). The temporary bypass will allow construction of the other components of the SPHC IMs described in the sections below. The temporary bypass will remain in service until 2015 when PPC realignment is scheduled for completion at which time the temporary bypass will be taken out of service and reclaimed.

1.2.2 Removal of Tito Park, Lower Lake, and Regrading of Upper Lake (Source Control Interim Measures)

Source control IMs include the planned removal of at least portions of Tito Park and Lower Lake and regrading of Upper Lake. This work will be integrated with the SPHC IM to incorporate PPC channel design with floodplain reconstruction. The anticipation is that removal of Tito Park, Lower Lake, and the open water of Upper Lake could increase potential wetland acreage in the system by up to 25 acres, which is expected to offset or provide mitigation for wetlands lost because of dewatering the upper lake and realigning PPC.

1.2.3 Smelter Dam Removal

Following the diversion of PPC flow into the bypass, the Upper Lake diversion structure will be demolished and removed and the Upper Lake dam breached to facilitate dewatering of the South Plant area. Removal of Smelter Dam will eliminate flow and sediment transport discontinuities through the project reach, and will remove a major fish passage barrier from the site.

Hydrometrics previously completed an inspection of Smelter Dam (also known as East Entrance Dam) and recorded the data in the East Entrance Dam Engineers Inspection Report (Hydrometrics, 2012). According to the report, Smelter Dam is a reinforced concrete structure, 21-ft high and about 60-ft long, comprising three bays, each nominally 20-ft wide. The two western bays are configured as a weir overflow spillway and the eastern bay is a solid concrete wall with two 36-inch, lower-level outlet gates. The bays are separated by upstream and downstream counterforts, which also serve as bridge supports. There are no known design documents for the dam's original construction. Smelter Dam will be removed during construction of the PPC realignment. The Custodial Trust will maintain the dam until the PPC realignment is constructed to serve in a contingency role for PPC flow management should spring runoff exceed the PPC temporary bypass capacity.

1.2.4 Bridge Construction at Smelter Dam

The current bridge structure over Smelter Dam is in disrepair and is not safe for vehicle passage. To provide construction vehicle access between the former Smelter site and the work areas east of PPC, the existing bridge supports through the spillway section, bridge beams, and decking on Smelter Dam will be removed and a new vehicle bridge structure installed. This work will help prepare for both the evapotranspiration (ET) Cover System IM and construction of the on-site Construction Area Management Units (CAMU). Simultaneously, following the recommendations in the Dam Inspection Report (Hydrometrics, 2012), riprap can be installed on the upstream and downstream faces of the spillway to increase resistance to erosion. Once the dam is demolished, the plan is to move the bridge structure and install it in a new haul road location (to be determined during PPC realignment detailed engineering).

1.2.5 Prickly Pear Creek Realignment

The goal of the permanent realignment of PPC, which is the focus of this document, is to regrade and rehabilitate two segments of PPC. The upper segment, considered the "South Realignment Segment," is currently 3,000-ft long and flowing closely along the eastern valley margin to Smelter Dam (STA 60+00 to 30+00). The second segment, referred to as the "North Realignment Segment," is a ~2,000-ft segment below Smelter Dam, where the channel intermittently has eroded into the slag pile (STA 30+00 to 10+00). The discussion information and analyses in the next section is pertinent to developing the design and engineering criteria needed to prepare the detailed engineering plans and specifications for the PPC realignment project.

1.3 *Prickly Pear Creek Alignment Design Process*

The PPC alignment design is part of a much larger and very complex project and must, therefore, be fully coordinated with other actions taking place concurrently or that rely on the outcomes of the realignment project. Design of stream channels and floodplains is itself an iterative process that relies on weighing complex factors including risk, engineering principles, cost, natural resource values, and other considerations. Figure 2 illustrates the design process for the PPC realignment design.

The goals/objectives developed at the team chartering meeting state that the PPC realignment project should:

1. Support the implementation of the cleanup management strategy for the East Helena Smelter RCRA site.
2. Reduce groundwater levels beneath the site as part of the overall SPHC Interim Measure.
3. Facilitate stabilization of the slag pile.
4. Provide habitat restoration and/or replacement as needed to comply with natural resource (NR) protection permitting requirements for remediation work.
5. Serve as a source of materials for use in other IM construction actions (such as ET Cover).
6. Facilitate elimination of the HDS Plant discharge to PPC (through negotiated modification of the plant MPDES discharge location).

The primary design criteria for the PPC realignment address the goals/objectives stated above to ensure protection of human health and the environment. These primary criteria include the following:

- Modify the hydraulic regime at the site to reduce the mass and rate of contaminant transport away from the site.
- Realign PPC to support the modification of groundwater paths.
- Realign PPC to prevent entrainment of slag materials into the creek.

Secondary design criteria support the development of a process-based realignment design (the application of fluvial geomorphologic processes such as sediment transport and deformable boundaries in the design practice) for the stream and its bounding floodplain. These criteria include the following:

- The design discharge (bankfull hydraulic capacity) should be the dominant or bankfull discharge for PPC.
- The bankfull channel should be competent to transport the estimated incoming sediment load without reach-scale aggradation.
- The stream bed should be vertically stable at the scale of the entire project reach.
- The channel should be designed with a meandering planform and deformable banks where geomorphically appropriate and incorporate pool, riffle, and run sequences.

- Floodplains should incorporate wetlands where hydrologically feasible and geomorphically stable; Grade controls and/or non-deformable bank treatments should be used where vertical stability and/or horizontal stability is required for the protection of infrastructure, buildings or contaminated materials.
- Riparian vegetation should consist of native species suitable for the hydrologic and climatic regimes at the project site.
- Deformable bank treatments should allow for some undercutting.
- Deformable bank treatments should incorporate woody vegetation.
- Fish Passage should provide upstream passage for adult native species and downstream passage for all salmonid age classes.

The design criteria provide a framework for developing design parameter values, referred to as engineering criteria. The engineering criteria addressed within this document include the following:

- Bankfull discharge
- Channel slope
- Channel width to depth ratios
- Channel cross-section dimensions
- Channel planform
- Bed material gradations
- Infrastructure protection
- Bank construction
- Bank revegetation
- Generalized floodplain slope and grading
- Instream habitat
- Fish passage

This document summarizes existing conditions related to channel morphology and substrate, as these data provide context and baseline information used to develop channel design parameters; and presents individual subsections listing proposed engineering criteria related to bankfull discharge, bank treatments, wetland and floodplain design, revegetation, instream habitat, fish passage, and infrastructure protection. The calculation briefs describing the watershed hydrology, existing conditions hydraulics, and existing conditions channel stability (Appendix A, B and C) form the foundation for the criteria developed in the Engineering Criteria Summary (Appendix D). This report summarizes the results from these calculation briefs, presents the key results from those analyses, and presents the 30 percent conceptual level design for the project.

2 EXISTING CHANNEL GEOMORPHOLOGY

2.1 *Geomorphic and Geologic Setting*

Prickly Pear Creek originates in the Elkhorn Mountains approximately 20 miles south of Helena, Montana. The creek flows northerly through a snowmelt-dominated watershed, entering the Helena Valley just upstream of the project site and continuing northward to its terminus at Lake Helena. The watershed area upstream of the former Smelter site is approximately 252 square miles. The primary geology of the upper watershed is the Butte Quartz Monzonite, which tends to naturally contribute large volumes of sand to receiving stream channels (Figure 3). As the creek approaches the Helena Valley, it leaves the monzonites known as the Boulder Batholith and flows through a series of Proterozoic-age Belt Supergroup Rocks and Paleozoic sedimentary rocks (Reynolds and Brandt, 2005). The geologic units bounding the stream channel become increasingly younger as the stream flows northward; about 2 miles south of the project area the begins to widen as it encounters Tertiary (Oligocene)-age sedimentary rocks that form sloping surfaces on the valley margin. Inset within these units, Quaternary sedimentary units bound the modern alluvial valley. These Quaternary sediments, mapped as Qac (Figure 3), are alluvial/colluvial deposits that are commonly referred to as the "east bench" and "west bench."

As PPC flows northward from its confined headwaters environment into the Helena Valley, lateral confinement is reduced, the valley gradient flattens, and the geomorphology of the creek and its floodplain changes in response. Coming into the valley, the floodplain area bounding the creek increases and multiple channel threads are common as the creek becomes increasingly depositional, forming an alluvial fan (Streamworks, 1984). This alluvial fan landform on PPC is most evident with respect to a series of mapped distributary channels emanating northward from East Helena towards Lake Helena. Figure 4 shows distributary channels digitized as part of a Channel Migration Zone mapping effort on PPC north of the project site (DTM and AGI, 2011).

The project area is located on the uppermost portion of the fan where valley confinement drops as the creek flows into the Helena Valley. The fan is bounded by Quaternary alluvial terraces that are inset within Oligocene-age sedimentary rocks of the Spokane Bench. The location of the project area on the fan surface suggests that it will be prone to sediment deposition on a landscape scale.

In addition to natural sediment sources, sediment loading to the reach has also contributed to PPC because of the relics of historic placer mining, as gravel tailings piles commonly line the stream banks (USEPA, 2004). Gold mining began in the Prickly Pear watershed in the 1860s, and remained intensive into the 20th Century. It is estimated that over 60 percent of PPC has been subjected to stream channelization and dredging (USEPA, 2004). The dredging history on PPC is described on a geologic road sign as follows:

> *"A gold dredge chewed through the gravels of Prickly Pear Creek beginning in 1938. Mounted on a barge floating on a 30-foot deep pond, the machinery consisted of a chain of buckets that dumped the gravel on a maze of screens and sluices inside the dredge. In its wake, the dredge left behind a "churned up" landscape. In some places scrub brush*

> *holding the gravel piles together is still the only vegetation. Although the dredge shut down permanently in the mid-1960's, it was not until the early 1970's that a South American mining company purchased it and moved it to Bolivia."*
> (http://www.mdt.mt.gov/travinfo/docs/roadsigns/elkhorn.pdf)

There is no evidence of placer mining on PPC within the project reach itself; however, instream placer mining did occur within a few miles of the project reach (METG, 2012b).

2.2 *Project Reaches*

This section summarizes PPC geomorphology, provides a brief site overview, and presents specific existing conditions data used to develop design parameters. The information is largely compiled from a topographic survey and a supporting field assessment performed in October/ November of 2011. This 2011 assessment consisted of topographic surveying of channel cross sections and profiles, and an inventory of geomorphologic features related to bed morphology, riparian conditions, and channel substrate. The results are summarized in an Existing Conditions Stream Assessment Report (METG, 2012b). The assessment extended from Hwy 12 (Station 0+00) upstream to station 110+00, approximately 1 mile upstream of the project area (Figure 5).

In order to capture the variability of stream conditions throughout the project, the creek was divided into six reaches based on trends in channel slope, cross section, pattern, and substrate (Figure 5) (METG, 2012b). These geomorphically-based reach segments range in length from 900 ft to 3,050 ft in length.

The segment of PPC to be realigned extends from approximately Station 10+00 to Station 60+00. This encompasses the upper 2,000 ft of Reach 1, the entire 2,050-ft length of Reach 2, and the entire 900-ft length of Reach 3. The realignment segment included Smelter Dam at the Reach 1/2 boundary, and the Upper Lake diversion site at the Reach 2/3 boundary (Figure 5).

For clarification, the term "dynamic" refers to morphologic adjustment of the stream channel that does not imply geomorphic instability. A dynamic channel is deformable and may migrate across its floodplain without destabilizing (changing overall profile or cross-section morphology). Similarly, the term "stable banks" indicates bank integrity and overall erosion resistance, but does not necessarily mean non-deformability under all flow conditions.

2.2.1 Reach 1: Highway 12 to Smelter Dam (STA 0+00 to 30+50)

Reach 1 extends 3,050 ft upstream from Hwy 12, ending at Smelter Dam (Figure 5 and Figure 6). Within Reach 1, PPC is relatively straight and steep, locally following the margin of slag piles on the former Smelter site (Photo 1 through Photo 4). Instream habitat units consist primarily of steep run environments. Floodplain access is severely limited due to confinement by the slag pile on the west and the Holocene-age alluvial terrace on the east (Figure 6). The reach was channelized prior to 1955 and relocated to the eastern margin of the stream corridor (METG, 2012b). Since 1955, PPC has migrated into the slag pile at four main sites. At three of these sites, the stream migrated approximately 20-30 ft into the slag pile. At one site (Station

20+00), the creek has eroded approximately 60-80 ft into the slag since 1955 (METG, 2012b). To the east, the right bank is locally eroding into the coarse boulder alluvium of the bounding Holocene terrace. The sediment gradation in Reach 1 ranges from rounded, native boulders derived from the Quaternary alluvial/colluvial bench ("east bench") to dense, slag fragments to arkosic sand derived from quartz monzonite in the PPC headwaters. Woody vegetation is relatively dense, consisting primarily of willows. Reach 1 is a Rosgen B2/B3 channel type (Rosgen 1996).

Prickly Pear Creek will be realigned along approximately 2,000 ft of Reach 1, extending from Smelter Dam down to Station 10+00 near the northern end of the slag pile where the channel makes an abrupt turn west to parallel the railroad grade. The lower ~1,000 ft of Reach 1 paralleling the railroad grade will not be realigned because it is located in the BNSF railroad right-of-way.

2.2.2 Reach 2: Smelter Dam to Upper Lake Diversion (Sta 30+50 to 51+00)

Reach 2 begins at Smelter Dam, which holds approximately 9 ft of grade on PPC (Figure 5 and Photo 5). From the dam upstream to the Upper Lake diversion, Reach 2 has a flat slope and is backwatered (Photo 6). The primary substrate is sand and overhanging banks are common (METG, 2012b). Similar to Reach 1, this channel segment was relocated prior to 1955 to the east side of the valley. The location and straight course of Reach 2 has been consistent since 1955 (Figure 7). Reach 2 has dense, bankline vegetation stands of both willow and alder. Reach 2 is classified as an F5 channel type.

In the project, Reach 2 will be realigned along its entire length.

2.2.3 Reach 3: Upper Lake Diversion to Sta 60+00 (Sta 51+00 to 60+00)

Reach 3 extends from Upper Lake diversion upstream for approximately 900 ft. Reach 3 marks a transition zone from areas affected by Smelter Dam and Upper Lake diversion to unimpacted areas upstream. Reach 3 also marks the upper limit of the project reach. In this reach, banks are largely stable and bank undercutting is common. A comparison of 1955 and 2008 imagery shows that the uppermost portion of Reach 3 has been characterized by active point bar development and bendway formation (Figure 8). Woody, bankline vegetation is most prominent on the left bank (Photo 7), and woody debris aggregates are common. Reach 3 is a C3 channel type (Rosgen, 1996).

In the project, Reach 3 will be realigned along its entire length.

2.2.4 Reach 4: Sta 60+00 to Lower Kleffner Ranch (Sta 60+00 to 78+50)

In Reach 4, bankline vegetation density is notably low. Cobble is the primary bed material, and bank undercutting is fairly common (Figure 9, Photo 8). This is the most sinuous reach in the project area, with a channel-length-to-valley-distance ratio of 1.35. Reach 4 was identified in the field as a potential design analog. The identification of Reach 4 as a reference is based on field indications that the reach appears to maintain sediment transport capacities that are in balance with the overall sediment supply. It is a C3 channel type. For example, riffles sampled in late 2011 (METG, 2012b) were unarmored and mobile, yet there was no evidence of excess channel deposition in the reach that would indicate insufficient transport energy. There were no indications of channel incision such as headcuts, knickpoints, bed armoring, or pervasive bank failure that would reflect excess transport energy.

However, Reach 4 does have some limitations as a reference. Planform complexity and woody riparian vegetation densities are low, and the reach has been impacted by historic influences of upstream placer mining and channelization. Reach 4 therefore provides an example of a reach that, although impacted, displays field indicators of having maintained a state of dynamic equilibrium with current hydrologic and sediment inputs. Reach 4 is also immediately upstream of the realigned channel, such that it forms the approach into the project.

2.2.5 Reach 5 Lower Kleffner Ranch to Upper Kleffner Ranch (Sta 82+00 to 95+00)

Reach 5 consists of a split flow segment that is locally armored through Kleffner Ranch. The reach was channelized sometime around the early 1950s (Figure 10). The reach may have been channelized in an effort to address historic sediment loading from upstream mining activities. Currently, the reach is characterized by some instability through split flow areas and very high bar deposits that grew substantially during spring runoff 2011 (Photo 9). Woody vegetation density is relatively low, as is pool frequency. Cottonwood trees are common in Reach 5, and beavers have aggressively foraged the cottonwood. It is a B3/C3 channel type. The extent of bank armor in Reach 5 likely reflects lateral instability induced by the channelization.

Reach 5 is not part of the PPC Realignment Project.

2.2.6 Reach 6: Upper Kleffner Ranch to Sta 111+00 (Sta 95+00 to 111+00)

Above Kleffner Ranch, Reach 6 is upstream of the head of the PPC alluvial fan, where confinement is still relatively high and the channel is straight and coarse grained. Bedrock is commonly exposed in the bank, and residual pool depths against the erosion-resistant bedrock are high (Figure 11 and Photo 10). Bed material in Reach 6 consists of coarse boulders and cobble, and is a B2/B3 channel type. Several large, woody debris jams are present in the reach, and woody vegetation consists primarily of alder. The stream corridor is bounded by an active rail line in Reach 6 that is locally armored and locally underlain by bedrock.

Reach 6 is not part of the PPC Realignment Project.

2.3 *Channel Morphology*

An existing assessment summarized the morphology of each reach in terms of the cross sections that are inundated at a bankfull flow event. Table 1 summarizes the reach-averaged summary data from this assessment used to help develop the engineering criteria. The morphologic parameters of mean bankfull depth, top width, and width-to-depth ratio were derived from the field survey data without hydraulic analysis. Ranges and mean values for morphological parameters are plotted in Figure 12. Existing conditions bankfull top widths range from 34 to 44 ft, and mean depths are typically on the order of 1.5 to 2 ft (Figure 13). Width-to-depth ratios are less than 30 for each reach (Figure 14). Mean width-to-depth ratios for each reach are less than 30. Table 1 summarizes the key geomorphic parameters for the PPC existing conditions.

Table 1 Summary of Geomorphic Parameters (Mean Reach Values) For Existing Condition (METG, 2012b).

Parameter Type		**Reach**					
		1	**2**	**3**	**4**	**5**	**6**
General	Number of Cross Sections	30	19	9	20	16	14
	Length (ft)	3050	2050	900	1850	1650	1600
	Average Channel Slope (%)	0.87	0.29	0.28	0.51	0.55	0.46
	Sinuosity	1.1	1.1	1.0	1.4	1.3	1.3
Cross Section Morphology	Mean Depth (ft)	1.82	1.68	2.14	1.5	1.99	2
	Maximum Depth (ft)	2.9	2.8	3.4	2.5	3.1	3.1
	Top Width (ft)	33.8	39.0	43.8	43.2	34.1	42.4
	Width/Depth	18.6	23.2	20.5	28.8	17.1	21.2
Riffle Substrate	D16 (mm)	3	---	---	29	3	---
	D50 (mm)	63	---	---	51	46	---
	D84 (mm)	140	---	---	75	80	---
	Mean Residual Pool Depth (ft)	1.8	1.7	2	2.5	2.5	2.6
	Pool Density (pools/mile)	10.4	15.5	29.3	20	6.4	13.2
	Riffle Spacing (riffles/mile)	22.5	12.9	29.3	28.5	19.2	16.5

2.4 *Channel Profile*

Figure 15 shows a plot of the PPC channel profile. Just upstream of the realignment section, Reach 4 has a channel slope of 0.51%. At Station 60+00, which is the start of the South Realignment segment, the gradient flattens to 0.28% to the Upper Lake Diversion, which creates an abrupt ~4-ft drop in the channel profile. From Upper Lake Diversion to Smelter Dam, the bed slope remains relatively flat at 0.29% to the Smelter Dam Crest, which holds approximately 13 ft of grade. Below the dam, PPC maintains a constant average slope of ~0.87% for 3,000 ft as it closely follows the slag pile before turning west to follow the rail grade towards the Hwy 12 bridge crossing at Station 0+00.

2.5 *Channel Substrate*

Bed materials within the project reach were characterized from pebble counts and bulk sampling sieve analysis. Channel bed materials include coarse gravel/cobble riffle crests that contribute to bed stability and bedform complexity. Point bars typically consist of a gravel/cobble surficial layer overlying poorly sorted sands, gravels, and cobbles.

Pebble counts were collected in riffle crests in Reaches 1, 4, and 5 as part of the 2011 assessment (METG, 2012b). The pebble count data show that the riffle D50 value ranges from 46 millimeters (mm) to 51 mm in Reaches 4 and 5, with notable coarsening downstream in Reach 1 (Table 2). More significant is the very coarse D84 value in Reach 1 (140 mm), which reflects coarse sediment inputs in this reach from the terrace on the east side of the channel and the slag pile from the west side of the channel (METG, 2012b).

Table 2. Pebble Count Gradation Summary.

Reach	Sample ID	Station (ft)	D16 (mm)	D50 (mm)	D84 (mm)	Dominant Particle Sizes
1	Reach 1 (Riffle)	15+00	3	63	140	Coarse gravel\Cobble
4	Reach 4 (Riffle)	64+00	29	51	72	Coarse gravel\Cobble
4	Reach 4 (Riffle)	75+00	28	51	79	Coarse gravel\Cobble
5	Reach 5 (Riffle)	85+75	3	46	80	Coarse gravel\Cobble
4 & 5	Reach 4&5 Ave		20	50	77	Coarse gravel\Cobble

To better quantify incoming sediment load, the 2011 assessment collected and analyzed a bulk sediment sample from a point bar in Reach 4 at Station 75+00 that was deposited during the 2011 flood (METG, 2012b). Table 3 shows the results of that gradation analysis. **Error! Reference source not found.** shows the plotted gradation curves for all the samples. The curves show the finer sediment representation in the bulk samples, which contain on the order of 20% sand and finer sediment.

Table 3. Sand and Gravel Bulk Gradation Data, Reach 4 Reference Site 1.

Sieve Size	Sieve Opening (mm)	Sample ID			Average
		TP-01 0-18	TP-01 18-24	TP-02 0-18	
		% Finer	% Finer	% Finer	% Finer
5	127	100		100	100
4	101.6	97		96	97
3	76.2	89	100	93	94
2	50.8	79	97	83	86
1.5	38.1	73	91	71	78
1	25.4	62	82	60	68
0.75	19.05	55	74	51	60
0.5	12.7	44	61	41	49
0.375	9.525	40	55	37	44
#4	4.75	33	42	30	35
#10	2	23	27	20	23
#20	0.85	11	8	8	9
#40	0.425	5	2	3	3
#60	0.25	3	1	1	2
#100	0.15	2	0.0	1	1
#200	0.075	1	0.3	0.3	1

3 HYDROLOGY

Basin hydrology estimates are needed to develop the channel and floodplain design. This section summarizes the results of the analyses completed previously and summarized in the Hydrology Calculation Summary in Appendix A. The completed hydrologic analyses data helped develop the basin hydrologic estimates including the following:

- Supplementing the flood frequency analysis for the project site as necessary to support channel realignment and functional floodplain design.
- Developing a flow-duration curve for the project site.
- Developing hydrologic calculations and interpretations to support bankfull discharge estimates.

The flood frequency analysis data will be used to help design the stream channel, banks, floodplain, and infrastructure armor following the Smelter Dam removal and excavation of sediments from behind the dam. The flow-duration curves established herein will be used in fish passage, sediment transport, and channel stability analyses. The bankfull estimates will help guide development of suitable channel size and main channel design criteria.

3.1 *Prickly Pear Creek Watershed Description and Gauging Network*

The PPC lies in a snowmelt-dominated watershed that flows in a northerly direction, from the Elkhorn Mountains into the Helena Valley passing through East Helena prior to discharging into Lake Helena. Elevations in the watershed range from 9,381 ft. to 3,651 ft. The drainage area at the project site is approximately 252 square miles (Appendix A).

The U.S. Geological Survey (USGS) maintains an active stream gaging station on PPC near Clancy, MT (USGS 06061500). The Clancy gage (or near-Clancy gage) is located approximately 5.3 miles upstream from the site. Between the Clancy gage and the site are several perennial tributaries that contribute flow to PPC.

The Montana Department of Natural Resources (DNRC) and the Helena Water Quality District (HWQD) conduct seasonal stream flow monitoring on PPC at various locations between the Kleffner Ranch and Lake Helena. Kleffner Ranch is located approximately 4,500 ft. upstream of Upper Lake.

3.2 *Flood Frequency Analysis*

The flood frequency analysis will help design the stream channel, banks, floodplain, and infrastructure armor following the Smelter Dam removal and excavation of impacted sediments.

3.2.1 Methods

Peak flows for select recurrence intervals were estimated using two methods:

- Bulletin #17B, Evaluation of Gage Records using the methods described in *Guidelines for Determining Flood Flow Frequency* (U.S. Department of the Interior, 1981). The calculations were performed using the USGS PEAK FQ software; and
- Regional Regression Equations.

3.2.1.1 Peak Flood Estimation – Bulletin #17B Analysis

Flood frequency estimates at the site were estimated by transferring the Bulletin #17B results from the PPC analysis near the Clancy station (based on annual, instantaneous peak-flow gage records) using a drainage-area ratio adjustment between the un-gaged site and the gaged site. The estimates were calculated for both the un-weighted and weighted results from the near-Clancy gage as described in the calculation summary (Appendix A).

3.2.1.2 Peak Flood Estimation – Regression Equations

To improve flood-frequency data at gaged sites, Bulletin #17B indicates that at-station flood frequency data can be weighted with estimated flood-frequency data from regional regression equations (USGS, 2004). The flow frequency characteristics at the PPC near-Clancy gage were weighted with the results from the regression analysis (USGS 2004) as described in the calculation summary (Appendix A).

Regression equations relating peak flows at un-gaged sites to basin characteristics, bankfull widths, and active channel widths were used as one of the methods to estimate flood peaks. Active width and bankfull widths for PPC at the project site were estimated from survey data and field observations. For the Southwest Region of Montana, the regression equation relied on drainage area (square miles) and percentage of the basin located above 6,000-ft elevation to predict estimated peak flood flows with recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years.

The method derived from the Bulletin 17B procedures (U.S. Department of the Interior, 1981) was used to estimate the peak flow with a 1.5-year recurrence interval from the regression equation relationships for the peak flows with a 2-year and 5-year recurrence interval as described in the calculation summary (Appendix A).

3.2.1.3 Stream Gage Data

USGS Gage 06061500 is located on PPC, 4 miles northeast of Clancy, MT. The gage is approximately 5.3 stream miles upstream from the PPC project area. The gage location is shown on Figure 1. Between the gage and the project site are five unnamed drainages and three named drainages (Clark Gulch, McClellan Creek, and Holmes Gulch), shown on USGS quad maps as either intermittent or perennial streams. The gage has been active on and off since 1908 with 70 water years of peak flow record.

3.2.2 Results

3.2.2.1 Bulletin #17B Estimates

Results for the flood frequency analysis conducted using the USGS PPC near-Clancy gage data are summarized in Table 4. Detailed calculation results are in Appendix A.

Table 4. PPC Peak Flow Estimates.

Method (Site)	Drainage Area (Sq. mi.)	Estimated Peak Flow (cfs)								
		Recurrence Interval (years)								
		1.5	2	5	10	25	50	100	200	500
Bulletin 17B Analysis of Gage Records 1911 - 1998 (Gage near Clancy) USGS 2004	189.1	186	247	428	577	813	1030	1280	1580	2060
Bulletin 17B Analysis of Gage Records 1911 - 2011 (Gage near Clancy)	189.1	197	254	435	590	829	1043	1291	1577	2024
USGS Regression Equations (Gage near Clancy)	189.1	247	331	579	799	1160	1490	1880	2330	3020
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Weighted	189.1	192	255	438	596	842	1063	1321	1618	2082
USGS Regression Equations (Project Site (Hwy 12)	251.9	481	611	966	1260	1710	2120	2580	3110	3930
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Adjusted to Site	251.9	252	327	542	723	999	1243	1523	1842	2338
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Weighted Adjusted to Site	251.9	252	328	545	730	1015	1268	1558	1890	2405
Flood Insurance Study Values 1908-1985(Project Site)	252			*680	890	*1250	1710	2190		3500

Sq. mi. = square mile
cfs = cubic feet per second.

As stated previously in the Methods section, the Bulletin #17B analysis conducted for the PPC near-Clancy gage was weighted and transferred downstream to the site using methods described in the USGS Water Resources Investigation Report 03-4308 (USGS, 2004).

Flood frequency analysis results developed for the Lewis and Clark County Flood Insurance Study (FIS) are also included in Table 4. The FIS estimates are based on hydrologic analysis conducted in 1985 using methods similar to those applied in this study.

3.2.2.2 Regional Regression Calculations

Detailed flood-flow estimate calculation results from the regional regression equations are in Appendix A and summarized in Table 4.

3.2.3 Discussion

Table 5 shows the proposed peak flow values and recurrence intervals selected for the PPC realignment design.

Table 5. PPC Realignment Design Peak Flows and Recurrence Intervals.

	Recurrence Interval (years)							
	1.5	**2**	**5**	**10**	**25**	**50**	**100**	**500**
Flow (cfs)	252	328	545	730	1015	1268	2190	3500

Appendix A contains an analysis of the accuracy of the various estimate methods. Given the long period of record used in the Bulletin 17B analysis, it is likely that peak flow estimates obtained for the gaging station near Clancy are more accurate than the results estimated from the regression equations.

The Bulletin #17B method estimates in this analysis are based on 70 years of data, which should produce credible flood frequency estimates up to a recurrence interval of 140 years. The greater accuracy of the Bulletin #17B-based estimates coupled with the long-gage record, support the selection of the Bulletin #17B estimates for use in the PPC realignment design.

Of the Bulletin #17B-based methods, the flood insurance study (FIS) estimates represent the largest peak flow estimates for a given recurrence interval. The FIS does not include flood frequency calculations, only methods and summary results. As part of the Federal Emergency Management Agency (FEMA) project permitting requirements, the project will use the FIS estimates for peak flows with the 100-year and 500-year recurrence intervals. The PPC channel realignment design will not use the 100-year or 500-year peak flows to develop channel geometry; therefore, no attempt was made to duplicate the FIS estimates for the purposes described in this report.

For the PPC realignment design, the weighted Bulletin #17B estimates adjusted to the site will be used for peak flow values for recurrence intervals less than 100 years. Peak flow estimates for recurrence intervals of 100 years and greater will use the FIS estimates to remain consistent with the FIS modeling and studies.

3.2.4 Other Considerations

A dam built by the Northern Pacific Railway Company exists on McClellan Creek, a PPC tributary upstream from the site. The Northern Pacific Railway Company built the dam to store water in winter to produce ice that was harvested and stored for summer usage. The dam sits on property currently owned by Ash Grove Cement in Montana City. The Northern Pacific dam has gates to control releases of water, but historically, Ash Grove operates the dam with the gates wide open so no water storage is accrued behind the dam. No significant impacts to PPC stream flow estimates are expected based on past or anticipated future operations of this dam.

In 2011 a causeway with culverts, constructed within the reservoir upstream of the dam, breached during a heavy runoff event. No damage to the dam was reported. The effect of this failure on the 2011 peak flow at the site is unknown. Given the relatively large dataset available, the effects of the failure on the flow estimates should not be significant.

3.3 ***Flow-Duration Curve***

3.3.1 Methods

The team constructed the flow-duration curve by sequencing the daily average flow series in decreasing order with each flow value being ranked (assigned an order number). For each flow value, the percent time was defined as the ratio of its order number to the total number of days. Plotting flow versus percent time created the duration curve.

The team estimated daily average flows at the site by developing an average flow ratio for a set of flow regimes between the PPC near-Clancy gage and the PPC at-Kleffner gage, then applied these average flow ratios to the PPC near-Clancy gage flow record to estimate a daily flow record at the site with the equivalent years of record as the PPC near-Clancy gage. A flow-duration curve was calculated, as described above, from this transferred flow record. Only the water years with complete data from July 1908 through October 2011 were used in the flow-duration curve calculations.

3.3.1.1 Stream Gage Data

Data sources available for this flow-duration analysis included the following:

- USGS Gage 06061500 PPC near Clancy (Active).
- USGS Gage 06062000 PPC at East Helena (Inactive).
- USGS Gage 06061900 McClellan Creek near East Helena (Inactive).
- DNRC data, PPC at the Kleffner Ranch.
- HWQD PPC Data:
  - PPC at Hwy 12.
  - PPC near Wylie Drive.
  - PPC at Canyon Ferry Drive.

Data from these sources were evaluated and selected for use in the analysis as described in Appendix A. The hydrographs indicated a relatively consistent relationship between the PPC Kleffner data and the PPC near-Clancy data, where 90% of the time flows at the Kleffner ranch were greater than or equal to the flows measured at the PPC near-Clancy gage. The correlation results combined with the hydrographs indicate that there is a relationship between the two gages within the binned flow data and support translation of the flow data using flow ratios. Therefore, the team used these data to develop a daily average flow ratio between the USGS PPC near-Clancy gage and the DNRC PPC at-Kleffner gage.

3.3.2 Results

Table 6 presents the results of the flow duration analysis described in Appendix A. The flow duration curve is in Figure 17. The flow increments shown in Table 6 are based on the anticipated flow increments to be used in the channel stability analysis to be completed in the future and presented as a separate analysis.

Table 6. Flow Duration Summary.

PPC Near Clancy				PPC at Project Site1		
Days In Record			26298	Days In Record		26298
Flow Range (cfs)	Days in Record	% of Record	Days per Year	Days in Record	% of Record	Days per Year
750+	11	0.04%	0.2	22	0.08%	0.3
400+-750	36	0.14%	0.5	116	0.44%	1.6
300+ -400	52	0.20%	0.7	289	1.10%	4.0
200-300	441	1.68%	6.1	524	1.99%	7.3
150-200	552	2.10%	7.7	890	3.38%	12.4
100-150	1478	5.62%	20.5	1458	5.54%	20.2
50-100	4047	15.39%	56.2	5841	22.21%	81.1
20-50	12595	47.89%	174.8	14279	54.30%	198.2
0-20	7086	26.95%	98.3	2879	10.95%	40.0
	26298	100%	365	26298	100%	365

3.3.3 Discussion

The flow-duration curve developed for the site is based on daily average flow data from the PPC near-Clancy gage, translated to the site using an average discharge ratio for each correlated data set or flow bin between the PPC at-Kleffner gage and the PPC near-Clancy gage. These results will be used to support sediment transport calculations in a subsequent Existing Condition Channel Stability analysis. While there is some variation in the flow relationships between the site and the Clancy gage (as discussed in the calculation summary), the variation is typically contained within the flow ranges used in the sediment transport analysis.

3.4 *Hydrology-Based Bankfull Discharge Estimate*

One method of estimating bankfull discharge or channel-forming discharge values uses empirical relationships between the bankfull discharge and a stream flow recurrence interval. Empirical studies indicate that for most streams the bankfull flow has a recurrence interval approximately equal to 1.5 years (Leopold, 1994). However, large variability in the recurrence interval can be associated with the bankfull discharge, which can have recurrence intervals ranging from 1 to 32 years (Hey, 1997). Therefore, other bankfull estimation methods tools will be used in addition to recurrence intervals. Flow frequency estimates developed in this analysis (Table 4**)** would place the bankfull discharge estimate in the range of 250-328 cfs, corresponding to a recurrence interval of 1.5 to 2 years.

Another method of estimating bankfull discharge is associated with flow-duration characteristics. Bankfull discharge in snowmelt-dominated basins typically occurs between 7 and 14 days per year (Wilkerson, 2008). Based on the flow-duration curve developed in this analysis, the 7-day duration approximately corresponds to a flow range of 200-300 cfs.

Lawlor (Lawlor, 2004) completed a detailed analysis of USGS gaging data at 41 sites in western Montana and proposed that the bankfull discharge was approximately 84% of the 2-year discharge, which is:

$$Q_{bf} = 0.84(328) = 276 \text{ cfs}$$

The bankfull discharge estimates developed here were also compared against the existing condition hydraulic model and the fluvial geomorphic indicators developed as part of the fluvial geomorphic analysis. The final selected bankfull flow estimate is documented in the Engineering Criteria technical memorandum (Appendix D) and in Section 7.1.

4 EXISTING CHANNEL HYDRAULICS

The calculation summary provided in Appendix B describes a hydraulic analysis of existing stream channel conditions. This hydraulic analysis of existing conditions includes the segment of PPC from the U.S. Hwy 12 Bridge and extends upstream approximately 2.06 miles (Figure 5). Results from the existing conditions model were used to:

- evaluate reach hydraulic conditions and to support the existing PPC channel bankfull capacity estimate;
- form the basis for the sediment transport analysis; and
- support the development of suitable design criteria for the PPC realignment.

This analysis focused on simulating the channel hydraulics for flows within the channel banks or slightly out of bank and does not replace the Existing Condition HEC- RAS model developed under the PPC Temporary Bypass flow modeling or in any way address project FEMA\CLOMAR requirements.

Results from the existing conditions model were used to evaluate reach-averaged hydraulic conditions in potential design analog reaches and to support the existing PPC channel bankfull capacity estimate. This model forms the basis for conducting the existing condition sediment transport analysis and support the development of suitable design criteria for the PPC realignment. Sediment transport and channel stability analyses conducted are described separately below.

4.1 *Method*

The modeling effort used the United States Army Corps of Engineers (USACE) Hydraulic Engineering Center River Analysis System (HEC-RAS) Version 4.1 computer program to simulate the existing conditions of the targeted segment of PPC. This software helped to develop a steady-state, one-dimensional, gradually varied flow model of the site. After all the geometric data, boundary conditions, roughness values, and expansion contraction coefficients were entered into the PPC Existing Conditions HEC-RAS model, the team performed a mixed steady flow analysis for the suite of selected flows.

4.2 *Results/Discussion*

4.2.1 Roughness Coefficient Calibration

Reference reach survey data conducted on November 7, 2012, included measured water surface elevations at reference cross sections. PPC streamflow measurements, corresponding to the reference reach survey date, were available at the DNRC PPC at-Kleffner gage and the USGS PPC near-Clancy gage.

Review of the streamflow data indicate streamflow conditions to be steady state at both gages for the six-day period leading up to the survey date and at the Clancy gage for the two days following the reference reach survey. Average daily flow fluctuations at both PPC gages for this period were 7% or less, which is within the range of typical streamflow measurement accuracy. Based on these data, it was concluded that using the streamflow value for November 6, 2012, from the DNRC PPC at-Kleffner gage would be a reasonable estimate for the average daily low flow through the project site on November 7, 2012 (33 cfs).

The model calibration results indicate that a channel roughness value of n = 0.035 produces average reference reach residuals of 0.26 ft (Reference Site 1) and 0.29 ft (Reference Site 2). These results are consistent with the range of published roughness values for gravel-bed natural streams (Chow, 1988). Based on the low calibration residuals and the agreement with published values, n = 0.035 was selected for the PPC Existing Conditions HEC-RAS model channel roughness value.

4.2.2 Flow Regimes

Flow regimes presented here are referenced to the project hydrologic analysis (Appendix A). The PPC Existing Condition HEC-RAS model was run using a suite of flows selected to represent the seasonal flux of PPC streamflow including bankfull flow candidates to support sediment transport/channel stability calculations (addressed below) and to estimate channel conveyance capacity. These flows ranged from 10 cfs through 750 cfs. Table 7 summarizes the discharges evaluated in the analysis.

Table 7. Discharges Evaluated in the Hydraulic Model for the Stability Analysis.

Profile Number	Discharge (cfs)	% Exceedance	Flow Regime
1	10	98	Lower Limit Base Flow
2	20	78	Average Base Flow
3	50	25	Rising\Descending limb of Runoff Hydrograph
4	100	10	Rising\Descending limb of Runoff Hydrograph
5	150	4	Rising\Descending limb of Runoff Hydrograph
6	200	2	Rising\Descending limb of Runoff Hydrograph
7	252	1	Q1.5 Possible Bankfull
8	328	0.28	Q2 Possible Bankfull
9	545	0.09	Q5
10	750	0.04	≈ Q10

4.2.3 Water Surface Profiles

Water surface profiles for 328 cfs (the 2-year flow) and 750 cfs (representative of the 10-year flow) are in Figure 18. The ASARCO Smelter Dam is the significant hydraulic control on the PPC system. At 750 cfs, backwater from the dam extends upstream to approximately station 42+00. The Upper Lake diversion, located at approximately station 51+00, is a secondary control on the PPC with backwater occurring upstream to approximately Station 54+00 at 750 cfs.

4.2.4 Channel Capacity

Figure 19 plots the $Q_{1.5}$ and the Q_2 for Reference Site 1. Figure 20 plots the $Q_{1.5}$, Q_2, and Q_5 for Reference Site 2. The cross section station numbers for the reference sites are in Table 8. These cross-section data were surveyed on November 7, 2012. During the survey, bankfull indicators were recorded and subsequently used in the HEC-RAS model as channel bank markers. Table 8 summarizes the comparison of model results with the field bankfull indicators.

Table 8. Modeled Discharge and Bankfull Indicator Comparison.

HECRAS Station	Reference Site	Avg. Bankfull Elev. (ft)	$Q_{1.5}$ WSEL Elev. (ft)	Q_2 WSEL Elev. (ft)	$Q_{1.5}$ Diff. (ft)	Q_2 WSEL Diff. (ft)
7659.13	1	3934.88	3933.86	3934.13	-1.02	-0.75
7592.36	1	3934.12	3933.52	3933.81	-0.6	-0.31
7550	1	3933.61	3933.11	3933.4	-0.495	-0.205
7486.87	1	3934.24	3932.82	3933.14	-1.42	-1.1
7446.03	1	3933.55	3932.65	3932.99	-0.9	-0.56
7388.7	1	3932.91	3932.19	3932.49	-0.72	-0.42
7321.95	1	3932.07	3931.98	3932.32	-0.085	0.255
7263.2	1	3931.44	3931.67	3932.02	0.23	0.58
1540.14	2	3894.25	3892.94	3893.21	-1.31	-1.04
1465.1	2	3893.64	3892.37	3892.74	-1.27	-0.9
1414.96	2	3894.28	3892.17	3892.51	-2.105	-1.765
1382.63	2	3892.50	3890.91	3891.14	-1.585	-1.355
1350.26	2	3893.06	3890.66	3891.01	-2.395	-2.045
1312.95	2	3892.01	3890.65	3890.99	-1.36	-1.02
1273.77	2	3891.99	3890.23	3890.64	-1.755	-1.345

Reference Site 1 was selected because it was one of the few stream segments that contained a pool-riffle sequence with bedform complexity, compared with other PPC stream segments. Field observations indicated that Reference Site 1 had undergone recent migration and adjustment, likely in response to the high magnitude, long duration 2011 spring runoff. As a result, field bankfull indicators have not had time to equilibrate to the new channel. For Reference Site 1, the 2-year flow (Q2 = 328 cfs) was within ± 0.5 ft of one of the field bankfull indicators for 8 of the 9 cross sections. Cross-section plots of Reference Site 1 are in Appendix B.

At Reference Site 2, field observations indicated there was also evidence that the channel was still adjusting to the 2011 hydrology; therefore, there are some elevation discrepancies between the left side and right side field-defined bankfull channel indicators. At Reference Site 2, the 2-year flow was within ± 0.5 ft of one of the field bankfull indicators, for 2 of the 7 cross sections. The 2-year flow at Reference Site 2 did not correlate as well with the field-defined bankfull indicators as at Reference Site 1. Cross-section plots of Reference Site 2 are in Appendix B.

The modeling indicates that the 5-year flow (Q_5 = 550 cfs) must achieve the stage associated with the field-defined bankfull field indicators. Fluvial geomorphic observations made by Pioneer Technical Services, Inc. (Pioneer) and Applied Geomorphology, Inc. (AGI) at Reference Site 2 suggest that PPC in Reach 1 has undergone some incision, likely occurring during the

2011 runoff. This hypothesis is further supported by the magnitude of the flow required to produce the water surface elevations defined by the field-defined bankfull indicators.

The modeling results indicate that the 2-year flow of 328 cfs generally matched the surveyed, field-defined bankfull indicators within 0.5 ft at Reference Site 1. At Reference Site 2, the 2-year flow was generally below the bankfull indicators and a 5-year flow better approximated the bankfull stage.

Results from the modeling also indicated there was some expected variability within the correlation of flows and bankfull indicators. Final selection of the bankfull flow magnitude requires integration of the hydrologic, geomorphic, hydraulic, and sediment transport analyses as described in Section 7.

4.2.5 Reach-Averaged Hydraulics

The team compiled reach-averaged hydraulic parameters to support the sediment transport analysis. The PPC reach was subdivided into six computational reaches, as defined in the PPC *Existing Conditions Stream Assessment r*eport (METG, 2012b) and described in Section 2. The reach delineations were based on the similarity of fluvial geomorphic characteristics, hydraulic characteristics, and the locations of significant structures.

Average values of main channel velocity, channel effective width, channel maximum depth, energy slope, and average channel boundary shear were calculated for each reach and for the range of flows from 10 cfs to 750 cfs. Model data from the ASARCO Smelter Dam structure were not included in the averaging calculations. Table 9 presents the results of the existing conditions hydraulic analysis.

Table 9. Summary of Reach Averaged Hydraulic Values.

HYDRAULIC REACH	DISCHARGE (cfs)										
	10	20	50	100	150	200	252	328	545	750	2190
MAIN CHANNEL VELOCITY (ft/s)											
1	1.87	2.29	2.99	3.73	4.21	4.57	4.86	5.23	6.06	6.81	9.56
2	0.78	1.02	1.58	2.15	2.52	2.45	2.62	2.84	3.30	3.77	3.09
3	1.56	1.82	2.21	2.72	3.04	3.31	3.55	3.77	4.24	4.12	2.58
4	1.59	1.90	2.45	3.02	3.36	3.64	3.89	4.22	4.97	5.43	7.03
5	1.69	2.03	2.32	2.89	3.30	3.61	3.88	4.19	4.90	5.36	6.81
6	1.46	1.69	2.25	2.86	3.33	3.70	4.03	4.39	5.26	5.94	8.69
MAIN MAX DEPTH (ft)											
1	0.84	1.05	1.46	1.89	2.21	2.48	2.73	3.05	3.76	6.35	6.67
2	2.67	2.86	3.25	3.70	4.05	4.42	4.72	5.11	5.95	6.56	8.80
3	0.95	1.17	1.57	2.02	2.39	2.69	2.96	3.32	4.23	4.64	5.90
4	0.95	1.16	1.54	1.94	2.25	2.51	2.74	3.02	3.65	4.12	5.75
5	0.87	1.13	1.61	2.03	2.34	2.59	2.82	3.10	3.72	4.16	5.99

HYDRAULIC REACH	DISCHARGE (cfs)									
	10	20	50	100	150	200	252	328	545	750	2190
6	0.96	1.15	1.51	1.89	2.18	2.43	2.66	2.96	3.65	4.18	6.88
MAIN CHANNEL EFFECTIVE WIDTH (ft)											
1	16.43	19.37	23.47	27.02	29.50	31.66	33.53	35.85	39.71	61.25	41.62
2	30.31	33.22	36.88	41.11	45.09	49.52	54.08	60.63	66.59	69.74	73.93
3	19.49	24.34	30.43	33.08	36.30	37.98	39.37	41.63	45.65	46.14	46.76
4	18.85	23.34	28.61	33.21	36.76	39.54	41.43	43.34	45.32	45.53	45.55
5	16.06	19.01	25.22	28.58	30.13	31.17	32.07	33.15	34.45	34.86	35.08
6	21.83	25.75	31.15	34.68	36.44	37.89	39.16	40.71	42.95	43.38	43.71
ENERGY SLOPE											
1	0.0134	0.0121	0.0103	0.0101	0.0097	0.0092	0.0089	0.0086	0.0079	0.0080	0.0085
2	0.0045	0.0045	0.0058	0.0073	0.0084	0.0024	0.0024	0.0024	0.0023	0.0030	0.0009
3	0.0114	0.0100	0.0060	0.0051	0.0047	0.0046	0.0042	0.0035	0.0028	0.0029	0.0011
4	0.0095	0.0091	0.0078	0.0069	0.0061	0.0058	0.0055	0.0053	0.0051	0.0049	0.0044
5	0.0109	0.0107	0.0070	0.0067	0.0065	0.0063	0.0062	0.0061	0.0060	0.0055	0.0050
6	0.0108	0.0076	0.0063	0.0061	0.0059	0.0058	0.0058	0.0055	0.0052	0.0052	0.0049
CHANNEL AVERAGE BOUNDARY SHEAR STRESS (lb/sq ft)											
1	0.23	0.29	0.40	0.55	0.65	0.72	0.78	0.86	1.04	0.62	2.15
2	0.07	0.09	0.18	0.28	0.37	0.25	0.28	0.31	0.38	0.53	0.27
3	0.17	0.21	0.22	0.28	0.33	0.36	0.39	0.41	0.46	0.52	0.30
4	0.17	0.21	0.28	0.36	0.40	0.44	0.48	0.54	0.69	0.79	1.13
5	0.23	0.29	0.30	0.39	0.47	0.53	0.59	0.66	0.82	0.91	1.35
6	0.16	0.17	0.23	0.32	0.40	0.46	0.52	0.58	0.75	0.90	1.59
CHANNEL HYDRAULIC RADIUS (FT)											
1	0.44	0.57	0.82	1.10	1.31	1.48	1.63	1.83	2.35	4.12	5.05
2	0.98	1.09	1.33	1.60	1.79	2.00	2.14	2.34	2.95	3.45	5.43
3	0.45	0.56	0.81	1.16	1.42	1.64	1.84	2.09	2.76	3.12	4.27
4	0.47	0.57	0.81	1.08	1.27	1.43	1.59	1.80	2.36	2.81	4.38
5	0.46	0.62	0.83	1.13	1.36	1.56	1.73	1.95	2.46	2.86	4.60
6	0.50	0.61	0.82	1.09	1.31	1.49	1.66	1.89	2.45	2.93	5.50

5 EXISTING CHANNEL SEDIMENT TRANSPORT AND CHANNEL STABILITY

The goal of this channel stability analysis of existing conditions is to quantify the sediment transport dynamics of the creek and to estimate the resulting potential for vertical and lateral instability. A channel stability analysis of existing conditions is described in a separate calculation summary provided in Appendix C.

5.1 *Methods and Data*

This channel stability analysis work consists of an incipient-motion analysis to determine the flows necessary to mobilize the existing bed material and a sediment-continuity analysis to evaluate the aggradation/degradation potential of the existing channel. Lateral stability is addressed qualitatively, primarily based on observations from the recent fluvial geomorphic investigations of the channel behavior.

5.1.1 Representative Bed Material Gradations

Sediment sources to the realignment reach include sand and fine gravels and coarse alluvium (large gravel and cobble). The coarse alluvium fraction is the primary bed material that provides the channel vertical stability, and the sand and small gravel fraction, located between riffles, represents the dominant sediment load through the system. The coarse alluvium bed materials within the project reach were characterized from pebble counts. The sand and fine gravel material were characterized from bulk sampling/sieve analysis collected as part of the project field investigations. To address these two discreet sediment sources, the team conducted the channel stability and sediment transport capacity calculations using two material gradations: one representing the sand and fine gravel material and one representing the coarse alluvium. Table 2 and Table 3 summarize the results of the bed material gradations. **Error! Reference source not found.** plots the particle size distributions.

Pebble count data indicated that Reach 1 had a coarser cobble/gravel fraction than Reaches 4 and 5 that was most likely related to the input of slag material and exposed colluvial/alluvial deposits on the east channel bank. Therefore, coarse alluvium material calculations for Reach 1 werer based on the Reach 1 pebble count gradation. Coarse alluvium for reaches upstream of Reach 1 use the average of the pebble count data for Reaches 4 and 5.

5.1.2 Vertical Stability

The existing channel vertical stability was evaluated using incipient motion calculations. The incipient-motion calculation estimates the range of flows over which the bed material will be mobile.

5.1.3 Incipient Motion

Incipient motion analysis evaluates the effective hydraulic shear stress on the channel bed with the shear stress required to mobilize the streambed materials (critical shear). The stream discharge that produces the effective hydraulic shear equal to the critical shear is termed the critical discharge The shear stress required for bed material mobilization was estimated using Shields relationship for particle motion (Shields, 1936) as described in the calculation summary (Appendix C).

Values for the Shields parameter(τ^*) can range from 0.02 for frequently moved, loosely packed gravel to 0.12 for tightly packed, imbricated material that results when transport is infrequent and the framework gravel is infilled with fines (Hey, 1997). Research by Neil (1968) indicates that a Shields parameter value of 0.03 corresponds to particle incipient motion and a value of 0.047 represents low but measurable transport. In this analysis, a value of $\tau^* = 0.03$ was used to represent the 'threshold' or 'incipient' motion condition, while a value of $\tau^* = 0.047$ was used to represent a low but measurable transport condition.

The total hydraulic shear stress can be partitioned into grain shear stress (the stress acting on the grains) and the bedform stress (the stress acting on the bedforms) (Einstein, 1950). The grain shear is the component that is responsible for bed-load transport. The remaining shear stress is used to overcome the flow resistance of the bed forms. The team estimated the shear stress as described in the calculation summary in Appendix C.

5.1.4 Sediment Transport Capacity Calculations

The existing conditions sediment transport capacity calculations estimate the sediment transport capacity *potential* of the existing channel using a bed-load transport function. This transport capacity estimate provides a relative reference for the proposed PPC channel design.

Numerous empirical relationships are available for estimating sediment transport in streams. While many of the available relationships have at least some theoretical basis, all have an empirical component that limits the range of conditions over which they are applicable. No single sediment transport relationship is ideal for the range of sediments that exists in PPC.

The Meyer-Peter Muller (MPM) bed-load equation (Meyer-Peter and Muller, 1948) was developed from laboratory flume experiments with sediment diameters ranging from 6.4 mm to 30 mm, which is consistent with the bed material D_{50} sizes found in PPC (12.7 mm sand and gravel and 50 mm for coarse gravel/cobble). This sediment transport relationship applies to coarse sediments (Chang, 1992) and is most successfully applied over the gravel range (ACOE, 2010). The team selected the MPM relationship to compute the transport capacity by fraction of the PPC bed material in the project reach based on the similarity of the MPM basic data and the PPC bed material, and previous use of the MPM relationship on similar streams such as Silver Bow Creek (Mussetter Engineering and Inter-Fluve, Inc., 1997; Mussetter Engineering and Maxim Technologies Inc., 2003; Montana DEQ/EPA, 2007; Montana DEQ/EPA, 2008).

5.1.5 Sediment Supply

Sediment supply is an important input for a sediment transport evaluation because the supply of bed material from upstream and lateral sources is either passed through the system or accumulates within the bed of the channel at some locations and times. Direct measurements of the bed load in PPC do not exist; therefore sediment load input to the project reach was estimated using the transport capacity of the reach that appears to be the most adjusted to the hydrology and sediment supply based on the geomorphological assessment (METG, 2011).

While Reach 4 appears to have laterally adjusted to the 2011 long-duration high-magnitude runoff, overall it has been relatively stable (cross section and slope maintained). There are no significant tributaries providing sediment input downstream of Reach 4. Hydraulic conditions in this reach are not affected by downstream backwater, and the existing bankfull flow capacity was approximately equal to the 1.5-year to 2-year flow (250-320 cfs), which was also approximately equal to the reach averaged critical discharge (240 cfs) for the representative bed material. Therefore, the team selected the sediment transport capacity of Reach 4 to represent and approximate the project sediment input.

5.1.6 Estimation of Sediment Transport Capacity

The MPM sediment transport capacity function in HEC-RAS was used to calculate the potential sediment transport rate at each section in all the reaches for the design flows and for both gradations representating the sediment input and bed material (the sand and fine gravel and the coarse gravel/cobble). The model provided an estimate of the potential transport rate per day for each of the design flow rates. The sediment transport rates were then averaged for each reach and design flow, and then integrated across the flow duration curve.

5.2 *Results/Discussion*

5.2.1 Incipient Motion

Table 10 provides the results of the existing conditions incipient motion calculations for PPC. The calculations indicate that the sand and gravel fraction are transported at all flows except within Reach 2, which was influenced by the Smelter Dam structure and characterized by low gradient energy slopes. Appendix A contains the calculations.

Table 10. PPC Existing Conditions Incipient Motion Calculations.

Reach	Critical Discharge (cfs)			
	Incipient Motion Sand & Gravel (T*c=0.03)	Measurable Transport Sand & Gravel (T*c=0.047)	Incipient Motion Coarse Gravel &Cobble (T*c=0.03)	Measurable Transport Coarse Gravel & Cobble (T*c=0.047)
1	<10	<10	45	220
2	40	80	>750	>750
3	<10	<10	>750	>750
4	<10	10	240	>750
5	<10	<10	210	>750
6	<10	10	210	650

For the coarse gravel & cobble material (representative of existing condition riffles), critical discharges range from 45 cfs within Reach 1 to greater than 750 cfs in Reaches 2 and 3. Critical discharge in Reaches 4, 5, and 6—which are the reaches least impacted by the East Helena Smelter facilities—range from 210 cfs to 240 cfs (approximately in the range of a 1.5-year event). These critical discharges in Reaches 4, 5, and 6 agree well with bankfull discharge estimates based on previous hydrology and existing condition hydraulic modeling estimates. These calculations were conducted using the reach average values; therefore, the potential exists that riffles locally mobilized at different discharges than those based on reach average hydraulics. With the exception of Reach 1, measurable transport of the riffle material requires flows approximately equal to or greater than a 10-year flow (739 cfs).

5.2.2 Estimation of Sediment Transport Capacity

Table 11 shows the estimated potential sediment transport capacity for each reach of the existing channel. The sediment transport model output and the sediment transport estimates are discussed in detail in Appendix C.

Table 11. PPC Existing Conditions Sediment Transport Capacity.

Reach	Estimated Potential Sediment Transport Rate (1)			
	Transport of Gravels (2) (tons/year)	Gravels Potential Bed Elevation Change (feet/year)	Transport of Representative Bed Material (3) (tons/year)	Bed-Material Potential Bed Elevation Change (feet/year)
Supply	100,000	na	27,000	na
6	100,000	0.00	34,000	0.03
5	91,000	-0.06	29,000	-0.03
4	100,000	0.06	27,000	-0.01
3	75,000	-0.21	20,000	-0.05
2	13,000	-0.62	300	-0.16
1	181,000	-3.04	64,000	-0.97

Notes: (1) Sediment sizes larger than 0.3 mm and assuming sediment transport is not limited by armoring or other controls.
(2) Bed-material size taken from coarsest sand and gravel gradations as determined by bulk samples for Reference Site 1.
3) Bed-material size based on average pebble count gradation from Reach 3 and 4(Cobbles)

The second column in Table 11 provides an estimate of the existing channel capacity to convey the potential sand and gravel input from upstream. The third column in Table 11 provides an estimate of the existing channel capacity to convey the coarse alluvium material.

The sediment transport calculations indicate that sediment transport capacity is relatively equivalent in the upper reaches (Reaches 4, 5, and 6). Reaches 2 and 3, which were affected by the backwater from the Smelter Dam and the Upper Lake Diversion, show measurably less transport potential than the upstream reaches. Reach 1 has very high sediment transport capacity rates due to the straight alignment, steep gradient, and incised channel geometry. The evidence suggests that the sediment supply in Reach 1 has been lower than the existing channel transport capacity.

Observations indicate that the existing channel is vertically stable on the coarse substrate materials in Reaches 4 and 5. Reach 6 is located above the head of the alluvial fan with exposed bedrock common and appears to be vertically stable. The Smelter Dam provides grade control for Reaches 2 and 3 and therefore prevents downcutting. Channel aggradation in Reach 2 has historically been partially mitigated by the Upper Lake Diversion, which routes a significant portion of the sediment load into the Upper Lake. Periodic sluicing of sediments at the Smelter Dam structure also served to control channel aggradation in Reach 2. In Reach 1, comparison of bankfull indicators with channel capacity indicate significantly greater bankfull capacity than Reaches 4, 5, and 6 and suggest that vertical downcutting is potentially occurring within this reach.

5.2.3 Lateral Stability

The lateral stability of the existing stream channel was not investigated quantitatively because lateral stability of the reconstructed channel will be ensured during design through developing appropriate bank treatments. Therefore, this report presents only a qualitative discussion of existing condition lateral stability based on recent fluvial geomorphic investigations (summarized in Section 2) (METG, 2012b).

Prickly Pear Creek has undergone significant channel modifications over the last century. The creek was channelized between the Upper Lake Diversion and Hwy 12 and relocated to the eastern margin of the historic stream corridor (METG, 2012b).

Geomorphic investigations indicate Reach 1 has undergone moderate planform migration with some locally significant lateral migration (60-80 ft) into the slag pile.

Reach 2, which is backwatered behind Smelter Dam, has shown little lateral movement since 1955.

Reach 3 has relatively stable, well-vegetated banks. Some lengthening and bendway formation has occurred in the upper reach between 1955 and 2008.

Reach 4 has low density, bankline vegetation where bank undercutting is common. Aerial photo investigations indicate measurable lateral migration at some bendways in the reach between 2008 and 2011.

Reach 5 is channelized and locally armored through the Kleffner Ranch. The reach has some lateral instability characterized by split flow areas and bar deposits.

Reach 6 is upstream of the PPC alluvial fan. Exposed bedrock on the bank is common. The stream is locally armored adjacent to the rail grade. No signs of significant lateral migration or instability have been observed for this reach.

6 SUPPLEMENTAL INVESTIGATIONS

6.1 *Groundwater Investigations*

The East Helena Smelter site has been the subject of extensive groundwater investigations. The results of groundwater investigations conducted to date in the vicinity of the PPC realignment project are summarized in the technical memorandum prepared by Hydrometrics in Appendix E. Results from these groundwater investigations were used to support the wetland\ vegetation design and assess potential construction dewatering requirements.

6.2 *Geotechnical Investigations*

The East Helena Smelter site has been the subject of extensive geotechnical investigations. The results of geotechnical investigations conducted to date in the vicinity of the PPC realignment project are summarized in the technical memorandum prepared by Hydrometrics in Appendix F. Data and results from these investigations were used to support stream channel design by identifying sub-surface material types and to characterize potentially available on-site material sources.

7 DESIGN CRITERIA

This section summarizes the design criteria for the PPC realignment and presents the major design and engineering criteria developed to meet overall project objectives. Appendix D contains detailed documentation of the criteria. The team developed the engineering criteria based on the existing conditions stream assessment completed in 2011 (METG, 2012b) and the hydrologic analysis, existing conditions hydraulic analysis, preliminary hydrogeologic analysis, and the existing conditions channel stability analyses (sediment transport capacity estimates) included as appendices to this report and summarized previously.

Primary design criteria for the PPC realignment address the goal of protecting human health and the environment. These criteria include the following:

- Modify the hydraulic regime on the site to reduce the mass and rate of contaminant transport away from the site.
- Realign the PPC to support the modification of groundwater paths.
- Realign the PPC to prevent entrainment of slag materials into the creek.

Secondary design criteria support the development of a process-based design for the stream and its bounding floodplain. These criteria include the following:

- The design discharge (bankfull hydraulic capacity) should be the dominant or bankfull discharge for PPC.
- The bankfull channel should be competent to transport the estimated incoming sediment load without reach-scale aggradation or degradation.
- The stream bed should be vertically stable at the scale of the entire project reach.
- The channel should be designed with a meandering planform and deformable banks where geomorphically appropriate, and incorporate pool, riffle, and run sequences.
- Floodplains should incorporate wetlands where hydrologically feasible and geomorphically stable; grade controls and/or non-deformable bank treatments should be used where vertical stability and/or horizontal stability is required for the protection of infrastructure, buildings, or contaminated materials.
- Riparian vegetation should consist of native species suitable for the hydrologic and climatic regimes at the project site.

- Deformable bank treatments should allow for some undercutting.
- Deformable bank treatments should incorporate woody vegetation where appropriate.
- The stream should provide upstream passage for adult native species and downstream passage for all salmonid age classes.

The design criteria provide a framework for developing design parameter values, referred to as engineering criteria. The engineering criteria addressed within this document include the following:

- Bankfull discharge
- Channel slope
- Channel width to depth ratios
- Channel cross-section dimensions
- Channel planform
- Bed material gradations
- Infrastructure protection
- Bank construction
- Bank revegetation
- Generalized floodplain slope and grading
- Instream habitat
- Fish passage

7.1 *Bankfull Discharge*

The team evaluated potential bankfull discharge estimates for PPC using a variety of analyses to provide multiple lines of evidence to select an appropriate bankfull discharge estimate for PPC realignment design. Section 3.4 previously presented bankfull estimates in the range of 250-330 cfs, based on hydrologic methodologies. In addition to the hydrology based estimates, hydraulic and sediment transport analyses were also conducted to support the selection of a bankfull discharge value. Results of these analyses are summarized below.

Results from the existing condition hydraulic analysis and the field-surveyed bankfull stage indicators for Reference Site 1 indicate the 2-year discharge (Q_2 = 328 cfs) is within ± 0.5 ft of the field bankfull stage indicators for 8 of the 9 cross sections. Therefore, the 2-year discharge is consistent with the bankfull stage field indicators at Reference Site 1.

Incipient motion calculations, conducted as part of the existing condition channel stability analysis, indicate critical discharge for the riffle size material in Reaches 4, 5, and 6 range from 210 cfs to 240 cfs (similar in magnitude to the 1.5-year discharge).

Based on the results of the analyses discussed above, the team determined that the channel forming discharge in the project reach was between the 1.5-year and 2-year discharges derived from the hydrologic analysis of 252 and 328 cfs, respectively.

Because of uncertainties regarding the overall sediment transport quantification in the system, to prevent undersizing the channel, the team selected the 2-year discharge of 328 cfs as the design discharge. Designing the channel capacity to the upper end of the estimated bankfull range will allow the channel to adjust to a smaller size in the event the dominant discharge is less.

7.2 *Channel Dimensions and Slope*

Design criteria for channel slope, capacity, and dimensions include the following:

- a bankfull channel that will competently transport the incoming sediment load;
- a bankfull channel that will convey the design discharge; and,
- a variable channel planform that is appropriate for the channel dimensions

To determine design parameter values to meet these criteria, the team used the following approach:

1. Identify reaches that demonstrate indicators of dynamic equilibrium.
2. Use reach-scale reference conditions to identify a target channel slope/profile that will minimize discontinuities between reaches and accommodate spatial site constraints.
3. Evaluate detailed channel segments as potential design templates or sediment transport analogs.
4. Apply hydraulic geometry relationships to help define dimensions based on the proposed design discharge/slope configuration.
5. Modify dimensions based on results of sediment transport analyses to meet transport competence criteria.

Using the approach described above (Appendix D), the Reach 4 channel was chosen to define a reference slope and sediment transport condition for the PPC Southern Realignment Segment. The average slope of Reach 4 is ~0.5%. The extension of the Reach 4 channel configuration (to the extent feasible) through the Southern Realignment would allow the downstream continuation of Reach 4 discharge and sediment transport capacities while minimizing a change in gradient at entrance to the realignment.

Downstream of Smelter Dam in the North Realignment Segment, the slag pile west of the channel and the high bench/utility corridor on the east side of the channel limit the width of the meander belt that can be built. Considering the area available for channel lengthening, an assessment of alternative alignments indicates that the channel slope below Smelter Dam can be reduced from its current 0.9% condition to 0.7%. However, a sediment transport analysis of this 0.7% condition indicates that bankfull transport energy is relatively high for this reach, creating a risk of excessive bed scour. Consequently, the channel below the dam cannot be lengthened sufficiently to accommodate an equilibrium slope.

Because of this finding, the North Realignment Segment design concept is to use small grade controls to absorb channel grade. The channel between the grade controls will be designed using the same channel slope and dimensions as the South Realignment Segment. These structures will be designed (during the post 30% design effort) to meet all fish passage criteria while contributing grade control in the naturally steep reach. As this portion of PPC has historically eroded into the slag pile, additional criteria regarding deformability and terrace construction will also be applied.

The team conducted a channel template hydraulic analysis to evaluate and adjust the preliminary channel design parameter values as a basis to develop the full detailed design. During the detailed design phase (post 30%), hydraulic modeling and channel stability will be conducted for the entire PPC channel realignment proposed design.

Table 12 presents the preliminary quantitative channel design parameters used for the conceptual channel template analysis. The values in Table 12 are based on a combined reference, hydraulic geometry, and meander equation assessment and were used to develop conceptual riffle, run, and pool templates.

Table 12 Preliminary Quantitative Channel Design Parameters for Template Analysis, PPC.

Parameter	Units	Preliminary Design Criteria	Basis
Bankfull Discharge	cfs	328	2-Year Discharge
Channel Slope and Dimensions			
Slope	%	0.5	Existing Reach 4
Mean Bankfull Topwidth	ft	43.2	Existing Reach 4
Mean Depth	ft	1.5	Existing Reach 4
Mean Width to Depth Ratio	---	28.8	Existing Reach 4
Mean Bankfull Pool Width	ft	41.7	Hey and Thorne (1986)
Mean Bankfull Riffle Width	ft	44.7	Hey and Thorne (1986)
Channel Planform			
Rc	ft	Mean: 88 Range: 55-137	Williams (1986)
Rc/W	---	Mean: 2.0 Range: 1.3- 3.2	Williams (1986)
Meander Length	ft	Mean: 441 Range: 269-728	Williams (1986)
Meander wavelength	ft	Mean: 299 Range: 182 493	Williams (1986)
Belt Width	ft	Mean: 251 Range: 146-437	Williams (1986)

The template geometries are based upon the geometry of natural channels but simplified for ease of construction. These cross sections were then hydraulically analyzed to quantify conveyance and sediment transport capacities. These template dimensions were modified in an iterative process until resultant reach average hydraulic parameter values from the template reach model were in relative agreement with the existing condition Reach 4 hydraulic parameter values (the selected analog reach).

Figure 21 shows the three types of cross-section templates developed for the proposed PPC channel. The design templates were used to develop a HEC-RAS hydraulic model of a short reach (Template Reach Model) to represent average conditions in the proposed PPC channel.

Figure 22 shows a plan view of the template reach model. The templae reach model is approximately 800-ft long and includes 2 riffle-pool sequences. A Mannings "n" roughness coefficient of 0.035, approximately equivalent to the existing condition roughness value, was used for the main channel. A valley width of 400 ft was used to represent the floodplain. A floodplain roughness of 0.1 was used for the overbank areas to represent the expected condition of the overbank roughness. Hydraulic calculations were conducted for a range of flows from 10 cfs to 750 cfs, the same range that was used to evaluate existing main channel conditions.

The design template hydraulic and sediment transport analyses (Appendix D) indicate that the proposed design template for 0.5% channel slope achieves the design goals in terms of flow conveyance, vertical stability, and sediment transport. Table 13 provides the proposed channel template dimensions.

Table 13 Proposed Channel Layout and Dimension Values.

Parameter	Units	Design Parameter Value	Basis
Bankfull Discharge	cfs	328	2-Year Discharge
Channel Slope and Dimensions			
Slope	%	0.5	Existing Reach 4
Bankfull Riffle Dimensions			
Top width	ft	41	Sediment Transport Analysis
Depth (max\mean)	ft	1.8\1.74	Sediment Transport Analysis
Width/Depth		23.6	Sediment Transport Analysis
Bankfull Pool Dimensions			
Topwidth	ft	35	Design Template Sediment Transport Analysis
Depth (max\mean)	ft	4.5\2.3	Design Template Sediment Transport Analysis
Width/Depth		15.2	Design Template Sediment Transport Analysis
Bankfull Run Dimensions			
Topwidth	ft	35	Design Template Sediment Transport Analysis
Depth (max\mean)	ft	2.5\2.0	Design Template Sediment Transport Analysis
Width/Depth		17.5	Design Template Sediment Transport Analysis
Channel Planform			
Sinuosity		1.5	30% Design Channel Length/Valley Distance
Rc	ft	Mean: 83 Range: 54-129	Williams (1986)
Rc/W	---	Mean: 2.0 Range: 1.3- 3.1	Williams (1986)
Meander Length	ft	Mean: 416 Range: 254-687	Williams (1986)
Meander wavelength	ft	Mean: 282 Range: 172 465	Williams (1986)
Belt Width	ft	Mean: 237 Range: 137-412	Williams (1986)
Substrate			
Particle size	mm	D16: 20mm D50: 51mm D84: 75mm	Existing Conditions Pebble Counts,
Pool Habitat			
Mean Residual Pool Depth	ft	2.5	Template Analysis
Pool Density	per mile	18-25	5-7 channel widths

7.3 *Streambank Construction*

The long-term goal for the PPC realignment is to allow for some level of bank deformability (where appropriate) to support self-sustaining riparian vegetation, geomorphic adjustment, and instream habitat formation. In some areas, such as adjacent to the slag pile, channel migration presents an unacceptable risk of material entrainment or infrastructure damage and the limits of channel migration will be controlled.

Streambank deformability will be defined by the design criteria applied to constructed bank treatments. Where deformability is considered appropriate, such as certain straight reaches or outer banks, the bank treatments will include toe protection designed to mobilize at the 10-year discharge. Upper bank treatments will consist of fabric-encapsulated soil lifts that will be planted with a variety of willow cuttings to promote vegetation establishment on the upper bank **(**Figure 23**).** This configuration will enhance short-term bank stability while vegetation re-establishes, without precluding long-term deformability that will include bank undercutting, bar formation and riparian colonization of those bars, and geomorphic adjustment of the channel.

Passive margins of the reconstructed channel will include passive bank treatments such as point bar features that will provide colonization sites for riparian vegetation.

Where the risk of channel migration is less acceptable, the bank treatments will be engineered for stability up to the 100-year flood event.

7.4 *Substrate*

Section 2 and Appendix D discuss the existing channel bed and bar material. The proposed channel dimensions and slopes assume the stream corridor (channel and floodplain) substrate will be of similar gradation to the substrate that exists in the PPC existing channel in Reaches 4 and 5.

Project geotechnical investigations (Appendix F) indicate some subsurface areas within the proposed PPC realignment are characterized as sand and sandy silts (primarily in the Upper Lake area west of the existing channel) and are unsuitable to function as the stream corridor substrate. In these areas the sand and sandy silt materials will be over excavated and coarse alluvial material, from the bypass channel excavation and the lower reach floodplain and channel excavation, will be placed to form a competent stream corridor surface. Detailed criteria for the coarse alluvial material will be developed as part of the post 30% design.

7.5 *Floodplain and Wetland Design*

7.5.1 Basis for Design

Wetland design guidelines are based on established, ecological restoration premises drawn from available scientific literature, professional experience, and observations. The proposed floodplain development will include suitable wetland replacement or reconstruction. Suitable habitat will subsequently result from the appropriately varied wetland, floodplain and stream channel designs.

7.5.2 Design Criteria and Considerations

Design criteria for wetlands include, but are not limited to the following:

- No net loss of wetland acreage.
- Vegetation design features will provide the following:
  - plant species diversity;
  - value for mammals and migratory birds;
  - thermal/hiding cover for fish; and
  - exclusive use of regional native species.

The single most significant parameter affecting the wetland design is hydrology. Site-specific estimates of groundwater elevations after PPC reconstruction are presented in Appendix E. The groundwater originates from the PPC as well as from the bench west of the site (Appendix E). Based on the preliminary estimates, groundwater entering the project from the west bench would be expected to enter at approximately 3,920 ft, travel to the northeast, and daylight at the stream elevation above the present dam location.

Results of the groundwater evaluation (Appendix E) indicate wetland vegetation communities have a better chance of being established within the upper segment floodplain (above the present dam area) than in the lower segment. Data indicate that above the dam, groundwater is present at or near the future floodplain surface. Below the dam, the groundwater elevation is expected to be several feet beneath the floodplain and not conducive to producing jurisdictional wetland acreage.

7.5.3 No Net Loss of Wetland Acreage

Present groundwater elevations and anticipated ground elevations indicate that there will be a loss of 30 acres of wetlands after the removal of smelter dam (Figure 24). It is the intent of the design to replace or mitigate these losses within the project area.

In the event that the detailed design shows a net loss in wetland acreage, several options exist to make up the deficit and comply with the USACE no net loss of wetland acreage policy:

1. Excavate to groundwater in the affected area beginning at the temporary bypass and working northward towards Tito Park. This option would involve readjusting grades to at or near the projected water table. The benefit of this alternative would be a reduction of groundwater volume due to increased evapotranspiration. The downside includes additional impact to vegetation and additional construction costs (excavation and revegetation).

2. Purchase wetland credits from an established wetland bank. This option is probably the easiest. The benefits would include the following:

   a. Transfer of liability: Complete and immediate transfer of liability (monitoring and maintenance) to the mitigation bank.
   b. Expedited USACE permitting.
   c. 1:1 mitigation ratio when using certified credits
   d. The option chosen during detailed engineering will be based on the provision that wetland bank credits are available and that the plan receives agency approval.

3. Construct a new wetland area. This option would involve designing and constructing a wetland outside the project limits. Actual construction may be easier and some of the construction costs could be offset if there was a market for the excavated material (i.e., gravel). However, there could be additional issues with groundwater studies, permitting, and general public relations with this alternative.

7.5.4 Designed Groundwater Elevations

The anticipated low flow stream elevation and projected groundwater elevations from the groundwater models will be used as the baseline to define final grades for the wetland complex. The grading plan will be created to place the ground surface within 1 ft of the projected groundwater surface in intended wetland areas during several weeks in June of each year.

Portions of the site adjacent to the Tito Park removal area may be designed to intersect groundwater and create a low-lying wet drainage toward the realigned PPC channel to aid in controlling groundwater elevations. This concept may also be applied to ensure that the adequate wetland acreage is created to meet applicable mitigation requirements.

7.5.5 Soil Salvage and Reapplication

Construction plans will include topsoil salvage and redistribution where feasible. Surface material salvaged from the floodplain is expected to meet texture (loamy) and organic (3-5%) requirements for wetland development. The depositional material with smaller grain size, smaller pore space and a medium texture (i.e., sandy loam, loams, silty loams, sandy clay loam, etc.) is well suited to wetlands establishment. Because of the availability of salvageable soils on site, the anticipation is that incorporation of organic amendments and fertilizer will not be necessary.

Topsoil will be applied to a depth of 6 inches, tapering out to a depth of 0 inches near the low water surface elevation. Additional soil material will be applied with salvaged sod and reapplication operations as well.

7.5.6 Habitat Development/Wildlife Benefit

Wetland communities can take up to 10 years to mature. Revegetation projects can sometimes appear as failures until root systems become fully established and growth rates increase. A sigmoid curve of biomass production over time is expected. The use of a variety of species on broad scale projects where generalities are assumed (i.e., grading, soil type, water availability) increase the chance of success as each plant species seeks an environment suitable to itself.

The inclusion of multilayered habitats (e.g., submergent, Palustrine-emergent, scrub/shrub) within a wetland design, proximal to riparian, forested, and upland environments, will benefit wildlife. Many species, particularly mammals and migratory birds, require different habitats for different activities (i.e., foraging, nesting, shelter) in relatively close proximity to each other. Sculpting low and high areas throughout the floodplain will add niches to tie the various habits together.

Creation of oxbow lakes within the floodplain would attract waterfowl. Where possible, open water areas with irregular shaped shorelines and shallow slopes (less than 5H:1V [horizontal:vertical]) will be developed.

Streambanks with well-developed woody vegetation will provide several key benefits. Woody vegetation stabilizes the stream banks and provides resilient, deformable resistance to erosion. Well-established root systems allow development of undercut banks which provide provide fish shelter from heat, predators, and high flows. A well-developed canopy will also provide shade and thermal cover. A mixture of faster growing species such as coyote willow (Salix exigua) will be combined with the slower, but taller species (e.g., cottonwood (Populus trichocarpa)) to speed root zone development and provide mid-term channel stability until the slower-growing, taller species develop.

7.6 *Revegetation*

The goal of the revegetation is to create natural plant communities reflecting the composition and diversity of habitats. To meet this goal, seedings and plantings will be correlated to hydraulic gradient and topography. The following will be the basis for plant community planning and revegetation:

- Using map zones based on depth-to-seasonal, low-stream flow elevation.
- Using a single seed mixture, with a range of species, for all wetland areas: scrub/shrub, Emergent 1, Emergent 2.
- Using a transitional seed mixture for in-between areas consisting of wetland and upland species.
- Salvaging and replacing wetland sod and woody vegetation, wherever possible.
- Planting shrubs and seedlings based on specific hydrologic zones.

Wetland vegetation data was obtained from the 2011 surveys (METG, 2012b) as well as from professional experience at the local and regional levels. Specific seeding mixes and planting schedules were developed based on frequency, ease of establishment, cost, and/or availability.

Designed or allowed irregularities in topography, species application, and allowed volunteer propagation will be used to emulate the randomness and variability that occur in natural systems in order to encourage development of a diverse vegetation class mosaic over time. Grouping species, offsetting planting rows, and overlapping planting zones will be used to hasten the development of random and diverse habitats. Natural selection will ultimately provide the appropriate degree of random species diversity and zonation as the site responds to variable survival, volunteerism, weather cycles, groundwater fluctuations, precipitation, etc.

7.6.1 Anticipated Planting Sequence

With the exception of streambank areas, a two-phased approach to vegetation—seedings the first year, plantings the second—will be used to improve chances of success. Delayed planting will allow seeded plants a year to establish and will permit the seedbed to firm up prior to being walked on by planting crews. Furthermore, volunteer vegetation from seed and existing root stock will occur during this time. Based on first year observations, planting prescription would likely be altered and refined to better reflect actual field conditions. The progression should be generally as follows:

- Excavation/grading - perform excavation/grading pursuant to final design plans, planning for contingencies to accommodate uncertainties with the projected groundwater elevation and terrain.
- Shaping - perform shaping activities, placing cover soil, and develop topographic features.
- Seeding - apply and cover seed.
- Streambank planting – plant streambank and install soft armor features to fortify banks against channel migration.
- Water level equalization/observation - allow the wetlands and stream channel to fill with water and equalize. Observe water level (using piezometers if possible) for one complete hydrologic cycle (i.e., through high and low periods) and assess the success of the seeding. Compare water levels to previous data to determine whether the data represent a wet, average, or dry season.
- Finalize planting - adjust the final plantings to the observed conditions, plant zonation, and anticipated seasonal variation. Based on the success of the seeding efforts, determine appropriate plant density and install additional material as necessary.

7.6.2 Planting Zones

Individual plant species occupy niches (“zones”) along the topographic gradient in the appropriate relation to hydrology. Table 14 summarizes the plant communities and planting zones relative to low-water elevation. Figure 24 shows a schematic cross section of a wetland that illustrates the plant community zonation in relation to groundwater and surface water.

Table 14. Planting Zones and Classes Relative to Stream Elevation.

Vegetative Class	Elevation Relative to 2-Year Seasonal High Steam Elevation – Q2 (ft.)
Upland	>+1
Riparian	>+1
Scrub/Shrub class (wetland)	+1 to 0
Emergent class 2 (wetland)	+0.5 to 0
Emergent class 1 (wetland)	0 to -1.0
Submergent Wetlands	-1.0 to -2.0

The applicable zones will be appropriately overlain on the grading plan to determine specific revegetation requirements. The revegetation areas and requirement shown on the construction plans will be adjusted in the field based upon actual conditions such as slope, soil saturation, and observed field water surface elevations.

7.6.2.1 Submergent Wetlands

Submergent and open water zones are inhabited by species capable of withstanding long periods of inundation (Figure 24). These species often colonize deeper water through root systems initiated from parent stock in “drier” zones. As a rule, this zone will not be actively planted below the average groundwater elevation, but will rely upon natural propagation and spreading of plants. However, a late season planting associated with natural drawdown could be completed if desired to speed development of the submergent wetland areas.

The Upper Lake Complex has a large component of cattail (Typhus latifolia), and the species will more than likely become the dominant plant within this zone. It is not included within the seed mixture but generally will come in on its own without much encouragement.

7.6.2.2 Emergent Zones 1 and 2

Emergent zones 1 and 2 are Palustrine-emergent herbaceous habitats developed relative to groundwater elevation (Figure 24). Emergent Zone 1 is at or within a foot of groundwater elevation and can be expected to have saturated ground conditions over much of the growing season. Emergent Zone 2 occupies the next upper foot of elevation and is expected to have saturated soil conditions for a shorter period of the growing season. Although herbaceous vegetation is expected to dominate these zones, woody vegetation will be planted within Zone 2. The herbaceous cover for Zone 1 is expected to be predominantly wetland forbs, such as rushes and sedges, transitioning into a more dominant grass community in the drier Zone 2. In time, woody vegetation will colonize areas within the wetter zone and provide additional diversity.

7.6.2.3 Scrub/Scrub Zone (Wetlands and Riparian)

The scrub/shrub plant community will include woody species of willows (Salix species), birch (Betula species), and dogwood (Cornus species) with an understory of sedges (Carex species), rushes (Juncus species), grasses, and forbs (Figure 24). This plant community is common along the PPC corridor and will be propagated under new construction to fortify streambanks and stabilize the floodplain. In cases where root development penetrates into the water table found deeper than that necessary to sustain a wetland, non-wetland riparian habitat will form.

7.6.2.4 Transitional Zone

The transitional zone area is found where vegetation changes from wetland to upland because of groundwater fluctuations. The boundary is expected to vary over time with the changes in groundwater conditions. The most common grass found in this area within the project limits is a nonnative species called smooth brome (Bromus inermis) and, although not included in the proposed seed mixture, its presence can be expected to dominate the post-construction landscape in these areas due to colonization. Native species found within these landscapes include slender wheatgrass (Agropyron trachycaulus), bluejoint reedgrass (Calamagrostis canadensis) and Great Basin wildrye (Elymus cinereus). Common shrubs include snowberry (Symphoricarpus alba), licorice (Glycyrrihiza lepidota) and rose (Rosa woodsii).

7.6.3 Seeding/Planting Prescription

The specific number of plants within each planting zone is estimated based upon the surface area of the zone, the percent cover desired, and the proposed spacing between the plants. Percent cover within each zone is based upon biological benchmarks within similar communities in wetlands throughout the intermountain west (Atlantic Richfield, 2004). The proposed amounts include the shrub/scrub zone to be an interspersed mosaic with 75% shrub cover and 25% herbaceous wetland cover; and the percent cover of emergent wetland zones to be 100%. The spacing between individual plants is based upon the rate of growth, spread, and full size of the plants predicted over a 5-10 year period. Propagation of shrubs from cuttings collected on site will be specified where practical because the existing on-site plant material sources offer a large source of plant stock already adapted to the site conditions. Table 15 provides the proposed seeding rates and plant spacing criteria.

Table 15. Proposed Seeding Rates and Plant Spacing

Planting Regime	Size/Form	Seeding*/Spacing Rate*
Upland Seeding	Seed	80 seeds / ft2
Wetland/Riparian Seeding	Seed	120 seeds / ft2
Shrubs	1 quart, 1 gallon	6-10 ft. on centers
Willows	10 cubic inches	4-8 ft. on centers
Willows	Cuttings	3-5 ft. on centers
Herbaceous Plugs	10 cubic inches	3-5 ft. on centers
Herbaceous Plugs	5 cubic inches	2-5 ft. on centers
Planting Regime	Size/Form	Spacing Rate*

* Seeding rate is for broadcast seeding and can be halved if drill seeded (Goodwin and Sheley, 2003).

7.6.3.1 Wetland Areas

A single seed mixture will be used for all wetland areas. The blend will encompass several wetland indicator statuses, such as Facultative (FAC), Facultative Wetland (FACW), and Obligate Wetland (OBL), to cover varying soil hydrology within the landscape (Reed 1988). The diverse native wetland seed mix will be seeded in all wetland zones except the submergent and open water. Planted species are expected over time to occupy the wetter area (submergent zones), as the ecosystem recovers toward its own stability.

7.6.3.2 Transitional Areas

The transitional plant community cover type will include upland and wetland grass species. The upland grass mixture will consist of a number of commonly found species that have demonstrated ease in establishment. The wetland component will include native grass species most easily established across a spectrum of areas, wet to dry. Shrub plantings will be prescribed as well favoring drier, mesic species.

7.6.4 Colonization

With the exception of weed species, colonization (i.e., natural revegetation) is expected and allowed to take place due to an abundant seed source present adjacent to disturbance and within the cover soil (seed bank); and deep rooted, mature shrubs are present adjacent to the disturbance area. The native cattail is prevalent in the current landscape and expected to colonize standing water areas. Another wetland species, the introduced redtop (Agrostis stolonifera) dominates Palustrine-emergent environments and will readily colonize in the area.

The submergent planting zone will not be actively planted until late season. Rooted, submerged species may eventually propagate and spread into water depths of 1.5 ft (or more); however, this will progress over several years. In the first 3 to 5 years after planting (i.e., the establishment period), the emergent and submerged species will mature and develop strong root/rhizome systems. After the establishment period, the plants will be mature and healthy enough to spread on their own.

7.7 *Infrastructure Protection*

Infrastructure elements in the project reach include a bridge crossing at Smelter Dam, protection/ isolation of the Slag Pile from PPC, protection of remaining irrigation diversions, and protection of the downstream highway and railroad bridges at Hwy 12. The design proposes that all infrastructure directly exposed to the stream channel be protected to withstand erosion up to the 100-year flow event.

7.8 *Fish Passage*

Primary fish passage design goals for the PPC requires upstream and downstream passage for salmonid species of all age classes. Design criteria, per MT FWP, to achieve this goal requires the proposed channel to be designed using a geomorphic process-based channel design process, which provides for variable depths, velocities, mobile boundaries (where the protection of property, infrastructure or source material is not required), and habitat zones. Drop structures shall provide variable crest elevations to provide flow slots and smaller jumping zones to promote juvenile upstream travel.

7.9 *Instream Habitat*

With the establishment of vegetation with significant root mass, undercut banks will develop providing fish shelter from heat, predators, and high flows. Establishing suitable vegetation will allow the canopy to develop and will also provide shade and thermal cover. A mixture of faster growing species such as coyote willow (Salix exigua) should be mixed with the slower but relatively taller species such as cottonwood (Populus trichocarpa) to speed development of short-term stability and allow the larger species to develop high-quality habitat over time.

7.10 *Summary of Design Criteria*

Table 16 summarizes applicable engineering criteria developed above.

Table 16. Design Criteria Summary.

Criterion	**Design representation**
Primary Design Criteria: Protect Human Health and Environment	
Modify the hydraulic regime on the south end of the former Smelter site to reduce both the mass and rate of contaminants transport away from the site.	
Realign and regrade PPC to support the modification of groundwater flow paths.	
Prevent entrainment of slag materials into PPC.	

Secondary Design Criteria: Develop Process-based Natural Channel Designs

CRITERION	**30% Design Representation**
Hydrology and Hydraulics	
Design discharge for the primary channel will be the estimated dominant or bankfull discharge for PPC.	Q_{bf} = 328 cfs
Design discharge for infrastructure protection will be the estimated 100-year discharge.	Q_{100} = 2190 cfs
Design discharge for protection of contaminated materials.	As required by EPA.
Sediment Transport and Channel Deformability	
The bankfull channel will be competent to transport the estimated incoming sediment load without reach scale aggradation.	Channel sizing based on sediment transport analyses. See Table 13.
The stream bed will be vertically stable at the scale of the entire project reach.	To be addressed as part the detailed design (Post 30% Engineering Design Report [EDR]).

Where long-term deformability is acceptable, long-term upper bank reinforcement will be enhanced by woody vegetation.	Willows will be incorporated into deformable bank design.
Where long-term deformability is acceptable, bank toes will be constructed to mobilize at a 10-year flow event.	To be addressed as part the detailed design (Post 30% EDR).
Where long-term deformability is unacceptable, banks will be designed to remain stable up to the 100-year flow event.	To be addressed as part the detailed design (Post 30% EDR).
Where the channel is realigned along the slag pile, a terrace will be constructed that will isolate flows up to the 100-year event from the slag.	Terrace height will be a minimum of 2 ft above the 100-year water surface elevation.
Where the channel is realigned along the slag pile, a terrace will be constructed to keep the channel at least 2 channel widths away from the slag.	To be addressed as part the detailed design (Post 30% EDR).
Channel Dimensions	
Bankfull channel geometry will convey the estimated 1.5 - 2.0 year discharge.	Channel geometry capacity based on hydraulic capacity analysis.
Channel slope will approximate existing condition of the channel just upstream of realignment reach (Reach 4).	Reach 4 = 0.5%.
Channel planform will be variable, reflecting the ranges in radius of curvature, meander wavelength, and meander belt width provided by meander geometry equations (Williams, 1986).	See Table 13.
Sinuosity will be determined as channel length/valley distance.	1.5 based on 30% design channel alignment.
Substrate	
Deformable riffles will reflect existing gradations in geomorphically stable reach (Reach 4).	D_{50} = 51 mm based on existing condition pebble count data.
Bedforms and instream Habitat	
Pool frequency.	See Table 13
Where bank deformability is acceptable, bank reconstruction will allow for development of undercut banks by mobilization of toe material at 10-year discharge event.	To be addressed as part the detailed design (Post 30% EDR).
Woody vegetation will be incorporated into bank treatments to provide shade, stability, and recruitment source.	To be addressed as part the detailed design (Post 30% EDR).
Floodplain and Wetlands	
Floodplain inundation will begin at discharges exceeding bankfull.	To be addressed as part the detailed design (Post 30% EDR)
Floodplain topography will be variable and will incorporate swales and oxbow features to increase habitat diversity.	To be addressed as part the detailed design (Post 30% EDR).
Floodplain groundwater hydrology and grading will support wetlands such that no net loss of wetland occurs relative to existing conditions.	To be addressed as part the detailed design (Post 30% PER) based on projected post-dam removal groundwater elevations.

Wetland habitat will include shallow, open water areas.	To be addressed as part the detailed design (Post 30% EDR).
Fish Passage	
Realigned channel will provide for upstream and downstream passage of all salmonid species and age classes.	The PPC will be designed using a geomorphic process-based channel design process, which provides for variable depths, velocities, mobile boundaries (where the protection of property, infrastructure or source material is not required), and habitat zones,. Drop structures shall provide variable crest elevations to provide flow slots and smaller jumping zones to promote juvenile upstream travel.
Vegetation	
Riparian and floodplain vegetation will consist of plant species native to the project site.	To be addressed as part the detailed design (Post 30% EDR).
The density and distribution of riparian and floodplain vegetation will be variable and will reflect micro-site soil and hydrologic conditions.	To be addressed as part the detailed design (Post 30% EDR).

8 PRICKLY PEAR CREEK REALIGNMENT CONCEPTUAL DESIGN

This section is reserved pending client and agency input on engineering criteria.

8.1 *Conceptual Phasing Plan*

It is anticipated that the PPC realignment construction will be completed in 7 significant phases. Each phase is summarized below.

Phase 1: excavation of materials from the east bench adjacent to the Lower Segment, construction of the lower reach of PPC, and construction of the east half of the lower PPC floodplain.

Phase 2: diverting the lower reach of PPC from the existing channel into the lower segment of PPC constructed in Phase 1, backfilling the existing lower segment of PPC, and placing fill adjacent to the slag pile obtained as excess material excavated from the lower segment of the east bench and temporary bypass construction. The area will be regraded to blend with adjacent topography and to provide a natural-appearing transition from the slag pile to the reconstructed PPC floodplain.

Phase 3: demolition of the Smelter Dam. After the dam is removed, live wetland plant materials and soils from the portions of the upper lake area that will be disturbed by the Upper Segment channel construction will be salvaged (if feasible) for vegetative material and clean vegetative backfill for use in the lower segment floodplain.

Phase 4: excavating materials from the Upper Segment of the PPC realignment to create the primary channel corridor and floodplain. Stream substrate material obtained from the lower Segment east bench and the bypass construction will be placed as needed in the channel and floodplain construction corridor.

Phase 5: construction of the new upper segment PPC channel and floodplain.

Phase 6: reconfiguring the Upper Lake and Tito Park areas to tie into the reconstructed floodplain. Live wetland plant materials and soils from the portions of the Upper Lake area that will be disturbed by the wetland reconfiguration will be salvaged (if feasible) for vegetative material and clean vegetative backfill for use in the upper segment floodplain constructed in Phase 5.

Phase 7: releasing PPC into the new channel, final grading of the wetland complex, regrading the PPC temporary bypass area into its final configuration, and planting the reconfigured wetland complex.

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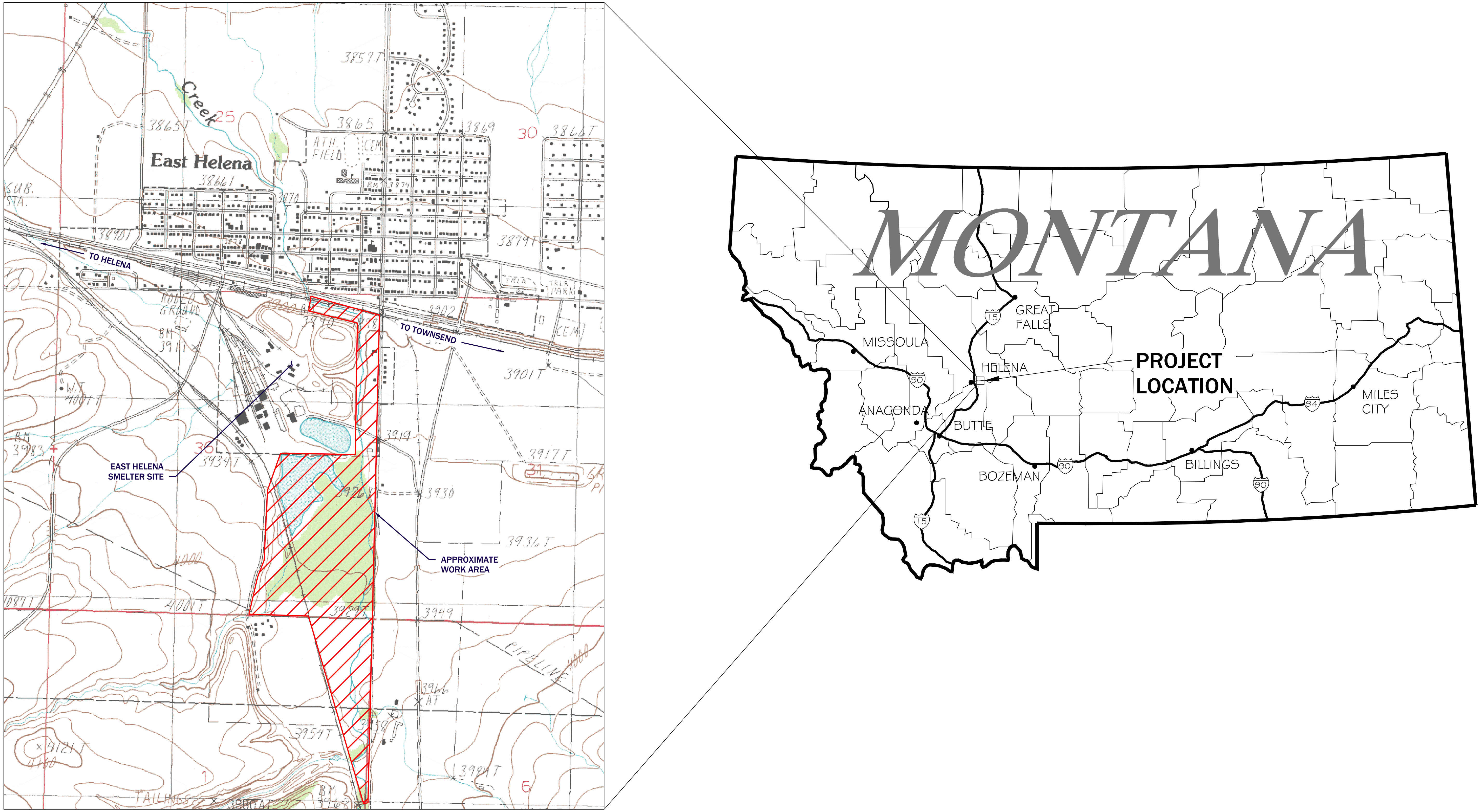
Figures



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DATUM: NAD83
UNITS: FEET
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FIGURE 1

PROJECT LOCATION MAP
EAST HELENA SMELTER
SITE LOCATION MAP

PIONEER
TECHNICAL SERVICES, INC.
201 E. BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

DATE: 3/26/13

6/22/2013 10:07:26 AM P:\CH2MHILL - METG\PPC REALIGNMENT\CAD\PRELIM WETLANDS\FIGURE 1_TITLE SHEET.DWG

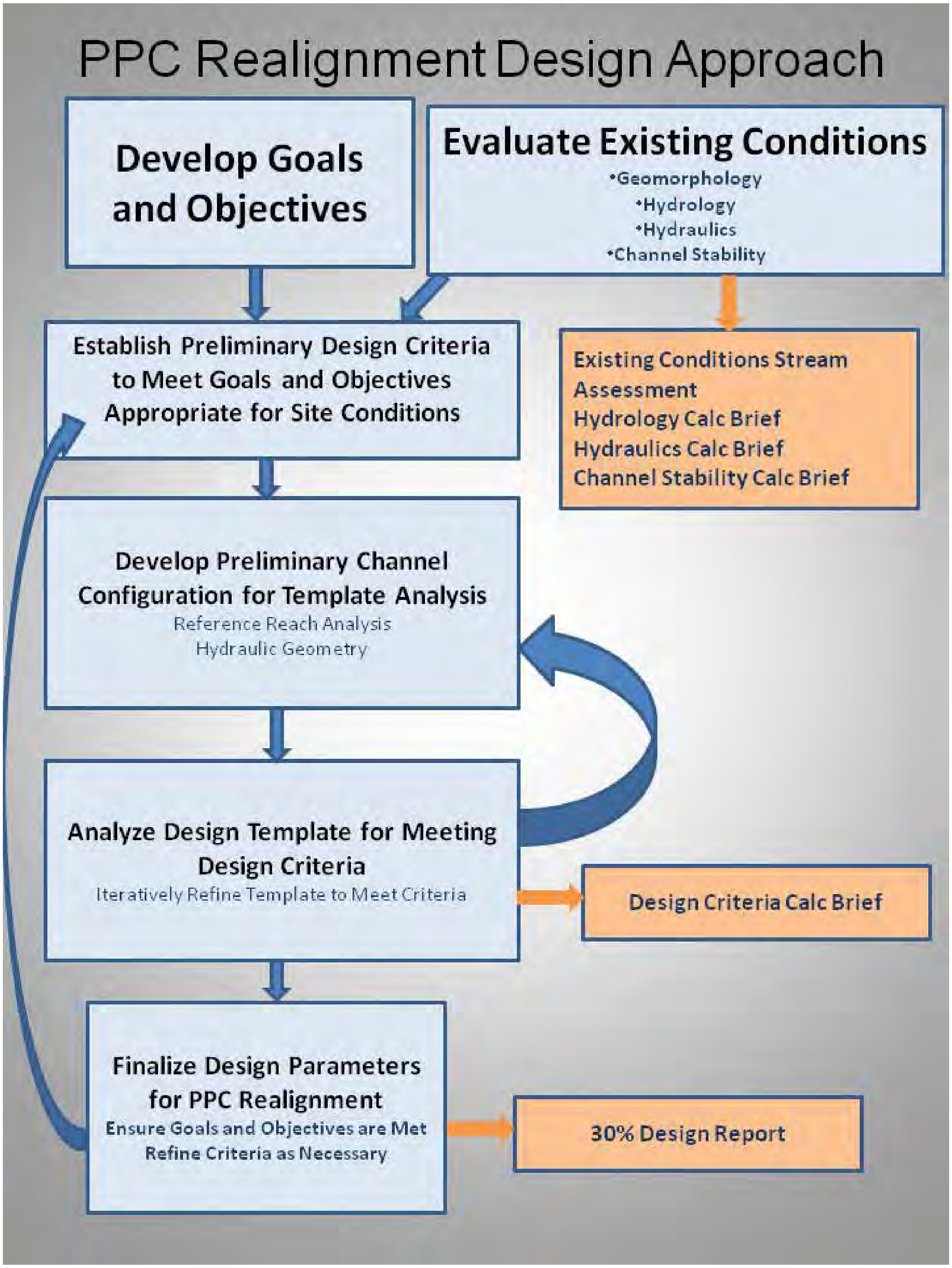


Figure 2. PPC Realignment Design Flowchart.

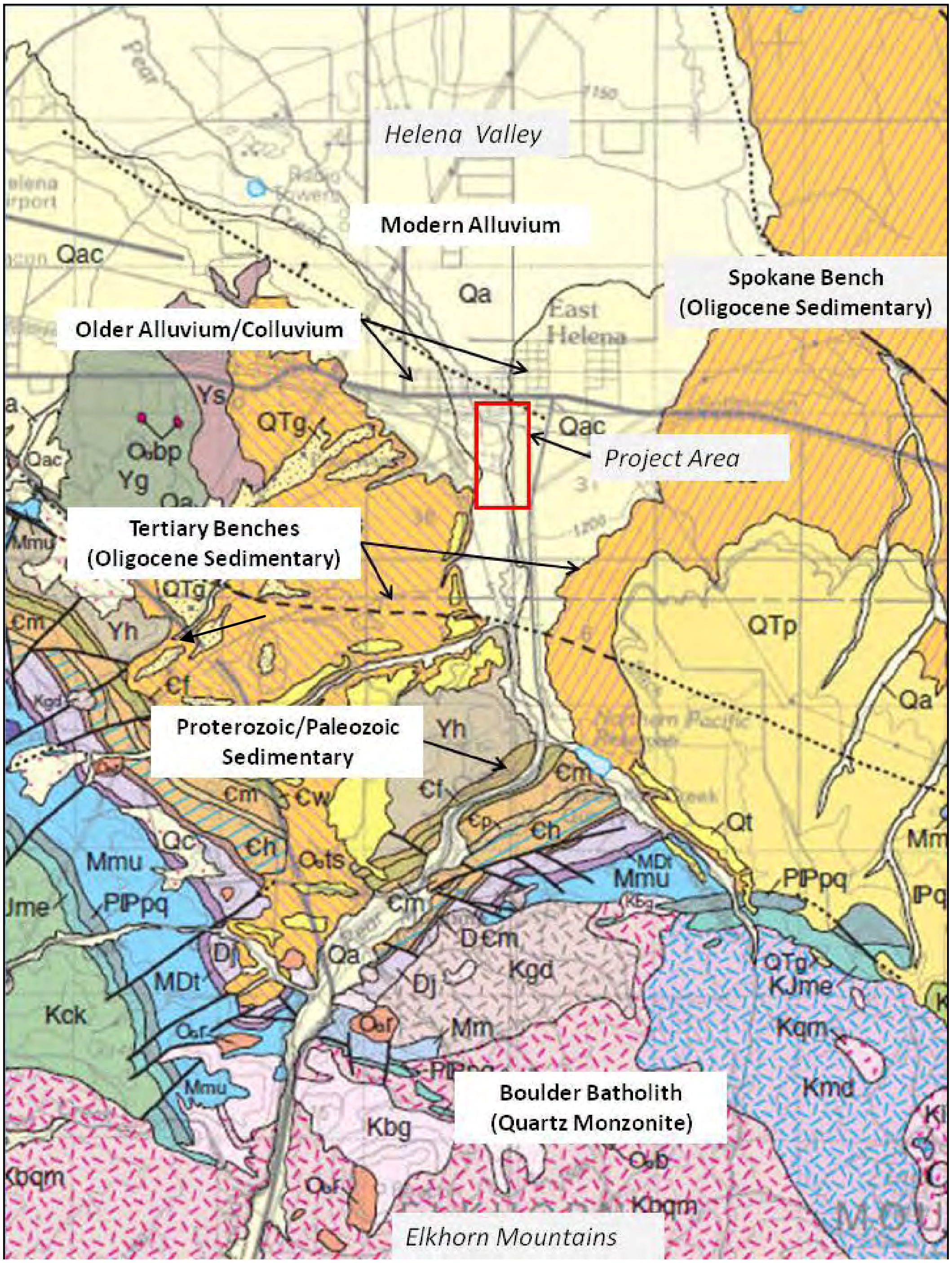


Figure 3. Geologic Map of Eastern Portion of Helena Valley, And Lower Prickly Pear Creek (Reynolds and Brandt, 2005).

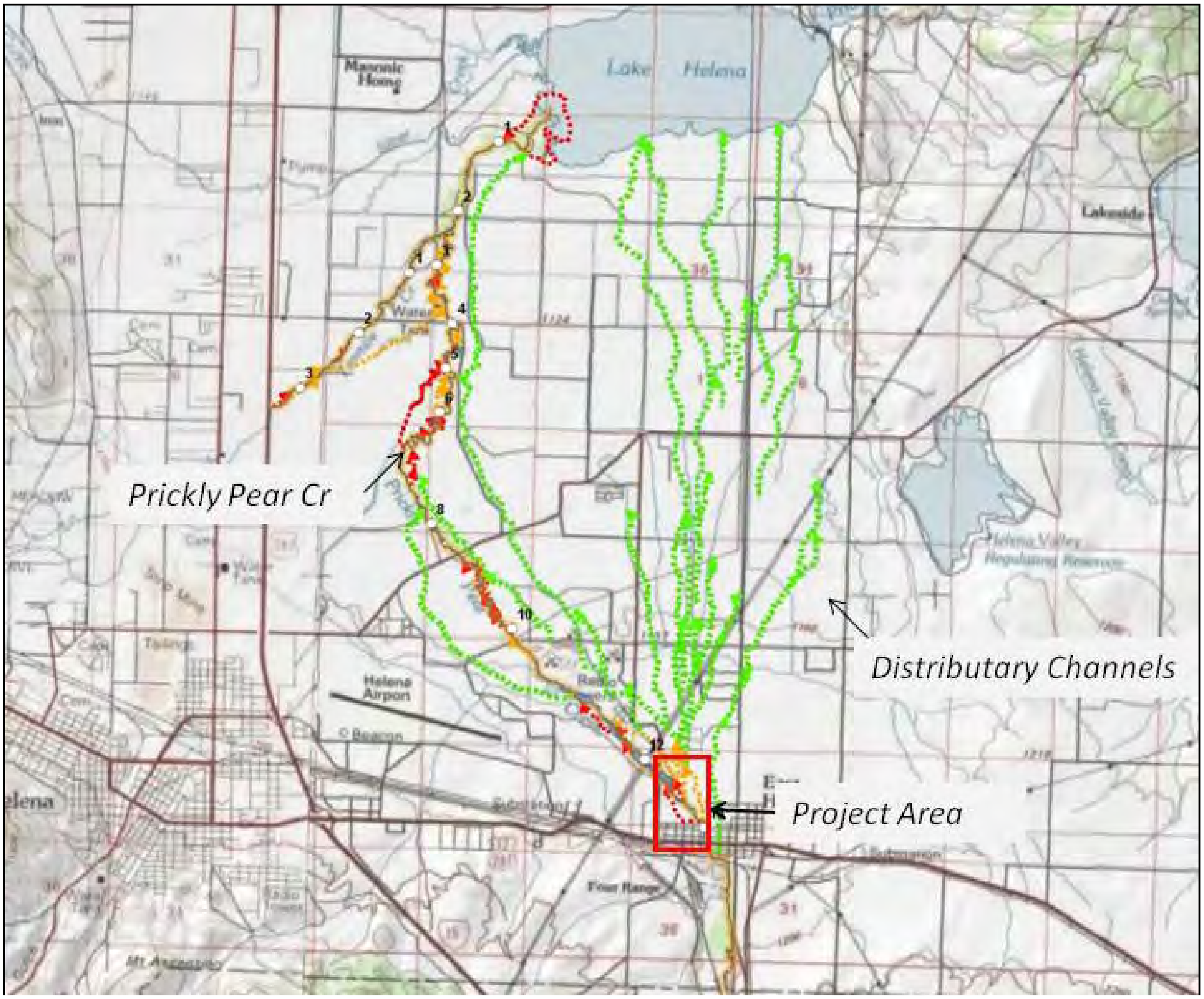


Figure 4. Topographic Map of Helena Valley Showing Digitized Distributary Channels (DTM and AGI, 2011).

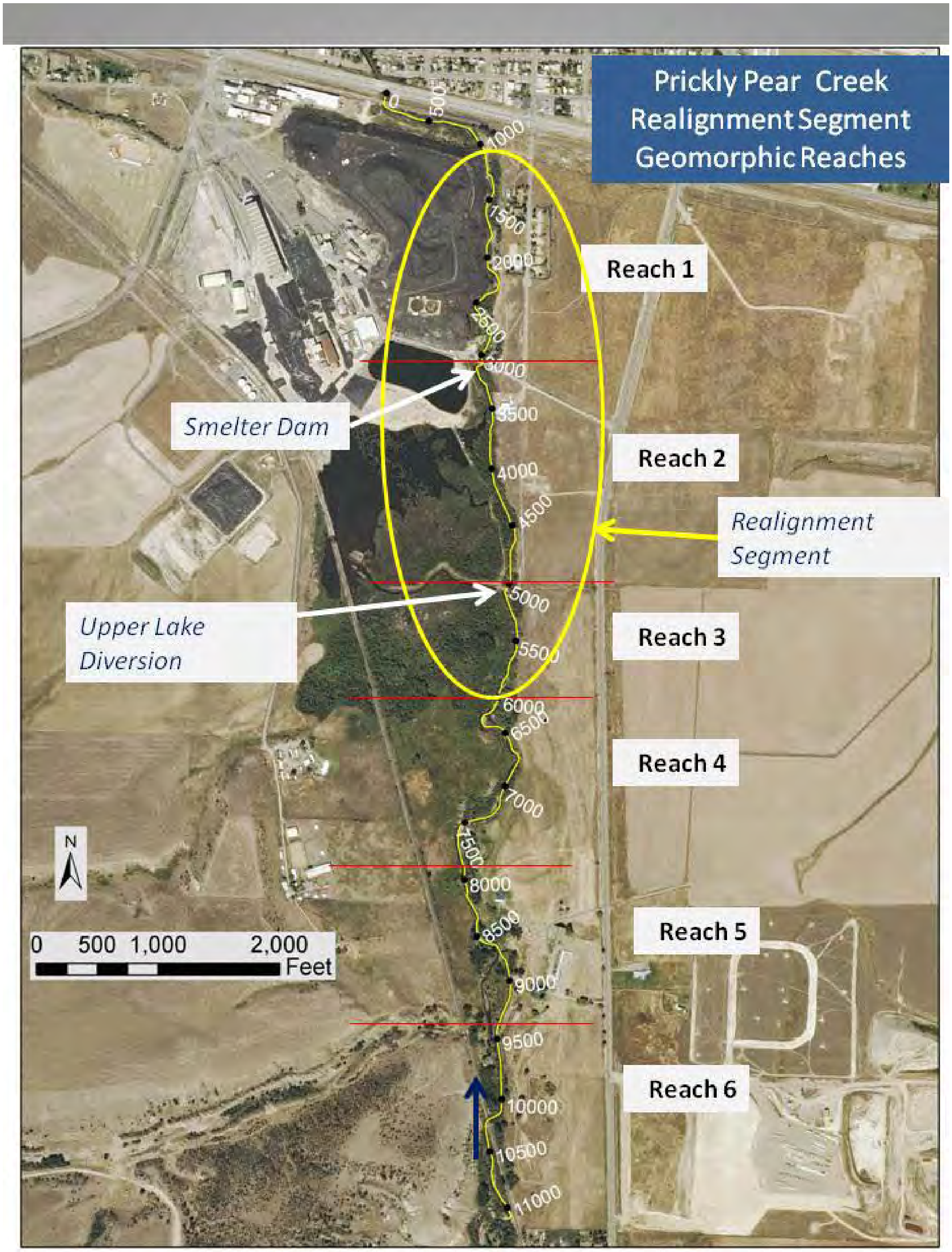


Figure 5. PPC Project Area Showing Geomorphic Reach Breaks and Channel Realignment Segment.

Figure 6. 1955 (left) and 2011 (right) Aerial Photography of Reach 1; Centerline on Both Images is from 2008 High Resolution Imagery.

Figure 7. 1955 (left) and 2011 (right) Aerial Photography of Reach 2; Centerline on Both Images is from 2008 High Resolution Imagery.

Figure 8. 1955 (left) and 2011 (right) Aerial Photography of Reach 3; Centerline on Both Images is from 2008 High Resolution Imagery.

Figure 9. 1955 (left) and 2011 (right) Aerial Photography of Reach 4; Centerline on Both Images is from 2008 High Resolution Imagery.

Figure 10. 1955 (left) and 2011 (right) Aerial Photography of Reach 5; Centerline on Both Images is from 2008 High Resolution Imagery.

Figure 11. 1955 (left) and 2011 (right) Aerial Photography of Reach 6; Centerline on Both Images is from 2008 High Resolution Imagery.

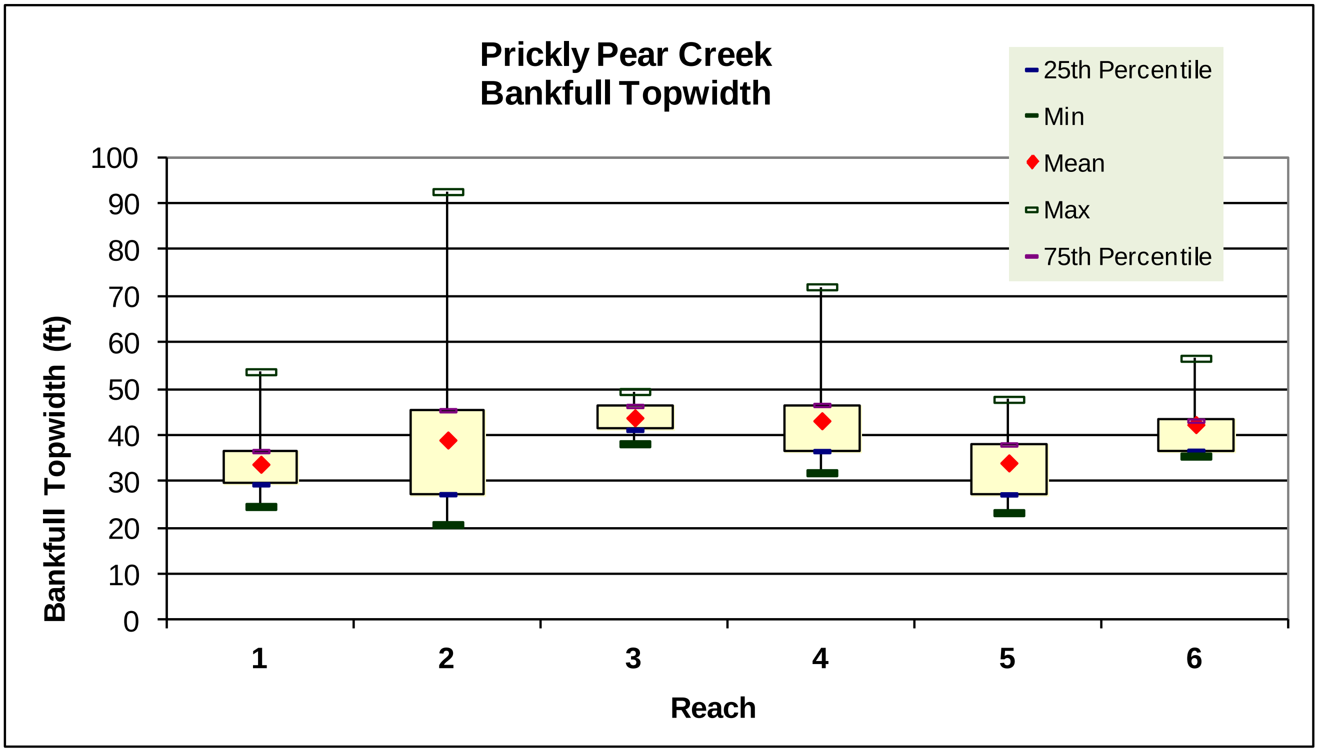


Figure 12. Existing Conditions Bankfull Topwidth.

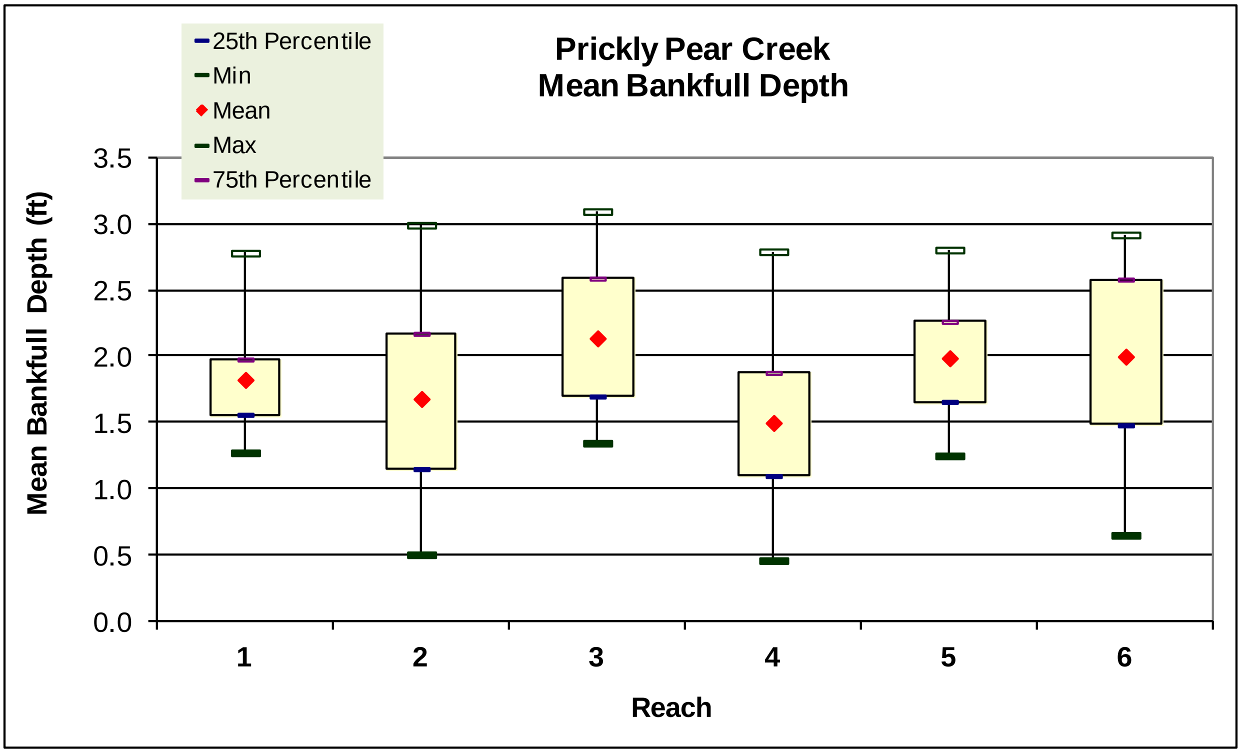


Figure 13. Existing Conditions Bankfull Depth.

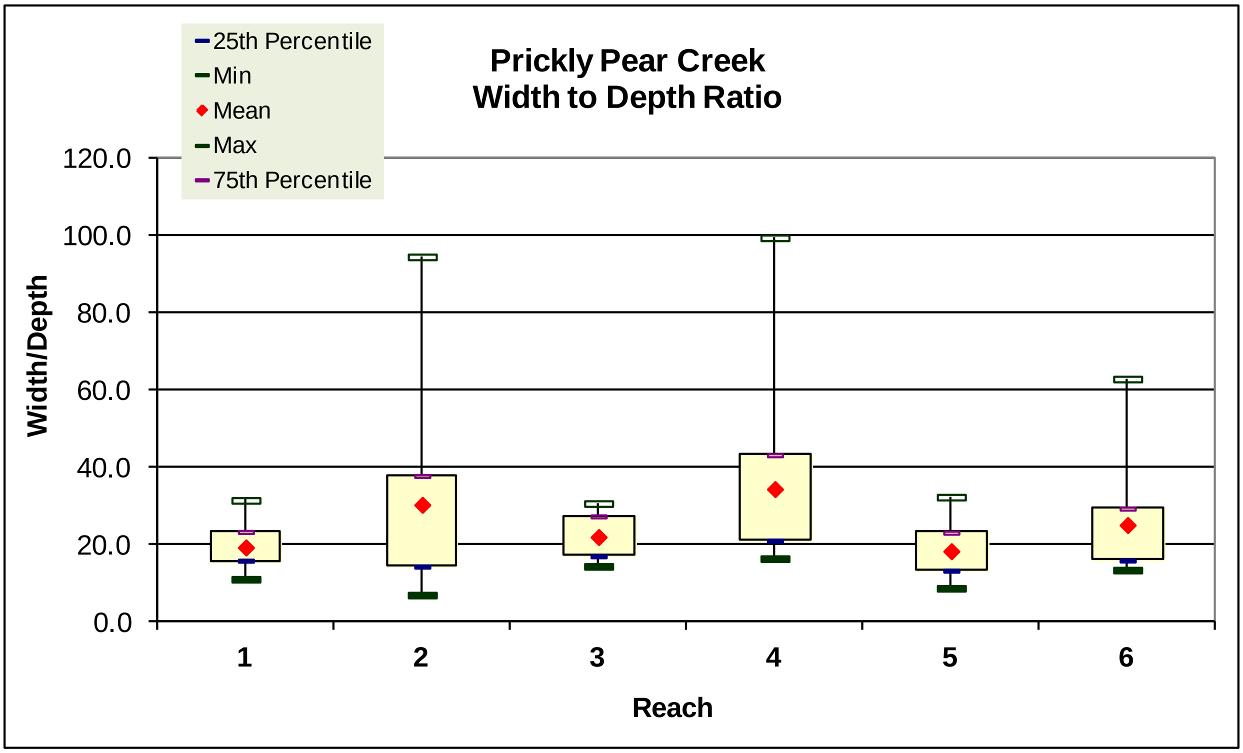


Figure 14. Existing Conditions Width-to-Depth Ratio.

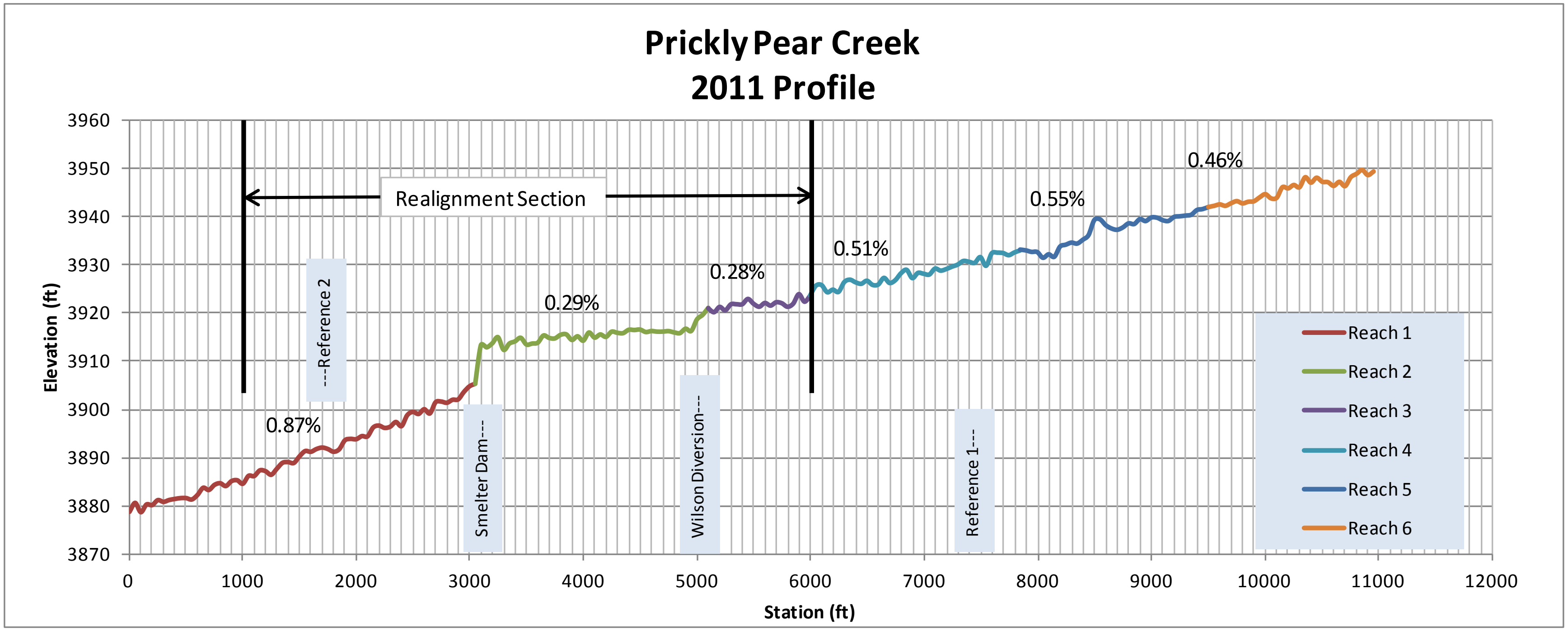


Figure 15. Fall 2011 Surveyed Bed Profile, PPC.

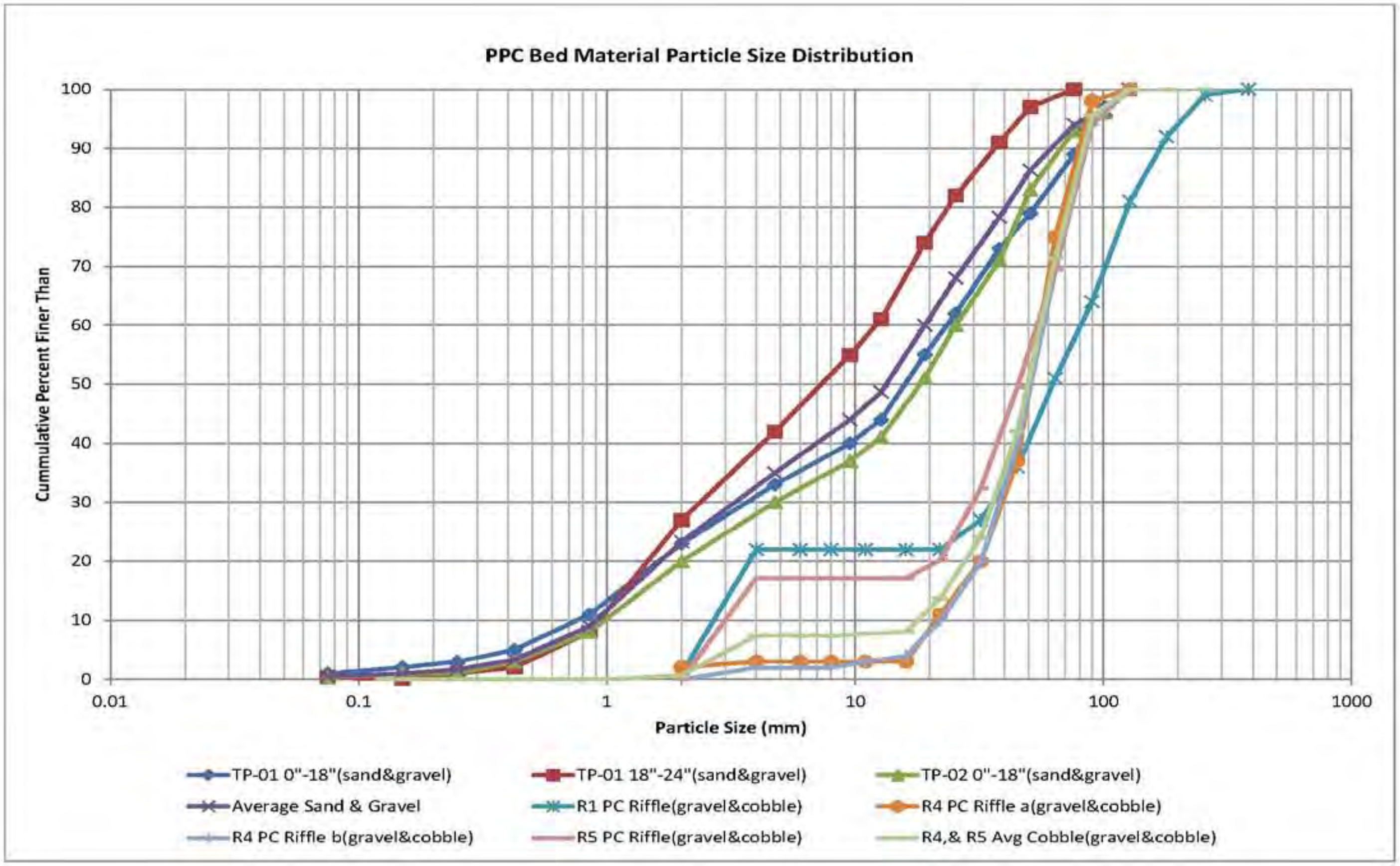


Figure 16. PPC Sampled Sediment Particle Size Distribution.

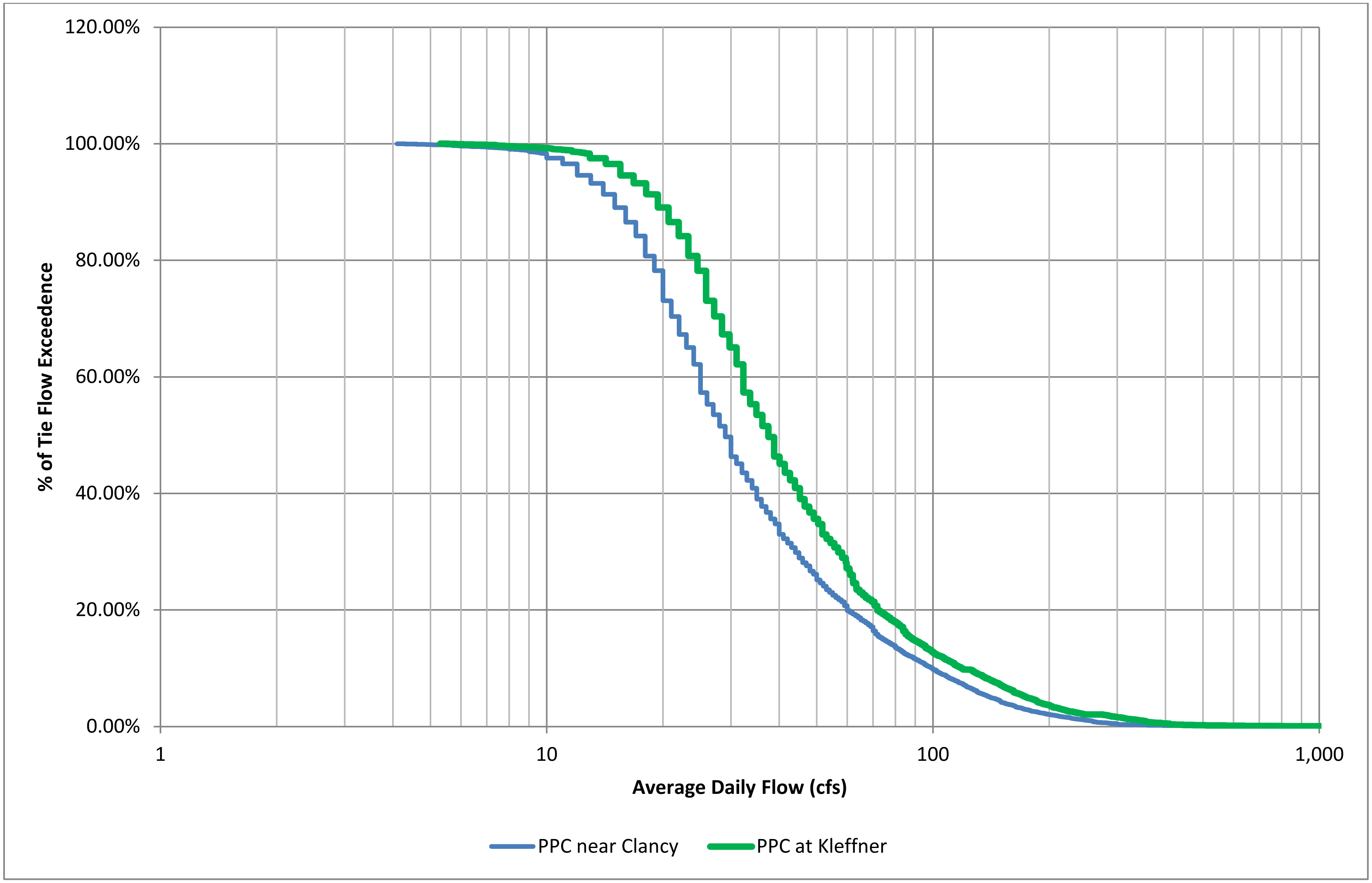
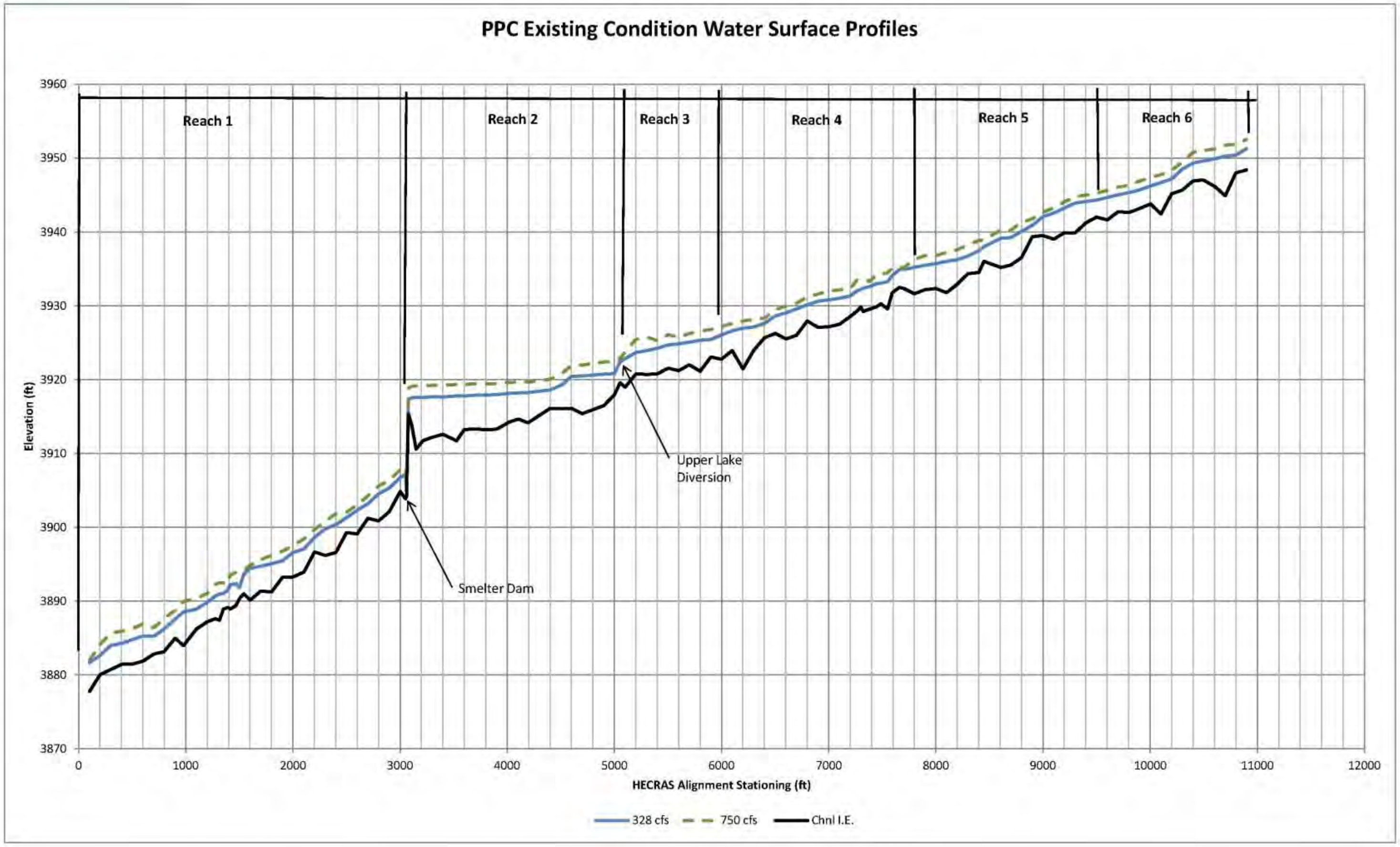


Figure 17. PPC Flow Duration Curve.



P:\CH2Mhill - METG\PPC Realignment\Data\H&H\PPC EC\Water Surface Profiles

Figure 18. PPC Existing Channel Water Surface Profiles.

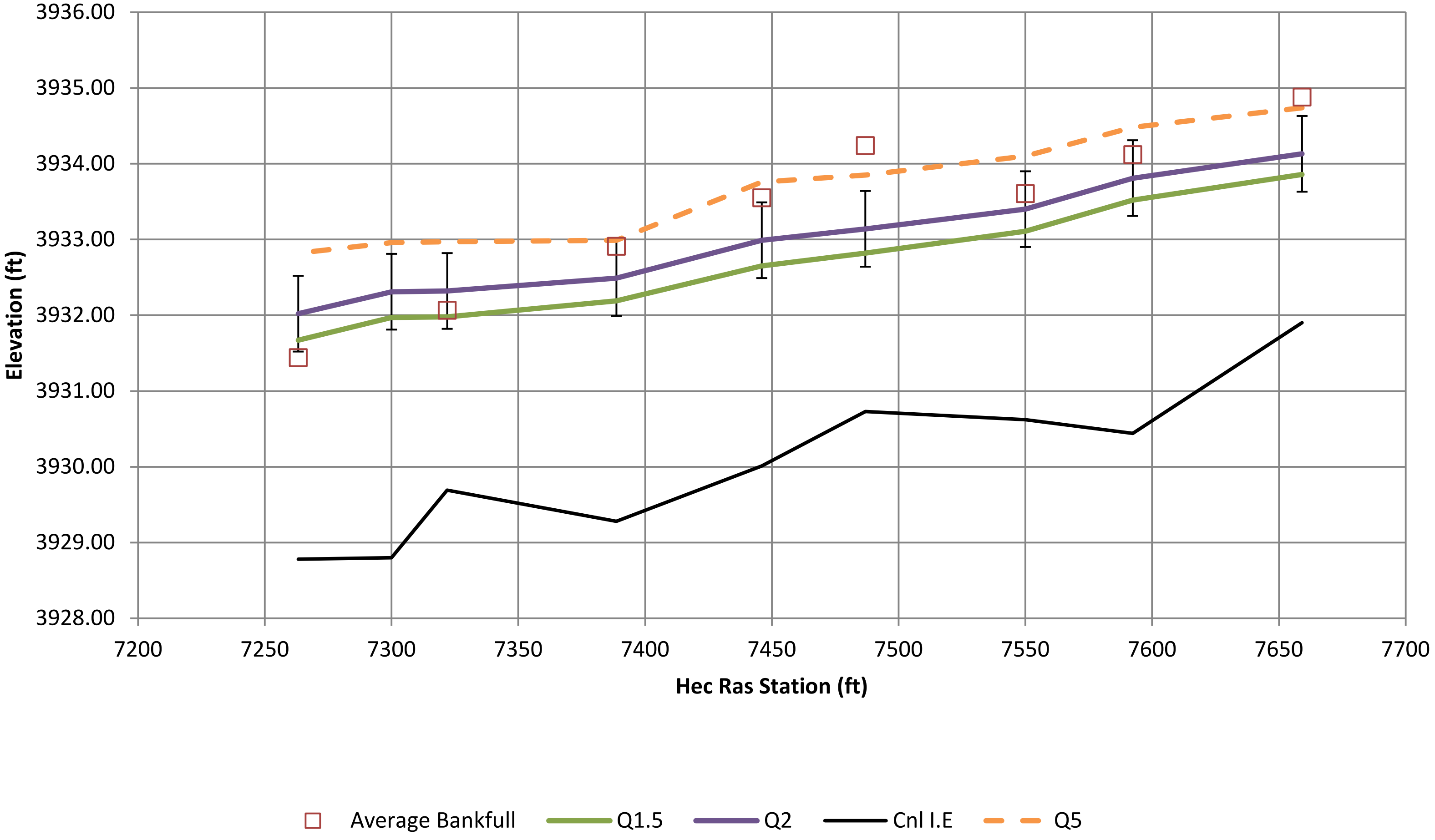


Figure 19. PPC Reference Site 1 Water Surface Profiles.

Figure 20. PPC Reference Site 2 Water Surface Profiles.

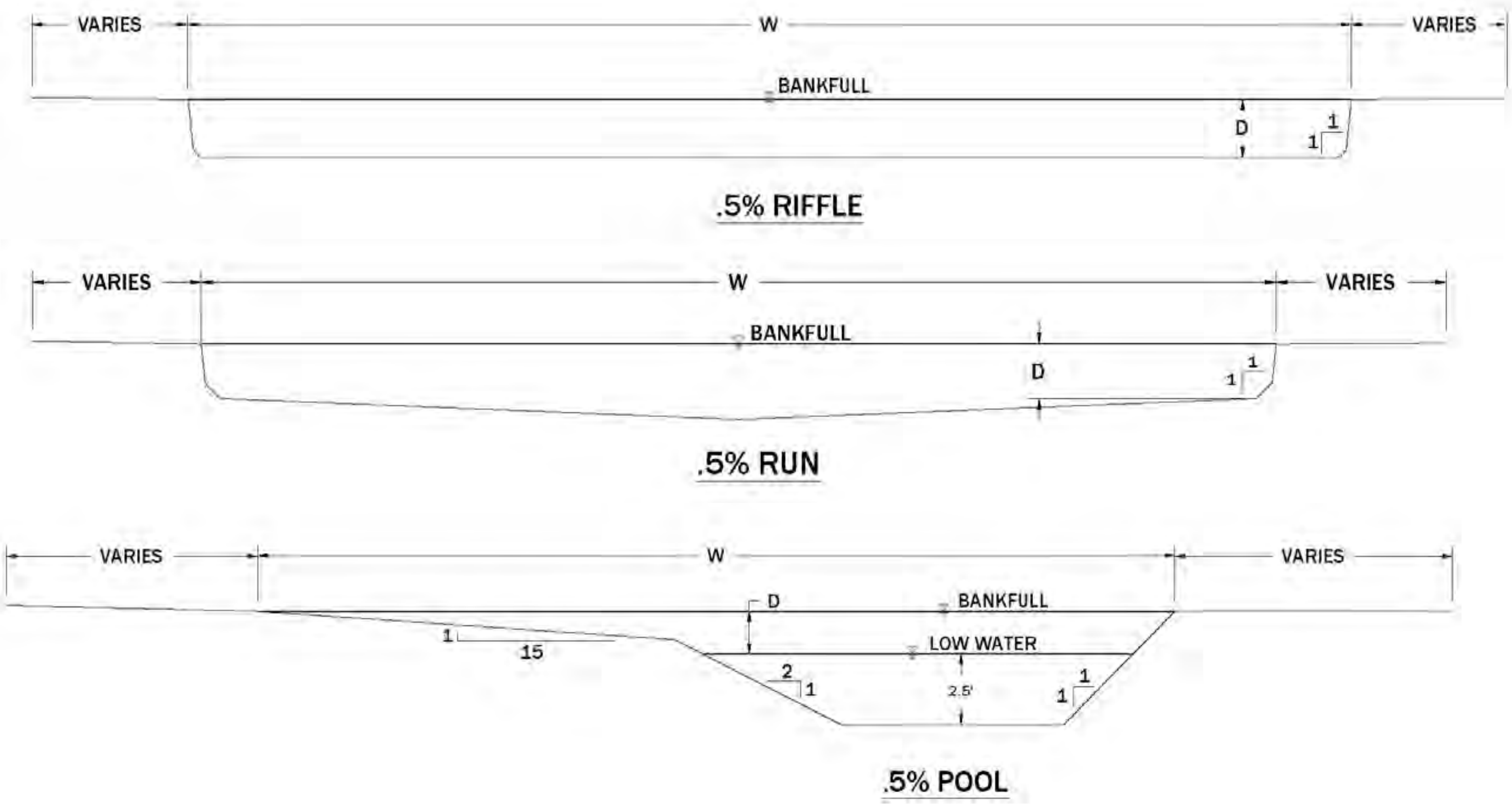


Figure 21: Cross-Section Templates.

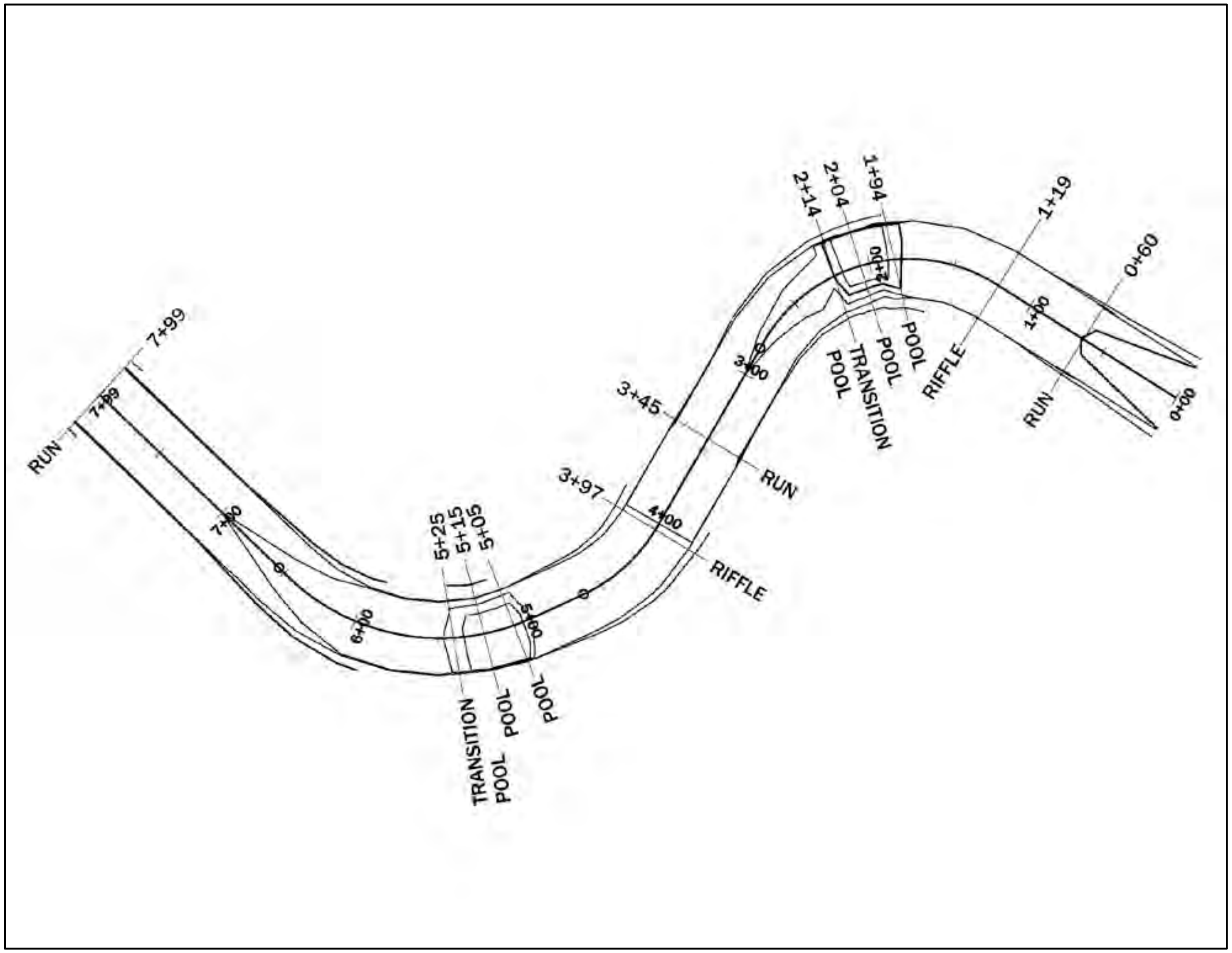


Figure 22. Design Template Plan View.

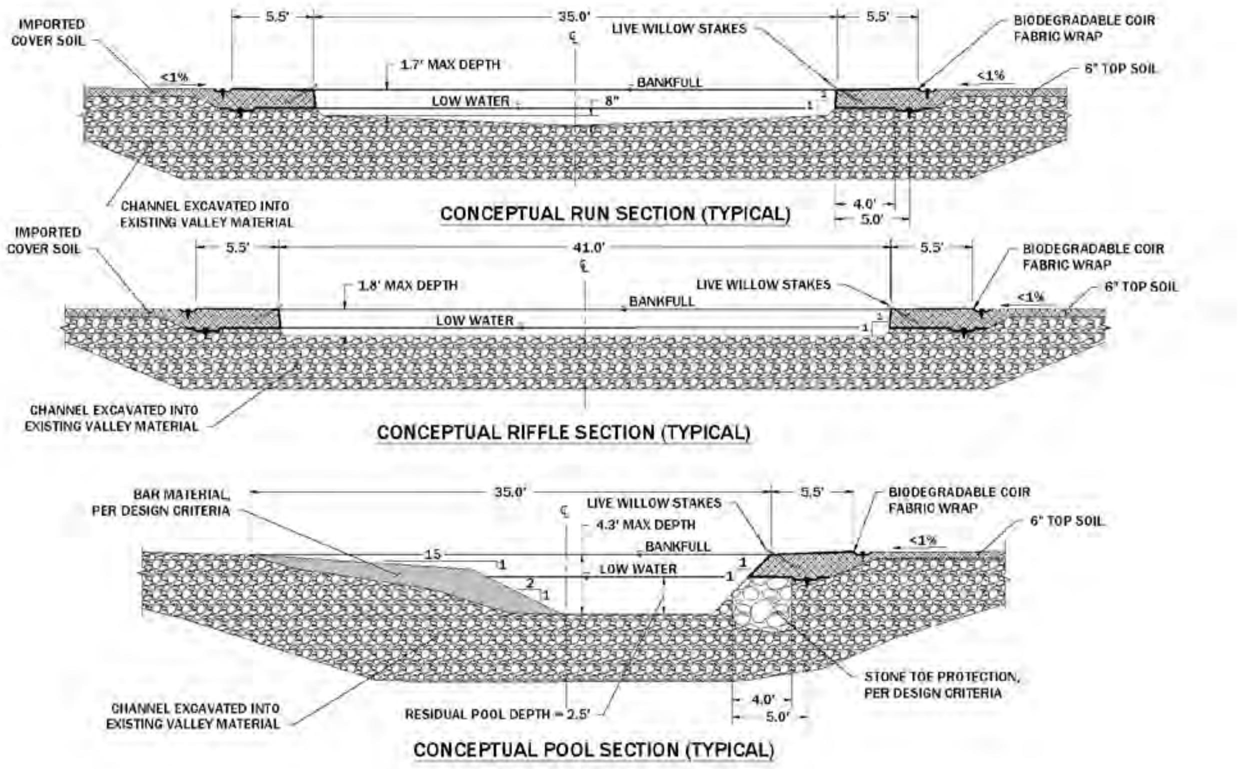
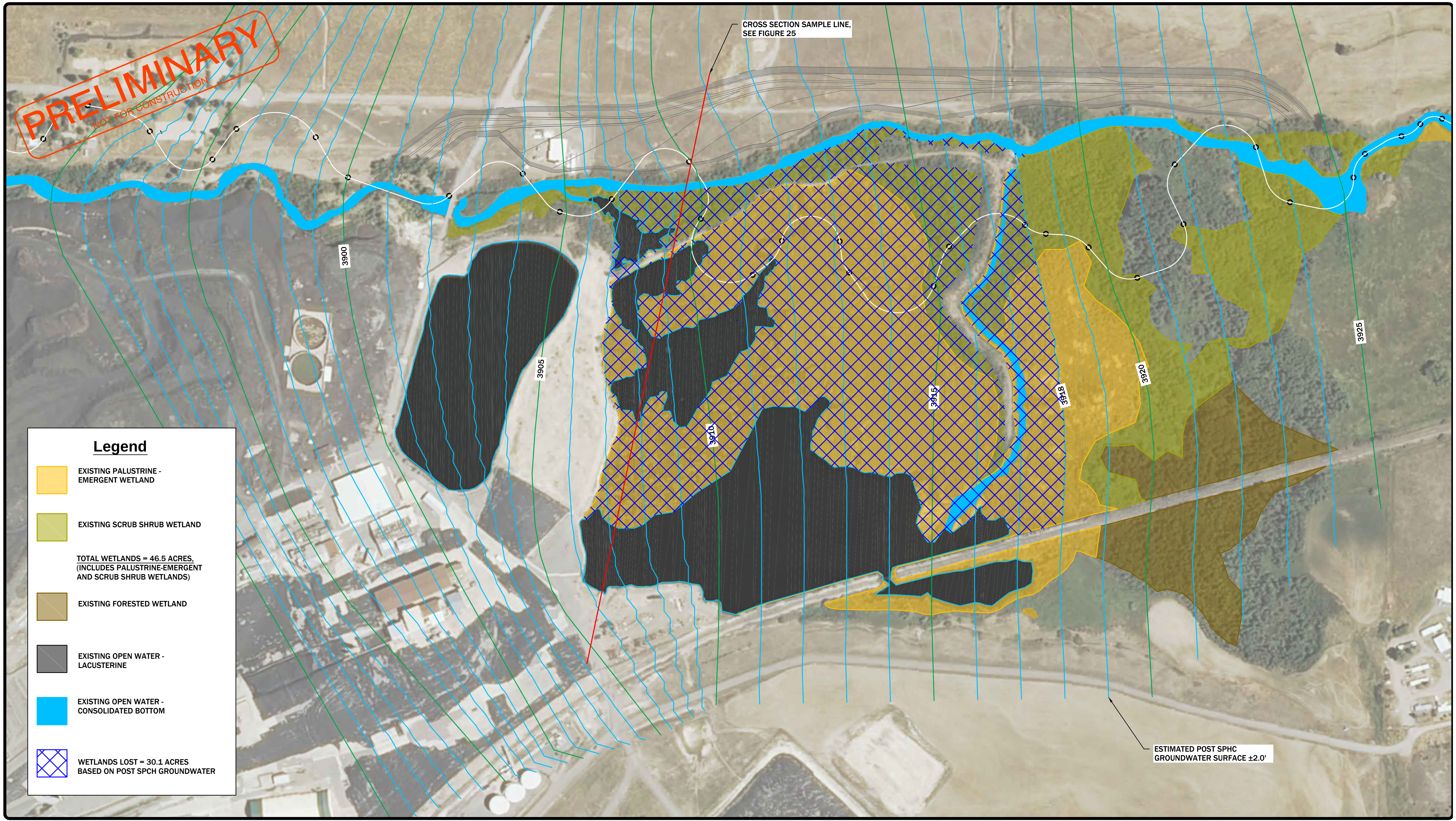


Figure 23. Conceptual Channel Cross Sections.



Legend

🟨	EXISTING PALUSTRINE - EMERGENT WETLAND
🟩	EXISTING SCRUB SHRUB WETLAND
	TOTAL WETLANDS = 46.5 ACRES, (INCLUDES PALUSTRINE-EMERGENT AND SCRUB SHRUB WETLANDS)
🟫	EXISTING FORESTED WETLAND
⬛	EXISTING OPEN WATER - LACUSTERINE
🟦	EXISTING OPEN WATER - CONSOLIDATED BOTTOM
▨	WETLANDS LOST = 30.1 ACRES BASED ON POST SPCH GROUNDWATER

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: MMI/HYDROMETRICS/PIONEER/NAIP 2011

SCALE IN FEET
0 150 300

FIGURE 24

PIONEER
TECHNICAL SERVICES, INC.
1101 S. MONTANA ST.
BUTTE, MONTANA 59701
(406) 782-5177

PRICKLY PEAR CREEK WETLAND HABITAT WITH PROPOSED GW PLAN VIEW

DATE: 3/28/13

4/1/2013 6:38:23 PM P:\CH2MHILL - METG\PPC REALIGNMENT\CAD\PRELIM WETLANDS\PPC-WTLND-FIG-001-13.DWG

Site Photos

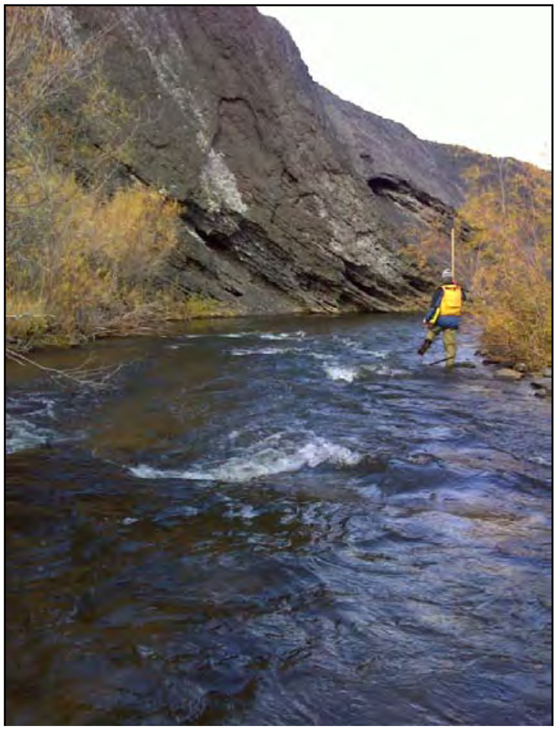


Photo 1. View Upstream in Reach 1 Showing Steep Cobble/Boulder Drop and Slag Pile in Background.

Photo 2. Active Erosion into Slag Pile, Reach 1.

Photo 3. Steep Grade Break in Channel Profile, Reach 1.

Photo 4. Right Bank Erosion into Coarse Alluvium/Colluvium, Reach 1.

Photo 5. Smelter Dam (Reach 1/Reach 2 Boundary).

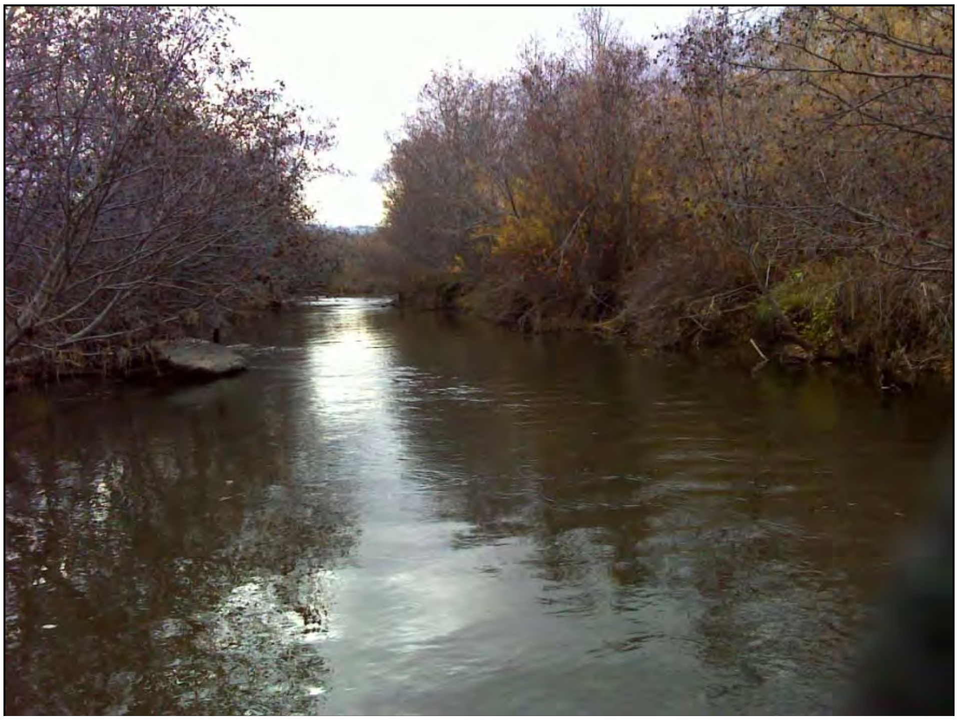


Photo 6. View Upstream of Reach 2 Showing High Banks, Low Gradient, and Dense Vegetation.

Photo 7. View Downstream of Reach 3; Note Stable Undercut Banks and Moderate Bed Slope.

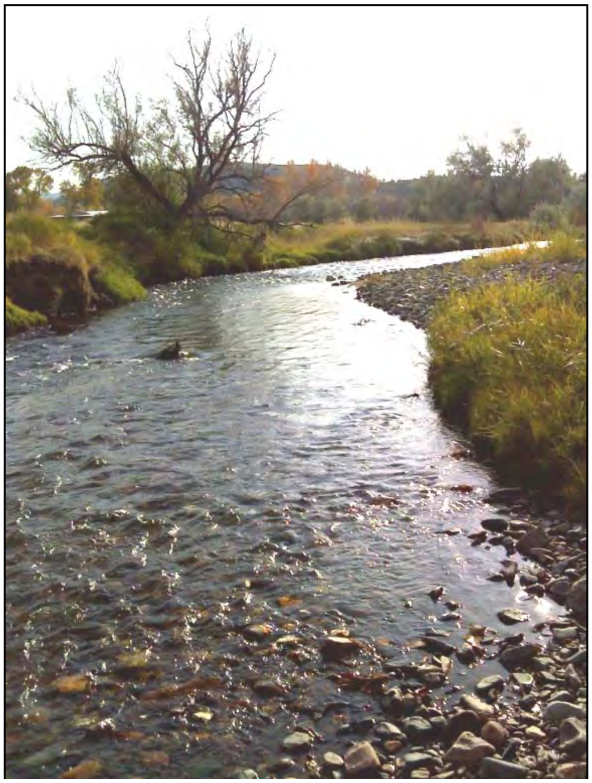


Photo 8. View Upstream of Reach 4; Note Coarse Substrate, Moderate Slope and Defined Point Bar.

Photo 9. View Downstream of Split Flow Segment in Reach 5; Note High, Broad Gravel/Cobble Bar.

Photo 10. View Upstream of Reach 6 Showing Railroad Grade/Bedrock Confinement.

Appendix A: Hydrology Calculation Summary

Date:	12/17/12	Project:	Prickly Pear Creek Realignment	Prepared By:	NJH
Rev. No.	3.0	Office:	Bozeman, Montana	Checked By:	GEA, JLG, EMG
Rev. Date:	06/25/13	Calc. No.	PPC-001	Approved By:	GEA
Subject:	Prickly Pear Creek Hydrologic Analysis				

PRICKLY PEAR CREEK HYDROLOGIC ANALYSIS

PURPOSE AND OBJECTIVES

As part of the East Helena Smelter Resource Conservation and Recovery Act (RCRA) Site, South Plant Hydraulic Controls Interim Measures (IM), Prickly Pear Creek (PPC) is proposed for realignment, which requires basin hydrology estimates for developing channel and floodplain designs. This calculation brief documents and summarizes the analyses completed to develop the basin hydrologic estimates, including:

- Supplementing the flood frequency analysis for the project site as necessary to support channel realignment and functional floodplain design;
- Developing a flow-duration curve for the project site; and
- Developing hydrologic calculations and interpretations to support bankfull discharge estimates.

The flood frequency analysis will be used for designing the stream channel, banks, floodplain, and armor infrastructure following the removal of the American Smelting and Refining Company (ASARCO) Smelter Dam and excavation of impacted sediments. The flow-duration curves established herein will be used in fish passage, sediment transport, and channel stability analyses. The bankfull estimates will be used to guide development of suitable channel size and main channel design criteria.

BACKGROUND

The PPC Permanent Realignment Project Site (Site) is located adjacent to and immediately southeast of the East Helena Smelter Site and extends approximately 1 mile south of Highway 12 (see Figure 1).

PPC lies in a snow-melt dominated watershed that flows in a northerly direction from the Elkhorn Mountains into the Helena Valley passing through East Helena prior to discharging into Lake Helena. Elevations in the watershed range from 9,381 to 3,651 ft. The drainage area at the Site is approximately 252 square miles (Figure 1).

The U.S. Geological Survey (USGS) maintains an active stream gaging station on PPC near Clancy, Montana (USGS 06061500) approximately 5.3 miles upstream from the Site. Between the Clancy gage and Site there are several perennial tributaries that contribute flow to PPC.

The Montana Department of Natural Resources (DNRC) and the Helena Water Quality District (HWQD) conduct seasonal stream flow monitoring on PPC at various locations between the Kleffner Ranch and Lake Helena. Kleffner Ranch is located approximately 4,500 feet upstream of Upper Lake.

Previous Hydrologic Studies

As part of the *Flood Insurance Study (FIS) for Lewis and Clark County, Montana and Incorporated Areas, Effective September 19, 2012* (FEMA 2012), hydrologic and hydraulic analyses were performed by USGS. The original study, completed in January 1979, covered all significant flooding sources affecting Lewis and Clark County. A revised hydrologic and hydraulic analysis was performed by Morrison-Maierle, Inc., for FEMA in 1983 and primarily covered the flooding sources in the Helena Valley (Tenmile and Prickly Pear Creeks). Results from these previous studies will be used for the floodplain modeling efforts, and the results presented and discussed in this calculation summary do not supplant or modify these previously accepted values.

Other Considerations

A dam built by the Northern Pacific railroad exists on McClellan Creek, which is a PPC tributary upstream from the Site and located on property currently owned by Ash Grove Cement (Ash Grove) in Montana City. The Northern Pacific railroad built the dam to store water in winter to produce ice that was harvested and stored for summer usage. The Northern Pacific dam has gates to control releases of water but the dam historically has been operated by Ash Grove with the gates wide open so no water storage is accrued behind the dam. No significant impacts to PPC stream flow estimates are expected based on past or anticipated future operations of this dam.

In 2011, a causeway with culverts constructed within the reservoir upstream of the dam, breached during a heavy runoff event. No damage to the dam was reported and the effect to the 2011 peak flow at the Site is unknown. Given the relatively large dataset available, effects on the flow estimates should not be significant.

FLOOD FREQUENCY ANALYSIS

Methods

Peak flows for select recurrence intervals were estimated using two methods:

- Bulletin #17B Evaluation of Gage Records using the methods described in *Guidelines for Determining Flood Flow Frequency* (Bulletin #17B, Interagency Advisory Committee on Water Data, 1981). The calculations were completed using the USGS PEAK FQ software; and

- Regional Regression Equations.

Peak Flood Estimation – Bulletin #17B Analysis

Flood frequency estimates at the Site were calculated by transferring the Bulletin #17B results from the PPC analysis near the Clancy station (based on annual, instantaneous peak-flow gage records) using a drainage area ratio adjustment between the un-gaged site and the gaged site.

The estimates were calculated for both the un-weighted and weighted results from the Clancy gage using the following equation (USGS, 2004):

$$Q_{TU} = Q_{TG}\left[\frac{A_U}{A_G}\right]^{expT}$$

Where:

Q_{TU} = T-year flood at the un-gaged site in cubic feet per second (cfs)
Q_{TG} = T-year flood at the gaged site in cfs
A_U = drainage area at the un-gaged site in square miles
A_G = drainage area at the gaged site in square miles
exp_T = regression coefficient relating the log of the T-year flood to the log of the drainage area.

Values for exp_T were obtained from Table 13 in *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998* (USGS, 2004). The above equation is applicable for area ratios in the range $0.5 < A_U/A_G < 1.5$. The area ratio at the Site is 1.3.

Peak Flood Estimation – Regression Equations

Flood frequency data for gaged sites may have errors due to large variability in annual peak discharges (time sampling errors), particularly if peak discharge records are short (USGS, 2004). To improve flood-frequency data at gaged sites, Bulletin #17B indicates that at-station flood frequency data can be weighted with estimated flood-frequency data from regional regression equations (USGS, 2004).

The flow frequency characteristics at the PPC near the Clancy gage were weighted with the results from the regression analysis (USGS, 2004) using the following relationship:

$$LOGQ_{TW} = \frac{LOGQ_{TE} \times EYR + LOGQ_{TR} \times LR}{EYR + LR}$$

Where:

$LOGQ_{TW}$ = weighted estimate for the T-Year flood in log units
$LOGQ_{TE}$ = estimated T-year flood based on regional regression equations in log units
EYR = equivalent years of record for the regional regression equation obtained from Table 4 in *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998* (USGS, 2004)

$LOGQ_{TR}$ = estimated T-year flood based on gaged record in log units
LR = number of years of gaged records

Regression equations relating peak flows at un-gaged sites to basin characteristics, bankfull widths and active channel widths were used as one of the methods to estimate flood peaks. A USGS report, entitled *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998* (USGS, 2004), describes the methods and provides estimates of the active and bankfull widths for the PPC near the USGS Clancy gage. Active width and bankfull widths for PPC at the Site were estimated from survey data and field observations. Active width and bankfull widths were used in the analysis rather than just the basin characteristics to improve the standard error of prediction. For the southwest region of Montana, the regression equation relies on drainage area (square miles) and percentage of the basin located above the 6,000 foot elevation, to predict estimated peak flood flows with recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years.

The following equation was derived from Bulletin #17B procedures and used to estimate the peak flow with a 1.5-year ($Q_{1.5}$) recurrence interval from the regression equation relationships for the peak flows with 2-year (Q_2) and 5-year (Q_5) recurrence intervals:

$$Q_{1.5} = Q_2 \left(\frac{Q_2}{Q_5}\right)^{0.52}$$

Stream Gage Data

USGS Gage 06061500 (PPC near Clancy) is located 4 miles northeast of Clancy, Montana, and approximately 5.3 river miles upstream from the Site (see Figure 1). Between the gage and Site are five unnamed drainages and three named drainages (Clark Gulch, McClellan Creek, and Holmes Gulch). These drainages are shown on USGS quad maps as either intermittent or perennial streams. This gage has operated actively and inactively since 1908 and has recorded70 water years of peak flow. The water years in which the gaging station was inactive include:

- 1917 to 1920
- 1934 to 1945
- 1971 to 197
- 2003 to 2005

There were also five years in which partial data were recorded but did not include the peak runoff event:

- 1908
- 1921
- 1954
- 1970
- 2011

Results

Bulletin #17B Estimates

Results for the flood frequency analysis conducted using data from the USGS PPC near Clancy gage are summarized in Table 1. Detailed calculation results are provided in Attachment A.

The accuracy of Bulletin #17B analyses can be estimated through confidence limits which define a range and specified probability that the peak flow lies within the range. Figure 2 shows the 95% confidence limits from the Bulletin #17B method calculations.

As stated previously in the Methods section, the Bulletin #17B analysis conducted for the PPC near the Clancy gage was weighted and transferred downstream to the Site using methods described in the *Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998* (USGS, 2004).

Flood frequency analysis results developed for the Lewis and Clark County Flood Insurance Study (FIS) are also included in Table 1. The FIS estimates are based on hydrologic analysis conducted in 1985 using methods similar to those applied in this study.

Regional Regression Calculations

Detailed flood flow estimate calculation results from the regional regression equations are provided in Attachment B and summarized in Table 2.

The accuracy of the regression equations can be measured using the average standard error of prediction. The true value of a predicted peak flood by the regression equations will be within +/- one standard error of prediction (two out of every three times). The average standard error of prediction for the PPC near the Clancy gage regression equation results are presented in Table 2. These results range from a high of 81.4% for the 2-year flood to a low of 63.3% for the 50-year flood.

Another method of measuring regression equation accuracy is through the equivalent years of record (EYR). EYR is the number of years of recorded flow data that would need to be collected to provide flood peak estimates with the same accuracy as the regression equations. For the southwest region, the EYR required ranges from 0.9 years for the 2-year flood to 5.3 years for the 500-year flood (Table 4, USGS 2004). These relatively short periods indicated low accuracy for the regression equation results, especially for less frequent (higher flow) events.

A third method of measuring accuracy is through confidence limits which define a range above and below the regression equation results. Within this range, it is known with a certain probability that the true value of the N-year peak flood lies. Figure 2 plots the 90% confidence limits for the regression equation results provided in Table 2.

Discussion

Figure 2 compares the 95% confidence limits from the Bulletin #17B analysis to the 90% confidence limits from the regression equation method for the PPC near the Clancy gage. In general, the confidence limits for the Bulletin #17B analysis are narrower than the confidence interval for the regression equations, indicating more reliable results from the Bulletin #17B analysis. Given the long period of record used in the Bulletin #17B analysis, it is likely that peak flow estimates obtained for the gaging station near Clancy are more accurate than the results estimated from the regression equations.

Based on the Bulletin #17B methods, the FIS estimates represent the largest peak flow estimates for a given recurrence interval. The FIS does not include flood frequency calculations, only methods and summary results. As part of the Federal Emergency Management Agency (FEMA) project permitting requirements, the project will use the FIS estimates for peak flows with the 100-year and 500-year recurrence intervals. The PPC channel realignment design will not use the 100-year or 500-year peak flows to develop channel geometry. Therefore, no attempt was made to duplicate the FIS estimates for the purposes described in this calculation summary.

Credible extrapolation of gaged data in flood frequency analysis generally is limited to twice the gage record length (IACWD, 1982). The Bulletin #17B method estimates are based on 70 years of data, which should produce credible flood frequency estimates up to a recurrence interval of 140 years. The greater accuracy of the Bulletin #17B based estimates, coupled with the long gage record, support the selection of the Bulletin #17B estimates for use in the PPC realignment design.

Applying the weighted peak flow estimates produces small but measurable increases in the peak flow magnitudes. For the PPC realignment design, the weighted Bulletin #17B estimates adjusted to the Site will be used for peak flow values for recurrence intervals less than 100 years. Peak flow estimates for recurrence intervals of 100 years and greater will use the FIS estimates to remain consistent with the FIS modeling and studies.

Table 3 shows the proposed peak flow values and recurrence intervals selected for design of the PPC realignment.

FLOW-DURATION CURVE

Methods

The flow-duration curve was constructed by sequencing the daily average flow series in decreasing order with each flow value being ranked (assigned an order number). For each flow value, the percent time was defined as the ratio of its order number to the total number of days and the curve was obtained by plotting flow versus percent time.

Daily average flows at the Site were estimated by developing a linear regression flow correlation between the PPC near Clancy gage and the PPC at the Kleffner gage. The regression equation was applied to estimate a daily average flow record at the Site with the equivalent years of record as the PPC near Clancy gage. A flow-duration curve was calculated, as described above from this transferred flow record. Only the water years with complete data from July 1908 through October 2011 were used in the flow-duration curve calculations.

Stream Gage Data

Data sources available for this flow-duration analysis included:

- USGS Gage 06061500 Prickly Pear Creek near Clancy (Active).
- USGS Gage 06062000 Prickly Pear Creek at East Helena(Inactive).
- USGS Gage 06061900 McClellan Creek near East Helena (Inactive).
- DNRC data, Prickly Pear Creek at the Kleffner Ranch.
- HWQD PPC Data:
  - PPC at Highway 12;
  - PPC near Wylie Drive; and
  - PPC at Canyon Ferry Drive.

Gaging station locations are shown on Figure 1.

USGS Gage 06061500 Prickly Pear Creek near Clancy was described previously in the flood frequency analysis section.

USGS Gage 06062000 Prickly Pear Creek at East Helena was located at PPC on the south side of Highway 12. The gage was operated continuously between 7/1/1908 and 9/30/1913. Review of these data indicate that much of the flow data appear to be estimated rather than measured. Detailed records of land and water resource use during this time period is not available, and determining the basis for the stream gains or losses of flow would be difficult to establish with measurable certainty. Therefore it was determined that the East Helena data were unsuitable for establishing a correlation between the PPC at the East Helena gage and the PPC near the Clancy gage, so were not used in the analysis.

USGS Gage 06061900 McClellan Creek near East Helena was located on McClellan Creek approximately 1.75 miles southeast (upstream) from the Northern Pacific Reservoir and operated intermittently between 9/1/1988 and 9/30/1990 collecting data between the following dates:

- 9/01/1988 to 11/28/1988
- 4/01/1989 to 9/30/1989
- 3/30/1990 to 9/30/1990

Because of the limited period of record and the fact that the gage is located above the reservoir, this gage was not used in the flow-duration analysis.

A seasonal DNRC gage is located on PPC at Kleffner Ranch approximately 0.35 miles upstream of the Site proximal to the Kleffner Ranch buildings. The gage is inactive during the winter months and has collected data between the following dates:

- 7/16/2005 to 11/08/2005
- 6/22/2007 to 11/15/2007
- 4/17/2008 to 11/20/2008
- 4/20/2009 to 11/16/2009
- 8/30/2011 to 10/31/2011
- 6/04/2012 to 11/06/2012

There are no PPC tributary flow inputs between the PPC at Kleffner Ranch gage and Site. This gaging site is located upstream of the Upper Lake diversion; therefore, was determined to be a good candidate for translating daily average flow estimates of the USGS PPC near Clancy gage to the Site.

All the HWQD PPC gaging stations are located downstream of the Upper Lake diversion and may not represent the full flow of PPC. Therefore, the HWQD data were not used in this hydrologic analysis.

Results

Figure 3 shows the daily average flow correlation between the PPC at Kleffner gage and the PPC near Clancy gage. Figures 4 through 9 compare the daily average flow data of the DNRC PPC at Kleffner gage with the USGS PPC near Clancy gage for the coincident periods of record. Figure 10 plots the flow ratio values calculated between the PPC at Kleffner gage and the PPC near Clancy gage.

The hydrographs indicate a relatively consistent relationship between the PPC at the Kleffner gage data and the PPC near Clancy data, where 90% of the time flows at the Kleffner Ranch are greater than or equal to the flows measured at the PPC near Clancy gage. One exception where the PPC at Kleffner gage is significantly less than the PPC near Clancy gage occurs during the time period of 8/15/07 to 9/19/07. This flow discrepancy is interpreted to be associated with either an instrumentation error related to a change in the measurement instrumentation or a significant, temporary diversion. This anomalous range was excluded from the flow correlation calculations shown on Figure 3. Other data ranges where the PPC at Kleffner flow data are less than the PPC near Clancy are interpreted to be within the potential measurement error (10 to15%). The correlation results combined with the hydrographs indicate there is a relationship between the two gages supporting translation of the flow data using a regression equation. Therefore, these data were used to develop a daily average flow ratio between the USGS PPC near Clancy gage and the DNRC PPC at the Kleffner gage. Table 4 summarizes the results of the flow ratio calculations.

The flow correlation shown in Figure 3 has an R^2 (coefficient of determination) value equal to 0.94. The R^2 value is a statistical measure, between 0 and 1, of how well the regression line approximates the real data points. An R^2 of 1 indicates that the regression line perfectly fits the data. The closer the R^2 value is to one the better the approximation. Typically an R^2 value of 0.80 is considered an acceptable value; therefore an R^2 of 0.94 indicates the correlation equation shown in Figure 3 is an acceptable approximation of flows at the site.

The correlation equation shown in Figure 3 was used to develop daily average flow estimates for PPC at Kleffner based on the USGS PPC near Clancy gage daily average flow data.

Figure 10 plots the flow-duration curves for PPC near Clancy and PPC at the Kleffner gage. Table 4 presents the flow durations in days per year for PPC near Clancy and the Site. The flow increments shown in Table 4 are based on the anticipated flow increments to be used in the channel stability analysis which is documented in Appendix C of the Engineering Design Report.

Discussion

The flow-duration curve developed for the Site is based on daily average flow data from PPC near Clancy, translated to the Site using a linear regression relationship between the PPC at Kleffner and the PPC near Clancy. These results will be used to support sediment transport calculations in the Existing Condition Channel Stability analysis (Appendix C of the Engineering Design Report).

BANKFULL DISCHARGE ESTIMATE

One method of estimating bankfull discharge or channel forming discharge values uses empirical relationships between the bankfull discharge and a stream flow recurrence interval. Empirical studies indicate that for most streams the bankfull flow has a recurrence interval approximately equal to 1.5 years (Leopold, 1994). However, large variability in the recurrence interval can be associated with the bankfull discharge, which can have recurrence intervals ranging from 1 to 32 years (Hey, 1997). Therefore, other bankfull estimation method tools will be used in addition to recurrence intervals. Flow frequency estimates developed in this analysis (Table 3) would place the bankfull discharge estimate at approximately 250 to 330 cfs and corresponding to a recurrence interval of 1.5 to 2 years.

Another method of estimating bankfull discharge is associated with flow-duration characteristics. Bankfull discharge in snowmelt dominated basins typically occurs between 7 and 14 days per year (Wilkerson, 2008). Based on the flow-duration curve developed in this analysis, the flow range of 200 to 300 cfs corresponds to a 9-day duration (Table 4) which is within the 7-14 days per year interval.

Lawlor (2004) completed a detailed analysis of USGS gaging data at 41 sites in western Montana and proposed that the bankfull discharge is approximately 84% of the 2-year discharge as shown by the following:

$$Q_{bf} = 0.84(328) = 276 \text{ cfs}$$

The bankfull discharge estimates will be further developed using the existing condition hydraulic model and the fluvial geomorphic indicators developed as part of the fluvial geomorphic analysis. The final selected bankfull flow estimate and will be documented in the Engineering Criteria technical memorandum (Appendix D Engineering Design Report).

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DOCUMENT REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	Team	Draft	For Internal Pioneer Review	12/17/12
Rev 1	Team	Draft	For CH2M Hill/EH Team Review	12/31/12
Rev 2.3	Team	Draft Final	For Client/Stakeholder Distribution	04/08/13
Rev 3	Team	Final	For Client/Stakeholder Distribution	06/25/13
Rev 4				

TABLES

Table 1
Flood Estimates of Prickly Pear Creek

Method (Site)	Drainage Area (sm)	Estimated Peak Flow (cfs) Recurrence Interval (years) 1.5	2	5	10	25	50	100	200	500
Bulletin 17B Analysis of Gage Records 1911 - 1998 (Gage near Clancy) USGS 2004	189.1	186	247	428	577	813	1030	1280	1580	2060
Bulletin 17B Analysis of Gage Records 1911 - 2011 (Gage near Clancy)	189.1	197	254	435	590	829	1043	1291	1577	2024
USGS Regression Equations (Gage near Clancy)	189.1	247	331	579	799	1160	1490	1880	2330	3020
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Weighted	189.1	192	255	438	596	842	1063	1321	1618	2082
USGS Regression Equations (Project Site (Highway 12)	251.9	481	611	966	1260	1710	2120	2580	3110	3930
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Adjusted to Site	251.9	252	327	542	723	999	1243	1523	1842	2338
Bulletin 17B Analysis of Gage Records (Gage near Clancy) Weighted Adjusted to Site	251.9	252	328	545	730	1015	1268	1558	1890	2405
Flood Insurance Study Values 1908-1985(Project Site)	252			*680	890	*1250	1710	2190		3500

*Note: Interpolation from September 2012 Flood Insurance Study

Table 2
Regression Equation Results

Location: USGS Gage PPC Near Clancy				
METHOD: Regression on basin characteristics, active channel width = 27 ft, bankfull width = 31				
Southwest Region: A = 189.14, E6,000 = 27				
Return Interval	Discharge (cfs)	Standard Error of Prediction	90% Prediction Interval	
2	331	49.8	150.2	730
5	579	47.2	272.6	1230
10	799	51.3	354.8	1800
25	1160	58.0	469.2	2870
50	1490	63.3	563.1	3960
100	1880	68.6	663.1	5340
200	2330	73.9	767.7	7060
500	3020	81.4	910.4	10000
Location: PPC at Project Site (Highway 12)				
METHOD: Regression on basin characteristics, active channel width = 43 ft, bankfull width= 45 ft				
Southwest Region: A = 251.92, E6,000 = 26				
Return Interval	Discharge (cfs)	Standard Error of Prediction	90% Prediction Interval	
2	611	50.1	276	1350
5	966	47.4	453.2	2060
10	1260	51.6	555.7	2840
25	1710	58.4	687.7	4240
50	2120	63.8	793.3	5650
100	2580	69.1	904.7	7380
200	3110	74.5	1020.0	9510
500	3930	82.1	1180.0	13100

Table 3
Prickly Pear Creek Realignment Design Peak Flows and Recurrence Intervals

	Recurrence Interval (years)							
	1.5	**2**	**5**	**10**	**25**	**50**	**100**	**500**
Flow(cfs)	252	328	545	730	1015	1268	2190	3500

P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\FFA PPC Regresion Equations (2)

Table 4

Flow Duration Curve Summary

PPC Near Clancy

Days In Record 26298

Flow Range (cfs)	Days in Record	% of Record	Days per Year
750+	11	0.04%	0.2
400+-750	36	0.14%	0.5
300+ -400	52	0.20%	0.7
200-300	441	1.68%	6.1
150-200	552	2.10%	7.7
100-150	1478	5.62%	20.5
50-100	4047	15.39%	56.2
20-50	12595	47.89%	174.8
0-20	7086	26.95%	98.3
	26298	100%	365

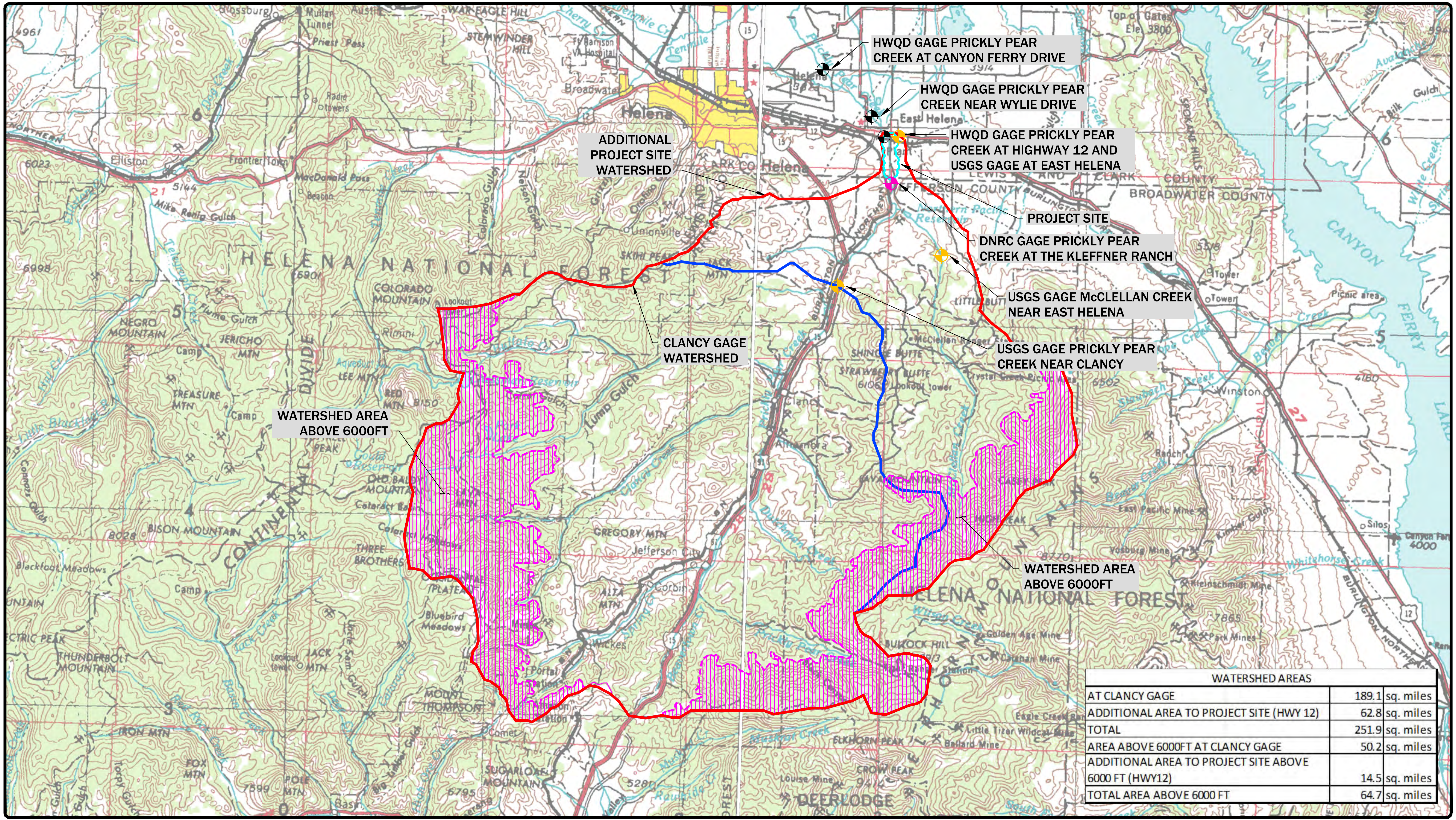
PPC at Project Site

Days In Record 26298

Flow Range (cfs)	Days in Record	% of Record	Days per Year
750+	19	0.07%	0.3
400+ -750	63	0.24%	0.9
300+ -400	241	0.92%	3.3
200+ -300	655	2.49%	9.1
150+ -200	941	3.58%	13.1
100+ -150	1728	6.57%	24.0
50+-100	5723	21.76%	79.4
20+-50	14645	55.69%	203.3
0-20	2283	8.68%	31.7
	26298	100%	365

[1] Estimated from PPC near Clancy flow records

FIGURES



WATERSHED AREAS		
AT CLANCY GAGE	189.1	sq. miles
ADDITIONAL AREA TO PROJECT SITE (HWY 12)	62.8	sq. miles
TOTAL	251.9	sq. miles
AREA ABOVE 6000FT AT CLANCY GAGE	50.2	sq. miles
ADDITIONAL AREA TO PROJECT SITE ABOVE 6000 FT (HWY12)	14.5	sq. miles
TOTAL AREA ABOVE 6000 FT	64.7	sq. miles

⊕ HWQD GAGE

⊕ USGS GAGE

⊕ DNRC GAGE

N

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD 83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 7,500 15,000

FIGURE 1

PIONEER
TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT WATERSHED MAP

DATE: 2/15/13

2/20/2013 4:48:27 PM \\192.168.253.15\PROJECT$\HELENADATA\METG\CONTRACT #7 PERMANENT PPC\DRAWINGS\FIGURE A.1 WATERSHED MAP.DWG

Figure 2

Comparison of Confidence Limits at PPC Gage near Clancy

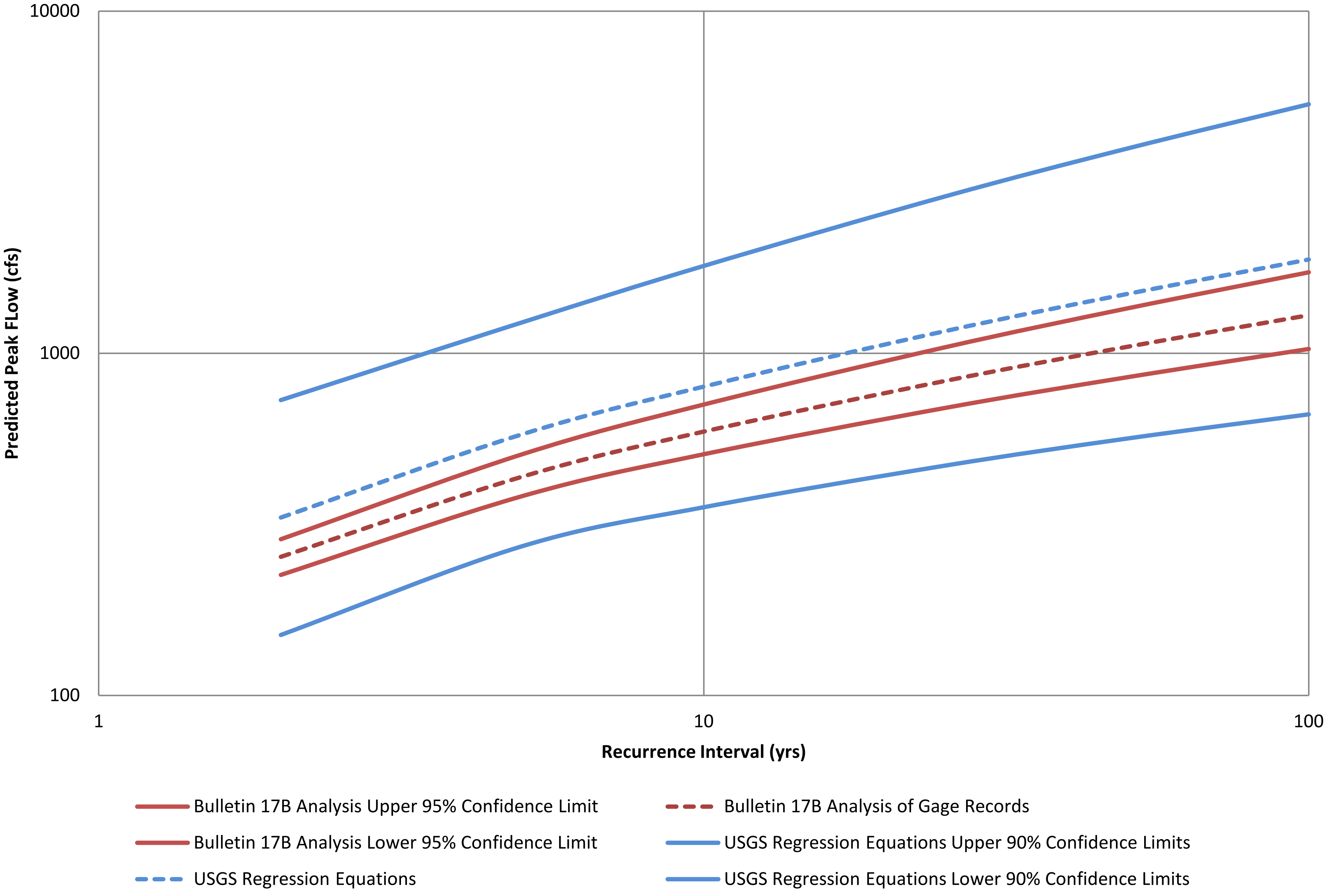


Figure 3
Flow Correlation Between PPC at Kleffner Ranch Gage and PPC near Clancy Gage

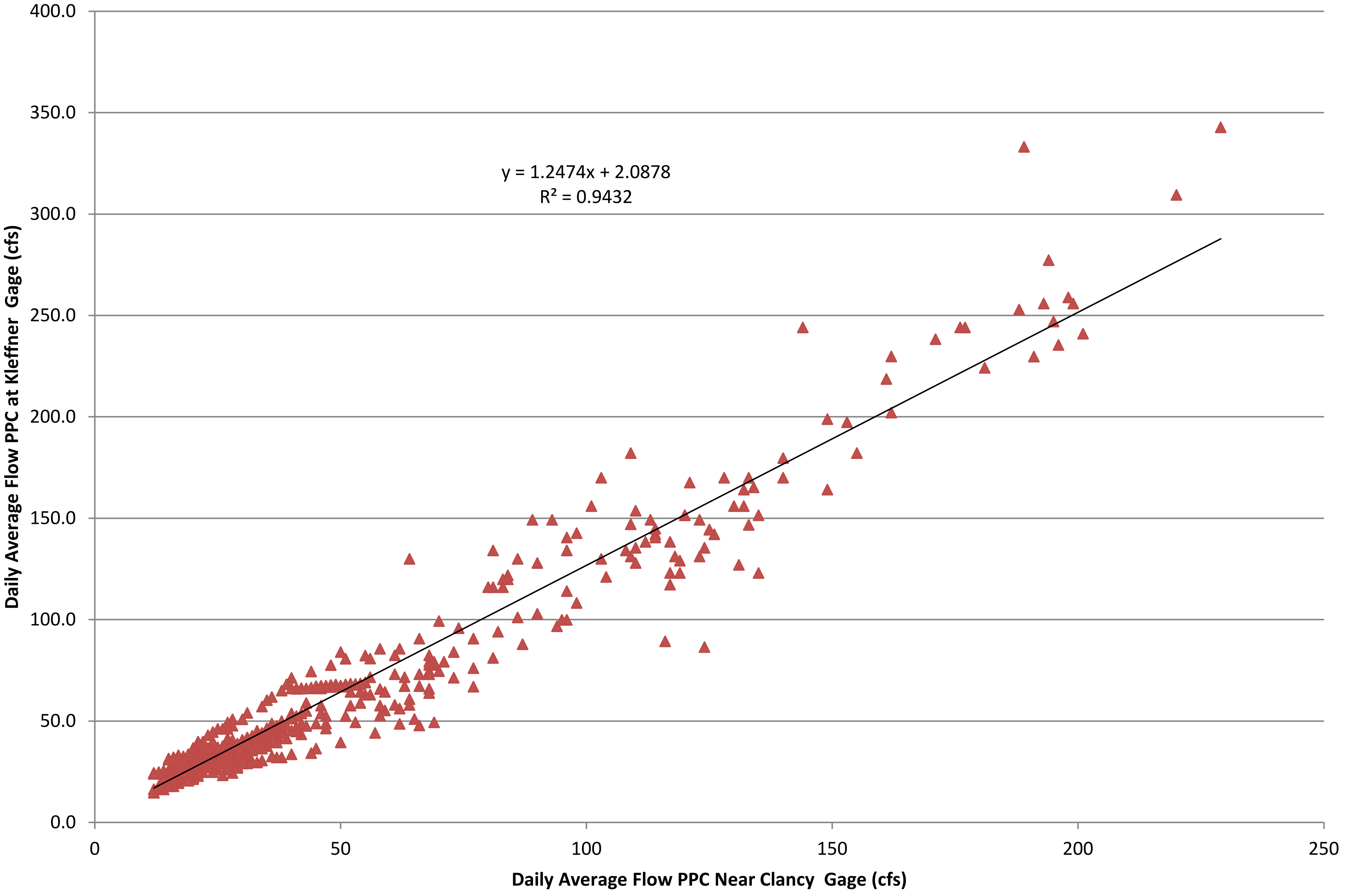
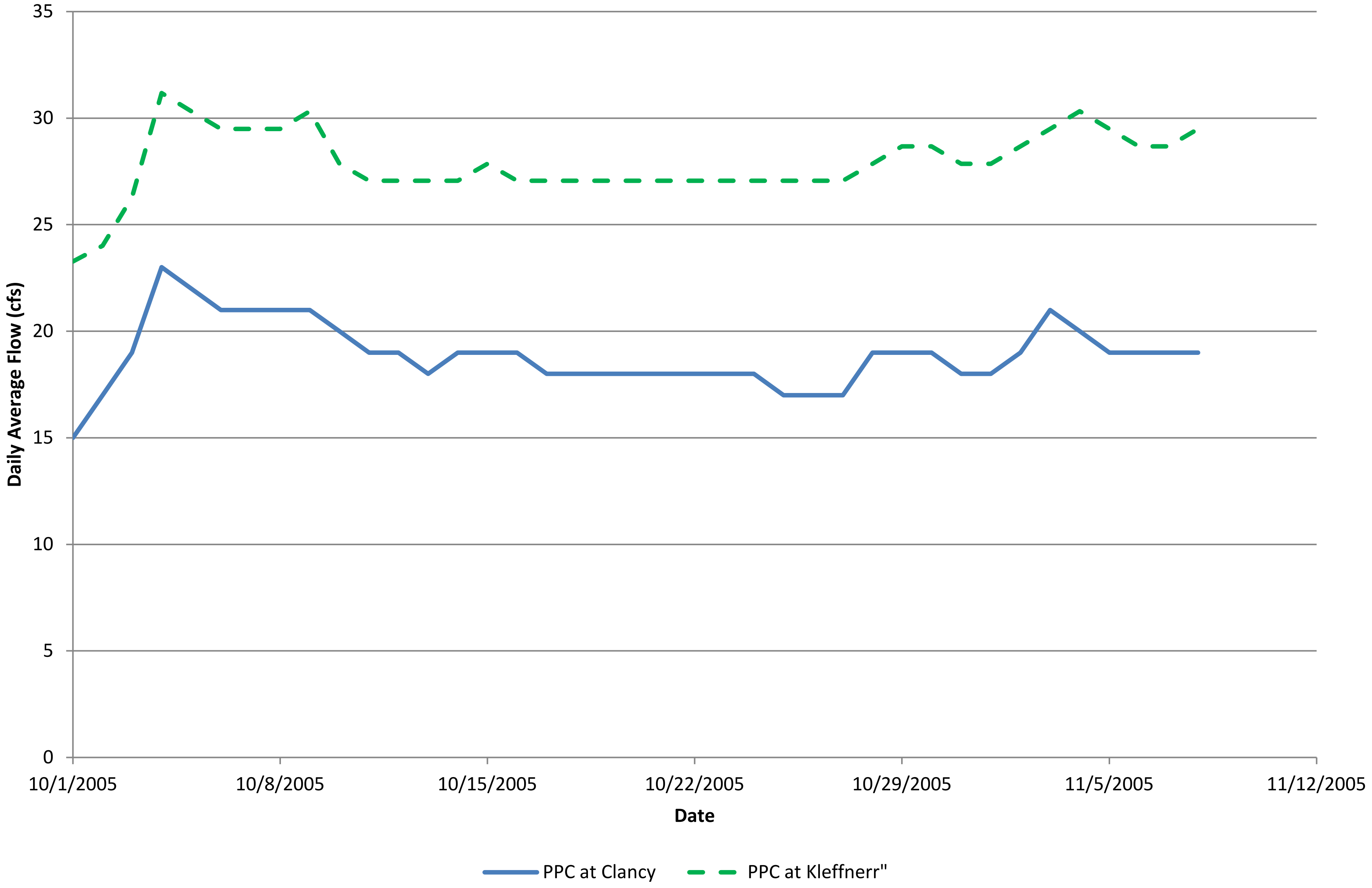
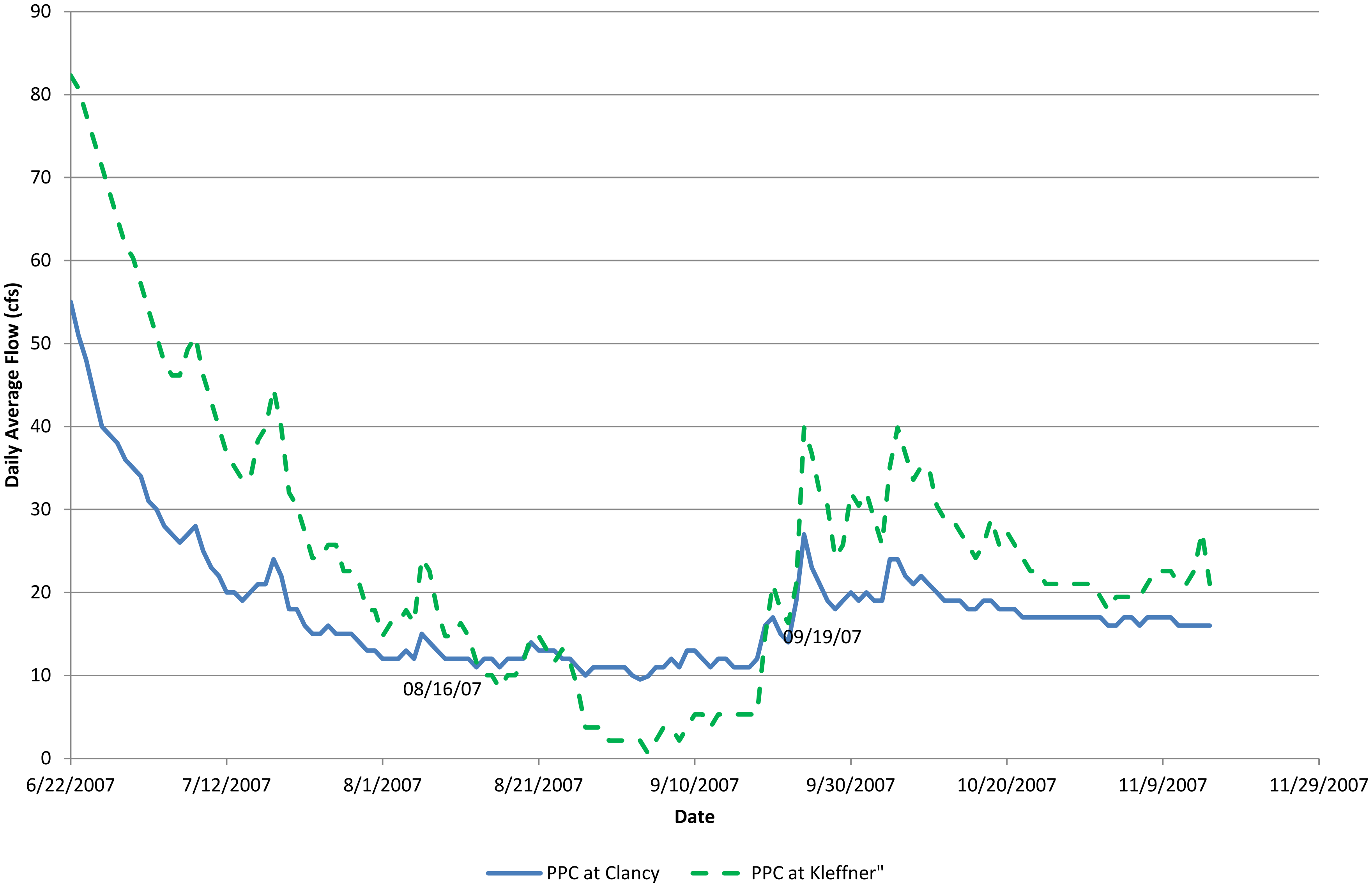


Figure 4
Prickly Pear Creek Hydrograph
Kleffner Gage Compared with Clancy Gage



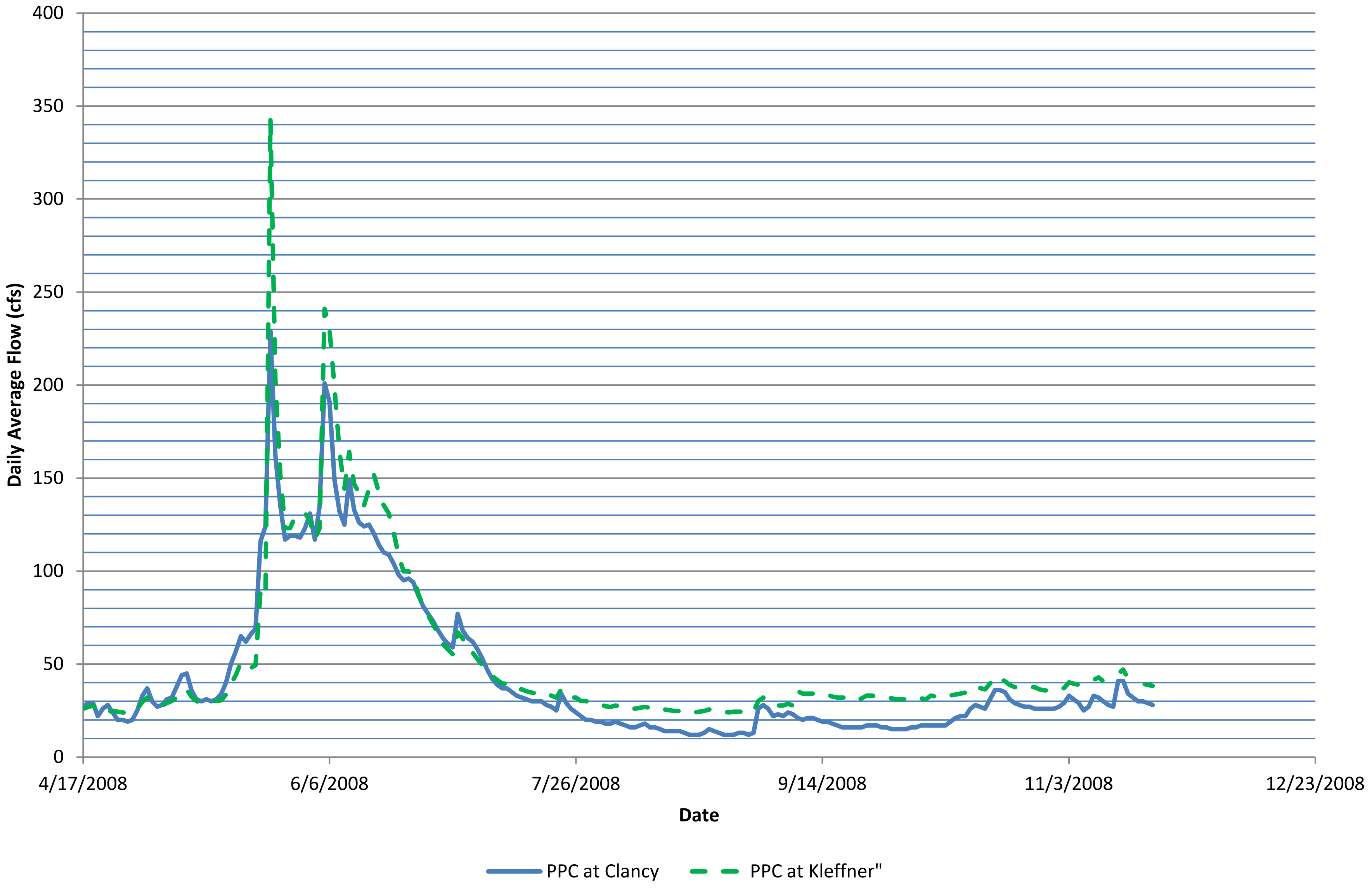
P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13

Figure 5
Prickly Pear Creek Hydrograph 2007
Kleffner Gage Compared with Clancy Gage

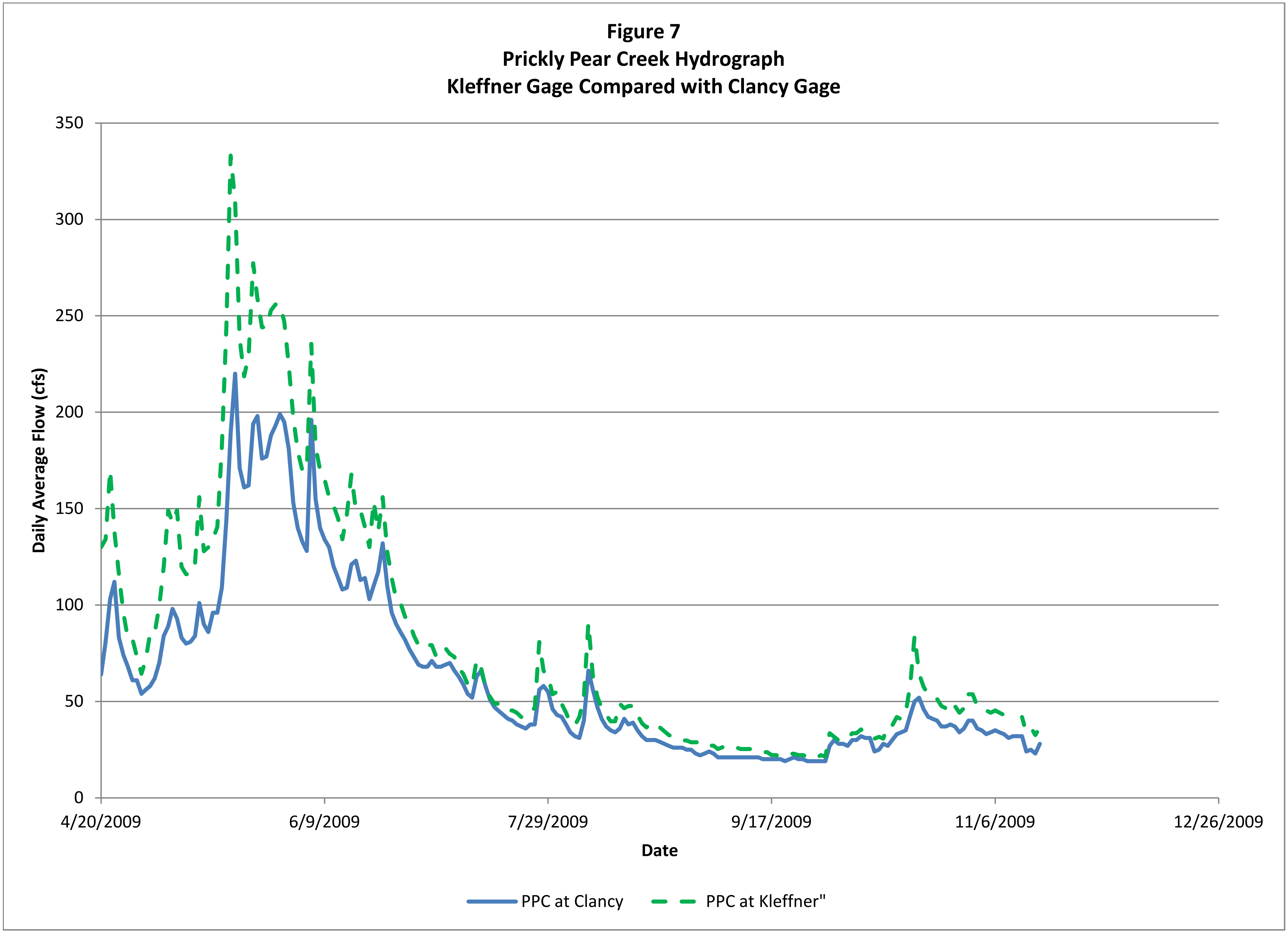


P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13

Figure 6
Prickly Pear Creek Hydrograph
Kleffner Gage Compared with Clancy Gage

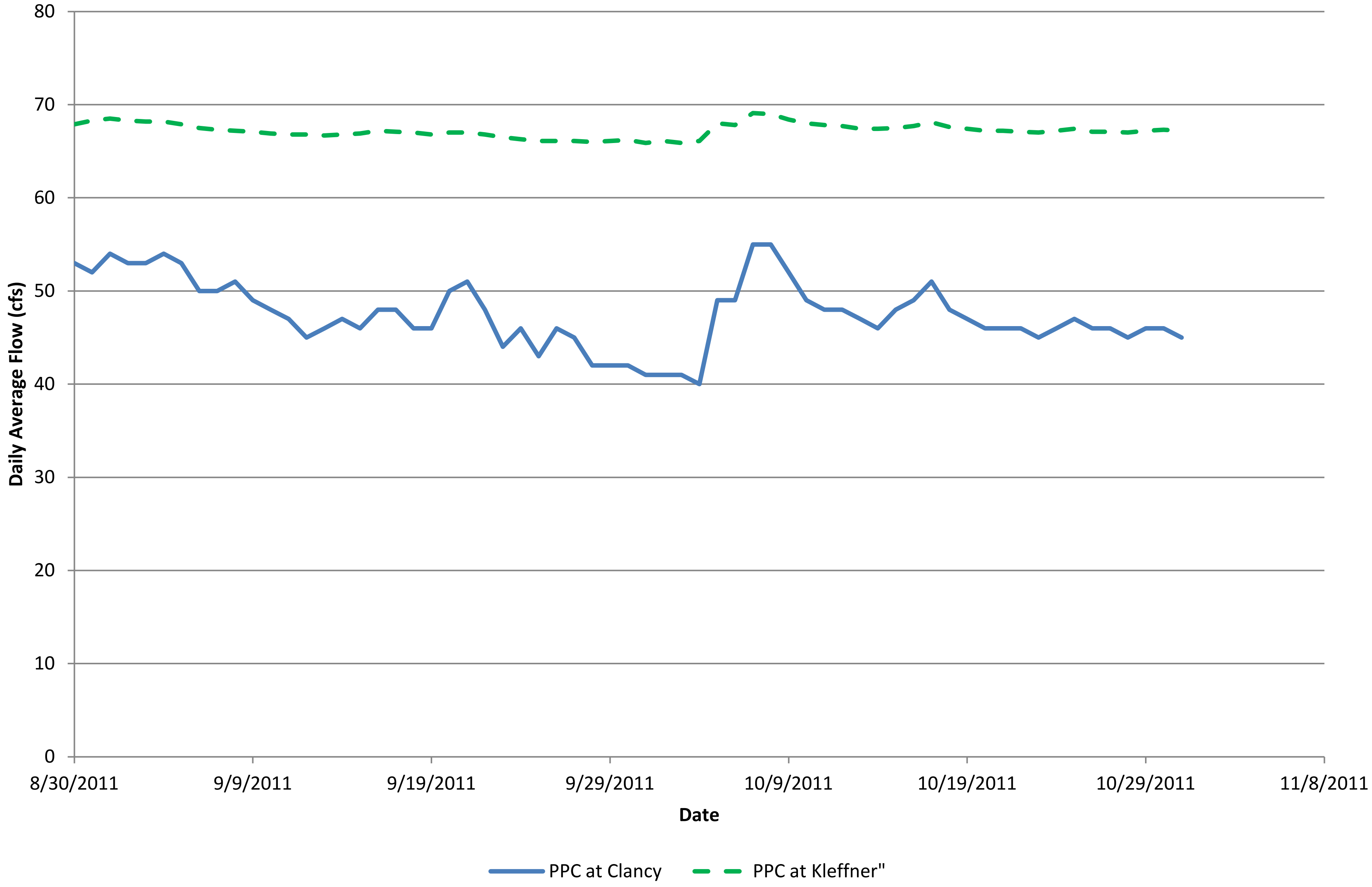


P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13



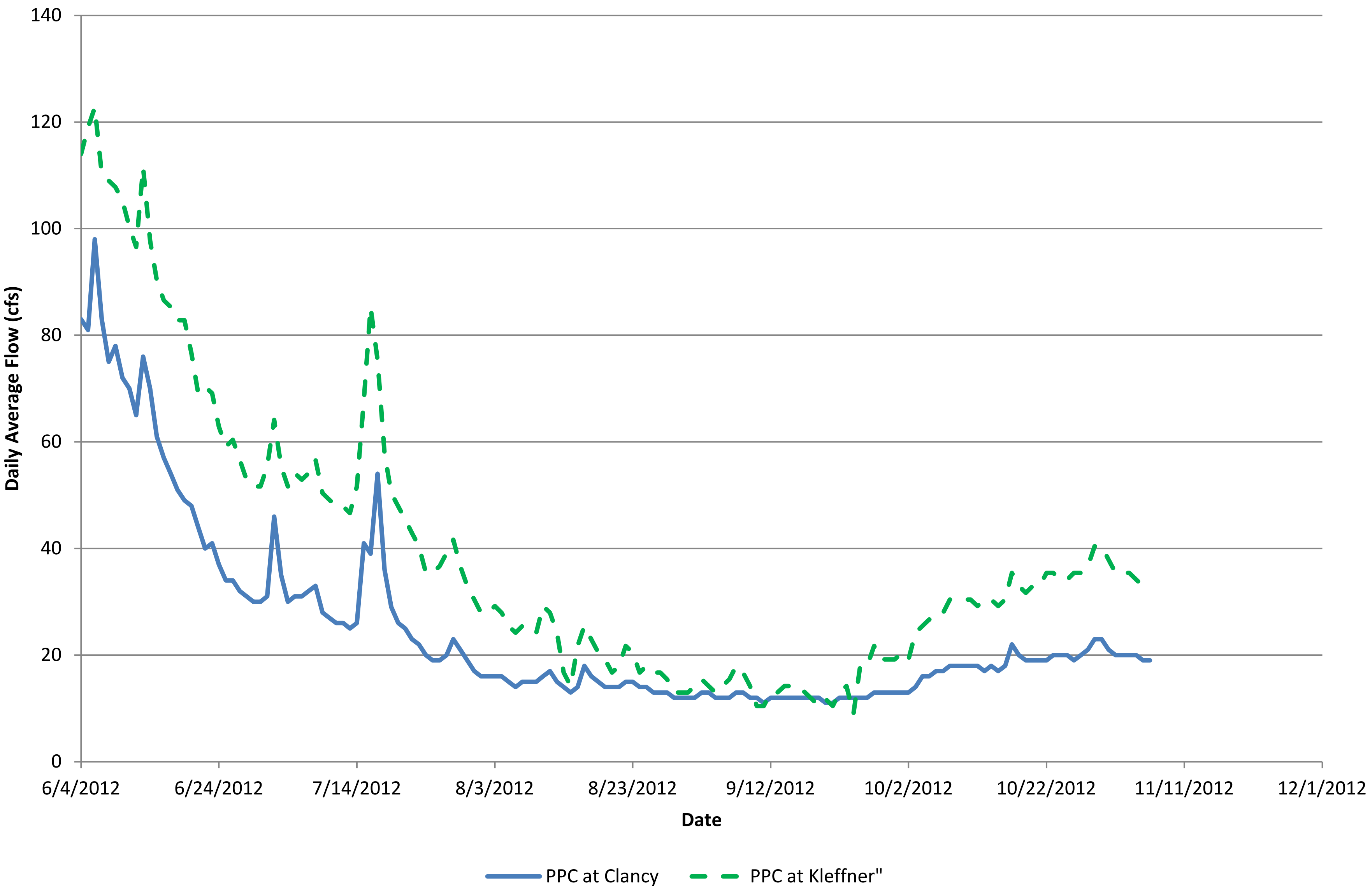
P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13

Figure 8
Prickly Pear Creek Hydrograph
Kleffner Gage Compared with Clancy Gage

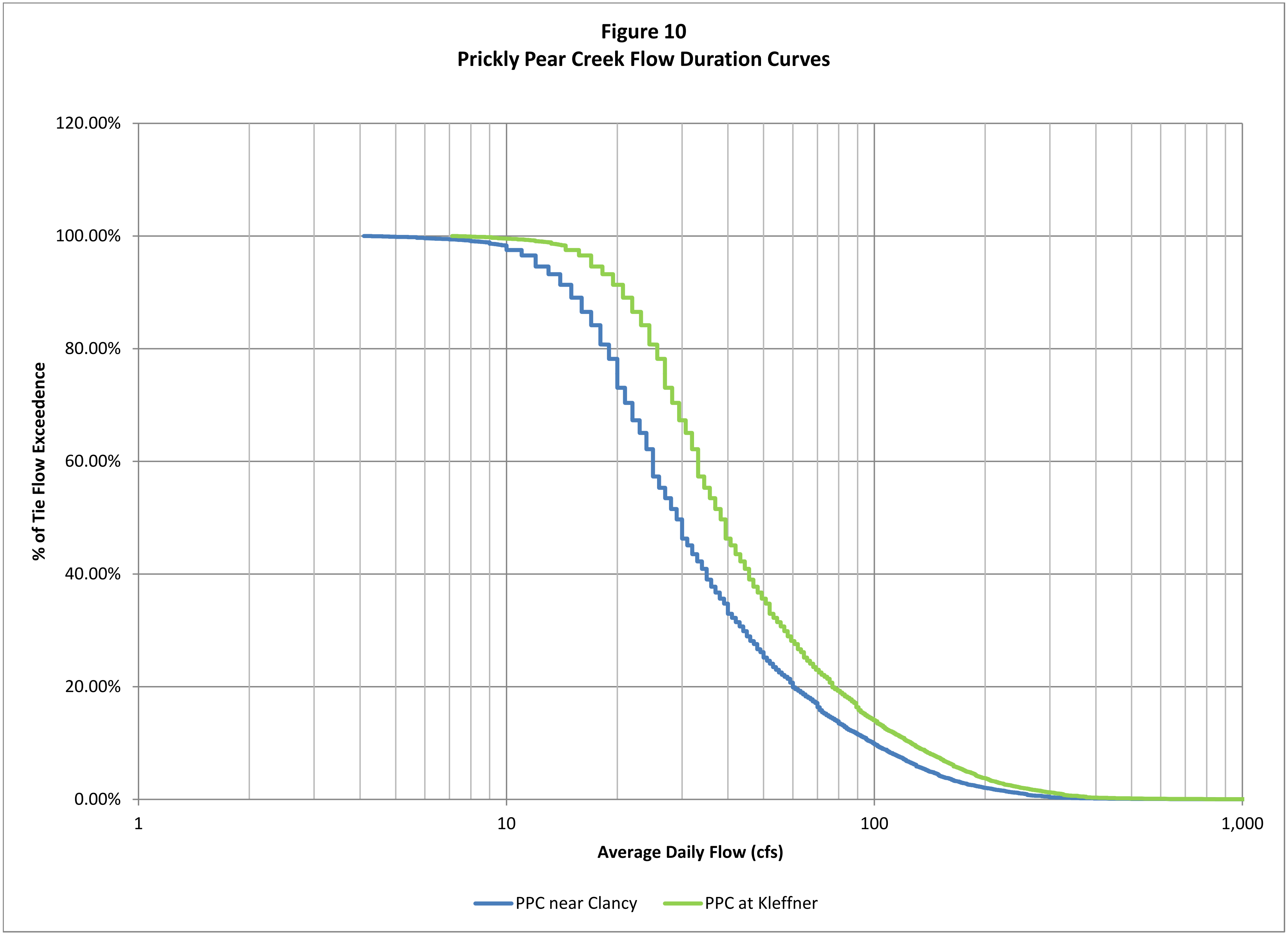


P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13

Figure 9
Prickly Pear Creek Hydrograph WY 2012
Kleffner Gage Compared with Clancy Gage



P:\CH2Mhill - METG\PPC Realignment\Data\H&H\Hydrology\CALCS\PPC FLOW DURATION CURVE 01-22-13



C:\Users\gaustiguy\Desktop\Projects\METG\Hydrology\CALCS\PPC FLOW DURATION CURVE 04-08-13

ATTACHMENT A

BULLETIN #17B ESTIMATES

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.000.000
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       11/15/2012 10:31

                         --- PROCESSING OPTIONS ---

                      Plot option         = Line printer
                      Basin char output   = None
                      Print option        = Yes
                      Debug print         = Yes
                      Input peaks listing = Long
                      Input peaks format  = WATSTORE peak file

                      Input files used:
                         peaks (ascii)  - C:\USERS\NHAGEN\DESKTOP\PRICKLY PEAR CREEK\PRICKLY PEAR
CREEK NEAR CLANCY MT\PEA
                         specifications - PKFQWPSF.TMP
                      Output file(s):
                         main - C:\USERS\NHAGEN\DESKTOP\PRICKLY PEAR CREEK\PRICKLY PEAR CREEK NEAR
CLANCY MT\PEA

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       11/15/2012 10:31

             Station - 06061500  Prickly Pear Creek near Clancy MT


                     I N P U T   D A T A   S U M M A R Y

                Number of peaks in record           =       71
                Peaks not used in analysis          =        1
                Systematic peaks in analysis        =       70
                Historic peaks in analysis          =        0
```

```
              Years of historic record            =       0
              Generalized skew                    =   0.172
                   Standard error                 =   0.550
                   Mean Square error              =   0.303
              Skew option                         =  WEIGHTED
              Gage base discharge                 =     0.0
              User supplied high outlier threshold =  --
              User supplied low outlier criterion  =  --
              Plotting position parameter         =    0.00



*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

 PeakFQ-DEBUG OPTION SET =          1
  WCF001J-FLOOD FREQUENCY, BULLETIN  17-B. VER 2.6P (12/19/83)
         -PRELIMINARY MACHINE COMPUTATIONS.  USER IS RE-
         -SPONSIBLE FOR ASSESSMENT AND INTERPRETATION.
  WCF101L-INPUT PARAMS- GENSKU OPT STD-ERR GAGEB  QLWOUT  QHIOUT  NHIST HISTPD
                         0.172  0  0.550    0.0     0.0       0.0    0     0.0
  WCF103L-INPUT PEAKS,HISTORIC FIRST. TOTAL NO =    71
                   310.0       358.0       420.0       306.0       465.0
                   441.0       196.0       161.0       164.0       213.0
                   900.0       174.0       273.0       189.0        63.0
                   260.0       142.0       135.0       333.0       778.0
                   168.0       246.0       247.0       193.0       476.0
                   220.0       180.0       154.0       251.0       210.0
                   256.0       120.0       235.0       486.0       700.0
                   418.0       156.0       377.0       446.0       296.0
                 -1200.0       204.0       349.0      2300.0       328.0
                   439.0       270.0       100.0       220.0       226.0
                   124.0       267.0       148.0       248.0       304.0
                   385.0       183.0       545.0       271.0       354.0
                   307.0       234.0        49.0       110.0       163.0
                   374.0       155.0       285.0       261.0       464.0
                  1030.0
**WCF109W-PEAKS WITH MINUS-FLAGGED DISCHARGES WERE BYPASSED.       1
```

```
  **WCF113W-NUMBER OF SYSTEMATIC PEAKS HAS BEEN REDUCED TO NSYS =   70
    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
    WCF203J-PLOTTING POSITIONS OF TOP TEN PEAKS.  SYS
          0.0141 0.0282 0.0423 0.0563 0.0704 0.0845 0.0986 0.1127 0.1268 0.1408
    WCF217L-FREQUENCY CURVE PARAMS -- SYS   1.0000  2.4208  0.2661  0.4349
                                                    2.4208  0.2661  0.4349
    WCF219J-FREQ CURVE ORDINATES SYS       2-YR (.50) 10-YR (.10) 100-YR (.01)
                                              252.1       591.3      1328.3
    WCF162I-SYSTEMATIC PEAKS EXCEEDED HIGH-OUTLIER CRITERION.   1    1550.9
    WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.             44.8
    WCF203J-PLOTTING POSITIONS OF TOP TEN PEAKS.  17B
          0.0141 0.0282 0.0423 0.0563 0.0704 0.0845 0.0986 0.1127 0.1268 0.1408
    WCF217L-FREQUENCY CURVE PARAMS -- 17B   1.0000  2.4208  0.2661  0.3689
                                                    2.4208  0.2661  0.4349
    WCF219J-FREQ CURVE ORDINATES 17B       2-YR (.50) 10-YR (.10) 100-YR (.01)
                                              253.8       589.6      1290.8
    WCF238J-FREQ CURVE 17B-EXPECT-PROB.       253.8       598.8      1367.6
    WCF239J-FREQ CURVE CONF LIMS B17B 95.0    286.4       708.4      1723.9
                                              224.5       506.8      1029.9
    WCF002J-CALCS COMPLETED.  RETURN CODE =  2
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.001.002
  Ver. 5.2            Annual peak flow frequency analysis     Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines      11/15/2012 10:31

             Station - 06061500  Prickly Pear Creek near Clancy MT


           ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                        FLOOD BASE                  LOGARITHMIC
                  ----------------------  -------------------------------
                             EXCEEDANCE                 STANDARD
                   DISCHARGE PROBABILITY     MEAN     DEVIATION     SKEW
                  -------------------------------------------------------
```

```
 SYSTEMATIC PKS
   ABOVE BASE            ---     ---        2.4208      0.2661      0.435
 BULL.17B-ADJ PKS
   ABOVE BASE            ---     ---        2.4208      0.2661      0.435
 SYSTEMATIC RECORD       0.0     1.0000     2.4208      0.2661      0.435
 BULL.17B ESTIMATE       0.0     1.0000     2.4208      0.2661      0.369



    ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

      ANNUAL                              'EXPECTED   95-PCT CONFIDENCE LIMITS
   EXCEEDANCE     BULL.17B    SYSTEMATIC PROBABILITY'  FOR BULL. 17B ESTIMATES
   PROBABILITY    ESTIMATE      RECORD     ESTIMATE        LOWER        UPPER

      0.9950         67.2         69.8         64.6         52.0         82.3
      0.9900         74.9         77.2         72.6         58.8         90.8
      0.9500        103.0        104.3        101.2         84.3        121.1
      0.9000        123.6        124.3        122.2        103.4        143.3
      0.8000        156.1        156.0        155.2        133.9        178.2
      0.6667        196.6        195.7        196.1        171.9        222.3
      0.5000        253.8        252.1        253.8        224.5        286.4
      0.4292        283.2        281.3        283.5        251.0        320.5
      0.2000        435.2        433.8        438.4        381.7        506.2
      0.1000        589.6        591.3        598.8        506.8        708.4
      0.0400        829.1        839.4        853.8        691.8       1040.0
      0.0200       1043.0       1065.0       1088.0        851.0       1351.0
      0.0100       1291.0       1328.0       1368.0       1030.0       1724.0
      0.0050       1577.0       1637.0       1701.0       1232.0       2169.0
      0.0020       2024.0       2127.0       2243.0       1538.0       2891.0
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.003
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       11/15/2012 10:31

             Station - 06061500  Prickly Pear Creek near Clancy MT
```

```
                  I N P U T   D A T A   L I S T I N G

WATER YEAR    DISCHARGE   CODES      WATER YEAR    DISCHARGE   CODES

   1911          310.0                  1966          156.0
   1912          358.0                  1967          377.0
   1913          420.0                  1968          446.0
   1914          306.0                  1969          296.0
   1915          465.0                  1975        -1200.0        H
   1916          441.0                  1979          204.0
   1923          196.0                  1980          349.0
   1924          161.0                  1981         2300.0
   1925          164.0                  1982          328.0
   1926          213.0                  1983          439.0
   1927          900.0                  1984          270.0
   1928          174.0                  1985          100.0
   1929          273.0                  1986          220.0
   1930          189.0                  1987          226.0
   1931           63.0                  1988          124.0
   1932          260.0                  1989          267.0
   1933          142.0                  1990          148.0
   1946          135.0                  1991          248.0
   1947          333.0                  1992          304.0
   1948          778.0                  1993          385.0
   1949          168.0                  1994          183.0
   1950          246.0                  1995          545.0
   1951          247.0                  1996          271.0
   1952          193.0                  1997          354.0
   1953          476.0                  1998          307.0
   1955          220.0                  1999          234.0
   1956          180.0                  2000           49.0
   1957          154.0                  2001          110.0
   1958          251.0                  2002          163.0
   1959          210.0                  2006          374.0
   1960          256.0                  2007          155.0
```

```
        1961          120.0                  2008          285.0
        1962          235.0                  2009          261.0
        1963          486.0                  2010          464.0
        1964          700.0                  2011         1030.0
        1965          418.0


        Explanation of peak discharge qualification codes

       PeakFQ    NWIS
        CODE     CODE   DEFINITION

          D        3    Dam failure, non-recurrent flow anomaly
          G        8    Discharge greater than stated value
          X       3+8   Both of the above
          L        4    Discharge less than stated value
          K      6 OR C Known effect of regulation or urbanization
          H        7    Historic peak

          -  Minus-flagged discharge -- Not used in computation
                -8888.0 -- No discharge value given
          -  Minus-flagged water year -- Historic peak used in computation



1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.004
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       11/15/2012 10:31

             Station - 06061500  Prickly Pear Creek near Clancy MT


   EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

      WATER         RANKED       SYSTEMATIC      BULL.17B
```

```
YEAR       DISCHARGE        RECORD        ESTIMATE

1981         2300.0         0.0141         0.0141
2011         1030.0         0.0282         0.0282
1927          900.0         0.0423         0.0423
1948          778.0         0.0563         0.0563
1964          700.0         0.0704         0.0704
1995          545.0         0.0845         0.0845
1963          486.0         0.0986         0.0986
1953          476.0         0.1127         0.1127
1915          465.0         0.1268         0.1268
2010          464.0         0.1408         0.1408
1968          446.0         0.1549         0.1549
1916          441.0         0.1690         0.1690
1983          439.0         0.1831         0.1831
1913          420.0         0.1972         0.1972
1965          418.0         0.2113         0.2113
1993          385.0         0.2254         0.2254
1967          377.0         0.2394         0.2394
2006          374.0         0.2535         0.2535
1912          358.0         0.2676         0.2676
1997          354.0         0.2817         0.2817
1980          349.0         0.2958         0.2958
1947          333.0         0.3099         0.3099
1982          328.0         0.3239         0.3239
1911          310.0         0.3380         0.3380
1998          307.0         0.3521         0.3521
1914          306.0         0.3662         0.3662
1992          304.0         0.3803         0.3803
1969          296.0         0.3944         0.3944
2008          285.0         0.4085         0.4085
1929          273.0         0.4225         0.4225
1996          271.0         0.4366         0.4366
1984          270.0         0.4507         0.4507
1989          267.0         0.4648         0.4648
2009          261.0         0.4789         0.4789
1932          260.0         0.4930         0.4930
1960          256.0         0.5070         0.5070
```

```
       1958          251.0         0.5211         0.5211
       1991          248.0         0.5352         0.5352
       1951          247.0         0.5493         0.5493
       1950          246.0         0.5634         0.5634
       1962          235.0         0.5775         0.5775
       1999          234.0         0.5915         0.5915
       1987          226.0         0.6056         0.6056
       1955          220.0         0.6197         0.6197
       1986          220.0         0.6338         0.6338
       1926          213.0         0.6479         0.6479
       1959          210.0         0.6620         0.6620
       1979          204.0         0.6761         0.6761
       1923          196.0         0.6901         0.6901
       1952          193.0         0.7042         0.7042
       1930          189.0         0.7183         0.7183
       1994          183.0         0.7324         0.7324
       1956          180.0         0.7465         0.7465
       1928          174.0         0.7606         0.7606
       1949          168.0         0.7746         0.7746
       1925          164.0         0.7887         0.7887
       2002          163.0         0.8028         0.8028
       1924          161.0         0.8169         0.8169
       1966          156.0         0.8310         0.8310
       2007          155.0         0.8451         0.8451
       1957          154.0         0.8592         0.8592
       1990          148.0         0.8732         0.8732
       1933          142.0         0.8873         0.8873
       1946          135.0         0.9014         0.9014
       1988          124.0         0.9155         0.9155
       1961          120.0         0.9296         0.9296
       2001          110.0         0.9437         0.9437
       1985          100.0         0.9577         0.9577
       1931           63.0         0.9718         0.9718
       2000           49.0         0.9859         0.9859
       1975        -1200.0           --             --
1

                           Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.001.005
```

```
                           Ver. 5.2           Annual peak flow frequency analysis      Run Date /
Time
                           11/01/2007         following Bulletin 17-B Guidelines       11/15/2012
10:31


                         Station - 06061500  Prickly Pear Creek near Clancy MT

       10000.0 +----+------------+------+--------+-----+---------+---------+-----+--------+------+----
---+----+----+-----+
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    | *****  NOTICE  *****  NOTICE  ******       |         |     |        |      |
|    |    |     |
 A             |    | * PRELIMINARY MACHINE COMPUTATION. *       |         |     |        |      |
|    |    |     |
 N             |    | *  USER IS RESPONSIBLE FOR ASSESS- *       |         |     |        |      |
|    |    |     |
 N             |    | *     MENT AND INTERPRETATION.     *       |         |     |        |      |
|    |    |     |
 U             |    | ************************************       |         |     |        |      |
|    |    |     |
 A             |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
 L      3160.0 +----+------------+------+--------+-----+---------+---------+-----+--------+------+----
---+----+----+-----+
               |    |         PLOT SYMBOL KEY          |         |         |     |        |      |
|    |    |     |
 P             |    |   *  17B FINAL FREQUENCY CURVE   |         |         |     |        |      |
|    |    |     |
 E             |    |   O  OBSERVED (SYSTEMATIC) PEAKS |         |         |     |        |      |
|  O |    |     #
```

```
 A             |    |   $  HISTORICALLY ADJUSTED PEAKS |         |         |     |        |      |
|    |    |     *
 K             |    |   #  SYSTEMATIC-RECORD FREQ CURVE|         |         |     |        |      |
|    |    |     |
               |    |   WHEN POINTS COINCIDE, ONLY THE |         |         |     |        |      |
|    |    *     |
 M             |    |   TOPMOST SYMBOL SHOWS.          |         |         |     |        |      |
|    |    |     |
 A             |    |            |      |        |     |         |         |     |        |      |
|    *    |     |
 G             |    |            |      |        |     |         |         |     |        |      |
#    |    |     |
 N      1000.0 +----+------------+------+--------+-----+---------+---------+-----+--------+------+----
O*-*----+----+-----+
 I             |    |            |      |        |     |         |         |     |        |      | O
|    |    |     |
 T             |    |            |      |        |     |         |         |     |        |     O* *
|    |    |     |
 U             |    |            |      |        |     |         |         |     |        |   O  |
|    |    |     |
 D             |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
 E             |    |            |      |        |     |         |         |     |        * O    |
|    |    |     |
 S             |    |            |      |        |     |         |         |     |       OO      |
|    |    |     |
               |    |            |      |        |     |         |         |     * OOOOO  |      |
|    |    |     |
               |    |            |      |        |     |         |         |   OOOO       |      |
|    |    |     |
               |    |            |      |        |     |         |         *OOO  |        |      |
|    |    |     |
 /       316.0 +----+------------+------+--------+-----+---------+-----OOOOO-----+--------+------+----
---+----+----+-----+
 L             |    |            |      |        |     |         | OO**    |     |        |      |
|    |    |     |
 O             |    |            |      |        |     |      OOO*O        |     |        |      |
|    |    |     |
```

```
 G             |    |            |      |        |     |  OO*O*  |         |     |        |      |
|    |    |     |
               |    |            |      |        |    OOO*       |         |     |        |      |
|    |    |     |
 S             |    |            |      |        |OOOO *         |         |     |        |      |
|    |    |     |
 C             |    |            |      |   OOO O*     |         |         |     |        |      |
|    |    |     |
 A             |    |            |      OO O     |     |         |         |     |        |      |
|    |    |     |
 L             |    |            |  O O *        |     |         |         |     |        |      |
|    |    |     |
 E             |    |            |O     |        |     |         |         |     |        |      |
|    |    |     |
 /       100.0 +----+----------*O*------+--------+-----+---------+---------+-----+--------+------+----
---+----+----+-----+
               |    |    * *     |      |        |     |         |         |     |        |      |
|    |    |     |
               |    #            |      |        |     |         |         |     |        |      |
|    |    |     |
               *    *            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |       O    |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    | O          |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
               |    |            |      |        |     |         |         |     |        |      |
|    |    |     |
          31.6 +----+------------+------+--------+-----+---------+---------+-----+--------+------+----
---+----+----+-----+
```

```
             99.5 99.0         95.0   90.0     80.0  70.0      50.0      30.0  20.0     10.0    5.0
2.0  1.0  0.5   0.2
                                   ANNUAL EXCEEDANCE PROBABILITY, PERCENT   (NORMAL SCALE)
1



 End PeakFQ analysis.
   Stations processed :       1
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :      71


Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  06061500       USGS Prickly Pear Creek near Clanc


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
```

ATTACHMENT B

REGIONAL REGRESSION CALCULATIONS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**PPC near Clancy**
Region:	**Southwest**
Estimation method:	**Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width**
Drainage area in square miles:	**189.14**
Percent basin above 6,000 feet:	**26.54**
Width of active channel in feet:	**27**
Width of bank full channel in feet:	**31**

Flood Discharge Estimation:

(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 PPC near Clancy
Southwest Region: A =    189.14 E6 =    27.
 RI       DISCHARGE  STD ERR OF              90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2       425.        93.1            112.7             1600.
     5       805.        77.9            253.3             2560.
    10      1140.        74.6            371.6             3480.
    25      1640.        74.3            539.7             5000.
    50      2080.        76.0            670.8             6480.
   100      2580.        78.7            803.5             8270.
   200      3130.        82.1            935.5            10400.
   500      3960.        88.0           1110.0            14100.
```

```
 METHOD: Regression on active channel width
 Flood frequency estimates for
 PPC near Clancy
```

```
Southwest Region: WAC =     27.00
 RI       DISCHARGE  STD ERR OF               90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2        296.        59.7             117.5              743.
     5        487.        56.3             202.8             1170.
    10        634.        61.8             245.4             1640.
    25        841.        71.9             285.9             2470.
    50       1010.        80.6             309.9             3290.
   100       1190.        89.5             330.9             4290.
   200       1390.        98.9             348.9             5510.
   500       1670.       112.4             368.7             7550.


 METHOD: Regression on bank full channel width
 Flood frequency estimates for
 PPC near Clancy
Southwest Region: WBF =     31.00
 RI       DISCHARGE  STD ERR OF               90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2        224.        68.0              79.9              627.
     5        384.        62.2             147.9              999.
    10        510.        66.3             186.2             1400.
    25        690.        75.4             225.3             2120.
    50        840.        83.5             249.4             2830.
   100       1000.        92.1             270.5             3710.
   200       1180.       101.3             289.2             4790.
   500       1430.       114.8             310.2             6620.


 METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
 PPC near Clancy
 Region 8
 RI       DISCHARGE  STD ERR OF               90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2        331.        49.8             150.2              730.
     5        579.        47.2             272.6             1230.
    10        799.        51.3             354.8             1800.
    25       1160.        58.0             469.2             2870.
    50       1490.        63.3             563.1             3960.
   100       1880.        68.6             663.1             5340.
   200       2330.        73.9             767.7             7060.
   500       3020.        81.4             910.4            10000.
```

Montana Flood-Frequency and Basin-Characteristic Data

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**PPC at Highway 12**
Region:	**Southwest**
Estimation method:	**Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width**
Drainage area in square miles:	**252**
Percent basin above 6,000 feet:	**25.8**
Width of active channel in feet:	**43**
Width of bank full channel in feet:	**45**

Flood Discharge Estimation:

(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)

```
 METHOD: Regression on basin characteristics
 Flood frequency estimates for
 PPC at Highway 12
Southwest Region: A =    252.00 E6 =    26.
 RI       DISCHARGE  STD ERR OF               90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
     2        546.        93.7             143.8             2070.
     5       1020.        78.4             317.8             3250.
    10       1420.        75.1             462.8             4380.
    25       2040.        74.8             667.2             6260.
    50       2580.        76.5             825.0             8070.
   100       3180.        79.2             983.3            10300.
   200       3830.        82.7            1140.0            12900.
   500       4830.        88.6            1340.0            17400.
```

```
 METHOD: Regression on active channel width
 Flood frequency estimates for
 PPC at Highway 12
```

```
Southwest Region: WAC =     43.00
 RI       DISCHARGE  STD ERR OF               90% PRED.  INTERVAL
            (cfs)      PREDICTION(%)
     2        643.        60.0             254.6             1620.
     5        941.        56.6             390.0             2270.
    10       1160.        62.1             445.6             3010.
    25       1450.        72.5             489.1             4280.
    50       1680.        81.2             510.5             5500.
   100       1910.        90.3             526.6             6940.
   200       2160.        99.9             538.0             8650.
   500       2510.       113.6             548.0            11500.


 METHOD: Regression on bank full channel width
 Flood frequency estimates for
 PPC at Highway 12
Southwest Region: WBF =     45.00
 RI       DISCHARGE  STD ERR OF               90% PRED.  INTERVAL
            (cfs)      PREDICTION(%)
     2        452.        68.2             161.2             1270.
     5        697.        62.4             267.8             1820.
    10        880.        66.5             320.2             2420.
    25       1130.        75.7             367.1             3470.
    50       1330.        83.9             392.8             4490.
   100       1540.        92.7             413.0             5730.
   200       1760.       102.0             429.1             7200.
   500       2070.       115.5             445.2             9640.


 METHOD: Combined methods 1, 2 and 3
Flood frequency estimates for
 PPC at Highway 12
 Region 8
 RI       DISCHARGE  STD ERR OF               90% PRED.  INTERVAL
            (cfs)      PREDICTION(%)
     2        611.        50.1             276.0             1350.
     5        966.        47.4             453.2             2060.
    10       1260.        51.6             555.7             2840.
    25       1710.        58.4             687.7             4240.
    50       2120.        63.8             793.3             5650.
   100       2580.        69.1             904.7             7380.
   200       3110.        74.5            1020.0             9510.
   500       3930.        82.1            1180.0            13100.
```

Montana Flood-Frequency and Basin-Characteristic Data

Retrieved on: 2013.02.20 17:50:46

Appendix B: Existing Conditions HEC-RAS Model Calculation Summary

Date:	12/26/12	Project:	Prickly Pear Creek Realignment	Prepared By:	CAR
Rev. No.	2.2	Office:	Bozeman, Montana	Checked By:	GEA, EMG
Rev. Date:	03/29/13	Calc. No.	PPC-002	Approved By:	JLG
Subject:	Prickly Pear Creek Channel Hydraulic Analysis of Existing Conditions				

PRICKLY PEAR CREEK CHANNEL HYDRAULIC ANALYSIS OF EXISTING CONDITIONS

PURPOSE AND OBJECTIVES

This calculation summary describes the work completed by Pioneer Technical Services, Inc. (Pioneer) to develop a hydraulic model of the existing conditions for Prickly Pear Creek (PPC) in the vicinity of the former East Helena Smelter Facility located near East Helena, Montana. This work was in support of the Montana Environmental Custodial Trust (MECT) Phase 1 Interim Measures (IM), South Plant Hydraulic Controls, PPC Permanent Realignment Project. Figure 1 provides a site plan view. The PPC segment targeted for realignment extends from alignment station 10+00 upstream approximately 1.0 mile to alignment station 62+00 (see Figures 2 and 3).

Results from the existing conditions model will be used to evaluate reach-averaged hydraulic conditions in potential design analog reaches and to support the existing PPC channel bankfull capacity estimate. This model will form the basis for conducting the existing condition sediment transport analysis and support the development of suitable design criteria for the PPC realignment. Sediment transport and channel stability analyses will be conducted and described under a separate calculation brief. Design criteria will be developed under a separate document. This analysis is focused on simulating the channel hydraulics for flows within the channel banks or slightly out of bank. This model is not intended to replace the PPC Existing Condition Hydrologic Engineering Center River Analysis System (HEC-RAS) model (HEC, 2010) developed under the PPC Temporary Bypass flow modeling or in any way address the project Federal Emergency Management Agency (FEMA)/ Conditional Letter of Map Revision (CLOMR) requirements.

METHODS AND DATA

The team used the United States Army Corps of Engineers (USACE) HEC-RAS Version 4.1 computer program to simulate the existing conditions of the targeted segment of PPC. This software helped to develop a steady-state, one-dimensional, gradually varied flow model of the site. Constructing the HEC-RAS model used the following methods and data:

- Develop an Autodesk Civil 3D® Digital Terrain Model (DTM) from the following:
    - November 2011 and May 2012 ground survey data of channel cross sections (1-foot [ft] contour interval), collected approximately every 100 ft. Cross-section survey locations were identified in the field during the field work conducted as part of the *Existing Conditions Stream Assessment* (AGI, Pioneer, and MMI, 2012);

  - November 7, 2012, ground survey channel cross-section data of reference reaches (1-ft contour interval); and
  - 2011 aerial topographic survey data (light detection and ranging [LIDAR]) (2-ft contour interval).

  To develop cross-section data for input to HEC-RAS, cross section, data were sampled at the same locations as the stream survey cross section. These cross section data were then exported to a geo-referenced HEC-RAS input file.

- Estimate channel Manning's *n* values for the model by calibrating to field conditions at Reference Site 1 and Reference Site 2. Compare measured water surface elevations and measured stream flow estimates with modeled water surface elevations. Adjust channel roughness values to produce model residuals less than 1 ft. Apply the calibrated channel roughness values to the full channel length based on field observations of channel roughness characteristics.

  Overbank roughness values came from the Existing Condition HEC-RAS model developed for the FEMA/CLOMR process as part of the PPC Temporary Bypass Flow Modeling Draft Technical Memorandum activities (CH2M HILL/MMI, 2012).

  Geometric data for the American Smelting and Refining Company (ASARCO) Smelter Dam is based on the PPC Existing Condition HEC-RAS model developed for the FEMA/CLOMR process as part of the PPC Temporary Bypass activities (CH2M HILL/MMI, 2012*)*. To allow use of the model sediment transport functions, the ASARCO Smelter Dam structure was modeled using cross section geometric data rather than the bridge modeling module. The cross sections located immediately upstream (river station 3078.79) and downstream (river station 3050.46) from the ASARCO Smelter Dam were copied and translated to river stations just immediately inside the dam opens (river stations 3076.79 and 3060.79). The copied cross sections were modified to represent the interior of the dam without the deck (i.e., spillway, abutments, and piers). Ineffective flow areas were applied to the modified cross sections to block out overbank areas past the dam abutments and the Manning's *n* value for the interior of the dam was set to 0.017 to represent unfinished concrete. Contraction expansion coefficients of 0.3 and 0.5, as recommended by the HEC-RAS reference manual for bridge openings, were applied to the cross sections. A total of 28 cross sections were interpolated in between the two modified cross sections to represent the structure. For the flow regime of interest in this analysis (less than or equal to 750 cubic feet per second [cfs]), the Smelter Dam bridge deck does not influence the hydraulics.

- Geometric data to model the Wilson Diversion is based on the November 2011 survey and the 2011 aerial survey data.

- The downstream boundary condition for the PPC Existing Conditions HEC-RAS model is based on normal depth with a slope of 0.0074 ft/ft. This slope was determined from the average channel slope of PPC from river station 794.36 to 101.64 based on the surveyed thalweg. The upstream boundary condition used a normal depth method with a slope of 0.005 ft/ft, which is the approximate slope of the upper reach (Reach 6).

- Select flow values for the modeling effort to represent the range of flows that exist in PPC seasonally, including bankfull flow candidates and flows that are slightly out of bank. These flows will be used to conduct the sediment transport capacity calculations and to support development of design criteria. Flows modeled in this analysis included 10, 20, 50, 100, 150, 200, 252, 328, 545, and 750 cfs. A flow of 750 cfs was selected rather than the 10-year flow of 730 cfs in order to capture the flow range represented in the flow duration curve. From a practical perspective, 750 cfs is representative of the hydraulics associated with the 10-year flow.

No known significant hydrologic events occurred between the time of the survey and modeling that would have significantly altered the cross section geometry

After all the geometric data, boundary conditions, roughness values, and expansion contraction coefficients were entered into the PPC Existing Conditions HEC-RAS model, the team performed a mixed steady flow analysis for the suite of selected flows.

RESULTS AND DISCUSSION

Roughness Coefficient Calibration

Reference reach survey data conducted on November 7, 2012, included measured water surface elevations at reference cross sections. PPC streamflow measurements, corresponding to the reference reach survey date, were available at the Department of Natural Resources and Conservation (DNRC) PPC at Kleffner gage and the United States Geological Survey (USGS) PPC near Clancy gage. The DNRC PPC gage at Kleffner ranch was shut down for the winter season after November 6, 2012.

Table 1 provides the average daily streamflow data immediately before, during, and after the November 7, 2012, reference site survey. Review of the streamflow data indicates streamflow conditions to be steady state at both gages for the six-day period leading up to the survey date and at the Clancy gage for the two days following the reference reach survey. Average daily flow fluctuations at both PPC gages for this period were 7% or less, which is within the range of typical streamflow measurement accuracy. Based on these data, it was concluded that using the streamflow value for November 6, 2012, from the DNRC PPC at Kleffner gage (33 cfs) would be a reasonable estimate for the average daily low flow through the project site on November 7, 2012.

Table 2 summarizes the model calibration results that indicate that a channel roughness value of n = 0.035 produces average reference reach residuals of 0.26 ft at Reference Site 1 and 0.29 ft at Reference Site 2. These results are consistent with the range of published roughness values for gravel-bed natural streams (Chow, 1988).

Based on the low calibration residuals and the agreement with published values, n = 0.035 was selected for the PPC Existing Conditions HEC-RAS model channel roughness value.

Flow Regimes

Flow regimes presented here are referenced to the project hydrologic analysis, which was conducted under a separate calculation brief (Appendix A, PER). The PPC Existing Condition HEC-RAS model was run using a suite of flows selected to represent the seasonal flux of PPC stream flow including bankfull flow candidates to support sediment transport/channel stability calculations (Appendix C, PER) and to estimate channel conveyance capacity. These flows ranged from 10 cfs through 750 cfs. Table 3 summarizes the discharges.

Water Surface Profiles

Water surface profiles for 328 cfs (the 2-year flow) and 750 cfs (representative of the 10-year flow) are shown in Figure 4. Profile summary tables are presented in Attachment A-1. The ASARCO Smelter Dam is the significant hydraulic control on the PPC system. At 750 cfs, backwater from the dam extends upstream to approximately station 42+00. The Upper Lake diversion, located at approximately station 51+00, is a secondary control on the PPC with backwater occurring upstream to approximately station 54+00 at 750 cfs.

Channel Capacity

Figure 5 plots the $Q_{1.5}$ and the Q_2 for Reference Site 1. Figure 6 plots the $Q_{1.5}$, Q_2, and Q_5 for Reference Site 2. The cross section station numbers for the reference sites are shown in Table 4. These cross section data were surveyed on November 7, 2012. During the survey, bankfull indicators were recorded and used in the HEC-RAS model as channel bank markers. Table 5 summarizes the comparison of model results with the field bankfull indicators.

Reference Site 1 was selected as a potential design analog because it was one of the few stream segments that contained a pool-riffle sequence with bedform complexity, compared with other PPC stream segments. Field observations indicate that Reference Site 1 has undergone recent migration and adjustment, likely in response to the high magnitude, long duration 2011 spring runoff. As a result, field bankfull indicators have not had time to equilibrate to the new channel. For Reference Site 1, Figure 5 shows that the 2-year flow (Q_2 = 328 cfs) is within ± 0.5 ft of one of the field bankfull indicators for eight of the nine cross sections. Cross section plots of Reference Site 1 are presented in Figures 7, 8, and 9.

At Reference Site 2, field observations indicated there was also evidence that the channel is still adjusting to the 2011 hydrology; therefore, there are some elevation discrepancies between the left side and right side field-defined bankfull channel indicators. Figure 6 shows that at Reference Site 2, the 2-year flow (Q_2 = 328 cfs) is within ± 0.5 ft of one of the field bankfull indicators, for two of the seven cross sections. The 2-year flow at Reference Site 2 does not correlate as well with the field-defined bankfull indicators as at Reference Site 1. Figures 10, 11, and 12 show the cross section plots of Reference Site 2.

Figure 6 shows that the 5-year flow (Q_5 = 550 cfs) is required to achieve the stage associated with the field-defined bank field indicators. Fluvial geomorphic observations made by Pioneer and AGI at Reference Site 2 suggest that PPC in Reach 1 has undergone some incision, likely occurring during the 2011 runoff. This hypothesis is further supported by the magnitude of the flow required to produce the water surface elevations defined by the field-defined bankfull indicators.

Modeling results indicate that the 2-year flow of 328 cfs generally matches the surveyed, field-defined bankfull indicators within ± 0.5 ft at Reference Site 1. At Reference Site 2, the 2-year flow is generally below the bankfull indicators and a 5-year flow better approximates the bankfull stage. Figures 7 through 12 plot the HEC-RAS cross sections for Reference Sites 1 and 2.

Results from this modeling also indicate there is some variability within the correlation of flows and bankfull indicators. A final selection of the bankfull flow magnitude will require integration of the hydrologic, geomorphic, hydraulic, and sediment transport analyses, which will occur in the Development of Design Criteria task.

Reach-Averaged Hydraulics

Reach-averaged hydraulic parameters were compiled to facilitate the sediment transport analysis. The PPC reach was subdivided into six computational reaches, as defined in the PPC *Existing Conditions Stream Assessment* (AGI, Pioneer, and MMI, 2012). The reach delineations were based on the similarity of fluvial geomorphic characteristics, hydraulic characteristics, and the locations of significant structures. Table 6 provides the HEC-RAS alignment station boundaries for each reach.

Average values of main channel velocity, channel effective width, channel maximum depth, energy slope, and average channel boundary shear were calculated for each reach and for the range of flows from 10 cfs to 750 cfs. Model data from the ASARCO Smelter Dam structure was not included in the averaging calculations. The results of the reach averaging are summarized in Table 7. Figures 13 through18 present a statistical summary of the reach averaging for selected flows.

REFERENCES

HEC, January 2010. U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC), "HEC-RAS River Analysis System Hydraulic Reference Manual."

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Chow V.T, 1988. Open Channel Hydraulics, McGraw-Hill, Inc.

AGI, Pioneer, MMI, January 2012. Applied Geomorphology, Pioneer Technical Services, Morrison Maierle, Existing Conditions Stream Assessment Prickly Pear Creek East Helena Smelter RCRA Site Final Report

Pioneer, December 2012. Draft Prickly Pear Hydrologic Analysis Calculation Brief.

DOCUMENT REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	Team	Draft	For Internal Pioneer Review	12/26/12
Rev 1	Team	Draft	For CH2M HILL/EH Team Review	01/22/13
Rev 2.2	Team	Final	For Client/Stakeholder Distribution	03/29/13
Rev 3	TEAM	Final	For Client/Stakeholder Distribution	06/21/13
Rev 4				

TABLES

Table 1

Average Daily Flow Data During Reference Reach Survey

Date	DNRC Kleffner Gage Flow (cfs)	USGS Gage near Clancy (#06061500) Flow(cfs)
11/01/12	35.4	20
11/02/12	35.4	20
11/03/12	35.4	20
11/04/12	34.2	20
11/05/12	32.9	19
11/06/12	32.9	19
11/07/12		19
11/08/12		20
11/09/12		19

Table 2
Channel Roughness Calibration

HECRAS Station	Reference Site/Section	11-07-12 Survey WSEL (ft)	Roughness Value	11-06-12 Flow (cfs) Elev. (ft)	Model WSEL (ft)	Difference Meas-Model (ft)	Abs Value Diff (ft)
7659.13	1a	3933.52	0.035	33	3932.91	0.61	0.61
7592.36	1b	3932.36	0.035	33	3932.01	0.35	0.35
7550	1c	3932.16	0.035	33	3931.75	0.41	0.41
7486.87	1d	3931.65	0.035	33	3931.48	0.17	0.17
7446.03	1e	3931.12	0.035	33	3931.15	-0.03	0.03
7388.7	1f	3931.15	0.035	33	3930.91	0.24	0.24
7321.95	1g	3930.59	0.035	33	3930.36	0.23	0.23
7263.2	1h	3930.10	0.035	33	3930.12	-0.02	0.02
						Average	0.26
1540.14	2a	3892.20	0.035	33	3891.92	0.27	0.27
1465.1	2b	3890.35	0.035	33	3890.56	-0.21	0.21
1414.96	2c	3890.46	0.035	33	3890.5	-0.05	0.05
1397.13	2d	3890.16	0.035	33	3890.22	-0.07	0.07
1382.63	2e	3889.75	0.035	33	3890.09	-0.34	0.34
1350.26	2f	3889.95	0.035	33	3889.49	0.46	0.46
1273.77	2g	3888.85	0.035	33	3888.74	0.11	0.11
						Average	0.22

P:\CH2Mhill - METG\PPC Realignment\Data\H&H\PPC EC\Ref Reach BF Comparison

Table 3
Discharges Evaluated In The Hydraulic Model To Support Channel Stability Analysis

Profile Number	Discharge (cfs)	% Time Flow Equaled or Exceeded [1]	Flow Regime
1	10	99	Lower Limit Base Flow
2	20	89	Average Base Flow
3	50	35	Rising\Desending limb of Runoff Hydrograph
4	100	13	Rising\Desending limb of Runoff Hydrograph
5	150	7	Rising\Desending limb of Runoff Hydrograph
6	200	4	Rising\Desending limb of Runoff Hydrograph
7	252	2	Q1.5 Possible Bankfull
8	329	1.22	Q2 Possible Bankfull
9	545	0.18	Q5
10	750	0.09	≈ Q10

Notes:
1: Based on Flow Duration Curve at Project Site.

Table 4

Reference Site Cross-Section Station Numbers

SITE 1	SITE 2
72+63.20	12+73.77
73+21.95	13+12.95
73+88.70	13+50.26
74+46.03	13+82.63
74+86.87	14+14.96
75+50.00	14+65.10
75+92.36	15+40.14
76+59.13	

Table 5

Modeled Discharge and Bankfull Indicator Comparison

HECRAS Station	Reference Site	Avg. Bankfull Elev. (ft)	$Q_{1.5}$ WSEL Elev. (ft)	Q_2 WSEL Elev. (ft)	$Q_{1.5}$ Diff. (ft)	Q_2 WSEL Diff. (ft)
7659.13	1	3934.88	3933.86	3934.13	-1.02	-0.75
7592.36	1	3934.12	3933.52	3933.81	-0.6	-0.31
7550	1	3933.61	3933.11	3933.4	-0.495	-0.205
7486.87	1	3934.24	3932.82	3933.14	-1.42	-1.1
7446.03	1	3933.55	3932.65	3932.99	-0.9	-0.56
7388.7	1	3932.91	3932.19	3932.49	-0.72	-0.42
7321.95	1	3932.07	3931.98	3932.32	-0.085	0.255
7263.2	1	3931.44	3931.67	3932.02	0.23	0.58
1540.14	2	3894.25	3892.94	3893.21	-1.31	-1.04
1465.1	2	3893.64	3892.37	3892.74	-1.27	-0.9
1414.96	2	3894.28	3892.17	3892.51	-2.105	-1.765
1382.63	2	3892.50	3890.91	3891.14	-1.585	-1.355
1350.26	2	3893.06	3890.66	3891.01	-2.395	-2.045
1312.95	2	3892.01	3890.65	3890.99	-1.36	-1.02
1273.77	2	3891.99	3890.23	3890.64	-1.755	-1.345

Table 6
HECRAS REACH STATIONING

Reach[1]	Starting Station	Ending Station
1	0+00	30+50
2	30+50	51+00
3	51+00	59+99.62
4	59+99.62	78+50
5	78+50	95+00.15
6	95+00.15	109+00

Notes: 1. Reach delineations are based on the 'Stream Assesment Report' dated 1-27-12.

TABLE 7

REACH AVERAGED HYDRAULIC PARAMETERS

HYDRAULIC REACH	DISCHARGE (cfs)									
	10	20	50	100	150	200	252	329	545	750
	MAIN CHANNEL VELOCITY (ft/s)									
1	1.87	2.29	2.99	3.73	4.21	4.57	4.86	5.23	6.06	6.81
2	0.78	1.02	1.58	2.15	2.52	2.45	2.62	2.84	3.30	3.77
3	1.56	1.82	2.21	2.72	3.04	3.31	3.55	3.77	4.24	4.12
4	1.59	1.90	2.45	3.02	3.36	3.64	3.89	4.22	4.97	5.43
5	1.69	2.03	2.32	2.89	3.30	3.61	3.88	4.19	4.90	5.36
6	1.46	1.69	2.25	2.86	3.33	3.70	4.03	4.39	5.26	5.94
	MAIN MAX DEPTH (ft)									
1	0.84	1.05	1.46	1.89	2.21	2.48	2.73	3.05	3.76	6.35
2	2.67	2.86	3.25	3.70	4.05	4.42	4.72	5.11	5.95	6.56
3	0.95	1.17	1.57	2.02	2.39	2.69	2.96	3.32	4.23	4.64
4	0.95	1.16	1.54	1.94	2.25	2.51	2.74	3.02	3.65	4.12
5	0.87	1.13	1.61	2.03	2.34	2.59	2.82	3.10	3.72	4.16
6	0.96	1.15	1.51	1.89	2.18	2.43	2.66	2.96	3.65	4.18
	MAIN CHANNEL EFFECTIVE WIDTH (ft)									
1	16.43	19.37	23.47	27.02	29.50	31.66	33.53	35.85	39.71	61.25
2	30.31	33.22	36.88	41.11	45.09	49.52	54.08	60.63	66.59	69.74
3	19.49	24.34	30.43	33.08	36.30	37.98	39.37	41.63	45.65	46.14
4	18.85	23.34	28.61	33.21	36.76	39.54	41.43	43.34	45.32	45.53
5	16.06	19.01	25.22	28.58	30.13	31.17	32.07	33.15	34.45	34.86
6	21.83	25.75	31.15	34.68	36.44	37.89	39.16	40.71	42.95	43.38
	ENERGY SLOPE									
1	0.0134	0.0121	0.0103	0.0101	0.0097	0.0092	0.0089	0.0086	0.0079	0.0080
2	0.0045	0.0045	0.0058	0.0073	0.0084	0.0024	0.0024	0.0024	0.0023	0.0030
3	0.0114	0.0100	0.0060	0.0051	0.0047	0.0046	0.0042	0.0035	0.0028	0.0029
4	0.0095	0.0091	0.0078	0.0069	0.0061	0.0058	0.0055	0.0053	0.0051	0.0049
5	0.0109	0.0107	0.0070	0.0067	0.0065	0.0063	0.0062	0.0061	0.0060	0.0055
6	0.0108	0.0076	0.0063	0.0061	0.0059	0.0058	0.0058	0.0055	0.0052	0.0052
	CHANNEL AVERAGE BOUNDARY SHEAR STRESS (lb/sq ft)									
1	0.23	0.29	0.40	0.55	0.65	0.72	0.78	0.86	1.04	0.62
2	0.07	0.09	0.18	0.28	0.37	0.25	0.28	0.31	0.38	0.53
3	0.17	0.21	0.22	0.28	0.33	0.36	0.39	0.41	0.46	0.52
4	0.17	0.21	0.28	0.36	0.40	0.44	0.48	0.54	0.69	0.79
5	0.23	0.29	0.30	0.39	0.47	0.53	0.59	0.66	0.82	0.91
6	0.16	0.17	0.23	0.32	0.40	0.46	0.52	0.58	0.75	0.90
	Channel Hydraulic Radius (ft)									
1	0.44	0.57	0.82	1.10	1.31	1.48	1.63	1.83	2.35	4.12
2	0.98	1.09	1.33	1.60	1.79	2.00	2.14	2.34	2.95	3.45
3	0.45	0.56	0.81	1.16	1.42	1.64	1.84	2.09	2.76	3.12
4	0.47	0.57	0.81	1.08	1.27	1.43	1.59	1.80	2.36	2.81
5	0.46	0.62	0.83	1.13	1.36	1.56	1.73	1.95	2.46	2.86
6	0.50	0.61	0.82	1.09	1.31	1.49	1.66	1.89	2.45	2.93

Notes: 1. Reach averages hydraulic parameters exclude the Smelter Dam structure values.

FIGURES

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 300 600

FIGURE 1

PIONEER TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT
HECRAS ALIGNMENT OVERALL

DATE: 12/21/12

1/17/2013 1:54:40 PM P:\CH2MHILL - METG\PPC REALIGNMENT\CAD\PPCR-FIG-PLN-003-12.DWG

N

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 150 300

FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT
HECRAS ALIGNMENT
STA. 0+00 TO 56+00

DATE: 12/21/12

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 150 300

FIGURE 3

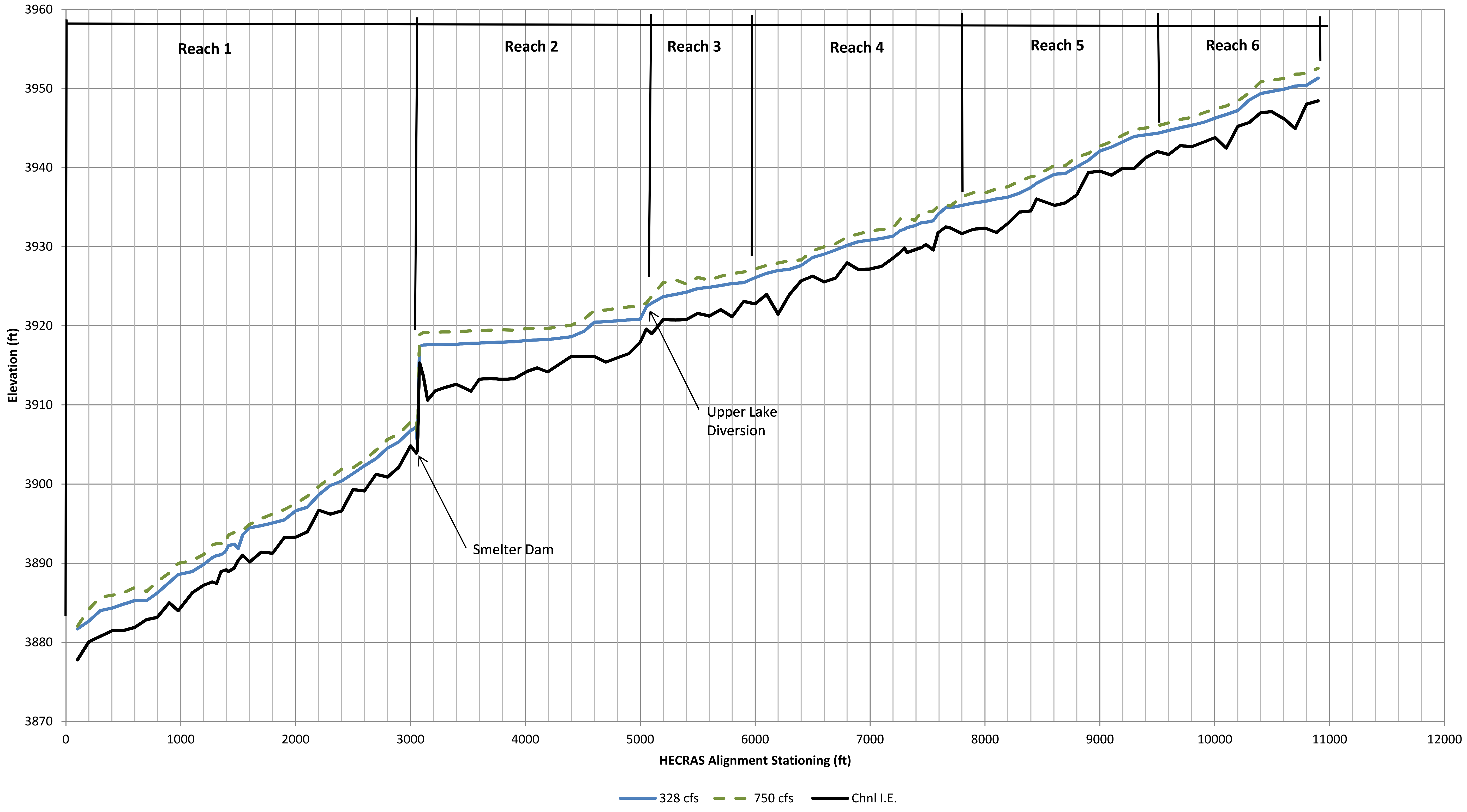
PIONEER
TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT
HECRAS ALIGNMENT
STA. 56+00 TO 109+77

DATE: 12/21/12

1/17/2013 2:00:20 PM P:\CH2MHILL - METG\PPC REALIGNMENT\CAD\PPCR-FIG-PLN-003-12.DWG

Figure 4
PPC Existing Condition Water Surface Profiles



P:\CH2Mhill - METG\PPC Realignment\Data\H&H\PPC EC\Water Surface Profiles

Figure 5
PPC Reference Site 1

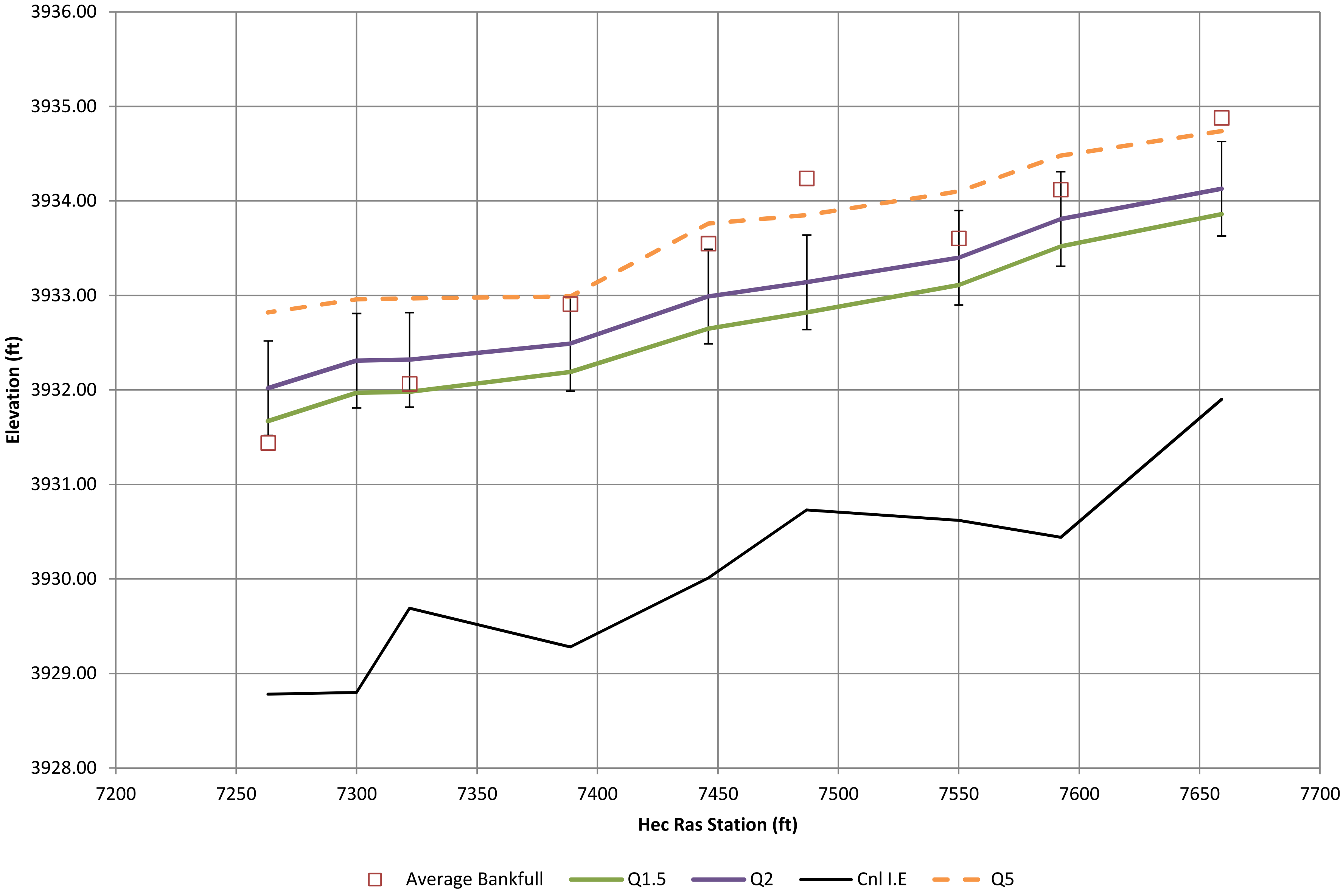


Figure 6
PPC Reference Site 2

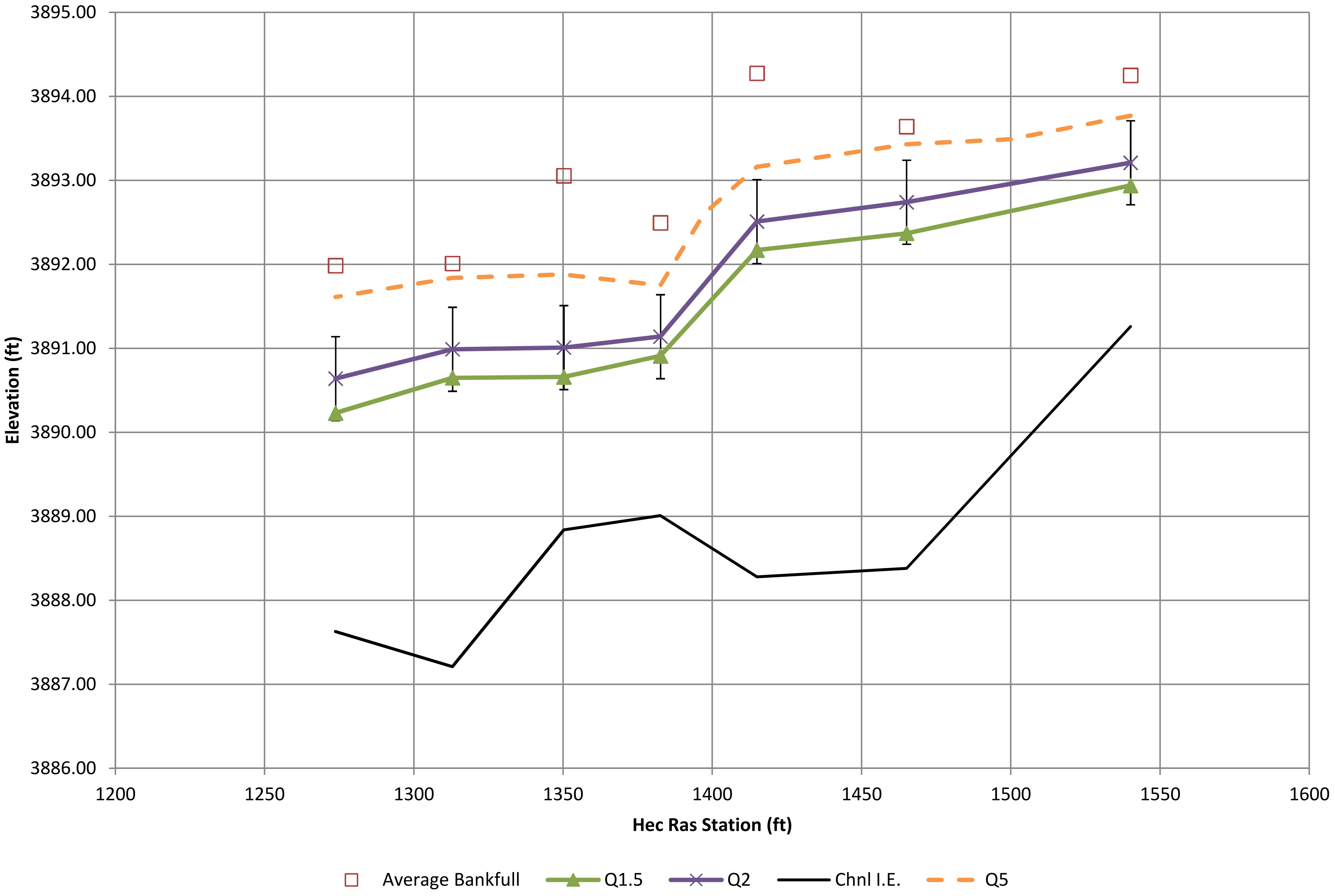


Figure 7
Reference Site 1

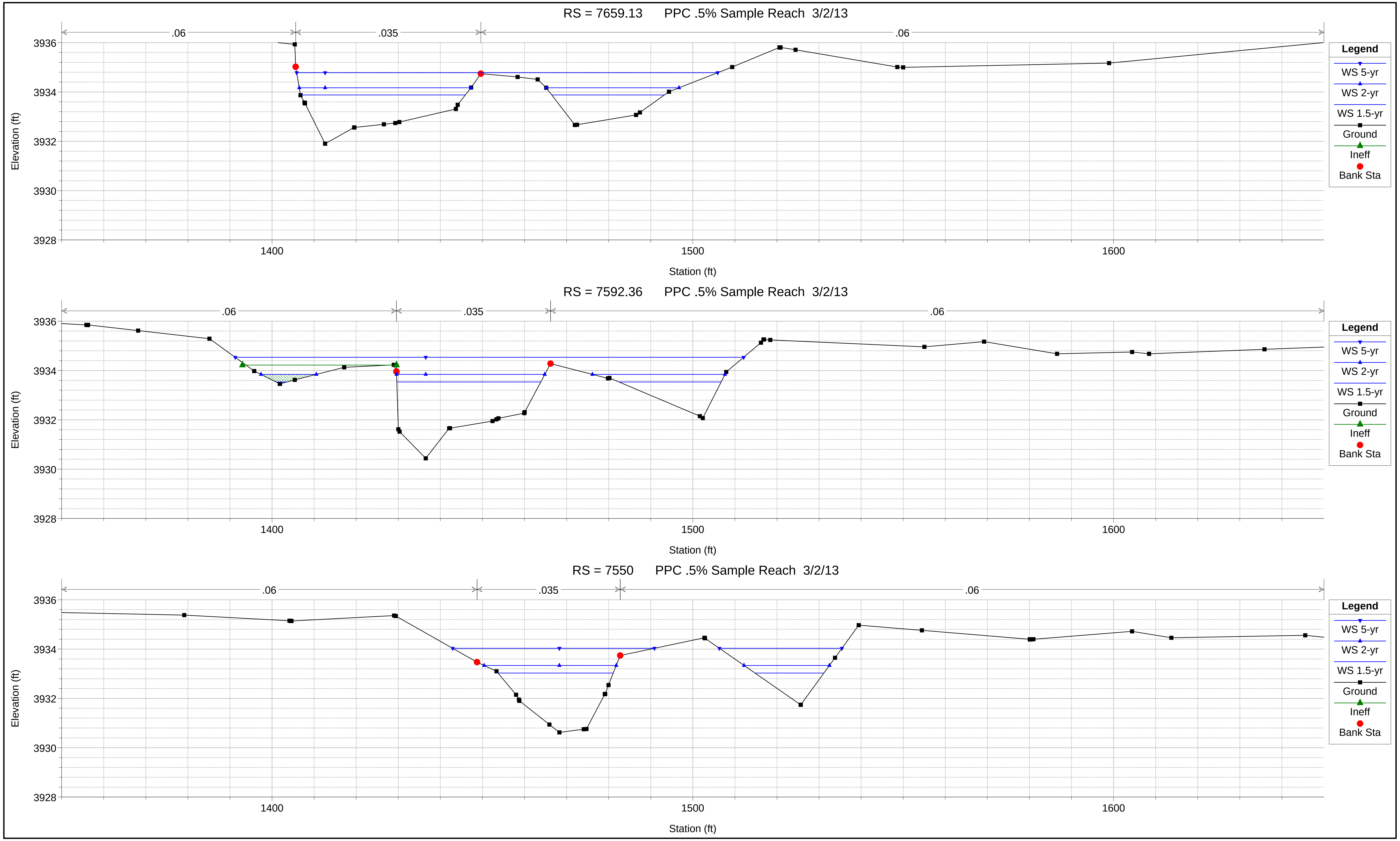


Figure 8
Reference Site 1

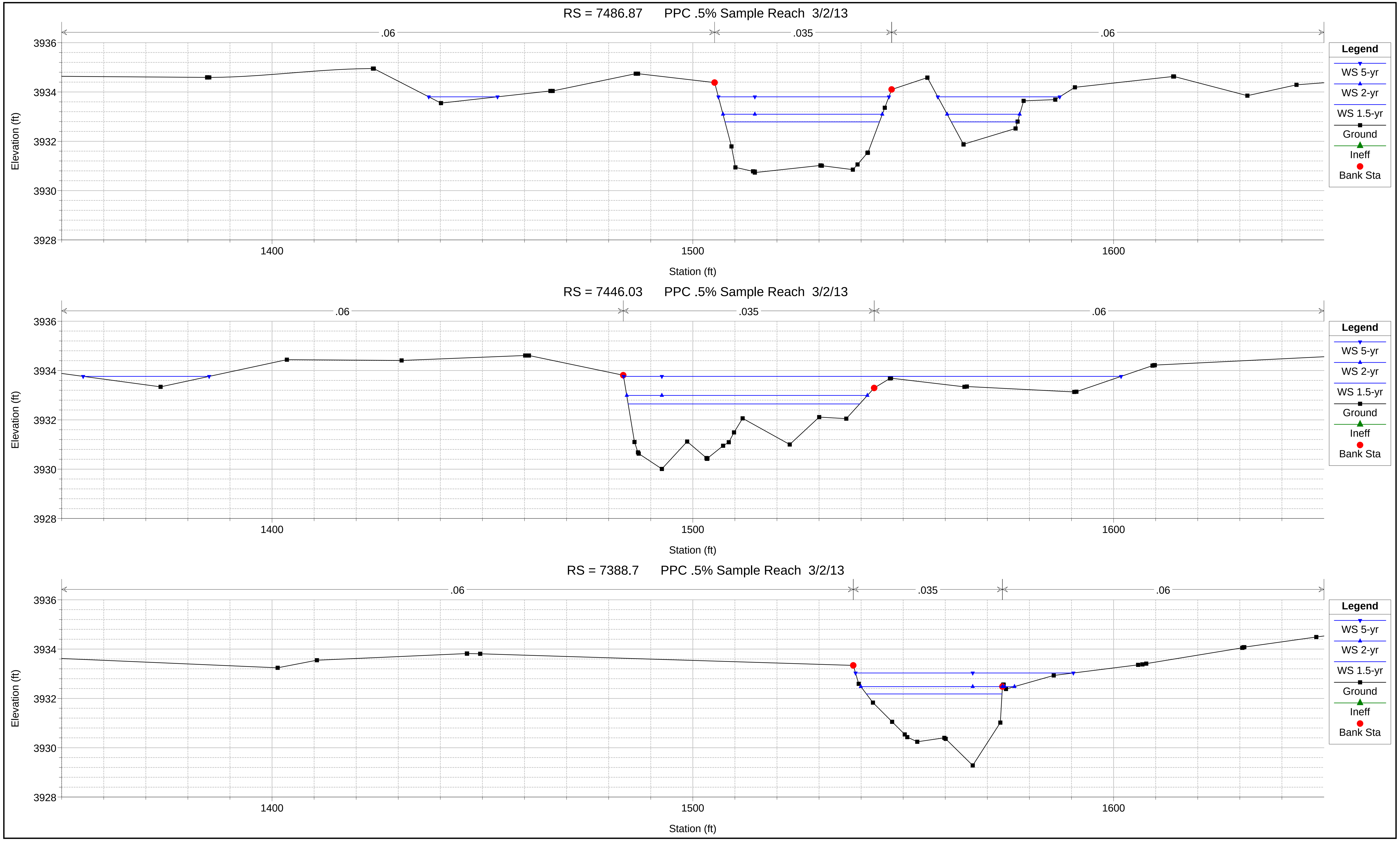


Figure 9
Reference Site 1

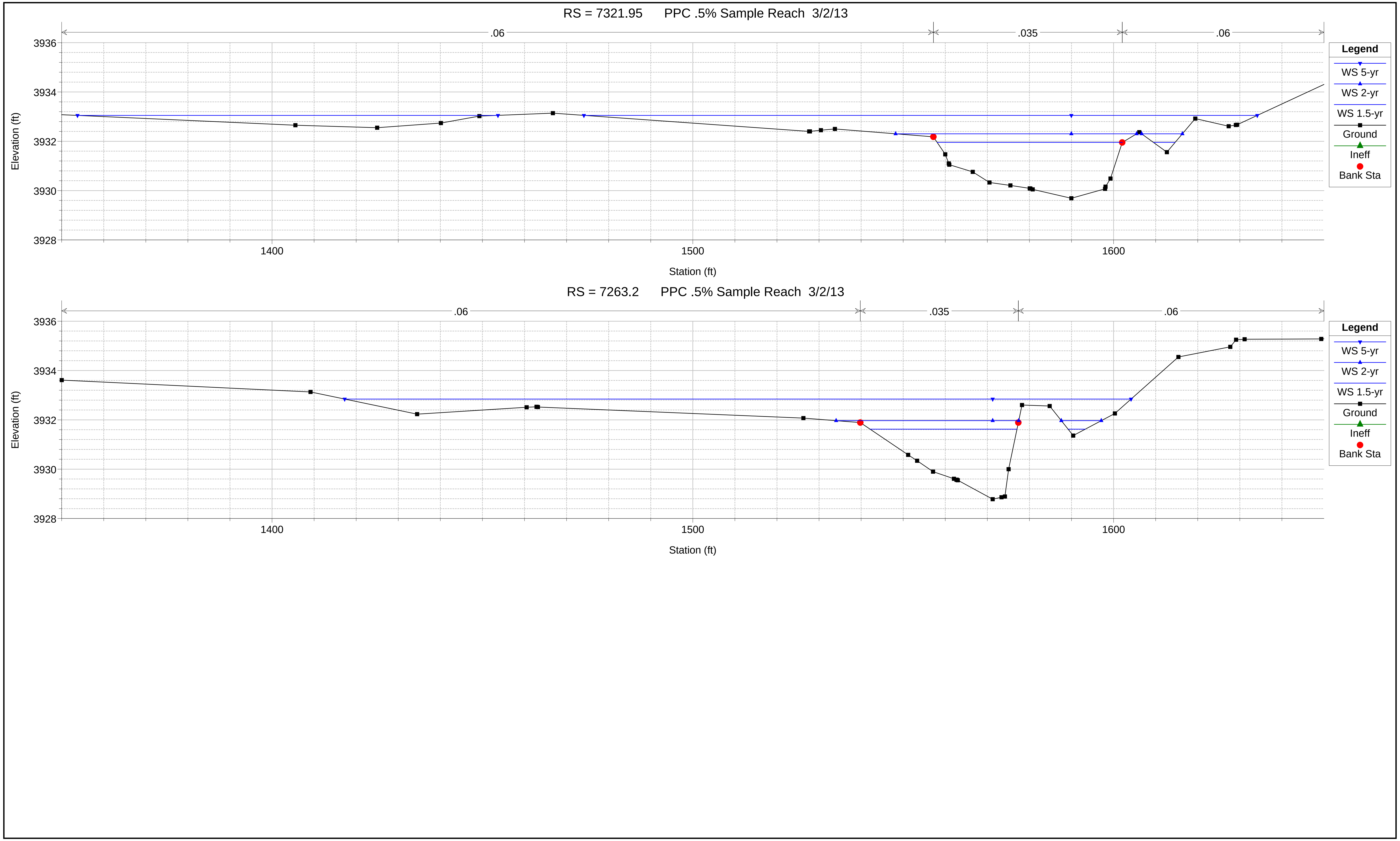


Figure 10
Reference Site 2

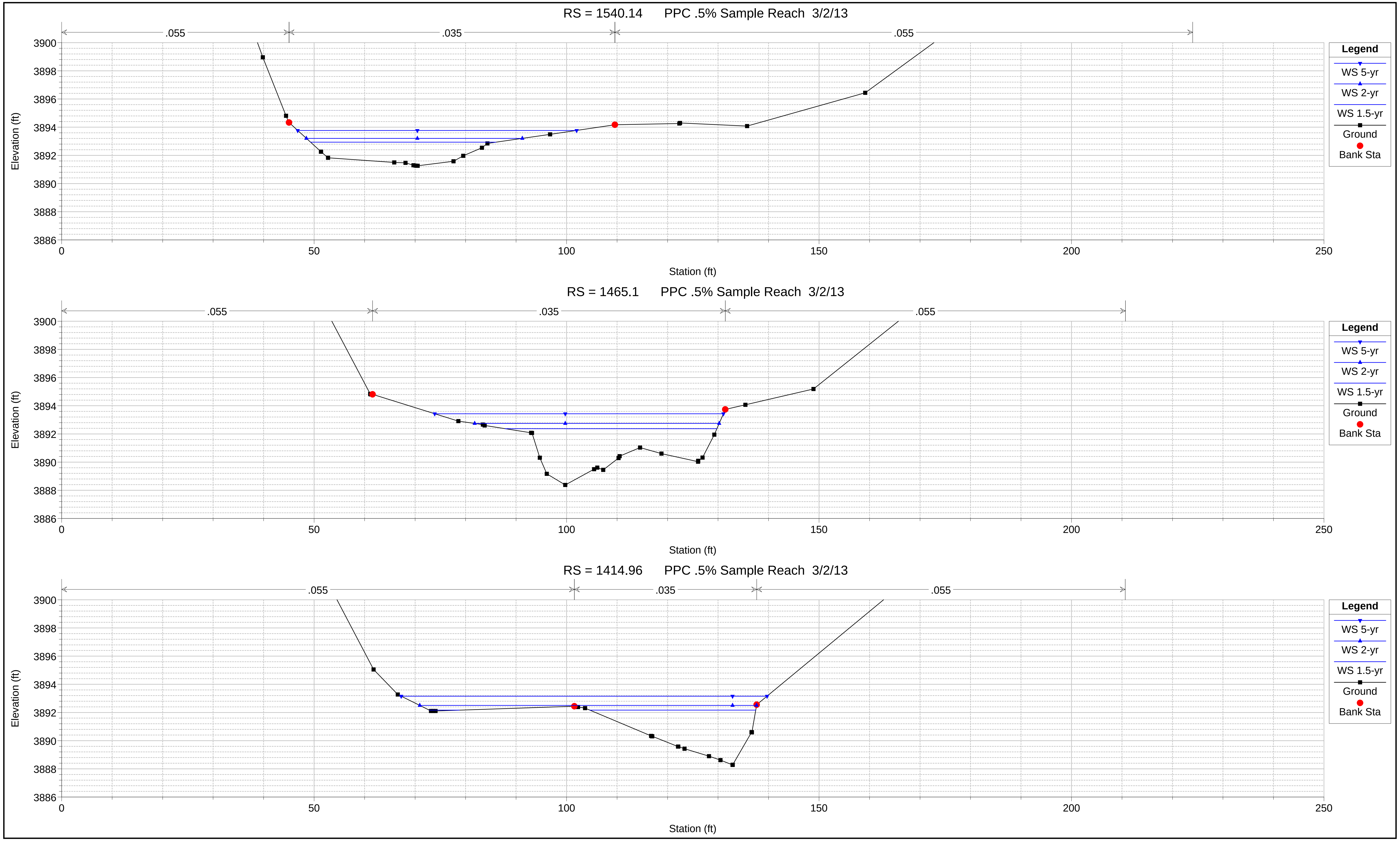


Figure 11
Reference Site 2

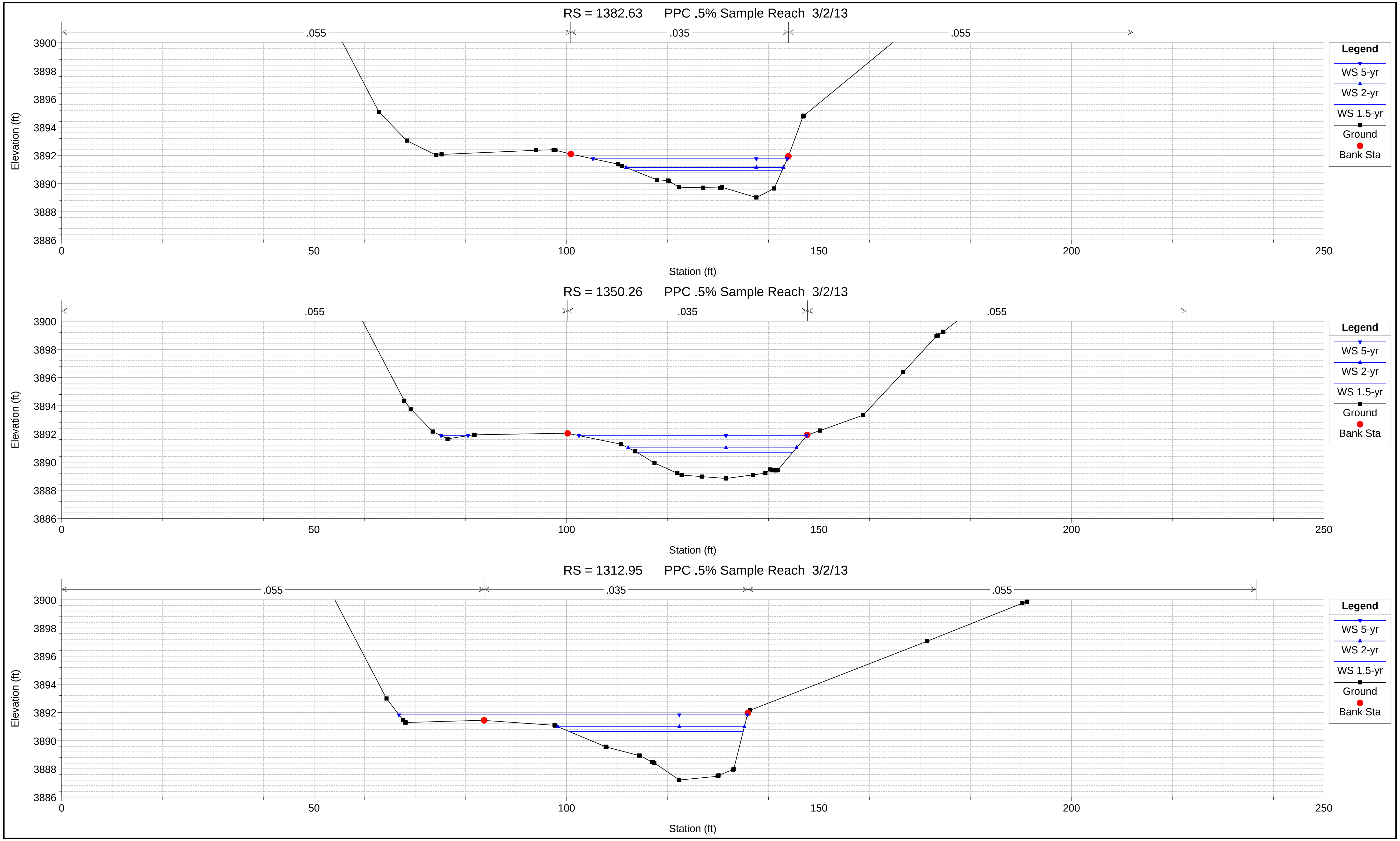


Figure 12
Reference Site 2

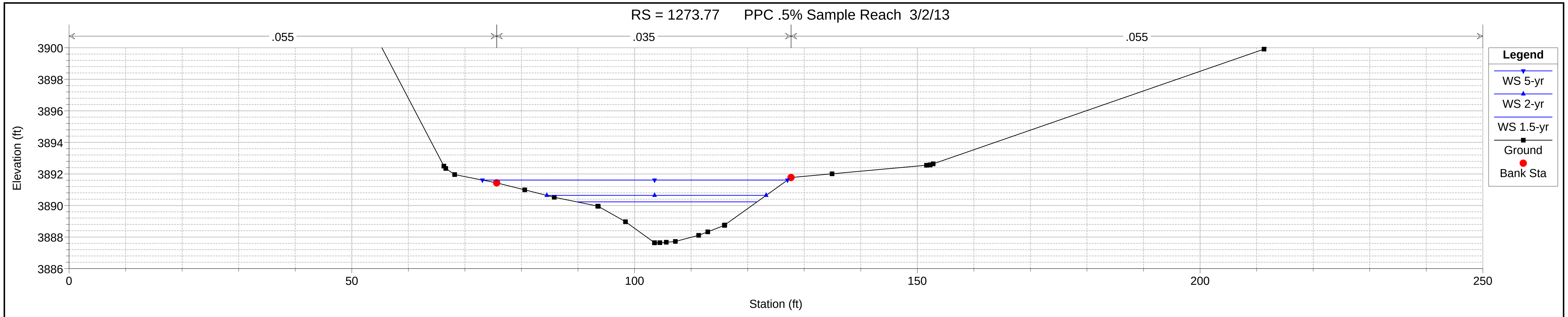
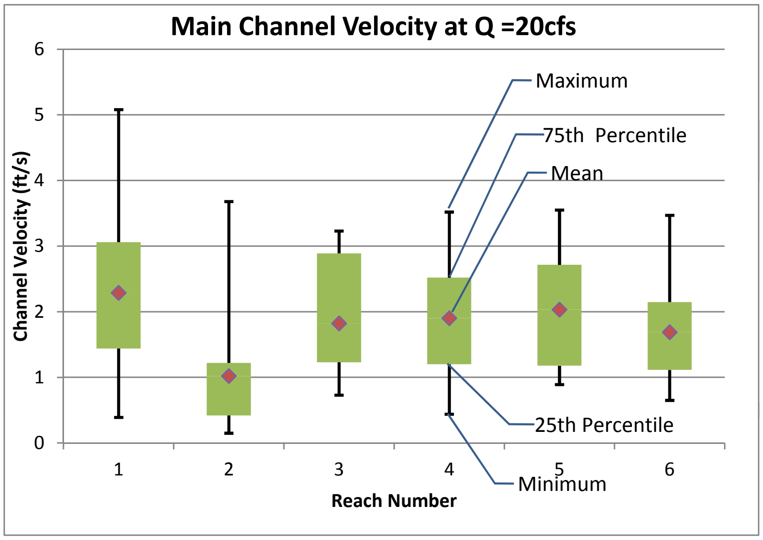
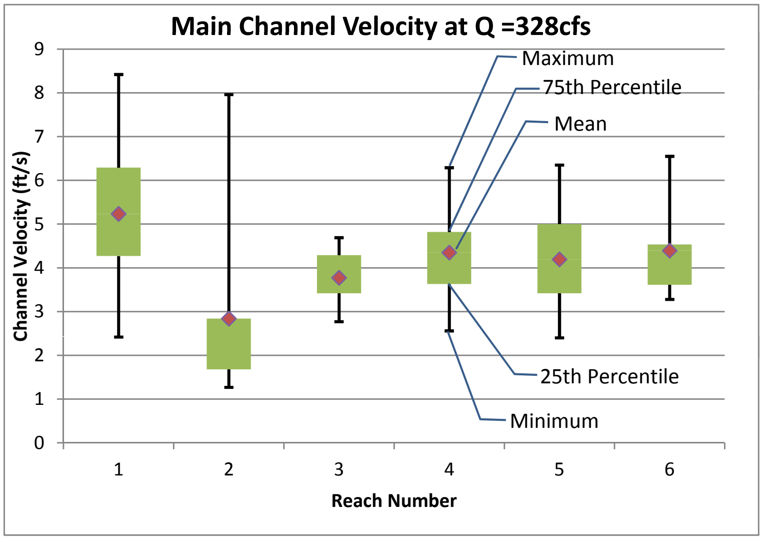


Figure 13

Main Channel Velocity (ft/s)





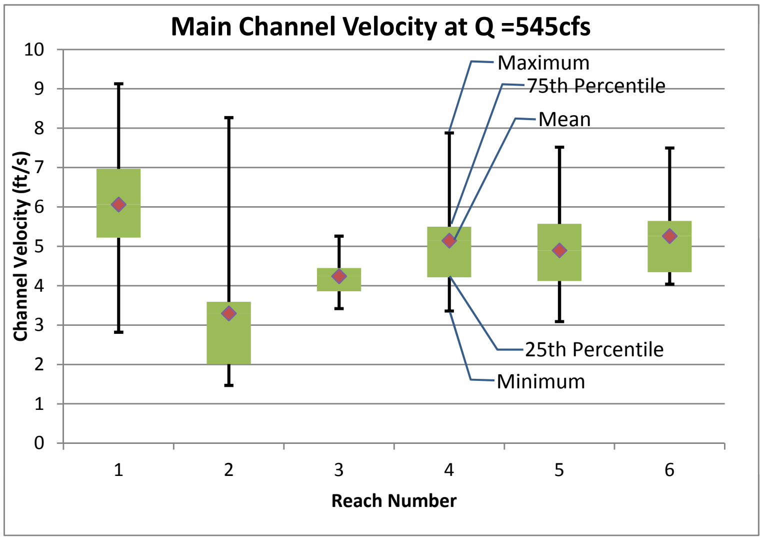


Figure 14

Max. Channel Depth

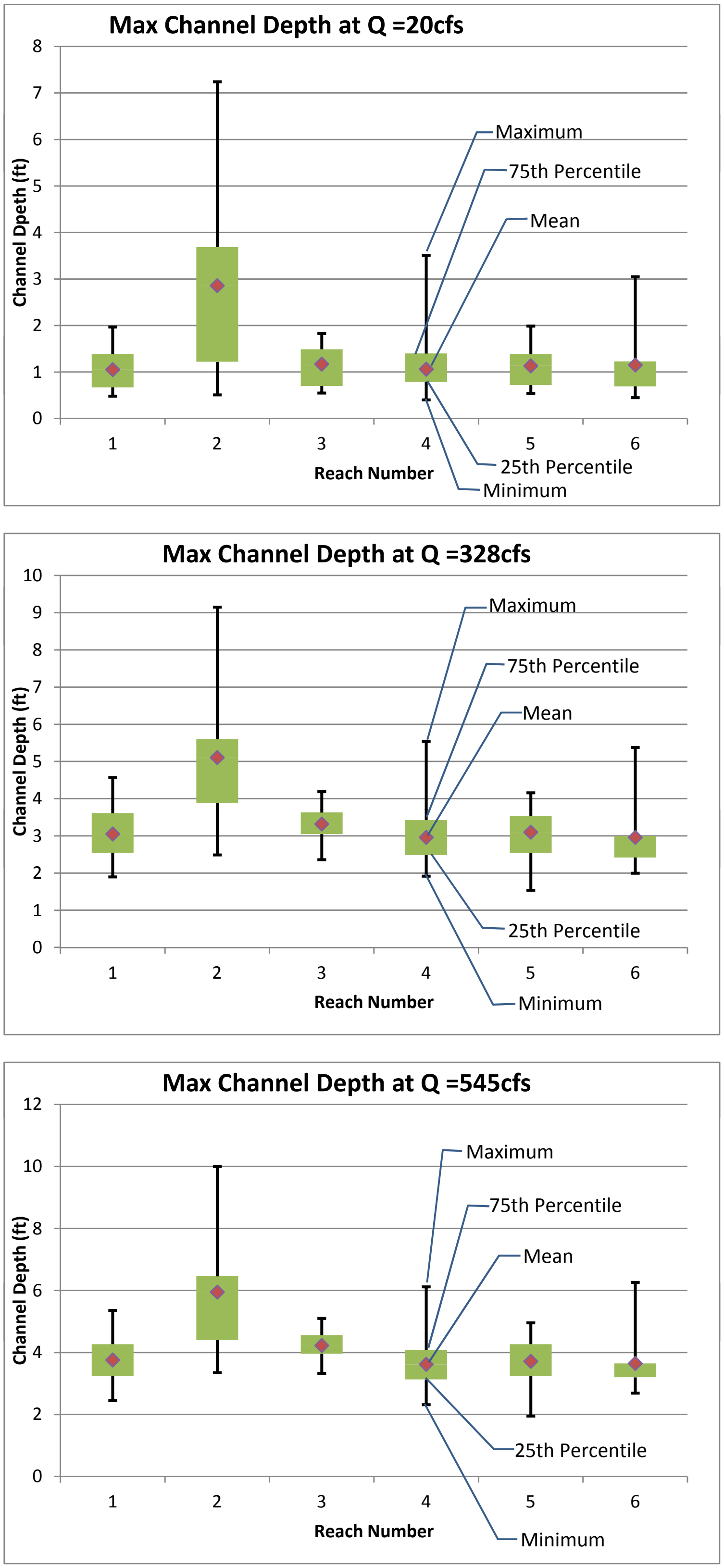
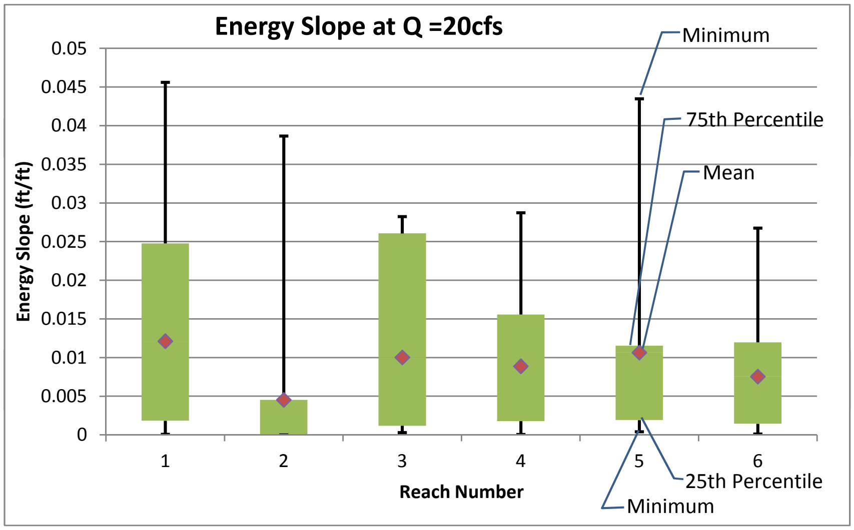
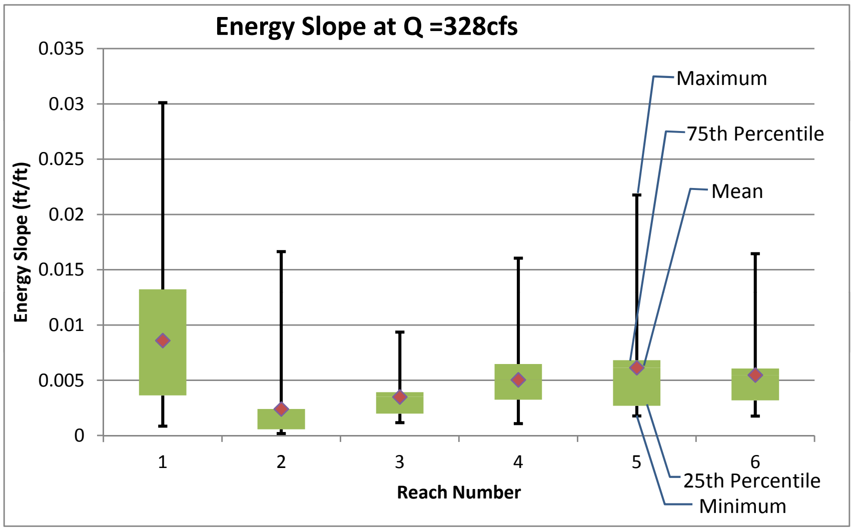


Figure 15

Energy Slope





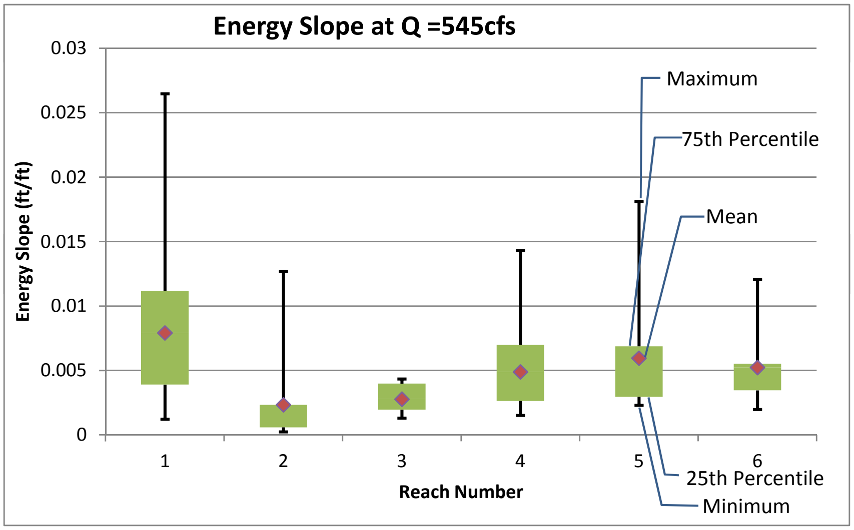
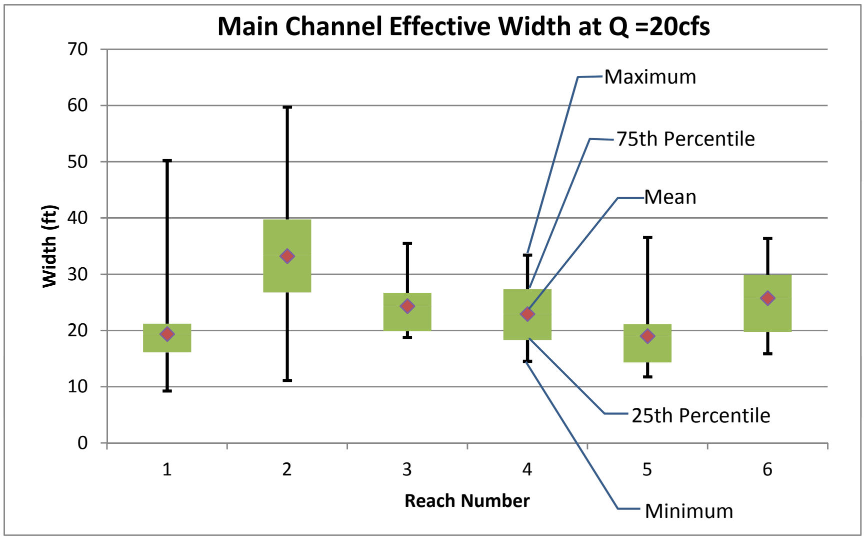
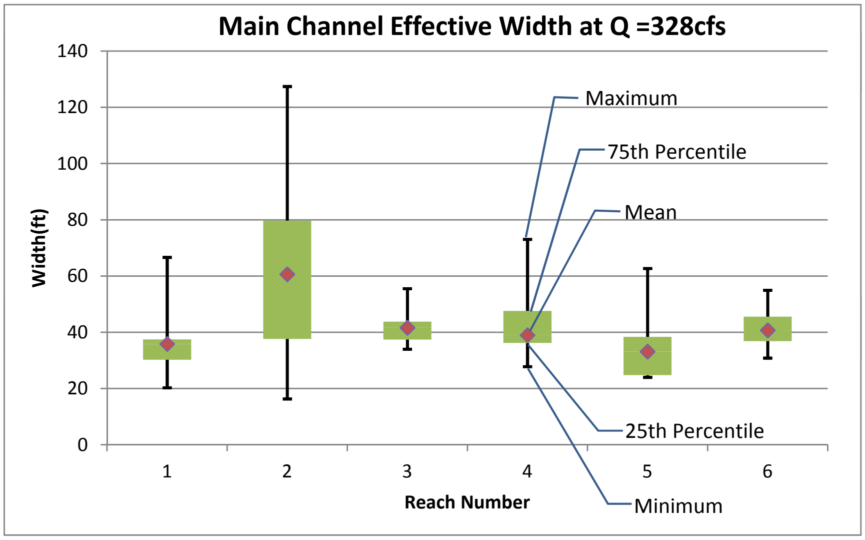


Figure 16

Main Channel Effective Width





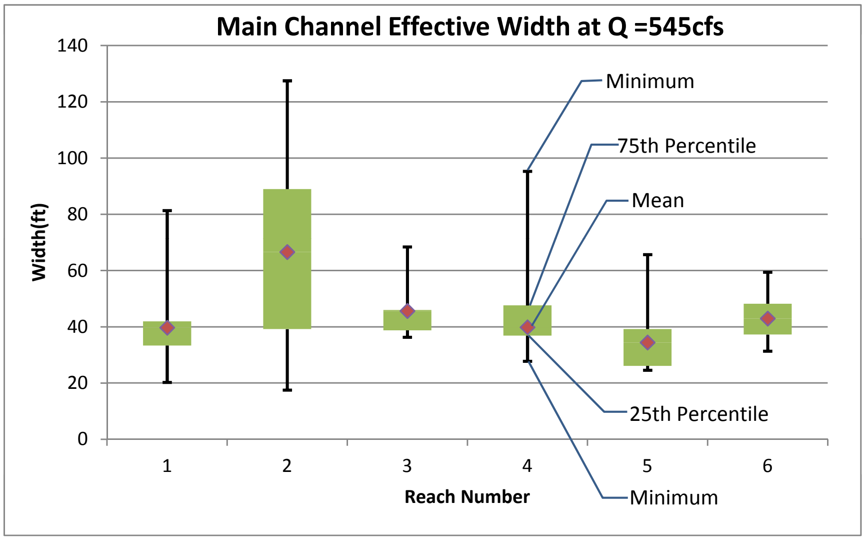
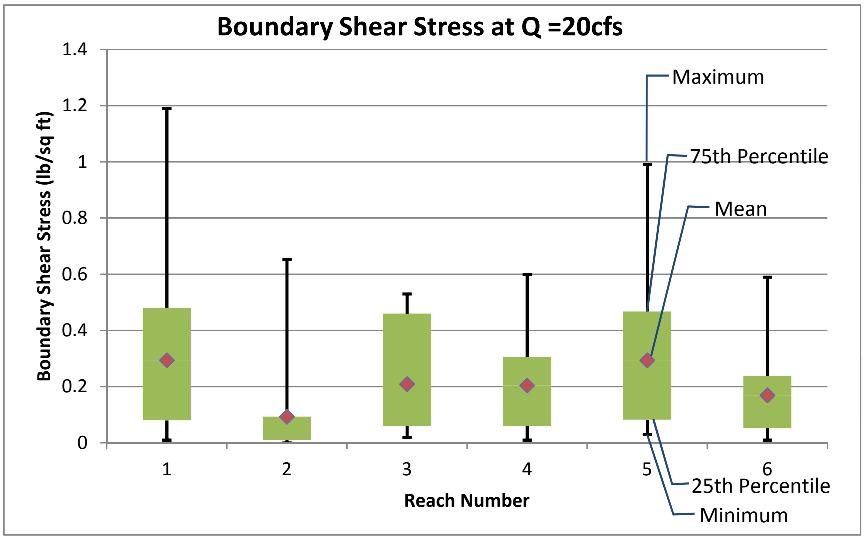
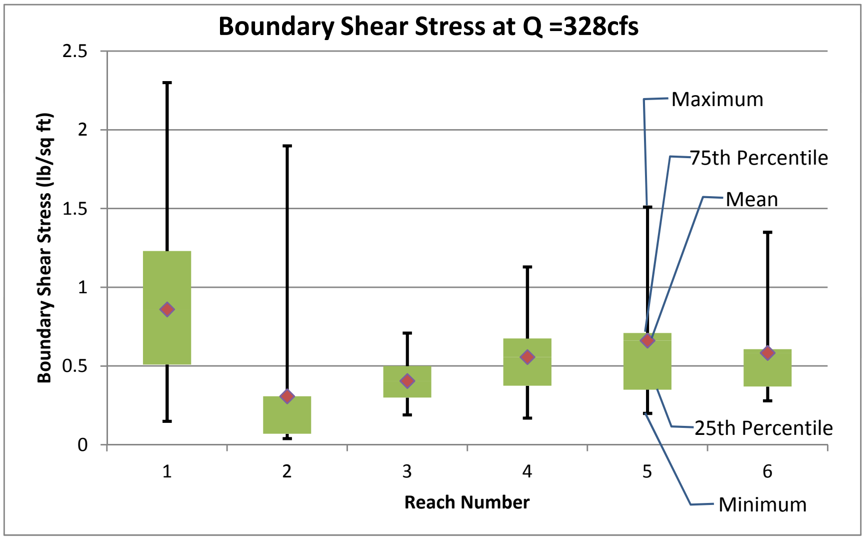


Figure 17

Boundary Shear Stress





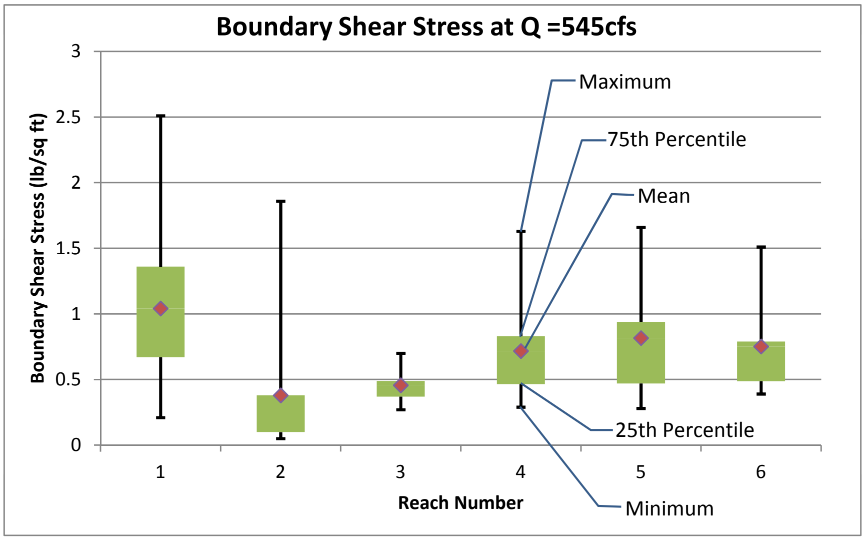
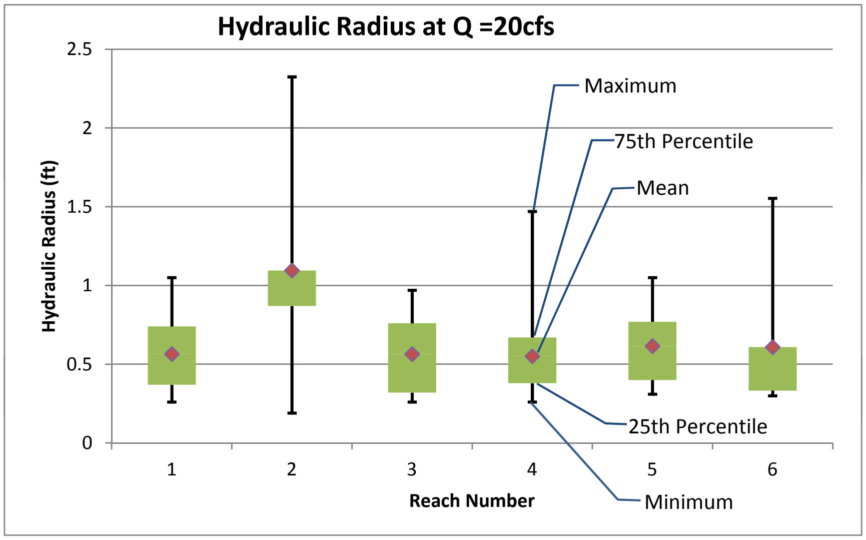
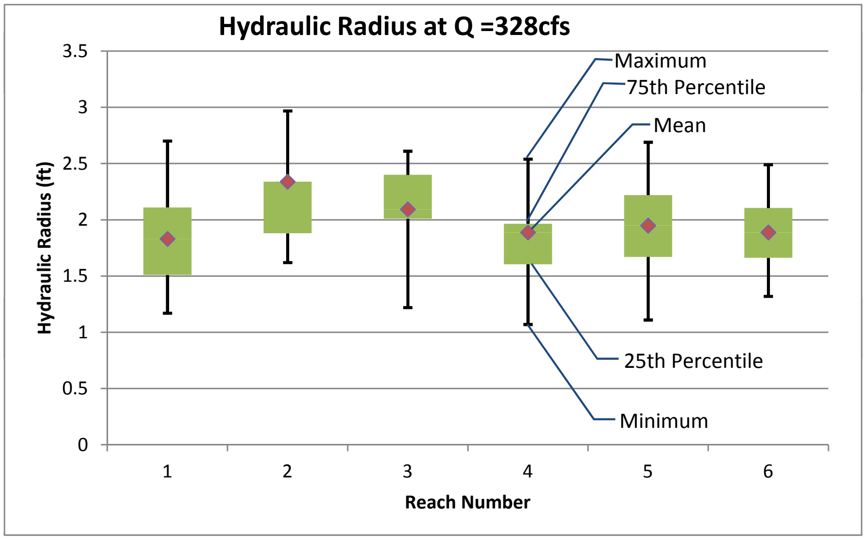
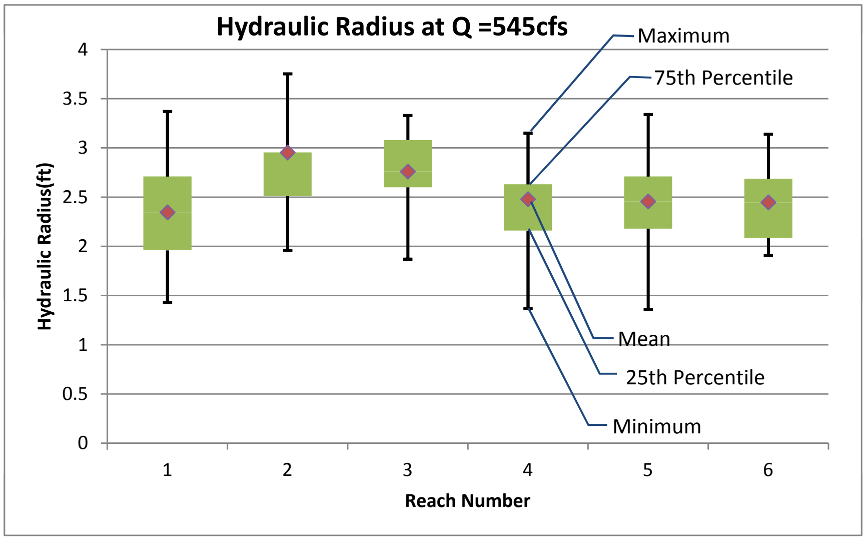


Figure 18

Hydraulic Radius







ATTACHMENT A-1

HEC-RAS Plan: Plan 12   River: Prickly Pear Cr.   Reach: EXISTING STREAM

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	10900	PF 1	10.00	3948.43	3949.18	0.75	0.39	0.96	0.001770	26.57	0.04	0.27
EXISTING STREAM	10900	PF 2	20.00	3948.43	3949.39	0.96	0.55	1.21	0.001806	29.97	0.06	0.29
EXISTING STREAM	10900	PF 3	50.00	3948.43	3949.79	1.36	0.86	1.70	0.001974	34.30	0.10	0.32
EXISTING STREAM	10900	PF 4	100.00	3948.43	3950.21	1.78	1.23	2.26	0.002194	35.98	0.17	0.36
EXISTING STREAM	10900	PF 5	150.00	3948.43	3950.52	2.09	1.51	2.69	0.002387	36.82	0.22	0.39
EXISTING STREAM	10900	PF 6	200.00	3948.43	3950.79	2.36	1.75	3.05	0.002533	37.55	0.27	0.41
EXISTING STREAM	10900	PF 7	252.00	3948.43	3951.03	2.60	1.96	3.37	0.002676	38.20	0.32	0.42
EXISTING STREAM	10900	PF 8	329.00	3948.43	3951.31	2.88	2.19	3.85	0.003011	38.95	0.40	0.46
EXISTING STREAM	10900	PF 9	750.00	3948.43	3952.55	4.12	3.31	5.52	0.003655	40.93	0.72	0.53
EXISTING STREAM	10800	PF 1	10.00	3948.02	3948.58	0.55	0.28	3.02	0.028186	11.97	0.48	1.01
EXISTING STREAM	10800	PF 2	20.00	3948.02	3948.75	0.73	0.36	3.47	0.025999	15.87	0.59	1.02
EXISTING STREAM	10800	PF 3	50.00	3948.02	3949.07	1.05	0.52	4.17	0.023187	23.11	0.75	1.02
EXISTING STREAM	10800	PF 4	100.00	3948.02	3949.40	1.38	0.69	4.79	0.020946	30.14	0.90	1.02
EXISTING STREAM	10800	PF 5	150.00	3948.02	3949.63	1.61	0.87	5.38	0.019620	32.08	1.05	1.02
EXISTING STREAM	10800	PF 6	200.00	3948.02	3949.82	1.80	1.03	5.83	0.018543	33.32	1.17	1.01
EXISTING STREAM	10800	PF 7	252.00	3948.02	3950.01	1.99	1.17	6.22	0.017761	34.50	1.28	1.01
EXISTING STREAM	10800	PF 8	329.00	3948.02	3950.40	2.38	1.47	6.04	0.012519	36.99	1.12	0.88
EXISTING STREAM	10800	PF 9	750.00	3948.02	3951.89	3.87	2.70	6.46	0.006584	42.69	1.06	0.69
EXISTING STREAM	10700	PF 1	10.00	3944.92	3947.73	2.81	1.49	0.38	0.000049	17.76	0.00	0.05
EXISTING STREAM	10700	PF 2	20.00	3944.92	3947.97	3.05	1.62	0.65	0.000131	19.09	0.01	0.09
EXISTING STREAM	10700	PF 3	50.00	3944.92	3948.45	3.53	1.74	1.21	0.000414	23.74	0.04	0.16
EXISTING STREAM	10700	PF 4	100.00	3944.92	3948.95	4.03	1.89	1.85	0.000854	28.66	0.10	0.24
EXISTING STREAM	10700	PF 5	150.00	3944.92	3949.32	4.40	2.07	2.29	0.001161	31.58	0.14	0.28
EXISTING STREAM	10700	PF 6	200.00	3944.92	3949.64	4.72	2.23	2.63	0.001395	34.05	0.19	0.31
EXISTING STREAM	10700	PF 7	252.00	3944.92	3949.93	5.01	2.37	2.93	0.001586	36.30	0.23	0.34
EXISTING STREAM	10700	PF 8	329.00	3944.92	3950.30	5.38	2.59	3.29	0.001778	38.62	0.28	0.36
EXISTING STREAM	10700	PF 9	750.00	3944.92	3951.79	6.87	3.92	4.55	0.001960	40.97	0.46	0.41
EXISTING STREAM	10606.75	PF 1	10.00	3946.14	3947.72	1.57	1.01	0.68	0.000260	14.66	0.02	0.12
EXISTING STREAM	10606.75	PF 2	20.00	3946.14	3947.93	1.79	1.08	1.10	0.000635	16.87	0.04	0.19
EXISTING STREAM	10606.75	PF 3	50.00	3946.14	3948.35	2.21	1.05	1.80	0.001730	26.49	0.11	0.31
EXISTING STREAM	10606.75	PF 4	100.00	3946.14	3948.77	2.63	1.37	2.55	0.002447	28.61	0.20	0.38
EXISTING STREAM	10606.75	PF 5	150.00	3946.14	3949.09	2.95	1.61	3.08	0.002910	30.25	0.28	0.43
EXISTING STREAM	10606.75	PF 6	200.00	3946.14	3949.36	3.22	1.80	3.51	0.003246	31.68	0.35	0.46
EXISTING STREAM	10606.75	PF 7	252.00	3946.14	3949.61	3.47	1.97	3.87	0.003514	32.99	0.42	0.49
EXISTING STREAM	10606.75	PF 8	329.00	3946.14	3949.93	3.79	2.23	4.33	0.003736	34.14	0.50	0.51
EXISTING STREAM	10606.75	PF 9	750.00	3946.14	3951.27	5.13	3.32	5.99	0.004232	37.26	0.84	0.58
EXISTING STREAM	10495.87	PF 1	10.00	3947.07	3947.65	0.58	0.37	0.83	0.001430	32.33	0.03	0.24
EXISTING STREAM	10495.87	PF 2	20.00	3947.07	3947.82	0.75	0.51	1.13	0.001756	34.97	0.06	0.28
EXISTING STREAM	10495.87	PF 3	50.00	3947.07	3948.14	1.07	0.77	1.71	0.002307	37.70	0.11	0.34
EXISTING STREAM	10495.87	PF 4	100.00	3947.07	3948.50	1.43	1.10	2.32	0.002665	39.23	0.18	0.39
EXISTING STREAM	10495.87	PF 5	150.00	3947.07	3948.79	1.72	1.36	2.73	0.002807	40.48	0.23	0.41
EXISTING STREAM	10495.87	PF 6	200.00	3947.07	3949.05	1.98	1.58	3.05	0.002870	41.58	0.28	0.43
EXISTING STREAM	10495.87	PF 7	252.00	3947.07	3949.30	2.23	1.78	3.32	0.002905	42.61	0.32	0.44
EXISTING STREAM	10495.87	PF 8	329.00	3947.07	3949.63	2.56	2.05	3.65	0.002915	43.97	0.37	0.45
EXISTING STREAM	10495.87	PF 9	750.00	3947.07	3951.04	3.97	3.37	4.83	0.002651	45.60	0.54	0.46
EXISTING STREAM	10400	PF 1	10.00	3946.93	3947.21	0.28	0.20	2.29	0.025271	21.97	0.31	0.91
EXISTING STREAM	10400	PF 2	20.00	3946.93	3947.39	0.46	0.30	2.25	0.014122	29.70	0.26	0.73
EXISTING STREAM	10400	PF 3	50.00	3946.93	3947.73	0.80	0.55	2.37	0.006947	38.52	0.24	0.56
EXISTING STREAM	10400	PF 4	100.00	3946.93	3948.14	1.21	0.90	2.67	0.004579	41.45	0.26	0.50
EXISTING STREAM	10400	PF 5	150.00	3946.93	3948.46	1.52	1.17	2.95	0.003940	43.27	0.29	0.48
EXISTING STREAM	10400	PF 6	200.00	3946.93	3948.73	1.80	1.41	3.17	0.003585	44.86	0.31	0.47
EXISTING STREAM	10400	PF 7	252.00	3946.93	3948.99	2.06	1.62	3.36	0.003352	46.36	0.33	0.47
EXISTING STREAM	10400	PF 8	329.00	3946.93	3949.34	2.41	1.89	3.60	0.003124	48.36	0.36	0.46
EXISTING STREAM	10400	PF 9	750.00	3946.93	3950.82	3.89	3.18	4.50	0.002457	52.29	0.48	0.44
EXISTING STREAM	10300	PF 1	10.00	3945.68	3946.56	0.88	0.43	1.34	0.003157	17.47	0.08	0.36
EXISTING STREAM	10300	PF 2	20.00	3945.68	3946.78	1.10	0.58	1.75	0.003530	19.55	0.13	0.40
EXISTING STREAM	10300	PF 3	50.00	3945.68	3947.17	1.49	0.85	2.53	0.004476	23.34	0.23	0.48
EXISTING STREAM	10300	PF 4	100.00	3945.68	3947.57	1.89	1.11	3.35	0.005500	26.89	0.38	0.56
EXISTING STREAM	10300	PF 5	150.00	3945.68	3947.84	2.16	1.33	4.03	0.006323	28.00	0.52	0.62
EXISTING STREAM	10300	PF 6	200.00	3945.68	3948.06	2.38	1.51	4.58	0.006920	28.94	0.64	0.66
EXISTING STREAM	10300	PF 7	252.00	3945.68	3948.26	2.58	1.66	5.09	0.007515	29.77	0.76	0.69
EXISTING STREAM	10300	PF 8	329.00	3945.68	3948.53	2.85	1.87	5.71	0.008179	30.87	0.93	0.74
EXISTING STREAM	10300	PF 9	750.00	3945.68	3949.43	3.75	2.60	8.65	0.012137	33.41	1.90	0.95
EXISTING STREAM	10200	PF 1	10.00	3945.19	3945.71	0.52	0.25	2.88	0.030174	14.13	0.46	1.03
EXISTING STREAM	10200	PF 2	20.00	3945.19	3945.87	0.68	0.31	3.18	0.026765	20.32	0.52	1.01
EXISTING STREAM	10200	PF 3	50.00	3945.19	3946.15	0.96	0.46	3.78	0.022680	28.99	0.64	0.99
EXISTING STREAM	10200	PF 4	100.00	3945.19	3946.42	1.23	0.63	4.50	0.021110	35.41	0.82	1.00
EXISTING STREAM	10200	PF 5	150.00	3945.19	3946.62	1.43	0.82	5.09	0.019002	35.79	0.96	0.99
EXISTING STREAM	10200	PF 6	200.00	3945.19	3946.80	1.61	0.99	5.60	0.018129	36.11	1.10	0.99
EXISTING STREAM	10200	PF 7	252.00	3945.19	3946.97	1.78	1.15	6.01	0.017167	36.44	1.20	0.99
EXISTING STREAM	10200	PF 8	329.00	3945.19	3947.19	2.00	1.36	6.56	0.016510	36.86	1.36	0.99
EXISTING STREAM	10200	PF 9	750.00	3945.19	3948.40	3.21	2.51	7.80	0.010691	38.13	1.58	0.87
EXISTING STREAM	10100	PF 1	10.00	3942.45	3944.72	2.27	1.12	0.46	0.000103	19.47	0.01	0.08
EXISTING STREAM	10100	PF 2	20.00	3942.45	3944.88	2.43	1.21	0.79	0.000281	20.91	0.02	0.13
EXISTING STREAM	10100	PF 3	50.00	3942.45	3945.24	2.79	1.38	1.51	0.000851	24.00	0.07	0.23
EXISTING STREAM	10100	PF 4	100.00	3942.45	3945.65	3.20	1.61	2.28	0.001592	27.28	0.16	0.32
EXISTING STREAM	10100	PF 5	150.00	3942.45	3945.96	3.51	1.81	2.85	0.002125	29.05	0.23	0.37
EXISTING STREAM	10100	PF 6	200.00	3942.45	3946.22	3.77	2.01	3.32	0.002530	29.89	0.31	0.41
EXISTING STREAM	10100	PF 7	252.00	3942.45	3946.44	3.99	2.19	3.76	0.002901	30.51	0.38	0.45
EXISTING STREAM	10100	PF 8	329.00	3942.45	3946.72	4.27	2.44	4.35	0.003378	30.98	0.49	0.49
EXISTING STREAM	10100	PF 9	750.00	3942.45	3947.78	5.33	3.47	6.86	0.005253	31.34	1.09	0.65

HEC-RAS Plan: Plan 12   River: Prickly Pear Cr.   Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	10004.49	PF 1	10.00	3943.80	3944.67	0.87	0.27	1.18	0.004537	31.44	0.08	0.40
EXISTING STREAM	10004.49	PF 2	20.00	3943.80	3944.78	0.98	0.34	1.64	0.006439	36.41	0.13	0.50
EXISTING STREAM	10004.49	PF 3	50.00	3943.80	3944.98	1.18	0.53	2.55	0.008643	37.28	0.28	0.62
EXISTING STREAM	10004.49	PF 4	100.00	3943.80	3945.26	1.46	0.79	3.28	0.008297	38.38	0.41	0.65
EXISTING STREAM	10004.49	PF 5	150.00	3943.80	3945.52	1.72	1.02	3.71	0.007617	39.69	0.48	0.65
EXISTING STREAM	10004.49	PF 6	200.00	3943.80	3945.75	1.95	1.19	4.02	0.007267	41.84	0.53	0.65
EXISTING STREAM	10004.49	PF 7	252.00	3943.80	3945.96	2.16	1.35	4.28	0.006995	43.67	0.58	0.65
EXISTING STREAM	10004.49	PF 8	329.00	3943.80	3946.25	2.45	1.56	4.58	0.006634	46.14	0.63	0.65
EXISTING STREAM	10004.49	PF 9	750.00	3943.80	3947.41	3.61	2.61	5.81	0.005362	49.17	0.86	0.63
EXISTING STREAM	9900.02	PF 1	10.00	3943.19	3943.60	0.41	0.20	2.55	0.030097	19.28	0.38	0.99
EXISTING STREAM	9900.02	PF 2	20.00	3943.19	3943.80	0.61	0.32	2.31	0.013374	26.66	0.27	0.72
EXISTING STREAM	9900.02	PF 3	50.00	3943.19	3944.17	0.98	0.63	2.58	0.006811	30.59	0.27	0.57
EXISTING STREAM	9900.02	PF 4	100.00	3943.19	3944.59	1.40	0.97	3.04	0.005410	34.03	0.32	0.54
EXISTING STREAM	9900.02	PF 5	150.00	3943.19	3944.91	1.72	1.22	3.40	0.004964	36.00	0.38	0.54
EXISTING STREAM	9900.02	PF 6	200.00	3943.19	3945.17	1.98	1.46	3.72	0.004713	36.81	0.42	0.54
EXISTING STREAM	9900.02	PF 7	252.00	3943.19	3945.41	2.22	1.69	4.02	0.004504	36.99	0.47	0.54
EXISTING STREAM	9900.02	PF 8	329.00	3943.19	3945.71	2.52	1.99	4.41	0.004344	36.99	0.54	0.55
EXISTING STREAM	9900.02	PF 9	750.00	3943.19	3946.90	3.71	3.18	6.01	0.004331	36.99	0.85	0.59
EXISTING STREAM	9800	PF 1	10.00	3942.65	3943.36	0.71	0.44	0.78	0.001000	28.99	0.03	0.21
EXISTING STREAM	9800	PF 2	20.00	3942.65	3943.53	0.88	0.60	1.11	0.001359	29.80	0.05	0.25
EXISTING STREAM	9800	PF 3	50.00	3942.65	3943.89	1.24	0.92	1.72	0.001856	31.47	0.11	0.32
EXISTING STREAM	9800	PF 4	100.00	3942.65	3944.28	1.63	1.25	2.41	0.002431	33.21	0.19	0.38
EXISTING STREAM	9800	PF 5	150.00	3942.65	3944.58	1.92	1.49	2.91	0.002808	34.52	0.26	0.42
EXISTING STREAM	9800	PF 6	200.00	3942.65	3944.82	2.17	1.69	3.32	0.003107	35.62	0.32	0.45
EXISTING STREAM	9800	PF 7	252.00	3942.65	3945.05	2.40	1.87	3.68	0.003357	36.62	0.38	0.47
EXISTING STREAM	9800	PF 8	329.00	3942.65	3945.34	2.69	2.11	4.16	0.003653	37.54	0.47	0.50
EXISTING STREAM	9800	PF 9	750.00	3942.65	3946.34	3.69	3.04	6.30	0.005181	38.75	0.96	0.64
EXISTING STREAM	9700	PF 1	10.00	3942.77	3943.01	0.24	0.18	2.10	0.023517	26.12	0.27	0.86
EXISTING STREAM	9700	PF 2	20.00	3942.77	3943.22	0.45	0.34	1.84	0.007818	31.66	0.17	0.55
EXISTING STREAM	9700	PF 3	50.00	3942.77	3943.60	0.83	0.61	2.03	0.004476	40.62	0.17	0.46
EXISTING STREAM	9700	PF 4	100.00	3942.77	3943.98	1.21	0.91	2.44	0.003753	44.80	0.21	0.45
EXISTING STREAM	9700	PF 5	150.00	3942.77	3944.27	1.50	1.15	2.75	0.003530	47.57	0.25	0.45
EXISTING STREAM	9700	PF 6	200.00	3942.77	3944.52	1.75	1.33	3.00	0.003443	49.90	0.28	0.46
EXISTING STREAM	9700	PF 7	252.00	3942.77	3944.75	1.98	1.50	3.22	0.003385	52.04	0.32	0.46
EXISTING STREAM	9700	PF 8	329.00	3942.77	3945.04	2.27	1.71	3.50	0.003359	54.81	0.36	0.47
EXISTING STREAM	9700	PF 9	750.00	3942.77	3946.08	3.31	2.57	4.85	0.003763	60.07	0.60	0.53
EXISTING STREAM	9599.98	PF 1	10.00	3941.65	3942.71	1.06	0.46	0.92	0.001309	23.51	0.04	0.24
EXISTING STREAM	9599.98	PF 2	20.00	3941.65	3942.92	1.27	0.58	1.21	0.001714	28.75	0.06	0.28
EXISTING STREAM	9599.98	PF 3	50.00	3941.65	3943.28	1.63	0.79	1.77	0.002432	36.01	0.12	0.35
EXISTING STREAM	9599.98	PF 4	100.00	3941.65	3943.65	2.00	1.03	2.34	0.002991	41.43	0.19	0.41
EXISTING STREAM	9599.98	PF 5	150.00	3941.65	3943.93	2.28	1.22	2.73	0.003269	45.12	0.24	0.44
EXISTING STREAM	9599.98	PF 6	200.00	3941.65	3944.17	2.52	1.37	3.03	0.003445	48.24	0.29	0.46
EXISTING STREAM	9599.98	PF 7	252.00	3941.65	3944.40	2.75	1.51	3.26	0.003515	51.19	0.32	0.47
EXISTING STREAM	9599.98	PF 8	329.00	3941.65	3944.69	3.04	1.68	3.55	0.003591	55.00	0.37	0.48
EXISTING STREAM	9599.98	PF 9	750.00	3941.65	3945.66	4.01	2.50	4.99	0.004222	59.77	0.64	0.56
EXISTING STREAM	9500.15	PF 1	10.00	3942.03	3942.54	0.50	0.33	0.97	0.002297	30.87	0.05	0.30
EXISTING STREAM	9500.15	PF 2	20.00	3942.03	3942.73	0.70	0.46	1.18	0.002161	36.57	0.06	0.30
EXISTING STREAM	9500.15	PF 3	50.00	3942.03	3942.99	0.96	0.66	1.85	0.003368	41.15	0.14	0.40
EXISTING STREAM	9500.15	PF 4	100.00	3942.03	3943.28	1.25	0.86	2.52	0.004416	46.07	0.23	0.48
EXISTING STREAM	9500.15	PF 5	150.00	3942.03	3943.54	1.51	1.04	2.87	0.004435	50.24	0.28	0.50
EXISTING STREAM	9500.15	PF 6	200.00	3942.03	3943.79	1.76	1.21	3.07	0.004186	54.09	0.31	0.49
EXISTING STREAM	9500.15	PF 7	252.00	3942.03	3944.03	2.00	1.36	3.19	0.003871	57.93	0.32	0.48
EXISTING STREAM	9500.15	PF 8	329.00	3942.03	3944.34	2.31	1.55	3.38	0.003653	62.74	0.34	0.48
EXISTING STREAM	9500.15	PF 9	750.00	3942.03	3945.25	3.22	2.34	4.77	0.004253	67.16	0.60	0.55
EXISTING STREAM	9400	PF 1	10.00	3941.25	3941.80	0.55	0.28	2.97	0.043765	11.84	0.77	0.98
EXISTING STREAM	9400	PF 2	20.00	3941.25	3941.97	0.72	0.37	3.51	0.043470	15.51	0.99	1.02
EXISTING STREAM	9400	PF 3	50.00	3941.25	3942.42	1.17	0.62	2.39	0.009985	23.82	0.39	0.53
EXISTING STREAM	9400	PF 4	100.00	3941.25	3942.87	1.62	0.99	2.12	0.004235	26.26	0.26	0.37
EXISTING STREAM	9400	PF 5	150.00	3941.25	3943.21	1.96	1.28	2.12	0.003036	27.66	0.24	0.33
EXISTING STREAM	9400	PF 6	200.00	3941.25	3943.52	2.27	1.57	2.17	0.002451	28.09	0.23	0.31
EXISTING STREAM	9400	PF 7	252.00	3941.25	3943.81	2.56	1.85	2.24	0.002081	28.09	0.24	0.29
EXISTING STREAM	9400	PF 8	329.00	3941.25	3944.14	2.89	2.18	2.41	0.001928	28.09	0.26	0.29
EXISTING STREAM	9400	PF 9	750.00	3941.25	3945.01	3.76	3.06	3.64	0.002812	28.09	0.53	0.37
EXISTING STREAM	9300	PF 1	10.00	3939.91	3940.99	1.08	0.69	1.15	0.002051	12.51	0.09	0.24
EXISTING STREAM	9300	PF 2	20.00	3939.91	3941.30	1.39	0.90	1.55	0.002657	14.39	0.14	0.29
EXISTING STREAM	9300	PF 3	50.00	3939.91	3941.91	2.00	1.29	2.20	0.003348	17.56	0.26	0.34
EXISTING STREAM	9300	PF 4	100.00	3939.91	3942.51	2.60	1.74	2.57	0.003106	19.39	0.32	0.34
EXISTING STREAM	9300	PF 5	150.00	3939.91	3942.95	3.04	2.06	2.59	0.002554	20.71	0.31	0.32
EXISTING STREAM	9300	PF 6	200.00	3939.91	3943.31	3.40	2.30	2.53	0.002127	21.88	0.28	0.29
EXISTING STREAM	9300	PF 7	252.00	3939.91	3943.64	3.73	2.52	2.48	0.001828	22.93	0.27	0.28
EXISTING STREAM	9300	PF 8	329.00	3939.91	3943.98	4.07	2.73	2.59	0.001789	24.02	0.28	0.28
EXISTING STREAM	9300	PF 9	750.00	3939.91	3944.80	4.89	3.24	3.59	0.002768	26.65	0.51	0.35
EXISTING STREAM	9200	PF 1	10.00	3939.93	3940.52	0.59	0.40	2.03	0.013281	12.42	0.32	0.57
EXISTING STREAM	9200	PF 2	20.00	3939.93	3940.85	0.92	0.66	2.12	0.007474	14.36	0.30	0.46
EXISTING STREAM	9200	PF 3	50.00	3939.93	3941.40	1.47	1.05	2.77	0.006869	17.12	0.44	0.48
EXISTING STREAM	9200	PF 4	100.00	3939.93	3941.95	2.02	1.47	3.55	0.007308	19.11	0.64	0.52
EXISTING STREAM	9200	PF 5	150.00	3939.93	3942.35	2.42	1.78	4.16	0.007917	20.30	0.83	0.55
EXISTING STREAM	9200	PF 6	200.00	3939.93	3942.68	2.75	2.00	4.67	0.008618	21.43	1.01	0.58
EXISTING STREAM	9200	PF 7	252.00	3939.93	3942.95	3.02	2.13	5.17	0.009671	22.87	1.21	0.62
EXISTING STREAM	9200	PF 8	329.00	3939.93	3943.24	3.31	2.27	5.62	0.010519	24.57	1.40	0.66
EXISTING STREAM	9200	PF 9	750.00	3939.93	3944.10	4.17	2.98	6.28	0.009118	26.13	1.60	0.64

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	9100	PF 1	10.00	3939.04	3940.41	1.37	0.82	0.65	0.000522	18.73	0.03	0.13
EXISTING STREAM	9100	PF 2	20.00	3939.04	3940.71	1.67	1.05	0.94	0.000797	20.21	0.05	0.16
EXISTING STREAM	9100	PF 3	50.00	3939.04	3941.16	2.12	1.44	1.63	0.001596	21.26	0.14	0.24
EXISTING STREAM	9100	PF 4	100.00	3939.04	3941.59	2.55	1.80	2.50	0.002824	22.26	0.30	0.33
EXISTING STREAM	9100	PF 5	150.00	3939.04	3941.88	2.84	2.03	3.23	0.004047	22.92	0.48	0.40
EXISTING STREAM	9100	PF 6	200.00	3939.04	3942.09	3.05	2.20	3.85	0.005213	23.42	0.67	0.46
EXISTING STREAM	9100	PF 7	252.00	3939.04	3942.28	3.24	2.34	4.35	0.006142	23.85	0.84	0.50
EXISTING STREAM	9100	PF 8	329.00	3939.04	3942.51	3.47	2.52	4.82	0.006884	24.39	1.00	0.54
EXISTING STREAM	9100	PF 9	750.00	3939.04	3943.28	4.24	3.15	6.24	0.008725	25.73	1.57	0.62
EXISTING STREAM	9000	PF 1	10.00	3939.55	3940.32	0.77	0.55	0.88	0.001601	20.57	0.05	0.21
EXISTING STREAM	9000	PF 2	20.00	3939.55	3940.58	1.03	0.72	1.15	0.001928	23.94	0.09	0.24
EXISTING STREAM	9000	PF 3	50.00	3939.55	3940.94	1.39	0.98	1.76	0.002981	27.08	0.18	0.31
EXISTING STREAM	9000	PF 4	100.00	3939.55	3941.30	1.75	1.28	2.30	0.003605	28.43	0.28	0.36
EXISTING STREAM	9000	PF 5	150.00	3939.55	3941.54	1.99	1.49	2.64	0.003922	29.10	0.35	0.38
EXISTING STREAM	9000	PF 6	200.00	3939.55	3941.72	2.17	1.64	2.94	0.004256	29.61	0.42	0.40
EXISTING STREAM	9000	PF 7	252.00	3939.55	3941.89	2.34	1.78	3.18	0.004484	30.08	0.48	0.42
EXISTING STREAM	9000	PF 8	329.00	3939.55	3942.10	2.55	1.96	3.45	0.004689	30.68	0.55	0.43
EXISTING STREAM	9000	PF 9	750.00	3939.55	3942.70	3.15	2.52	5.01	0.007107	31.28	1.07	0.56
EXISTING STREAM	8900	PF 1	10.00	3939.37	3939.81	0.44	0.23	2.28	0.033811	18.96	0.49	0.84
EXISTING STREAM	8900	PF 2	20.00	3939.37	3939.91	0.54	0.31	3.09	0.042165	20.89	0.81	0.98
EXISTING STREAM	8900	PF 3	50.00	3939.37	3940.20	0.83	0.56	3.23	0.020872	22.77	0.73	0.76
EXISTING STREAM	8900	PF 4	100.00	3939.37	3940.37	1.00	0.71	4.08	0.024469	23.48	1.07	0.85
EXISTING STREAM	8900	PF 5	150.00	3939.37	3940.51	1.14	0.83	4.51	0.024203	24.09	1.24	0.87
EXISTING STREAM	8900	PF 6	200.00	3939.37	3940.64	1.27	0.94	4.76	0.022967	24.64	1.33	0.86
EXISTING STREAM	8900	PF 7	252.00	3939.37	3940.75	1.38	1.03	5.00	0.022568	25.32	1.42	0.87
EXISTING STREAM	8900	PF 8	329.00	3939.37	3940.91	1.54	1.13	5.22	0.021748	26.61	1.51	0.86
EXISTING STREAM	8900	PF 9	750.00	3939.37	3941.78	2.41	1.69	4.73	0.010539	33.34	1.09	0.64
EXISTING STREAM	8800	PF 1	10.00	3936.54	3937.37	0.83	0.45	2.56	0.018038	8.64	0.49	0.67
EXISTING STREAM	8800	PF 2	20.00	3936.54	3937.75	1.21	0.65	2.59	0.011534	11.88	0.45	0.57
EXISTING STREAM	8800	PF 3	50.00	3936.54	3938.55	2.01	0.71	2.34	0.008207	29.97	0.35	0.49
EXISTING STREAM	8800	PF 4	100.00	3936.54	3938.96	2.42	1.04	2.86	0.007486	33.57	0.47	0.50
EXISTING STREAM	8800	PF 5	150.00	3936.54	3939.25	2.71	1.30	3.25	0.007183	34.51	0.56	0.50
EXISTING STREAM	8800	PF 6	200.00	3936.54	3939.52	2.98	1.53	3.41	0.006389	35.26	0.59	0.49
EXISTING STREAM	8800	PF 7	252.00	3936.54	3939.77	3.23	1.76	3.45	0.005459	35.80	0.57	0.46
EXISTING STREAM	8800	PF 8	329.00	3936.54	3940.09	3.54	2.08	3.41	0.004284	35.80	0.53	0.42
EXISTING STREAM	8800	PF 9	750.00	3936.54	3941.35	4.81	3.34	3.55	0.002466	35.80	0.49	0.34
EXISTING STREAM	8700	PF 1	10.00	3935.53	3936.94	1.41	0.71	1.50	0.002156	9.43	0.09	0.31
EXISTING STREAM	8700	PF 2	20.00	3935.53	3937.30	1.76	0.88	1.93	0.002641	11.76	0.14	0.36
EXISTING STREAM	8700	PF 3	50.00	3935.53	3937.95	2.41	0.79	2.38	0.004551	26.64	0.22	0.47
EXISTING STREAM	8700	PF 4	100.00	3935.53	3938.40	2.87	1.03	2.79	0.004354	34.78	0.27	0.48
EXISTING STREAM	8700	PF 5	150.00	3935.53	3938.69	3.16	1.29	3.26	0.004418	35.79	0.34	0.51
EXISTING STREAM	8700	PF 6	200.00	3935.53	3938.92	3.39	1.49	3.67	0.004644	36.65	0.41	0.53
EXISTING STREAM	8700	PF 7	252.00	3935.53	3939.14	3.60	1.67	4.04	0.004843	37.43	0.48	0.55
EXISTING STREAM	8700	PF 8	329.00	3935.53	3939.40	3.87	1.88	4.55	0.005227	38.40	0.59	0.58
EXISTING STREAM	8700	PF 9	750.00	3935.53	3940.24	4.71	2.64	6.93	0.007796	40.23	1.22	0.75
EXISTING STREAM	8606.36	PF 1	10.00	3937.56	3936.87	1.66			0.000701			0.00
EXISTING STREAM	8606.36	PF 2	20.00	3937.56	3937.20	1.99			0.001039			0.00
EXISTING STREAM	8606.36	PF 3	50.00	3937.56	3937.77	2.57	0.11	0.40	0.001640	30.99	0.01	0.21
EXISTING STREAM	8606.36	PF 4	100.00	3937.56	3938.21	3.01	0.51	1.20	0.001988	36.22	0.06	0.30
EXISTING STREAM	8606.36	PF 5	150.00	3937.56	3938.51	3.30	0.74	1.62	0.002182	39.72	0.10	0.33
EXISTING STREAM	8606.36	PF 6	200.00	3937.56	3938.75	3.54	0.93	1.92	0.002308	42.56	0.13	0.35
EXISTING STREAM	8606.36	PF 7	252.00	3937.56	3938.97	3.77	1.09	2.20	0.002442	45.21	0.16	0.37
EXISTING STREAM	8606.36	PF 8	329.00	3937.56	3939.25	4.05	1.29	2.51	0.002553	48.46	0.20	0.39
EXISTING STREAM	8606.36	PF 9	750.00	3937.56	3940.27	5.07	2.25	3.66	0.002574	50.57	0.36	0.43
EXISTING STREAM	8449.56	PF 1	10.00	3936.04	3936.48	0.44	0.29	2.98	0.026454	11.74	0.47	0.98
EXISTING STREAM	8449.56	PF 2	20.00	3936.04	3936.66	0.62	0.40	3.55	0.024072	14.11	0.60	0.99
EXISTING STREAM	8449.56	PF 3	50.00	3936.04	3937.01	0.97	0.64	4.41	0.019878	17.54	0.78	0.97
EXISTING STREAM	8449.56	PF 4	100.00	3936.04	3937.41	1.37	0.90	4.68	0.014351	21.07	0.79	0.87
EXISTING STREAM	8449.56	PF 5	150.00	3936.04	3937.62	1.58	1.03	5.17	0.014635	22.95	0.92	0.90
EXISTING STREAM	8449.56	PF 6	200.00	3936.04	3937.78	1.74	1.12	5.59	0.015138	24.42	1.05	0.93
EXISTING STREAM	8449.56	PF 7	252.00	3936.04	3937.93	1.89	1.21	5.96	0.015599	25.74	1.16	0.95
EXISTING STREAM	8449.56	PF 8	329.00	3936.04	3938.13	2.09	1.33	6.36	0.015756	27.52	1.28	0.97
EXISTING STREAM	8449.56	PF 9	750.00	3936.04	3938.97	2.93	2.10	8.05	0.013724	28.99	1.76	0.98
EXISTING STREAM	8400	PF 1	10.00	3934.52	3935.49	0.97	0.42	1.29	0.003030	18.60	0.08	0.35
EXISTING STREAM	8400	PF 2	20.00	3934.52	3935.74	1.22	0.63	1.60	0.002715	19.88	0.10	0.36
EXISTING STREAM	8400	PF 3	50.00	3934.52	3936.14	1.62	0.95	2.39	0.003502	21.91	0.20	0.43
EXISTING STREAM	8400	PF 4	100.00	3934.52	3936.55	2.03	1.30	3.28	0.004405	23.15	0.35	0.51
EXISTING STREAM	8400	PF 5	150.00	3934.52	3936.80	2.28	1.51	3.84	0.004992	23.93	0.45	0.55
EXISTING STREAM	8400	PF 6	200.00	3934.52	3936.98	2.46	1.65	4.33	0.005628	24.48	0.56	0.59
EXISTING STREAM	8400	PF 7	252.00	3934.52	3937.15	2.63	1.81	4.73	0.005932	24.58	0.64	0.62
EXISTING STREAM	8400	PF 8	329.00	3934.52	3937.40	2.88	2.06	5.09	0.005788	24.58	0.72	0.62
EXISTING STREAM	8400	PF 9	750.00	3934.52	3938.85	4.32	3.51	5.27	0.003056	24.58	0.64	0.50
EXISTING STREAM	8300	PF 1	10.00	3934.37	3934.93	0.56	0.29	1.97	0.011495	17.68	0.21	0.65
EXISTING STREAM	8300	PF 2	20.00	3934.37	3934.99	0.62	0.32	3.20	0.026206	19.56	0.52	1.00
EXISTING STREAM	8300	PF 3	50.00	3934.37	3935.28	0.91	0.47	3.80	0.022143	28.18	0.64	0.98
EXISTING STREAM	8300	PF 4	100.00	3934.37	3935.57	1.20	0.64	4.49	0.020365	34.81	0.81	0.99
EXISTING STREAM	8300	PF 5	150.00	3934.37	3935.83	1.46	0.84	4.72	0.015800	38.08	0.82	0.91
EXISTING STREAM	8300	PF 6	200.00	3934.37	3936.09	1.72	1.07	4.75	0.011544	39.24	0.77	0.81
EXISTING STREAM	8300	PF 7	252.00	3934.37	3936.35	1.98	1.33	4.82	0.008906	39.24	0.73	0.74
EXISTING STREAM	8300	PF 8	329.00	3934.37	3936.71	2.34	1.69	4.94	0.006799	39.24	0.71	0.67
EXISTING STREAM	8300	PF 9	750.00	3934.37	3938.27	3.90	3.26	5.74	0.003829	39.24	0.77	0.56

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	8200	PF 1	10.00	3932.94	3933.30	0.36	0.32	2.86	0.021681	11.09	0.42	0.90
EXISTING STREAM	8200	PF 2	20.00	3932.94	3933.67	0.73	0.57	2.47	0.007410	14.20	0.26	0.58
EXISTING STREAM	8200	PF 3	50.00	3932.94	3934.24	1.30	0.89	2.84	0.005464	19.70	0.29	0.53
EXISTING STREAM	8200	PF 4	100.00	3932.94	3934.80	1.86	1.24	3.26	0.004651	24.77	0.35	0.52
EXISTING STREAM	8200	PF 5	150.00	3932.94	3935.20	2.26	1.63	3.70	0.004136	24.77	0.41	0.51
EXISTING STREAM	8200	PF 6	200.00	3932.94	3935.52	2.58	1.96	4.11	0.004009	24.77	0.47	0.52
EXISTING STREAM	8200	PF 7	252.00	3932.94	3935.81	2.87	2.25	4.49	0.003979	24.77	0.54	0.53
EXISTING STREAM	8200	PF 8	329.00	3932.94	3936.19	3.25	2.62	5.01	0.004025	24.77	0.64	0.54
EXISTING STREAM	8200	PF 9	750.00	3932.94	3937.59	4.65	4.03	7.11	0.004582	24.77	1.11	0.62
EXISTING STREAM	8100	PF 1	10.00	3931.81	3933.30	1.49	0.90	0.62	0.000249	18.14	0.01	0.11
EXISTING STREAM	8100	PF 2	20.00	3931.81	3933.62	1.81	1.07	0.89	0.000416	20.89	0.03	0.15
EXISTING STREAM	8100	PF 3	50.00	3931.81	3934.14	2.33	1.45	1.47	0.000754	23.42	0.07	0.21
EXISTING STREAM	8100	PF 4	100.00	3931.81	3934.66	2.85	1.87	2.15	0.001176	24.90	0.13	0.28
EXISTING STREAM	8100	PF 5	150.00	3931.81	3935.03	3.22	2.16	2.68	0.001520	25.97	0.20	0.32
EXISTING STREAM	8100	PF 6	200.00	3931.81	3935.34	3.53	2.39	3.12	0.001812	26.77	0.26	0.36
EXISTING STREAM	8100	PF 7	252.00	3931.81	3935.62	3.80	2.60	3.52	0.002072	27.53	0.32	0.38
EXISTING STREAM	8100	PF 8	329.00	3931.81	3935.98	4.17	2.87	4.02	0.002403	28.51	0.40	0.42
EXISTING STREAM	8100	PF 9	750.00	3931.81	3937.29	5.48	3.93	6.14	0.003730	30.85	0.85	0.55
EXISTING STREAM	8000.06	PF 1	10.00	3932.34	3933.25	0.91	0.61	0.89	0.000860	18.50	0.03	0.20
EXISTING STREAM	8000.06	PF 2	20.00	3932.34	3933.54	1.20	0.79	1.17	0.001071	21.79	0.05	0.23
EXISTING STREAM	8000.06	PF 3	50.00	3932.34	3934.02	1.68	1.10	1.74	0.001526	26.26	0.10	0.29
EXISTING STREAM	8000.06	PF 4	100.00	3932.34	3934.49	2.14	1.50	2.43	0.001988	27.52	0.18	0.35
EXISTING STREAM	8000.06	PF 5	150.00	3932.34	3934.81	2.47	1.77	2.98	0.002410	28.41	0.26	0.39
EXISTING STREAM	8000.06	PF 6	200.00	3932.34	3935.08	2.74	1.96	3.45	0.002838	29.60	0.33	0.43
EXISTING STREAM	8000.06	PF 7	252.00	3932.34	3935.32	2.98	2.12	3.86	0.003211	30.78	0.41	0.47
EXISTING STREAM	8000.06	PF 8	329.00	3932.34	3935.63	3.29	2.33	4.37	0.003648	32.33	0.51	0.50
EXISTING STREAM	8000.06	PF 9	750.00	3932.34	3936.80	4.46	3.21	6.40	0.005129	36.14	0.98	0.63
EXISTING STREAM	7900	PF 1	10.00	3932.20	3933.08	0.88	0.41	1.42	0.003746	17.29	0.09	0.39
EXISTING STREAM	7900	PF 2	20.00	3932.20	3933.35	1.15	0.53	1.57	0.003309	24.16	0.11	0.38
EXISTING STREAM	7900	PF 3	50.00	3932.20	3933.81	1.60	0.78	1.92	0.002899	33.31	0.14	0.38
EXISTING STREAM	7900	PF 4	100.00	3932.20	3934.25	2.05	1.06	2.36	0.002935	40.07	0.19	0.40
EXISTING STREAM	7900	PF 5	150.00	3932.20	3934.57	2.37	1.30	2.69	0.002917	43.02	0.23	0.42
EXISTING STREAM	7900	PF 6	200.00	3932.20	3934.83	2.63	1.56	2.99	0.002812	43.02	0.27	0.42
EXISTING STREAM	7900	PF 7	252.00	3932.20	3935.07	2.87	1.80	3.25	0.002756	43.02	0.30	0.43
EXISTING STREAM	7900	PF 8	329.00	3932.20	3935.39	3.19	2.12	3.59	0.002689	43.02	0.35	0.43
EXISTING STREAM	7900	PF 9	750.00	3932.20	3936.81	4.61	3.54	4.07	0.001746	43.02	0.38	0.38
EXISTING STREAM	7800	PF 1	10.00	3931.65	3932.99	1.34	0.67	0.69	0.000460	21.73	0.02	0.15
EXISTING STREAM	7800	PF 2	20.00	3931.65	3933.22	1.57	0.79	1.00	0.000796	25.43	0.04	0.20
EXISTING STREAM	7800	PF 3	50.00	3931.65	3933.61	1.96	0.98	1.61	0.001526	31.74	0.09	0.29
EXISTING STREAM	7800	PF 4	100.00	3931.65	3934.01	2.36	1.27	2.24	0.002114	35.16	0.16	0.35
EXISTING STREAM	7800	PF 5	150.00	3931.65	3934.29	2.64	1.53	2.74	0.002479	35.84	0.23	0.39
EXISTING STREAM	7800	PF 6	200.00	3931.65	3934.53	2.88	1.74	3.16	0.002811	36.40	0.29	0.42
EXISTING STREAM	7800	PF 7	252.00	3931.65	3934.74	3.09	1.93	3.55	0.003089	36.91	0.36	0.45
EXISTING STREAM	7800	PF 8	329.00	3931.65	3935.03	3.38	2.18	4.01	0.003378	37.61	0.44	0.48
EXISTING STREAM	7800	PF 9	750.00	3931.65	3936.31	4.66	3.40	5.51	0.003549	38.60	0.71	0.53
EXISTING STREAM	7699.86	PF 1	10.00	3932.37	3932.91	0.54	0.37	0.87	0.001602	31.28	0.04	0.25
EXISTING STREAM	7699.86	PF 2	20.00	3932.37	3933.11	0.73	0.53	1.12	0.001647	33.41	0.05	0.27
EXISTING STREAM	7699.86	PF 3	50.00	3932.37	3933.42	1.05	0.80	1.74	0.002299	35.96	0.11	0.34
EXISTING STREAM	7699.86	PF 4	100.00	3932.37	3933.73	1.36	1.08	2.50	0.003196	36.92	0.21	0.42
EXISTING STREAM	7699.86	PF 5	150.00	3932.37	3933.95	1.58	1.30	3.11	0.003908	37.20	0.31	0.48
EXISTING STREAM	7699.86	PF 6	200.00	3932.37	3934.10	1.73	1.45	3.70	0.004765	37.20	0.42	0.54
EXISTING STREAM	7699.86	PF 7	252.00	3932.37	3934.24	1.86	1.58	4.27	0.005650	37.20	0.55	0.60
EXISTING STREAM	7699.86	PF 8	329.00	3932.37	3934.44	2.07	1.79	4.94	0.006442	37.20	0.70	0.65
EXISTING STREAM	7699.86	PF 9	750.00	3932.37	3935.14	2.77	2.49	8.04	0.010959	37.20	1.66	0.90
EXISTING STREAM	7659.13	PF 1	10.00	3931.90	3932.59	0.69	0.30	3.14	0.027330	10.53	0.51	1.00
EXISTING STREAM	7659.13	PF 2	20.00	3931.90	3932.79	0.89	0.31	3.08	0.025067	20.49	0.49	0.97
EXISTING STREAM	7659.13	PF 3	50.00	3931.90	3933.06	1.16	0.46	3.59	0.020399	28.01	0.58	0.93
EXISTING STREAM	7659.13	PF 4	100.00	3931.90	3933.29	1.39	0.58	4.25	0.020706	34.70	0.75	0.98
EXISTING STREAM	7659.13	PF 5	150.00	3931.90	3933.46	1.56	0.73	4.83	0.020060	35.99	0.90	1.00
EXISTING STREAM	7659.13	PF 6	200.00	3931.90	3933.66	1.76	0.89	4.93	0.015869	37.48	0.88	0.92
EXISTING STREAM	7659.13	PF 7	252.00	3931.90	3933.88	1.98	1.07	4.86	0.012132	39.18	0.80	0.83
EXISTING STREAM	7659.13	PF 8	329.00	3931.90	3934.17	2.27	1.31	4.89	0.009405	40.80	0.76	0.75
EXISTING STREAM	7659.13	PF 9	750.00	3931.90	3935.25	3.35	2.28	5.56	0.005902	44.00	0.82	0.65
EXISTING STREAM	7592.36	PF 1	10.00	3930.44	3931.51	1.07	0.53	1.71	0.003838	10.99	0.13	0.41
EXISTING STREAM	7592.36	PF 2	20.00	3930.44	3931.77	1.33	0.57	2.17	0.005679	16.18	0.20	0.51
EXISTING STREAM	7592.36	PF 3	50.00	3930.44	3932.24	1.80	0.69	2.48	0.005836	29.28	0.24	0.53
EXISTING STREAM	7592.36	PF 4	100.00	3930.44	3932.69	2.25	1.07	2.90	0.004471	31.40	0.29	0.49
EXISTING STREAM	7592.36	PF 5	150.00	3930.44	3933.02	2.58	1.37	3.23	0.004057	32.51	0.33	0.49
EXISTING STREAM	7592.36	PF 6	200.00	3930.44	3933.29	2.85	1.60	3.50	0.003903	33.41	0.37	0.49
EXISTING STREAM	7592.36	PF 7	252.00	3930.44	3933.54	3.10	1.80	3.74	0.003832	34.21	0.41	0.49
EXISTING STREAM	7592.36	PF 8	329.00	3930.44	3933.84	3.40	2.05	4.07	0.003855	35.22	0.46	0.50
EXISTING STREAM	7592.36	PF 9	750.00	3930.44	3935.09	4.65	3.21	4.60	0.002711	36.61	0.51	0.45
EXISTING STREAM	7550	PF 1	10.00	3930.62	3931.39	0.76	0.51	1.38	0.002611	14.04	0.08	0.34
EXISTING STREAM	7550	PF 2	20.00	3930.62	3931.58	0.96	0.63	1.98	0.004086	16.06	0.16	0.44
EXISTING STREAM	7550	PF 3	50.00	3930.62	3931.93	1.31	0.83	3.05	0.006697	19.60	0.34	0.59
EXISTING STREAM	7550	PF 4	100.00	3930.62	3932.30	1.68	1.09	4.07	0.008441	22.16	0.56	0.69
EXISTING STREAM	7550	PF 5	150.00	3930.62	3932.58	1.96	1.27	4.69	0.009102	24.19	0.71	0.73
EXISTING STREAM	7550	PF 6	200.00	3930.62	3932.81	2.19	1.41	5.16	0.009600	25.85	0.83	0.77
EXISTING STREAM	7550	PF 7	252.00	3930.62	3933.03	2.41	1.54	5.51	0.009765	27.40	0.92	0.78
EXISTING STREAM	7550	PF 8	329.00	3930.62	3933.34	2.72	1.63	5.76	0.009865	31.41	0.98	0.79
EXISTING STREAM	7550	PF 9	750.00	3930.62	3934.50	3.88	2.66	6.86	0.007287	34.01	1.18	0.74

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	7486.87	PF 1	10.00	3930.73	3931.16	0.42	0.26	1.29	0.005621	29.74	0.09	0.45
EXISTING STREAM	7486.87	PF 2	20.00	3930.73	3931.31	0.58	0.40	1.63	0.005006	30.66	0.12	0.45
EXISTING STREAM	7486.87	PF 3	50.00	3930.73	3931.65	0.91	0.71	2.17	0.004211	32.48	0.18	0.45
EXISTING STREAM	7486.87	PF 4	100.00	3930.73	3932.02	1.29	1.05	2.82	0.004224	33.83	0.27	0.48
EXISTING STREAM	7486.87	PF 5	150.00	3930.73	3932.33	1.60	1.32	3.22	0.004109	34.98	0.33	0.50
EXISTING STREAM	7486.87	PF 6	200.00	3930.73	3932.56	1.83	1.51	3.61	0.004301	35.85	0.40	0.52
EXISTING STREAM	7486.87	PF 7	252.00	3930.73	3932.79	2.05	1.70	3.89	0.004279	36.69	0.44	0.53
EXISTING STREAM	7486.87	PF 8	329.00	3930.73	3933.10	2.37	1.96	4.19	0.004141	37.87	0.49	0.53
EXISTING STREAM	7486.87	PF 9	750.00	3930.73	3934.33	3.60	2.94	5.30	0.003898	42.01	0.69	0.54
EXISTING STREAM	7446.03	PF 1	10.00	3930.01	3930.72	0.71	0.30	2.42	0.016211	13.66	0.30	0.77
EXISTING STREAM	7446.03	PF 2	20.00	3930.01	3930.94	0.93	0.42	2.59	0.012185	18.46	0.31	0.71
EXISTING STREAM	7446.03	PF 3	50.00	3930.01	3931.35	1.34	0.61	2.81	0.008768	29.41	0.33	0.64
EXISTING STREAM	7446.03	PF 4	100.00	3930.01	3931.76	1.75	0.83	3.16	0.007291	38.15	0.37	0.61
EXISTING STREAM	7446.03	PF 5	150.00	3930.01	3932.12	2.11	0.91	3.19	0.006601	51.71	0.37	0.59
EXISTING STREAM	7446.03	PF 6	200.00	3930.01	3932.39	2.38	1.14	3.27	0.005110	53.41	0.36	0.54
EXISTING STREAM	7446.03	PF 7	252.00	3930.01	3932.65	2.64	1.36	3.36	0.004277	55.03	0.36	0.51
EXISTING STREAM	7446.03	PF 8	329.00	3930.01	3932.99	2.98	1.65	3.49	0.003598	57.20	0.36	0.48
EXISTING STREAM	7446.03	PF 9	750.00	3930.01	3934.35	4.34	2.93	3.82	0.002009	59.64	0.36	0.39
EXISTING STREAM	7388.7	PF 1	10.00	3929.28	3930.53	1.25	0.45	1.08	0.001906	20.77	0.05	0.28
EXISTING STREAM	7388.7	PF 2	20.00	3929.28	3930.73	1.45	0.61	1.45	0.002316	22.76	0.09	0.33
EXISTING STREAM	7388.7	PF 3	50.00	3929.28	3931.09	1.81	0.87	2.22	0.003361	25.97	0.18	0.42
EXISTING STREAM	7388.7	PF 4	100.00	3929.28	3931.41	2.13	1.12	3.20	0.005048	27.97	0.34	0.53
EXISTING STREAM	7388.7	PF 5	150.00	3929.28	3931.70	2.41	1.33	3.81	0.005751	29.71	0.46	0.58
EXISTING STREAM	7388.7	PF 6	200.00	3929.28	3931.95	2.67	1.51	4.25	0.006056	31.10	0.55	0.61
EXISTING STREAM	7388.7	PF 7	252.00	3929.28	3932.18	2.90	1.69	4.63	0.006222	32.22	0.63	0.63
EXISTING STREAM	7388.7	PF 8	329.00	3929.28	3932.48	3.20	1.91	5.12	0.006520	33.65	0.74	0.65
EXISTING STREAM	7388.7	PF 9	750.00	3929.28	3933.32	4.04	2.64	7.86	0.010020	35.40	1.57	0.85
EXISTING STREAM	7321.95	PF 1	10.00	3929.69	3930.10	0.41	0.21	2.59	0.029691	18.23	0.39	0.99
EXISTING STREAM	7321.95	PF 2	20.00	3929.69	3930.23	0.54	0.28	3.04	0.028197	23.63	0.49	1.01
EXISTING STREAM	7321.95	PF 3	50.00	3929.69	3930.49	0.80	0.46	3.62	0.020759	30.19	0.59	0.94
EXISTING STREAM	7321.95	PF 4	100.00	3929.69	3931.00	1.31	0.81	3.22	0.007662	38.34	0.39	0.63
EXISTING STREAM	7321.95	PF 5	150.00	3929.69	3931.38	1.69	1.13	3.25	0.005013	40.76	0.35	0.54
EXISTING STREAM	7321.95	PF 6	200.00	3929.69	3931.68	1.99	1.39	3.41	0.004239	42.38	0.36	0.51
EXISTING STREAM	7321.95	PF 7	252.00	3929.69	3931.95	2.26	1.60	3.57	0.003837	43.99	0.38	0.50
EXISTING STREAM	7321.95	PF 8	329.00	3929.69	3932.30	2.61	1.92	3.79	0.003406	44.87	0.40	0.48
EXISTING STREAM	7321.95	PF 9	750.00	3929.69	3933.66	3.97	3.28	3.62	0.001520	44.87	0.31	0.35
EXISTING STREAM	7300	PF 1	10.00	3928.80	3929.76	0.96	0.50	1.08	0.001698	18.53	0.05	0.27
EXISTING STREAM	7300	PF 2	20.00	3928.80	3930.05	1.25	0.58	1.28	0.001940	27.07	0.07	0.30
EXISTING STREAM	7300	PF 3	50.00	3928.80	3930.49	1.69	0.88	1.74	0.002061	32.70	0.11	0.33
EXISTING STREAM	7300	PF 4	100.00	3928.80	3930.98	2.18	1.22	2.18	0.002072	37.59	0.15	0.35
EXISTING STREAM	7300	PF 5	150.00	3928.80	3931.36	2.56	1.44	2.47	0.002141	42.32	0.19	0.36
EXISTING STREAM	7300	PF 6	200.00	3928.80	3931.67	2.86	1.69	2.70	0.002063	43.90	0.21	0.37
EXISTING STREAM	7300	PF 7	252.00	3928.80	3931.94	3.14	1.97	2.92	0.001979	43.90	0.24	0.37
EXISTING STREAM	7300	PF 8	329.00	3928.80	3932.29	3.49	2.31	3.23	0.001946	43.90	0.27	0.37
EXISTING STREAM	7300	PF 9	750.00	3928.80	3933.63	4.83	3.65	3.53	0.001268	43.90	0.28	0.33
EXISTING STREAM	7263.2	PF 1	10.00	3928.78	3929.66	0.88	0.50	1.46	0.003058	13.62	0.09	0.36
EXISTING STREAM	7263.2	PF 2	20.00	3928.78	3929.93	1.15	0.61	1.79	0.003568	18.16	0.13	0.40
EXISTING STREAM	7263.2	PF 3	50.00	3928.78	3930.31	1.53	0.86	2.67	0.005077	21.86	0.26	0.51
EXISTING STREAM	7263.2	PF 4	100.00	3928.78	3930.74	1.96	1.11	3.43	0.005918	26.21	0.40	0.57
EXISTING STREAM	7263.2	PF 5	150.00	3928.78	3931.08	2.30	1.31	3.89	0.006160	29.55	0.48	0.60
EXISTING STREAM	7263.2	PF 6	200.00	3928.78	3931.36	2.58	1.46	4.24	0.006292	32.31	0.55	0.62
EXISTING STREAM	7263.2	PF 7	252.00	3928.78	3931.62	2.84	1.60	4.49	0.006255	34.90	0.60	0.63
EXISTING STREAM	7263.2	PF 8	329.00	3928.78	3931.97	3.19	1.83	4.76	0.005902	37.56	0.65	0.62
EXISTING STREAM	7263.2	PF 9	750.00	3928.78	3933.51	4.73	3.37	4.21	0.002038	37.56	0.41	0.40
EXISTING STREAM	7200.13	PF 1	10.00	3928.55	3929.12	0.57	0.29	2.94	0.025689	11.90	0.46	0.97
EXISTING STREAM	7200.13	PF 2	20.00	3928.55	3929.29	0.74	0.37	3.52	0.026040	15.40	0.60	1.02
EXISTING STREAM	7200.13	PF 3	50.00	3928.55	3929.73	1.18	0.66	3.60	0.012664	21.02	0.52	0.78
EXISTING STREAM	7200.13	PF 4	100.00	3928.55	3930.20	1.65	1.00	4.05	0.009437	24.80	0.57	0.71
EXISTING STREAM	7200.13	PF 5	150.00	3928.55	3930.56	2.01	1.24	4.39	0.008323	27.51	0.63	0.69
EXISTING STREAM	7200.13	PF 6	200.00	3928.55	3930.76	2.21	1.43	5.05	0.009191	27.61	0.79	0.74
EXISTING STREAM	7200.13	PF 7	252.00	3928.55	3930.95	2.39	1.62	5.61	0.009693	27.70	0.94	0.78
EXISTING STREAM	7200.13	PF 8	329.00	3928.55	3931.20	2.65	1.86	6.30	0.010163	27.78	1.13	0.81
EXISTING STREAM	7200.13	PF 9	750.00	3928.55	3932.32	3.77	2.99	8.52	0.009913	27.78	1.77	0.87
EXISTING STREAM	7100.19	PF 1	10.00	3927.52	3928.51	0.99	0.54	1.24	0.001936	14.88	0.07	0.30
EXISTING STREAM	7100.19	PF 2	20.00	3927.52	3928.74	1.22	0.67	1.69	0.002727	17.52	0.11	0.36
EXISTING STREAM	7100.19	PF 3	50.00	3927.52	3929.19	1.67	0.90	2.37	0.003662	23.41	0.20	0.44
EXISTING STREAM	7100.19	PF 4	100.00	3927.52	3929.68	2.16	1.11	2.91	0.004164	30.87	0.29	0.49
EXISTING STREAM	7100.19	PF 5	150.00	3927.52	3930.06	2.54	1.14	3.11	0.004592	42.28	0.32	0.51
EXISTING STREAM	7100.19	PF 6	200.00	3927.52	3930.36	2.84	1.44	3.29	0.003759	42.28	0.33	0.48
EXISTING STREAM	7100.19	PF 7	252.00	3927.52	3930.62	3.10	1.70	3.49	0.003380	42.28	0.35	0.47
EXISTING STREAM	7100.19	PF 8	329.00	3927.52	3930.96	3.44	2.04	3.78	0.003117	42.28	0.39	0.47
EXISTING STREAM	7100.19	PF 9	750.00	3927.52	3932.19	4.67	3.27	5.21	0.003152	42.28	0.64	0.51
EXISTING STREAM	7000	PF 1	10.00	3927.17	3928.42	1.25	0.50	0.65	0.000598	30.31	0.02	0.16
EXISTING STREAM	7000	PF 2	20.00	3927.17	3928.63	1.46	0.70	0.92	0.000776	31.02	0.03	0.19
EXISTING STREAM	7000	PF 3	50.00	3927.17	3929.05	1.88	1.08	1.42	0.001040	32.48	0.07	0.24
EXISTING STREAM	7000	PF 4	100.00	3927.17	3929.51	2.34	1.49	1.98	0.001322	33.95	0.12	0.29
EXISTING STREAM	7000	PF 5	150.00	3927.17	3929.85	2.68	1.78	2.41	0.001554	34.88	0.17	0.32
EXISTING STREAM	7000	PF 6	200.00	3927.17	3930.15	2.98	2.03	2.76	0.001718	35.67	0.21	0.34
EXISTING STREAM	7000	PF 7	252.00	3927.17	3930.40	3.23	2.25	3.08	0.001894	36.37	0.25	0.36
EXISTING STREAM	7000	PF 8	329.00	3927.17	3930.72	3.55	2.51	3.51	0.002125	37.27	0.32	0.39
EXISTING STREAM	7000	PF 9	750.00	3927.17	3932.00	4.83	3.75	4.67	0.002212	37.84	0.49	0.42

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	6900	PF 1	10.00	3927.09	3928.40	1.31	0.92	0.41	0.000104	26.79	0.01	0.07
EXISTING STREAM	6900	PF 2	20.00	3927.09	3928.59	1.50	1.08	0.67	0.000230	27.65	0.02	0.11
EXISTING STREAM	6900	PF 3	50.00	3927.09	3928.98	1.89	1.39	1.22	0.000547	29.42	0.05	0.18
EXISTING STREAM	6900	PF 4	100.00	3927.09	3929.41	2.32	1.71	1.85	0.000973	31.64	0.10	0.25
EXISTING STREAM	6900	PF 5	150.00	3927.09	3929.71	2.62	1.91	2.35	0.001348	33.53	0.16	0.30
EXISTING STREAM	6900	PF 6	200.00	3927.09	3929.98	2.89	2.09	2.73	0.001617	34.95	0.20	0.33
EXISTING STREAM	6900	PF 7	252.00	3927.09	3930.22	3.13	2.33	3.08	0.001785	34.95	0.25	0.36
EXISTING STREAM	6900	PF 8	329.00	3927.09	3930.52	3.43	2.63	3.53	0.001985	34.95	0.32	0.38
EXISTING STREAM	6900	PF 9	750.00	3927.09	3931.60	4.51	3.71	5.41	0.002946	34.95	0.66	0.49
EXISTING STREAM	6800	PF 1	10.00	3927.97	3928.27	0.30	0.18	2.39	0.031648	23.45	0.35	1.00
EXISTING STREAM	6800	PF 2	20.00	3927.97	3928.37	0.40	0.26	2.94	0.028744	25.92	0.47	1.01
EXISTING STREAM	6800	PF 3	50.00	3927.97	3928.61	0.64	0.43	3.72	0.023903	31.43	0.64	1.00
EXISTING STREAM	6800	PF 4	100.00	3927.97	3928.88	0.91	0.61	4.34	0.020571	37.99	0.77	0.98
EXISTING STREAM	6800	PF 5	150.00	3927.97	3929.20	1.23	0.89	4.22	0.011769	40.11	0.64	0.79
EXISTING STREAM	6800	PF 6	200.00	3927.97	3929.49	1.52	1.13	4.20	0.008430	42.00	0.59	0.70
EXISTING STREAM	6800	PF 7	252.00	3927.97	3929.76	1.79	1.39	4.29	0.006686	42.10	0.57	0.64
EXISTING STREAM	6800	PF 8	329.00	3927.97	3930.07	2.10	1.71	4.51	0.005607	42.10	0.59	0.61
EXISTING STREAM	6800	PF 9	750.00	3927.97	3931.21	3.24	2.85	5.67	0.004496	42.10	0.79	0.59
EXISTING STREAM	6700	PF 1	10.00	3926.02	3927.09	1.07	0.53	1.17	0.001789	16.15	0.06	0.28
EXISTING STREAM	6700	PF 2	20.00	3926.02	3927.37	1.35	0.68	1.47	0.002059	20.04	0.09	0.32
EXISTING STREAM	6700	PF 3	50.00	3926.02	3927.85	1.83	1.04	2.09	0.002354	22.97	0.15	0.36
EXISTING STREAM	6700	PF 4	100.00	3926.02	3928.34	2.32	1.37	2.79	0.002934	26.10	0.24	0.42
EXISTING STREAM	6700	PF 5	150.00	3926.02	3928.67	2.65	1.51	3.31	0.003646	30.02	0.33	0.47
EXISTING STREAM	6700	PF 6	200.00	3926.02	3929.00	2.98	1.65	3.58	0.003796	33.84	0.38	0.49
EXISTING STREAM	6700	PF 7	252.00	3926.02	3929.30	3.28	1.78	3.79	0.003874	37.37	0.42	0.50
EXISTING STREAM	6700	PF 8	329.00	3926.02	3929.61	3.59	1.90	4.19	0.004316	41.25	0.50	0.53
EXISTING STREAM	6700	PF 9	750.00	3926.02	3930.36	4.34	2.65	6.81	0.007347	41.27	1.17	0.74
EXISTING STREAM	6600	PF 1	10.00	3925.53	3927.03	1.50	0.74	0.67	0.000390	20.15	0.02	0.14
EXISTING STREAM	6600	PF 2	20.00	3925.53	3927.27	1.74	0.85	1.00	0.000703	23.42	0.04	0.19
EXISTING STREAM	6600	PF 3	50.00	3925.53	3927.70	2.17	1.16	1.61	0.001208	26.79	0.09	0.26
EXISTING STREAM	6600	PF 4	100.00	3925.53	3928.13	2.60	1.43	2.31	0.001893	30.18	0.17	0.34
EXISTING STREAM	6600	PF 5	150.00	3925.53	3928.40	2.87	1.61	2.90	0.002567	32.09	0.25	0.40
EXISTING STREAM	6600	PF 6	200.00	3925.53	3928.65	3.12	1.49	3.31	0.003676	40.41	0.34	0.48
EXISTING STREAM	6600	PF 7	252.00	3925.53	3928.88	3.35	1.28	3.53	0.005111	55.89	0.40	0.55
EXISTING STREAM	6600	PF 8	329.00	3925.53	3929.14	3.61	1.20	3.74	0.006204	73.28	0.46	0.60
EXISTING STREAM	6600	PF 9	750.00	3925.53	3929.99	4.46	1.69	4.53	0.005731	97.69	0.60	0.61
EXISTING STREAM	6500	PF 1	10.00	3926.27	3926.93	0.66	0.37	1.12	0.002640	24.18	0.06	0.32
EXISTING STREAM	6500	PF 2	20.00	3926.27	3927.12	0.85	0.52	1.47	0.002883	26.32	0.09	0.36
EXISTING STREAM	6500	PF 3	50.00	3926.27	3927.49	1.22	0.82	2.09	0.003199	29.03	0.16	0.41
EXISTING STREAM	6500	PF 4	100.00	3926.27	3927.85	1.58	1.10	2.71	0.003656	31.67	0.25	0.46
EXISTING STREAM	6500	PF 5	150.00	3926.27	3928.08	1.81	1.27	3.10	0.003947	33.44	0.31	0.49
EXISTING STREAM	6500	PF 6	200.00	3926.27	3928.28	2.01	1.41	3.39	0.004093	34.90	0.36	0.50
EXISTING STREAM	6500	PF 7	252.00	3926.27	3928.43	2.16	1.55	3.70	0.004300	35.14	0.41	0.52
EXISTING STREAM	6500	PF 8	329.00	3926.27	3928.64	2.37	1.75	4.06	0.004398	35.14	0.48	0.54
EXISTING STREAM	6500	PF 9	750.00	3926.27	3929.47	3.20	2.59	5.44	0.004704	35.14	0.75	0.60
EXISTING STREAM	6400	PF 1	10.00	3925.69	3926.29	0.60	0.28	2.50	0.018886	14.28	0.33	0.83
EXISTING STREAM	6400	PF 2	20.00	3925.69	3926.48	0.79	0.28	2.40	0.017361	29.58	0.30	0.80
EXISTING STREAM	6400	PF 3	50.00	3925.69	3926.66	0.96	0.41	3.59	0.023831	34.24	0.60	0.99
EXISTING STREAM	6400	PF 4	100.00	3925.69	3926.90	1.21	0.60	4.40	0.021164	37.66	0.79	1.00
EXISTING STREAM	6400	PF 5	150.00	3925.69	3927.12	1.43	0.76	4.75	0.018111	41.21	0.86	0.96
EXISTING STREAM	6400	PF 6	200.00	3925.69	3927.30	1.61	0.82	4.97	0.017840	47.81	0.91	0.96
EXISTING STREAM	6400	PF 7	252.00	3925.69	3927.45	1.76	0.92	5.15	0.016507	51.02	0.94	0.94
EXISTING STREAM	6400	PF 8	329.00	3925.69	3927.61	1.92	1.08	5.64	0.016073	51.02	1.08	0.96
EXISTING STREAM	6400	PF 9	750.00	3925.69	3928.32	2.63	1.79	7.25	0.013540	51.02	1.50	0.96
EXISTING STREAM	6300.01	PF 1	10.00	3923.98	3924.67	0.69	0.35	2.47	0.013941	11.65	0.30	0.74
EXISTING STREAM	6300.01	PF 2	20.00	3923.98	3924.94	0.96	0.35	2.45	0.013794	23.46	0.30	0.73
EXISTING STREAM	6300.01	PF 3	50.00	3923.98	3925.46	1.48	0.72	2.02	0.003553	34.61	0.16	0.42
EXISTING STREAM	6300.01	PF 4	100.00	3923.98	3925.97	1.99	0.96	2.19	0.002837	47.41	0.17	0.39
EXISTING STREAM	6300.01	PF 5	150.00	3923.98	3926.33	2.35	1.21	2.36	0.002433	52.59	0.18	0.38
EXISTING STREAM	6300.01	PF 6	200.00	3923.98	3926.61	2.63	1.35	2.54	0.002420	58.27	0.20	0.38
EXISTING STREAM	6300.01	PF 7	252.00	3923.98	3926.85	2.87	1.48	2.69	0.002426	63.25	0.22	0.39
EXISTING STREAM	6300.01	PF 8	329.00	3923.98	3927.14	3.16	1.63	2.91	0.002479	69.34	0.25	0.40
EXISTING STREAM	6300.01	PF 9	750.00	3923.98	3928.21	4.23	2.50	3.68	0.002245	77.74	0.35	0.41
EXISTING STREAM	6200	PF 1	10.00	3921.46	3924.72	3.26	1.48	0.26	0.000024	25.78	0.00	0.04
EXISTING STREAM	6200	PF 2	20.00	3921.46	3924.97	3.51	1.52	0.44	0.000065	29.64	0.01	0.06
EXISTING STREAM	6200	PF 3	50.00	3921.46	3925.44	3.98	1.75	0.83	0.000189	34.50	0.02	0.11
EXISTING STREAM	6200	PF 4	100.00	3921.46	3925.92	4.46	1.97	1.28	0.000384	39.59	0.05	0.16
EXISTING STREAM	6200	PF 5	150.00	3921.46	3926.26	4.80	2.10	1.63	0.000568	43.81	0.07	0.20
EXISTING STREAM	6200	PF 6	200.00	3921.46	3926.51	5.05	2.20	1.93	0.000750	47.11	0.10	0.23
EXISTING STREAM	6200	PF 7	252.00	3921.46	3926.73	5.27	2.29	2.20	0.000928	49.98	0.13	0.26
EXISTING STREAM	6200	PF 8	329.00	3921.46	3927.01	5.55	2.54	2.57	0.001093	50.38	0.17	0.28
EXISTING STREAM	6200	PF 9	750.00	3921.46	3927.94	6.48	3.47	4.16	0.001896	50.38	0.40	0.39
EXISTING STREAM	6099.55	PF 1	10.00	3923.96	3924.55	0.59	0.29	3.12	0.027898	10.89	0.51	1.01
EXISTING STREAM	6099.55	PF 2	20.00	3923.96	3924.75	0.78	0.39	3.50	0.023871	14.53	0.58	0.98
EXISTING STREAM	6099.55	PF 3	50.00	3923.96	3925.09	1.13	0.56	4.20	0.021389	20.95	0.74	0.99
EXISTING STREAM	6099.55	PF 4	100.00	3923.96	3925.48	1.52	0.73	4.58	0.018049	29.56	0.81	0.95
EXISTING STREAM	6099.55	PF 5	150.00	3923.96	3925.83	1.87	0.85	4.36	0.013208	39.31	0.70	0.83
EXISTING STREAM	6099.55	PF 6	200.00	3923.96	3926.13	2.17	0.88	3.96	0.010433	55.18	0.57	0.74
EXISTING STREAM	6099.55	PF 7	252.00	3923.96	3926.34	2.38	1.09	4.03	0.008155	55.18	0.55	0.68
EXISTING STREAM	6099.55	PF 8	329.00	3923.96	3926.61	2.65	1.36	4.19	0.006523	55.18	0.55	0.63
EXISTING STREAM	6099.55	PF 9	750.00	3923.96	3927.64	3.68	2.39	4.73	0.003937	55.18	0.58	0.54

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	5999.62	PF 1	10.00	3922.77	3923.99	1.22	0.66	0.89	0.000803	17.02	0.03	0.19
EXISTING STREAM	5999.62	PF 2	20.00	3922.77	3924.26	1.49	0.81	1.24	0.001192	19.88	0.06	0.24
EXISTING STREAM	5999.62	PF 3	50.00	3922.77	3924.74	1.97	0.91	1.70	0.001887	32.21	0.10	0.31
EXISTING STREAM	5999.62	PF 4	100.00	3922.77	3925.15	2.38	1.28	2.31	0.002245	33.80	0.17	0.36
EXISTING STREAM	5999.62	PF 5	150.00	3922.77	3925.45	2.68	1.54	2.81	0.002587	34.61	0.24	0.40
EXISTING STREAM	5999.62	PF 6	200.00	3922.77	3925.69	2.92	1.76	3.24	0.002874	34.92	0.30	0.43
EXISTING STREAM	5999.62	PF 7	252.00	3922.77	3925.88	3.11	1.94	3.67	0.003257	35.18	0.38	0.46
EXISTING STREAM	5999.62	PF 8	329.00	3922.77	3926.09	3.32	2.14	4.30	0.003940	35.46	0.50	0.52
EXISTING STREAM	5999.62	PF 9	750.00	3922.77	3927.17	4.40	3.11	5.40	0.003820	36.89	0.70	0.54
EXISTING STREAM	5900	PF 1	10.00	3923.08	3923.63	0.55	0.23	2.79	0.031060	15.35	0.44	1.02
EXISTING STREAM	5900	PF 2	20.00	3923.08	3923.78	0.70	0.32	3.20	0.026516	19.31	0.52	0.99
EXISTING STREAM	5900	PF 3	50.00	3923.08	3924.07	0.99	0.48	3.91	0.023398	26.64	0.68	1.00
EXISTING STREAM	5900	PF 4	100.00	3923.08	3924.35	1.27	0.64	4.67	0.022682	33.32	0.88	1.03
EXISTING STREAM	5900	PF 5	150.00	3923.08	3924.58	1.50	0.79	5.08	0.020329	37.35	0.97	1.01
EXISTING STREAM	5900	PF 6	200.00	3923.08	3924.78	1.70	0.87	5.34	0.019799	42.97	1.05	1.01
EXISTING STREAM	5900	PF 7	252.00	3923.08	3924.99	1.91	1.01	5.35	0.016328	46.64	1.00	0.94
EXISTING STREAM	5900	PF 8	329.00	3923.08	3925.45	2.37	1.26	4.69	0.009327	55.63	0.71	0.74
EXISTING STREAM	5900	PF 9	750.00	3923.08	3926.81	3.73	2.34	4.63	0.004008	68.42	0.57	0.53
EXISTING STREAM	5800	PF 1	10.00	3921.15	3922.73	1.58	0.82	0.48	0.000171	25.28	0.01	0.09
EXISTING STREAM	5800	PF 2	20.00	3921.15	3922.98	1.83	0.98	0.73	0.000308	27.89	0.02	0.13
EXISTING STREAM	5800	PF 3	50.00	3921.15	3923.42	2.27	1.21	1.22	0.000656	33.90	0.05	0.20
EXISTING STREAM	5800	PF 4	100.00	3921.15	3923.94	2.79	1.54	1.66	0.000875	39.29	0.08	0.24
EXISTING STREAM	5800	PF 5	150.00	3921.15	3924.36	3.21	1.89	1.95	0.000925	40.63	0.11	0.25
EXISTING STREAM	5800	PF 6	200.00	3921.15	3924.67	3.52	2.15	2.23	0.001025	41.63	0.13	0.27
EXISTING STREAM	5800	PF 7	252.00	3921.15	3924.96	3.81	2.39	2.47	0.001099	42.57	0.16	0.28
EXISTING STREAM	5800	PF 8	329.00	3921.15	3925.35	4.20	2.71	2.77	0.001183	43.82	0.19	0.30
EXISTING STREAM	5800	PF 9	750.00	3921.15	3926.59	5.44	3.81	4.26	0.001787	45.96	0.41	0.38
EXISTING STREAM	5700.12	PF 1	10.00	3922.04	3922.53	0.49	0.26	2.93	0.029277	13.12	0.47	1.01
EXISTING STREAM	5700.12	PF 2	20.00	3922.04	3922.71	0.67	0.33	3.23	0.026072	18.79	0.53	0.99
EXISTING STREAM	5700.12	PF 3	50.00	3922.04	3923.15	1.11	0.63	2.84	0.008491	27.90	0.33	0.63
EXISTING STREAM	5700.12	PF 4	100.00	3922.04	3923.65	1.60	1.09	3.15	0.005139	29.14	0.34	0.53
EXISTING STREAM	5700.12	PF 5	150.00	3922.04	3924.07	2.03	1.08	3.15	0.005146	44.14	0.34	0.53
EXISTING STREAM	5700.12	PF 6	200.00	3922.04	3924.40	2.36	1.37	3.21	0.003906	45.33	0.32	0.48
EXISTING STREAM	5700.12	PF 7	252.00	3922.04	3924.70	2.66	1.64	3.31	0.003282	46.43	0.32	0.45
EXISTING STREAM	5700.12	PF 8	329.00	3922.04	3925.10	3.06	1.98	3.46	0.002813	47.93	0.34	0.43
EXISTING STREAM	5700.12	PF 9	750.00	3922.04	3926.25	4.21	2.98	4.90	0.003294	51.23	0.59	0.50
EXISTING STREAM	5600	PF 1	10.00	3921.23	3922.30	1.07	0.57	0.69	0.000571	25.38	0.02	0.16
EXISTING STREAM	5600	PF 2	20.00	3921.23	3922.54	1.31	0.78	0.96	0.000746	26.69	0.04	0.19
EXISTING STREAM	5600	PF 3	50.00	3921.23	3922.97	1.74	1.13	1.53	0.001147	29.05	0.08	0.25
EXISTING STREAM	5600	PF 4	100.00	3921.23	3923.45	2.22	1.51	2.11	0.001489	31.38	0.14	0.30
EXISTING STREAM	5600	PF 5	150.00	3921.23	3923.84	2.61	1.81	2.50	0.001661	33.04	0.18	0.33
EXISTING STREAM	5600	PF 6	200.00	3921.23	3924.17	2.94	2.06	2.81	0.001780	34.45	0.22	0.35
EXISTING STREAM	5600	PF 7	252.00	3921.23	3924.47	3.24	2.29	3.08	0.001872	35.76	0.25	0.36
EXISTING STREAM	5600	PF 8	329.00	3921.23	3924.87	3.64	2.57	3.42	0.001984	37.45	0.30	0.38
EXISTING STREAM	5600	PF 9	750.00	3921.23	3925.77	4.54	3.37	5.65	0.003814	38.77	0.75	0.54
EXISTING STREAM	5500	PF 1	10.00	3921.56	3922.15	0.65	0.29	1.24	0.004501	27.82	0.08	0.41
EXISTING STREAM	5500	PF 2	20.00	3921.56	3922.40	0.90	0.46	1.23	0.002413	35.53	0.07	0.32
EXISTING STREAM	5500	PF 3	50.00	3921.56	3922.82	1.32	0.85	1.59	0.001771	36.80	0.09	0.30
EXISTING STREAM	5500	PF 4	100.00	3921.56	3923.30	1.80	1.30	2.03	0.001672	37.99	0.13	0.31
EXISTING STREAM	5500	PF 5	150.00	3921.56	3923.68	2.18	1.65	2.34	0.001633	38.94	0.16	0.32
EXISTING STREAM	5500	PF 6	200.00	3921.56	3924.01	2.51	1.93	2.60	0.001630	39.82	0.19	0.33
EXISTING STREAM	5500	PF 7	252.00	3921.56	3924.31	2.81	2.19	2.83	0.001643	40.71	0.22	0.34
EXISTING STREAM	5500	PF 8	329.00	3921.56	3924.71	3.21	2.52	3.12	0.001677	41.90	0.25	0.35
EXISTING STREAM	5500	PF 9	750.00	3921.56	3926.10	4.60	3.70	0.52	0.000028	44.98	0.01	0.05
EXISTING STREAM	5400	PF 1	10.00	3920.79	3921.82	1.54	0.54	1.39	0.002546	13.41	0.08	0.33
EXISTING STREAM	5400	PF 2	20.00	3920.79	3922.11	1.83	0.59	1.63	0.003083	20.77	0.11	0.37
EXISTING STREAM	5400	PF 3	50.00	3920.79	3922.54	2.26	0.92	2.26	0.003318	24.15	0.18	0.42
EXISTING STREAM	5400	PF 4	100.00	3920.79	3922.96	2.68	1.24	3.06	0.004057	26.37	0.30	0.48
EXISTING STREAM	5400	PF 5	150.00	3920.79	3923.31	3.03	1.50	3.55	0.004274	28.21	0.39	0.51
EXISTING STREAM	5400	PF 6	200.00	3920.79	3923.61	3.33	1.70	3.92	0.004433	30.00	0.45	0.53
EXISTING STREAM	5400	PF 7	252.00	3920.79	3923.89	3.61	1.87	4.24	0.004545	31.73	0.51	0.55
EXISTING STREAM	5400	PF 8	329.00	3920.79	3924.25	3.97	2.10	4.61	0.004652	34.04	0.58	0.56
EXISTING STREAM	5400	PF 9	750.00	3920.79	3925.29	5.01	2.80	6.85	0.007022	39.08	1.17	0.72
EXISTING STREAM	5306.78	PF 1	10.00	3920.72	3921.67	1.02	0.54	0.99	0.001248	18.67	0.04	0.24
EXISTING STREAM	5306.78	PF 2	20.00	3920.72	3921.91	1.26	0.65	1.30	0.001707	23.75	0.07	0.28
EXISTING STREAM	5306.78	PF 3	50.00	3920.72	3922.27	1.62	0.82	1.96	0.002858	31.24	0.14	0.38
EXISTING STREAM	5306.78	PF 4	100.00	3920.72	3922.64	1.99	1.14	2.67	0.003417	32.83	0.24	0.44
EXISTING STREAM	5306.78	PF 5	150.00	3920.72	3923.01	2.36	1.45	3.02	0.003190	34.39	0.28	0.44
EXISTING STREAM	5306.78	PF 6	200.00	3920.72	3923.32	2.67	1.70	3.30	0.003101	35.70	0.32	0.45
EXISTING STREAM	5306.78	PF 7	252.00	3920.72	3923.60	2.95	1.92	3.56	0.003064	36.91	0.36	0.45
EXISTING STREAM	5306.78	PF 8	329.00	3920.72	3923.97	3.32	2.20	3.88	0.003061	38.47	0.41	0.46
EXISTING STREAM	5306.78	PF 9	750.00	3920.72	3925.79	5.14	3.63	0.37	0.000014	44.53	0.00	0.03
EXISTING STREAM	5200.18	PF 1	10.00	3920.78	3921.20	0.42	0.20	2.60	0.032829	19.33	0.40	1.03
EXISTING STREAM	5200.18	PF 2	20.00	3920.78	3921.33	0.55	0.26	2.89	0.028243	26.45	0.46	1.00
EXISTING STREAM	5200.18	PF 3	50.00	3920.78	3921.67	0.89	0.54	2.87	0.010544	32.02	0.35	0.69
EXISTING STREAM	5200.18	PF 4	100.00	3920.78	3922.22	1.44	1.05	2.83	0.004307	33.60	0.28	0.49
EXISTING STREAM	5200.18	PF 5	150.00	3920.78	3922.69	1.91	1.45	2.92	0.003001	35.40	0.26	0.43
EXISTING STREAM	5200.18	PF 6	200.00	3920.78	3923.01	2.23	1.71	3.17	0.002864	36.98	0.29	0.43
EXISTING STREAM	5200.18	PF 7	252.00	3920.78	3923.30	2.52	1.93	3.41	0.002818	38.40	0.33	0.43
EXISTING STREAM	5200.18	PF 8	329.00	3920.78	3923.67	2.89	2.20	3.72	0.002821	40.21	0.37	0.44
EXISTING STREAM	5200.18	PF 9	750.00	3920.78	3925.45	4.66	3.66	4.50	0.002120	45.41	0.46	0.41

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	5100	PF 1	10.00	3918.99	3920.25	1.26	0.75	1.34	0.001545	9.99	0.07	0.27
EXISTING STREAM	5100	PF 2	20.00	3918.99	3920.54	1.55	0.91	1.87	0.002336	11.72	0.13	0.34
EXISTING STREAM	5100	PF 3	50.00	3918.99	3921.12	2.13	1.17	2.67	0.003442	15.99	0.24	0.44
EXISTING STREAM	5100	PF 4	100.00	3918.99	3921.79	2.80	1.51	3.19	0.003513	20.79	0.31	0.46
EXISTING STREAM	5100	PF 5	150.00	3918.99	3922.31	3.32	1.91	3.54	0.003206	22.10	0.36	0.45
EXISTING STREAM	5100	PF 6	200.00	3918.99	3922.54	3.55	2.08	4.20	0.004046	22.83	0.49	0.51
EXISTING STREAM	5100	PF 7	252.00	3918.99	3922.72	3.73	2.21	4.86	0.005017	23.40	0.64	0.58
EXISTING STREAM	5100	PF 8	329.00	3918.99	3922.88	3.89	2.33	5.92	0.006977	23.90	0.94	0.68
EXISTING STREAM	5100	PF 9	750.00	3918.99	3923.76	4.77	2.92	9.66	0.013941	26.61	2.33	1.00
EXISTING STREAM	5052.71	PF 1	10.00	3919.59	3919.92	0.47	0.28	2.95	0.026628	12.01	0.46	0.98
EXISTING STREAM	5052.71	PF 2	20.00	3919.59	3920.08	0.64	0.43	3.68	0.023568	12.55	0.62	0.98
EXISTING STREAM	5052.71	PF 3	50.00	3919.59	3920.45	1.00	0.76	4.93	0.020630	13.32	0.94	1.00
EXISTING STREAM	5052.71	PF 4	100.00	3919.59	3920.87	1.43	1.16	6.28	0.020093	13.72	1.34	1.03
EXISTING STREAM	5052.71	PF 5	150.00	3919.59	3921.27	1.82	1.52	7.02	0.018324	14.10	1.54	1.00
EXISTING STREAM	5052.71	PF 6	200.00	3919.59	3921.85	2.41	1.97	6.28	0.010671	15.18	1.14	0.79
EXISTING STREAM	5052.71	PF 7	252.00	3919.59	3922.12	2.68	2.17	6.49	0.010124	15.73	1.18	0.78
EXISTING STREAM	5052.71	PF 8	329.00	3919.59	3922.42	2.97	2.38	6.85	0.010095	16.33	1.28	0.78
EXISTING STREAM	5052.71	PF 9	750.00	3919.59	3922.88	3.43	2.70	11.39	0.023985	17.25	3.42	1.22
EXISTING STREAM	4998.95	PF 1	10.00	3917.95	3918.42	0.47	0.23	2.76	0.029461	15.52	0.43	1.01
EXISTING STREAM	4998.95	PF 2	20.00	3917.95	3918.59	0.64	0.19	2.64	0.035461	39.75	0.42	1.07
EXISTING STREAM	4998.95	PF 3	50.00	3917.95	3918.68	0.73	0.27	4.47	0.063782	41.54	1.07	1.52
EXISTING STREAM	4998.95	PF 4	100.00	3917.95	3918.78	0.83	0.35	6.52	0.095638	43.71	2.09	1.94
EXISTING STREAM	4998.95	PF 5	150.00	3917.95	3918.84	0.89	0.40	8.20	0.125131	45.20	3.15	2.27
EXISTING STREAM	4998.95	PF 6	200.00	3917.95	3919.94	1.99	1.22	2.55	0.002760	64.21	0.21	0.41
EXISTING STREAM	4998.95	PF 7	252.00	3917.95	3920.34	2.39	1.48	2.39	0.001890	71.15	0.17	0.35
EXISTING STREAM	4998.95	PF 8	329.00	3917.95	3920.83	2.88	1.79	2.31	0.001369	79.82	0.15	0.30
EXISTING STREAM	4998.95	PF 9	750.00	3917.95	3922.47	4.52	2.95	2.59	0.000883	97.71	0.16	0.27
EXISTING STREAM	4899.97	PF 1	10.00	3916.49	3917.18	0.69	0.45	1.14	0.002091	19.55	0.06	0.30
EXISTING STREAM	4899.97	PF 2	20.00	3916.49	3917.53	1.04	0.71	1.22	0.001325	22.89	0.06	0.26
EXISTING STREAM	4899.97	PF 3	50.00	3916.49	3918.19	1.70	1.11	1.49	0.001092	30.25	0.07	0.25
EXISTING STREAM	4899.97	PF 4	100.00	3916.49	3918.89	2.40	1.43	1.71	0.001026	40.77	0.09	0.25
EXISTING STREAM	4899.97	PF 5	150.00	3916.49	3919.38	2.89	1.66	1.87	0.001006	48.18	0.10	0.26
EXISTING STREAM	4899.97	PF 6	200.00	3916.49	3919.83	3.34	1.88	1.93	0.000912	55.04	0.11	0.25
EXISTING STREAM	4899.97	PF 7	252.00	3916.49	3920.24	3.75	2.08	1.98	0.000834	61.29	0.11	0.24
EXISTING STREAM	4899.97	PF 8	329.00	3916.49	3920.75	4.25	2.33	2.05	0.000773	68.97	0.11	0.24
EXISTING STREAM	4899.97	PF 9	750.00	3916.49	3922.39	5.90	3.24	2.56	0.000774	90.05	0.15	0.25
EXISTING STREAM	4699.72	PF 1	10.00	3915.41	3917.11	1.70	0.98	0.53	0.000164	19.41	0.01	0.09
EXISTING STREAM	4699.72	PF 2	20.00	3915.41	3917.44	2.03	1.16	0.78	0.000281	22.12	0.02	0.13
EXISTING STREAM	4699.72	PF 3	50.00	3915.41	3918.06	2.65	1.56	1.23	0.000482	26.19	0.05	0.17
EXISTING STREAM	4699.72	PF 4	100.00	3915.41	3918.73	3.32	1.97	1.68	0.000662	30.22	0.08	0.21
EXISTING STREAM	4699.72	PF 5	150.00	3915.41	3919.19	3.78	2.32	2.02	0.000786	31.95	0.11	0.23
EXISTING STREAM	4699.72	PF 6	200.00	3915.41	3919.63	4.22	2.67	2.26	0.000820	33.17	0.13	0.24
EXISTING STREAM	4699.72	PF 7	252.00	3915.41	3920.04	4.62	3.02	2.47	0.000836	33.81	0.15	0.25
EXISTING STREAM	4699.72	PF 8	329.00	3915.41	3920.52	5.11	3.46	2.77	0.000881	34.25	0.18	0.26
EXISTING STREAM	4699.72	PF 9	750.00	3915.41	3921.99	6.58	4.80	4.28	0.001400	35.38	0.39	0.34
EXISTING STREAM	4600	PF 1	10.00	3916.12	3917.09	0.97	0.84	0.47	0.000159	25.47	0.01	0.09
EXISTING STREAM	4600	PF 2	20.00	3916.12	3917.41	1.29	1.11	0.67	0.000229	26.77	0.02	0.11
EXISTING STREAM	4600	PF 3	50.00	3916.12	3918.02	1.90	1.61	1.07	0.000359	28.96	0.03	0.15
EXISTING STREAM	4600	PF 4	100.00	3916.12	3918.67	2.55	2.14	1.51	0.000492	31.03	0.06	0.18
EXISTING STREAM	4600	PF 5	150.00	3916.12	3919.13	3.01	2.48	1.86	0.000618	32.44	0.09	0.21
EXISTING STREAM	4600	PF 6	200.00	3916.12	3919.56	3.44	2.82	2.10	0.000669	33.69	0.11	0.22
EXISTING STREAM	4600	PF 7	252.00	3916.12	3919.97	3.85	3.16	2.31	0.000694	34.47	0.13	0.23
EXISTING STREAM	4600	PF 8	329.00	3916.12	3920.46	4.33	3.65	2.57	0.000712	34.47	0.15	0.24
EXISTING STREAM	4600	PF 9	750.00	3916.12	3921.93	5.81	5.12	3.77	0.000976	34.47	0.29	0.29
EXISTING STREAM	4510.06	PF 1	10.00	3916.09	3917.04	0.95	0.76	1.30	0.001436	10.19	0.06	0.26
EXISTING STREAM	4510.06	PF 2	20.00	3916.09	3917.31	1.22	0.96	1.87	0.002223	11.14	0.13	0.34
EXISTING STREAM	4510.06	PF 3	50.00	3916.09	3917.81	1.72	1.30	3.02	0.003953	12.75	0.30	0.47
EXISTING STREAM	4510.06	PF 4	100.00	3916.09	3918.28	2.19	1.58	4.34	0.006381	14.59	0.58	0.61
EXISTING STREAM	4510.06	PF 5	150.00	3916.09	3918.45	2.36	1.64	5.86	0.011022	15.66	1.04	0.81
EXISTING STREAM	4510.06	PF 6	200.00	3916.09	3918.58	2.49	1.68	7.23	0.016146	16.46	1.56	0.98
EXISTING STREAM	4510.06	PF 7	252.00	3916.09	3918.87	2.78	1.79	7.70	0.016807	18.27	1.74	1.01
EXISTING STREAM	4510.06	PF 8	329.00	3916.09	3919.32	3.23	1.97	7.91	0.015517	21.08	1.77	0.99
EXISTING STREAM	4510.06	PF 9	750.00	3916.09	3920.86	4.77	3.34	8.54	0.008947	22.90	1.73	0.82
EXISTING STREAM	4400.23	PF 1	10.00	3916.13	3916.54	0.41	0.16	2.23	0.031562	27.68	0.32	0.98
EXISTING STREAM	4400.23	PF 2	20.00	3916.13	3916.64	0.51	0.25	2.79	0.027502	28.50	0.43	0.98
EXISTING STREAM	4400.23	PF 3	50.00	3916.13	3916.85	0.72	0.44	3.74	0.023071	30.02	0.64	0.99
EXISTING STREAM	4400.23	PF 4	100.00	3916.13	3917.13	1.00	0.69	4.53	0.018907	32.04	0.81	0.96
EXISTING STREAM	4400.23	PF 5	150.00	3916.13	3917.57	1.44	1.05	4.08	0.008736	34.90	0.57	0.70
EXISTING STREAM	4400.23	PF 6	200.00	3916.13	3917.91	1.78	1.35	4.09	0.006382	36.28	0.53	0.62
EXISTING STREAM	4400.23	PF 7	252.00	3916.13	3918.22	2.09	1.60	4.18	0.005315	37.53	0.52	0.58
EXISTING STREAM	4400.23	PF 8	329.00	3916.13	3918.62	2.49	1.93	4.35	0.004519	39.17	0.53	0.55
EXISTING STREAM	4400.23	PF 9	750.00	3916.13	3920.08	3.95	3.04	5.47	0.003972	45.12	0.72	0.55
EXISTING STREAM	4194.27	PF 1	10.00	3914.17	3915.69	1.52	0.79	0.46	0.000160	27.76	0.01	0.09
EXISTING STREAM	4194.27	PF 2	20.00	3914.17	3915.90	1.73	0.96	0.71	0.000303	29.04	0.02	0.13
EXISTING STREAM	4194.27	PF 3	50.00	3914.17	3916.36	2.19	1.32	1.19	0.000558	31.80	0.05	0.18
EXISTING STREAM	4194.27	PF 4	100.00	3914.17	3916.86	2.69	1.71	1.71	0.000815	34.27	0.08	0.23
EXISTING STREAM	4194.27	PF 5	150.00	3914.17	3917.25	3.08	2.00	2.08	0.000990	36.10	0.12	0.26
EXISTING STREAM	4194.27	PF 6	200.00	3914.17	3917.57	3.40	2.24	2.38	0.001125	37.63	0.15	0.28
EXISTING STREAM	4194.27	PF 7	252.00	3914.17	3917.87	3.70	2.44	2.64	0.001234	39.12	0.18	0.30
EXISTING STREAM	4194.27	PF 8	329.00	3914.17	3918.26	4.09	2.71	2.95	0.001354	41.09	0.22	0.32
EXISTING STREAM	4194.27	PF 9	750.00	3914.17	3919.67	5.50	3.85	4.32	0.001819	45.00	0.42	0.39

HEC-RAS Plan: Plan 12   River: Prickly Pear Cr.   Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	4103.16	PF 1	10.00	3914.67	3915.65	0.98	0.51	0.69	0.000661	28.38	0.02	0.17
EXISTING STREAM	4103.16	PF 2	20.00	3914.67	3915.84	1.17	0.61	0.99	0.001048	33.25	0.04	0.22
EXISTING STREAM	4103.16	PF 3	50.00	3914.67	3916.28	1.61	0.84	1.35	0.001292	44.30	0.07	0.26
EXISTING STREAM	4103.16	PF 4	100.00	3914.67	3916.77	2.10	1.12	1.61	0.001249	55.74	0.09	0.27
EXISTING STREAM	4103.16	PF 5	150.00	3914.67	3917.16	2.49	1.35	1.76	0.001158	63.20	0.10	0.27
EXISTING STREAM	4103.16	PF 6	200.00	3914.67	3917.49	2.82	1.54	1.86	0.001092	69.54	0.10	0.26
EXISTING STREAM	4103.16	PF 7	252.00	3914.67	3917.80	3.13	1.72	1.95	0.001031	75.43	0.11	0.26
EXISTING STREAM	4103.16	PF 8	329.00	3914.67	3918.21	3.54	1.95	2.03	0.000950	83.30	0.11	0.26
EXISTING STREAM	4103.16	PF 9	750.00	3914.67	3919.70	5.03	3.19	2.49	0.000743	93.88	0.15	0.25
EXISTING STREAM	4016.11	PF 1	10.00	3914.25	3915.64	1.39	0.83	0.32	0.000074	37.50	0.00	0.06
EXISTING STREAM	4016.11	PF 2	20.00	3914.25	3915.82	1.57	0.94	0.53	0.000169	40.65	0.01	0.10
EXISTING STREAM	4016.11	PF 3	50.00	3914.25	3916.23	1.98	1.18	0.89	0.000356	47.95	0.03	0.14
EXISTING STREAM	4016.11	PF 4	100.00	3914.25	3916.72	2.47	1.44	1.22	0.000518	57.01	0.05	0.18
EXISTING STREAM	4016.11	PF 5	150.00	3914.25	3917.11	2.86	1.64	1.43	0.000591	64.23	0.06	0.20
EXISTING STREAM	4016.11	PF 6	200.00	3914.25	3917.43	3.18	1.81	1.57	0.000628	70.38	0.07	0.21
EXISTING STREAM	4016.11	PF 7	252.00	3914.25	3917.74	3.49	1.96	1.68	0.000648	76.62	0.08	0.21
EXISTING STREAM	4016.11	PF 8	329.00	3914.25	3918.15	3.90	2.19	1.80	0.000637	83.66	0.09	0.21
EXISTING STREAM	4016.11	PF 9	750.00	3914.25	3919.66	5.41	3.55	2.34	0.000567	88.98	0.12	0.22
EXISTING STREAM	3901.43	PF 1	10.00	3913.29	3915.64	2.35	1.13	0.28	0.000039	31.32	0.00	0.05
EXISTING STREAM	3901.43	PF 2	20.00	3913.29	3915.81	2.52	1.27	0.49	0.000101	32.10	0.01	0.08
EXISTING STREAM	3901.43	PF 3	50.00	3913.29	3916.20	2.91	1.60	0.94	0.000270	33.44	0.03	0.13
EXISTING STREAM	3901.43	PF 4	100.00	3913.29	3916.65	3.36	2.00	1.45	0.000488	34.51	0.06	0.18
EXISTING STREAM	3901.43	PF 5	150.00	3913.29	3917.01	3.72	2.30	1.84	0.000655	35.36	0.09	0.21
EXISTING STREAM	3901.43	PF 6	200.00	3913.29	3917.32	4.03	2.56	2.17	0.000792	36.08	0.12	0.24
EXISTING STREAM	3901.43	PF 7	252.00	3913.29	3917.60	4.31	2.79	2.45	0.000911	36.75	0.15	0.26
EXISTING STREAM	3901.43	PF 8	329.00	3913.29	3917.98	4.69	3.10	2.81	0.001049	37.66	0.19	0.28
EXISTING STREAM	3901.43	PF 9	750.00	3913.29	3919.46	6.17	4.43	3.70	0.001142	39.34	0.29	0.31
EXISTING STREAM	3801.24	PF 1	10.00	3913.24	3915.63	2.39	0.84	0.41	0.000124	29.10	0.01	0.08
EXISTING STREAM	3801.24	PF 2	20.00	3913.24	3915.79	2.55	0.95	0.69	0.000294	30.67	0.02	0.12
EXISTING STREAM	3801.24	PF 3	50.00	3913.24	3916.15	2.91	1.25	1.19	0.000618	32.51	0.05	0.19
EXISTING STREAM	3801.24	PF 4	100.00	3913.24	3916.60	3.36	1.63	1.50	0.000683	34.03	0.07	0.21
EXISTING STREAM	3801.24	PF 5	150.00	3913.24	3916.96	3.72	1.93	1.66	0.000672	35.20	0.08	0.21
EXISTING STREAM	3801.24	PF 6	200.00	3913.24	3917.27	4.03	2.18	1.78	0.000659	36.20	0.09	0.21
EXISTING STREAM	3801.24	PF 7	252.00	3913.24	3917.56	4.32	2.41	1.88	0.000647	37.14	0.09	0.21
EXISTING STREAM	3801.24	PF 8	329.00	3913.24	3917.94	4.70	2.71	2.19	0.000753	38.37	0.12	0.23
EXISTING STREAM	3801.24	PF 9	750.00	3913.24	3919.48	6.24	3.97	2.24	0.000480	41.93	0.11	0.20
EXISTING STREAM	3700.03	PF 1	10.00	3913.32	3915.62	2.30	1.05	0.29	0.000044	33.09	0.00	0.05
EXISTING STREAM	3700.03	PF 2	20.00	3913.32	3915.77	2.45	1.18	0.50	0.000115	33.82	0.01	0.08
EXISTING STREAM	3700.03	PF 3	50.00	3913.32	3916.11	2.79	1.44	0.94	0.000315	35.88	0.03	0.14
EXISTING STREAM	3700.03	PF 4	100.00	3913.32	3916.55	3.23	1.82	1.22	0.000389	37.18	0.04	0.16
EXISTING STREAM	3700.03	PF 5	150.00	3913.32	3916.92	3.59	2.13	1.35	0.000390	38.25	0.05	0.16
EXISTING STREAM	3700.03	PF 6	200.00	3913.32	3917.23	3.91	2.39	1.44	0.000382	39.17	0.05	0.16
EXISTING STREAM	3700.03	PF 7	252.00	3913.32	3917.52	4.20	2.63	1.51	0.000373	40.04	0.06	0.16
EXISTING STREAM	3700.03	PF 8	329.00	3913.32	3917.90	4.58	2.93	1.68	0.000402	41.17	0.07	0.17
EXISTING STREAM	3700.03	PF 9	750.00	3913.32	3919.45	6.13	4.34	1.88	0.000301	43.02	0.08	0.16
EXISTING STREAM	3599.38	PF 1	10.00	3913.26	3915.62	2.36	1.10	0.27	0.000037	34.02	0.00	0.04
EXISTING STREAM	3599.38	PF 2	20.00	3913.26	3915.76	2.50	1.18	0.47	0.000105	36.11	0.01	0.08
EXISTING STREAM	3599.38	PF 3	50.00	3913.26	3916.08	2.82	1.33	0.91	0.000338	41.11	0.03	0.14
EXISTING STREAM	3599.38	PF 4	100.00	3913.26	3916.49	3.23	1.48	1.36	0.000649	49.66	0.06	0.20
EXISTING STREAM	3599.38	PF 5	150.00	3913.26	3916.84	3.58	1.51	1.63	0.000894	60.97	0.08	0.23
EXISTING STREAM	3599.38	PF 6	200.00	3913.26	3917.14	3.88	1.54	1.78	0.001038	73.38	0.10	0.25
EXISTING STREAM	3599.38	PF 7	252.00	3913.26	3917.43	4.17	1.59	1.86	0.001079	85.21	0.10	0.26
EXISTING STREAM	3599.38	PF 8	329.00	3913.26	3917.81	4.55	1.67	1.92	0.001077	102.27	0.11	0.26
EXISTING STREAM	3599.38	PF 9	750.00	3913.26	3919.37	6.11	2.60	2.07	0.000689	139.49	0.11	0.23
EXISTING STREAM	3526.68	PF 1	10.00	3911.74	3915.62	3.88	1.50	0.12	0.000005	55.63	0.00	0.02
EXISTING STREAM	3526.68	PF 2	20.00	3911.74	3915.76	4.02	1.57	0.22	0.000016	58.16	0.00	0.03
EXISTING STREAM	3526.68	PF 3	50.00	3911.74	3916.08	4.34	1.74	0.45	0.000058	63.82	0.01	0.06
EXISTING STREAM	3526.68	PF 4	100.00	3911.74	3916.49	4.75	1.95	0.72	0.000128	71.21	0.01	0.09
EXISTING STREAM	3526.68	PF 5	150.00	3911.74	3916.83	5.09	2.16	0.91	0.000180	75.94	0.02	0.11
EXISTING STREAM	3526.68	PF 6	200.00	3911.74	3917.13	5.39	2.42	1.07	0.000212	77.32	0.03	0.12
EXISTING STREAM	3526.68	PF 7	252.00	3911.74	3917.42	5.68	2.66	1.20	0.000236	78.83	0.04	0.13
EXISTING STREAM	3526.68	PF 8	329.00	3911.74	3917.80	6.06	3.00	1.37	0.000260	79.74	0.05	0.14
EXISTING STREAM	3526.68	PF 9	750.00	3911.74	3919.35	7.61	4.53	1.94	0.000303	80.43	0.08	0.16
EXISTING STREAM	3399.05	PF 1	10.00	3912.61	3915.62	3.55	1.53	0.23	0.000018	28.17	0.00	0.03
EXISTING STREAM	3399.05	PF 2	20.00	3912.61	3915.76	3.69	1.60	0.42	0.000057	29.43	0.01	0.06
EXISTING STREAM	3399.05	PF 3	50.00	3912.61	3916.05	3.98	1.75	0.89	0.000221	32.17	0.02	0.12
EXISTING STREAM	3399.05	PF 4	100.00	3912.61	3916.43	4.36	1.83	1.44	0.000550	38.00	0.06	0.19
EXISTING STREAM	3399.05	PF 5	150.00	3912.61	3916.75	4.68	1.77	1.82	0.000903	46.70	0.10	0.24
EXISTING STREAM	3399.05	PF 6	200.00	3912.61	3917.03	4.96	1.76	2.06	0.001164	55.05	0.12	0.27
EXISTING STREAM	3399.05	PF 7	252.00	3912.61	3917.30	5.23	1.78	2.23	0.001332	63.76	0.14	0.29
EXISTING STREAM	3399.05	PF 8	329.00	3912.61	3917.67	5.60	1.83	2.37	0.001448	76.00	0.16	0.31
EXISTING STREAM	3399.05	PF 9	750.00	3912.61	3919.24	7.17	2.31	2.46	0.001122	132.19	0.16	0.29
EXISTING STREAM	3299.86	PF 1	10.00	3912.21	3915.62	7.10	2.25	0.08	0.000001	52.35	0.00	0.01
EXISTING STREAM	3299.86	PF 2	20.00	3912.21	3915.76	7.24	2.28	0.16	0.000005	54.96	0.00	0.02
EXISTING STREAM	3299.86	PF 3	50.00	3912.21	3916.06	7.54	2.38	0.35	0.000022	59.80	0.00	0.04
EXISTING STREAM	3299.86	PF 4	100.00	3912.21	3916.44	7.92	2.60	0.60	0.000058	63.88	0.01	0.07
EXISTING STREAM	3299.86	PF 5	150.00	3912.21	3916.75	8.23	2.68	0.80	0.000099	69.66	0.02	0.09
EXISTING STREAM	3299.86	PF 6	200.00	3912.21	3917.03	8.51	2.79	0.96	0.000136	74.27	0.02	0.10
EXISTING STREAM	3299.86	PF 7	252.00	3912.21	3917.31	8.79	3.04	1.11	0.000160	75.00	0.03	0.11
EXISTING STREAM	3299.86	PF 8	329.00	3912.21	3917.67	9.15	3.30	1.28	0.000193	77.36	0.04	0.12
EXISTING STREAM	3299.86	PF 9	750.00	3912.21	3919.22	10.70	4.81	1.86	0.000244	78.42	0.07	0.15

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	3214.62	PF 1	10.00	3911.77	3915.62	7.10	1.84	0.14	0.000006	35.48	0.00	0.02
EXISTING STREAM	3214.62	PF 2	20.00	3911.77	3915.75	7.23	1.91	0.27	0.000018	36.80	0.00	0.03
EXISTING STREAM	3214.62	PF 3	50.00	3911.77	3916.05	7.53	2.06	0.57	0.000074	39.60	0.01	0.07
EXISTING STREAM	3214.62	PF 4	100.00	3911.77	3916.42	7.90	2.25	0.95	0.000181	43.08	0.02	0.11
EXISTING STREAM	3214.62	PF 5	150.00	3911.77	3916.73	8.20	2.02	1.21	0.000339	55.11	0.04	0.15
EXISTING STREAM	3214.62	PF 6	200.00	3911.77	3917.00	8.48	1.87	1.39	0.000486	68.80	0.05	0.18
EXISTING STREAM	3214.62	PF 7	252.00	3911.77	3917.27	8.75	1.98	1.52	0.000536	74.70	0.06	0.19
EXISTING STREAM	3214.62	PF 8	329.00	3911.77	3917.63	9.11	2.22	1.68	0.000565	79.26	0.08	0.20
EXISTING STREAM	3214.62	PF 9	750.00	3911.77	3919.18	10.66	3.23	2.11	0.000537	96.63	0.11	0.21
EXISTING STREAM	3148.18	PF 1	10.00	3910.60	3915.62	7.10	2.79	0.08	0.000001	45.31	0.00	0.01
EXISTING STREAM	3148.18	PF 2	20.00	3910.60	3915.75	7.23	2.80	0.15	0.000004	47.42	0.00	0.02
EXISTING STREAM	3148.18	PF 3	50.00	3910.60	3916.05	7.53	2.87	0.34	0.000019	51.35	0.00	0.04
EXISTING STREAM	3148.18	PF 4	100.00	3910.60	3916.42	7.90	3.15	0.60	0.000052	52.95	0.01	0.06
EXISTING STREAM	3148.18	PF 5	150.00	3910.60	3916.72	8.20	3.36	0.82	0.000090	54.35	0.02	0.08
EXISTING STREAM	3148.18	PF 6	200.00	3910.60	3916.99	8.47	3.56	1.01	0.000127	55.61	0.02	0.09
EXISTING STREAM	3148.18	PF 7	252.00	3910.60	3917.25	8.73	2.66	1.16	0.000236	81.49	0.04	0.13
EXISTING STREAM	3148.18	PF 8	329.00	3910.60	3917.61	9.09	2.02	1.28	0.000391	127.41	0.05	0.16
EXISTING STREAM	3148.18	PF 9	750.00	3910.60	3919.17	10.65	3.58	1.57	0.000277	127.49	0.06	0.15
EXISTING STREAM	3110.32	PF 1	10.00	3913.68	3915.62	7.10	0.90	0.19	0.000023	58.63	0.00	0.03
EXISTING STREAM	3110.32	PF 2	20.00	3913.68	3915.75	7.23	1.01	0.32	0.000059	59.73	0.00	0.06
EXISTING STREAM	3110.32	PF 3	50.00	3913.68	3916.04	7.52	1.27	0.62	0.000161	61.82	0.01	0.10
EXISTING STREAM	3110.32	PF 4	100.00	3913.68	3916.41	7.89	1.56	0.95	0.000286	64.88	0.03	0.13
EXISTING STREAM	3110.32	PF 5	150.00	3913.68	3916.71	8.18	1.80	1.18	0.000372	67.35	0.04	0.16
EXISTING STREAM	3110.32	PF 6	200.00	3913.68	3916.97	8.45	2.00	1.36	0.000429	69.58	0.05	0.17
EXISTING STREAM	3110.32	PF 7	252.00	3913.68	3917.23	8.71	2.07	1.53	0.000522	75.95	0.06	0.19
EXISTING STREAM	3110.32	PF 8	329.00	3913.68	3917.57	9.05	2.12	1.64	0.000580	88.24	0.07	0.20
EXISTING STREAM	3110.32	PF 9	750.00	3913.68	3919.14	10.62	3.69	1.97	0.000397	88.24	0.09	0.18
EXISTING STREAM	3078.79	PF 1	10.00	3915.30	3915.61	7.08	0.29	0.79	0.001780	43.47	0.03	0.26
EXISTING STREAM	3078.79	PF 2	20.00	3915.30	3915.73	7.21	0.40	1.10	0.002273	44.87	0.06	0.30
EXISTING STREAM	3078.79	PF 3	50.00	3915.30	3915.99	7.47	0.63	1.65	0.002826	47.85	0.11	0.36
EXISTING STREAM	3078.79	PF 4	100.00	3915.30	3916.33	7.80	0.94	2.14	0.002839	50.00	0.16	0.39
EXISTING STREAM	3078.79	PF 5	150.00	3915.30	3916.60	8.08	1.21	2.48	0.002748	50.00	0.20	0.40
EXISTING STREAM	3078.79	PF 6	200.00	3915.30	3916.85	8.32	1.46	2.75	0.002641	50.00	0.23	0.40
EXISTING STREAM	3078.79	PF 7	252.00	3915.30	3917.08	8.56	1.69	2.98	0.002556	50.00	0.26	0.40
EXISTING STREAM	3078.79	PF 8	329.00	3915.30	3917.40	8.88	2.01	3.27	0.002471	50.00	0.30	0.41
EXISTING STREAM	3078.79	PF 9	750.00	3915.30	3918.86	10.34	3.47	4.32	0.002163	50.00	0.44	0.41
EXISTING STREAM	3076.79	PF 1	10.00	3915.30	3915.43	6.91	0.13	2.09	0.008889	37.00	0.07	1.02
EXISTING STREAM	3076.79	PF 2	20.00	3915.30	3915.51	6.99	0.21	2.58	0.007218	37.00	0.09	0.99
EXISTING STREAM	3076.79	PF 3	50.00	3915.30	3915.69	7.17	0.39	3.49	0.005954	37.00	0.14	0.99
EXISTING STREAM	3076.79	PF 4	100.00	3915.30	3915.91	7.39	0.61	4.46	0.005534	37.00	0.20	1.01
EXISTING STREAM	3076.79	PF 5	150.00	3915.30	3916.10	7.58	0.80	5.06	0.005044	37.00	0.23	1.00
EXISTING STREAM	3076.79	PF 6	200.00	3915.30	3916.27	7.75	0.97	5.59	0.004875	37.00	0.27	1.00
EXISTING STREAM	3076.79	PF 7	252.00	3915.30	3916.43	7.91	1.13	6.03	0.004729	37.00	0.30	1.00
EXISTING STREAM	3076.79	PF 8	329.00	3915.30	3916.66	8.14	1.36	6.56	0.004496	37.00	0.33	0.99
EXISTING STREAM	3076.79	PF 9	750.00	3915.30	3917.64	9.12	2.34	8.65	0.004251	37.00	0.50	1.00
EXISTING STREAM	3076.23*	PF 1	10.00	3914.92	3915.06	6.00	0.13	2.03	0.008103	37.00	0.07	0.98
EXISTING STREAM	3076.23*	PF 2	20.00	3914.92	3915.14	6.08	0.21	2.63	0.007712	37.00	0.10	1.02
EXISTING STREAM	3076.23*	PF 3	50.00	3914.92	3915.32	6.26	0.39	3.48	0.005930	37.00	0.14	0.99
EXISTING STREAM	3076.23*	PF 4	100.00	3914.92	3915.55	6.49	0.62	4.39	0.005240	37.00	0.19	0.99
EXISTING STREAM	3076.23*	PF 5	150.00	3914.92	3915.72	6.66	0.79	5.12	0.005238	37.00	0.24	1.02
EXISTING STREAM	3076.23*	PF 6	200.00	3914.92	3915.90	6.84	0.97	5.57	0.004820	37.00	0.26	1.00
EXISTING STREAM	3076.23*	PF 7	252.00	3914.92	3916.05	6.99	1.12	6.09	0.004869	37.00	0.30	1.01
EXISTING STREAM	3076.23*	PF 8	329.00	3914.92	3916.28	7.22	1.35	6.57	0.004519	37.00	0.33	0.99
EXISTING STREAM	3076.23*	PF 9	750.00	3914.92	3917.26	8.20	2.33	8.68	0.004303	37.00	0.50	1.00
EXISTING STREAM	3075.68*	PF 1	10.00	3914.53	3914.68	5.07	0.13	2.07	0.008670	37.00	0.07	1.01
EXISTING STREAM	3075.68*	PF 2	20.00	3914.53	3914.76	5.15	0.21	2.60	0.007445	37.00	0.09	1.01
EXISTING STREAM	3075.68*	PF 3	50.00	3914.53	3914.94	5.33	0.39	3.50	0.006004	37.00	0.14	0.99
EXISTING STREAM	3075.68*	PF 4	100.00	3914.53	3915.16	5.55	0.61	4.43	0.005391	37.00	0.19	1.00
EXISTING STREAM	3075.68*	PF 5	150.00	3914.53	3915.35	5.74	0.80	5.07	0.005064	37.00	0.23	1.00
EXISTING STREAM	3075.68*	PF 6	200.00	3914.53	3915.51	5.90	0.96	5.65	0.005044	37.00	0.27	1.02
EXISTING STREAM	3075.68*	PF 7	252.00	3914.53	3915.66	6.05	1.11	6.12	0.004937	37.00	0.31	1.02
EXISTING STREAM	3075.68*	PF 8	329.00	3914.53	3915.91	6.30	1.36	6.56	0.004498	37.00	0.33	0.99
EXISTING STREAM	3075.68*	PF 9	750.00	3914.53	3916.88	7.27	2.33	8.68	0.004303	37.00	0.50	1.00
EXISTING STREAM	3075.13*	PF 1	10.00	3914.15	3914.31	4.16	0.13	2.04	0.008253	37.00	0.07	0.99
EXISTING STREAM	3075.13*	PF 2	20.00	3914.15	3914.39	4.24	0.21	2.63	0.007652	37.00	0.10	1.02
EXISTING STREAM	3075.13*	PF 3	50.00	3914.15	3914.56	4.41	0.38	3.52	0.006130	37.00	0.14	1.00
EXISTING STREAM	3075.13*	PF 4	100.00	3914.15	3914.79	4.64	0.61	4.43	0.005391	37.00	0.19	1.00
EXISTING STREAM	3075.13*	PF 5	150.00	3914.15	3914.99	4.83	0.80	5.04	0.004956	37.00	0.23	0.99
EXISTING STREAM	3075.13*	PF 6	200.00	3914.15	3915.15	5.00	0.97	5.60	0.004899	37.00	0.27	1.00
EXISTING STREAM	3075.13*	PF 7	252.00	3914.15	3915.32	5.17	1.14	5.99	0.004613	37.00	0.29	0.99
EXISTING STREAM	3075.13*	PF 8	329.00	3914.15	3915.54	5.39	1.36	6.55	0.004488	37.00	0.33	0.99
EXISTING STREAM	3075.13*	PF 9	750.00	3914.15	3916.52	6.37	2.34	8.65	0.004259	37.00	0.50	1.00
EXISTING STREAM	3074.58*	PF 1	10.00	3913.77	3913.94	3.25	0.13	2.07	0.008603	37.00	0.07	1.01
EXISTING STREAM	3074.58*	PF 2	20.00	3913.77	3914.01	3.32	0.21	2.62	0.007555	37.00	0.10	1.01
EXISTING STREAM	3074.58*	PF 3	50.00	3913.77	3914.19	3.50	0.38	3.54	0.006243	37.00	0.14	1.01
EXISTING STREAM	3074.58*	PF 4	100.00	3913.77	3914.43	3.74	0.62	4.38	0.005191	37.00	0.19	0.98
EXISTING STREAM	3074.58*	PF 5	150.00	3913.77	3914.60	3.91	0.79	5.13	0.005247	37.00	0.24	1.02
EXISTING STREAM	3074.58*	PF 6	200.00	3913.77	3914.78	4.09	0.97	5.55	0.004780	37.00	0.26	0.99
EXISTING STREAM	3074.58*	PF 7	252.00	3913.77	3914.94	4.25	1.13	6.00	0.004651	37.00	0.29	0.99
EXISTING STREAM	3074.58*	PF 8	329.00	3913.77	3915.16	4.47	1.35	6.60	0.004583	37.00	0.34	1.00
EXISTING STREAM	3074.58*	PF 9	750.00	3913.77	3916.11	5.42	2.31	8.79	0.004470	37.00	0.51	1.02

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	3074.03*	PF 1	10.00	3913.39	3913.56	2.32	0.13	2.10	0.009086	37.00	0.07	1.03
EXISTING STREAM	3074.03*	PF 2	20.00	3913.39	3913.64	2.40	0.21	2.61	0.007489	37.00	0.09	1.01
EXISTING STREAM	3074.03*	PF 3	50.00	3913.39	3913.82	2.58	0.38	3.55	0.006332	37.00	0.14	1.02
EXISTING STREAM	3074.03*	PF 4	100.00	3913.39	3914.05	2.81	0.62	4.38	0.005203	37.00	0.19	0.98
EXISTING STREAM	3074.03*	PF 5	150.00	3913.39	3914.24	3.00	0.81	5.02	0.004910	37.00	0.23	0.99
EXISTING STREAM	3074.03*	PF 6	200.00	3913.39	3914.41	3.17	0.98	5.53	0.004715	37.00	0.26	0.99
EXISTING STREAM	3074.03*	PF 7	252.00	3913.39	3914.57	3.33	1.14	5.98	0.004602	37.00	0.29	0.99
EXISTING STREAM	3074.03*	PF 8	329.00	3913.39	3914.79	3.55	1.35	6.58	0.004543	37.00	0.33	1.00
EXISTING STREAM	3074.03*	PF 9	750.00	3913.39	3915.31	4.07	1.88	10.79	0.008423	37.00	0.82	1.39
EXISTING STREAM	3073.48*	PF 1	10.00	3913.00	3913.19	1.41	0.13	2.04	0.008203	37.00	0.07	0.99
EXISTING STREAM	3073.48*	PF 2	20.00	3913.00	3913.26	1.48	0.20	2.75	0.008948	37.00	0.11	1.10
EXISTING STREAM	3073.48*	PF 3	50.00	3913.00	3913.44	1.66	0.38	3.55	0.006299	37.00	0.14	1.01
EXISTING STREAM	3073.48*	PF 4	100.00	3913.00	3913.67	1.89	0.61	4.43	0.005405	37.00	0.19	1.00
EXISTING STREAM	3073.48*	PF 5	150.00	3913.00	3913.86	2.08	0.80	5.09	0.005140	37.00	0.24	1.01
EXISTING STREAM	3073.48*	PF 6	200.00	3913.00	3914.03	2.25	0.97	5.56	0.004801	37.00	0.26	0.99
EXISTING STREAM	3073.48*	PF 7	252.00	3913.00	3914.19	2.41	1.13	6.01	0.004661	37.00	0.29	0.99
EXISTING STREAM	3073.48*	PF 8	329.00	3913.00	3914.06	2.28	1.00	8.86	0.011720	37.00	0.66	1.56
EXISTING STREAM	3073.48*	PF 9	750.00	3913.00	3914.75	2.97	1.69	11.99	0.011696	37.00	1.04	1.63
EXISTING STREAM	3072.92*	PF 1	10.00	3912.62	3912.74	0.41	0.06	5.09	0.138272	31.46	0.54	3.59
EXISTING STREAM	3072.92*	PF 2	20.00	3912.62	3912.79	0.46	0.10	5.43	0.084678	37.00	0.52	3.03
EXISTING STREAM	3072.92*	PF 3	50.00	3912.62	3912.91	0.58	0.22	6.20	0.039534	37.00	0.53	2.34
EXISTING STREAM	3072.92*	PF 4	100.00	3912.62	3913.08	0.75	0.39	6.97	0.023767	37.00	0.55	1.97
EXISTING STREAM	3072.92*	PF 5	150.00	3912.62	3913.23	0.89	0.54	7.55	0.018415	37.00	0.58	1.81
EXISTING STREAM	3072.92*	PF 6	200.00	3912.62	3913.37	1.03	0.68	7.98	0.015387	37.00	0.61	1.71
EXISTING STREAM	3072.92*	PF 7	252.00	3912.62	3913.50	1.17	0.81	8.37	0.013533	37.00	0.63	1.64
EXISTING STREAM	3072.92*	PF 8	329.00	3912.62	3913.57	1.24	0.88	10.09	0.017817	37.00	0.89	1.89
EXISTING STREAM	3072.92*	PF 9	750.00	3912.62	3914.25	1.92	1.56	12.95	0.014894	37.00	1.24	1.83
EXISTING STREAM	3072.37*	PF 1	10.00	3912.24	3912.36	0.12	0.06	6.07	0.210849	27.81	0.77	4.40
EXISTING STREAM	3072.37*	PF 2	20.00	3912.24	3912.40	0.16	0.08	6.59	0.161742	37.00	0.82	4.06
EXISTING STREAM	3072.37*	PF 3	50.00	3912.24	3912.50	0.26	0.18	7.48	0.073659	37.00	0.81	3.10
EXISTING STREAM	3072.37*	PF 4	100.00	3912.24	3912.64	0.40	0.33	8.26	0.041434	37.00	0.82	2.54
EXISTING STREAM	3072.37*	PF 5	150.00	3912.24	3912.77	0.53	0.46	8.82	0.030673	37.00	0.84	2.29
EXISTING STREAM	3072.37*	PF 6	200.00	3912.24	3912.90	0.66	0.58	9.28	0.025107	37.00	0.86	2.14
EXISTING STREAM	3072.37*	PF 7	252.00	3912.24	3913.02	0.78	0.71	9.62	0.021208	37.00	0.87	2.02
EXISTING STREAM	3072.37*	PF 8	329.00	3912.24	3913.12	0.88	0.80	11.09	0.024154	37.00	1.11	2.18
EXISTING STREAM	3072.37*	PF 9	750.00	3912.24	3913.79	1.55	1.47	13.79	0.018111	37.00	1.43	2.00
EXISTING STREAM	3071.82*	PF 1	10.00	3911.86	3911.98	0.12	0.06	6.68	0.246616	24.65	0.93	4.77
EXISTING STREAM	3071.82*	PF 2	20.00	3911.86	3912.02	0.16	0.08	7.31	0.206392	34.35	1.02	4.56
EXISTING STREAM	3071.82*	PF 3	50.00	3911.86	3912.11	0.25	0.16	8.42	0.108936	37.00	1.07	3.70
EXISTING STREAM	3071.82*	PF 4	100.00	3911.86	3912.24	0.38	0.29	9.29	0.060967	37.00	1.07	3.03
EXISTING STREAM	3071.82*	PF 5	150.00	3911.86	3912.36	0.50	0.41	9.83	0.043669	37.00	1.08	2.70
EXISTING STREAM	3071.82*	PF 6	200.00	3911.86	3912.47	0.61	0.53	10.28	0.035113	37.00	1.09	2.50
EXISTING STREAM	3071.82*	PF 7	252.00	3911.86	3912.59	0.73	0.64	10.63	0.029282	37.00	1.10	2.34
EXISTING STREAM	3071.82*	PF 8	329.00	3911.86	3912.69	0.83	0.75	11.93	0.030589	37.00	1.32	2.44
EXISTING STREAM	3071.82*	PF 9	750.00	3911.86	3913.34	1.48	1.40	14.53	0.021367	37.00	1.62	2.17
EXISTING STREAM	3071.27*	PF 1	10.00	3911.47	3911.59	0.12	0.06	7.15	0.265866	21.98	1.05	4.99
EXISTING STREAM	3071.27*	PF 2	20.00	3911.47	3911.63	0.16	0.08	7.88	0.222944	30.08	1.16	4.78
EXISTING STREAM	3071.27*	PF 3	50.00	3911.47	3911.72	0.25	0.15	9.16	0.143713	37.00	1.30	4.20
EXISTING STREAM	3071.27*	PF 4	100.00	3911.47	3911.83	0.36	0.27	10.13	0.081302	37.00	1.32	3.46
EXISTING STREAM	3071.27*	PF 5	150.00	3911.47	3911.95	0.48	0.38	10.70	0.057594	37.00	1.31	3.06
EXISTING STREAM	3071.27*	PF 6	200.00	3911.47	3912.05	0.58	0.48	11.16	0.045831	37.00	1.32	2.82
EXISTING STREAM	3071.27*	PF 7	252.00	3911.47	3912.16	0.69	0.59	11.50	0.037824	37.00	1.31	2.63
EXISTING STREAM	3071.27*	PF 8	329.00	3911.47	3912.27	0.80	0.70	12.71	0.037567	37.00	1.52	2.68
EXISTING STREAM	3071.27*	PF 9	750.00	3911.47	3912.90	1.43	1.33	15.24	0.024867	37.00	1.81	2.33
EXISTING STREAM	3070.72*	PF 1	10.00	3911.09	3911.21	0.12	0.06	7.50	0.286577	20.62	1.15	5.20
EXISTING STREAM	3070.72*	PF 2	20.00	3911.09	3911.26	0.16	0.08	8.32	0.249953	28.65	1.30	5.06
EXISTING STREAM	3070.72*	PF 3	50.00	3911.09	3911.33	0.24	0.14	9.74	0.176390	37.00	1.51	4.61
EXISTING STREAM	3070.72*	PF 4	100.00	3911.09	3911.44	0.35	0.25	10.84	0.101549	37.00	1.54	3.83
EXISTING STREAM	3070.72*	PF 5	150.00	3911.09	3911.55	0.46	0.35	11.46	0.072192	37.00	1.54	3.39
EXISTING STREAM	3070.72*	PF 6	200.00	3911.09	3911.65	0.56	0.45	11.91	0.056818	37.00	1.53	3.12
EXISTING STREAM	3070.72*	PF 7	252.00	3911.09	3911.75	0.66	0.56	12.27	0.046645	37.00	1.53	2.90
EXISTING STREAM	3070.72*	PF 8	329.00	3911.09	3911.86	0.77	0.66	13.43	0.044898	37.00	1.73	2.91
EXISTING STREAM	3070.72*	PF 9	750.00	3911.09	3912.47	1.38	1.28	15.88	0.028308	37.00	1.98	2.48
EXISTING STREAM	3070.16*	PF 1	10.00	3910.71	3910.83	0.12	0.07	7.82	0.285404	18.50	1.22	5.25
EXISTING STREAM	3070.16*	PF 2	20.00	3910.71	3910.88	0.17	0.09	8.71	0.256511	26.06	1.40	5.17
EXISTING STREAM	3070.16*	PF 3	50.00	3910.71	3910.96	0.24	0.13	10.21	0.206323	37.00	1.68	4.95
EXISTING STREAM	3070.16*	PF 4	100.00	3910.71	3911.06	0.35	0.24	11.45	0.121586	37.00	1.75	4.15
EXISTING STREAM	3070.16*	PF 5	150.00	3910.71	3911.16	0.45	0.33	12.12	0.086842	37.00	1.75	3.69
EXISTING STREAM	3070.16*	PF 6	200.00	3910.71	3911.25	0.54	0.43	12.60	0.068252	37.00	1.75	3.39
EXISTING STREAM	3070.16*	PF 7	252.00	3910.71	3911.35	0.64	0.53	12.96	0.055766	37.00	1.73	3.15
EXISTING STREAM	3070.16*	PF 8	329.00	3910.71	3911.46	0.74	0.63	14.07	0.052152	37.00	1.93	3.12
EXISTING STREAM	3070.16*	PF 9	750.00	3910.71	3912.05	1.34	1.23	16.47	0.031821	37.00	2.16	2.62
EXISTING STREAM	3069.61*	PF 1	10.00	3910.32	3910.45	0.13	0.07	8.10	0.319705	18.50	1.32	5.52
EXISTING STREAM	3069.61*	PF 2	20.00	3910.32	3910.49	0.17	0.09	9.03	0.268244	24.57	1.49	5.30
EXISTING STREAM	3069.61*	PF 3	50.00	3910.32	3910.58	0.25	0.13	10.60	0.227417	36.27	1.82	5.18
EXISTING STREAM	3069.61*	PF 4	100.00	3910.32	3910.67	0.35	0.23	11.99	0.141791	37.00	1.95	4.45
EXISTING STREAM	3069.61*	PF 5	150.00	3910.32	3910.77	0.45	0.32	12.71	0.101636	37.00	1.96	3.97
EXISTING STREAM	3069.61*	PF 6	200.00	3910.32	3910.86	0.54	0.41	13.22	0.079820	37.00	1.95	3.64
EXISTING STREAM	3069.61*	PF 7	252.00	3910.32	3910.95	0.63	0.50	13.58	0.064923	37.00	1.93	3.38
EXISTING STREAM	3069.61*	PF 8	329.00	3910.32	3911.05	0.73	0.61	14.67	0.059742	37.00	2.12	3.32
EXISTING STREAM	3069.61*	PF 9	750.00	3910.32	3911.64	1.32	1.19	17.04	0.035420	37.00	2.33	2.75

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	3069.06*	PF 1	10.00	3909.94	3910.07	0.13	0.07	8.25	0.339928	18.50	1.38	5.68
EXISTING STREAM	3069.06*	PF 2	20.00	3909.94	3910.12	0.18	0.09	9.33	0.282926	23.61	1.59	5.45
EXISTING STREAM	3069.06*	PF 3	50.00	3909.94	3910.20	0.26	0.13	10.92	0.243011	35.37	1.94	5.35
EXISTING STREAM	3069.06*	PF 4	100.00	3909.94	3910.29	0.35	0.22	12.46	0.160649	37.00	2.13	4.71
EXISTING STREAM	3069.06*	PF 5	150.00	3909.94	3910.38	0.44	0.31	13.24	0.116247	37.00	2.15	4.22
EXISTING STREAM	3069.06*	PF 6	200.00	3909.94	3910.47	0.53	0.39	13.76	0.091109	37.00	2.14	3.87
EXISTING STREAM	3069.06*	PF 7	252.00	3909.94	3910.56	0.62	0.48	14.16	0.074558	37.00	2.13	3.60
EXISTING STREAM	3069.06*	PF 8	329.00	3909.94	3910.66	0.72	0.58	15.22	0.067387	37.00	2.31	3.51
EXISTING STREAM	3069.06*	PF 9	750.00	3909.94	3911.23	1.29	1.15	17.57	0.039028	37.00	2.50	2.88
EXISTING STREAM	3068.51*	PF 1	10.00	3909.56	3909.69	0.13	0.06	8.35	0.354201	18.47	1.42	5.78
EXISTING STREAM	3068.51*	PF 2	20.00	3909.56	3909.74	0.18	0.10	9.60	0.280815	21.85	1.65	5.48
EXISTING STREAM	3068.51*	PF 3	50.00	3909.56	3909.82	0.26	0.13	11.22	0.244698	33.23	2.02	5.40
EXISTING STREAM	3068.51*	PF 4	100.00	3909.56	3909.91	0.35	0.21	12.88	0.179427	37.00	2.30	4.95
EXISTING STREAM	3068.51*	PF 5	150.00	3909.56	3910.00	0.44	0.30	13.72	0.130486	37.00	2.33	4.45
EXISTING STREAM	3068.51*	PF 6	200.00	3909.56	3910.08	0.52	0.38	14.27	0.102608	37.00	2.33	4.09
EXISTING STREAM	3068.51*	PF 7	252.00	3909.56	3910.17	0.61	0.46	14.70	0.084245	37.00	2.32	3.81
EXISTING STREAM	3068.51*	PF 8	329.00	3909.56	3910.27	0.71	0.57	15.74	0.075091	37.00	2.50	3.69
EXISTING STREAM	3068.51*	PF 9	750.00	3909.56	3910.82	1.26	1.12	18.07	0.042693	37.00	2.67	3.01
EXISTING STREAM	3067.96*	PF 1	10.00	3909.18	3909.31	0.13	0.07	8.46	0.348800	17.66	1.45	5.77
EXISTING STREAM	3067.96*	PF 2	20.00	3909.18	3909.36	0.18	0.10	9.84	0.288583	20.95	1.73	5.57
EXISTING STREAM	3067.96*	PF 3	50.00	3909.18	3909.45	0.27	0.13	11.51	0.257765	32.42	2.12	5.54
EXISTING STREAM	3067.96*	PF 4	100.00	3909.18	3909.53	0.35	0.20	13.24	0.196445	37.00	2.45	5.16
EXISTING STREAM	3067.96*	PF 5	150.00	3909.18	3909.62	0.44	0.29	14.15	0.144631	37.00	2.51	4.66
EXISTING STREAM	3067.96*	PF 6	200.00	3909.18	3909.70	0.52	0.37	14.75	0.114315	37.00	2.52	4.29
EXISTING STREAM	3067.96*	PF 7	252.00	3909.18	3909.78	0.60	0.45	15.20	0.093957	37.00	2.51	4.00
EXISTING STREAM	3067.96*	PF 8	329.00	3909.18	3909.88	0.70	0.55	16.22	0.082902	37.00	2.68	3.86
EXISTING STREAM	3067.96*	PF 9	750.00	3909.18	3910.42	1.24	1.09	18.54	0.046396	37.00	2.83	3.13
EXISTING STREAM	3067.41*	PF 1	10.00	3908.79	3908.93	0.14	0.07	8.59	0.332976	16.41	1.46	5.69
EXISTING STREAM	3067.41*	PF 2	20.00	3908.79	3908.98	0.19	0.10	10.06	0.300502	20.42	1.81	5.68
EXISTING STREAM	3067.41*	PF 3	50.00	3908.79	3909.07	0.27	0.14	11.78	0.259036	30.63	2.20	5.58
EXISTING STREAM	3067.41*	PF 4	100.00	3908.79	3909.15	0.36	0.20	13.58	0.213673	37.00	2.60	5.36
EXISTING STREAM	3067.41*	PF 5	150.00	3908.79	3909.23	0.44	0.28	14.56	0.158883	37.00	2.68	4.86
EXISTING STREAM	3067.41*	PF 6	200.00	3908.79	3909.31	0.52	0.36	15.20	0.126329	37.00	2.70	4.49
EXISTING STREAM	3067.41*	PF 7	252.00	3908.79	3909.39	0.60	0.43	15.67	0.103795	37.00	2.69	4.19
EXISTING STREAM	3067.41*	PF 8	329.00	3908.79	3909.49	0.70	0.53	16.67	0.090556	37.00	2.85	4.02
EXISTING STREAM	3067.41*	PF 9	750.00	3908.79	3910.02	1.23	1.07	19.00	0.050160	37.00	2.99	3.24
EXISTING STREAM	3066.85*	PF 1	10.00	3908.41	3908.55	0.14	0.07	8.73	0.346535	16.27	1.51	5.79
EXISTING STREAM	3066.85*	PF 2	20.00	3908.41	3908.60	0.19	0.10	10.29	0.294819	19.03	1.86	5.68
EXISTING STREAM	3066.85*	PF 3	50.00	3908.41	3908.69	0.28	0.14	12.03	0.258900	29.05	2.27	5.60
EXISTING STREAM	3066.85*	PF 4	100.00	3908.41	3908.78	0.37	0.19	13.87	0.229326	37.00	2.73	5.54
EXISTING STREAM	3066.85*	PF 5	150.00	3908.41	3908.85	0.44	0.27	14.93	0.172575	37.00	2.84	5.05
EXISTING STREAM	3066.85*	PF 6	200.00	3908.41	3908.93	0.52	0.35	15.60	0.137553	37.00	2.87	4.67
EXISTING STREAM	3066.85*	PF 7	252.00	3908.41	3909.01	0.60	0.42	16.11	0.113567	37.00	2.87	4.37
EXISTING STREAM	3066.85*	PF 8	329.00	3908.41	3909.10	0.69	0.52	17.09	0.098294	37.00	3.02	4.18
EXISTING STREAM	3066.85*	PF 9	750.00	3908.41	3909.63	1.22	1.04	19.44	0.053902	37.00	3.15	3.35
EXISTING STREAM	3066.30*	PF 1	10.00	3908.03	3908.17	0.14	0.07	8.85	0.346622	15.68	1.54	5.81
EXISTING STREAM	3066.30*	PF 2	20.00	3908.03	3908.22	0.19	0.10	10.49	0.302845	18.50	1.93	5.76
EXISTING STREAM	3066.30*	PF 3	50.00	3908.03	3908.31	0.28	0.14	12.26	0.267776	28.41	2.36	5.70
EXISTING STREAM	3066.30*	PF 4	100.00	3908.03	3908.40	0.37	0.19	14.14	0.244175	37.00	2.85	5.70
EXISTING STREAM	3066.30*	PF 5	150.00	3908.03	3908.48	0.45	0.27	15.28	0.186005	37.00	3.00	5.23
EXISTING STREAM	3066.30*	PF 6	200.00	3908.03	3908.55	0.52	0.34	15.97	0.148610	37.00	3.03	4.84
EXISTING STREAM	3066.30*	PF 7	252.00	3908.03	3908.62	0.59	0.41	16.52	0.123316	37.00	3.04	4.53
EXISTING STREAM	3066.30*	PF 8	329.00	3908.03	3908.72	0.69	0.51	17.50	0.106212	37.00	3.19	4.33
EXISTING STREAM	3066.30*	PF 9	750.00	3908.03	3909.23	1.20	1.02	19.86	0.057791	37.00	3.32	3.47
EXISTING STREAM	3065.75*	PF 1	10.00	3907.64	3907.79	0.15	0.07	8.99	0.347209	15.12	1.58	5.84
EXISTING STREAM	3065.75*	PF 2	20.00	3907.64	3907.83	0.19	0.10	10.67	0.320134	18.50	2.00	5.91
EXISTING STREAM	3065.75*	PF 3	50.00	3907.64	3907.93	0.29	0.15	12.50	0.266127	26.92	2.43	5.72
EXISTING STREAM	3065.75*	PF 4	100.00	3907.64	3908.02	0.38	0.19	14.39	0.250048	36.05	2.95	5.77
EXISTING STREAM	3065.75*	PF 5	150.00	3907.64	3908.09	0.45	0.26	15.59	0.198976	37.00	3.14	5.39
EXISTING STREAM	3065.75*	PF 6	200.00	3907.64	3908.16	0.52	0.33	16.34	0.160082	37.00	3.19	5.01
EXISTING STREAM	3065.75*	PF 7	252.00	3907.64	3908.24	0.60	0.40	16.91	0.133128	37.00	3.21	4.69
EXISTING STREAM	3065.75*	PF 8	329.00	3907.64	3908.33	0.69	0.50	17.90	0.114254	37.00	3.36	4.47
EXISTING STREAM	3065.75*	PF 9	750.00	3907.64	3908.83	1.19	1.00	20.29	0.061818	37.00	3.48	3.58
EXISTING STREAM	3065.20*	PF 1	10.00	3907.26	3907.41	0.15	0.08	9.08	0.344617	14.65	1.60	5.83
EXISTING STREAM	3065.20*	PF 2	20.00	3907.26	3907.46	0.20	0.10	10.80	0.333278	18.50	2.06	6.02
EXISTING STREAM	3065.20*	PF 3	50.00	3907.26	3907.55	0.29	0.15	12.72	0.269371	26.00	2.50	5.77
EXISTING STREAM	3065.20*	PF 4	100.00	3907.26	3907.65	0.39	0.20	14.60	0.251340	34.88	3.02	5.80
EXISTING STREAM	3065.20*	PF 5	150.00	3907.26	3907.72	0.46	0.26	15.86	0.210647	37.00	3.27	5.53
EXISTING STREAM	3065.20*	PF 6	200.00	3907.26	3907.79	0.53	0.32	16.66	0.170717	37.00	3.34	5.16
EXISTING STREAM	3065.20*	PF 7	252.00	3907.26	3907.86	0.60	0.39	17.27	0.142606	37.00	3.37	4.84
EXISTING STREAM	3065.20*	PF 8	329.00	3907.26	3907.95	0.69	0.49	18.27	0.122158	37.00	3.53	4.61
EXISTING STREAM	3065.20*	PF 9	750.00	3907.26	3908.44	1.18	0.98	20.68	0.065763	37.00	3.64	3.68
EXISTING STREAM	3064.65*	PF 1	10.00	3906.88	3907.03	0.15	0.08	9.18	0.342732	14.19	1.63	5.84
EXISTING STREAM	3064.65*	PF 2	20.00	3906.88	3907.08	0.20	0.10	10.91	0.342088	18.41	2.10	6.09
EXISTING STREAM	3064.65*	PF 3	50.00	3906.88	3907.18	0.29	0.15	12.95	0.277044	25.41	2.58	5.85
EXISTING STREAM	3064.65*	PF 4	100.00	3906.88	3907.27	0.39	0.20	14.79	0.257883	34.38	3.10	5.88
EXISTING STREAM	3064.65*	PF 5	150.00	3906.88	3907.34	0.46	0.25	16.13	0.222692	37.00	3.40	5.67
EXISTING STREAM	3064.65*	PF 6	200.00	3906.88	3907.41	0.53	0.32	16.96	0.181036	37.00	3.48	5.30
EXISTING STREAM	3064.65*	PF 7	252.00	3906.88	3907.48	0.60	0.39	17.60	0.151803	37.00	3.52	4.98
EXISTING STREAM	3064.65*	PF 8	329.00	3906.88	3907.57	0.69	0.48	18.62	0.129977	37.00	3.68	4.75
EXISTING STREAM	3064.65*	PF 9	750.00	3906.88	3908.05	1.17	0.96	21.07	0.069777	37.00	3.80	3.78

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	3064.1*	PF 1	10.00	3906.50	3906.65	0.15	0.08	9.28	0.353725	14.12	1.67	5.92
EXISTING STREAM	3064.1*	PF 2	20.00	3906.50	3906.70	0.20	0.10	11.00	0.350310	18.34	2.14	6.16
EXISTING STREAM	3064.1*	PF 3	50.00	3906.50	3906.80	0.30	0.16	13.14	0.274235	24.27	2.63	5.85
EXISTING STREAM	3064.1*	PF 4	100.00	3906.50	3906.90	0.40	0.20	15.00	0.256761	33.06	3.16	5.89
EXISTING STREAM	3064.1*	PF 5	150.00	3906.50	3906.97	0.47	0.25	16.36	0.232983	37.00	3.51	5.79
EXISTING STREAM	3064.1*	PF 6	200.00	3906.50	3907.03	0.53	0.31	17.25	0.191447	37.00	3.62	5.43
EXISTING STREAM	3064.1*	PF 7	252.00	3906.50	3907.10	0.60	0.38	17.93	0.161281	37.00	3.67	5.12
EXISTING STREAM	3064.1*	PF 8	329.00	3906.50	3907.19	0.69	0.47	18.96	0.137877	37.00	3.84	4.88
EXISTING STREAM	3064.1*	PF 9	750.00	3906.50	3907.66	1.16	0.95	21.44	0.073785	37.00	3.95	3.88
EXISTING STREAM	3063.54*	PF 1	10.00	3906.11	3906.27	0.16	0.08	9.39	0.342147	13.39	1.68	5.86
EXISTING STREAM	3063.54*	PF 2	20.00	3906.11	3906.32	0.21	0.10	11.10	0.336885	17.41	2.15	6.08
EXISTING STREAM	3063.54*	PF 3	50.00	3906.11	3906.41	0.30	0.16	13.34	0.278391	23.63	2.70	5.90
EXISTING STREAM	3063.54*	PF 4	100.00	3906.11	3906.52	0.41	0.21	15.20	0.255650	31.83	3.22	5.89
EXISTING STREAM	3063.54*	PF 5	150.00	3906.11	3906.59	0.48	0.24	16.56	0.242705	37.00	3.61	5.90
EXISTING STREAM	3063.54*	PF 6	200.00	3906.11	3906.65	0.54	0.31	17.52	0.201342	37.00	3.75	5.56
EXISTING STREAM	3063.54*	PF 7	252.00	3906.11	3906.72	0.61	0.37	18.22	0.170268	37.00	3.82	5.25
EXISTING STREAM	3063.54*	PF 8	329.00	3906.11	3906.80	0.69	0.46	19.26	0.145286	37.00	3.99	5.00
EXISTING STREAM	3063.54*	PF 9	750.00	3906.11	3907.27	1.16	0.93	21.80	0.077874	37.00	4.11	3.98
EXISTING STREAM	3062.99*	PF 1	10.00	3905.73	3905.89	0.16	0.08	9.52	0.345083	13.00	1.72	5.90
EXISTING STREAM	3062.99*	PF 2	20.00	3905.73	3905.94	0.21	0.11	11.20	0.335610	16.95	2.18	6.08
EXISTING STREAM	3062.99*	PF 3	50.00	3905.73	3906.04	0.31	0.16	13.52	0.283149	23.13	2.77	5.96
EXISTING STREAM	3062.99*	PF 4	100.00	3905.73	3906.14	0.41	0.21	15.40	0.261970	31.38	3.30	5.97
EXISTING STREAM	3062.99*	PF 5	150.00	3905.73	3906.21	0.48	0.24	16.76	0.252330	37.00	3.71	6.00
EXISTING STREAM	3062.99*	PF 6	200.00	3905.73	3906.27	0.54	0.30	17.76	0.210380	37.00	3.87	5.67
EXISTING STREAM	3062.99*	PF 7	252.00	3905.73	3906.34	0.61	0.37	18.50	0.178845	37.00	3.95	5.37
EXISTING STREAM	3062.99*	PF 8	329.00	3905.73	3906.43	0.69	0.45	19.55	0.152484	37.00	4.13	5.11
EXISTING STREAM	3062.99*	PF 9	750.00	3905.73	3906.89	1.16	0.92	22.15	0.081932	37.00	4.26	4.08
EXISTING STREAM	3062.44*	PF 1	10.00	3905.35	3905.51	0.16	0.08	9.61	0.353543	12.94	1.75	5.97
EXISTING STREAM	3062.44*	PF 2	20.00	3905.35	3905.56	0.21	0.10	11.31	0.344029	16.87	2.22	6.15
EXISTING STREAM	3062.44*	PF 3	50.00	3905.35	3905.66	0.31	0.16	13.72	0.280155	22.15	2.82	5.96
EXISTING STREAM	3062.44*	PF 4	100.00	3905.35	3905.76	0.41	0.21	15.60	0.260822	30.28	3.36	5.97
EXISTING STREAM	3062.44*	PF 5	150.00	3905.35	3905.84	0.49	0.25	16.94	0.252421	35.96	3.78	6.02
EXISTING STREAM	3062.44*	PF 6	200.00	3905.35	3905.90	0.55	0.30	17.98	0.219368	37.00	3.99	5.78
EXISTING STREAM	3062.44*	PF 7	252.00	3905.35	3905.96	0.61	0.36	18.76	0.187168	37.00	4.08	5.49
EXISTING STREAM	3062.44*	PF 8	329.00	3905.35	3906.05	0.70	0.45	19.82	0.159588	37.00	4.26	5.22
EXISTING STREAM	3062.44*	PF 9	750.00	3905.35	3906.50	1.15	0.90	22.49	0.086124	37.00	4.41	4.18
EXISTING STREAM	3061.89*	PF 1	10.00	3904.97	3905.13	0.16	0.08	9.70	0.352709	12.61	1.78	5.98
EXISTING STREAM	3061.89*	PF 2	20.00	3904.97	3905.18	0.21	0.11	11.40	0.341835	16.45	2.25	6.15
EXISTING STREAM	3061.89*	PF 3	50.00	3904.97	3905.28	0.31	0.17	13.90	0.282335	21.54	2.89	6.00
EXISTING STREAM	3061.89*	PF 4	100.00	3904.97	3905.39	0.42	0.21	15.78	0.261801	29.48	3.43	6.00
EXISTING STREAM	3061.89*	PF 5	150.00	3904.97	3905.46	0.49	0.25	17.13	0.253191	35.03	3.84	6.04
EXISTING STREAM	3061.89*	PF 6	200.00	3904.97	3905.53	0.55	0.30	18.19	0.227785	37.00	4.09	5.88
EXISTING STREAM	3061.89*	PF 7	252.00	3904.97	3905.59	0.62	0.36	19.00	0.195241	37.00	4.21	5.59
EXISTING STREAM	3061.89*	PF 8	329.00	3904.97	3905.67	0.70	0.44	20.09	0.166605	37.00	4.39	5.32
EXISTING STREAM	3061.89*	PF 9	750.00	3904.97	3906.12	1.15	0.89	22.82	0.090225	37.00	4.56	4.27
EXISTING STREAM	3061.34*	PF 1	10.00	3904.58	3905.30	0.72	0.45	0.60	0.000144	37.00	0.00	0.16
EXISTING STREAM	3061.34*	PF 2	20.00	3904.58	3905.51	0.93	0.66	0.82	0.000169	37.00	0.01	0.18
EXISTING STREAM	3061.34*	PF 3	50.00	3904.58	3905.89	1.31	1.04	1.29	0.000238	37.00	0.01	0.22
EXISTING STREAM	3061.34*	PF 4	100.00	3904.58	3905.00	0.42	0.22	15.98	0.263812	28.71	3.50	6.03
EXISTING STREAM	3061.34*	PF 5	150.00	3904.58	3905.08	0.50	0.25	17.32	0.254113	34.15	3.91	6.06
EXISTING STREAM	3061.34*	PF 6	200.00	3904.58	3905.14	0.56	0.29	18.40	0.236629	37.00	4.21	5.98
EXISTING STREAM	3061.34*	PF 7	252.00	3904.58	3905.20	0.62	0.35	19.24	0.203314	37.00	4.33	5.70
EXISTING STREAM	3061.34*	PF 8	329.00	3904.58	3905.29	0.70	0.44	20.34	0.173715	37.00	4.53	5.42
EXISTING STREAM	3061.34*	PF 9	750.00	3904.58	3905.72	1.14	0.88	23.15	0.094418	37.00	4.72	4.36
EXISTING STREAM	3060.79	PF 1	10.00	3904.20	3905.30	1.10	0.82	0.33	0.000020	37.00	0.00	0.06
EXISTING STREAM	3060.79	PF 2	20.00	3904.20	3905.51	1.31	1.03	0.52	0.000040	37.00	0.00	0.09
EXISTING STREAM	3060.79	PF 3	50.00	3904.20	3905.90	1.70	1.42	0.95	0.000090	37.00	0.01	0.14
EXISTING STREAM	3060.79	PF 4	100.00	3904.20	3906.28	2.08	1.80	1.50	0.000171	37.00	0.02	0.20
EXISTING STREAM	3060.79	PF 5	150.00	3904.20	3906.54	2.34	2.06	1.96	0.000252	37.00	0.03	0.24
EXISTING STREAM	3060.79	PF 6	200.00	3904.20	3904.77	0.57	0.29	18.59	0.244571	37.00	4.30	6.07
EXISTING STREAM	3060.79	PF 7	252.00	3904.20	3904.83	0.63	0.35	19.45	0.210860	37.00	4.44	5.79
EXISTING STREAM	3060.79	PF 8	329.00	3904.20	3904.91	0.71	0.43	20.59	0.180558	37.00	4.65	5.52
EXISTING STREAM	3060.79	PF 9	750.00	3904.20	3905.34	1.14	0.86	23.45	0.098513	37.00	4.86	4.45
EXISTING STREAM	3050.46	PF 1	10.00	3903.90	3905.30	1.40	0.82	0.24	0.000043	50.20	0.00	0.05
EXISTING STREAM	3050.46	PF 2	20.00	3903.90	3905.51	1.61	1.02	0.39	0.000082	50.20	0.01	0.07
EXISTING STREAM	3050.46	PF 3	50.00	3903.90	3905.90	2.00	1.41	0.71	0.000175	50.20	0.02	0.10
EXISTING STREAM	3050.46	PF 4	100.00	3903.90	3906.28	2.38	1.79	1.11	0.000316	50.20	0.04	0.15
EXISTING STREAM	3050.46	PF 5	150.00	3903.90	3906.54	2.64	2.05	1.46	0.000451	50.20	0.06	0.18
EXISTING STREAM	3050.46	PF 6	200.00	3903.90	3906.74	2.84	2.26	1.77	0.000586	50.20	0.08	0.21
EXISTING STREAM	3050.46	PF 7	252.00	3903.90	3906.93	3.03	2.45	2.05	0.000709	50.20	0.11	0.23
EXISTING STREAM	3050.46	PF 8	329.00	3903.90	3907.19	3.29	2.70	2.42	0.000865	50.20	0.15	0.26
EXISTING STREAM	3050.46	PF 9	750.00	3903.90	3908.26	4.36	3.78	3.96	0.001476	50.20	0.35	0.36
EXISTING STREAM	3000.73	PF 1	10.00	3904.84	3905.19	0.35	0.25	2.32	0.018839	17.18	0.29	0.81
EXISTING STREAM	3000.73	PF 2	20.00	3904.84	3905.32	0.48	0.35	2.98	0.020253	19.35	0.44	0.89
EXISTING STREAM	3000.73	PF 3	50.00	3904.84	3905.59	0.75	0.45	3.76	0.022655	29.31	0.64	0.98
EXISTING STREAM	3000.73	PF 4	100.00	3904.84	3905.88	1.04	0.58	4.30	0.021390	40.20	0.77	1.00
EXISTING STREAM	3000.73	PF 5	150.00	3904.84	3906.09	1.25	0.67	4.57	0.019819	48.94	0.83	0.98
EXISTING STREAM	3000.73	PF 6	200.00	3904.84	3906.31	1.47	0.80	4.53	0.015462	55.23	0.77	0.89
EXISTING STREAM	3000.73	PF 7	252.00	3904.84	3906.50	1.66	0.97	4.61	0.012415	56.48	0.75	0.83
EXISTING STREAM	3000.73	PF 8	329.00	3904.84	3906.75	1.91	1.19	4.77	0.010134	58.14	0.74	0.77
EXISTING STREAM	3000.73	PF 9	750.00	3904.84	3907.83	2.99	2.08	5.52	0.006485	65.31	0.83	0.68

HEC-RAS Plan: Plan 12   River: Prickly Pear Cr.   Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	2899.44	PF 1	10.00	3902.15	3902.80	0.65	0.33	3.31	0.027227	9.16	0.55	1.02
EXISTING STREAM	2899.44	PF 2	20.00	3902.15	3903.02	0.87	0.44	3.72	0.023353	12.23	0.63	0.99
EXISTING STREAM	2899.44	PF 3	50.00	3902.15	3903.43	1.28	0.73	4.52	0.017852	15.20	0.79	0.94
EXISTING STREAM	2899.44	PF 4	100.00	3902.15	3903.96	1.81	1.10	5.02	0.012888	18.16	0.86	0.85
EXISTING STREAM	2899.44	PF 5	150.00	3902.15	3904.34	2.19	1.33	5.51	0.012025	20.41	0.97	0.84
EXISTING STREAM	2899.44	PF 6	200.00	3902.15	3904.67	2.52	1.45	5.83	0.011979	23.63	1.05	0.85
EXISTING STREAM	2899.44	PF 7	252.00	3902.15	3904.97	2.82	1.50	5.99	0.012047	28.06	1.09	0.86
EXISTING STREAM	2899.44	PF 8	329.00	3902.15	3905.33	3.18	1.59	6.17	0.011764	33.42	1.14	0.86
EXISTING STREAM	2899.44	PF 9	750.00	3902.15	3906.34	4.19	2.37	7.97	0.011522	38.47	1.66	0.91
EXISTING STREAM	2800	PF 1	10.00	3900.88	3902.20	1.32	0.68	1.18	0.001342	12.39	0.06	0.25
EXISTING STREAM	2800	PF 2	20.00	3900.88	3902.47	1.59	0.82	1.65	0.002050	14.82	0.10	0.32
EXISTING STREAM	2800	PF 3	50.00	3900.88	3902.93	2.05	1.05	2.50	0.003364	19.02	0.21	0.43
EXISTING STREAM	2800	PF 4	100.00	3900.88	3903.40	2.52	1.30	3.35	0.004551	22.94	0.36	0.52
EXISTING STREAM	2800	PF 5	150.00	3900.88	3903.73	2.85	1.47	3.95	0.005372	25.73	0.48	0.57
EXISTING STREAM	2800	PF 6	200.00	3900.88	3904.00	3.12	1.60	4.43	0.006023	28.21	0.59	0.62
EXISTING STREAM	2800	PF 7	252.00	3900.88	3904.24	3.36	1.72	4.82	0.006520	30.42	0.68	0.65
EXISTING STREAM	2800	PF 8	329.00	3900.88	3904.54	3.66	1.87	5.34	0.007155	33.02	0.81	0.69
EXISTING STREAM	2800	PF 9	750.00	3900.88	3905.63	4.75	2.85	7.01	0.007044	34.82	1.21	0.73
EXISTING STREAM	2700	PF 1	10.00	3901.23	3901.73	0.50	0.16	2.46	0.038386	25.08	0.39	1.08
EXISTING STREAM	2700	PF 2	20.00	3901.23	3901.84	0.61	0.26	2.98	0.029868	25.81	0.48	1.03
EXISTING STREAM	2700	PF 3	50.00	3901.23	3902.07	0.83	0.47	3.92	0.023856	27.40	0.69	1.01
EXISTING STREAM	2700	PF 4	100.00	3901.23	3902.35	1.12	0.71	4.82	0.020679	29.38	0.90	1.01
EXISTING STREAM	2700	PF 5	150.00	3901.23	3902.58	1.34	0.89	5.43	0.019291	30.98	1.06	1.01
EXISTING STREAM	2700	PF 6	200.00	3901.23	3902.78	1.55	1.05	5.87	0.018167	32.40	1.18	1.01
EXISTING STREAM	2700	PF 7	252.00	3901.23	3902.97	1.73	1.19	6.26	0.017459	33.71	1.28	1.01
EXISTING STREAM	2700	PF 8	329.00	3901.23	3903.22	1.99	1.38	6.70	0.016505	35.61	1.40	1.00
EXISTING STREAM	2700	PF 9	750.00	3901.23	3904.28	3.04	2.07	8.24	0.014595	43.89	1.86	1.01
EXISTING STREAM	2598.88	PF 1	10.00	3899.13	3900.24	1.11	0.59	0.98	0.001086	17.34	0.04	0.22
EXISTING STREAM	2598.88	PF 2	20.00	3899.13	3900.50	1.37	0.75	1.33	0.001469	20.00	0.07	0.27
EXISTING STREAM	2598.88	PF 3	50.00	3899.13	3900.95	1.82	1.03	2.00	0.002165	24.36	0.14	0.35
EXISTING STREAM	2598.88	PF 4	100.00	3899.13	3901.41	2.28	1.29	2.68	0.002883	28.78	0.23	0.42
EXISTING STREAM	2598.88	PF 5	150.00	3899.13	3901.68	2.55	1.45	3.31	0.003781	31.36	0.34	0.48
EXISTING STREAM	2598.88	PF 6	200.00	3899.13	3901.90	2.77	1.56	3.82	0.004552	33.43	0.44	0.54
EXISTING STREAM	2598.88	PF 7	252.00	3899.13	3902.09	2.96	1.67	4.28	0.005223	35.28	0.54	0.58
EXISTING STREAM	2598.88	PF 8	329.00	3899.13	3902.32	3.19	1.80	4.88	0.006145	37.48	0.68	0.64
EXISTING STREAM	2598.88	PF 9	750.00	3899.13	3903.05	3.92	2.52	7.81	0.010075	37.61	1.56	0.87
EXISTING STREAM	2499.55	PF 1	10.00	3899.29	3899.80	0.51	0.26	2.96	0.029140	12.88	0.47	1.02
EXISTING STREAM	2499.55	PF 2	20.00	3899.29	3899.98	0.69	0.30	3.12	0.027045	21.41	0.50	1.00
EXISTING STREAM	2499.55	PF 3	50.00	3899.29	3900.23	0.94	0.48	4.04	0.023883	25.56	0.72	1.02
EXISTING STREAM	2499.55	PF 4	100.00	3899.29	3900.54	1.25	0.69	4.74	0.020687	30.61	0.88	1.01
EXISTING STREAM	2499.55	PF 5	150.00	3899.29	3900.83	1.54	0.93	4.80	0.014136	32.45	0.82	0.87
EXISTING STREAM	2499.55	PF 6	200.00	3899.29	3901.00	1.71	1.08	5.15	0.013476	33.23	0.90	0.87
EXISTING STREAM	2499.55	PF 7	252.00	3899.29	3901.14	1.85	1.20	5.55	0.013681	33.86	1.01	0.89
EXISTING STREAM	2499.55	PF 8	329.00	3899.29	3901.32	2.03	1.34	6.03	0.013870	34.68	1.15	0.92
EXISTING STREAM	2499.55	PF 9	750.00	3899.29	3902.04	2.75	1.99	7.77	0.013748	36.49	1.67	0.97
EXISTING STREAM	2400.3	PF 1	10.00	3896.60	3897.68	1.07	0.58	0.94	0.001029	18.51	0.04	0.22
EXISTING STREAM	2400.3	PF 2	20.00	3896.60	3898.00	1.40	0.81	1.16	0.000994	21.21	0.05	0.23
EXISTING STREAM	2400.3	PF 3	50.00	3896.60	3898.50	1.90	1.25	1.73	0.001291	22.46	0.10	0.27
EXISTING STREAM	2400.3	PF 4	100.00	3896.60	3899.01	2.41	1.69	2.33	0.001590	23.76	0.16	0.32
EXISTING STREAM	2400.3	PF 5	150.00	3896.60	3899.40	2.80	1.99	2.73	0.001785	24.85	0.21	0.34
EXISTING STREAM	2400.3	PF 6	200.00	3896.60	3899.72	3.12	2.16	3.01	0.001953	26.77	0.25	0.36
EXISTING STREAM	2400.3	PF 7	252.00	3896.60	3900.01	3.41	2.31	3.23	0.002068	28.49	0.28	0.38
EXISTING STREAM	2400.3	PF 8	329.00	3896.60	3900.38	3.78	2.55	3.50	0.002125	29.97	0.32	0.39
EXISTING STREAM	2400.3	PF 9	750.00	3896.60	3901.86	5.26	4.01	4.51	0.001953	30.26	0.45	0.40
EXISTING STREAM	2300.27	PF 1	10.00	3896.20	3897.55	1.35	0.67	1.14	0.001283	13.11	0.05	0.25
EXISTING STREAM	2300.27	PF 2	20.00	3896.20	3897.85	1.65	0.70	1.45	0.001910	19.73	0.08	0.30
EXISTING STREAM	2300.27	PF 3	50.00	3896.20	3898.29	2.09	0.99	2.15	0.002693	23.50	0.16	0.38
EXISTING STREAM	2300.27	PF 4	100.00	3896.20	3898.73	2.53	1.29	2.91	0.003469	26.60	0.27	0.45
EXISTING STREAM	2300.27	PF 5	150.00	3896.20	3899.05	2.85	1.52	3.48	0.003984	28.35	0.37	0.50
EXISTING STREAM	2300.27	PF 6	200.00	3896.20	3899.31	3.11	1.71	3.94	0.004408	29.65	0.46	0.53
EXISTING STREAM	2300.27	PF 7	252.00	3896.20	3899.54	3.34	1.90	4.38	0.004732	30.25	0.54	0.56
EXISTING STREAM	2300.27	PF 8	329.00	3896.20	3899.81	3.61	2.18	4.98	0.005112	30.25	0.67	0.59
EXISTING STREAM	2300.27	PF 9	750.00	3896.20	3900.80	4.60	3.16	7.69	0.007418	30.25	1.41	0.76
EXISTING STREAM	2201	PF 1	10.00	3896.68	3897.09	0.41	0.23	2.78	0.030405	15.60	0.44	1.02
EXISTING STREAM	2201	PF 2	20.00	3896.68	3897.24	0.56	0.31	3.15	0.026566	20.61	0.51	1.00
EXISTING STREAM	2201	PF 3	50.00	3896.68	3897.51	0.82	0.47	3.93	0.023489	27.08	0.69	1.01
EXISTING STREAM	2201	PF 4	100.00	3896.68	3897.79	1.11	0.69	4.77	0.020693	30.20	0.89	1.01
EXISTING STREAM	2201	PF 5	150.00	3896.68	3898.02	1.34	0.87	5.34	0.019171	32.22	1.04	1.01
EXISTING STREAM	2201	PF 6	200.00	3896.68	3898.21	1.53	1.03	5.81	0.018131	33.34	1.16	1.01
EXISTING STREAM	2201	PF 7	252.00	3896.68	3898.39	1.71	1.19	6.23	0.017314	33.87	1.27	1.00
EXISTING STREAM	2201	PF 8	329.00	3896.68	3898.64	1.95	1.44	6.74	0.015865	33.90	1.40	0.99
EXISTING STREAM	2201	PF 9	750.00	3896.68	3899.69	3.01	2.49	8.48	0.012052	33.90	1.85	0.95
EXISTING STREAM	2101.86	PF 1	10.00	3893.95	3894.56	0.61	0.26	1.95	0.013055	20.02	0.21	0.68
EXISTING STREAM	2101.86	PF 2	20.00	3893.95	3894.78	0.83	0.42	1.97	0.006824	23.85	0.18	0.53
EXISTING STREAM	2101.86	PF 3	50.00	3893.95	3895.25	1.30	0.73	2.17	0.004028	31.65	0.18	0.45
EXISTING STREAM	2101.86	PF 4	100.00	3893.95	3895.75	1.80	1.06	2.45	0.003108	38.40	0.20	0.42
EXISTING STREAM	2101.86	PF 5	150.00	3893.95	3896.12	2.17	1.38	2.70	0.002678	40.20	0.23	0.41
EXISTING STREAM	2101.86	PF 6	200.00	3893.95	3896.44	2.49	1.65	2.93	0.002486	41.35	0.25	0.40
EXISTING STREAM	2101.86	PF 7	252.00	3893.95	3896.72	2.77	1.91	3.15	0.002363	41.94	0.28	0.40
EXISTING STREAM	2101.86	PF 8	329.00	3893.95	3897.08	3.13	2.27	3.44	0.002241	41.94	0.31	0.40
EXISTING STREAM	2101.86	PF 9	750.00	3893.95	3898.45	4.50	3.64	4.65	0.002185	41.94	0.49	0.43

HEC-RAS Plan: Plan 12   River: Prickly Pear Cr.   Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	2000.77	PF 1	10.00	3893.29	3894.23	0.94	0.51	1.09	0.001628	17.88	0.05	0.27
EXISTING STREAM	2000.77	PF 2	20.00	3893.29	3894.48	1.19	0.69	1.44	0.001899	20.05	0.08	0.30
EXISTING STREAM	2000.77	PF 3	50.00	3893.29	3894.94	1.65	1.00	2.07	0.002433	24.06	0.15	0.37
EXISTING STREAM	2000.77	PF 4	100.00	3893.29	3895.42	2.13	1.36	2.75	0.002858	26.75	0.24	0.41
EXISTING STREAM	2000.77	PF 5	150.00	3893.29	3895.77	2.48	1.62	3.26	0.003205	28.43	0.32	0.45
EXISTING STREAM	2000.77	PF 6	200.00	3893.29	3896.05	2.76	1.83	3.69	0.003516	29.70	0.39	0.48
EXISTING STREAM	2000.77	PF 7	252.00	3893.29	3896.30	3.01	2.00	4.07	0.003828	31.01	0.46	0.51
EXISTING STREAM	2000.77	PF 8	329.00	3893.29	3896.62	3.33	2.20	4.57	0.004240	32.67	0.56	0.54
EXISTING STREAM	2000.77	PF 9	750.00	3893.29	3897.54	4.25	3.05	7.26	0.006953	33.74	1.28	0.73
EXISTING STREAM	1900	PF 1	10.00	3893.21	3893.68	0.47	0.25	2.82	0.028568	14.30	0.44	1.00
EXISTING STREAM	1900	PF 2	20.00	3893.21	3893.83	0.62	0.35	3.40	0.026038	16.66	0.57	1.01
EXISTING STREAM	1900	PF 3	50.00	3893.21	3894.14	0.93	0.57	4.32	0.022503	20.44	0.78	1.01
EXISTING STREAM	1900	PF 4	100.00	3893.21	3894.49	1.28	0.79	5.09	0.020136	24.82	0.98	1.01
EXISTING STREAM	1900	PF 5	150.00	3893.21	3894.76	1.55	0.95	5.61	0.019161	28.12	1.12	1.01
EXISTING STREAM	1900	PF 6	200.00	3893.21	3894.99	1.78	1.08	5.97	0.018261	30.95	1.21	1.01
EXISTING STREAM	1900	PF 7	252.00	3893.21	3895.20	1.99	1.20	6.27	0.017581	33.50	1.29	1.01
EXISTING STREAM	1900	PF 8	329.00	3893.21	3895.47	2.26	1.35	6.64	0.016860	36.80	1.39	1.01
EXISTING STREAM	1900	PF 9	750.00	3893.21	3896.77	3.56	2.55	7.26	0.008661	39.67	1.35	0.80
EXISTING STREAM	1800	PF 1	10.00	3891.25	3892.34	1.09	0.75	0.90	0.000695	14.74	0.03	0.18
EXISTING STREAM	1800	PF 2	20.00	3891.25	3892.64	1.39	0.91	1.27	0.001064	17.36	0.06	0.23
EXISTING STREAM	1800	PF 3	50.00	3891.25	3893.14	1.89	1.17	1.96	0.001811	21.83	0.13	0.32
EXISTING STREAM	1800	PF 4	100.00	3891.25	3893.66	2.41	1.56	2.66	0.002292	24.04	0.21	0.37
EXISTING STREAM	1800	PF 5	150.00	3891.25	3894.05	2.80	1.84	3.18	0.002645	25.64	0.29	0.41
EXISTING STREAM	1800	PF 6	200.00	3891.25	3894.36	3.11	2.06	3.60	0.002949	26.96	0.36	0.44
EXISTING STREAM	1800	PF 7	252.00	3891.25	3894.63	3.38	2.24	4.00	0.003262	28.09	0.43	0.47
EXISTING STREAM	1800	PF 8	329.00	3891.25	3894.98	3.73	2.41	4.50	0.003729	30.33	0.53	0.51
EXISTING STREAM	1800	PF 9	750.00	3891.25	3896.21	4.96	3.37	6.58	0.005121	33.70	1.02	0.63
EXISTING STREAM	1700	PF 1	10.00	3891.39	3891.97	0.58	0.32	3.24	0.027227	9.68	0.54	1.01
EXISTING STREAM	1700	PF 2	20.00	3891.39	3892.26	0.87	0.36	2.78	0.016875	19.98	0.38	0.81
EXISTING STREAM	1700	PF 3	50.00	3891.39	3892.77	1.38	0.78	2.76	0.006000	23.09	0.29	0.55
EXISTING STREAM	1700	PF 4	100.00	3891.39	3893.27	1.88	1.14	3.27	0.005118	26.76	0.36	0.54
EXISTING STREAM	1700	PF 5	150.00	3891.39	3893.63	2.24	1.38	3.67	0.005060	29.67	0.42	0.55
EXISTING STREAM	1700	PF 6	200.00	3891.39	3893.93	2.54	1.54	3.98	0.005136	32.60	0.48	0.57
EXISTING STREAM	1700	PF 7	252.00	3891.39	3894.19	2.80	1.73	4.28	0.005092	33.93	0.53	0.57
EXISTING STREAM	1700	PF 8	329.00	3891.39	3894.52	3.13	1.98	4.68	0.005108	35.46	0.61	0.59
EXISTING STREAM	1700	PF 9	750.00	3891.39	3895.62	4.23	3.01	6.75	0.006096	36.63	1.11	0.69
EXISTING STREAM	1600	PF 1	10.00	3890.13	3891.87	1.74	0.87	0.74	0.000391	15.44	0.02	0.14
EXISTING STREAM	1600	PF 2	20.00	3890.13	3892.09	1.96	0.91	1.16	0.000885	18.99	0.05	0.21
EXISTING STREAM	1600	PF 3	50.00	3890.13	3892.51	2.37	1.10	1.90	0.001851	23.93	0.12	0.32
EXISTING STREAM	1600	PF 4	100.00	3890.13	3892.94	2.81	1.36	2.66	0.002744	27.71	0.22	0.40
EXISTING STREAM	1600	PF 5	150.00	3890.13	3893.26	3.13	1.54	3.20	0.003378	30.45	0.31	0.46
EXISTING STREAM	1600	PF 6	200.00	3890.13	3893.52	3.39	1.68	3.64	0.003861	32.70	0.39	0.49
EXISTING STREAM	1600	PF 7	252.00	3890.13	3893.75	3.62	1.81	4.02	0.004271	34.70	0.46	0.53
EXISTING STREAM	1600	PF 8	329.00	3890.13	3894.04	3.91	1.92	4.49	0.004925	38.25	0.57	0.57
EXISTING STREAM	1600	PF 9	750.00	3890.13	3894.88	4.75	2.61	6.95	0.007824	41.17	1.23	0.76
EXISTING STREAM	1540.14	PF 1	10.00	3891.26	3891.69	0.43	0.20	2.58	0.032170	19.68	0.40	1.02
EXISTING STREAM	1540.14	PF 2	20.00	3891.26	3891.82	0.56	0.27	2.93	0.027816	25.49	0.46	1.00
EXISTING STREAM	1540.14	PF 3	50.00	3891.26	3892.05	0.78	0.46	3.86	0.023134	27.97	0.67	1.00
EXISTING STREAM	1540.14	PF 4	100.00	3891.26	3892.32	1.06	0.69	4.76	0.020865	30.64	0.89	1.01
EXISTING STREAM	1540.14	PF 5	150.00	3891.26	3892.54	1.28	0.86	5.33	0.019522	32.76	1.04	1.01
EXISTING STREAM	1540.14	PF 6	200.00	3891.26	3892.74	1.47	1.01	5.80	0.018516	34.02	1.16	1.01
EXISTING STREAM	1540.14	PF 7	252.00	3891.26	3892.94	1.68	1.13	6.07	0.017529	36.70	1.23	1.01
EXISTING STREAM	1540.14	PF 8	329.00	3891.26	3893.21	1.95	1.22	6.29	0.017011	42.78	1.29	1.00
EXISTING STREAM	1540.14	PF 9	750.00	3891.26	3894.17	2.91	1.62	7.22	0.015369	64.05	1.54	1.00
EXISTING STREAM	1500.07	PF 1	10.00	3889.53	3889.94	0.41	0.30	4.17	0.048023	7.93	0.90	1.33
EXISTING STREAM	1500.07	PF 2	20.00	3889.53	3890.12	0.59	0.43	5.08	0.045608	9.26	1.19	1.37
EXISTING STREAM	1500.07	PF 3	50.00	3889.53	3890.82	1.29	0.83	3.87	0.011131	15.61	0.56	0.75
EXISTING STREAM	1500.07	PF 4	100.00	3889.53	3891.33	1.80	1.07	4.50	0.010732	20.84	0.69	0.77
EXISTING STREAM	1500.07	PF 5	150.00	3889.53	3891.71	2.18	1.03	4.80	0.012602	30.25	0.80	0.83
EXISTING STREAM	1500.07	PF 6	200.00	3889.53	3892.07	2.54	1.06	4.48	0.010556	42.20	0.69	0.77
EXISTING STREAM	1500.07	PF 7	252.00	3889.53	3892.40	2.86	1.27	4.24	0.007429	46.78	0.58	0.66
EXISTING STREAM	1500.07	PF 8	329.00	3889.53	3892.79	3.26	1.53	4.18	0.005649	51.36	0.53	0.60
EXISTING STREAM	1500.07	PF 9	750.00	3889.53	3893.93	4.40	2.52	5.34	0.004759	55.62	0.73	0.59
EXISTING STREAM	1465.1	PF 1	10.00	3888.38	3890.03	1.65	0.89	0.78	0.000417	14.35	0.02	0.15
EXISTING STREAM	1465.1	PF 2	20.00	3888.38	3890.29	1.91	0.87	1.16	0.000947	19.69	0.05	0.22
EXISTING STREAM	1465.1	PF 3	50.00	3888.38	3890.83	2.45	1.02	1.63	0.001523	30.18	0.09	0.28
EXISTING STREAM	1465.1	PF 4	100.00	3888.38	3891.40	3.02	1.43	2.01	0.001493	34.73	0.13	0.30
EXISTING STREAM	1465.1	PF 5	150.00	3888.38	3891.77	3.39	1.76	2.39	0.001603	35.59	0.17	0.32
EXISTING STREAM	1465.1	PF 6	200.00	3888.38	3892.08	3.70	2.03	2.71	0.001717	36.49	0.20	0.33
EXISTING STREAM	1465.1	PF 7	252.00	3888.38	3892.37	3.99	2.03	2.95	0.002025	41.97	0.24	0.37
EXISTING STREAM	1465.1	PF 8	329.00	3888.38	3892.74	4.36	2.11	3.22	0.002281	48.42	0.29	0.39
EXISTING STREAM	1465.1	PF 9	750.00	3888.38	3893.88	5.50	2.69	4.54	0.003250	61.51	0.52	0.49
EXISTING STREAM	1414.96	PF 1	10.00	3888.28	3890.02	1.73	0.87	0.69	0.000334	16.65	0.02	0.13
EXISTING STREAM	1414.96	PF 2	20.00	3888.28	3890.26	1.97	1.00	1.07	0.000664	18.72	0.04	0.19
EXISTING STREAM	1414.96	PF 3	50.00	3888.28	3890.76	2.48	1.28	1.71	0.001225	22.83	0.09	0.27
EXISTING STREAM	1414.96	PF 4	100.00	3888.28	3891.29	3.01	1.59	2.36	0.001766	26.62	0.17	0.33
EXISTING STREAM	1414.96	PF 5	150.00	3888.28	3891.63	3.35	1.79	2.89	0.002298	29.03	0.24	0.38
EXISTING STREAM	1414.96	PF 6	200.00	3888.28	3891.91	3.63	1.94	3.32	0.002706	31.05	0.31	0.42
EXISTING STREAM	1414.96	PF 7	252.00	3888.28	3892.17	3.89	2.08	3.68	0.003052	32.85	0.37	0.45
EXISTING STREAM	1414.96	PF 8	329.00	3888.28	3892.51	4.23	2.22	4.05	0.003400	36.08	0.44	0.48
EXISTING STREAM	1414.96	PF 9	750.00	3888.28	3893.56	5.28	3.27	5.66	0.003958	36.10	0.76	0.55

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	1397.13	PF 1	10.00	3889.04	3889.93	0.89	0.42	2.13	0.008439	11.27	0.21	0.58
EXISTING STREAM	1397.13	PF 2	20.00	3889.04	3890.08	1.04	0.52	3.06	0.013001	12.46	0.41	0.75
EXISTING STREAM	1397.13	PF 3	50.00	3889.04	3890.38	1.34	0.68	4.67	0.021367	15.73	0.87	1.00
EXISTING STREAM	1397.13	PF 4	100.00	3889.04	3890.84	1.80	0.85	5.27	0.020085	22.26	1.03	1.01
EXISTING STREAM	1397.13	PF 5	150.00	3889.04	3891.14	2.10	0.99	5.64	0.018960	26.96	1.12	1.00
EXISTING STREAM	1397.13	PF 6	200.00	3889.04	3891.35	2.31	1.14	6.16	0.018638	28.53	1.27	1.02
EXISTING STREAM	1397.13	PF 7	252.00	3889.04	3891.56	2.52	1.28	6.53	0.017887	30.07	1.38	1.02
EXISTING STREAM	1397.13	PF 8	329.00	3889.04	3891.85	2.81	1.46	6.93	0.017035	32.62	1.49	1.01
EXISTING STREAM	1397.13	PF 9	750.00	3889.04	3892.99	3.95	2.23	7.65	0.011808	41.22	1.57	0.90
EXISTING STREAM	1382.63	PF 1	10.00	3889.01	3889.81	0.80	0.28	1.83	0.010192	19.36	0.18	0.61
EXISTING STREAM	1382.63	PF 2	20.00	3889.01	3889.95	0.94	0.41	2.39	0.010422	20.20	0.27	0.65
EXISTING STREAM	1382.63	PF 3	50.00	3889.01	3890.25	1.24	0.62	3.42	0.012464	23.48	0.48	0.76
EXISTING STREAM	1382.63	PF 4	100.00	3889.01	3890.34	1.33	0.68	5.99	0.034020	24.56	1.42	1.28
EXISTING STREAM	1382.63	PF 5	150.00	3889.01	3890.56	1.55	0.85	6.72	0.032089	26.39	1.66	1.29
EXISTING STREAM	1382.63	PF 6	200.00	3889.01	3890.75	1.73	0.98	7.29	0.031085	27.94	1.87	1.30
EXISTING STREAM	1382.63	PF 7	252.00	3889.01	3890.91	1.90	1.10	7.82	0.030823	29.32	2.07	1.31
EXISTING STREAM	1382.63	PF 8	329.00	3889.01	3891.14	2.13	1.25	8.42	0.030099	31.19	2.30	1.33
EXISTING STREAM	1382.63	PF 9	750.00	3889.01	3892.25	3.24	1.87	9.27	0.021363	43.11	2.44	1.19
EXISTING STREAM	1350.26	PF 1	10.00	3888.84	3889.22	0.37	0.22	2.66	0.030388	17.48	0.41	1.01
EXISTING STREAM	1350.26	PF 2	20.00	3888.84	3889.34	0.50	0.32	3.31	0.027399	18.67	0.55	1.02
EXISTING STREAM	1350.26	PF 3	50.00	3888.84	3889.63	0.79	0.53	4.15	0.022621	22.93	0.74	1.01
EXISTING STREAM	1350.26	PF 4	100.00	3888.84	3889.95	1.11	0.78	5.02	0.019866	25.67	0.95	1.00
EXISTING STREAM	1350.26	PF 5	150.00	3888.84	3890.20	1.36	0.97	5.64	0.018637	27.43	1.12	1.01
EXISTING STREAM	1350.26	PF 6	200.00	3888.84	3890.42	1.58	1.13	6.09	0.017726	28.98	1.24	1.01
EXISTING STREAM	1350.26	PF 7	252.00	3888.84	3890.66	1.82	1.31	6.29	0.015673	30.67	1.26	0.97
EXISTING STREAM	1350.26	PF 8	329.00	3888.84	3891.01	2.17	1.54	6.42	0.013202	33.34	1.25	0.91
EXISTING STREAM	1350.26	PF 9	750.00	3888.84	3892.49	3.65	2.39	6.41	0.007285	47.45	1.07	0.73
EXISTING STREAM	1312.95	PF 1	10.00	3887.21	3888.40	1.19	0.82	0.76	0.000431	15.96	0.02	0.15
EXISTING STREAM	1312.95	PF 2	20.00	3887.21	3888.66	1.45	1.00	1.14	0.000756	17.63	0.05	0.20
EXISTING STREAM	1312.95	PF 3	50.00	3887.21	3889.14	1.93	1.24	1.87	0.001539	21.65	0.11	0.30
EXISTING STREAM	1312.95	PF 4	100.00	3887.21	3889.67	2.46	1.46	2.52	0.002255	27.18	0.20	0.37
EXISTING STREAM	1312.95	PF 5	150.00	3887.21	3890.06	2.85	1.69	2.95	0.002548	30.07	0.26	0.40
EXISTING STREAM	1312.95	PF 6	200.00	3887.21	3890.38	3.16	1.88	3.29	0.002769	32.42	0.31	0.42
EXISTING STREAM	1312.95	PF 7	252.00	3887.21	3890.65	3.44	2.03	3.60	0.002974	34.47	0.36	0.44
EXISTING STREAM	1312.95	PF 8	329.00	3887.21	3890.99	3.78	2.22	4.01	0.003297	36.94	0.43	0.47
EXISTING STREAM	1312.95	PF 9	750.00	3887.21	3892.47	5.26	2.97	4.65	0.002982	52.22	0.53	0.48
EXISTING STREAM	1273.77	PF 1	10.00	3887.63	3888.32	0.69	0.43	1.93	0.006439	12.01	0.17	0.52
EXISTING STREAM	1273.77	PF 2	20.00	3887.63	3888.55	0.92	0.56	2.47	0.007418	14.45	0.26	0.58
EXISTING STREAM	1273.77	PF 3	50.00	3887.63	3888.93	1.30	0.80	3.48	0.009299	18.03	0.46	0.69
EXISTING STREAM	1273.77	PF 4	100.00	3887.63	3889.35	1.72	1.05	4.39	0.010263	21.72	0.66	0.76
EXISTING STREAM	1273.77	PF 5	150.00	3887.63	3889.69	2.06	1.24	4.91	0.010308	24.67	0.78	0.78
EXISTING STREAM	1273.77	PF 6	200.00	3887.63	3889.96	2.33	1.39	5.31	0.010352	27.14	0.88	0.79
EXISTING STREAM	1273.77	PF 7	252.00	3887.63	3890.23	2.60	1.43	5.52	0.010737	31.90	0.94	0.81
EXISTING STREAM	1273.77	PF 8	329.00	3887.63	3890.64	3.01	1.55	5.47	0.009462	38.79	0.90	0.77
EXISTING STREAM	1273.77	PF 9	750.00	3887.63	3892.28	4.65	2.68	5.31	0.004290	52.05	0.71	0.57
EXISTING STREAM	1200	PF 1	10.00	3887.21	3887.88	0.67	0.33	1.59	0.006075	18.76	0.13	0.49
EXISTING STREAM	1200	PF 2	20.00	3887.21	3888.06	0.85	0.45	1.98	0.006312	22.31	0.18	0.52
EXISTING STREAM	1200	PF 3	50.00	3887.21	3888.40	1.19	0.77	2.81	0.006340	23.10	0.30	0.56
EXISTING STREAM	1200	PF 4	100.00	3887.21	3888.81	1.60	1.14	3.62	0.006377	24.31	0.44	0.60
EXISTING STREAM	1200	PF 5	150.00	3887.21	3889.14	1.93	1.41	4.19	0.006494	25.35	0.55	0.62
EXISTING STREAM	1200	PF 6	200.00	3887.21	3889.35	2.14	1.58	4.86	0.007511	25.97	0.71	0.68
EXISTING STREAM	1200	PF 7	252.00	3887.21	3889.56	2.35	1.77	5.40	0.008019	26.43	0.85	0.72
EXISTING STREAM	1200	PF 8	329.00	3887.21	3889.85	2.64	2.01	6.03	0.008428	27.06	1.01	0.75
EXISTING STREAM	1200	PF 9	750.00	3887.21	3891.08	3.87	3.10	8.21	0.008792	28.70	1.63	0.82
EXISTING STREAM	1100	PF 1	10.00	3886.23	3886.64	0.41	0.25	2.84	0.028227	13.98	0.44	1.00
EXISTING STREAM	1100	PF 2	20.00	3886.23	3886.79	0.56	0.38	3.49	0.025091	15.25	0.59	1.00
EXISTING STREAM	1100	PF 3	50.00	3886.23	3887.11	0.88	0.62	4.51	0.021448	17.72	0.83	1.01
EXISTING STREAM	1100	PF 4	100.00	3886.23	3887.50	1.27	0.91	5.46	0.019081	20.11	1.07	1.01
EXISTING STREAM	1100	PF 5	150.00	3886.23	3887.80	1.57	1.13	6.06	0.017812	21.98	1.23	1.01
EXISTING STREAM	1100	PF 6	200.00	3886.23	3888.20	1.97	1.38	5.87	0.012772	24.63	1.08	0.88
EXISTING STREAM	1100	PF 7	252.00	3886.23	3888.54	2.31	1.58	5.90	0.010786	26.96	1.04	0.83
EXISTING STREAM	1100	PF 8	329.00	3886.23	3888.93	2.70	1.81	6.12	0.009708	29.62	1.07	0.80
EXISTING STREAM	1100	PF 9	750.00	3886.23	3890.33	4.10	2.73	7.44	0.008424	36.88	1.39	0.79
EXISTING STREAM	977.24	PF 1	10.00	3883.98	3885.68	1.70	0.93	0.75	0.000359	14.40	0.02	0.14
EXISTING STREAM	977.24	PF 2	20.00	3883.98	3885.95	1.97	1.09	1.14	0.000681	16.11	0.04	0.19
EXISTING STREAM	977.24	PF 3	50.00	3883.98	3886.49	2.50	1.39	1.85	0.001291	19.48	0.11	0.28
EXISTING STREAM	977.24	PF 4	100.00	3883.98	3887.07	3.09	1.77	2.54	0.001777	22.16	0.19	0.34
EXISTING STREAM	977.24	PF 5	150.00	3883.98	3887.52	3.54	2.06	3.02	0.002069	24.17	0.25	0.37
EXISTING STREAM	977.24	PF 6	200.00	3883.98	3887.89	3.91	2.26	3.39	0.002315	26.05	0.31	0.40
EXISTING STREAM	977.24	PF 7	252.00	3883.98	3888.20	4.21	2.47	3.76	0.002549	27.19	0.37	0.42
EXISTING STREAM	977.24	PF 8	329.00	3883.98	3888.55	4.57	2.80	4.28	0.002796	27.44	0.46	0.45
EXISTING STREAM	977.24	PF 9	750.00	3883.98	3889.98	6.00	4.22	5.97	0.003151	27.44	0.78	0.51
EXISTING STREAM	901.03	PF 1	10.00	3885.00	3885.47	0.47	0.24	2.79	0.029320	15.02	0.43	1.01
EXISTING STREAM	901.03	PF 2	20.00	3885.00	3885.61	0.61	0.37	3.49	0.025777	15.53	0.59	1.01
EXISTING STREAM	901.03	PF 3	50.00	3885.00	3885.93	0.93	0.65	4.60	0.021429	16.67	0.85	1.00
EXISTING STREAM	901.03	PF 4	100.00	3885.00	3886.32	1.32	0.98	5.65	0.019105	18.07	1.13	1.01
EXISTING STREAM	901.03	PF 5	150.00	3885.00	3886.64	1.64	1.23	6.35	0.018016	19.21	1.32	1.01
EXISTING STREAM	901.03	PF 6	200.00	3885.00	3886.96	1.96	1.35	6.63	0.017287	22.35	1.40	1.01
EXISTING STREAM	901.03	PF 7	252.00	3885.00	3887.25	2.25	1.42	6.79	0.016848	26.11	1.44	1.00
EXISTING STREAM	901.03	PF 8	329.00	3885.00	3887.56	2.55	1.57	7.19	0.016522	29.13	1.56	1.01
EXISTING STREAM	901.03	PF 9	750.00	3885.00	3888.76	3.76	2.38	8.84	0.014417	35.63	2.05	1.01

HEC-RAS Plan: Plan 12 River: Prickly Pear Cr. Reach: EXISTING STREAM (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)	
EXISTING STREAM	794.36	PF 1	10.00	3883.13	3883.95	0.82	0.38	1.27	0.003416	20.84	0.08	0.36
EXISTING STREAM	794.36	PF 2	20.00	3883.13	3884.16	1.03	0.58	1.61	0.003140	21.34	0.11	0.37
EXISTING STREAM	794.36	PF 3	50.00	3883.13	3884.57	1.44	0.96	2.34	0.003427	22.30	0.20	0.42
EXISTING STREAM	794.36	PF 4	100.00	3883.13	3885.01	1.88	1.34	3.20	0.004194	23.30	0.33	0.49
EXISTING STREAM	794.36	PF 5	150.00	3883.13	3885.34	2.21	1.62	3.84	0.004723	24.06	0.45	0.53
EXISTING STREAM	794.36	PF 6	200.00	3883.13	3885.62	2.49	1.86	4.36	0.005104	24.59	0.55	0.56
EXISTING STREAM	794.36	PF 7	252.00	3883.13	3885.88	2.75	2.06	4.81	0.005456	25.42	0.65	0.59
EXISTING STREAM	794.36	PF 8	329.00	3883.13	3886.21	3.08	2.38	5.40	0.005712	25.58	0.78	0.62
EXISTING STREAM	794.36	PF 9	750.00	3883.13	3887.62	4.49	3.79	7.41	0.005770	25.58	1.26	0.67
EXISTING STREAM	702.95	PF 1	10.00	3882.86	3883.46	0.60	0.32	1.76	0.007866	17.47	0.16	0.55
EXISTING STREAM	702.95	PF 2	20.00	3882.86	3883.58	0.72	0.39	2.55	0.012686	19.86	0.31	0.72
EXISTING STREAM	702.95	PF 3	50.00	3882.86	3883.83	0.97	0.56	3.74	0.017186	23.87	0.59	0.88
EXISTING STREAM	702.95	PF 4	100.00	3882.86	3884.18	1.32	0.88	4.57	0.014113	24.78	0.76	0.86
EXISTING STREAM	702.95	PF 5	150.00	3882.86	3884.47	1.61	1.14	5.12	0.012713	25.70	0.88	0.84
EXISTING STREAM	702.95	PF 6	200.00	3882.86	3884.72	1.86	1.36	5.59	0.012071	26.32	0.99	0.84
EXISTING STREAM	702.95	PF 7	252.00	3882.86	3884.95	2.09	1.56	6.01	0.011705	26.90	1.09	0.85
EXISTING STREAM	702.95	PF 8	329.00	3882.86	3885.26	2.40	1.82	6.53	0.011355	27.68	1.23	0.85
EXISTING STREAM	702.95	PF 9	750.00	3882.86	3886.43	3.57	2.75	8.90	0.012466	30.60	2.00	0.94
EXISTING STREAM	599.9	PF 1	10.00	3881.87	3882.58	0.71	0.30	1.83	0.009294	18.28	0.17	0.59
EXISTING STREAM	599.9	PF 2	20.00	3881.87	3882.85	0.98	0.45	1.75	0.004970	25.61	0.14	0.46
EXISTING STREAM	599.9	PF 3	50.00	3881.87	3883.34	1.47	0.77	1.91	0.002877	34.02	0.14	0.38
EXISTING STREAM	599.9	PF 4	100.00	3881.87	3883.85	1.98	1.07	2.18	0.002435	42.72	0.16	0.37
EXISTING STREAM	599.9	PF 5	150.00	3881.87	3884.24	2.37	1.29	2.36	0.002226	49.23	0.18	0.37
EXISTING STREAM	599.9	PF 6	200.00	3881.87	3884.56	2.69	1.47	2.49	0.002086	54.69	0.19	0.36
EXISTING STREAM	599.9	PF 7	252.00	3881.87	3884.87	3.00	1.63	2.58	0.001954	59.77	0.20	0.36
EXISTING STREAM	599.9	PF 8	329.00	3881.87	3885.27	3.40	1.84	2.67	0.001786	66.74	0.20	0.35
EXISTING STREAM	599.9	PF 9	750.00	3881.87	3886.92	5.05	3.10	2.95	0.001092	81.35	0.21	0.30
EXISTING STREAM	504.08	PF 1	10.00	3881.49	3882.32	0.83	0.58	1.09	0.001389	15.71	0.05	0.25
EXISTING STREAM	504.08	PF 2	20.00	3881.49	3882.58	1.09	0.74	1.47	0.001844	18.28	0.08	0.30
EXISTING STREAM	504.08	PF 3	50.00	3881.49	3883.07	1.58	0.98	2.10	0.002593	24.37	0.16	0.37
EXISTING STREAM	504.08	PF 4	100.00	3881.49	3883.55	2.06	1.31	2.72	0.002943	28.00	0.24	0.42
EXISTING STREAM	504.08	PF 5	150.00	3881.49	3883.91	2.42	1.61	3.19	0.003102	29.18	0.30	0.44
EXISTING STREAM	504.08	PF 6	200.00	3881.49	3884.20	2.71	1.85	3.60	0.003306	30.01	0.37	0.47
EXISTING STREAM	504.08	PF 7	252.00	3881.49	3884.47	2.98	2.07	3.95	0.003462	30.78	0.43	0.48
EXISTING STREAM	504.08	PF 8	329.00	3881.49	3884.82	3.33	2.35	4.40	0.003637	31.80	0.51	0.50
EXISTING STREAM	504.08	PF 9	750.00	3881.49	3886.27	4.78	3.63	6.06	0.003905	33.78	0.84	0.56
EXISTING STREAM	405.1	PF 1	10.00	3881.46	3881.95	0.49	0.28	2.18	0.014256	16.17	0.25	0.72
EXISTING STREAM	405.1	PF 2	20.00	3881.46	3882.13	0.67	0.43	2.61	0.011823	17.90	0.31	0.70
EXISTING STREAM	405.1	PF 3	50.00	3881.46	3882.51	1.05	0.70	3.30	0.009870	21.54	0.43	0.69
EXISTING STREAM	405.1	PF 4	100.00	3881.46	3882.96	1.49	1.00	3.89	0.008714	25.78	0.53	0.69
EXISTING STREAM	405.1	PF 5	150.00	3881.46	3883.31	1.85	1.21	4.21	0.007963	29.47	0.58	0.68
EXISTING STREAM	405.1	PF 6	200.00	3881.46	3883.62	2.16	1.43	4.43	0.007067	31.66	0.61	0.65
EXISTING STREAM	405.1	PF 7	252.00	3881.46	3883.92	2.46	1.64	4.60	0.006340	33.43	0.63	0.63
EXISTING STREAM	405.1	PF 8	329.00	3881.46	3884.32	2.86	1.91	4.80	0.005630	35.79	0.65	0.61
EXISTING STREAM	405.1	PF 9	750.00	3881.46	3885.95	4.49	3.52	5.74	0.003565	36.26	0.76	0.54
EXISTING STREAM	299.4	PF 1	10.00	3880.75	3881.38	0.63	0.40	1.27	0.003038	19.69	0.08	0.35
EXISTING STREAM	299.4	PF 2	20.00	3880.75	3881.60	0.85	0.57	1.59	0.003018	22.30	0.11	0.37
EXISTING STREAM	299.4	PF 3	50.00	3880.75	3882.04	1.29	0.89	2.16	0.003087	26.14	0.17	0.40
EXISTING STREAM	299.4	PF 4	100.00	3880.75	3882.53	1.78	1.26	2.72	0.003066	29.14	0.24	0.43
EXISTING STREAM	299.4	PF 5	150.00	3880.75	3882.92	2.17	1.58	3.10	0.002985	30.69	0.29	0.43
EXISTING STREAM	299.4	PF 6	200.00	3880.75	3883.26	2.51	1.84	3.39	0.002922	32.03	0.33	0.44
EXISTING STREAM	299.4	PF 7	252.00	3880.75	3883.58	2.83	2.09	3.63	0.002856	33.30	0.36	0.44
EXISTING STREAM	299.4	PF 8	329.00	3880.75	3883.99	3.24	2.40	3.93	0.002814	34.93	0.41	0.45
EXISTING STREAM	299.4	PF 9	750.00	3880.75	3885.70	4.94	3.44	4.98	0.002805	43.75	0.58	0.47
EXISTING STREAM	199.35	PF 1	10.00	3880.05	3880.56	0.51	0.29	3.09	0.027382	10.97	0.50	1.00
EXISTING STREAM	199.35	PF 2	20.00	3880.05	3880.74	0.69	0.42	3.71	0.024773	12.89	0.64	1.01
EXISTING STREAM	199.35	PF 3	50.00	3880.05	3881.11	1.06	0.65	4.59	0.021398	16.81	0.85	1.01
EXISTING STREAM	199.35	PF 4	100.00	3880.05	3881.50	1.45	0.94	5.57	0.019242	19.03	1.10	1.01
EXISTING STREAM	199.35	PF 5	150.00	3880.05	3881.80	1.75	1.21	6.29	0.017996	19.77	1.31	1.01
EXISTING STREAM	199.35	PF 6	200.00	3880.05	3882.07	2.02	1.44	6.85	0.016894	20.24	1.46	1.00
EXISTING STREAM	199.35	PF 7	252.00	3880.05	3882.33	2.28	1.70	7.31	0.015489	20.27	1.57	0.99
EXISTING STREAM	199.35	PF 8	329.00	3880.05	3882.68	2.63	2.05	7.85	0.013933	20.27	1.70	0.97
EXISTING STREAM	199.35	PF 9	750.00	3880.05	3884.17	4.12	3.54	9.64	0.010136	20.27	2.14	0.90
EXISTING STREAM	101.64	PF 1	10.00	3877.77	3878.82	1.05	0.52	2.32	0.007397	8.26	0.23	0.56
EXISTING STREAM	101.64	PF 2	20.00	3877.77	3879.12	1.35	0.68	2.76	0.007398	10.62	0.30	0.59
EXISTING STREAM	101.64	PF 3	50.00	3877.77	3879.68	1.91	0.97	3.49	0.007403	14.74	0.43	0.63
EXISTING STREAM	101.64	PF 4	100.00	3877.77	3880.25	2.48	1.27	4.17	0.007413	18.91	0.56	0.65
EXISTING STREAM	101.64	PF 5	150.00	3877.77	3880.66	2.89	1.50	4.66	0.007402	21.48	0.67	0.67
EXISTING STREAM	101.64	PF 6	200.00	3877.77	3881.00	3.23	1.69	5.03	0.007401	23.58	0.75	0.68
EXISTING STREAM	101.64	PF 7	252.00	3877.77	3881.30	3.53	1.85	5.35	0.007402	25.47	0.82	0.69
EXISTING STREAM	101.64	PF 8	329.00	3877.77	3881.68	3.91	2.06	5.73	0.007411	27.88	0.91	0.70
EXISTING STREAM	101.64	PF 9	750.00	3877.77	3882.01	4.24	2.34	11.25	0.024040	28.39	3.35	1.29

Appendix C: Existing Conditions Sediment Transport Calculation Summary

CALCULATION SUMMARY

Date:	02/05/13	Project:	Prickly Pear Creek Realignment	Prepared By:	GEA
Rev. No.	2.2	Office:	Bozeman, Montana	Checked By:	JLG, EMG
Rev. Date:	04/04/13	Calc. No.	PPC-003	Approved By:	JLG
Subject:	Prickly Pear Creek Channel Stability Analysis of Existing Conditions				

PRICKLY PEAR CREEK CHANNEL STABILITY ANALYSIS OF EXISTING CONDITIONS

PURPOSE AND OBJECTIVES

This calculation summary describes the work completed by Pioneer Technical Services, Inc. (Pioneer), to perform a channel stability analysis of existing conditions for Prickly Pear Creek (PPC) to quantify the sediment transport dynamics of the creek and to estimate the resulting potential for vertical and lateral instability. This work was performed in support of the Montana Environmental Custodial Trust (MECT) Phase 1 Interim Measures (IM), South Plant Hydraulic Controls, PPC Permanent Realignment Project. Figure 1 provides a site overview. The segment of PPC targeted for realignment approximately begins at Station 10+00 and extends upstream approximately 1.0 mile to Station 68+00. Figures 2 and 3 provide the project reach Hydrologic Engineering Center River Analysis System (HEC-RAS) alignment and cross-section locations used to support the sediment transport calculations.

METHODS AND DATA

This channel stability analysis work consists of an incipient-motion analysis to determine the flows necessary to mobilize the existing bed material and a sediment-continuity analysis to evaluate the aggradation/degradation potential of the existing channel. Lateral stability is addressed qualitatively, primarily based on observations from the recent fluvial geomorphic investigations of the channel behavior.

Representative Bed Material Gradations

Sediment sources to the project reach include sand and fine gravels and course alluvium (large gravel and cobble). The course alluvium fraction is the primary bed material that provides the channel vertical stability, and the sand and small gravel fraction, located between riffles represents the dominant sediment load through the system. The sand and fine gravel material moves through the system independent of the coarse alluvium material (except under high flows). The coarse alluvium bed materials within the project reach were characterized from pebble counts. The sand and gravel material were characterized from bulk sampling/sieve analysis collected as part of the project field investigations.

In the reaches above Smelter Dam, the course alluvium bed material provides an armor layer that infrequently mobilizes, while the sand and fine gravel material is constantly moving through the system. To address these two discreet sediment sources, the channel stability and sediment transport capacity calculations were conducted using two material gradations; one representing the sand and fine gravel material and one representing the course alluvium. Table 1 summarizes the results of the bed material gradations. Figure 4 plots the particle size distributions. Gradations representing the fine sand and gravel were bulk sampled from a point bar in Reference Site 1.

Pebble count data in Figure 5 indicate that Reach 1 has a coarser cobble/gravel fraction than Reaches 4 and 5, most likely related to the input of slag material and exposed Holocene colluvial/alluvial deposits on the east channel bank. Therefore course alluvium material calculations for Reach 1 are based on the Reach 1 pebble count gradation. Course alluvium for reaches upstream of Reach 1 use the average of the pebble count data for Reaches 4 and 5.

A detailed description of the field data collection methods and analysis is provided in Existing Conditions Stream Assessment Prickly Pear Creek East Helena Smelter RCRA Site Final Report (AGI, Pioneer, MMI, January 2012).

Vertical Stability

The existing channel vertical stability was evaluated using incipient motion calculations. The incipient motion calculation estimates the range of flows over which the bed material will be mobile.

Incipient Motion

Incipient motion analysis evaluates the effective hydraulic shear stress on the channel bed with the shear stress required to mobilize the streambed materials (critical shear). The shear stress required for bed material mobilization was estimated using Shields relationship for particle motion (Shields, 1936).

The Shields relationship is represented by:

$$\tau_c = \tau^*(\Upsilon_s - \Upsilon_w)D_{50}$$

Where:

τ_c = critical shear stress for particle motion
τ^* = dimensionless Shields Parameter
Υ_s = unit weight of the sediment
Υ_w = unit weight water
D_{50} = median particle size of the bed material

In gravel and cobble bed streams, when the critical shear stress for the median particle size is exceeded, the bed is mobilized and all sizes up to about five times the median size are capable of being transported by the flow (Parker et al., 1982, Andrews, 1984).

Values for the Shields parameter (τ^*) can range from 0.02 for frequently moved loosely, packed gravel to 0.12 for tightly packed, imbricated material that results when transport is infrequent and the framework gravel is infilled with fines (Hey, 1979). Research by Neil (1968) indicates that a Shields parameter value of 0.03 corresponds to particle incipient motion and a value of 0.047 represents low but measurable transport. In this analysis, a value of $\tau^* = 0.03$ was used to represent the ”threshold” or ”incipient” motion condition while a value of $\tau^* = 0.047$ was used to represent a low but measurable transport condition.

The total hydraulic shear stress can be partitioned into grain shear stress (the stress acting on the grains) and the bedform stress (the stress acting on the bedforms) (Einstein, 1950). The grain shear is the component that is responsible for bedload transport. The remaining shear stress is used to overcome the flow resistance of the bed forms.

The relationship for total bed shear stress is represented by:

$$\tau = \tau' + \tau'' = \Upsilon_w RS$$

Where:
τ' = grain shear stress
τ'' = form shear stress
Υ_w = unit weight water
R = channel hydraulic radius
S = energy slope

Einstein (1950) also determined that the hydraulic radius terms could be partitioned into a grain component and a form component such that:

$$\tau' = \Upsilon_w R'S$$
$$\tau'' = \Upsilon_w R''S$$

Where:
R′ = hydraulic radius associated with the grain roughness
R″ = hydraulic radius associated with the form roughness

The value of R’ is solved iteratively by solving the semi-logarithmic velocity profile equation (Mussetter et al., 1994):

$$\frac{V}{V_*'} = 5.75LOG\left(12.27\frac{R'}{k_s}\right)$$

Where:
V = mean flow velocity
k_s = characteristic bed grain roughness
V_*' = shear velocity given by:

$$V_*' = \sqrt{gR'S}$$

Where:

g = acceleration due to gravity
S = energy slope

The characteristic bed grain roughness (Hey, 1979) is k_s = 3.5D$_{84}$.

Critical discharge is the discharge at which the incipient motion threshold is exceeded. The critical discharge required for incipient motion (τ^* = 0.03) and for measurable transport (τ^* = 0.047) was estimated for each reach using the existing reach averaged hydraulics (Appendix B, PER).

Sediment Transport Capacity Calculations

The existing conditions sediment transport capacity calculations estimate the sediment transport capacity potential of the existing channel using a bedload transport function. This transport capacity estimate will provide a relative reference for the proposed PPC channel design.

Selection of the Sediment Transport Relationship

Numerous empirical relationships are available for estimating sediment transport in streams. While many of the available relationships have at least some theoretical basis, all have an empirical component that limits the range of conditions over which they are applicable. No single sediment transport relationship is ideal for the range of sediments which exist in PPC.

The Meyer-Peter Muller (MPM) bedload equation (Meyer-Peter and Müller, 1948) was developed from laboratory flume experiments with sediment diameters ranging from 6.4 mm to 30 mm, which is consistent with the bed material D$_{50}$ sizes found in PPC (12.7 mm sand and gravel and 50 mm for coarse cobble/gravel). This sediment transport relationship is applicable to coarse sediments (Chang, 1992) and most successfully applied over the gravel range (ACOE, 2010). Based on the similarity of the MPM basic data and the PPC bed material, and previous use of the MPM relationship on similar streams such as Silver Bow Creek (Mussetter Eng. et. al., 1997, Mussetter Eng. et. al., 2003, TetraTech , et. al., 2007, Pioneer et.al., 2008), the MPM relationship was selected to compute the transport capacity by fraction of the PPC bed material in the project reach.

The Meyer-Peter Müller bed load function is as follows:

$$\left(\frac{k_r}{k_r'}\right)^{\frac{3}{2}} \gamma RS = 0.047(\gamma_s - \gamma)d_m + 0.25\left(\frac{\gamma}{g}\right)^{\frac{1}{3}}\left(\frac{\gamma_s-\gamma}{\gamma_s}\right)^{\frac{2}{3}} q_b^{\frac{2}{3}}$$

Where:

q_b = unit bed load transport capacity per unit width of channel
γ = unit weight of water
γ_s = unit weight of the sediment
g = acceleration due to gravity

d_m = median particle diameter
R = hydraulic radius
S = energy slope
k_r = total roughness coefficient
k_r' = grain roughness coefficient

Sediment Supply

Sediment supply is an important input for a sediment transport evaluation because the supply of bed material from upstream and lateral sources is either passed through the system or accumulates within the bed of the channel at some locations and times. Direct measurements of the bed load in PPC do not exist; therefore sediment load input to the project reach was estimated by using the transport capacity of the reach that appears to be the most adjusted to the hydrology and sediment supply based on the geomorphological assessment. While Reach 4 appears to have laterally adjusted to the 2011 long-duration high-magnitude runoff, overall it has been relatively stable (cross-section and slope maintained). There are no significant tributaries providing sediment input downstream of Reach 4. Hydraulic conditions in this reach are not affected by downstream backwater, and the existing bankfull flow capacity is approximately equal to the 1.5-year to 2-year flow (250 to 330 cfs), which is also approximately equal to the reach averaged critical discharge (240 cfs) for the representative bed material. Therefore the sediment transport capacity of Reach 4 was selected to represent and approximate the project sediment input.

Estimation of Sediment Transport Capacity

The MPM sediment transport capacity function in HEC-RAS was used to calculate the potential sediment transport rate at each section in all of the reaches for the design flows and for both gradations representative of the sediment input and bed material (the sand and fine gravel and the coarse alluvium). The HEC-RAS model provided an estimate of the potential transport rate per day for each of the design flow rates. The geometric mean of the sediment transport rates was found for each reach and design flow. The average of the flow range was multiplied by the days per year that the flow range occurs, as determined from the flow duration curve, which results in an annual sediment potential. The coarsest sand and gravel gradation was selected to represent the sand and fine gravel material in the sediment transport capacity calculations to provide a conservative gradation estimate.

RESULTS AND DISCUSSION

Incipient Motion

Table 2 provides the results of the existing conditions incipient motion calculations for PPC. The calculations indicate that the sand and gravel fraction is transported at all flows except within Reach 2 which is influenced by the Smelter Dam structure and is characterized by low gradient energy slopes. Incipient motion calculations are provided in Attachment A.

For the riffle size material (the coarse cobble/gravel material), critical discharges range from 45 cfs within Reach 1 to greater than 750 cfs in Reaches 2 and 3. Critical discharge in Reaches 4, 5 and 6, which are the reaches least impacted by the East Helena Smelter facilities, range from 210 cfs to 240 cfs (approximately in the range of the 1.5-year event). The critical discharges in Reaches 4, 5 and 6 agree with bankfull discharge estimates based on hydrology and existing condition hydraulic modeling estimates (Appendix A and B, PER). These calculations were conducted using the reach average values; therefore the potential exists that riffles may locally begin to mobilize at different discharges than those based on reach average hydraulics. With the exception of Reach 1, measurable transport of the riffle material requires flows approximately equal to or greater than a 10-year flow (739 cfs).

Estimation of Sediment Transport Capacity

The estimated potential sediment transport capacity for each reach of the existing channel is presented in Table 3. The sediment transport model output is provided in Attachment B and the sediment transport estimates are provided in Attachment C.

The second column in Table 3 provides an estimate of the existing channel capacity to convey the potential sand and fine gravel input from upstream. The third column in Table 3 provides an estimate of the existing channel capacity to convey the coarse alluvium material.

The sediment transport calculations in Attachment C indicate that sediment transport capacity is relatively equivalent in the upper reaches (Reaches 4, 5 and 6). Reaches 2 and 3, which are affected by the backwater from the Smelter Dam and the Upper Lake Diversion, show measurably less transport potential than the upstream reaches. Reach 1 has very high sediment transport capacity rates due to the straight alignment, steep gradient and incised channel geometry.

Observations indicate that the existing channel is vertically stable on the coarse substrate materials in Reaches 4 and 5. Reach 6 is located above the head of the alluvial fan with exposed bedrock common and appears to be vertically stable. The Smelter Dam provides grade control for Reaches 2 and 3 and therefore prevents downcutting. Channel aggradation in Reach 2 has historically been partially mitigated by the Upper Lake Diversion, which routes a significant portion of the sediment load into the Upper Lake. Periodic sluicing of sediments at the Smelter Dam structure has also served to control channel aggradation in Reach 2. In Reach 1, comparison of bankfull indicators with channel capacity indicate significantly greater bankfull capacity than Reaches 4, 5 and 6 and suggests that vertical downcutting is potentially occurring within this reach.

Lateral Stability

The lateral stability of the existing stream channel was not investigated quantitatively because lateral stability of the reconstructed channel will be ensured during design through development of appropriate bank treatments. Only a qualitative discussion of existing condition lateral stability is presented herein based on recent fluvial geomorphic investigations (AGI, Pioneer, MMI, January 2012).

PPC has undergone significant channel modifications over the last century. The creek was channelized between the Upper Lake Diversion and Highway 12 and relocated to the eastern margin of the historic stream corridor (AGI, Pioneer, MMI, January 2012).

Geomorphic investigations indicate Reach 1 has undergone moderate planform migration with some locally significant lateral migration (60 to80 feet) into the slag pile. Reach 2, which is backwatered behind Smelter Dam, has shown little lateral movement since 1955. Reach 3 has relatively stable, well-vegetated banks. Some lengthening and bendway formation has occurred in the upper reach between 1955 and 2008.

Reach 4 has low density bankline vegetation where bank undercutting is common. Aerial photo investigations indicate measurable lateral migration at some bendways in the reach between 2008 and 2011. Reach 5 is channelized and is locally armored through the Kleffner Ranch. The reach has some lateral instability characterized by split flow areas and bar deposits.

Reach 6 is upstream of the PPC alluvial fan. Exposed bedrock on the bank is common. The stream is locally armored adjacent to the railgrade. No signs of significant lateral migration or instability have been observed for this reach.

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DOCUMENT REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	Team	Draft	For Internal Pioneer Review	02/05/13
Rev 1	Team	Draft	For CH2M Hill/EH Team Review	02/05/13
Rev 2.2	Team	Final	For Client/Stakeholder Distribution	03/29/13
Rev 3				
Rev 4				

TABLES

Table 1
PPC Bed Gradation Summary
(Pebble Count Data)

Sample ID	Station (ft)	D16 (mm)	D50 (mm)	D84 (mm)	Dominant Particle Sizes
Reach 1 (Riffle)	1500	3	63	140	Coarse gravel\Cobble
Reach 4 (Riffle)	6400	29	51	72	Coarse gravel\cobble
Reach 4 (Riffle)	7500	28	51	79	Coarse gravel\cobble
Reach 5 (Riffle)	8575	3	46	80	Coarse gravel\cobble
Reach 4&5 Ave		20	50	77	

Sand & Fine Gravel Bulk Gradation Data

Sieve Size	Sieve Opening mm	Sample ID TP-01 0-18 % Finer	TP-01 18-24 % Finer	TP-02 0-18 % Finer	Average % Finer
5	127	100		100	100
4	101.6	97		96	97
3	76.2	89	100	93	94
2	50.8	79	97	83	86
1.5	38.1	73	91	71	78
1	25.4	62	82	60	68
0.75	19.05	55	74	51	60
0.5	12.7	44	61	41	49
0.375	9.525	40	55	37	44
#4	4.75	33	42	30	35
#10	2	23	27	20	23
#20	0.85	11	8	8	9
#40	0.425	5	2	3	3
#60	0.25	3	1	1	2
#100	0.15	2	0.00	1	1
#200	0.075	1	0.30	0.3	1

Gradation Summary

		Reach 2-6				Reach 1[5]	
		Particle Size(mm)		Particle Size (ft)		Particle Size (mm)	Particle Size (ft)
% Finer		Sand & Gravel	Coarse Gravel & Cobble[1]	Sand & Gravel	Coarse Gravel & Cobble[1]	Coarse Gravel & Cobble[2]	Coarse Gravel & Cobble[2]
D10	10	0.85	5.00	0.0028	0.02	2.80	0.009
D16	16	2.00	20.00	0.01	0.07	3.00	0.010
D50	50	12.70	50.00	0.04	0.16	63.00	0.207
D84	84	50.80	77.00	0.17	0.25	140.00	0.459
D100	100	127.00	260.00	0.42	0.85	384.00	1.260

Critical Shear (lb/sq ft)		
	Reach 1	Reach 2-6
IM[3] Critical Shear Gravel	0.128	0.128
MT[4] Critical Shear Gravel	0.201	0.201
IM[3] Critical Shear Cobble[1,2]	0.636	0.505
MT[4] Critical Shear Cobble[1,2]	0.997	0.791

1: Reaches 2-6 use average of Reach 4 & 5 Pebble Count Data
2: Reach 1 uses Reach 1 pebble count data
3: IM = Insipient Motion ($\tau^* = 0.03$)
4: MT = Measurable Transport ($\tau^* = 0.047$)
5.: Reach 1 uses the same sand&gravel gradations as Reach 2-6

Table 2

Results of Incipient Motion Calculations for Prickly Pear Creek
Existing Conditions

Reach	Critical Discharge (cfs)			
	Incipient Motion Sand & Fine Gravel (τ*=0.03)	Measurable Transport Sand & Fine Gravel (τ*=0.047)	Incipient Motion Coarse Gravel &Cobble (τ*=0.03)	Measurable Transport Coarse Gravel & Cobble (τ*=0.047)
1	<10	<10	45	220
2	40	80	>750	>750
3	<10	<10	>750	>750
4	<10	10	240	>750
5	<10	<10	210	>750
6	<10	10	210	650

Notes:

1. Calculations for sand and fine gravel bed-material use average of bulk sample gradationsfrom Reference Site 1.

Table 3

Reach	Estimated Potential Sediment Transport Rate [1]	
	Transport of Sand and Fine Gravel Material [2] (tons/year)	Transport of Coarse Alluvium Material [3] (tons/year)
Supply	100,000	27,000
6	100,000	34,000
5	91,000	29,000
4	100,000	27,000
3	75,000	20,000
2	13,000	300
1	182,000	140,000

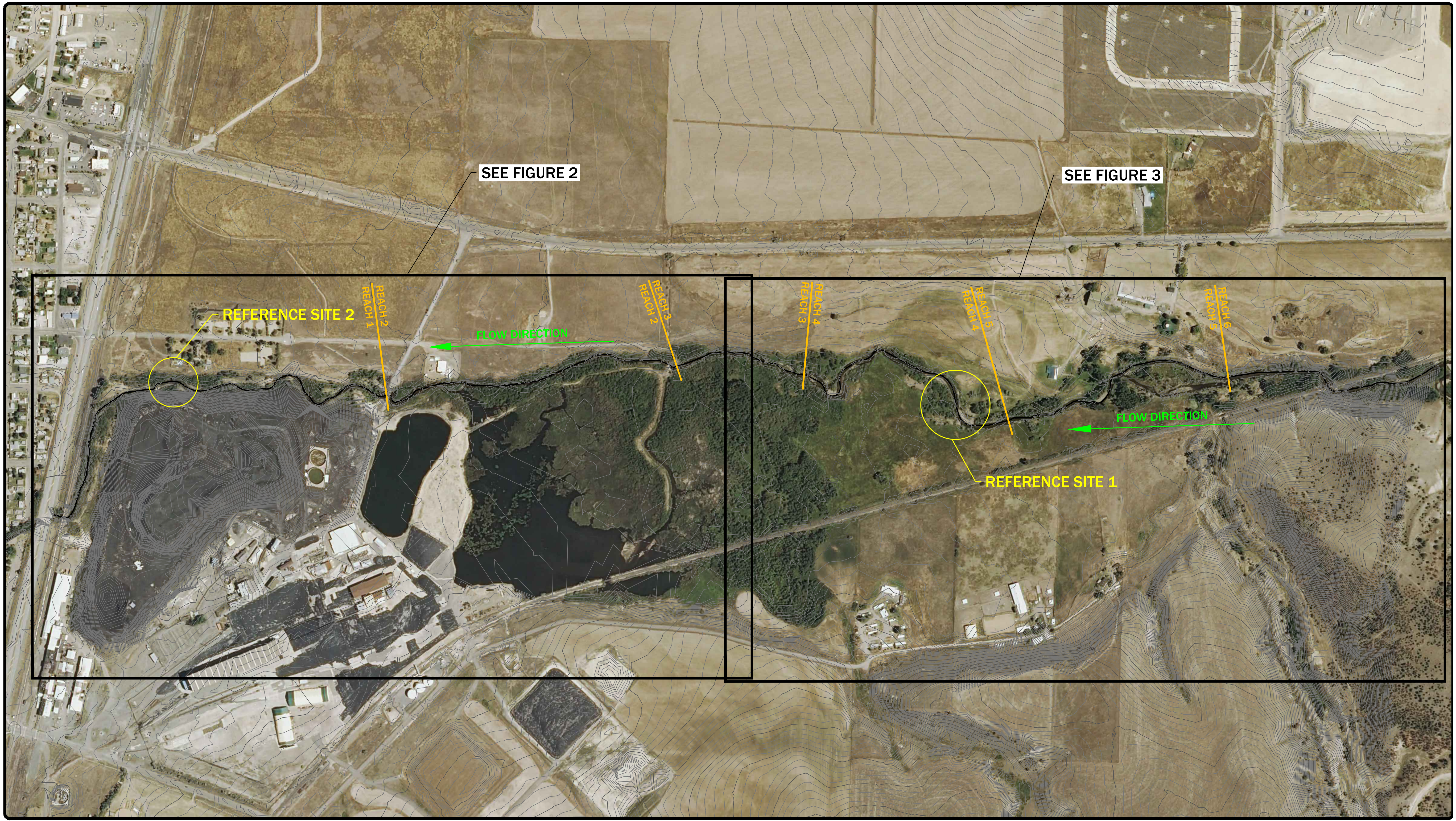
Notes:

(1) Sediment sizes larger than 0.3 mm and assuming sediment transport is not limited by armoring or other controls.

(2) Bed-material size taken from coarsest sand and gravel gradations as determined by bulk samples
for Reference Site 1.

(3) Reachs 2-6: Bed-material size based on average pebble count gradation from Reach 4 and 5(coarse gravel and cobbles)
Reach 1: Bed-material size based on Reach 1 pebble count gradation (coarse gravel and cobbles)

FIGURES



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DATUM: NAD83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 300 600

FIGURE 1

PIONEER TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT HECRAS ALIGNMENT OVERALL

DATE: 12/21/12

3/21/2013 12:26:10 PM P:\CH2MHILL - METG\PPC REALIGNMENT\CAD\PPCR-FIG-PLN-003-12.DWG

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 150 300

FIGURE 2

PIONEER
TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT HECRAS ALIGNMENT STA. 0+00 TO 56+00

DATE: 12/21/12

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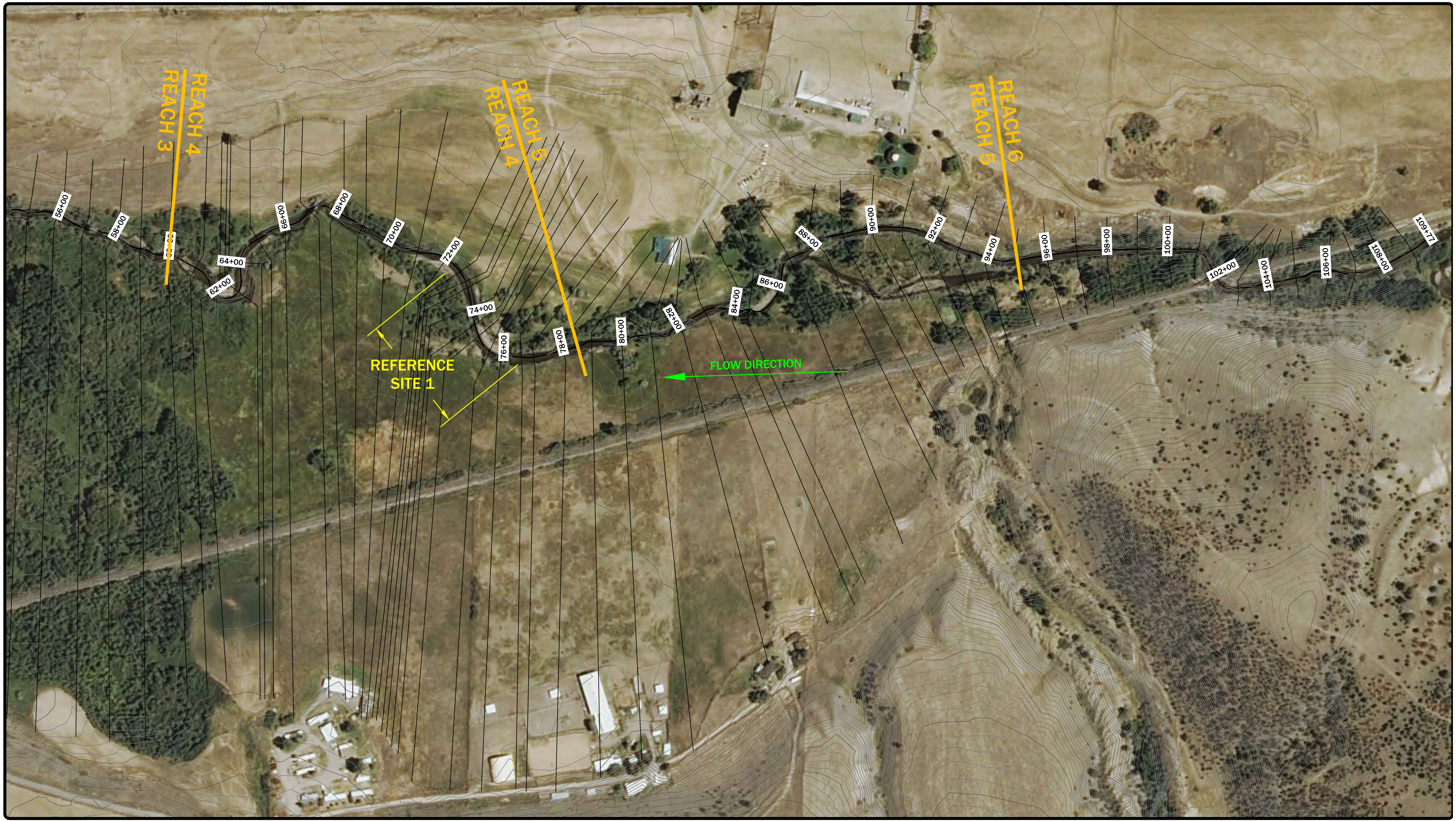

DISPLAYED AS:

COORD SYS/ZONE: MSP

DATUM: NAD83

UNITS: FEET

SOURCE: PIONEER

SCALE IN FEET
0 150 300

FIGURE 3

PIONEER
TECHNICAL SERVICES, INC.
201 E. Broadway, Suite C
Helena, MT 59601
(406) 457-8252

PRICKLY PEAR CREEK REALIGNMENT PROJECT
HECRAS ALIGNMENT
STA. 56+00 TO 109+77

DATE: 12/21/12

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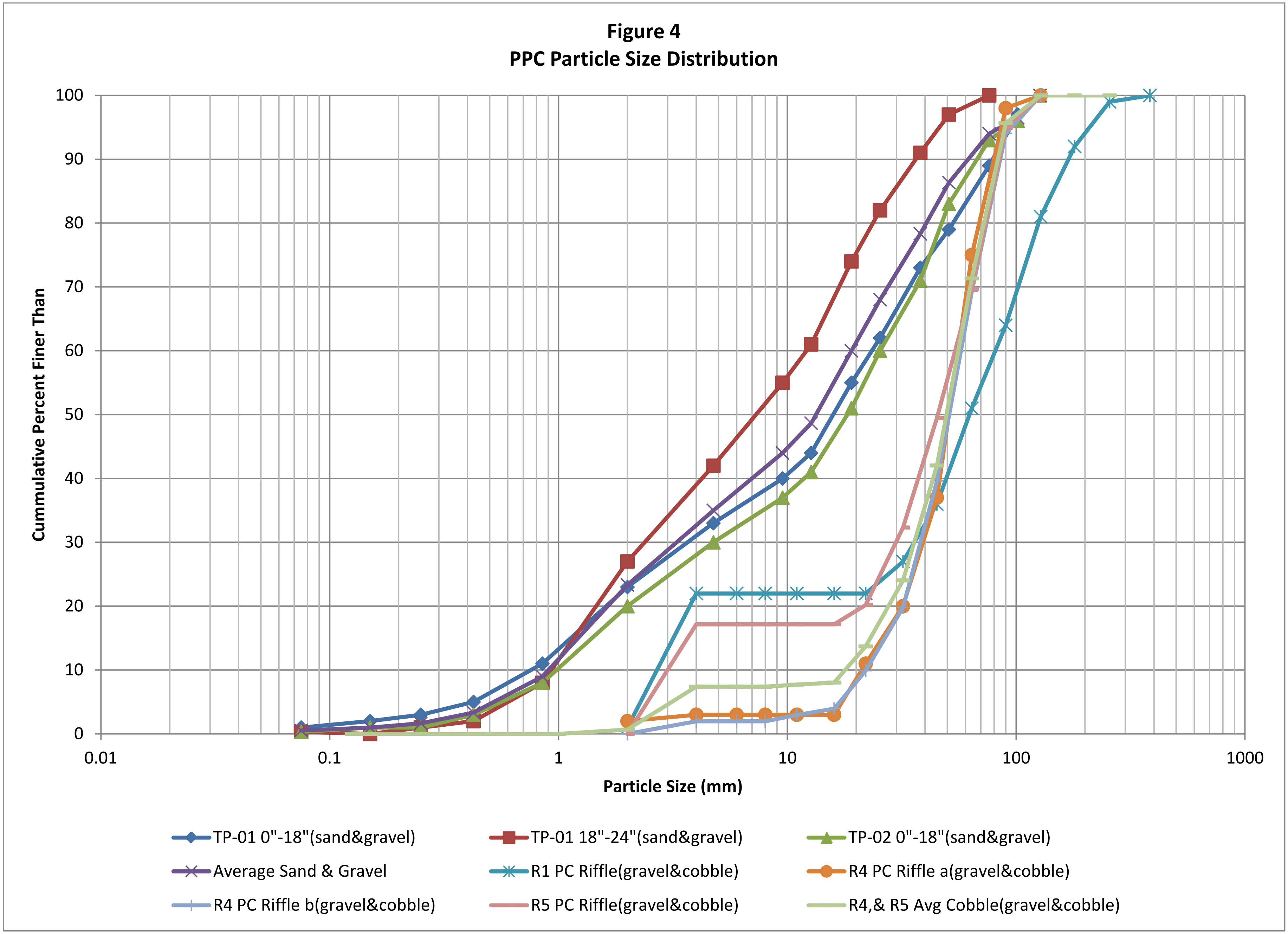
Figure 4
PPC Particle Size Distribution
Cummulative Percent Finer Than
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
Particle Size (mm)
TP-01 0"-18"(sand&gravel)
TP-01 18"-24"(sand&gravel)
TP-02 0"-18"(sand&gravel)
Average Sand & Gravel
R1 PC Riffle(gravel&cobble)
R4 PC Riffle a(gravel&cobble)
R4 PC Riffle b(gravel&cobble)
R5 PC Riffle(gravel&cobble)
R4,& R5 Avg Cobble(gravel&cobble)

ATTACHMENT A

Reach 1

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs)										
		10	20	50	100	150	200	252	328	545	750	2190
1	V - Main Channel Velocity (ft/s)	1.9	2.3	3.0	3.7	4.2	4.6	4.9	5.2	6.1	6.8	9.6
1	d - Main Channel Max Depth (ft)	0.8	1.1	1.5	1.9	2.2	2.5	2.7	3.1	3.8	6.4	6.7
1	W - Main Channel Effective Width	16	19	23	27	29	32	34	36	40	61	42
1	S - Energy Slope	1.34%	1.21%	1.03%	1.01%	0.97%	0.92%	0.89%	0.86%	0.79%	0.80%	0.85%
1	R- Hyd Radius Channel	0.44	0.57	0.82	1.10	1.31	1.48	1.63	1.83	2.35	4.12	5.05
1	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.37	0.43	0.53	0.70	0.79	0.85	0.91	0.98	1.16	2.067247	2.676855
	Max Boundary Shear (lbs/sf)	0.70	0.80	0.94	1.19	1.34	1.43	1.52	1.64	1.86	3.19	3.54

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	1.608
	lbs/sf
τ_c - IM[1] Critical Shear Gravel	0.128
τc - MT[2] Critical Shear Gravel	0.201
τc - IM[1] Critical Shear Cobble	0.636
τc - MT[2] Critical Shear Cobble	0.997
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I[3]

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.34	0.383	4.913	4.897	-0.016	0.284	76%	2.22
20	0.44	0.415	5.557	5.523	-0.033	0.333	78%	2.60
50	0.637	0.461	6.481	6.484	0.003	0.412	78%	3.21
100	0.83	0.521	7.142	7.165	0.024	0.526	75%	4.10
150	0.99	0.555	7.582	7.585	0.003	0.598	75%	4.67
200	1.125	0.578	7.901	7.892	-0.009	0.649	76%	5.06
252	1.24	0.596	8.144	8.157	0.013	0.690	76%	5.38
328	1.39	0.620	8.429	8.437	0.008	0.746	76%	5.82
545	1.77	0.672	9.033	9.030	-0.003	0.875	75%	6.82
750	2.035	0.725	9.381	9.382	0.001	1.021	49%	7.96
2190	3.08	0.918	10.416	10.424	0.008	1.633	61%	12.73

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.585	0.502	3.736	3.733	-0.003	0.489	132%	0.77
20	0.73	0.534	4.289	4.288	-0.001	0.553	129%	0.87
50	1.02	0.583	5.125	5.124	-0.001	0.659	124%	1.04
100	1.3	0.652	5.730	5.725	-0.005	0.824	118%	1.29
150	1.52	0.688	6.121	6.121	0.000	0.919	116%	1.44
200	1.705	0.712	6.408	6.411	0.003	0.984	115%	1.55
252	1.87	0.732	6.638	6.642	0.004	1.041	115%	1.64
328	2.08	0.759	6.904	6.897	-0.007	1.117	114%	1.76
545	2.6	0.814	7.461	7.450	-0.011	1.285	111%	2.02
750	2.96	0.875	7.785	7.780	-0.006	1.485	72%	2.33
2190	4.37	1.093	8.758	8.751	-0.007	2.317	87%	3.64

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

Reach 2

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs)										
		10	20	50	100	150	200	252	328	545	750	2190
2	V - Main Channel Velocity (ft/s)	0.8	1.0	1.6	2.1	2.5	2.5	2.6	2.8	3.3	3.8	3.1
2	d - Main Channel Max Depth (ft)	2.7	2.9	3.2	3.7	4.1	4.4	4.7	5.1	5.9	6.6	8.8
2	W - Main Channel Effective Width	30	33	37	41	45	50	54	61	67	70	74
2	S - Energy Slope	0.45%	0.45%	0.58%	0.73%	0.84%	0.24%	0.24%	0.24%	0.23%	0.30%	0.09%
2	R- Hyd Radius Channel	0.98	1.09	1.33	1.60	1.79	2.00	2.14	2.34	2.95	3.45	5.43
2	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.28	0.31	0.48	0.73	0.94	0.30	0.32	0.35	0.43	0.65	0.30
	Max Boundary Shear (lbs/sf)	0.75	0.81	1.17	1.68	2.12	0.67	0.71	0.77	0.87	1.24	0.48

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	0.884
	lbs/sf
τ_c - IM¹ Critical Shear Grave	0.128
τc - MT² Critical Shear Gravel	0.201
τc - IM¹ Critical Shear Cobble	0.505
τc - MT² Critical Shear Cobble	0.791
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I³

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.25	0.190	4.145	4.079	-0.066	0.070	25%	0.55
20	0.32	0.216	4.761	4.723	-0.038	0.091	29%	0.71
50	0.44	0.286	5.557	5.539	-0.018	0.159	33%	1.24
100	0.54	0.356	6.068	6.037	-0.031	0.245	34%	1.91
150	0.59	0.399	6.289	6.315	0.026	0.309	33%	2.41
200	1.19	0.304	8.041	8.060	0.019	0.179	59%	1.40
252	1.3	0.317	8.262	8.273	0.011	0.195	61%	1.52
328	1.44	0.334	8.517	8.506	-0.011	0.216	62%	1.69
545	1.78	0.366	9.047	9.009	-0.037	0.260	60%	2.03
750	1.78	0.416	9.047	9.060	0.014	0.336	52%	2.62
2190	3.1	0.295	10.432	10.469	0.037	0.169	57%	1.32

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.312	0.212	3.660	3.651	-0.009	0.087	32%	0.17
20	0.4	0.242	4.280	4.225	-0.055	0.113	37%	0.22
50	0.54	0.317	5.029	5.000	-0.030	0.195	41%	0.39
100	0.65	0.390	5.492	5.503	0.010	0.295	41%	0.58
150	0.72	0.441	5.748	5.716	-0.031	0.377	40%	0.75
200	1.4	0.330	7.408	7.431	0.023	0.211	70%	0.42
252	1.53	0.344	7.630	7.626	-0.004	0.230	71%	0.45
328	1.69	0.362	7.879	7.852	-0.027	0.254	72%	0.50
545	2.08	0.396	8.397	8.334	-0.063	0.304	70%	0.60
750	2.08	0.450	8.397	8.382	-0.015	0.393	60%	0.78
2190	3.6	0.318	9.767	9.715	-0.052	0.197	66%	0.39

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

Reach 3

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs)										
		10	20	50	100	150	200	252	328	545	750	2190
3	V - Main Channel Velocity (ft/s)	1.6	1.8	2.2	2.7	3.0	3.3	3.5	3.8	4.2	4.1	2.6
3	d - Main Channel Max Depth (ft)	0.9	1.2	1.6	2.0	2.4	2.7	3.0	3.3	4.2	4.6	5.9
3	W - Main Channel Effective Width	19	24	30	33	36	38	39	42	46	46	47
3	S - Energy Slope	1.145%	1.003%	0.601%	0.510%	0.475%	0.460%	0.421%	0.350%	0.278%	0.288%	0.108%
3	R- Hyd Radius Channel	0.45	0.56	0.81	1.16	1.42	1.64	1.84	2.09	2.76	3.12	4.27
3	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.32	0.35	0.31	0.37	0.42	0.47	0.48	0.46	0.48	0.56	0.29
	Max Boundary Shear (lbs/sf)	0.68	0.73	0.59	0.64	0.71	0.77	0.78	0.73	0.73	0.83	0.40

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	0.884
	lbs/sf
τ_c - IM[1] Critical Shear Grave	0.128
τc - MT[2] Critical Shear Gravel	0.201
τc - IM[1] Critical Shear Cobble	0.505
τc - MT[2] Critical Shear Cobble	0.791
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I[3]

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.305	0.335	4.642	4.640	-0.002	0.218	68%	1.70
20	0.382	0.351	5.204	5.191	-0.013	0.239	68%	1.87
50	0.615	0.345	6.393	6.404	0.011	0.231	76%	1.80
100	0.86	0.376	7.230	7.242	0.012	0.274	74%	2.14
150	1.02	0.395	7.656	7.686	0.029	0.303	72%	2.36
200	1.16	0.415	7.977	7.992	0.015	0.333	71%	2.60
252	1.34	0.426	8.338	8.319	-0.018	0.353	73%	2.75
328	1.63	0.429	8.827	8.803	-0.024	0.356	78%	2.78
545	2.2	0.444	9.576	9.564	-0.012	0.382	80%	2.98
750	2.07	0.438	9.424	9.406	-0.018	0.372	66%	2.90
2190	2.12	0.272	9.483	9.486	0.003	0.144	50%	1.12

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.38	0.374	4.152	4.157	0.005	0.272	85%	0.54
20	0.472	0.390	4.693	4.670	-0.024	0.296	84%	0.59
50	0.74	0.378	5.816	5.838	0.022	0.278	91%	0.55
100	1.03	0.411	6.642	6.618	-0.025	0.328	88%	0.65
150	1.21	0.430	7.044	7.057	0.012	0.359	85%	0.71
200	1.37	0.451	7.354	7.354	0.000	0.394	84%	0.78
252	1.57	0.461	7.695	7.686	-0.009	0.413	85%	0.82
328	1.9	0.463	8.171	8.153	-0.018	0.416	91%	0.82
545	2.55	0.478	8.906	8.883	-0.022	0.442	92%	0.88
750	2.38	0.470	8.734	8.772	0.038	0.428	76%	0.85
2190	2.47	0.294	8.826	8.788	-0.038	0.167	58%	0.33

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

Reach 4

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs)										
		10	20	50	100	150	200	252	328	545	750	2190
4	V - Main Channel Velocity (ft/s)	1.6	1.9	2.5	3.0	3.4	3.6	3.9	4.2	5.0	5.4	7.0
4	d - Main Channel Max Depth (ft)	0.9	1.2	1.5	1.9	2.3	2.5	2.7	3.0	3.7	4.1	5.7
4	W - Main Channel Effective Width	19	23	29	33	37	40	41	43	45	46	46
4	S - Energy Slope	0.95%	0.91%	0.78%	0.69%	0.61%	0.58%	0.55%	0.53%	0.51%	0.49%	0.44%
4	R- Hyd Radius Channel	0.47	0.57	0.81	1.08	1.27	1.43	1.59	1.80	2.36	2.81	4.38
4	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.28	0.33	0.39	0.46	0.49	0.52	0.54	0.60	0.75	0.86	1.19
	Max Boundary Shear (lbs/sf)	0.57	0.66	0.75	0.84	0.87	0.90	0.94	1.01	1.16	1.27	1.57

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	0.884
	lbs/sf
τ_c - IM¹ Critical Shear Grave	0.128
τc - MT² Critical Shear Gravel	0.201
τc - IM¹ Critical Shear Cobble	0.505
τc - MT² Critical Shear Cobble	0.791
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I³

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.34	0.323	4.913	4.929	0.016	0.203	72%	1.58
20	0.42	0.351	5.441	5.398	-0.043	0.239	73%	1.87
50	0.6	0.387	6.331	6.339	0.008	0.291	74%	2.27
100	0.81	0.424	7.081	7.113	0.032	0.349	75%	2.72
150	0.99	0.443	7.582	7.593	0.011	0.380	78%	2.97
200	1.13	0.458	7.912	7.936	0.024	0.407	79%	3.18
252	1.27	0.473	8.204	8.213	0.009	0.435	80%	3.39
328	1.44	0.497	8.517	8.488	-0.030	0.479	80%	3.74
545	1.82	0.545	9.102	9.118	0.015	0.576	77%	4.49
750	2.09	0.576	9.448	9.439	-0.009	0.643	74%	5.01
2190	3.2	0.670	10.511	10.480	-0.032	0.872	73%	6.80

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.42	0.359	4.402	4.435	0.033	0.250	89%	0.50
20	0.51	0.387	4.887	4.899	0.012	0.291	89%	0.58
50	0.72	0.424	5.748	5.787	0.039	0.349	89%	0.69
100	0.97	0.464	6.492	6.499	0.007	0.418	90%	0.83
150	1.18	0.483	6.982	6.954	-0.027	0.453	93%	0.90
200	1.34	0.499	7.299	7.288	-0.012	0.483	94%	0.96
252	1.49	0.513	7.564	7.583	0.019	0.510	94%	1.01
328	1.69	0.538	7.879	7.835	-0.044	0.562	94%	1.11
545	2.12	0.588	8.445	8.448	0.003	0.671	90%	1.33
750	2.42	0.620	8.775	8.772	-0.003	0.745	86%	1.47
2190	3.66	0.717	9.808	9.799	-0.009	0.997	83%	1.98

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

Reach 5

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs) 10	20	50	100	150	200	252	328	545	750	2190
5	V - Main Channel Velocity (ft/s)	1.7	2.0	2.3	2.9	3.3	3.6	3.9	4.2	4.9	5.4	6.8
5	d - Main Channel Max Depth (ft)	0.9	1.1	1.6	2.0	2.3	2.6	2.8	3.1	3.7	4.2	6.0
5	W - Main Channel Effective Width	16	19	25	29	30	31	32	33	34	35	35
5	S - Energy Slope	1.09%	1.07%	0.70%	0.67%	0.65%	0.63%	0.62%	0.61%	0.60%	0.55%	0.50%
5	R- Hyd Radius Channel	0.46	0.62	0.83	1.13	1.36	1.56	1.73	1.95	2.46	2.86	4.60
5	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.31	0.41	0.37	0.47	0.55	0.61	0.67	0.75	0.91	0.99	1.45
	Max Boundary Shear (lbs/sf)	0.59	0.75	0.71	0.85	0.95	1.02	1.10	1.19	1.38	1.44	1.88

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	0.884
	lbs/sf
τ_c - IM^1 Critical Shear Gravel	0.128
τc - MT^2 Critical Shear Gravel	0.201
τc - IM^1 Critical Shear Cobble	0.505
τc - MT^2 Critical Shear Cobble	0.791
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I^3

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ	τ /τ	φ'
10	0.34	0.346	4.913	4.883	-0.030	0.232	74%	1.81
20	0.41	0.375	5.380	5.419	0.038	0.273	67%	2.13
50	0.6	0.369	6.331	6.306	-0.025	0.264	72%	2.06
100	0.79	0.412	7.018	7.009	-0.009	0.330	70%	2.57
150	0.94	0.443	7.452	7.437	-0.015	0.381	69%	2.97
200	1.07	0.466	7.776	7.749	-0.027	0.420	69%	3.28
252	1.17	0.484	7.999	8.008	0.009	0.455	68%	3.55
328	1.3	0.507	8.262	8.272	0.010	0.499	67%	3.89
545	1.62	0.557	8.812	8.789	-0.022	0.603	66%	4.70
750	1.9	0.581	9.210	9.224	0.014	0.656	66%	5.11
2190	2.78	0.671	10.160	10.145	-0.015	0.874	60%	6.82

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.42	0.384	4.402	4.393	-0.009	0.287	91%	0.57
20	0.51	0.418	4.887	4.858	-0.028	0.339	83%	0.67
50	0.72	0.404	5.748	5.757	0.009	0.316	87%	0.63
100	0.94	0.450	6.414	6.426	0.012	0.393	83%	0.78
150	1.12	0.484	6.851	6.813	-0.038	0.454	82%	0.90
200	1.26	0.505	7.145	7.141	-0.004	0.495	81%	0.98
252	1.38	0.526	7.373	7.373	0.001	0.537	80%	1.06
328	1.53	0.550	7.630	7.625	-0.006	0.587	78%	1.16
545	1.88	0.600	8.145	8.159	0.014	0.699	77%	1.38
750	2.2	0.626	8.537	8.572	0.035	0.760	77%	1.50
2190	3.2	0.720	9.473	9.456	-0.017	1.007	70%	1.99

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

Reach 6

		Modeled Flow Rate(cfs)										
Hydraulic Reach	**Variable Description**	10	20	50	100	150	200	252	328	545	750	2190
6	V - Main Channel Velocity (ft/s)	1.5	1.7	2.2	2.9	3.3	3.7	4.0	4.4	5.3	5.9	8.7
6	d - Main Channel Max Depth (ft)	1.0	1.2	1.5	1.9	2.2	2.4	2.7	3.0	3.6	4.2	6.9
6	W - Main Channel Effective Width (	22	26	31	35	36	38	39	41	43	43	44
6	S - Energy Slope	1.08%	0.76%	0.63%	0.61%	0.59%	0.58%	0.58%	0.55%	0.52%	0.52%	0.49%
6	R- Hyd Radius Channel	0.50	0.61	0.82	1.09	1.31	1.49	1.66	1.89	2.45	2.93	5.50
6	τ - Calculated Ave Channel Boundary Shear (lbs/sf)	0.33	0.29	0.32	0.41	0.48	0.54	0.60	0.65	0.80	0.95	1.70
	Max Boundary Shear (lbs/sf)	0.65	0.54	0.60	0.72	0.80	0.89	0.96	1.01	1.19	1.35	2.13

k_s - 3.5 D84 Gravel (ft)	0.583
k_s- 3.5 D84 Cobble (ft) "ks"	0.884
	lbs/sf
τ_c - IM[1] Critical Shear Gravel	0.128
τc - MT[2] Critical Shear Gravel	0.201
τc - IM[1] Critical Shear Cobble	0.505
τc - MT[2] Critical Shear Cobble	0.791
Υ_w - Unit Wt of Water (pcf)	62.4
Υ_s - Unit Wt of Solid(pcf)	165
g- Acceleration (ft/s^2)	32.2

Method I[3]

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.295	0.320	4.558	4.548	-0.011	0.199	60%	1.55
20	0.41	0.316	5.380	5.348	-0.033	0.193	67%	1.51
50	0.61	0.353	6.372	6.361	-0.012	0.242	75%	1.88
100	0.83	0.402	7.142	7.117	-0.025	0.314	76%	2.45
150	1.01	0.438	7.632	7.603	-0.028	0.372	77%	2.90
200	1.15	0.465	7.956	7.963	0.007	0.419	77%	3.27
252	1.28	0.489	8.223	8.242	0.018	0.463	77%	3.61
328	1.48	0.511	8.586	8.599	0.013	0.507	78%	3.95
545	1.92	0.569	9.236	9.253	0.017	0.628	78%	4.90
750	2.27	0.615	9.654	9.651	-0.002	0.734	78%	5.72
2190	3.92	0.790	11.018	10.992	-0.026	1.212	71%	9.45

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τ'	τ'/τ	φ'
10	0.37	0.358	4.085	4.061	-0.025	0.249	75%	0.49
20	0.5	0.349	4.837	4.843	0.005	0.236	82%	0.47
50	0.73	0.386	5.782	5.815	0.032	0.289	89%	0.57
100	0.99	0.439	6.543	6.516	-0.027	0.374	91%	0.74
150	1.19	0.475	7.003	7.005	0.002	0.438	91%	0.87
200	1.36	0.506	7.336	7.322	-0.014	0.496	91%	0.98
252	1.51	0.531	7.597	7.588	-0.009	0.547	91%	1.08
328	1.74	0.554	7.951	7.931	-0.021	0.596	92%	1.18
545	2.23	0.613	8.571	8.585	0.015	0.729	91%	1.44
750	2.62	0.661	8.973	8.984	0.010	0.847	90%	1.68
2190	4.44	0.841	10.291	10.328	0.038	1.372	81%	2.72

Notes:
1: IM = Insipient Motion
2: MT = Measurable Transport
3: $\phi' = \tau'/\tau_c$
3: Parameters used in Grain Shear Calculations are identified in the text of the Calculation Brief.

ATTACHMENT B

Sediment Reach Sand and Gravel

River: Prickly Pear Cr., Reach: EXISTING STREAM

RS: 10900 to 101.64

Sediment Transport Functions: MPM

Temperature: 55

Specific Gravity of Sediment: 2.65

Concentration of Fine Sediment: 0

Fall Velocity Method: Default

Depth/Width Type: Default

Gradation	Left Overbank	Main Channel	Right Overbank			
	Diameter	% Finer	Diameter	% Finer	Diameter	% Finer
	127	100	127	100	127100	
	102	96	102	96	10296	
	76.2	93	76.2	93	76.2	93
	50.8	83	50.8	83	50.8	83
	38.1	71	38.1	71	38.1	71
	25.4	60	25.4	60	25.4	60
	19.0	51	19.0	51	19.0	51
	12.7	41	12.7	41	12.7	41
	9.52	37	9.52	37	9.52	37
	4.75	30	4.75	30	4.75	30
	2.00	20	2.00	20	2.00	20
	.850	8	.850	8	.850	8
	.425	3	.425	3	.425	3
	.250	1	.250	1	.250	1
	.150	1	.150	1	.150	1
	.0750	0.3	.0750	0.3	.0750	0.3
d90	67.5		67.5		67.5	
d84	53.0		53.0		53.0	
d50	18.2		18.2		18.2	

Bed Material Fraction by Standard Grade Size

Class	dm (mm)	Left	Main	Right
1	.003	0.000	0.000	0.000
2	.006	0.000	0.000	0.000
3	.011	0.000	0.000	0.000
4	.023	0.000	0.000	0.000
5	.045	0.000	0.000	0.000
6	.088	0.008	0.008	0.008
7	.177	0.002	0.002	0.002
8	.354	0.032	0.032	0.032
9	.707	0.061	0.061	0.061
10	1.41	0.097	0.097	0.097
11	2.83	0.080	0.080	0.080
12	5.64	0.073	0.073	0.073
13	11.3	0.115	0.115	0.115

14	22.6	0.195	0.195	0.195
15	45.1	0.224	0.224	0.224
16	90.5	0.083	0.083	0.083
17	181	0.030	0.030	0.030
18	362	0.000	0.000	0.000
19	724	0.000	0.000	0.000
20	1448	0.000	0.000	0.000

Sediment Transport Potential (tons/day) Sand and Gravel 10900 MPM Total All Grains (tons/day)

	Sed Reach	RS	Profile	Function	All Grains	
1	Sand and Gravel		10900 ...	PF 1	MPM	9.092
2	Sand and Gravel		10900 ...	PF 2	MPM	23.18
3	Sand and Gravel		10900 ...	PF 3	MPM	81.75
4	Sand and Gravel		10900 ...	PF 4	MPM	221.9
5	Sand and Gravel		10900 ...	PF 5	MPM	402.8
6	Sand and Gravel		10900 ...	PF 6	MPM	600.8
7	Sand and Gravel		10900 ...	PF 7	MPM	826.5
8	Sand and Gravel		10900 ...	PF 8	MPM	1310
9	Sand and Gravel		10900 ...	PF 9	MPM	2705
10	Sand and Gravel		10900 ...	PF 10	MPM	4286
11						
12	Sand and Gravel		10800 ...	PF 1	MPM	1011
13	Sand and Gravel		10800 ...	PF 2	MPM	1436
14	Sand and Gravel		10800 ...	PF 3	MPM	2520
15	Sand and Gravel		10800 ...	PF 4	MPM	4439
16	Sand and Gravel		10800 ...	PF 5	MPM	6643
17	Sand and Gravel		10800 ...	PF 6	MPM	8562
18	Sand and Gravel		10800 ...	PF 7	MPM	10450
19	Sand and Gravel		10800 ...	PF 8	MPM	8572
20	Sand and Gravel		10800 ...	PF 9	MPM	8270
21	Sand and Gravel		10800 ...	PF 10	MPM	9035
22						
23	Sand and Gravel		10700 ...	PF 1	MPM	.00585...
24	Sand and Gravel		10700 ...	PF 2	MPM	.1255
25	Sand and Gravel		10700 ...	PF 3	MPM	4.970
26	Sand and Gravel		10700 ...	PF 4	MPM	42.73
27	Sand and Gravel		10700 ...	PF 5	MPM	111.5
28	Sand and Gravel		10700 ...	PF 6	MPM	202.0
29	Sand and Gravel		10700 ...	PF 7	MPM	314.9
30	Sand and Gravel		10700 ...	PF 8	MPM	496.8
31	Sand and Gravel		10700 ...	PF 9	MPM	1073
32	Sand and Gravel		10700 ...	PF 10	MPM	1615
33						
34	Sand and Gravel		10606....	PF 1	MPM	.1992
35	Sand and Gravel		10606....	PF 2	MPM	3.192
36	Sand and Gravel		10606....	PF 3	MPM	42.04
37	Sand and Gravel		10606....	PF 4	MPM	180.9

38	Sand and Gravel	10606....	PF 5	MPM	385.7
39	Sand and Gravel	10606....	PF 6	MPM	639.6
40	Sand and Gravel	10606....	PF 7	MPM	949.2
41	Sand and Gravel	10606....	PF 8	MPM	1438
42	Sand and Gravel	10606....	PF 9	MPM	3054
43	Sand and Gravel	10606....	PF 10	MPM	4781
44					
45	Sand and Gravel	10495....	PF 1	MPM	6.111
46	Sand and Gravel	10495....	PF 2	MPM	23.97
47	Sand and Gravel	10495....	PF 3	MPM	116.4
48	Sand and Gravel	10495....	PF 4	MPM	315.5
49	Sand and Gravel	10495....	PF 5	MPM	525.2
50	Sand and Gravel	10495....	PF 6	MPM	729.1
51	Sand and Gravel	10495....	PF 7	MPM	939.2
52	Sand and Gravel	10495....	PF 8	MPM	1255
53	Sand and Gravel	10495....	PF 9	MPM	2147
54	Sand and Gravel	10495....	PF 10	MPM	2839
55					
56	Sand and Gravel	10400 ...	PF 1	MPM	757.5
57	Sand and Gravel	10400 ...	PF 2	MPM	575.6
58	Sand and Gravel	10400 ...	PF 3	MPM	568.6
59	Sand and Gravel	10400 ...	PF 4	MPM	668.4
60	Sand and Gravel	10400 ...	PF 5	MPM	821.8
61	Sand and Gravel	10400 ...	PF 6	MPM	969.1
62	Sand and Gravel	10400 ...	PF 7	MPM	1124
63	Sand and Gravel	10400 ...	PF 8	MPM	1349
64	Sand and Gravel	10400 ...	PF 9	MPM	1950
65	Sand and Gravel	10400 ...	PF 10	MPM	2460
66					
67	Sand and Gravel	10300 ...	PF 1	MPM	30.74
68	Sand and Gravel	10300 ...	PF 2	MPM	83.35
69	Sand and Gravel	10300 ...	PF 3	MPM	308.5
70	Sand and Gravel	10300 ...	PF 4	MPM	819.9
71	Sand and Gravel	10300 ...	PF 5	MPM	1550
72	Sand and Gravel	10300 ...	PF 6	MPM	2358
73	Sand and Gravel	10300 ...	PF 7	MPM	3431
74	Sand and Gravel	10300 ...	PF 8	MPM	5164
75	Sand and Gravel	10300 ...	PF 9	MPM	13880
76	Sand and Gravel	10300 ...	PF 10	MPM	22740
77					
78	Sand and Gravel	10200 ...	PF 1	MPM	1009
79	Sand and Gravel	10200 ...	PF 2	MPM	1223
80	Sand and Gravel	10200 ...	PF 3	MPM	2363
81	Sand and Gravel	10200 ...	PF 4	MPM	4714
82	Sand and Gravel	10200 ...	PF 5	MPM	6906
83	Sand and Gravel	10200 ...	PF 6	MPM	9192
84	Sand and Gravel	10200 ...	PF 7	MPM	11110
85	Sand and Gravel	10200 ...	PF 8	MPM	14260

86	Sand and Gravel	10200 ...	PF 9	MPM	16300
87	Sand and Gravel	10200 ...	PF 10	MPM	19910
88					
89	Sand and Gravel	10100 ...	PF 1	MPM	.02334
90	Sand and Gravel	10100 ...	PF 2	MPM	.5829
91	Sand and Gravel	10100 ...	PF 3	MPM	19.39
92	Sand and Gravel	10100 ...	PF 4	MPM	117.9
93	Sand and Gravel	10100 ...	PF 5	MPM	286.8
94	Sand and Gravel	10100 ...	PF 6	MPM	506.7
95	Sand and Gravel	10100 ...	PF 7	MPM	807.9
96	Sand and Gravel	10100 ...	PF 8	MPM	1372
97	Sand and Gravel	10100 ...	PF 9	MPM	3747
98	Sand and Gravel	10100 ...	PF 10	MPM	7064
99					
100	Sand and Gravel	10004....	PF 1	MPM	42.43
101	Sand and Gravel	10004....	PF 2	MPM	161.1
102	Sand and Gravel	10004....	PF 3	MPM	760.7
103	Sand and Gravel	10004....	PF 4	MPM	1589
104	Sand and Gravel	10004....	PF 5	MPM	2144
105	Sand and Gravel	10004....	PF 6	MPM	2620
106	Sand and Gravel	10004....	PF 7	MPM	3084
107	Sand and Gravel	10004....	PF 8	MPM	3667
108	Sand and Gravel	10004....	PF 9	MPM	5514
109	Sand and Gravel	10004....	PF 10	MPM	7289
110					
111	Sand and Gravel	9900.0...	PF 1	MPM	2397
112	Sand and Gravel	9900.0...	PF 2	MPM	776.2
113	Sand and Gravel	9900.0...	PF 3	MPM	607.9
114	Sand and Gravel	9900.0...	PF 4	MPM	847.0
115	Sand and Gravel	9900.0...	PF 5	MPM	1145
116	Sand and Gravel	9900.0...	PF 6	MPM	1470
117	Sand and Gravel	9900.0...	PF 7	MPM	1804
118	Sand and Gravel	9900.0...	PF 8	MPM	2321
119	Sand and Gravel	9900.0...	PF 9	MPM	4038
120	Sand and Gravel	9900.0...	PF 10	MPM	5798
121					
122	Sand and Gravel	9800	PF 1	MPM	3.263
123	Sand and Gravel	9800	PF 2	MPM	16.27
124	Sand and Gravel	9800	PF 3	MPM	86.09
125	Sand and Gravel	9800	PF 4	MPM	277.4
126	Sand and Gravel	9800	PF 5	MPM	520.2
127	Sand and Gravel	9800	PF 6	MPM	796.6
128	Sand and Gravel	9800	PF 7	MPM	1138
129	Sand and Gravel	9800	PF 8	MPM	1704
130	Sand and Gravel	9800	PF 9	MPM	3957
131	Sand and Gravel	9800	PF 10	MPM	7162
132					
133	Sand and Gravel	9700	PF 1	MPM	789.6

134	Sand and Gravel	9700	PF 2	MPM	277.0
135	Sand and Gravel	9700	PF 3	MPM	290.2
136	Sand and Gravel	9700	PF 4	MPM	481.0
137	Sand and Gravel	9700	PF 5	MPM	677.4
138	Sand and Gravel	9700	PF 6	MPM	871.0
139	Sand and Gravel	9700	PF 7	MPM	1071
140	Sand and Gravel	9700	PF 8	MPM	1391
141	Sand and Gravel	9700	PF 9	MPM	2664
142	Sand and Gravel	9700	PF 10	MPM	4111
143					
144	Sand and Gravel	9599.9...	PF 1	MPM	3.780
145	Sand and Gravel	9599.9...	PF 2	MPM	15.68
146	Sand and Gravel	9599.9...	PF 3	MPM	90.30
147	Sand and Gravel	9599.9...	PF 4	MPM	277.4
148	Sand and Gravel	9599.9...	PF 5	MPM	492.3
149	Sand and Gravel	9599.9...	PF 6	MPM	715.1
150	Sand and Gravel	9599.9...	PF 7	MPM	934.4
151	Sand and Gravel	9599.9...	PF 8	MPM	1287
152	Sand and Gravel	9599.9...	PF 9	MPM	2739
153	Sand and Gravel	9599.9...	PF 10	MPM	4398
154					
155	Sand and Gravel	9500.1...	PF 1	MPM	16.07
156	Sand and Gravel	9500.1...	PF 2	MPM	30.86
157	Sand and Gravel	9500.1...	PF 3	MPM	180.3
158	Sand and Gravel	9500.1...	PF 4	MPM	556.7
159	Sand and Gravel	9500.1...	PF 5	MPM	845.8
160	Sand and Gravel	9500.1...	PF 6	MPM	1043
161	Sand and Gravel	9500.1...	PF 7	MPM	1187
162	Sand and Gravel	9500.1...	PF 8	MPM	1442
163	Sand and Gravel	9500.1...	PF 9	MPM	2876
164	Sand and Gravel	9500.1...	PF 10	MPM	4737
165					
166	Sand and Gravel	9400	PF 1	MPM	730.9
167	Sand and Gravel	9400	PF 2	MPM	1367
168	Sand and Gravel	9400	PF 3	MPM	459.0
169	Sand and Gravel	9400	PF 4	MPM	377.2
170	Sand and Gravel	9400	PF 5	MPM	380.5
171	Sand and Gravel	9400	PF 6	MPM	391.5
172	Sand and Gravel	9400	PF 7	MPM	403.9
173	Sand and Gravel	9400	PF 8	MPM	490.6
174	Sand and Gravel	9400	PF 9	MPM	1181
175	Sand and Gravel	9400	PF 10	MPM	2112
176					
177	Sand and Gravel	9300	PF 1	MPM	7.981
178	Sand and Gravel	9300	PF 2	MPM	27.88
179	Sand and Gravel	9300	PF 3	MPM	112.0
180	Sand and Gravel	9300	PF 4	MPM	163.5
181	Sand and Gravel	9300	PF 5	MPM	193.5

182	Sand and Gravel	9300	PF 6	MPM	209.7
183	Sand and Gravel	9300	PF 7	MPM	230.8
184	Sand and Gravel	9300	PF 8	MPM	309.8
185	Sand and Gravel	9300	PF 9	MPM	796.7
186	Sand and Gravel	9300	PF 10	MPM	1451
187					
188	Sand and Gravel	9200	PF 1	MPM	176.4
189	Sand and Gravel	9200	PF 2	MPM	155.2
190	Sand and Gravel	9200	PF 3	MPM	337.5
191	Sand and Gravel	9200	PF 4	MPM	769.3
192	Sand and Gravel	9200	PF 5	MPM	1299
193	Sand and Gravel	9200	PF 6	MPM	1952
194	Sand and Gravel	9200	PF 7	MPM	2876
195	Sand and Gravel	9200	PF 8	MPM	2967
196	Sand and Gravel	9200	PF 9	MPM	4078
197	Sand and Gravel	9200	PF 10	MPM	5523
198					
199	Sand and Gravel	9100	PF 1	MPM	.3854
200	Sand and Gravel	9100	PF 2	MPM	2.876
201	Sand and Gravel	9100	PF 3	MPM	37.40
202	Sand and Gravel	9100	PF 4	MPM	200.5
203	Sand and Gravel	9100	PF 5	MPM	508.0
204	Sand and Gravel	9100	PF 6	MPM	912.0
205	Sand and Gravel	9100	PF 7	MPM	1256
206	Sand and Gravel	9100	PF 8	MPM	1705
207	Sand and Gravel	9100	PF 9	MPM	3445
208	Sand and Gravel	9100	PF 10	MPM	6223
209					
210	Sand and Gravel	9000	PF 1	MPM	4.010
211	Sand and Gravel	9000	PF 2	MPM	13.56
212	Sand and Gravel	9000	PF 3	MPM	78.86
213	Sand and Gravel	9000	PF 4	MPM	219.1
214	Sand and Gravel	9000	PF 5	MPM	397.8
215	Sand and Gravel	9000	PF 6	MPM	620.3
216	Sand and Gravel	9000	PF 7	MPM	867.9
217	Sand and Gravel	9000	PF 8	MPM	1248
218	Sand and Gravel	9000	PF 9	MPM	2502
219	Sand and Gravel	9000	PF 10	MPM	4975
220					
221	Sand and Gravel	8900	PF 1	MPM	767.6
222	Sand and Gravel	8900	PF 2	MPM	2063
223	Sand and Gravel	8900	PF 3	MPM	1523
224	Sand and Gravel	8900	PF 4	MPM	4298
225	Sand and Gravel	8900	PF 5	MPM	7048
226	Sand and Gravel	8900	PF 6	MPM	9337
227	Sand and Gravel	8900	PF 7	MPM	11800
228	Sand and Gravel	8900	PF 8	MPM	14750
229	Sand and Gravel	8900	PF 9	MPM	17510

230	Sand and Gravel	8900	PF 10	MPM	9709
231					
232	Sand and Gravel	8800	PF 1	MPM	322.0
233	Sand and Gravel	8800	PF 2	MPM	263.9
234	Sand and Gravel	8800	PF 3	MPM	207.4
235	Sand and Gravel	8800	PF 4	MPM	486.6
236	Sand and Gravel	8800	PF 5	MPM	767.1
237	Sand and Gravel	8800	PF 6	MPM	886.9
238	Sand and Gravel	8800	PF 7	MPM	929.1
239	Sand and Gravel	8800	PF 8	MPM	970.0
240	Sand and Gravel	8800	PF 9	MPM	1095
241	Sand and Gravel	8800	PF 10	MPM	1190
242					
243	Sand and Gravel	8700	PF 1	MPM	29.27
244	Sand and Gravel	8700	PF 2	MPM	62.92
245	Sand and Gravel	8700	PF 3	MPM	163.6
246	Sand and Gravel	8700	PF 4	MPM	354.4
247	Sand and Gravel	8700	PF 5	MPM	650.5
248	Sand and Gravel	8700	PF 6	MPM	1038
249	Sand and Gravel	8700	PF 7	MPM	1488
250	Sand and Gravel	8700	PF 8	MPM	2275
251	Sand and Gravel	8700	PF 9	MPM	6222
252	Sand and Gravel	8700	PF 10	MPM	10830
253					
254	Sand and Gravel	8606.3...	PF 1	MPM	.3618
255	Sand and Gravel	8606.3...	PF 2	MPM	2.312
256	Sand and Gravel	8606.3...	PF 3	MPM	15.07
257	Sand and Gravel	8606.3...	PF 4	MPM	45.90
258	Sand and Gravel	8606.3...	PF 5	MPM	97.45
259	Sand and Gravel	8606.3...	PF 6	MPM	161.6
260	Sand and Gravel	8606.3...	PF 7	MPM	236.6
261	Sand and Gravel	8606.3...	PF 8	MPM	353.4
262	Sand and Gravel	8606.3...	PF 9	MPM	771.7
263	Sand and Gravel	8606.3...	PF 10	MPM	1256
264					
265	Sand and Gravel	8449.5...	PF 1	MPM	792.6
266	Sand and Gravel	8449.5...	PF 2	MPM	1249
267	Sand and Gravel	8449.5...	PF 3	MPM	2127
268	Sand and Gravel	8449.5...	PF 4	MPM	2099
269	Sand and Gravel	8449.5...	PF 5	MPM	3425
270	Sand and Gravel	8449.5...	PF 6	MPM	5031
271	Sand and Gravel	8449.5...	PF 7	MPM	6869
272	Sand and Gravel	8449.5...	PF 8	MPM	9374
273	Sand and Gravel	8449.5...	PF 9	MPM	17270
274	Sand and Gravel	8449.5...	PF 10	MPM	18200
275					
276	Sand and Gravel	8400	PF 1	MPM	17.18
277	Sand and Gravel	8400	PF 2	MPM	41.67

278	Sand and Gravel	8400	PF 3	MPM	193.4
279	Sand and Gravel	8400	PF 4	MPM	489.7
280	Sand and Gravel	8400	PF 5	MPM	762.9
281	Sand and Gravel	8400	PF 6	MPM	1209
282	Sand and Gravel	8400	PF 7	MPM	1712
283	Sand and Gravel	8400	PF 8	MPM	2266
284	Sand and Gravel	8400	PF 9	MPM	2638
285	Sand and Gravel	8400	PF 10	MPM	2427
286					
287	Sand and Gravel	8300	PF 1	MPM	205.9
288	Sand and Gravel	8300	PF 2	MPM	1276
289	Sand and Gravel	8300	PF 3	MPM	2501
290	Sand and Gravel	8300	PF 4	MPM	4766
291	Sand and Gravel	8300	PF 5	MPM	5257
292	Sand and Gravel	8300	PF 6	MPM	4815
293	Sand and Gravel	8300	PF 7	MPM	4474
294	Sand and Gravel	8300	PF 8	MPM	4225
295	Sand and Gravel	8300	PF 9	MPM	4109
296	Sand and Gravel	8300	PF 10	MPM	4749
297					
298	Sand and Gravel	8200	PF 1	MPM	667.4
299	Sand and Gravel	8200	PF 2	MPM	233.8
300	Sand and Gravel	8200	PF 3	MPM	331.6
301	Sand and Gravel	8200	PF 4	MPM	541.6
302	Sand and Gravel	8200	PF 5	MPM	793.6
303	Sand and Gravel	8200	PF 6	MPM	1091
304	Sand and Gravel	8200	PF 7	MPM	1421
305	Sand and Gravel	8200	PF 8	MPM	1947
306	Sand and Gravel	8200	PF 9	MPM	3780
307	Sand and Gravel	8200	PF 10	MPM	5985
308					
309	Sand and Gravel	8100	PF 1	MPM	.1556
310	Sand and Gravel	8100	PF 2	MPM	1.344
311	Sand and Gravel	8100	PF 3	MPM	16.28
312	Sand and Gravel	8100	PF 4	MPM	83.15
313	Sand and Gravel	8100	PF 5	MPM	194.9
314	Sand and Gravel	8100	PF 6	MPM	346.6
315	Sand and Gravel	8100	PF 7	MPM	530.3
316	Sand and Gravel	8100	PF 8	MPM	870.4
317	Sand and Gravel	8100	PF 9	MPM	2156
318	Sand and Gravel	8100	PF 10	MPM	4066
319					
320	Sand and Gravel	8000.0...	PF 1	MPM	2.333
321	Sand and Gravel	8000.0...	PF 2	MPM	9.166
322	Sand and Gravel	8000.0...	PF 3	MPM	53.76
323	Sand and Gravel	8000.0...	PF 4	MPM	190.6
324	Sand and Gravel	8000.0...	PF 5	MPM	400.6
325	Sand and Gravel	8000.0...	PF 6	MPM	674.3

326	Sand and Gravel	8000.0...	PF 7	MPM	1022
327	Sand and Gravel	8000.0...	PF 8	MPM	1591
328	Sand and Gravel	8000.0...	PF 9	MPM	3638
329	Sand and Gravel	8000.0...	PF 10	MPM	6197
330					
331	Sand and Gravel	7900	PF 1	MPM	35.34
332	Sand and Gravel	7900	PF 2	MPM	51.59
333	Sand and Gravel	7900	PF 3	MPM	122.7
334	Sand and Gravel	7900	PF 4	MPM	276.9
335	Sand and Gravel	7900	PF 5	MPM	446.5
336	Sand and Gravel	7900	PF 6	MPM	617.4
337	Sand and Gravel	7900	PF 7	MPM	795.3
338	Sand and Gravel	7900	PF 8	MPM	1058
339	Sand and Gravel	7900	PF 9	MPM	1562
340	Sand and Gravel	7900	PF 10	MPM	853.1
341					
342	Sand and Gravel	7800	PF 1	MPM	1.689
343	Sand and Gravel	7800	PF 2	MPM	10.30
344	Sand and Gravel	7800	PF 3	MPM	76.56
345	Sand and Gravel	7800	PF 4	MPM	242.1
346	Sand and Gravel	7800	PF 5	MPM	469.1
347	Sand and Gravel	7800	PF 6	MPM	743.0
348	Sand and Gravel	7800	PF 7	MPM	1074
349	Sand and Gravel	7800	PF 8	MPM	1603
350	Sand and Gravel	7800	PF 9	MPM	3212
351	Sand and Gravel	7800	PF 10	MPM	3900
352					
353	Sand and Gravel	7699.8...	PF 1	MPM	10.03
354	Sand and Gravel	7699.8...	PF 2	MPM	23.78
355	Sand and Gravel	7699.8...	PF 3	MPM	119.0
356	Sand and Gravel	7699.8...	PF 4	MPM	419.6
357	Sand and Gravel	7699.8...	PF 5	MPM	857.7
358	Sand and Gravel	7699.8...	PF 6	MPM	1572
359	Sand and Gravel	7699.8...	PF 7	MPM	2547
360	Sand and Gravel	7699.8...	PF 8	MPM	4043
361	Sand and Gravel	7699.8...	PF 9	MPM	9673
362	Sand and Gravel	7699.8...	PF 10	MPM	21170
363					
364	Sand and Gravel	7659.1...	PF 1	MPM	919.2
365	Sand and Gravel	7659.1...	PF 2	MPM	868.7
366	Sand and Gravel	7659.1...	PF 3	MPM	1542
367	Sand and Gravel	7659.1...	PF 4	MPM	3346
368	Sand and Gravel	7659.1...	PF 5	MPM	5338
369	Sand and Gravel	7659.1...	PF 6	MPM	5343
370	Sand and Gravel	7659.1...	PF 7	MPM	4639
371	Sand and Gravel	7659.1...	PF 8	MPM	4287
372	Sand and Gravel	7659.1...	PF 9	MPM	4825
373	Sand and Gravel	7659.1...	PF 10	MPM	.3354

374					
375	Sand and Gravel	7592.3...	PF 1	MPM	62.79
376	Sand and Gravel	7592.3...	PF 2	MPM	141.8
377	Sand and Gravel	7592.3...	PF 3	MPM	265.6
378	Sand and Gravel	7592.3...	PF 4	MPM	419.0
379	Sand and Gravel	7592.3...	PF 5	MPM	565.9
380	Sand and Gravel	7592.3...	PF 6	MPM	724.0
381	Sand and Gravel	7592.3...	PF 7	MPM	902.1
382	Sand and Gravel	7592.3...	PF 8	MPM	1187
383	Sand and Gravel	7592.3...	PF 9	MPM	395.8
384	Sand and Gravel	7592.3...	PF 10	MPM	19.47
385					
386	Sand and Gravel	7550	PF 1	MPM	20.63
387	Sand and Gravel	7550	PF 2	MPM	87.49
388	Sand and Gravel	7550	PF 3	MPM	450.5
389	Sand and Gravel	7550	PF 4	MPM	1176
390	Sand and Gravel	7550	PF 5	MPM	1802
391	Sand and Gravel	7550	PF 6	MPM	2507
392	Sand and Gravel	7550	PF 7	MPM	3177
393	Sand and Gravel	7550	PF 8	MPM	3918
394	Sand and Gravel	7550	PF 9	MPM	759.7
395	Sand and Gravel	7550	PF 10	MPM	18.01
396					
397	Sand and Gravel	7486.8...	PF 1	MPM	104.2
398	Sand and Gravel	7486.8...	PF 2	MPM	165.5
399	Sand and Gravel	7486.8...	PF 3	MPM	315.8
400	Sand and Gravel	7486.8...	PF 4	MPM	626.5
401	Sand and Gravel	7486.8...	PF 5	MPM	828.4
402	Sand and Gravel	7486.8...	PF 6	MPM	1125
403	Sand and Gravel	7486.8...	PF 7	MPM	1378
404	Sand and Gravel	7486.8...	PF 8	MPM	1689
405	Sand and Gravel	7486.8...	PF 9	MPM	2700
406	Sand and Gravel	7486.8...	PF 10	MPM	1591
407					
408	Sand and Gravel	7446.0...	PF 1	MPM	420.2
409	Sand and Gravel	7446.0...	PF 2	MPM	484.4
410	Sand and Gravel	7446.0...	PF 3	MPM	608.7
411	Sand and Gravel	7446.0...	PF 4	MPM	922.3
412	Sand and Gravel	7446.0...	PF 5	MPM	1070
413	Sand and Gravel	7446.0...	PF 6	MPM	1139
414	Sand and Gravel	7446.0...	PF 7	MPM	1225
415	Sand and Gravel	7446.0...	PF 8	MPM	1361
416	Sand and Gravel	7446.0...	PF 9	MPM	1461
417	Sand and Gravel	7446.0...	PF 10	MPM	525.7
418					
419	Sand and Gravel	7388.7 ...	PF 1	MPM	10.63
420	Sand and Gravel	7388.7 ...	PF 2	MPM	37.59
421	Sand and Gravel	7388.7 ...	PF 3	MPM	192.0

422	Sand and Gravel	7388.7 ...	PF 4	MPM	711.6
423	Sand and Gravel	7388.7 ...	PF 5	MPM	1300
424	Sand and Gravel	7388.7 ...	PF 6	MPM	1872
425	Sand and Gravel	7388.7 ...	PF 7	MPM	2451
426	Sand and Gravel	7388.7 ...	PF 8	MPM	3478
427	Sand and Gravel	7388.7 ...	PF 9	MPM	8189
428	Sand and Gravel	7388.7 ...	PF 10	MPM	16300
429					
430	Sand and Gravel	7321.9...	PF 1	MPM	1297
431	Sand and Gravel	7321.9...	PF 2	MPM	1670
432	Sand and Gravel	7321.9...	PF 3	MPM	2527
433	Sand and Gravel	7321.9...	PF 4	MPM	1198
434	Sand and Gravel	7321.9...	PF 5	MPM	1061
435	Sand and Gravel	7321.9...	PF 6	MPM	1166
436	Sand and Gravel	7321.9...	PF 7	MPM	1304
437	Sand and Gravel	7321.9...	PF 8	MPM	1506
438	Sand and Gravel	7321.9...	PF 9	MPM	1723
439	Sand and Gravel	7321.9...	PF 10	MPM	795.7
440					
441	Sand and Gravel	7300	PF 1	MPM	10.81
442	Sand and Gravel	7300	PF 2	MPM	21.10
443	Sand and Gravel	7300	PF 3	MPM	75.18
444	Sand and Gravel	7300	PF 4	MPM	172.1
445	Sand and Gravel	7300	PF 5	MPM	278.5
446	Sand and Gravel	7300	PF 6	MPM	379.5
447	Sand and Gravel	7300	PF 7	MPM	486.5
448	Sand and Gravel	7300	PF 8	MPM	659.0
449	Sand and Gravel	7300	PF 9	MPM	945.4
450	Sand and Gravel	7300	PF 10	MPM	623.2
451					
452	Sand and Gravel	7263.2 ...	PF 1	MPM	27.00
453	Sand and Gravel	7263.2 ...	PF 2	MPM	62.24
454	Sand and Gravel	7263.2 ...	PF 3	MPM	287.0
455	Sand and Gravel	7263.2 ...	PF 4	MPM	735.6
456	Sand and Gravel	7263.2 ...	PF 5	MPM	1172
457	Sand and Gravel	7263.2 ...	PF 6	MPM	1604
458	Sand and Gravel	7263.2 ...	PF 7	MPM	1963
459	Sand and Gravel	7263.2 ...	PF 8	MPM	2317
460	Sand and Gravel	7263.2 ...	PF 9	MPM	1754
461	Sand and Gravel	7263.2 ...	PF 10	MPM	967.7
462					
463	Sand and Gravel	7200.1...	PF 1	MPM	651.1
464	Sand and Gravel	7200.1...	PF 2	MPM	1455
465	Sand and Gravel	7200.1...	PF 3	MPM	1352
466	Sand and Gravel	7200.1...	PF 4	MPM	1705
467	Sand and Gravel	7200.1...	PF 5	MPM	2096
468	Sand and Gravel	7200.1...	PF 6	MPM	3415
469	Sand and Gravel	7200.1...	PF 7	MPM	4741

470	Sand and Gravel	7200.1...	PF 8	MPM	6615
471	Sand and Gravel	7200.1...	PF 9	MPM	12320
472	Sand and Gravel	7200.1...	PF 10	MPM	13660
473					
474	Sand and Gravel	7100.1...	PF 1	MPM	12.43
475	Sand and Gravel	7100.1...	PF 2	MPM	47.74
476	Sand and Gravel	7100.1...	PF 3	MPM	178.8
477	Sand and Gravel	7100.1...	PF 4	MPM	410.1
478	Sand and Gravel	7100.1...	PF 5	MPM	602.1
479	Sand and Gravel	7100.1...	PF 6	MPM	708.1
480	Sand and Gravel	7100.1...	PF 7	MPM	850.1
481	Sand and Gravel	7100.1...	PF 8	MPM	1082
482	Sand and Gravel	7100.1...	PF 9	MPM	1977
483	Sand and Gravel	7100.1...	PF 10	MPM	2868
484					
485	Sand and Gravel	7000	PF 1	MPM	.5849
486	Sand and Gravel	7000	PF 2	MPM	3.769
487	Sand and Gravel	7000	PF 3	MPM	27.97
488	Sand and Gravel	7000	PF 4	MPM	103.7
489	Sand and Gravel	7000	PF 5	MPM	211.6
490	Sand and Gravel	7000	PF 6	MPM	341.9
491	Sand and Gravel	7000	PF 7	MPM	507.6
492	Sand and Gravel	7000	PF 8	MPM	779.7
493	Sand and Gravel	7000	PF 9	MPM	1559
494	Sand and Gravel	7000	PF 10	MPM	1948
495					
496	Sand and Gravel	6900	PF 1	MPM	.02665
497	Sand and Gravel	6900	PF 2	MPM	.4092
498	Sand and Gravel	6900	PF 3	MPM	9.642
499	Sand and Gravel	6900	PF 4	MPM	64.06
500	Sand and Gravel	6900	PF 5	MPM	164.4
501	Sand and Gravel	6900	PF 6	MPM	294.8
502	Sand and Gravel	6900	PF 7	MPM	418.4
503	Sand and Gravel	6900	PF 8	MPM	610.8
504	Sand and Gravel	6900	PF 9	MPM	1362
505	Sand and Gravel	6900	PF 10	MPM	2284
506					
507	Sand and Gravel	6800	PF 1	MPM	1381
508	Sand and Gravel	6800	PF 2	MPM	2028
509	Sand and Gravel	6800	PF 3	MPM	3327
510	Sand and Gravel	6800	PF 4	MPM	5086
511	Sand and Gravel	6800	PF 5	MPM	3658
512	Sand and Gravel	6800	PF 6	MPM	3131
513	Sand and Gravel	6800	PF 7	MPM	2890
514	Sand and Gravel	6800	PF 8	MPM	2826
515	Sand and Gravel	6800	PF 9	MPM	3757
516	Sand and Gravel	6800	PF 10	MPM	4404
517					

518	Sand and Gravel	6700	PF 1	MPM	11.41
519	Sand and Gravel	6700	PF 2	MPM	32.91
520	Sand and Gravel	6700	PF 3	MPM	116.7
521	Sand and Gravel	6700	PF 4	MPM	325.9
522	Sand and Gravel	6700	PF 5	MPM	609.7
523	Sand and Gravel	6700	PF 6	MPM	826.1
524	Sand and Gravel	6700	PF 7	MPM	1049
525	Sand and Gravel	6700	PF 8	MPM	1559
526	Sand and Gravel	6700	PF 9	MPM	4211
527	Sand and Gravel	6700	PF 10	MPM	8971
528					
529	Sand and Gravel	6600	PF 1	MPM	.3124
530	Sand and Gravel	6600	PF 2	MPM	3.147
531	Sand and Gravel	6600	PF 3	MPM	33.76
532	Sand and Gravel	6600	PF 4	MPM	155.3
533	Sand and Gravel	6600	PF 5	MPM	379.6
534	Sand and Gravel	6600	PF 6	MPM	687.0
535	Sand and Gravel	6600	PF 7	MPM	1029
536	Sand and Gravel	6600	PF 8	MPM	1478
537	Sand and Gravel	6600	PF 9	MPM	2642
538	Sand and Gravel	6600	PF 10	MPM	3965
539					
540	Sand and Gravel	6500	PF 1	MPM	20.44
541	Sand and Gravel	6500	PF 2	MPM	56.97
542	Sand and Gravel	6500	PF 3	MPM	171.8
543	Sand and Gravel	6500	PF 4	MPM	313.0
544	Sand and Gravel	6500	PF 5	MPM	493.4
545	Sand and Gravel	6500	PF 6	MPM	680.7
546	Sand and Gravel	6500	PF 7	MPM	951.5
547	Sand and Gravel	6500	PF 8	MPM	1334
548	Sand and Gravel	6500	PF 9	MPM	2594
549	Sand and Gravel	6500	PF 10	MPM	3683
550					
551	Sand and Gravel	6400	PF 1	MPM	518.9
552	Sand and Gravel	6400	PF 2	MPM	586.6
553	Sand and Gravel	6400	PF 3	MPM	3006
554	Sand and Gravel	6400	PF 4	MPM	5999
555	Sand and Gravel	6400	PF 5	MPM	7218
556	Sand and Gravel	6400	PF 6	MPM	8327
557	Sand and Gravel	6400	PF 7	MPM	9110
558	Sand and Gravel	6400	PF 8	MPM	11930
559	Sand and Gravel	6400	PF 9	MPM	18110
560	Sand and Gravel	6400	PF 10	MPM	23910
561					
562	Sand and Gravel	6300.0...	PF 1	MPM	261.8
563	Sand and Gravel	6300.0...	PF 2	MPM	339.7
564	Sand and Gravel	6300.0...	PF 3	MPM	182.8
565	Sand and Gravel	6300.0...	PF 4	MPM	250.5

566	Sand and Gravel	6300.0...	PF 5	MPM	323.0
567	Sand and Gravel	6300.0...	PF 6	MPM	424.8
568	Sand and Gravel	6300.0...	PF 7	MPM	534.0
569	Sand and Gravel	6300.0...	PF 8	MPM	717.0
570	Sand and Gravel	6300.0...	PF 9	MPM	1242
571	Sand and Gravel	6300.0...	PF 10	MPM	1679
572					
573	Sand and Gravel	6200	PF 1	MPM	0
574	Sand and Gravel	6200	PF 2	MPM	.01774
575	Sand and Gravel	6200	PF 3	MPM	.6654
576	Sand and Gravel	6200	PF 4	MPM	8.608
577	Sand and Gravel	6200	PF 5	MPM	30.58
578	Sand and Gravel	6200	PF 6	MPM	69.24
579	Sand and Gravel	6200	PF 7	MPM	127.1
580	Sand and Gravel	6200	PF 8	MPM	230.3
581	Sand and Gravel	6200	PF 9	MPM	705.6
582	Sand and Gravel	6200	PF 10	MPM	1368
583					
584	Sand and Gravel	6099.5...	PF 1	MPM	2673
585	Sand and Gravel	6099.5...	PF 2	MPM	2367
586	Sand and Gravel	6099.5...	PF 3	MPM	2945
587	Sand and Gravel	6099.5...	PF 4	MPM	3470
588	Sand and Gravel	6099.5...	PF 5	MPM	2817
589	Sand and Gravel	6099.5...	PF 6	MPM	2298
590	Sand and Gravel	6099.5...	PF 7	MPM	2376
591	Sand and Gravel	6099.5...	PF 8	MPM	2575
592	Sand and Gravel	6099.5...	PF 9	MPM	2673
593	Sand and Gravel	6099.5...	PF 10	MPM	3352
594					
595	Sand and Gravel	5999.6...	PF 1	MPM	2.216
596	Sand and Gravel	5999.6...	PF 2	MPM	11.18
597	Sand and Gravel	5999.6...	PF 3	MPM	52.81
598	Sand and Gravel	5999.6...	PF 4	MPM	181.0
599	Sand and Gravel	5999.6...	PF 5	MPM	378.6
600	Sand and Gravel	5999.6...	PF 6	MPM	622.0
601	Sand and Gravel	5999.6...	PF 7	MPM	983.6
602	Sand and Gravel	5999.6...	PF 8	MPM	1743
603	Sand and Gravel	5999.6...	PF 9	MPM	2842
604	Sand and Gravel	5999.6...	PF 10	MPM	2868
605					
606	Sand and Gravel	5900	PF 1	MPM	937.4
607	Sand and Gravel	5900	PF 2	MPM	1312
608	Sand and Gravel	5900	PF 3	MPM	2550
609	Sand and Gravel	5900	PF 4	MPM	5132
610	Sand and Gravel	5900	PF 5	MPM	6795
611	Sand and Gravel	5900	PF 6	MPM	8299
612	Sand and Gravel	5900	PF 7	MPM	8157
613	Sand and Gravel	5900	PF 8	MPM	4784

614	Sand and Gravel	5900	PF 9	MPM	2783
615	Sand and Gravel	5900	PF 10	MPM	1551
616					
617	Sand and Gravel	5800	PF 1	MPM	.05614
618	Sand and Gravel	5800	PF 2	MPM	.6456
619	Sand and Gravel	5800	PF 3	MPM	11.04
620	Sand and Gravel	5800	PF 4	MPM	43.63
621	Sand and Gravel	5800	PF 5	MPM	84.73
622	Sand and Gravel	5800	PF 6	MPM	143.2
623	Sand and Gravel	5800	PF 7	MPM	208.6
624	Sand and Gravel	5800	PF 8	MPM	318.6
625	Sand and Gravel	5800	PF 9	MPM	11.46
626	Sand and Gravel	5800	PF 10	MPM	3.395
627					
628	Sand and Gravel	5700.1...	PF 1	MPM	990.5
629	Sand and Gravel	5700.1...	PF 2	MPM	1166
630	Sand and Gravel	5700.1...	PF 3	MPM	669.1
631	Sand and Gravel	5700.1...	PF 4	MPM	765.4
632	Sand and Gravel	5700.1...	PF 5	MPM	813.4
633	Sand and Gravel	5700.1...	PF 6	MPM	830.5
634	Sand and Gravel	5700.1...	PF 7	MPM	891.5
635	Sand and Gravel	5700.1...	PF 8	MPM	1011
636	Sand and Gravel	5700.1...	PF 9	MPM	1383
637	Sand and Gravel	5700.1...	PF 10	MPM	.00144...
638					
639	Sand and Gravel	5600	PF 1	MPM	1.109
640	Sand and Gravel	5600	PF 2	MPM	5.081
641	Sand and Gravel	5600	PF 3	MPM	38.28
642	Sand and Gravel	5600	PF 4	MPM	129.6
643	Sand and Gravel	5600	PF 5	MPM	233.5
644	Sand and Gravel	5600	PF 6	MPM	349.9
645	Sand and Gravel	5600	PF 7	MPM	475.6
646	Sand and Gravel	5600	PF 8	MPM	671.6
647	Sand and Gravel	5600	PF 9	MPM	0
648	Sand and Gravel	5600	PF 10	MPM	0
649					
650	Sand and Gravel	5500	PF 1	MPM	88.06
651	Sand and Gravel	5500	PF 2	MPM	47.87
652	Sand and Gravel	5500	PF 3	MPM	82.56
653	Sand and Gravel	5500	PF 4	MPM	164.6
654	Sand and Gravel	5500	PF 5	MPM	246.6
655	Sand and Gravel	5500	PF 6	MPM	336.7
656	Sand and Gravel	5500	PF 7	MPM	435.5
657	Sand and Gravel	5500	PF 8	MPM	589.0
658	Sand and Gravel	5500	PF 9	MPM	0
659	Sand and Gravel	5500	PF 10	MPM	.01901
660					
661	Sand and Gravel	5400	PF 1	MPM	23.04

662	Sand and Gravel	5400	PF 2	MPM	45.60
663	Sand and Gravel	5400	PF 3	MPM	161.8
664	Sand and Gravel	5400	PF 4	MPM	480.6
665	Sand and Gravel	5400	PF 5	MPM	822.6
666	Sand and Gravel	5400	PF 6	MPM	1178
667	Sand and Gravel	5400	PF 7	MPM	1543
668	Sand and Gravel	5400	PF 8	MPM	2069
669	Sand and Gravel	5400	PF 9	MPM	3210
670	Sand and Gravel	5400	PF 10	MPM	9022
671					
672	Sand and Gravel	5306.7...	PF 1	MPM	5.194
673	Sand and Gravel	5306.7...	PF 2	MPM	18.28
674	Sand and Gravel	5306.7...	PF 3	MPM	114.2
675	Sand and Gravel	5306.7...	PF 4	MPM	369.1
676	Sand and Gravel	5306.7...	PF 5	MPM	544.7
677	Sand and Gravel	5306.7...	PF 6	MPM	724.4
678	Sand and Gravel	5306.7...	PF 7	MPM	928.1
679	Sand and Gravel	5306.7...	PF 8	MPM	1248
680	Sand and Gravel	5306.7...	PF 9	MPM	1942
681	Sand and Gravel	5306.7...	PF 10	MPM	.00015...
682					
683	Sand and Gravel	5200.1...	PF 1	MPM	3552
684	Sand and Gravel	5200.1...	PF 2	MPM	2873
685	Sand and Gravel	5200.1...	PF 3	MPM	1235
686	Sand and Gravel	5200.1...	PF 4	MPM	661.4
687	Sand and Gravel	5200.1...	PF 5	MPM	587.8
688	Sand and Gravel	5200.1...	PF 6	MPM	721.8
689	Sand and Gravel	5200.1...	PF 7	MPM	882.6
690	Sand and Gravel	5200.1...	PF 8	MPM	1159
691	Sand and Gravel	5200.1...	PF 9	MPM	1656
692	Sand and Gravel	5200.1...	PF 10	MPM	0
693					
694	Sand and Gravel	5100	PF 1	MPM	9.532
695	Sand and Gravel	5100	PF 2	MPM	40.38
696	Sand and Gravel	5100	PF 3	MPM	167.1
697	Sand and Gravel	5100	PF 4	MPM	337.8
698	Sand and Gravel	5100	PF 5	MPM	497.0
699	Sand and Gravel	5100	PF 6	MPM	956.2
700	Sand and Gravel	5100	PF 7	MPM	1635
701	Sand and Gravel	5100	PF 8	MPM	3540
702	Sand and Gravel	5100	PF 9	MPM	12820
703	Sand and Gravel	5100	PF 10	MPM	22770
704					
705	Sand and Gravel	5052.7...	PF 1	MPM	1005
706	Sand and Gravel	5052.7...	PF 2	MPM	1539
707	Sand and Gravel	5052.7...	PF 3	MPM	3017
708	Sand and Gravel	5052.7...	PF 4	MPM	5646
709	Sand and Gravel	5052.7...	PF 5	MPM	7351

710	Sand and Gravel	5052.7...	PF 6	MPM	4042
711	Sand and Gravel	5052.7...	PF 7	MPM	4336
712	Sand and Gravel	5052.7...	PF 8	MPM	5064
713	Sand and Gravel	5052.7...	PF 9	MPM	7305
714	Sand and Gravel	5052.7...	PF 10	MPM	34190
715					
716	Sand and Gravel	4998.9...	PF 1	MPM	837.7
717	Sand and Gravel	4998.9...	PF 2	MPM	966.1
718	Sand and Gravel	4998.9...	PF 3	MPM	7856
719	Sand and Gravel	4998.9...	PF 4	MPM	34920
720	Sand and Gravel	4998.9...	PF 5	MPM	80290
721	Sand and Gravel	4998.9...	PF 6	MPM	583.4
722	Sand and Gravel	4998.9...	PF 7	MPM	408.3
723	Sand and Gravel	4998.9...	PF 8	MPM	326.1
724	Sand and Gravel	4998.9...	PF 9	MPM	353.3
725	Sand and Gravel	4998.9...	PF 10	MPM	451.3
726					
727	Sand and Gravel	4899.9...	PF 1	MPM	16.59
728	Sand and Gravel	4899.9...	PF 2	MPM	16.24
729	Sand and Gravel	4899.9...	PF 3	MPM	29.75
730	Sand and Gravel	4899.9...	PF 4	MPM	50.91
731	Sand and Gravel	4899.9...	PF 5	MPM	73.45
732	Sand and Gravel	4899.9...	PF 6	MPM	83.56
733	Sand and Gravel	4899.9...	PF 7	MPM	93.24
734	Sand and Gravel	4899.9...	PF 8	MPM	112.9
735	Sand and Gravel	4899.9...	PF 9	MPM	209.9
736	Sand and Gravel	4899.9...	PF 10	MPM	330.5
737					
738	Sand and Gravel	4699.7...	PF 1	MPM	.05575
739	Sand and Gravel	4699.7...	PF 2	MPM	.5471
740	Sand and Gravel	4699.7...	PF 3	MPM	6.389
741	Sand and Gravel	4699.7...	PF 4	MPM	28.49
742	Sand and Gravel	4699.7...	PF 5	MPM	65.37
743	Sand and Gravel	4699.7...	PF 6	MPM	101.2
744	Sand and Gravel	4699.7...	PF 7	MPM	139.9
745	Sand and Gravel	4699.7...	PF 8	MPM	211.4
746	Sand and Gravel	4699.7...	PF 9	MPM	552.8
747	Sand and Gravel	4699.7...	PF 10	MPM	1055
748					
749	Sand and Gravel	4600	PF 1	MPM	.05880
750	Sand and Gravel	4600	PF 2	MPM	.4146
751	Sand and Gravel	4600	PF 3	MPM	4.251
752	Sand and Gravel	4600	PF 4	MPM	20.59
753	Sand and Gravel	4600	PF 5	MPM	49.79
754	Sand and Gravel	4600	PF 6	MPM	80.87
755	Sand and Gravel	4600	PF 7	MPM	113.5
756	Sand and Gravel	4600	PF 8	MPM	162.6
757	Sand and Gravel	4600	PF 9	MPM	2.321

758	Sand and Gravel	4600	PF 10	MPM	.3063
759					
760	Sand and Gravel	4510.0...	PF 1	MPM	8.403
761	Sand and Gravel	4510.0...	PF 2	MPM	37.41
762	Sand and Gravel	4510.0...	PF 3	MPM	219.9
763	Sand and Gravel	4510.0...	PF 4	MPM	860.3
764	Sand and Gravel	4510.0...	PF 5	MPM	2812
765	Sand and Gravel	4510.0...	PF 6	MPM	6409
766	Sand and Gravel	4510.0...	PF 7	MPM	8381
767	Sand and Gravel	4510.0...	PF 8	MPM	9746
768	Sand and Gravel	4510.0...	PF 9	MPM	9726
769	Sand and Gravel	4510.0...	PF 10	MPM	2764
770					
771	Sand and Gravel	4400.2...	PF 1	MPM	1621
772	Sand and Gravel	4400.2...	PF 2	MPM	2223
773	Sand and Gravel	4400.2...	PF 3	MPM	3823
774	Sand and Gravel	4400.2...	PF 4	MPM	5465
775	Sand and Gravel	4400.2...	PF 5	MPM	2581
776	Sand and Gravel	4400.2...	PF 6	MPM	2237
777	Sand and Gravel	4400.2...	PF 7	MPM	2180
778	Sand and Gravel	4400.2...	PF 8	MPM	2264
779	Sand and Gravel	4400.2...	PF 9	MPM	3141
780	Sand and Gravel	4400.2...	PF 10	MPM	4455
781					
782	Sand and Gravel	4194.2...	PF 1	MPM	.03959
783	Sand and Gravel	4194.2...	PF 2	MPM	.5341
784	Sand and Gravel	4194.2...	PF 3	MPM	8.630
785	Sand and Gravel	4194.2...	PF 4	MPM	45.08
786	Sand and Gravel	4194.2...	PF 5	MPM	103.9
787	Sand and Gravel	4194.2...	PF 6	MPM	175.6
788	Sand and Gravel	4194.2...	PF 7	MPM	261.8
789	Sand and Gravel	4194.2...	PF 8	MPM	400.9
790	Sand and Gravel	4194.2...	PF 9	MPM	931.8
791	Sand and Gravel	4194.2...	PF 10	MPM	1579
792					
793	Sand and Gravel	4103.1...	PF 1	MPM	.9005
794	Sand and Gravel	4103.1...	PF 2	MPM	5.857
795	Sand and Gravel	4103.1...	PF 3	MPM	29.13
796	Sand and Gravel	4103.1...	PF 4	MPM	67.84
797	Sand and Gravel	4103.1...	PF 5	MPM	102.5
798	Sand and Gravel	4103.1...	PF 6	MPM	135.0
799	Sand and Gravel	4103.1...	PF 7	MPM	164.5
800	Sand and Gravel	4103.1...	PF 8	MPM	198.0
801	Sand and Gravel	4103.1...	PF 9	MPM	308.9
802	Sand and Gravel	4103.1...	PF 10	MPM	412.6
803					
804	Sand and Gravel	4016.1...	PF 1	MPM	.00769...
805	Sand and Gravel	4016.1...	PF 2	MPM	.1025

806	Sand and Gravel	4016.1...	PF 3	MPM	2.451
807	Sand and Gravel	4016.1...	PF 4	MPM	13.18
808	Sand and Gravel	4016.1...	PF 5	MPM	29.78
809	Sand and Gravel	4016.1...	PF 6	MPM	48.14
810	Sand and Gravel	4016.1...	PF 7	MPM	67.43
811	Sand and Gravel	4016.1...	PF 8	MPM	92.65
812	Sand and Gravel	4016.1...	PF 9	MPM	178.0
813	Sand and Gravel	4016.1...	PF 10	MPM	269.2
814					
815	Sand and Gravel	3901.4...	PF 1	MPM	.00072...
816	Sand and Gravel	3901.4...	PF 2	MPM	.04946
817	Sand and Gravel	3901.4...	PF 3	MPM	2.070
818	Sand and Gravel	3901.4...	PF 4	MPM	19.14
819	Sand and Gravel	3901.4...	PF 5	MPM	53.93
820	Sand and Gravel	3901.4...	PF 6	MPM	105.6
821	Sand and Gravel	3901.4...	PF 7	MPM	170.3
822	Sand and Gravel	3901.4...	PF 8	MPM	281.2
823	Sand and Gravel	3901.4...	PF 9	MPM	679.7
824	Sand and Gravel	3901.4...	PF 10	MPM	709.0
825					
826	Sand and Gravel	3801.2...	PF 1	MPM	.02687
827	Sand and Gravel	3801.2...	PF 2	MPM	.4992
828	Sand and Gravel	3801.2...	PF 3	MPM	9.982
829	Sand and Gravel	3801.2...	PF 4	MPM	26.42
830	Sand and Gravel	3801.2...	PF 5	MPM	37.80
831	Sand and Gravel	3801.2...	PF 6	MPM	48.48
832	Sand and Gravel	3801.2...	PF 7	MPM	59.25
833	Sand and Gravel	3801.2...	PF 8	MPM	108.8
834	Sand and Gravel	3801.2...	PF 9	MPM	122.7
835	Sand and Gravel	3801.2...	PF 10	MPM	100.8
836					
837	Sand and Gravel	3700.0...	PF 1	MPM	.00107...
838	Sand and Gravel	3700.0...	PF 2	MPM	.05567
839	Sand and Gravel	3700.0...	PF 3	MPM	2.433
840	Sand and Gravel	3700.0...	PF 4	MPM	8.314
841	Sand and Gravel	3700.0...	PF 5	MPM	13.17
842	Sand and Gravel	3700.0...	PF 6	MPM	17.29
843	Sand and Gravel	3700.0...	PF 7	MPM	20.93
844	Sand and Gravel	3700.0...	PF 8	MPM	32.68
845	Sand and Gravel	3700.0...	PF 9	MPM	40.59
846	Sand and Gravel	3700.0...	PF 10	MPM	44.52
847					
848	Sand and Gravel	3599.3...	PF 1	MPM	.00005...
849	Sand and Gravel	3599.3...	PF 2	MPM	.03984
850	Sand and Gravel	3599.3...	PF 3	MPM	2.055
851	Sand and Gravel	3599.3...	PF 4	MPM	17.85
852	Sand and Gravel	3599.3...	PF 5	MPM	44.73
853	Sand and Gravel	3599.3...	PF 6	MPM	73.63

854	Sand and Gravel	3599.3...	PF 7	MPM	98.47
855	Sand and Gravel	3599.3...	PF 8	MPM	128.8
856	Sand and Gravel	3599.3...	PF 9	MPM	186.3
857	Sand and Gravel	3599.3...	PF 10	MPM	227.4
858					
859	Sand and Gravel	3526.6...	PF 1	MPM	0
860	Sand and Gravel	3526.6...	PF 2	MPM	0
861	Sand and Gravel	3526.6...	PF 3	MPM	.04081
862	Sand and Gravel	3526.6...	PF 4	MPM	.6039
863	Sand and Gravel	3526.6...	PF 5	MPM	2.401
864	Sand and Gravel	3526.6...	PF 6	MPM	5.888
865	Sand and Gravel	3526.6...	PF 7	MPM	10.49
866	Sand and Gravel	3526.6...	PF 8	MPM	19.43
867	Sand and Gravel	3526.6...	PF 9	MPM	56.69
868	Sand and Gravel	3526.6...	PF 10	MPM	92.01
869					
870	Sand and Gravel	3399.0...	PF 1	MPM	0
871	Sand and Gravel	3399.0...	PF 2	MPM	.02453
872	Sand and Gravel	3399.0...	PF 3	MPM	1.702
873	Sand and Gravel	3399.0...	PF 4	MPM	24.45
874	Sand and Gravel	3399.0...	PF 5	MPM	75.93
875	Sand and Gravel	3399.0...	PF 6	MPM	139.1
876	Sand and Gravel	3399.0...	PF 7	MPM	197.0
877	Sand and Gravel	3399.0...	PF 8	MPM	266.1
878	Sand and Gravel	3399.0...	PF 9	MPM	388.0
879	Sand and Gravel	3399.0...	PF 10	MPM	0
880					
881	Sand and Gravel	3299.8...	PF 1	MPM	0
882	Sand and Gravel	3299.8...	PF 2	MPM	0
883	Sand and Gravel	3299.8...	PF 3	MPM	.00397...
884	Sand and Gravel	3299.8...	PF 4	MPM	.1205
885	Sand and Gravel	3299.8...	PF 5	MPM	.7802
886	Sand and Gravel	3299.8...	PF 6	MPM	2.293
887	Sand and Gravel	3299.8...	PF 7	MPM	5.108
888	Sand and Gravel	3299.8...	PF 8	MPM	0
889	Sand and Gravel	3299.8...	PF 9	MPM	0
890	Sand and Gravel	3299.8...	PF 10	MPM	0
891					
892	Sand and Gravel	3214.6...	PF 1	MPM	0
893	Sand and Gravel	3214.6...	PF 2	MPM	0
894	Sand and Gravel	3214.6...	PF 3	MPM	.06433
895	Sand and Gravel	3214.6...	PF 4	MPM	1.536
896	Sand and Gravel	3214.6...	PF 5	MPM	7.099
897	Sand and Gravel	3214.6...	PF 6	MPM	17.37
898	Sand and Gravel	3214.6...	PF 7	MPM	28.47
899	Sand and Gravel	3214.6...	PF 8	MPM	46.11
900	Sand and Gravel	3214.6...	PF 9	MPM	117.9
901	Sand and Gravel	3214.6...	PF 10	MPM	144.1

902					
903	Sand and Gravel	3148.1...	PF 1	MPM	0
904	Sand and Gravel	3148.1...	PF 2	MPM	0
905	Sand and Gravel	3148.1...	PF 3	MPM	.00150...
906	Sand and Gravel	3148.1...	PF 4	MPM	.08974
907	Sand and Gravel	3148.1...	PF 5	MPM	.6324
908	Sand and Gravel	3148.1...	PF 6	MPM	2.165
909	Sand and Gravel	3148.1...	PF 7	MPM	0
910	Sand and Gravel	3148.1...	PF 8	MPM	0
911	Sand and Gravel	3148.1...	PF 9	MPM	0
912	Sand and Gravel	3148.1...	PF 10	MPM	0
913					
914	Sand and Gravel	3110.3...	PF 1	MPM	0
915	Sand and Gravel	3110.3...	PF 2	MPM	.01010
916	Sand and Gravel	3110.3...	PF 3	MPM	.4042
917	Sand and Gravel	3110.3...	PF 4	MPM	4.430
918	Sand and Gravel	3110.3...	PF 5	MPM	12.89
919	Sand and Gravel	3110.3...	PF 6	MPM	26.55
920	Sand and Gravel	3110.3...	PF 7	MPM	0
921	Sand and Gravel	3110.3...	PF 8	MPM	0
922	Sand and Gravel	3110.3...	PF 9	MPM	0
923	Sand and Gravel	3110.3...	PF 10	MPM	0
924					
925	Sand and Gravel	3078.7...	PF 1	MPM	11.52
926	Sand and Gravel	3078.7...	PF 2	MPM	42.34
927	Sand and Gravel	3078.7...	PF 3	MPM	165.6
928	Sand and Gravel	3078.7...	PF 4	MPM	347.6
929	Sand and Gravel	3078.7...	PF 5	MPM	521.2
930	Sand and Gravel	3078.7...	PF 6	MPM	667.2
931	Sand and Gravel	3078.7...	PF 7	MPM	808.8
932	Sand and Gravel	3078.7...	PF 8	MPM	983.8
933	Sand and Gravel	3078.7...	PF 9	MPM	1433
934	Sand and Gravel	3078.7...	PF 10	MPM	1794
935					
936	Sand and Gravel	3076.7...	PF 1	MPM	1295
937	Sand and Gravel	3076.7...	PF 2	MPM	1443
938	Sand and Gravel	3076.7...	PF 3	MPM	2274
939	Sand and Gravel	3076.7...	PF 4	MPM	3761
940	Sand and Gravel	3076.7...	PF 5	MPM	4836
941	Sand and Gravel	3076.7...	PF 6	MPM	6095
942	Sand and Gravel	3076.7...	PF 7	MPM	7303
943	Sand and Gravel	3076.7...	PF 8	MPM	9297
944	Sand and Gravel	3076.7...	PF 9	MPM	13440
945	Sand and Gravel	3076.7...	PF 10	MPM	17730
946					
947	Sand and Gravel	3076.2...	PF 1	MPM	1086
948	Sand and Gravel	3076.2...	PF 2	MPM	1634
949	Sand and Gravel	3076.2...	PF 3	MPM	2273

950	Sand and Gravel	3076.2...	PF 4	MPM	3468
951	Sand and Gravel	3076.2...	PF 5	MPM	5146
952	Sand and Gravel	3076.2...	PF 6	MPM	6004
953	Sand and Gravel	3076.2...	PF 7	MPM	7647
954	Sand and Gravel	3076.2...	PF 8	MPM	8744
955	Sand and Gravel	3076.2...	PF 9	MPM	13180
956	Sand and Gravel	3076.2...	PF 10	MPM	18080
957					
958	Sand and Gravel	3075.6...	PF 1	MPM	1213
959	Sand and Gravel	3075.6...	PF 2	MPM	1506
960	Sand and Gravel	3075.6...	PF 3	MPM	2298
961	Sand and Gravel	3075.6...	PF 4	MPM	3608
962	Sand and Gravel	3075.6...	PF 5	MPM	4864
963	Sand and Gravel	3075.6...	PF 6	MPM	6439
964	Sand and Gravel	3075.6...	PF 7	MPM	7776
965	Sand and Gravel	3075.6...	PF 8	MPM	8743
966	Sand and Gravel	3075.6...	PF 9	MPM	13610
967	Sand and Gravel	3075.6...	PF 10	MPM	18080
968					
969	Sand and Gravel	3075.1...	PF 1	MPM	1086
970	Sand and Gravel	3075.1...	PF 2	MPM	1568
971	Sand and Gravel	3075.1...	PF 3	MPM	2380
972	Sand and Gravel	3075.1...	PF 4	MPM	3604
973	Sand and Gravel	3075.1...	PF 5	MPM	4714
974	Sand and Gravel	3075.1...	PF 6	MPM	6152
975	Sand and Gravel	3075.1...	PF 7	MPM	7060
976	Sand and Gravel	3075.1...	PF 8	MPM	9013
977	Sand and Gravel	3075.1...	PF 9	MPM	14630
978	Sand and Gravel	3075.1...	PF 10	MPM	17790
979					
980	Sand and Gravel	3074.5...	PF 1	MPM	1091
981	Sand and Gravel	3074.5...	PF 2	MPM	1516
982	Sand and Gravel	3074.5...	PF 3	MPM	2441
983	Sand and Gravel	3074.5...	PF 4	MPM	3416
984	Sand and Gravel	3074.5...	PF 5	MPM	5151
985	Sand and Gravel	3074.5...	PF 6	MPM	5922
986	Sand and Gravel	3074.5...	PF 7	MPM	7130
987	Sand and Gravel	3074.5...	PF 8	MPM	8723
988	Sand and Gravel	3074.5...	PF 9	MPM	13320
989	Sand and Gravel	3074.5...	PF 10	MPM	19140
990					
991	Sand and Gravel	3074.0...	PF 1	MPM	1181
992	Sand and Gravel	3074.0...	PF 2	MPM	1484
993	Sand and Gravel	3074.0...	PF 3	MPM	2482
994	Sand and Gravel	3074.0...	PF 4	MPM	3426
995	Sand and Gravel	3074.0...	PF 5	MPM	4649
996	Sand and Gravel	3074.0...	PF 6	MPM	5789
997	Sand and Gravel	3074.0...	PF 7	MPM	7025

998	Sand and Gravel	3074.0...	PF 8	MPM	8590
999	Sand and Gravel	3074.0...	PF 9	MPM	13310
1000	Sand and Gravel	3074.0...	PF 10	MPM	48100
1001					
1002	Sand and Gravel	3073.4...	PF 1	MPM	915.8
1003	Sand and Gravel	3073.4...	PF 2	MPM	1915
1004	Sand and Gravel	3073.4...	PF 3	MPM	2437
1005	Sand and Gravel	3073.4...	PF 4	MPM	3616
1006	Sand and Gravel	3073.4...	PF 5	MPM	4970
1007	Sand and Gravel	3073.4...	PF 6	MPM	5960
1008	Sand and Gravel	3073.4...	PF 7	MPM	7139
1009	Sand and Gravel	3073.4...	PF 8	MPM	35670
1010	Sand and Gravel	3073.4...	PF 9	MPM	41800
1011	Sand and Gravel	3073.4...	PF 10	MPM	76020
1012					
1013	Sand and Gravel	3072.9...	PF 1	MPM	57400
1014	Sand and Gravel	3072.9...	PF 2	MPM	50460
1015	Sand and Gravel	3072.9...	PF 3	MPM	37970
1016	Sand and Gravel	3072.9...	PF 4	MPM	33380
1017	Sand and Gravel	3072.9...	PF 5	MPM	32960
1018	Sand and Gravel	3072.9...	PF 6	MPM	33210
1019	Sand and Gravel	3072.9...	PF 7	MPM	34170
1020	Sand and Gravel	3072.9...	PF 8	MPM	64100
1021	Sand and Gravel	3072.9...	PF 9	MPM	69950
1022	Sand and Gravel	3072.9...	PF 10	MPM	105500
1023					
1024	Sand and Gravel	3072.3...	PF 1	MPM	111500
1025	Sand and Gravel	3072.3...	PF 2	MPM	109200
1026	Sand and Gravel	3072.3...	PF 3	MPM	90280
1027	Sand and Gravel	3072.3...	PF 4	MPM	73610
1028	Sand and Gravel	3072.3...	PF 5	MPM	68380
1029	Sand and Gravel	3072.3...	PF 6	MPM	66120
1030	Sand and Gravel	3072.3...	PF 7	MPM	64240
1031	Sand and Gravel	3072.3...	PF 8	MPM	97390
1032	Sand and Gravel	3072.3...	PF 9	MPM	100700
1033	Sand and Gravel	3072.3...	PF 10	MPM	136700
1034					
1035	Sand and Gravel	3071.8...	PF 1	MPM	144800
1036	Sand and Gravel	3071.8...	PF 2	MPM	138000
1037	Sand and Gravel	3071.8...	PF 3	MPM	148700
1038	Sand and Gravel	3071.8...	PF 4	MPM	122900
1039	Sand and Gravel	3071.8...	PF 5	MPM	110500
1040	Sand and Gravel	3071.8...	PF 6	MPM	104400
1041	Sand and Gravel	3071.8...	PF 7	MPM	99800
1042	Sand and Gravel	3071.8...	PF 8	MPM	133600
1043	Sand and Gravel	3071.8...	PF 9	MPM	133400
1044	Sand and Gravel	3071.8...	PF 10	MPM	169300
1045					

1046	Sand and Gravel	3071.2...	PF 1	MPM	184600
1047	Sand and Gravel	3071.2...	PF 2	MPM	154900
1048	Sand and Gravel	3071.2...	PF 3	MPM	193100
1049	Sand and Gravel	3071.2...	PF 4	MPM	175100
1050	Sand and Gravel	3071.2...	PF 5	MPM	155900
1051	Sand and Gravel	3071.2...	PF 6	MPM	148000
1052	Sand and Gravel	3071.2...	PF 7	MPM	139500
1053	Sand and Gravel	3071.2...	PF 8	MPM	173800
1054	Sand and Gravel	3071.2...	PF 9	MPM	169300
1055	Sand and Gravel	3071.2...	PF 10	MPM	205800
1056					
1057	Sand and Gravel	3070.7...	PF 1	MPM	231500
1058	Sand and Gravel	3070.7...	PF 2	MPM	183800
1059	Sand and Gravel	3070.7...	PF 3	MPM	237200
1060	Sand and Gravel	3070.7...	PF 4	MPM	230500
1061	Sand and Gravel	3070.7...	PF 5	MPM	208400
1062	Sand and Gravel	3070.7...	PF 6	MPM	194400
1063	Sand and Gravel	3070.7...	PF 7	MPM	183700
1064	Sand and Gravel	3070.7...	PF 8	MPM	217300
1065	Sand and Gravel	3070.7...	PF 9	MPM	206600
1066	Sand and Gravel	3070.7...	PF 10	MPM	242100
1067					
1068	Sand and Gravel	3070.1...	PF 1	MPM	260900
1069	Sand and Gravel	3070.1...	PF 2	MPM	197100
1070	Sand and Gravel	3070.1...	PF 3	MPM	259700
1071	Sand and Gravel	3070.1...	PF 4	MPM	274100
1072	Sand and Gravel	3070.1...	PF 5	MPM	258800
1073	Sand and Gravel	3070.1...	PF 6	MPM	244700
1074	Sand and Gravel	3070.1...	PF 7	MPM	229000
1075	Sand and Gravel	3070.1...	PF 8	MPM	262700
1076	Sand and Gravel	3070.1...	PF 9	MPM	245400
1077	Sand and Gravel	3070.1...	PF 10	MPM	280700
1078					
1079	Sand and Gravel	3069.6...	PF 1	MPM	303100
1080	Sand and Gravel	3069.6...	PF 2	MPM	217200
1081	Sand and Gravel	3069.6...	PF 3	MPM	277800
1082	Sand and Gravel	3069.6...	PF 4	MPM	321700
1083	Sand and Gravel	3069.6...	PF 5	MPM	311200
1084	Sand and Gravel	3069.6...	PF 6	MPM	295000
1085	Sand and Gravel	3069.6...	PF 7	MPM	276000
1086	Sand and Gravel	3069.6...	PF 8	MPM	308600
1087	Sand and Gravel	3069.6...	PF 9	MPM	286500
1088	Sand and Gravel	3069.6...	PF 10	MPM	320900
1089					
1090	Sand and Gravel	3069.0...	PF 1	MPM	327200
1091	Sand and Gravel	3069.0...	PF 2	MPM	243100
1092	Sand and Gravel	3069.0...	PF 3	MPM	300600
1093	Sand and Gravel	3069.0...	PF 4	MPM	367500

1094	Sand and Gravel	3069.0...	PF 5	MPM	362200
1095	Sand and Gravel	3069.0...	PF 6	MPM	343300
1096	Sand and Gravel	3069.0...	PF 7	MPM	326100
1097	Sand and Gravel	3069.0...	PF 8	MPM	358900
1098	Sand and Gravel	3069.0...	PF 9	MPM	329900
1099	Sand and Gravel	3069.0...	PF 10	MPM	361600
1100					
1101	Sand and Gravel	3068.5...	PF 1	MPM	353700
1102	Sand and Gravel	3068.5...	PF 2	MPM	262100
1103	Sand and Gravel	3068.5...	PF 3	MPM	289200
1104	Sand and Gravel	3068.5...	PF 4	MPM	398800
1105	Sand and Gravel	3068.5...	PF 5	MPM	403500
1106	Sand and Gravel	3068.5...	PF 6	MPM	391600
1107	Sand and Gravel	3068.5...	PF 7	MPM	373800
1108	Sand and Gravel	3068.5...	PF 8	MPM	404900
1109	Sand and Gravel	3068.5...	PF 9	MPM	373500
1110	Sand and Gravel	3068.5...	PF 10	MPM	403900
1111					
1112	Sand and Gravel	3067.9...	PF 1	MPM	370200
1113	Sand and Gravel	3067.9...	PF 2	MPM	275900
1114	Sand and Gravel	3067.9...	PF 3	MPM	311600
1115	Sand and Gravel	3067.9...	PF 4	MPM	432000
1116	Sand and Gravel	3067.9...	PF 5	MPM	452800
1117	Sand and Gravel	3067.9...	PF 6	MPM	439100
1118	Sand and Gravel	3067.9...	PF 7	MPM	425900
1119	Sand and Gravel	3067.9...	PF 8	MPM	457300
1120	Sand and Gravel	3067.9...	PF 9	MPM	419300
1121	Sand and Gravel	3067.9...	PF 10	MPM	446400
1122					
1123	Sand and Gravel	3067.4...	PF 1	MPM	389300
1124	Sand and Gravel	3067.4...	PF 2	MPM	300000
1125	Sand and Gravel	3067.4...	PF 3	MPM	317200
1126	Sand and Gravel	3067.4...	PF 4	MPM	455400
1127	Sand and Gravel	3067.4...	PF 5	MPM	492800
1128	Sand and Gravel	3067.4...	PF 6	MPM	486900
1129	Sand and Gravel	3067.4...	PF 7	MPM	473200
1130	Sand and Gravel	3067.4...	PF 8	MPM	502900
1131	Sand and Gravel	3067.4...	PF 9	MPM	465700
1132	Sand and Gravel	3067.4...	PF 10	MPM	489500
1133					
1134	Sand and Gravel	3066.8...	PF 1	MPM	417000
1135	Sand and Gravel	3066.8...	PF 2	MPM	324100
1136	Sand and Gravel	3066.8...	PF 3	MPM	317300
1137	Sand and Gravel	3066.8...	PF 4	MPM	466400
1138	Sand and Gravel	3066.8...	PF 5	MPM	518500
1139	Sand and Gravel	3066.8...	PF 6	MPM	526700
1140	Sand and Gravel	3066.8...	PF 7	MPM	520800
1141	Sand and Gravel	3066.8...	PF 8	MPM	549300

1142	Sand and Gravel	3066.8...	PF 9	MPM	511200
1143	Sand and Gravel	3066.8...	PF 10	MPM	534100
1144					
1145	Sand and Gravel	3066.3...	PF 1	MPM	449200
1146	Sand and Gravel	3066.3...	PF 2	MPM	349900
1147	Sand and Gravel	3066.3...	PF 3	MPM	332000
1148	Sand and Gravel	3066.3...	PF 4	MPM	487400
1149	Sand and Gravel	3066.3...	PF 5	MPM	559300
1150	Sand and Gravel	3066.3...	PF 6	MPM	573200
1151	Sand and Gravel	3066.3...	PF 7	MPM	569900
1152	Sand and Gravel	3066.3...	PF 8	MPM	600900
1153	Sand and Gravel	3066.3...	PF 9	MPM	558400
1154	Sand and Gravel	3066.3...	PF 10	MPM	580400
1155					
1156	Sand and Gravel	3065.7...	PF 1	MPM	478300
1157	Sand and Gravel	3065.7...	PF 2	MPM	383300
1158	Sand and Gravel	3065.7...	PF 3	MPM	333300
1159	Sand and Gravel	3065.7...	PF 4	MPM	483100
1160	Sand and Gravel	3065.7...	PF 5	MPM	571100
1161	Sand and Gravel	3065.7...	PF 6	MPM	605600
1162	Sand and Gravel	3065.7...	PF 7	MPM	610000
1163	Sand and Gravel	3065.7...	PF 8	MPM	647000
1164	Sand and Gravel	3065.7...	PF 9	MPM	605400
1165	Sand and Gravel	3065.7...	PF 10	MPM	625400
1166					
1167	Sand and Gravel	3065.2...	PF 1	MPM	504300
1168	Sand and Gravel	3065.2...	PF 2	MPM	401500
1169	Sand and Gravel	3065.2...	PF 3	MPM	348800
1170	Sand and Gravel	3065.2...	PF 4	MPM	480700
1171	Sand and Gravel	3065.2...	PF 5	MPM	594900
1172	Sand and Gravel	3065.2...	PF 6	MPM	634600
1173	Sand and Gravel	3065.2...	PF 7	MPM	648000
1174	Sand and Gravel	3065.2...	PF 8	MPM	691800
1175	Sand and Gravel	3065.2...	PF 9	MPM	653300
1176	Sand and Gravel	3065.2...	PF 10	MPM	671400
1177					
1178	Sand and Gravel	3064.6...	PF 1	MPM	527000
1179	Sand and Gravel	3064.6...	PF 2	MPM	419500
1180	Sand and Gravel	3064.6...	PF 3	MPM	363300
1181	Sand and Gravel	3064.6...	PF 4	MPM	489000
1182	Sand and Gravel	3064.6...	PF 5	MPM	624000
1183	Sand and Gravel	3064.6...	PF 6	MPM	668100
1184	Sand and Gravel	3064.6...	PF 7	MPM	690300
1185	Sand and Gravel	3064.6...	PF 8	MPM	735400
1186	Sand and Gravel	3064.6...	PF 9	MPM	701900
1187	Sand and Gravel	3064.6...	PF 10	MPM	721000
1188					
1189	Sand and Gravel	3064.1...	PF 1	MPM	527000

1190	Sand and Gravel	3064.1...	PF 2	MPM	438500
1191	Sand and Gravel	3064.1...	PF 3	MPM	374500
1192	Sand and Gravel	3064.1...	PF 4	MPM	485500
1193	Sand and Gravel	3064.1...	PF 5	MPM	627400
1194	Sand and Gravel	3064.1...	PF 6	MPM	688200
1195	Sand and Gravel	3064.1...	PF 7	MPM	723700
1196	Sand and Gravel	3064.1...	PF 8	MPM	772900
1197	Sand and Gravel	3064.1...	PF 9	MPM	747100
1198	Sand and Gravel	3064.1...	PF 10	MPM	766500
1199					
1200	Sand and Gravel	3063.5...	PF 1	MPM	562900
1201	Sand and Gravel	3063.5...	PF 2	MPM	440000
1202	Sand and Gravel	3063.5...	PF 3	MPM	384300
1203	Sand and Gravel	3063.5...	PF 4	MPM	484500
1204	Sand and Gravel	3063.5...	PF 5	MPM	635500
1205	Sand and Gravel	3063.5...	PF 6	MPM	712100
1206	Sand and Gravel	3063.5...	PF 7	MPM	753500
1207	Sand and Gravel	3063.5...	PF 8	MPM	813600
1208	Sand and Gravel	3063.5...	PF 9	MPM	791200
1209	Sand and Gravel	3063.5...	PF 10	MPM	815000
1210					
1211	Sand and Gravel	3062.9...	PF 1	MPM	576300
1212	Sand and Gravel	3062.9...	PF 2	MPM	447000
1213	Sand and Gravel	3062.9...	PF 3	MPM	398000
1214	Sand and Gravel	3062.9...	PF 4	MPM	499900
1215	Sand and Gravel	3062.9...	PF 5	MPM	648500
1216	Sand and Gravel	3062.9...	PF 6	MPM	741000
1217	Sand and Gravel	3062.9...	PF 7	MPM	787600
1218	Sand and Gravel	3062.9...	PF 8	MPM	851600
1219	Sand and Gravel	3062.9...	PF 9	MPM	838500
1220	Sand and Gravel	3062.9...	PF 10	MPM	863200
1221					
1222	Sand and Gravel	3062.4...	PF 1	MPM	612600
1223	Sand and Gravel	3062.4...	PF 2	MPM	466100
1224	Sand and Gravel	3062.4...	PF 3	MPM	414800
1225	Sand and Gravel	3062.4...	PF 4	MPM	493900
1226	Sand and Gravel	3062.4...	PF 5	MPM	633800
1227	Sand and Gravel	3062.4...	PF 6	MPM	744900
1228	Sand and Gravel	3062.4...	PF 7	MPM	800500
1229	Sand and Gravel	3062.4...	PF 8	MPM	879500
1230	Sand and Gravel	3062.4...	PF 9	MPM	878900
1231	Sand and Gravel	3062.4...	PF 10	MPM	907700
1232					
1233	Sand and Gravel	3061.8...	PF 1	MPM	623100
1234	Sand and Gravel	3061.8...	PF 2	MPM	490700
1235	Sand and Gravel	3061.8...	PF 3	MPM	426900
1236	Sand and Gravel	3061.8...	PF 4	MPM	503400
1237	Sand and Gravel	3061.8...	PF 5	MPM	639700

1238	Sand and Gravel	3061.8...	PF 6	MPM	753000
1239	Sand and Gravel	3061.8...	PF 7	MPM	824600
1240	Sand and Gravel	3061.8...	PF 8	MPM	910400
1241	Sand and Gravel	3061.8...	PF 9	MPM	921600
1242	Sand and Gravel	3061.8...	PF 10	MPM	954600
1243					
1244	Sand and Gravel	3061.3...	PF 1	MPM	.2983
1245	Sand and Gravel	3061.3...	PF 2	MPM	1.286
1246	Sand and Gravel	3061.3...	PF 3	MPM	10.40
1247	Sand and Gravel	3061.3...	PF 4	MPM	504600
1248	Sand and Gravel	3061.3...	PF 5	MPM	636900
1249	Sand and Gravel	3061.3...	PF 6	MPM	770000
1250	Sand and Gravel	3061.3...	PF 7	MPM	841000
1251	Sand and Gravel	3061.3...	PF 8	MPM	934500
1252	Sand and Gravel	3061.3...	PF 9	MPM	966400
1253	Sand and Gravel	3061.3...	PF 10	MPM	100400...
1254					
1255	Sand and Gravel	3060.7...	PF 1	MPM	.00272...
1256	Sand and Gravel	3060.7...	PF 2	MPM	.05517
1257	Sand and Gravel	3060.7...	PF 3	MPM	1.296
1258	Sand and Gravel	3060.7...	PF 4	MPM	14.01
1259	Sand and Gravel	3060.7...	PF 5	MPM	47.60
1260	Sand and Gravel	3060.7...	PF 6	MPM	778500
1261	Sand and Gravel	3060.7...	PF 7	MPM	857600
1262	Sand and Gravel	3060.7...	PF 8	MPM	959000
1263	Sand and Gravel	3060.7...	PF 9	MPM	100800...
1264	Sand and Gravel	3060.7...	PF 10	MPM	104800...
1265					
1266	Sand and Gravel	3050.4...	PF 1	MPM	0
1267	Sand and Gravel	3050.4...	PF 2	MPM	.01753
1268	Sand and Gravel	3050.4...	PF 3	MPM	.3767
1269	Sand and Gravel	3050.4...	PF 4	MPM	4.682
1270	Sand and Gravel	3050.4...	PF 5	MPM	17.10
1271	Sand and Gravel	3050.4...	PF 6	MPM	44.05
1272	Sand and Gravel	3050.4...	PF 7	MPM	82.10
1273	Sand and Gravel	3050.4...	PF 8	MPM	161.7
1274	Sand and Gravel	3050.4...	PF 9	MPM	492.8
1275	Sand and Gravel	3050.4...	PF 10	MPM	935.6
1276					
1277	Sand and Gravel	3000.7...	PF 1	MPM	498.2
1278	Sand and Gravel	3000.7...	PF 2	MPM	1005
1279	Sand and Gravel	3000.7...	PF 3	MPM	2230
1280	Sand and Gravel	3000.7...	PF 4	MPM	3995
1281	Sand and Gravel	3000.7...	PF 5	MPM	5469
1282	Sand and Gravel	3000.7...	PF 6	MPM	5396
1283	Sand and Gravel	3000.7...	PF 7	MPM	5557
1284	Sand and Gravel	3000.7...	PF 8	MPM	5963
1285	Sand and Gravel	3000.7...	PF 9	MPM	7446

1286	Sand and Gravel	3000.7...	PF 10	MPM	8554
1287					
1288	Sand and Gravel	2899.4...	PF 1	MPM	1538
1289	Sand and Gravel	2899.4...	PF 2	MPM	1836
1290	Sand and Gravel	2899.4...	PF 3	MPM	2569
1291	Sand and Gravel	2899.4...	PF 4	MPM	3019
1292	Sand and Gravel	2899.4...	PF 5	MPM	3987
1293	Sand and Gravel	2899.4...	PF 6	MPM	4845
1294	Sand and Gravel	2899.4...	PF 7	MPM	5415
1295	Sand and Gravel	2899.4...	PF 8	MPM	6225
1296	Sand and Gravel	2899.4...	PF 9	MPM	10410
1297	Sand and Gravel	2899.4...	PF 10	MPM	16750
1298					
1299	Sand and Gravel	2800	PF 1	MPM	6.205
1300	Sand and Gravel	2800	PF 2	MPM	28.24
1301	Sand and Gravel	2800	PF 3	MPM	161.1
1302	Sand and Gravel	2800	PF 4	MPM	529.5
1303	Sand and Gravel	2800	PF 5	MPM	1039
1304	Sand and Gravel	2800	PF 6	MPM	1614
1305	Sand and Gravel	2800	PF 7	MPM	2276
1306	Sand and Gravel	2800	PF 8	MPM	3443
1307	Sand and Gravel	2800	PF 9	MPM	7076
1308	Sand and Gravel	2800	PF 10	MPM	9060
1309					
1310	Sand and Gravel	2700	PF 1	MPM	628.7
1311	Sand and Gravel	2700	PF 2	MPM	1349
1312	Sand and Gravel	2700	PF 3	MPM	3334
1313	Sand and Gravel	2700	PF 4	MPM	5839
1314	Sand and Gravel	2700	PF 5	MPM	7995
1315	Sand and Gravel	2700	PF 6	MPM	9783
1316	Sand and Gravel	2700	PF 7	MPM	11730
1317	Sand and Gravel	2700	PF 8	MPM	14300
1318	Sand and Gravel	2700	PF 9	MPM	20570
1319	Sand and Gravel	2700	PF 10	MPM	26700
1320					
1321	Sand and Gravel	2598.8...	PF 1	MPM	4.087
1322	Sand and Gravel	2598.8...	PF 2	MPM	16.64
1323	Sand and Gravel	2598.8...	PF 3	MPM	84.84
1324	Sand and Gravel	2598.8...	PF 4	MPM	268.3
1325	Sand and Gravel	2598.8...	PF 5	MPM	597.9
1326	Sand and Gravel	2598.8...	PF 6	MPM	1072
1327	Sand and Gravel	2598.8...	PF 7	MPM	1663
1328	Sand and Gravel	2598.8...	PF 8	MPM	2770
1329	Sand and Gravel	2598.8...	PF 9	MPM	8360
1330	Sand and Gravel	2598.8...	PF 10	MPM	16310
1331					
1332	Sand and Gravel	2499.5...	PF 1	MPM	1135
1333	Sand and Gravel	2499.5...	PF 2	MPM	1372

1334	Sand and Gravel	2499.5...	PF 3	MPM	3162
1335	Sand and Gravel	2499.5...	PF 4	MPM	5223
1336	Sand and Gravel	2499.5...	PF 5	MPM	4727
1337	Sand and Gravel	2499.5...	PF 6	MPM	5765
1338	Sand and Gravel	2499.5...	PF 7	MPM	7275
1339	Sand and Gravel	2499.5...	PF 8	MPM	9283
1340	Sand and Gravel	2499.5...	PF 9	MPM	14620
1341	Sand and Gravel	2499.5...	PF 10	MPM	20620
1342					
1343	Sand and Gravel	2400.3 ...	PF 1	MPM	4.084
1344	Sand and Gravel	2400.3 ...	PF 2	MPM	9.689
1345	Sand and Gravel	2400.3 ...	PF 3	MPM	47.14
1346	Sand and Gravel	2400.3 ...	PF 4	MPM	134.3
1347	Sand and Gravel	2400.3 ...	PF 5	MPM	236.9
1348	Sand and Gravel	2400.3 ...	PF 6	MPM	334.9
1349	Sand and Gravel	2400.3 ...	PF 7	MPM	430.5
1350	Sand and Gravel	2400.3 ...	PF 8	MPM	558.1
1351	Sand and Gravel	2400.3 ...	PF 9	MPM	930.2
1352	Sand and Gravel	2400.3 ...	PF 10	MPM	1258
1353					
1354	Sand and Gravel	2300.2...	PF 1	MPM	5.933
1355	Sand and Gravel	2300.2...	PF 2	MPM	20.47
1356	Sand and Gravel	2300.2...	PF 3	MPM	110.6
1357	Sand and Gravel	2300.2...	PF 4	MPM	358.4
1358	Sand and Gravel	2300.2...	PF 5	MPM	689.7
1359	Sand and Gravel	2300.2...	PF 6	MPM	1106
1360	Sand and Gravel	2300.2...	PF 7	MPM	1603
1361	Sand and Gravel	2300.2...	PF 8	MPM	2470
1362	Sand and Gravel	2300.2...	PF 9	MPM	6399
1363	Sand and Gravel	2300.2...	PF 10	MPM	11640
1364					
1365	Sand and Gravel	2201	PF 1	MPM	826.8
1366	Sand and Gravel	2201	PF 2	MPM	1356
1367	Sand and Gravel	2201	PF 3	MPM	3060
1368	Sand and Gravel	2201	PF 4	MPM	5473
1369	Sand and Gravel	2201	PF 5	MPM	7466
1370	Sand and Gravel	2201	PF 6	MPM	9400
1371	Sand and Gravel	2201	PF 7	MPM	11430
1372	Sand and Gravel	2201	PF 8	MPM	14100
1373	Sand and Gravel	2201	PF 9	MPM	19130
1374	Sand and Gravel	2201	PF 10	MPM	24470
1375					
1376	Sand and Gravel	2101.8...	PF 1	MPM	261.7
1377	Sand and Gravel	2101.8...	PF 2	MPM	213.5
1378	Sand and Gravel	2101.8...	PF 3	MPM	251.8
1379	Sand and Gravel	2101.8...	PF 4	MPM	359.7
1380	Sand and Gravel	2101.8...	PF 5	MPM	464.5
1381	Sand and Gravel	2101.8...	PF 6	MPM	580.0

1382	Sand and Gravel	2101.8...	PF 7	MPM	704.6
1383	Sand and Gravel	2101.8...	PF 8	MPM	892.0
1384	Sand and Gravel	2101.8...	PF 9	MPM	1611
1385	Sand and Gravel	2101.8...	PF 10	MPM	2201
1386					
1387	Sand and Gravel	2000.7...	PF 1	MPM	8.804
1388	Sand and Gravel	2000.7...	PF 2	MPM	27.66
1389	Sand and Gravel	2000.7...	PF 3	MPM	115.8
1390	Sand and Gravel	2000.7...	PF 4	MPM	317.8
1391	Sand and Gravel	2000.7...	PF 5	MPM	566.5
1392	Sand and Gravel	2000.7...	PF 6	MPM	885.1
1393	Sand and Gravel	2000.7...	PF 7	MPM	1267
1394	Sand and Gravel	2000.7...	PF 8	MPM	1891
1395	Sand and Gravel	2000.7...	PF 9	MPM	5238
1396	Sand and Gravel	2000.7...	PF 10	MPM	10150
1397					
1398	Sand and Gravel	1900	PF 1	MPM	1081
1399	Sand and Gravel	1900	PF 2	MPM	1584
1400	Sand and Gravel	1900	PF 3	MPM	2801
1401	Sand and Gravel	1900	PF 4	MPM	4462
1402	Sand and Gravel	1900	PF 5	MPM	6189
1403	Sand and Gravel	1900	PF 6	MPM	7787
1404	Sand and Gravel	1900	PF 7	MPM	9482
1405	Sand and Gravel	1900	PF 8	MPM	12110
1406	Sand and Gravel	1900	PF 9	MPM	12570
1407	Sand and Gravel	1900	PF 10	MPM	13960
1408					
1409	Sand and Gravel	1800	PF 1	MPM	1.571
1410	Sand and Gravel	1800	PF 2	MPM	8.996
1411	Sand and Gravel	1800	PF 3	MPM	64.92
1412	Sand and Gravel	1800	PF 4	MPM	211.9
1413	Sand and Gravel	1800	PF 5	MPM	403.5
1414	Sand and Gravel	1800	PF 6	MPM	643.1
1415	Sand and Gravel	1800	PF 7	MPM	958.5
1416	Sand and Gravel	1800	PF 8	MPM	1483
1417	Sand and Gravel	1800	PF 9	MPM	3508
1418	Sand and Gravel	1800	PF 10	MPM	6119
1419					
1420	Sand and Gravel	1700	PF 1	MPM	903.5
1421	Sand and Gravel	1700	PF 2	MPM	571.7
1422	Sand and Gravel	1700	PF 3	MPM	434.7
1423	Sand and Gravel	1700	PF 4	MPM	698.6
1424	Sand and Gravel	1700	PF 5	MPM	1033
1425	Sand and Gravel	1700	PF 6	MPM	1375
1426	Sand and Gravel	1700	PF 7	MPM	1752
1427	Sand and Gravel	1700	PF 8	MPM	2342
1428	Sand and Gravel	1700	PF 9	MPM	5109
1429	Sand and Gravel	1700	PF 10	MPM	8480

1430					
1431	Sand and Gravel	1600	PF 1	MPM	.4601
1432	Sand and Gravel	1600	PF 2	MPM	5.674
1433	Sand and Gravel	1600	PF 3	MPM	59.89
1434	Sand and Gravel	1600	PF 4	MPM	239.0
1435	Sand and Gravel	1600	PF 5	MPM	493.7
1436	Sand and Gravel	1600	PF 6	MPM	824.8
1437	Sand and Gravel	1600	PF 7	MPM	1230
1438	Sand and Gravel	1600	PF 8	MPM	1919
1439	Sand and Gravel	1600	PF 9	MPM	4967
1440	Sand and Gravel	1600	PF 10	MPM	10230
1441					
1442	Sand and Gravel	1540.1...	PF 1	MPM	885.4
1443	Sand and Gravel	1540.1...	PF 2	MPM	1385
1444	Sand and Gravel	1540.1...	PF 3	MPM	3200
1445	Sand and Gravel	1540.1...	PF 4	MPM	5710
1446	Sand and Gravel	1540.1...	PF 5	MPM	7751
1447	Sand and Gravel	1540.1...	PF 6	MPM	9647
1448	Sand and Gravel	1540.1...	PF 7	MPM	10830
1449	Sand and Gravel	1540.1...	PF 8	MPM	12150
1450	Sand and Gravel	1540.1...	PF 9	MPM	17480
1451	Sand and Gravel	1540.1...	PF 10	MPM	21780
1452					
1453	Sand and Gravel	1500.0...	PF 1	MPM	1870
1454	Sand and Gravel	1500.0...	PF 2	MPM	3384
1455	Sand and Gravel	1500.0...	PF 3	MPM	936.8
1456	Sand and Gravel	1500.0...	PF 4	MPM	1643
1457	Sand and Gravel	1500.0...	PF 5	MPM	2408
1458	Sand and Gravel	1500.0...	PF 6	MPM	2164
1459	Sand and Gravel	1500.0...	PF 7	MPM	1901
1460	Sand and Gravel	1500.0...	PF 8	MPM	1939
1461	Sand and Gravel	1500.0...	PF 9	MPM	3143
1462	Sand and Gravel	1500.0...	PF 10	MPM	4925
1463					
1464	Sand and Gravel	1465.1 ...	PF 1	MPM	.5760
1465	Sand and Gravel	1465.1 ...	PF 2	MPM	5.670
1466	Sand and Gravel	1465.1 ...	PF 3	MPM	32.86
1467	Sand and Gravel	1465.1 ...	PF 4	MPM	86.20
1468	Sand and Gravel	1465.1 ...	PF 5	MPM	170.4
1469	Sand and Gravel	1465.1 ...	PF 6	MPM	277.9
1470	Sand and Gravel	1465.1 ...	PF 7	MPM	412.9
1471	Sand and Gravel	1465.1 ...	PF 8	MPM	599.1
1472	Sand and Gravel	1465.1 ...	PF 9	MPM	1370
1473	Sand and Gravel	1465.1 ...	PF 10	MPM	2393
1474					
1475	Sand and Gravel	1414.9...	PF 1	MPM	.2781
1476	Sand and Gravel	1414.9...	PF 2	MPM	3.283
1477	Sand and Gravel	1414.9...	PF 3	MPM	33.15

1478	Sand and Gravel	1414.9...	PF 4	MPM	126.0
1479	Sand and Gravel	1414.9...	PF 5	MPM	287.3
1480	Sand and Gravel	1414.9...	PF 6	MPM	486.1
1481	Sand and Gravel	1414.9...	PF 7	MPM	743.4
1482	Sand and Gravel	1414.9...	PF 8	MPM	1119
1483	Sand and Gravel	1414.9...	PF 9	MPM	2170
1484	Sand and Gravel	1414.9...	PF 10	MPM	3687
1485					
1486	Sand and Gravel	1397.1...	PF 1	MPM	113.2
1487	Sand and Gravel	1397.1...	PF 2	MPM	452.6
1488	Sand and Gravel	1397.1...	PF 3	MPM	2275
1489	Sand and Gravel	1397.1...	PF 4	MPM	3681
1490	Sand and Gravel	1397.1...	PF 5	MPM	5037
1491	Sand and Gravel	1397.1...	PF 6	MPM	6996
1492	Sand and Gravel	1397.1...	PF 7	MPM	8775
1493	Sand and Gravel	1397.1...	PF 8	MPM	11060
1494	Sand and Gravel	1397.1...	PF 9	MPM	12370
1495	Sand and Gravel	1397.1...	PF 10	MPM	16400
1496					
1497	Sand and Gravel	1382.6...	PF 1	MPM	139.5
1498	Sand and Gravel	1382.6...	PF 2	MPM	340.7
1499	Sand and Gravel	1382.6...	PF 3	MPM	1156
1500	Sand and Gravel	1382.6...	PF 4	MPM	9930
1501	Sand and Gravel	1382.6...	PF 5	MPM	14150
1502	Sand and Gravel	1382.6...	PF 6	MPM	18230
1503	Sand and Gravel	1382.6...	PF 7	MPM	22870
1504	Sand and Gravel	1382.6...	PF 8	MPM	29010
1505	Sand and Gravel	1382.6...	PF 9	MPM	38120
1506	Sand and Gravel	1382.6...	PF 10	MPM	39730
1507					
1508	Sand and Gravel	1350.2...	PF 1	MPM	1024
1509	Sand and Gravel	1350.2...	PF 2	MPM	1744
1510	Sand and Gravel	1350.2...	PF 3	MPM	3024
1511	Sand and Gravel	1350.2...	PF 4	MPM	5122
1512	Sand and Gravel	1350.2...	PF 5	MPM	7019
1513	Sand and Gravel	1350.2...	PF 6	MPM	8719
1514	Sand and Gravel	1350.2...	PF 7	MPM	9218
1515	Sand and Gravel	1350.2...	PF 8	MPM	9402
1516	Sand and Gravel	1350.2...	PF 9	MPM	9824
1517	Sand and Gravel	1350.2...	PF 10	MPM	8899
1518					
1519	Sand and Gravel	1312.9...	PF 1	MPM	.6958
1520	Sand and Gravel	1312.9...	PF 2	MPM	5.543
1521	Sand and Gravel	1312.9...	PF 3	MPM	52.21
1522	Sand and Gravel	1312.9...	PF 4	MPM	178.2
1523	Sand and Gravel	1312.9...	PF 5	MPM	329.4
1524	Sand and Gravel	1312.9...	PF 6	MPM	496.4
1525	Sand and Gravel	1312.9...	PF 7	MPM	705.9

1526	Sand and Gravel	1312.9...	PF 8	MPM	1093
1527	Sand and Gravel	1312.9...	PF 9	MPM	1904
1528	Sand and Gravel	1312.9...	PF 10	MPM	2223
1529					
1530	Sand and Gravel	1273.7...	PF 1	MPM	88.65
1531	Sand and Gravel	1273.7...	PF 2	MPM	214.7
1532	Sand and Gravel	1273.7...	PF 3	MPM	768.9
1533	Sand and Gravel	1273.7...	PF 4	MPM	1702
1534	Sand and Gravel	1273.7...	PF 5	MPM	2539
1535	Sand and Gravel	1273.7...	PF 6	MPM	3415
1536	Sand and Gravel	1273.7...	PF 7	MPM	4157
1537	Sand and Gravel	1273.7...	PF 8	MPM	4276
1538	Sand and Gravel	1273.7...	PF 9	MPM	4082
1539	Sand and Gravel	1273.7...	PF 10	MPM	4159
1540					
1541	Sand and Gravel	1200	PF 1	MPM	82.89
1542	Sand and Gravel	1200	PF 2	MPM	191.4
1543	Sand and Gravel	1200	PF 3	MPM	533.5
1544	Sand and Gravel	1200	PF 4	MPM	1098
1545	Sand and Gravel	1200	PF 5	MPM	1679
1546	Sand and Gravel	1200	PF 6	MPM	2775
1547	Sand and Gravel	1200	PF 7	MPM	3944
1548	Sand and Gravel	1200	PF 8	MPM	5645
1549	Sand and Gravel	1200	PF 9	MPM	10290
1550	Sand and Gravel	1200	PF 10	MPM	14980
1551					
1552	Sand and Gravel	1100	PF 1	MPM	1005
1553	Sand and Gravel	1100	PF 2	MPM	1564
1554	Sand and Gravel	1100	PF 3	MPM	2953
1555	Sand and Gravel	1100	PF 4	MPM	4887
1556	Sand and Gravel	1100	PF 5	MPM	6574
1557	Sand and Gravel	1100	PF 6	MPM	5372
1558	Sand and Gravel	1100	PF 7	MPM	5241
1559	Sand and Gravel	1100	PF 8	MPM	5807
1560	Sand and Gravel	1100	PF 9	MPM	8244
1561	Sand and Gravel	1100	PF 10	MPM	11420
1562					
1563	Sand and Gravel	977.24 ...	PF 1	MPM	.4305
1564	Sand and Gravel	977.24 ...	PF 2	MPM	4.402
1565	Sand and Gravel	977.24 ...	PF 3	MPM	41.70
1566	Sand and Gravel	977.24 ...	PF 4	MPM	148.9
1567	Sand and Gravel	977.24 ...	PF 5	MPM	287.5
1568	Sand and Gravel	977.24 ...	PF 6	MPM	444.4
1569	Sand and Gravel	977.24 ...	PF 7	MPM	655.0
1570	Sand and Gravel	977.24 ...	PF 8	MPM	1043
1571	Sand and Gravel	977.24 ...	PF 9	MPM	2286
1572	Sand and Gravel	977.24 ...	PF 10	MPM	3224
1573					

1574	Sand and Gravel	901.03 ...	PF 1	MPM	877.5
1575	Sand and Gravel	901.03 ...	PF 2	MPM	1585
1576	Sand and Gravel	901.03 ...	PF 3	MPM	3019
1577	Sand and Gravel	901.03 ...	PF 4	MPM	4974
1578	Sand and Gravel	901.03 ...	PF 5	MPM	6843
1579	Sand and Gravel	901.03 ...	PF 6	MPM	7739
1580	Sand and Gravel	901.03 ...	PF 7	MPM	8554
1581	Sand and Gravel	901.03 ...	PF 8	MPM	10800
1582	Sand and Gravel	901.03 ...	PF 9	MPM	17230
1583	Sand and Gravel	901.03 ...	PF 10	MPM	23860
1584					
1585	Sand and Gravel	794.36 ...	PF 1	MPM	41.10
1586	Sand and Gravel	794.36 ...	PF 2	MPM	77.57
1587	Sand and Gravel	794.36 ...	PF 3	MPM	230.7
1588	Sand and Gravel	794.36 ...	PF 4	MPM	613.8
1589	Sand and Gravel	794.36 ...	PF 5	MPM	1107
1590	Sand and Gravel	794.36 ...	PF 6	MPM	1642
1591	Sand and Gravel	794.36 ...	PF 7	MPM	2229
1592	Sand and Gravel	794.36 ...	PF 8	MPM	3247
1593	Sand and Gravel	794.36 ...	PF 9	MPM	6251
1594	Sand and Gravel	794.36 ...	PF 10	MPM	8348
1595					
1596	Sand and Gravel	702.95 ...	PF 1	MPM	108.4
1597	Sand and Gravel	702.95 ...	PF 2	MPM	424.0
1598	Sand and Gravel	702.95 ...	PF 3	MPM	1703
1599	Sand and Gravel	702.95 ...	PF 4	MPM	3112
1600	Sand and Gravel	702.95 ...	PF 5	MPM	4253
1601	Sand and Gravel	702.95 ...	PF 6	MPM	5442
1602	Sand and Gravel	702.95 ...	PF 7	MPM	6669
1603	Sand and Gravel	702.95 ...	PF 8	MPM	8395
1604	Sand and Gravel	702.95 ...	PF 9	MPM	14860
1605	Sand and Gravel	702.95 ...	PF 10	MPM	23250
1606					
1607	Sand and Gravel	599.9	PF 1	MPM	263.6
1608	Sand and Gravel	599.9	PF 2	MPM	180.8
1609	Sand and Gravel	599.9	PF 3	MPM	176.7
1610	Sand and Gravel	599.9	PF 4	MPM	240.6
1611	Sand and Gravel	599.9	PF 5	MPM	296.3
1612	Sand and Gravel	599.9	PF 6	MPM	348.8
1613	Sand and Gravel	599.9	PF 7	MPM	395.4
1614	Sand and Gravel	599.9	PF 8	MPM	455.7
1615	Sand and Gravel	599.9	PF 9	MPM	592.5
1616	Sand and Gravel	599.9	PF 10	MPM	662.8
1617					
1618	Sand and Gravel	504.08 ...	PF 1	MPM	6.813
1619	Sand and Gravel	504.08 ...	PF 2	MPM	24.31
1620	Sand and Gravel	504.08 ...	PF 3	MPM	107.2
1621	Sand and Gravel	504.08 ...	PF 4	MPM	297.6

1622	Sand and Gravel	504.08 ...	PF 5	MPM	514.7
1623	Sand and Gravel	504.08 ...	PF 6	MPM	790.8
1624	Sand and Gravel	504.08 ...	PF 7	MPM	1102
1625	Sand and Gravel	504.08 ...	PF 8	MPM	1577
1626	Sand and Gravel	504.08 ...	PF 9	MPM	3105
1627	Sand and Gravel	504.08 ...	PF 10	MPM	4604
1628					
1629	Sand and Gravel	405.1	PF 1	MPM	411.7
1630	Sand and Gravel	405.1	PF 2	MPM	562.2
1631	Sand and Gravel	405.1	PF 3	MPM	998.7
1632	Sand and Gravel	405.1	PF 4	MPM	1577
1633	Sand and Gravel	405.1	PF 5	MPM	1958
1634	Sand and Gravel	405.1	PF 6	MPM	2214
1635	Sand and Gravel	405.1	PF 7	MPM	2427
1636	Sand and Gravel	405.1	PF 8	MPM	2718
1637	Sand and Gravel	405.1	PF 9	MPM	3377
1638	Sand and Gravel	405.1	PF 10	MPM	4166
1639					
1640	Sand and Gravel	299.4	PF 1	MPM	27.09
1641	Sand and Gravel	299.4	PF 2	MPM	59.99
1642	Sand and Gravel	299.4	PF 3	MPM	165.4
1643	Sand and Gravel	299.4	PF 4	MPM	353.4
1644	Sand and Gravel	299.4	PF 5	MPM	524.9
1645	Sand and Gravel	299.4	PF 6	MPM	687.8
1646	Sand and Gravel	299.4	PF 7	MPM	856.4
1647	Sand and Gravel	299.4	PF 8	MPM	1115
1648	Sand and Gravel	299.4	PF 9	MPM	1789
1649	Sand and Gravel	299.4	PF 10	MPM	2476
1650					
1651	Sand and Gravel	199.35 ...	PF 1	MPM	806.3
1652	Sand and Gravel	199.35 ...	PF 2	MPM	1324
1653	Sand and Gravel	199.35 ...	PF 3	MPM	2646
1654	Sand and Gravel	199.35 ...	PF 4	MPM	4907
1655	Sand and Gravel	199.35 ...	PF 5	MPM	7000
1656	Sand and Gravel	199.35 ...	PF 6	MPM	8901
1657	Sand and Gravel	199.35 ...	PF 7	MPM	10460
1658	Sand and Gravel	199.35 ...	PF 8	MPM	12340
1659	Sand and Gravel	199.35 ...	PF 9	MPM	16810
1660	Sand and Gravel	199.35 ...	PF 10	MPM	19260

Hydraulic Design Data
Sediment Reach R1 Large Gravel and Cobble
River: Prickly Pear Cr., Reach: EXISTING STREAM
RS: 3000.73 to 101.64
Sediment Transport Functions: MPM
Temperature: 55
Specific Gravity of Sediment: 2.65
Concentration of Fine Sediment: 0
Fall Velocity Method: Default
Depth/Width Type: Default

Gradation	Left Overba	Main Chan	Right Overbank			
	Diameter	% Finer	Diameter	% Finer	Diameter	% Finer
	384	100	384	100	384	100
	256	99	256	99	256	99
	180	92	180	92	180	92
	128	81	128	81	128	81
	90	64	90	64	90	64
	64	51	64	51	64	51
	45	36	45	36	45	36
	32	27	32	27	32	27
	22	22	22	22	22	22
	16	22	16	22	16	22
	11	22	11	22	11	22
	8	22	8	22	8	22
	6	22	6	22	6	22
	4	22	4	22	4	22
	2	1	2	1	2	1
d90	169		169		169	
d84	141		141		141	
d50	62.5		62.5		62.5	

Bed Material Fraction by Standard Grade Size

Class	dm (mm)	Left	Main	Right
1	0.003	0	0	0
2	0.006	0	0	0
3	0.011	0	0	0
4	0.023	0	0	0
5	0.045	0	0	0
6	0.088	0	0	0
7	0.177	0	0	0
8	0.354	0	0	0
9	0.707	0	0	0
10	1.41	0.01	0.01	0.01
11	2.83	0.21	0.21	0.21
12	5.64	0	0	0
13	11.3	0	0	0
14	22.6	0.05	0.05	0.05
15	45.1	0.24	0.24	0.24
16	90.5	0.3	0.3	0.3
17	181	0.18	0.18	0.18
18	362	0.004	0.004	0.004
19	724	0.003	0.003	0.003
20	1448	0.003	0.003	0.003

Sediment T R1 Large Gravel and Cobble 3000.73 MPM Total All Grains (tons/day)

	Sed Reach	RS	Profile	Function	All Grains
1	R1 Large Gravel and Cob...	3000.7	PF 1	MPM	777.8
2	R1 Large Gravel and Cob...	3000.7	PF 2	MPM	1326
3	R1 Large Gravel and Cob...	3000.7	PF 3	MPM	2477

4	R1 Large Gravel and Cob...	3000.7	PF 4	MPM	4021
5	R1 Large Gravel and Cob...	3000.7	PF 5	MPM	5322
6	R1 Large Gravel and Cob...	3000.7	PF 6	MPM	5180
7	R1 Large Gravel and Cob...	3000.7	PF 7	MPM	5292
8	R1 Large Gravel and Cob...	3000.7	PF 8	MPM	5573
9	R1 Large Gravel and Cob...	3000.7	PF 9	MPM	6595
10	R1 Large Gravel and Cob...	3000.7	PF 10	MPM	7326
11					
12	R1 Large Gravel and Cob...	2899.4	PF 1	MPM	2493
13	R1 Large Gravel and Cob...	2899.4	PF 2	MPM	2341
14	R1 Large Gravel and Cob...	2899.4	PF 3	MPM	2685
15	R1 Large Gravel and Cob...	2899.4	PF 4	MPM	2829
16	R1 Large Gravel and Cob...	2899.4	PF 5	MPM	3620
17	R1 Large Gravel and Cob...	2899.4	PF 6	MPM	4335
18	R1 Large Gravel and Cob...	2899.4	PF 7	MPM	4776
19	R1 Large Gravel and Cob...	2899.4	PF 8	MPM	5427
20	R1 Large Gravel and Cob...	2899.4	PF 9	MPM	9194
21	R1 Large Gravel and Cob...	2899.4	PF 10	MPM	14810
22					
23	R1 Large Gravel and Cob...	2800	PF 1	MPM	2.089
24	R1 Large Gravel and Cob...	2800	PF 2	MPM	28.65
25	R1 Large Gravel and Cob...	2800	PF 3	MPM	181.5
26	R1 Large Gravel and Cob...	2800	PF 4	MPM	552.8
27	R1 Large Gravel and Cob...	2800	PF 5	MPM	1003
28	R1 Large Gravel and Cob...	2800	PF 6	MPM	1516
29	R1 Large Gravel and Cob...	2800	PF 7	MPM	2071
30	R1 Large Gravel and Cob...	2800	PF 8	MPM	2962
31	R1 Large Gravel and Cob...	2800	PF 9	MPM	5884
32	R1 Large Gravel and Cob...	2800	PF 10	MPM	7613
33					
34	R1 Large Gravel and Cob...	2700	PF 1	MPM	919.1
35	R1 Large Gravel and Cob...	2700	PF 2	MPM	1839
36	R1 Large Gravel and Cob...	2700	PF 3	MPM	3792
37	R1 Large Gravel and Cob...	2700	PF 4	MPM	6150
38	R1 Large Gravel and Cob...	2700	PF 5	MPM	8224
39	R1 Large Gravel and Cob...	2700	PF 6	MPM	9914
40	R1 Large Gravel and Cob...	2700	PF 7	MPM	11690
41	R1 Large Gravel and Cob...	2700	PF 8	MPM	13920
42	R1 Large Gravel and Cob...	2700	PF 9	MPM	19180
43	R1 Large Gravel and Cob...	2700	PF 10	MPM	24380
44					
45	R1 Large Gravel and Cob...	2598.8	PF 1	MPM	0.3476
46	R1 Large Gravel and Cob...	2598.8	PF 2	MPM	10.39
47	R1 Large Gravel and Cob...	2598.8	PF 3	MPM	91.32
48	R1 Large Gravel and Cob...	2598.8	PF 4	MPM	290.1
49	R1 Large Gravel and Cob...	2598.8	PF 5	MPM	621.9
50	R1 Large Gravel and Cob...	2598.8	PF 6	MPM	1039
51	R1 Large Gravel and Cob...	2598.8	PF 7	MPM	1557
52	R1 Large Gravel and Cob...	2598.8	PF 8	MPM	2507
53	R1 Large Gravel and Cob...	2598.8	PF 9	MPM	7109
54	R1 Large Gravel and Cob...	2598.8	PF 10	MPM	14450
55					
56	R1 Large Gravel and Cob...	2499.5	PF 1	MPM	1752
57	R1 Large Gravel and Cob...	2499.5	PF 2	MPM	1828
58	R1 Large Gravel and Cob...	2499.5	PF 3	MPM	3501
59	R1 Large Gravel and Cob...	2499.5	PF 4	MPM	5358
60	R1 Large Gravel and Cob...	2499.5	PF 5	MPM	4496
61	R1 Large Gravel and Cob...	2499.5	PF 6	MPM	5373
62	R1 Large Gravel and Cob...	2499.5	PF 7	MPM	6806
63	R1 Large Gravel and Cob...	2499.5	PF 8	MPM	8770
64	R1 Large Gravel and Cob...	2499.5	PF 9	MPM	13730
65	R1 Large Gravel and Cob...	2499.5	PF 10	MPM	19100

66					
67	R1 Large Gravel and Cob...	2400.3	PF 1	MPM	0.3569
68	R1 Large Gravel and Cob...	2400.3	PF 2	MPM	1.071
69	R1 Large Gravel and Cob...	2400.3	PF 3	MPM	41.74
70	R1 Large Gravel and Cob...	2400.3	PF 4	MPM	140.8
71	R1 Large Gravel and Cob...	2400.3	PF 5	MPM	246.3
72	R1 Large Gravel and Cob...	2400.3	PF 6	MPM	342.4
73	R1 Large Gravel and Cob...	2400.3	PF 7	MPM	434.1
74	R1 Large Gravel and Cob...	2400.3	PF 8	MPM	554.6
75	R1 Large Gravel and Cob...	2400.3	PF 9	MPM	867.1
76	R1 Large Gravel and Cob...	2400.3	PF 10	MPM	1122
77					
78	R1 Large Gravel and Cob...	2300.2	PF 1	MPM	1.332
79	R1 Large Gravel and Cob...	2300.2	PF 2	MPM	17.05
80	R1 Large Gravel and Cob...	2300.2	PF 3	MPM	123.6
81	R1 Large Gravel and Cob...	2300.2	PF 4	MPM	386.2
82	R1 Large Gravel and Cob...	2300.2	PF 5	MPM	701.6
83	R1 Large Gravel and Cob...	2300.2	PF 6	MPM	1058
84	R1 Large Gravel and Cob...	2300.2	PF 7	MPM	1488
85	R1 Large Gravel and Cob...	2300.2	PF 8	MPM	2223
86	R1 Large Gravel and Cob...	2300.2	PF 9	MPM	5229
87	R1 Large Gravel and Cob...	2300.2	PF 10	MPM	10020
88					
89	R1 Large Gravel and Cob...	2201	PF 1	MPM	1238
90	R1 Large Gravel and Cob...	2201	PF 2	MPM	1805
91	R1 Large Gravel and Cob...	2201	PF 3	MPM	3406
92	R1 Large Gravel and Cob...	2201	PF 4	MPM	5655
93	R1 Large Gravel and Cob...	2201	PF 5	MPM	7539
94	R1 Large Gravel and Cob...	2201	PF 6	MPM	9419
95	R1 Large Gravel and Cob...	2201	PF 7	MPM	11330
96	R1 Large Gravel and Cob...	2201	PF 8	MPM	13680
97	R1 Large Gravel and Cob...	2201	PF 9	MPM	17760
98	R1 Large Gravel and Cob...	2201	PF 10	MPM	22210
99					
100	R1 Large Gravel and Cob...	2101.8	PF 1	MPM	431.1
101	R1 Large Gravel and Cob...	2101.8	PF 2	MPM	308.1
102	R1 Large Gravel and Cob...	2101.8	PF 3	MPM	314.1
103	R1 Large Gravel and Cob...	2101.8	PF 4	MPM	411.6
104	R1 Large Gravel and Cob...	2101.8	PF 5	MPM	508.9
105	R1 Large Gravel and Cob...	2101.8	PF 6	MPM	618.2
106	R1 Large Gravel and Cob...	2101.8	PF 7	MPM	735.7
107	R1 Large Gravel and Cob...	2101.8	PF 8	MPM	911.3
108	R1 Large Gravel and Cob...	2101.8	PF 9	MPM	1509
109	R1 Large Gravel and Cob...	2101.8	PF 10	MPM	1963
110					
111	R1 Large Gravel and Cob...	2000.7	PF 1	MPM	3.448
112	R1 Large Gravel and Cob...	2000.7	PF 2	MPM	26.03
113	R1 Large Gravel and Cob...	2000.7	PF 3	MPM	131.8
114	R1 Large Gravel and Cob...	2000.7	PF 4	MPM	346.8
115	R1 Large Gravel and Cob...	2000.7	PF 5	MPM	596.3
116	R1 Large Gravel and Cob...	2000.7	PF 6	MPM	878.4
117	R1 Large Gravel and Cob...	2000.7	PF 7	MPM	1196
118	R1 Large Gravel and Cob...	2000.7	PF 8	MPM	1728
119	R1 Large Gravel and Cob...	2000.7	PF 9	MPM	4252
120	R1 Large Gravel and Cob...	2000.7	PF 10	MPM	8609
121					
122	R1 Large Gravel and Cob...	1900	PF 1	MPM	1677
123	R1 Large Gravel and Cob...	1900	PF 2	MPM	2014
124	R1 Large Gravel and Cob...	1900	PF 3	MPM	2973
125	R1 Large Gravel and Cob...	1900	PF 4	MPM	4468
126	R1 Large Gravel and Cob...	1900	PF 5	MPM	6125
127	R1 Large Gravel and Cob...	1900	PF 6	MPM	7642

128	R1 Large Gravel and Cob…	1900	PF 7	MPM	9197
129	R1 Large Gravel and Cob…	1900	PF 8	MPM	11570
130	R1 Large Gravel and Cob…	1900	PF 9	MPM	11360
131	R1 Large Gravel and Cob…	1900	PF 10	MPM	12310
132					
133	R1 Large Gravel and Cob…	1800	PF 1	MPM	0.06773
134	R1 Large Gravel and Cob…	1800	PF 2	MPM	2.356
135	R1 Large Gravel and Cob…	1800	PF 3	MPM	65.9
136	R1 Large Gravel and Cob…	1800	PF 4	MPM	224.9
137	R1 Large Gravel and Cob…	1800	PF 5	MPM	417.4
138	R1 Large Gravel and Cob…	1800	PF 6	MPM	638.8
139	R1 Large Gravel and Cob…	1800	PF 7	MPM	904.6
140	R1 Large Gravel and Cob…	1800	PF 8	MPM	1340
141	R1 Large Gravel and Cob…	1800	PF 9	MPM	2921
142	R1 Large Gravel and Cob…	1800	PF 10	MPM	4803
143					
144	R1 Large Gravel and Cob…	1700	PF 1	MPM	1236
145	R1 Large Gravel and Cob…	1700	PF 2	MPM	715.1
146	R1 Large Gravel and Cob…	1700	PF 3	MPM	516.2
147	R1 Large Gravel and Cob…	1700	PF 4	MPM	747.5
148	R1 Large Gravel and Cob…	1700	PF 5	MPM	1033
149	R1 Large Gravel and Cob…	1700	PF 6	MPM	1322
150	R1 Large Gravel and Cob…	1700	PF 7	MPM	1646
151	R1 Large Gravel and Cob…	1700	PF 8	MPM	2151
152	R1 Large Gravel and Cob…	1700	PF 9	MPM	4223
153	R1 Large Gravel and Cob…	1700	PF 10	MPM	6927
154					
155	R1 Large Gravel and Cob…	1600	PF 1	MPM	0
156	R1 Large Gravel and Cob…	1600	PF 2	MPM	0.4264
157	R1 Large Gravel and Cob…	1600	PF 3	MPM	59.58
158	R1 Large Gravel and Cob…	1600	PF 4	MPM	255.8
159	R1 Large Gravel and Cob…	1600	PF 5	MPM	515.4
160	R1 Large Gravel and Cob…	1600	PF 6	MPM	814.1
161	R1 Large Gravel and Cob…	1600	PF 7	MPM	1158
162	R1 Large Gravel and Cob…	1600	PF 8	MPM	1755
163	R1 Large Gravel and Cob…	1600	PF 9	MPM	4103
164	R1 Large Gravel and Cob…	1600	PF 10	MPM	8667
165					
166	R1 Large Gravel and Cob…	1540.1	PF 1	MPM	1383
167	R1 Large Gravel and Cob…	1540.1	PF 2	MPM	1902
168	R1 Large Gravel and Cob…	1540.1	PF 3	MPM	3620
169	R1 Large Gravel and Cob…	1540.1	PF 4	MPM	5944
170	R1 Large Gravel and Cob…	1540.1	PF 5	MPM	7875
171	R1 Large Gravel and Cob…	1540.1	PF 6	MPM	9707
172	R1 Large Gravel and Cob…	1540.1	PF 7	MPM	10670
173	R1 Large Gravel and Cob…	1540.1	PF 8	MPM	11670
174	R1 Large Gravel and Cob…	1540.1	PF 9	MPM	16260
175	R1 Large Gravel and Cob…	1540.1	PF 10	MPM	19890
176					
177	R1 Large Gravel and Cob…	1500	PF 1	MPM	2666
178	R1 Large Gravel and Cob…	1500	PF 2	MPM	4322
179	R1 Large Gravel and Cob…	1500	PF 3	MPM	974.6
180	R1 Large Gravel and Cob…	1500	PF 4	MPM	1562
181	R1 Large Gravel and Cob…	1500	PF 5	MPM	2156
182	R1 Large Gravel and Cob…	1500	PF 6	MPM	1993
183	R1 Large Gravel and Cob…	1500	PF 7	MPM	1777
184	R1 Large Gravel and Cob…	1500	PF 8	MPM	1801
185	R1 Large Gravel and Cob…	1500	PF 9	MPM	2837
186	R1 Large Gravel and Cob…	1500	PF 10	MPM	4242
187					
188	R1 Large Gravel and Cob…	1465.1	PF 1	MPM	0
189	R1 Large Gravel and Cob…	1465.1	PF 2	MPM	0.4209

190	R1 Large Gravel and Cob...	1465.1	PF 3	MPM	25.64
191	R1 Large Gravel and Cob...	1465.1	PF 4	MPM	81.1
192	R1 Large Gravel and Cob...	1465.1	PF 5	MPM	173.1
193	R1 Large Gravel and Cob...	1465.1	PF 6	MPM	283
194	R1 Large Gravel and Cob...	1465.1	PF 7	MPM	416.7
195	R1 Large Gravel and Cob...	1465.1	PF 8	MPM	597
196	R1 Large Gravel and Cob...	1465.1	PF 9	MPM	1278
197	R1 Large Gravel and Cob...	1465.1	PF 10	MPM	2111
198					
199	R1 Large Gravel and Cob...	1414.9	PF 1	MPM	0
200	R1 Large Gravel and Cob...	1414.9	PF 2	MPM	0.2038
201	R1 Large Gravel and Cob...	1414.9	PF 3	MPM	26.17
202	R1 Large Gravel and Cob...	1414.9	PF 4	MPM	129.7
203	R1 Large Gravel and Cob...	1414.9	PF 5	MPM	295.3
204	R1 Large Gravel and Cob...	1414.9	PF 6	MPM	492.6
205	R1 Large Gravel and Cob...	1414.9	PF 7	MPM	722.9
206	R1 Large Gravel and Cob...	1414.9	PF 8	MPM	1038
207	R1 Large Gravel and Cob...	1414.9	PF 9	MPM	1914
208	R1 Large Gravel and Cob...	1414.9	PF 10	MPM	3081
209					
210	R1 Large Gravel and Cob...	1397.1	PF 1	MPM	154.1
211	R1 Large Gravel and Cob...	1397.1	PF 2	MPM	530.4
212	R1 Large Gravel and Cob...	1397.1	PF 3	MPM	2271
213	R1 Large Gravel and Cob...	1397.1	PF 4	MPM	3517
214	R1 Large Gravel and Cob...	1397.1	PF 5	MPM	4766
215	R1 Large Gravel and Cob...	1397.1	PF 6	MPM	6685
216	R1 Large Gravel and Cob...	1397.1	PF 7	MPM	8316
217	R1 Large Gravel and Cob...	1397.1	PF 8	MPM	10340
218	R1 Large Gravel and Cob...	1397.1	PF 9	MPM	11110
219	R1 Large Gravel and Cob...	1397.1	PF 10	MPM	14600
220					
221	R1 Large Gravel and Cob...	1382.6	PF 1	MPM	208.5
222	R1 Large Gravel and Cob...	1382.6	PF 2	MPM	459.2
223	R1 Large Gravel and Cob...	1382.6	PF 3	MPM	1289
224	R1 Large Gravel and Cob...	1382.6	PF 4	MPM	10880
225	R1 Large Gravel and Cob...	1382.6	PF 5	MPM	14950
226	R1 Large Gravel and Cob...	1382.6	PF 6	MPM	19250
227	R1 Large Gravel and Cob...	1382.6	PF 7	MPM	24420
228	R1 Large Gravel and Cob...	1382.6	PF 8	MPM	31290
229	R1 Large Gravel and Cob...	1382.6	PF 9	MPM	40120
230	R1 Large Gravel and Cob...	1382.6	PF 10	MPM	40040
231					
232	R1 Large Gravel and Cob...	1350.2	PF 1	MPM	1614
233	R1 Large Gravel and Cob...	1350.2	PF 2	MPM	2287
234	R1 Large Gravel and Cob...	1350.2	PF 3	MPM	3273
235	R1 Large Gravel and Cob...	1350.2	PF 4	MPM	5205
236	R1 Large Gravel and Cob...	1350.2	PF 5	MPM	7023
237	R1 Large Gravel and Cob...	1350.2	PF 6	MPM	8622
238	R1 Large Gravel and Cob...	1350.2	PF 7	MPM	8871
239	R1 Large Gravel and Cob...	1350.2	PF 8	MPM	8746
240	R1 Large Gravel and Cob...	1350.2	PF 9	MPM	8553
241	R1 Large Gravel and Cob...	1350.2	PF 10	MPM	7312
242					
243	R1 Large Gravel and Cob...	1312.9	PF 1	MPM	0
244	R1 Large Gravel and Cob...	1312.9	PF 2	MPM	0.4117
245	R1 Large Gravel and Cob...	1312.9	PF 3	MPM	49.35
246	R1 Large Gravel and Cob...	1312.9	PF 4	MPM	187.5
247	R1 Large Gravel and Cob...	1312.9	PF 5	MPM	340
248	R1 Large Gravel and Cob...	1312.9	PF 6	MPM	504.2
249	R1 Large Gravel and Cob...	1312.9	PF 7	MPM	693.7
250	R1 Large Gravel and Cob...	1312.9	PF 8	MPM	1020
251	R1 Large Gravel and Cob...	1312.9	PF 9	MPM	1691

252	R1 Large Gravel and Cob...	1312.9	PF 10	MPM	1950
253					
254	R1 Large Gravel and Cob...	1273.7	PF 1	MPM	124.4
255	R1 Large Gravel and Cob...	1273.7	PF 2	MPM	272.6
256	R1 Large Gravel and Cob...	1273.7	PF 3	MPM	822.6
257	R1 Large Gravel and Cob...	1273.7	PF 4	MPM	1659
258	R1 Large Gravel and Cob...	1273.7	PF 5	MPM	2305
259	R1 Large Gravel and Cob...	1273.7	PF 6	MPM	2957
260	R1 Large Gravel and Cob...	1273.7	PF 7	MPM	3542
261	R1 Large Gravel and Cob...	1273.7	PF 8	MPM	3585
262	R1 Large Gravel and Cob...	1273.7	PF 9	MPM	3503
263	R1 Large Gravel and Cob...	1273.7	PF 10	MPM	3583
264					
265	R1 Large Gravel and Cob...	1200	PF 1	MPM	129.4
266	R1 Large Gravel and Cob...	1200	PF 2	MPM	267.5
267	R1 Large Gravel and Cob...	1200	PF 3	MPM	641.6
268	R1 Large Gravel and Cob...	1200	PF 4	MPM	1138
269	R1 Large Gravel and Cob...	1200	PF 5	MPM	1648
270	R1 Large Gravel and Cob...	1200	PF 6	MPM	2569
271	R1 Large Gravel and Cob...	1200	PF 7	MPM	3436
272	R1 Large Gravel and Cob...	1200	PF 8	MPM	4818
273	R1 Large Gravel and Cob...	1200	PF 9	MPM	9062
274	R1 Large Gravel and Cob...	1200	PF 10	MPM	13090
275					
276	R1 Large Gravel and Cob...	1100	PF 1	MPM	1524
277	R1 Large Gravel and Cob...	1100	PF 2	MPM	1954
278	R1 Large Gravel and Cob...	1100	PF 3	MPM	3121
279	R1 Large Gravel and Cob...	1100	PF 4	MPM	4922
280	R1 Large Gravel and Cob...	1100	PF 5	MPM	6503
281	R1 Large Gravel and Cob...	1100	PF 6	MPM	4893
282	R1 Large Gravel and Cob...	1100	PF 7	MPM	4590
283	R1 Large Gravel and Cob...	1100	PF 8	MPM	4987
284	R1 Large Gravel and Cob...	1100	PF 9	MPM	7047
285	R1 Large Gravel and Cob...	1100	PF 10	MPM	9814
286					
287	R1 Large Gravel and Cob...	977.24	PF 1	MPM	0
288	R1 Large Gravel and Cob...	977.24	PF 2	MPM	0.3113
289	R1 Large Gravel and Cob...	977.24	PF 3	MPM	37.22
290	R1 Large Gravel and Cob...	977.24	PF 4	MPM	154.6
291	R1 Large Gravel and Cob...	977.24	PF 5	MPM	293.4
292	R1 Large Gravel and Cob...	977.24	PF 6	MPM	445.9
293	R1 Large Gravel and Cob...	977.24	PF 7	MPM	632.6
294	R1 Large Gravel and Cob...	977.24	PF 8	MPM	950.6
295	R1 Large Gravel and Cob...	977.24	PF 9	MPM	1965
296	R1 Large Gravel and Cob...	977.24	PF 10	MPM	2635
297					
298	R1 Large Gravel and Cob...	901.03	PF 1	MPM	1303
299	R1 Large Gravel and Cob...	901.03	PF 2	MPM	1976
300	R1 Large Gravel and Cob...	901.03	PF 3	MPM	3207
301	R1 Large Gravel and Cob...	901.03	PF 4	MPM	5055
302	R1 Large Gravel and Cob...	901.03	PF 5	MPM	6781
303	R1 Large Gravel and Cob...	901.03	PF 6	MPM	7433
304	R1 Large Gravel and Cob...	901.03	PF 7	MPM	8048
305	R1 Large Gravel and Cob...	901.03	PF 8	MPM	10020
306	R1 Large Gravel and Cob...	901.03	PF 9	MPM	15580
307	R1 Large Gravel and Cob...	901.03	PF 10	MPM	21730
308					
309	R1 Large Gravel and Cob...	794.36	PF 1	MPM	57.37
310	R1 Large Gravel and Cob...	794.36	PF 2	MPM	100.2
311	R1 Large Gravel and Cob...	794.36	PF 3	MPM	276.2
312	R1 Large Gravel and Cob...	794.36	PF 4	MPM	667.8
313	R1 Large Gravel and Cob...	794.36	PF 5	MPM	1094

314	R1 Large Gravel and Cob...	794.36	PF 6	MPM	1557
315	R1 Large Gravel and Cob...	794.36	PF 7	MPM	2054
316	R1 Large Gravel and Cob...	794.36	PF 8	MPM	2812
317	R1 Large Gravel and Cob...	794.36	PF 9	MPM	5097
318	R1 Large Gravel and Cob...	794.36	PF 10	MPM	6945
319					
320	R1 Large Gravel and Cob...	702.95	PF 1	MPM	162.5
321	R1 Large Gravel and Cob...	702.95	PF 2	MPM	553.5
322	R1 Large Gravel and Cob...	702.95	PF 3	MPM	1886
323	R1 Large Gravel and Cob...	702.95	PF 4	MPM	3036
324	R1 Large Gravel and Cob...	702.95	PF 5	MPM	3921
325	R1 Large Gravel and Cob...	702.95	PF 6	MPM	4957
326	R1 Large Gravel and Cob...	702.95	PF 7	MPM	6075
327	R1 Large Gravel and Cob...	702.95	PF 8	MPM	7686
328	R1 Large Gravel and Cob...	702.95	PF 9	MPM	13400
329	R1 Large Gravel and Cob...	702.95	PF 10	MPM	20970
330					
331	R1 Large Gravel and Cob...	599.9	PF 1	MPM	483.4
332	R1 Large Gravel and Cob...	599.9	PF 2	MPM	279.3
333	R1 Large Gravel and Cob...	599.9	PF 3	MPM	219
334	R1 Large Gravel and Cob...	599.9	PF 4	MPM	272
335	R1 Large Gravel and Cob...	599.9	PF 5	MPM	321.7
336	R1 Large Gravel and Cob...	599.9	PF 6	MPM	369.7
337	R1 Large Gravel and Cob...	599.9	PF 7	MPM	411.8
338	R1 Large Gravel and Cob...	599.9	PF 8	MPM	466.1
339	R1 Large Gravel and Cob...	599.9	PF 9	MPM	587.1
340	R1 Large Gravel and Cob...	599.9	PF 10	MPM	643.4
341					
342	R1 Large Gravel and Cob...	504.08	PF 1	MPM	1.508
343	R1 Large Gravel and Cob...	504.08	PF 2	MPM	22.03
344	R1 Large Gravel and Cob...	504.08	PF 3	MPM	120.2
345	R1 Large Gravel and Cob...	504.08	PF 4	MPM	322.8
346	R1 Large Gravel and Cob...	504.08	PF 5	MPM	541.6
347	R1 Large Gravel and Cob...	504.08	PF 6	MPM	792.1
348	R1 Large Gravel and Cob...	504.08	PF 7	MPM	1053
349	R1 Large Gravel and Cob...	504.08	PF 8	MPM	1446
350	R1 Large Gravel and Cob...	504.08	PF 9	MPM	2679
351	R1 Large Gravel and Cob...	504.08	PF 10	MPM	3734
352					
353	R1 Large Gravel and Cob...	405.1	PF 1	MPM	680.3
354	R1 Large Gravel and Cob...	405.1	PF 2	MPM	765.2
355	R1 Large Gravel and Cob...	405.1	PF 3	MPM	1134
356	R1 Large Gravel and Cob...	405.1	PF 4	MPM	1625
357	R1 Large Gravel and Cob...	405.1	PF 5	MPM	1929
358	R1 Large Gravel and Cob...	405.1	PF 6	MPM	2123
359	R1 Large Gravel and Cob...	405.1	PF 7	MPM	2278
360	R1 Large Gravel and Cob...	405.1	PF 8	MPM	2488
361	R1 Large Gravel and Cob...	405.1	PF 9	MPM	2950
362	R1 Large Gravel and Cob...	405.1	PF 10	MPM	3494
363					
364	R1 Large Gravel and Cob...	299.4	PF 1	MPM	32.13
365	R1 Large Gravel and Cob...	299.4	PF 2	MPM	72.49
366	R1 Large Gravel and Cob...	299.4	PF 3	MPM	195.1
367	R1 Large Gravel and Cob...	299.4	PF 4	MPM	390
368	R1 Large Gravel and Cob...	299.4	PF 5	MPM	558.1
369	R1 Large Gravel and Cob...	299.4	PF 6	MPM	709.4
370	R1 Large Gravel and Cob...	299.4	PF 7	MPM	853.6
371	R1 Large Gravel and Cob...	299.4	PF 8	MPM	1067
372	R1 Large Gravel and Cob...	299.4	PF 9	MPM	1595
373	R1 Large Gravel and Cob...	299.4	PF 10	MPM	2146
374					
375	R1 Large Gravel and Cob...	199.35	PF 1	MPM	1119

376	R1 Large Gravel and Cob...	199.35	PF 2	MPM	1554
377	R1 Large Gravel and Cob...	199.35	PF 3	MPM	2746
378	R1 Large Gravel and Cob...	199.35	PF 4	MPM	4955
379	R1 Large Gravel and Cob...	199.35	PF 5	MPM	6944
380	R1 Large Gravel and Cob...	199.35	PF 6	MPM	8623
381	R1 Large Gravel and Cob...	199.35	PF 7	MPM	9931
382	R1 Large Gravel and Cob...	199.35	PF 8	MPM	11450
383	R1 Large Gravel and Cob...	199.35	PF 9	MPM	15220
384	R1 Large Gravel and Cob...	199.35	PF 10	MPM	17370

Sediment Reach Large Gravel and Cobble

River: Prickly Pear Cr., Reach: EXISTING STREAM
RS: 10900 to 101.64
Sediment Transport Functions: MPM
Temperature: 55
Specific Gravity of Sediment: 2.65
Concentration of Fine Sediment: 0
Fall Velocity Method: Default
Depth/Width Type: Default

Gradation	Left Overbank	Main Channel	Right Overbank			
	Diameter	% Finer	Diameter	% Finer	Diameter	% Finer
	128	100	128	100	128100	
	90.0	95	90.0	95	90.0	95
	64.0	70	64.0	70	64.0	70
	45.0	49	45.0	49	45.0	49
	32.0	32	32.0	32	32.0	32
	22.0	20	22.0	20	22.0	20
	16.0	17	16.0	17	16.0	17
	11.0	17	11.0	17	11.0	17
	8.00	17	8.00	17	8.00	17
	6.00	17	6.00	17	6.00	17
	4.00	17	4.00	17	4.00	17
	2.00	0	2.00	0	2.00	0
d90	84.0		84.0		84.0	
d84	77.4		77.4		77.4	
d50	45.9		45.9		45.9	

Bed Material Fraction by Standard Grade Size

Class	dm (mm)	Left	Main	Right
1	.003	0.000	0.000	0.000
2	.006	0.000	0.000	0.000
3	.011	0.000	0.000	0.000
4	.023	0.000	0.000	0.000
5	.045	0.000	0.000	0.000
6	.088	0.000	0.000	0.000
7	.177	0.000	0.000	0.000
8	.354	0.000	0.000	0.000
9	.707	0.000	0.000	0.000
10	1.41	0.000	0.000	0.000
11	2.83	0.170	0.170	0.170
12	5.64	0.000	0.000	0.000
13	11.3	0.000	0.000	0.000
14	22.6	0.150	0.150	0.150
15	45.1	0.380	0.380	0.380
16	90.5	0.267	0.267	0.267
17	181	0.033	0.033	0.033

18	362	0.000	0.000	0.000
19	724	0.000	0.000	0.000
20	1448	0.000	0.000	0.000

Sediment Transport Potential (tons/day) Sand and Gravel 10900 MPM Total All Grains (tons/day)

	Sed Reach	RS	Profile	Function	All Grains
1	Large Gravel and Cobble	10900 ...	PF 1	MPM	0
2	Large Gravel and Cobble	10900 ...	PF 2	MPM	0
3	Large Gravel and Cobble	10900 ...	PF 3	MPM	23.23
4	Large Gravel and Cobble	10900 ...	PF 4	MPM	98.43
5	Large Gravel and Cobble	10900 ...	PF 5	MPM	193.7
6	Large Gravel and Cobble	10900 ...	PF 6	MPM	297.3
7	Large Gravel and Cobble	10900 ...	PF 7	MPM	414.2
8	Large Gravel and Cobble	10900 ...	PF 8	MPM	639.6
9	Large Gravel and Cobble	10900 ...	PF 9	MPM	1247
10	Large Gravel and Cobble	10900 ...	PF 10	MPM	2018
11					
12	Large Gravel and Cobble	10800 ...	PF 1	MPM	530.4
13	Large Gravel and Cobble	10800 ...	PF 2	MPM	740.2
14	Large Gravel and Cobble	10800 ...	PF 3	MPM	1286
15	Large Gravel and Cobble	10800 ...	PF 4	MPM	2264
16	Large Gravel and Cobble	10800 ...	PF 5	MPM	3403
17	Large Gravel and Cobble	10800 ...	PF 6	MPM	4540
18	Large Gravel and Cobble	10800 ...	PF 7	MPM	5782
19	Large Gravel and Cobble	10800 ...	PF 8	MPM	4329
20	Large Gravel and Cobble	10800 ...	PF 9	MPM	4102
21	Large Gravel and Cobble	10800 ...	PF 10	MPM	4460
22					
23	Large Gravel and Cobble	10700 ...	PF 1	MPM	0
24	Large Gravel and Cobble	10700 ...	PF 2	MPM	0
25	Large Gravel and Cobble	10700 ...	PF 3	MPM	0
26	Large Gravel and Cobble	10700 ...	PF 4	MPM	7.576
27	Large Gravel and Cobble	10700 ...	PF 5	MPM	42.04
28	Large Gravel and Cobble	10700 ...	PF 6	MPM	89.85
29	Large Gravel and Cobble	10700 ...	PF 7	MPM	148.2
30	Large Gravel and Cobble	10700 ...	PF 8	MPM	241.9
31	Large Gravel and Cobble	10700 ...	PF 9	MPM	521.0
32	Large Gravel and Cobble	10700 ...	PF 10	MPM	763.2
33					
34	Large Gravel and Cobble	10606....	PF 1	MPM	0
35	Large Gravel and Cobble	10606....	PF 2	MPM	0
36	Large Gravel and Cobble	10606....	PF 3	MPM	11.60
37	Large Gravel and Cobble	10606....	PF 4	MPM	84.59
38	Large Gravel and Cobble	10606....	PF 5	MPM	191.2
39	Large Gravel and Cobble	10606....	PF 6	MPM	317.3
40	Large Gravel and Cobble	10606....	PF 7	MPM	459.7
41	Large Gravel and Cobble	10606....	PF 8	MPM	677.1

42	Large Gravel and Cobble	10606....	PF 9	MPM	1434
43	Large Gravel and Cobble	10606....	PF 10	MPM	2291
44					
45	Large Gravel and Cobble	10495....	PF 1	MPM	0
46	Large Gravel and Cobble	10495....	PF 2	MPM	0
47	Large Gravel and Cobble	10495....	PF 3	MPM	38.24
48	Large Gravel and Cobble	10495....	PF 4	MPM	147.0
49	Large Gravel and Cobble	10495....	PF 5	MPM	257.4
50	Large Gravel and Cobble	10495....	PF 6	MPM	364.0
51	Large Gravel and Cobble	10495....	PF 7	MPM	472.1
52	Large Gravel and Cobble	10495....	PF 8	MPM	620.8
53	Large Gravel and Cobble	10495....	PF 9	MPM	1018
54	Large Gravel and Cobble	10495....	PF 10	MPM	1315
55					
56	Large Gravel and Cobble	10400 ...	PF 1	MPM	404.9
57	Large Gravel and Cobble	10400 ...	PF 2	MPM	311.0
58	Large Gravel and Cobble	10400 ...	PF 3	MPM	294.0
59	Large Gravel and Cobble	10400 ...	PF 4	MPM	339.0
60	Large Gravel and Cobble	10400 ...	PF 5	MPM	416.8
61	Large Gravel and Cobble	10400 ...	PF 6	MPM	490.4
62	Large Gravel and Cobble	10400 ...	PF 7	MPM	564.1
63	Large Gravel and Cobble	10400 ...	PF 8	MPM	668.6
64	Large Gravel and Cobble	10400 ...	PF 9	MPM	938.5
65	Large Gravel and Cobble	10400 ...	PF 10	MPM	1161
66					
67	Large Gravel and Cobble	10300 ...	PF 1	MPM	7.355
68	Large Gravel and Cobble	10300 ...	PF 2	MPM	34.58
69	Large Gravel and Cobble	10300 ...	PF 3	MPM	155.1
70	Large Gravel and Cobble	10300 ...	PF 4	MPM	408.6
71	Large Gravel and Cobble	10300 ...	PF 5	MPM	734.4
72	Large Gravel and Cobble	10300 ...	PF 6	MPM	1122
73	Large Gravel and Cobble	10300 ...	PF 7	MPM	1664
74	Large Gravel and Cobble	10300 ...	PF 8	MPM	2548
75	Large Gravel and Cobble	10300 ...	PF 9	MPM	8090
76	Large Gravel and Cobble	10300 ...	PF 10	MPM	14720
77					
78	Large Gravel and Cobble	10200 ...	PF 1	MPM	525.7
79	Large Gravel and Cobble	10200 ...	PF 2	MPM	619.1
80	Large Gravel and Cobble	10200 ...	PF 3	MPM	1195
81	Large Gravel and Cobble	10200 ...	PF 4	MPM	2403
82	Large Gravel and Cobble	10200 ...	PF 5	MPM	3534
83	Large Gravel and Cobble	10200 ...	PF 6	MPM	4744
84	Large Gravel and Cobble	10200 ...	PF 7	MPM	5978
85	Large Gravel and Cobble	10200 ...	PF 8	MPM	8144
86	Large Gravel and Cobble	10200 ...	PF 9	MPM	9354
87	Large Gravel and Cobble	10200 ...	PF 10	MPM	11890
88					
89	Large Gravel and Cobble	10100 ...	PF 1	MPM	0

90	Large Gravel and Cobble	10100 ...	PF 2	MPM	0
91	Large Gravel and Cobble	10100 ...	PF 3	MPM	.02877
92	Large Gravel and Cobble	10100 ...	PF 4	MPM	48.50
93	Large Gravel and Cobble	10100 ...	PF 5	MPM	137.4
94	Large Gravel and Cobble	10100 ...	PF 6	MPM	252.3
95	Large Gravel and Cobble	10100 ...	PF 7	MPM	395.9
96	Large Gravel and Cobble	10100 ...	PF 8	MPM	646.9
97	Large Gravel and Cobble	10100 ...	PF 9	MPM	1790
98	Large Gravel and Cobble	10100 ...	PF 10	MPM	3475
99					
100	Large Gravel and Cobble	10004....	PF 1	MPM	9.062
101	Large Gravel and Cobble	10004....	PF 2	MPM	74.34
102	Large Gravel and Cobble	10004....	PF 3	MPM	399.8
103	Large Gravel and Cobble	10004....	PF 4	MPM	788.4
104	Large Gravel and Cobble	10004....	PF 5	MPM	1033
105	Large Gravel and Cobble	10004....	PF 6	MPM	1239
106	Large Gravel and Cobble	10004....	PF 7	MPM	1448
107	Large Gravel and Cobble	10004....	PF 8	MPM	1738
108	Large Gravel and Cobble	10004....	PF 9	MPM	2647
109	Large Gravel and Cobble	10004....	PF 10	MPM	3530
110					
111	Large Gravel and Cobble	9900.0...	PF 1	MPM	1361
112	Large Gravel and Cobble	9900.0...	PF 2	MPM	420.4
113	Large Gravel and Cobble	9900.0...	PF 3	MPM	317.0
114	Large Gravel and Cobble	9900.0...	PF 4	MPM	431.9
115	Large Gravel and Cobble	9900.0...	PF 5	MPM	569.9
116	Large Gravel and Cobble	9900.0...	PF 6	MPM	716.1
117	Large Gravel and Cobble	9900.0...	PF 7	MPM	863.3
118	Large Gravel and Cobble	9900.0...	PF 8	MPM	1087
119	Large Gravel and Cobble	9900.0...	PF 9	MPM	1914
120	Large Gravel and Cobble	9900.0...	PF 10	MPM	2795
121					
122	Large Gravel and Cobble	9800	PF 1	MPM	0
123	Large Gravel and Cobble	9800	PF 2	MPM	0
124	Large Gravel and Cobble	9800	PF 3	MPM	25.05
125	Large Gravel and Cobble	9800	PF 4	MPM	129.3
126	Large Gravel and Cobble	9800	PF 5	MPM	257.4
127	Large Gravel and Cobble	9800	PF 6	MPM	400.5
128	Large Gravel and Cobble	9800	PF 7	MPM	559.9
129	Large Gravel and Cobble	9800	PF 8	MPM	812.1
130	Large Gravel and Cobble	9800	PF 9	MPM	1874
131	Large Gravel and Cobble	9800	PF 10	MPM	3496
132					
133	Large Gravel and Cobble	9700	PF 1	MPM	435.9
134	Large Gravel and Cobble	9700	PF 2	MPM	141.5
135	Large Gravel and Cobble	9700	PF 3	MPM	138.5
136	Large Gravel and Cobble	9700	PF 4	MPM	236.1
137	Large Gravel and Cobble	9700	PF 5	MPM	337.7

138	Large Gravel and Cobble	9700	PF 6	MPM	438.1
139	Large Gravel and Cobble	9700	PF 7	MPM	539.8
140	Large Gravel and Cobble	9700	PF 8	MPM	692.1
141	Large Gravel and Cobble	9700	PF 9	MPM	1263
142	Large Gravel and Cobble	9700	PF 10	MPM	1892
143					
144	Large Gravel and Cobble	9599.9...	PF 1	MPM	0
145	Large Gravel and Cobble	9599.9...	PF 2	MPM	0
146	Large Gravel and Cobble	9599.9...	PF 3	MPM	30.45
147	Large Gravel and Cobble	9599.9...	PF 4	MPM	129.7
148	Large Gravel and Cobble	9599.9...	PF 5	MPM	241.9
149	Large Gravel and Cobble	9599.9...	PF 6	MPM	358.1
150	Large Gravel and Cobble	9599.9...	PF 7	MPM	469.1
151	Large Gravel and Cobble	9599.9...	PF 8	MPM	636.3
152	Large Gravel and Cobble	9599.9...	PF 9	MPM	1286
153	Large Gravel and Cobble	9599.9...	PF 10	MPM	2049
154					
155	Large Gravel and Cobble	9500.1...	PF 1	MPM	0
156	Large Gravel and Cobble	9500.1...	PF 2	MPM	.3864
157	Large Gravel and Cobble	9500.1...	PF 3	MPM	76.36
158	Large Gravel and Cobble	9500.1...	PF 4	MPM	278.6
159	Large Gravel and Cobble	9500.1...	PF 5	MPM	429.7
160	Large Gravel and Cobble	9500.1...	PF 6	MPM	529.9
161	Large Gravel and Cobble	9500.1...	PF 7	MPM	599.6
162	Large Gravel and Cobble	9500.1...	PF 8	MPM	721.1
163	Large Gravel and Cobble	9500.1...	PF 9	MPM	1371
164	Large Gravel and Cobble	9500.1...	PF 10	MPM	2190
165					
166	Large Gravel and Cobble	9400	PF 1	MPM	374.7
167	Large Gravel and Cobble	9400	PF 2	MPM	705.3
168	Large Gravel and Cobble	9400	PF 3	MPM	235.1
169	Large Gravel and Cobble	9400	PF 4	MPM	176.2
170	Large Gravel and Cobble	9400	PF 5	MPM	171.5
171	Large Gravel and Cobble	9400	PF 6	MPM	173.1
172	Large Gravel and Cobble	9400	PF 7	MPM	176.2
173	Large Gravel and Cobble	9400	PF 8	MPM	219.2
174	Large Gravel and Cobble	9400	PF 9	MPM	578.8
175	Large Gravel and Cobble	9400	PF 10	MPM	1043
176					
177	Large Gravel and Cobble	9300	PF 1	MPM	0
178	Large Gravel and Cobble	9300	PF 2	MPM	6.803
179	Large Gravel and Cobble	9300	PF 3	MPM	50.72
180	Large Gravel and Cobble	9300	PF 4	MPM	73.52
181	Large Gravel and Cobble	9300	PF 5	MPM	83.92
182	Large Gravel and Cobble	9300	PF 6	MPM	86.95
183	Large Gravel and Cobble	9300	PF 7	MPM	93.12
184	Large Gravel and Cobble	9300	PF 8	MPM	131.5
185	Large Gravel and Cobble	9300	PF 9	MPM	381.7

186	Large Gravel and Cobble	9300	PF 10	MPM	719.4
187					
188	Large Gravel and Cobble	9200	PF 1	MPM	93.00
189	Large Gravel and Cobble	9200	PF 2	MPM	77.59
190	Large Gravel and Cobble	9200	PF 3	MPM	172.3
191	Large Gravel and Cobble	9200	PF 4	MPM	372.2
192	Large Gravel and Cobble	9200	PF 5	MPM	603.3
193	Large Gravel and Cobble	9200	PF 6	MPM	927.5
194	Large Gravel and Cobble	9200	PF 7	MPM	1393
195	Large Gravel and Cobble	9200	PF 8	MPM	1427
196	Large Gravel and Cobble	9200	PF 9	MPM	1946
197	Large Gravel and Cobble	9200	PF 10	MPM	2636
198					
199	Large Gravel and Cobble	9100	PF 1	MPM	0
200	Large Gravel and Cobble	9100	PF 2	MPM	0
201	Large Gravel and Cobble	9100	PF 3	MPM	6.842
202	Large Gravel and Cobble	9100	PF 4	MPM	93.86
203	Large Gravel and Cobble	9100	PF 5	MPM	253.9
204	Large Gravel and Cobble	9100	PF 6	MPM	439.1
205	Large Gravel and Cobble	9100	PF 7	MPM	592.5
206	Large Gravel and Cobble	9100	PF 8	MPM	793.5
207	Large Gravel and Cobble	9100	PF 9	MPM	1616
208	Large Gravel and Cobble	9100	PF 10	MPM	2994
209					
210	Large Gravel and Cobble	9000	PF 1	MPM	0
211	Large Gravel and Cobble	9000	PF 2	MPM	0
212	Large Gravel and Cobble	9000	PF 3	MPM	24.56
213	Large Gravel and Cobble	9000	PF 4	MPM	96.94
214	Large Gravel and Cobble	9000	PF 5	MPM	189.0
215	Large Gravel and Cobble	9000	PF 6	MPM	304.5
216	Large Gravel and Cobble	9000	PF 7	MPM	433.1
217	Large Gravel and Cobble	9000	PF 8	MPM	627.6
218	Large Gravel and Cobble	9000	PF 9	MPM	1221
219	Large Gravel and Cobble	9000	PF 10	MPM	2322
220					
221	Large Gravel and Cobble	8900	PF 1	MPM	404.5
222	Large Gravel and Cobble	8900	PF 2	MPM	1082
223	Large Gravel and Cobble	8900	PF 3	MPM	762.8
224	Large Gravel and Cobble	8900	PF 4	MPM	2156
225	Large Gravel and Cobble	8900	PF 5	MPM	3579
226	Large Gravel and Cobble	8900	PF 6	MPM	4757
227	Large Gravel and Cobble	8900	PF 7	MPM	6032
228	Large Gravel and Cobble	8900	PF 8	MPM	7546
229	Large Gravel and Cobble	8900	PF 9	MPM	8870
230	Large Gravel and Cobble	8900	PF 10	MPM	4665
231					
232	Large Gravel and Cobble	8800	PF 1	MPM	166.7
233	Large Gravel and Cobble	8800	PF 2	MPM	136.5

234	Large Gravel and Cobble	8800	PF 3	MPM	102.5
235	Large Gravel and Cobble	8800	PF 4	MPM	245.8
236	Large Gravel and Cobble	8800	PF 5	MPM	381.8
237	Large Gravel and Cobble	8800	PF 6	MPM	442.1
238	Large Gravel and Cobble	8800	PF 7	MPM	465.9
239	Large Gravel and Cobble	8800	PF 8	MPM	484.6
240	Large Gravel and Cobble	8800	PF 9	MPM	534.6
241	Large Gravel and Cobble	8800	PF 10	MPM	571.9
242					
243	Large Gravel and Cobble	8700	PF 1	MPM	7.547
244	Large Gravel and Cobble	8700	PF 2	MPM	26.02
245	Large Gravel and Cobble	8700	PF 3	MPM	78.92
246	Large Gravel and Cobble	8700	PF 4	MPM	176.5
247	Large Gravel and Cobble	8700	PF 5	MPM	325.7
248	Large Gravel and Cobble	8700	PF 6	MPM	505.8
249	Large Gravel and Cobble	8700	PF 7	MPM	707.2
250	Large Gravel and Cobble	8700	PF 8	MPM	1052
251	Large Gravel and Cobble	8700	PF 9	MPM	3045
252	Large Gravel and Cobble	8700	PF 10	MPM	5500
253					
254	Large Gravel and Cobble	8606.3...	PF 1	MPM	0
255	Large Gravel and Cobble	8606.3...	PF 2	MPM	0
256	Large Gravel and Cobble	8606.3...	PF 3	MPM	0
257	Large Gravel and Cobble	8606.3...	PF 4	MPM	3.651
258	Large Gravel and Cobble	8606.3...	PF 5	MPM	23.30
259	Large Gravel and Cobble	8606.3...	PF 6	MPM	52.89
260	Large Gravel and Cobble	8606.3...	PF 7	MPM	90.32
261	Large Gravel and Cobble	8606.3...	PF 8	MPM	150.2
262	Large Gravel and Cobble	8606.3...	PF 9	MPM	363.1
263	Large Gravel and Cobble	8606.3...	PF 10	MPM	612.3
264					
265	Large Gravel and Cobble	8449.5...	PF 1	MPM	406.7
266	Large Gravel and Cobble	8449.5...	PF 2	MPM	640.5
267	Large Gravel and Cobble	8449.5...	PF 3	MPM	1079
268	Large Gravel and Cobble	8449.5...	PF 4	MPM	1020
269	Large Gravel and Cobble	8449.5...	PF 5	MPM	1685
270	Large Gravel and Cobble	8449.5...	PF 6	MPM	2501
271	Large Gravel and Cobble	8449.5...	PF 7	MPM	3442
272	Large Gravel and Cobble	8449.5...	PF 8	MPM	4723
273	Large Gravel and Cobble	8449.5...	PF 9	MPM	9294
274	Large Gravel and Cobble	8449.5...	PF 10	MPM	9513
275					
276	Large Gravel and Cobble	8400	PF 1	MPM	2.392
277	Large Gravel and Cobble	8400	PF 2	MPM	12.45
278	Large Gravel and Cobble	8400	PF 3	MPM	93.31
279	Large Gravel and Cobble	8400	PF 4	MPM	248.2
280	Large Gravel and Cobble	8400	PF 5	MPM	382.5
281	Large Gravel and Cobble	8400	PF 6	MPM	592.6

282	Large Gravel and Cobble	8400	PF 7	MPM	823.4
283	Large Gravel and Cobble	8400	PF 8	MPM	1076
284	Large Gravel and Cobble	8400	PF 9	MPM	1257
285	Large Gravel and Cobble	8400	PF 10	MPM	1172
286					
287	Large Gravel and Cobble	8300	PF 1	MPM	110.1
288	Large Gravel and Cobble	8300	PF 2	MPM	652.4
289	Large Gravel and Cobble	8300	PF 3	MPM	1270
290	Large Gravel and Cobble	8300	PF 4	MPM	2430
291	Large Gravel and Cobble	8300	PF 5	MPM	2647
292	Large Gravel and Cobble	8300	PF 6	MPM	2381
293	Large Gravel and Cobble	8300	PF 7	MPM	2181
294	Large Gravel and Cobble	8300	PF 8	MPM	2032
295	Large Gravel and Cobble	8300	PF 9	MPM	1938
296	Large Gravel and Cobble	8300	PF 10	MPM	2243
297					
298	Large Gravel and Cobble	8200	PF 1	MPM	336.5
299	Large Gravel and Cobble	8200	PF 2	MPM	121.5
300	Large Gravel and Cobble	8200	PF 3	MPM	169.5
301	Large Gravel and Cobble	8200	PF 4	MPM	271.6
302	Large Gravel and Cobble	8200	PF 5	MPM	388.6
303	Large Gravel and Cobble	8200	PF 6	MPM	521.9
304	Large Gravel and Cobble	8200	PF 7	MPM	667.0
305	Large Gravel and Cobble	8200	PF 8	MPM	899.1
306	Large Gravel and Cobble	8200	PF 9	MPM	1810
307	Large Gravel and Cobble	8200	PF 10	MPM	2924
308					
309	Large Gravel and Cobble	8100	PF 1	MPM	0
310	Large Gravel and Cobble	8100	PF 2	MPM	0
311	Large Gravel and Cobble	8100	PF 3	MPM	0
312	Large Gravel and Cobble	8100	PF 4	MPM	28.85
313	Large Gravel and Cobble	8100	PF 5	MPM	88.75
314	Large Gravel and Cobble	8100	PF 6	MPM	167.8
315	Large Gravel and Cobble	8100	PF 7	MPM	263.3
316	Large Gravel and Cobble	8100	PF 8	MPM	421.8
317	Large Gravel and Cobble	8100	PF 9	MPM	991.2
318	Large Gravel and Cobble	8100	PF 10	MPM	1941
319					
320	Large Gravel and Cobble	8000.0...	PF 1	MPM	0
321	Large Gravel and Cobble	8000.0...	PF 2	MPM	0
322	Large Gravel and Cobble	8000.0...	PF 3	MPM	13.39
323	Large Gravel and Cobble	8000.0...	PF 4	MPM	86.25
324	Large Gravel and Cobble	8000.0...	PF 5	MPM	196.6
325	Large Gravel and Cobble	8000.0...	PF 6	MPM	337.0
326	Large Gravel and Cobble	8000.0...	PF 7	MPM	497.5
327	Large Gravel and Cobble	8000.0...	PF 8	MPM	748.4
328	Large Gravel and Cobble	8000.0...	PF 9	MPM	1727
329	Large Gravel and Cobble	8000.0...	PF 10	MPM	3015

330					
331	Large Gravel and Cobble	7900	PF 1	MPM	10.47
332	Large Gravel and Cobble	7900	PF 2	MPM	16.75
333	Large Gravel and Cobble	7900	PF 3	MPM	50.05
334	Large Gravel and Cobble	7900	PF 4	MPM	129.6
335	Large Gravel and Cobble	7900	PF 5	MPM	217.1
336	Large Gravel and Cobble	7900	PF 6	MPM	305.5
337	Large Gravel and Cobble	7900	PF 7	MPM	397.6
338	Large Gravel and Cobble	7900	PF 8	MPM	527.3
339	Large Gravel and Cobble	7900	PF 9	MPM	760.1
340	Large Gravel and Cobble	7900	PF 10	MPM	416.8
341					
342	Large Gravel and Cobble	7800	PF 1	MPM	0
343	Large Gravel and Cobble	7800	PF 2	MPM	0
344	Large Gravel and Cobble	7800	PF 3	MPM	16.11
345	Large Gravel and Cobble	7800	PF 4	MPM	107.0
346	Large Gravel and Cobble	7800	PF 5	MPM	227.9
347	Large Gravel and Cobble	7800	PF 6	MPM	372.5
348	Large Gravel and Cobble	7800	PF 7	MPM	534.5
349	Large Gravel and Cobble	7800	PF 8	MPM	773.1
350	Large Gravel and Cobble	7800	PF 9	MPM	1492
351	Large Gravel and Cobble	7800	PF 10	MPM	1825
352					
353	Large Gravel and Cobble	7699.8...	PF 1	MPM	0
354	Large Gravel and Cobble	7699.8...	PF 2	MPM	0
355	Large Gravel and Cobble	7699.8...	PF 3	MPM	40.05
356	Large Gravel and Cobble	7699.8...	PF 4	MPM	204.3
357	Large Gravel and Cobble	7699.8...	PF 5	MPM	435.9
358	Large Gravel and Cobble	7699.8...	PF 6	MPM	767.7
359	Large Gravel and Cobble	7699.8...	PF 7	MPM	1196
360	Large Gravel and Cobble	7699.8...	PF 8	MPM	1938
361	Large Gravel and Cobble	7699.8...	PF 9	MPM	4824
362	Large Gravel and Cobble	7699.8...	PF 10	MPM	12730
363					
364	Large Gravel and Cobble	7659.1...	PF 1	MPM	479.2
365	Large Gravel and Cobble	7659.1...	PF 2	MPM	429.0
366	Large Gravel and Cobble	7659.1...	PF 3	MPM	753.9
367	Large Gravel and Cobble	7659.1...	PF 4	MPM	1653
368	Large Gravel and Cobble	7659.1...	PF 5	MPM	2669
369	Large Gravel and Cobble	7659.1...	PF 6	MPM	2630
370	Large Gravel and Cobble	7659.1...	PF 7	MPM	2228
371	Large Gravel and Cobble	7659.1...	PF 8	MPM	2013
372	Large Gravel and Cobble	7659.1...	PF 9	MPM	2251
373	Large Gravel and Cobble	7659.1...	PF 10	MPM	0
374					
375	Large Gravel and Cobble	7592.3...	PF 1	MPM	27.04
376	Large Gravel and Cobble	7592.3...	PF 2	MPM	70.19
377	Large Gravel and Cobble	7592.3...	PF 3	MPM	132.7

378	Large Gravel and Cobble	7592.3...	PF 4	MPM	209.6
379	Large Gravel and Cobble	7592.3...	PF 5	MPM	283.7
380	Large Gravel and Cobble	7592.3...	PF 6	MPM	364.1
381	Large Gravel and Cobble	7592.3...	PF 7	MPM	453.3
382	Large Gravel and Cobble	7592.3...	PF 8	MPM	591.6
383	Large Gravel and Cobble	7592.3...	PF 9	MPM	173.0
384	Large Gravel and Cobble	7592.3...	PF 10	MPM	0
385					
386	Large Gravel and Cobble	7550	PF 1	MPM	3.960
387	Large Gravel and Cobble	7550	PF 2	MPM	40.34
388	Large Gravel and Cobble	7550	PF 3	MPM	228.8
389	Large Gravel and Cobble	7550	PF 4	MPM	558.5
390	Large Gravel and Cobble	7550	PF 5	MPM	855.0
391	Large Gravel and Cobble	7550	PF 6	MPM	1205
392	Large Gravel and Cobble	7550	PF 7	MPM	1536
393	Large Gravel and Cobble	7550	PF 8	MPM	1896
394	Large Gravel and Cobble	7550	PF 9	MPM	375.0
395	Large Gravel and Cobble	7550	PF 10	MPM	0
396					
397	Large Gravel and Cobble	7486.8...	PF 1	MPM	40.20
398	Large Gravel and Cobble	7486.8...	PF 2	MPM	74.14
399	Large Gravel and Cobble	7486.8...	PF 3	MPM	153.8
400	Large Gravel and Cobble	7486.8...	PF 4	MPM	317.9
401	Large Gravel and Cobble	7486.8...	PF 5	MPM	420.6
402	Large Gravel and Cobble	7486.8...	PF 6	MPM	562.3
403	Large Gravel and Cobble	7486.8...	PF 7	MPM	680.0
404	Large Gravel and Cobble	7486.8...	PF 8	MPM	822.6
405	Large Gravel and Cobble	7486.8...	PF 9	MPM	1274
406	Large Gravel and Cobble	7486.8...	PF 10	MPM	782.3
407					
408	Large Gravel and Cobble	7446.0...	PF 1	MPM	223.6
409	Large Gravel and Cobble	7446.0...	PF 2	MPM	253.3
410	Large Gravel and Cobble	7446.0...	PF 3	MPM	312.5
411	Large Gravel and Cobble	7446.0...	PF 4	MPM	461.8
412	Large Gravel and Cobble	7446.0...	PF 5	MPM	534.1
413	Large Gravel and Cobble	7446.0...	PF 6	MPM	569.3
414	Large Gravel and Cobble	7446.0...	PF 7	MPM	611.0
415	Large Gravel and Cobble	7446.0...	PF 8	MPM	675.8
416	Large Gravel and Cobble	7446.0...	PF 9	MPM	723.3
417	Large Gravel and Cobble	7446.0...	PF 10	MPM	240.3
418					
419	Large Gravel and Cobble	7388.7 ...	PF 1	MPM	0
420	Large Gravel and Cobble	7388.7 ...	PF 2	MPM	7.585
421	Large Gravel and Cobble	7388.7 ...	PF 3	MPM	90.25
422	Large Gravel and Cobble	7388.7 ...	PF 4	MPM	358.7
423	Large Gravel and Cobble	7388.7 ...	PF 5	MPM	625.5
424	Large Gravel and Cobble	7388.7 ...	PF 6	MPM	875.5
425	Large Gravel and Cobble	7388.7 ...	PF 7	MPM	1156

426	Large Gravel and Cobble	7388.7 ...	PF 8	MPM	1669
427	Large Gravel and Cobble	7388.7 ...	PF 9	MPM	4076
428	Large Gravel and Cobble	7388.7 ...	PF 10	MPM	9633
429					
430	Large Gravel and Cobble	7321.9...	PF 1	MPM	678.5
431	Large Gravel and Cobble	7321.9...	PF 2	MPM	859.0
432	Large Gravel and Cobble	7321.9...	PF 3	MPM	1274
433	Large Gravel and Cobble	7321.9...	PF 4	MPM	597.7
434	Large Gravel and Cobble	7321.9...	PF 5	MPM	533.4
435	Large Gravel and Cobble	7321.9...	PF 6	MPM	581.5
436	Large Gravel and Cobble	7321.9...	PF 7	MPM	644.7
437	Large Gravel and Cobble	7321.9...	PF 8	MPM	735.9
438	Large Gravel and Cobble	7321.9...	PF 9	MPM	831.6
439	Large Gravel and Cobble	7321.9...	PF 10	MPM	388.6
440					
441	Large Gravel and Cobble	7300	PF 1	MPM	0
442	Large Gravel and Cobble	7300	PF 2	MPM	.5349
443	Large Gravel and Cobble	7300	PF 3	MPM	22.73
444	Large Gravel and Cobble	7300	PF 4	MPM	72.61
445	Large Gravel and Cobble	7300	PF 5	MPM	127.3
446	Large Gravel and Cobble	7300	PF 6	MPM	178.8
447	Large Gravel and Cobble	7300	PF 7	MPM	233.6
448	Large Gravel and Cobble	7300	PF 8	MPM	322.3
449	Large Gravel and Cobble	7300	PF 9	MPM	468.5
450	Large Gravel and Cobble	7300	PF 10	MPM	297.1
451					
452	Large Gravel and Cobble	7263.2 ...	PF 1	MPM	7.224
453	Large Gravel and Cobble	7263.2 ...	PF 2	MPM	25.13
454	Large Gravel and Cobble	7263.2 ...	PF 3	MPM	144.9
455	Large Gravel and Cobble	7263.2 ...	PF 4	MPM	362.5
456	Large Gravel and Cobble	7263.2 ...	PF 5	MPM	558.7
457	Large Gravel and Cobble	7263.2 ...	PF 6	MPM	748.4
458	Large Gravel and Cobble	7263.2 ...	PF 7	MPM	912.4
459	Large Gravel and Cobble	7263.2 ...	PF 8	MPM	1080
460	Large Gravel and Cobble	7263.2 ...	PF 9	MPM	835.5
461	Large Gravel and Cobble	7263.2 ...	PF 10	MPM	478.4
462					
463	Large Gravel and Cobble	7200.1...	PF 1	MPM	330.4
464	Large Gravel and Cobble	7200.1...	PF 2	MPM	755.1
465	Large Gravel and Cobble	7200.1...	PF 3	MPM	650.0
466	Large Gravel and Cobble	7200.1...	PF 4	MPM	810.4
467	Large Gravel and Cobble	7200.1...	PF 5	MPM	1000
468	Large Gravel and Cobble	7200.1...	PF 6	MPM	1671
469	Large Gravel and Cobble	7200.1...	PF 7	MPM	2350
470	Large Gravel and Cobble	7200.1...	PF 8	MPM	3312
471	Large Gravel and Cobble	7200.1...	PF 9	MPM	6949
472	Large Gravel and Cobble	7200.1...	PF 10	MPM	7589
473					

474	Large Gravel and Cobble	7100.1...	PF 1	MPM	.1849
475	Large Gravel and Cobble	7100.1...	PF 2	MPM	16.19
476	Large Gravel and Cobble	7100.1...	PF 3	MPM	85.88
477	Large Gravel and Cobble	7100.1...	PF 4	MPM	206.0
478	Large Gravel and Cobble	7100.1...	PF 5	MPM	302.7
479	Large Gravel and Cobble	7100.1...	PF 6	MPM	354.8
480	Large Gravel and Cobble	7100.1...	PF 7	MPM	423.6
481	Large Gravel and Cobble	7100.1...	PF 8	MPM	533.7
482	Large Gravel and Cobble	7100.1...	PF 9	MPM	940.2
483	Large Gravel and Cobble	7100.1...	PF 10	MPM	1332
484					
485	Large Gravel and Cobble	7000	PF 1	MPM	0
486	Large Gravel and Cobble	7000	PF 2	MPM	0
487	Large Gravel and Cobble	7000	PF 3	MPM	.01510
488	Large Gravel and Cobble	7000	PF 4	MPM	32.89
489	Large Gravel and Cobble	7000	PF 5	MPM	91.63
490	Large Gravel and Cobble	7000	PF 6	MPM	160.1
491	Large Gravel and Cobble	7000	PF 7	MPM	246.7
492	Large Gravel and Cobble	7000	PF 8	MPM	388.2
493	Large Gravel and Cobble	7000	PF 9	MPM	744.7
494	Large Gravel and Cobble	7000	PF 10	MPM	913.7
495					
496	Large Gravel and Cobble	6900	PF 1	MPM	0
497	Large Gravel and Cobble	6900	PF 2	MPM	0
498	Large Gravel and Cobble	6900	PF 3	MPM	0
499	Large Gravel and Cobble	6900	PF 4	MPM	13.67
500	Large Gravel and Cobble	6900	PF 5	MPM	67.33
501	Large Gravel and Cobble	6900	PF 6	MPM	136.4
502	Large Gravel and Cobble	6900	PF 7	MPM	200.5
503	Large Gravel and Cobble	6900	PF 8	MPM	299.8
504	Large Gravel and Cobble	6900	PF 9	MPM	662.8
505	Large Gravel and Cobble	6900	PF 10	MPM	1077
506					
507	Large Gravel and Cobble	6800	PF 1	MPM	729.2
508	Large Gravel and Cobble	6800	PF 2	MPM	1058
509	Large Gravel and Cobble	6800	PF 3	MPM	1710
510	Large Gravel and Cobble	6800	PF 4	MPM	2594
511	Large Gravel and Cobble	6800	PF 5	MPM	1790
512	Large Gravel and Cobble	6800	PF 6	MPM	1490
513	Large Gravel and Cobble	6800	PF 7	MPM	1354
514	Large Gravel and Cobble	6800	PF 8	MPM	1328
515	Large Gravel and Cobble	6800	PF 9	MPM	1743
516	Large Gravel and Cobble	6800	PF 10	MPM	2033
517					
518	Large Gravel and Cobble	6700	PF 1	MPM	0
519	Large Gravel and Cobble	6700	PF 2	MPM	6.257
520	Large Gravel and Cobble	6700	PF 3	MPM	49.63
521	Large Gravel and Cobble	6700	PF 4	MPM	160.0

522	Large Gravel and Cobble	6700	PF 5	MPM	305.6
523	Large Gravel and Cobble	6700	PF 6	MPM	406.9
524	Large Gravel and Cobble	6700	PF 7	MPM	509.1
525	Large Gravel and Cobble	6700	PF 8	MPM	735.9
526	Large Gravel and Cobble	6700	PF 9	MPM	2014
527	Large Gravel and Cobble	6700	PF 10	MPM	4445
528					
529	Large Gravel and Cobble	6600	PF 1	MPM	0
530	Large Gravel and Cobble	6600	PF 2	MPM	0
531	Large Gravel and Cobble	6600	PF 3	MPM	4.220
532	Large Gravel and Cobble	6600	PF 4	MPM	67.26
533	Large Gravel and Cobble	6600	PF 5	MPM	185.4
534	Large Gravel and Cobble	6600	PF 6	MPM	343.0
535	Large Gravel and Cobble	6600	PF 7	MPM	501.8
536	Large Gravel and Cobble	6600	PF 8	MPM	706.2
537	Large Gravel and Cobble	6600	PF 9	MPM	1233
538	Large Gravel and Cobble	6600	PF 10	MPM	1826
539					
540	Large Gravel and Cobble	6500	PF 1	MPM	.4224
541	Large Gravel and Cobble	6500	PF 2	MPM	15.47
542	Large Gravel and Cobble	6500	PF 3	MPM	76.98
543	Large Gravel and Cobble	6500	PF 4	MPM	147.2
544	Large Gravel and Cobble	6500	PF 5	MPM	237.2
545	Large Gravel and Cobble	6500	PF 6	MPM	331.6
546	Large Gravel and Cobble	6500	PF 7	MPM	471.8
547	Large Gravel and Cobble	6500	PF 8	MPM	669.9
548	Large Gravel and Cobble	6500	PF 9	MPM	1282
549	Large Gravel and Cobble	6500	PF 10	MPM	1775
550					
551	Large Gravel and Cobble	6400	PF 1	MPM	273.1
552	Large Gravel and Cobble	6400	PF 2	MPM	309.8
553	Large Gravel and Cobble	6400	PF 3	MPM	1540
554	Large Gravel and Cobble	6400	PF 4	MPM	3091
555	Large Gravel and Cobble	6400	PF 5	MPM	3689
556	Large Gravel and Cobble	6400	PF 6	MPM	4240
557	Large Gravel and Cobble	6400	PF 7	MPM	4622
558	Large Gravel and Cobble	6400	PF 8	MPM	6086
559	Large Gravel and Cobble	6400	PF 9	MPM	10040
560	Large Gravel and Cobble	6400	PF 10	MPM	14120
561					
562	Large Gravel and Cobble	6300.0...	PF 1	MPM	138.5
563	Large Gravel and Cobble	6300.0...	PF 2	MPM	178.0
564	Large Gravel and Cobble	6300.0...	PF 3	MPM	82.68
565	Large Gravel and Cobble	6300.0...	PF 4	MPM	112.7
566	Large Gravel and Cobble	6300.0...	PF 5	MPM	147.4
567	Large Gravel and Cobble	6300.0...	PF 6	MPM	199.1
568	Large Gravel and Cobble	6300.0...	PF 7	MPM	254.7
569	Large Gravel and Cobble	6300.0...	PF 8	MPM	348.4

570	Large Gravel and Cobble	6300.0...	PF 9	MPM	617.5
571	Large Gravel and Cobble	6300.0...	PF 10	MPM	830.3
572					
573	Large Gravel and Cobble	6200	PF 1	MPM	0
574	Large Gravel and Cobble	6200	PF 2	MPM	0
575	Large Gravel and Cobble	6200	PF 3	MPM	0
576	Large Gravel and Cobble	6200	PF 4	MPM	0
577	Large Gravel and Cobble	6200	PF 5	MPM	0
578	Large Gravel and Cobble	6200	PF 6	MPM	13.13
579	Large Gravel and Cobble	6200	PF 7	MPM	41.28
580	Large Gravel and Cobble	6200	PF 8	MPM	96.46
581	Large Gravel and Cobble	6200	PF 9	MPM	342.7
582	Large Gravel and Cobble	6200	PF 10	MPM	666.4
583					
584	Large Gravel and Cobble	6099.5...	PF 1	MPM	1524
585	Large Gravel and Cobble	6099.5...	PF 2	MPM	1260
586	Large Gravel and Cobble	6099.5...	PF 3	MPM	1508
587	Large Gravel and Cobble	6099.5...	PF 4	MPM	1742
588	Large Gravel and Cobble	6099.5...	PF 5	MPM	1364
589	Large Gravel and Cobble	6099.5...	PF 6	MPM	1088
590	Large Gravel and Cobble	6099.5...	PF 7	MPM	1132
591	Large Gravel and Cobble	6099.5...	PF 8	MPM	1229
592	Large Gravel and Cobble	6099.5...	PF 9	MPM	1282
593	Large Gravel and Cobble	6099.5...	PF 10	MPM	1582
594					
595	Large Gravel and Cobble	5999.6...	PF 1	MPM	0
596	Large Gravel and Cobble	5999.6...	PF 2	MPM	0
597	Large Gravel and Cobble	5999.6...	PF 3	MPM	13.55
598	Large Gravel and Cobble	5999.6...	PF 4	MPM	80.56
599	Large Gravel and Cobble	5999.6...	PF 5	MPM	183.9
600	Large Gravel and Cobble	5999.6...	PF 6	MPM	311.3
601	Large Gravel and Cobble	5999.6...	PF 7	MPM	484.3
602	Large Gravel and Cobble	5999.6...	PF 8	MPM	821.8
603	Large Gravel and Cobble	5999.6...	PF 9	MPM	1321
604	Large Gravel and Cobble	5999.6...	PF 10	MPM	1326
605					
606	Large Gravel and Cobble	5900	PF 1	MPM	485.4
607	Large Gravel and Cobble	5900	PF 2	MPM	671.2
608	Large Gravel and Cobble	5900	PF 3	MPM	1300
609	Large Gravel and Cobble	5900	PF 4	MPM	2635
610	Large Gravel and Cobble	5900	PF 5	MPM	3479
611	Large Gravel and Cobble	5900	PF 6	MPM	4244
612	Large Gravel and Cobble	5900	PF 7	MPM	4131
613	Large Gravel and Cobble	5900	PF 8	MPM	2314
614	Large Gravel and Cobble	5900	PF 9	MPM	1323
615	Large Gravel and Cobble	5900	PF 10	MPM	769.6
616					
617	Large Gravel and Cobble	5800	PF 1	MPM	0

618	Large Gravel and Cobble	5800	PF 2	MPM	0
619	Large Gravel and Cobble	5800	PF 3	MPM	0
620	Large Gravel and Cobble	5800	PF 4	MPM	3.555
621	Large Gravel and Cobble	5800	PF 5	MPM	20.58
622	Large Gravel and Cobble	5800	PF 6	MPM	50.17
623	Large Gravel and Cobble	5800	PF 7	MPM	85.57
624	Large Gravel and Cobble	5800	PF 8	MPM	143.0
625	Large Gravel and Cobble	5800	PF 9	MPM	0
626	Large Gravel and Cobble	5800	PF 10	MPM	0
627					
628	Large Gravel and Cobble	5700.1...	PF 1	MPM	515.5
629	Large Gravel and Cobble	5700.1...	PF 2	MPM	589.3
630	Large Gravel and Cobble	5700.1...	PF 3	MPM	343.7
631	Large Gravel and Cobble	5700.1...	PF 4	MPM	387.4
632	Large Gravel and Cobble	5700.1...	PF 5	MPM	409.3
633	Large Gravel and Cobble	5700.1...	PF 6	MPM	417.7
634	Large Gravel and Cobble	5700.1...	PF 7	MPM	446.9
635	Large Gravel and Cobble	5700.1...	PF 8	MPM	504.1
636	Large Gravel and Cobble	5700.1...	PF 9	MPM	678.0
637	Large Gravel and Cobble	5700.1...	PF 10	MPM	0
638					
639	Large Gravel and Cobble	5600	PF 1	MPM	0
640	Large Gravel and Cobble	5600	PF 2	MPM	0
641	Large Gravel and Cobble	5600	PF 3	MPM	3.011
642	Large Gravel and Cobble	5600	PF 4	MPM	48.14
643	Large Gravel and Cobble	5600	PF 5	MPM	104.5
644	Large Gravel and Cobble	5600	PF 6	MPM	165.3
645	Large Gravel and Cobble	5600	PF 7	MPM	230.6
646	Large Gravel and Cobble	5600	PF 8	MPM	332.1
647	Large Gravel and Cobble	5600	PF 9	MPM	0
648	Large Gravel and Cobble	5600	PF 10	MPM	0
649					
650	Large Gravel and Cobble	5500	PF 1	MPM	29.68
651	Large Gravel and Cobble	5500	PF 2	MPM	4.631
652	Large Gravel and Cobble	5500	PF 3	MPM	18.69
653	Large Gravel and Cobble	5500	PF 4	MPM	61.22
654	Large Gravel and Cobble	5500	PF 5	MPM	106.3
655	Large Gravel and Cobble	5500	PF 6	MPM	153.6
656	Large Gravel and Cobble	5500	PF 7	MPM	205.0
657	Large Gravel and Cobble	5500	PF 8	MPM	284.7
658	Large Gravel and Cobble	5500	PF 9	MPM	0
659	Large Gravel and Cobble	5500	PF 10	MPM	0
660					
661	Large Gravel and Cobble	5400	PF 1	MPM	4.584
662	Large Gravel and Cobble	5400	PF 2	MPM	14.93
663	Large Gravel and Cobble	5400	PF 3	MPM	75.89
664	Large Gravel and Cobble	5400	PF 4	MPM	243.5
665	Large Gravel and Cobble	5400	PF 5	MPM	405.8

666	Large Gravel and Cobble	5400	PF 6	MPM	566.3
667	Large Gravel and Cobble	5400	PF 7	MPM	726.9
668	Large Gravel and Cobble	5400	PF 8	MPM	954.8
669	Large Gravel and Cobble	5400	PF 9	MPM	1508
670	Large Gravel and Cobble	5400	PF 10	MPM	4478
671					
672	Large Gravel and Cobble	5306.7...	PF 1	MPM	0
673	Large Gravel and Cobble	5306.7...	PF 2	MPM	.2755
674	Large Gravel and Cobble	5306.7...	PF 3	MPM	47.16
675	Large Gravel and Cobble	5306.7...	PF 4	MPM	181.8
676	Large Gravel and Cobble	5306.7...	PF 5	MPM	272.4
677	Large Gravel and Cobble	5306.7...	PF 6	MPM	363.9
678	Large Gravel and Cobble	5306.7...	PF 7	MPM	460.8
679	Large Gravel and Cobble	5306.7...	PF 8	MPM	607.5
680	Large Gravel and Cobble	5306.7...	PF 9	MPM	914.8
681	Large Gravel and Cobble	5306.7...	PF 10	MPM	0
682					
683	Large Gravel and Cobble	5200.1...	PF 1	MPM	2110
684	Large Gravel and Cobble	5200.1...	PF 2	MPM	1547
685	Large Gravel and Cobble	5200.1...	PF 3	MPM	632.3
686	Large Gravel and Cobble	5200.1...	PF 4	MPM	336.9
687	Large Gravel and Cobble	5200.1...	PF 5	MPM	292.8
688	Large Gravel and Cobble	5200.1...	PF 6	MPM	361.9
689	Large Gravel and Cobble	5200.1...	PF 7	MPM	442.1
690	Large Gravel and Cobble	5200.1...	PF 8	MPM	571.1
691	Large Gravel and Cobble	5200.1...	PF 9	MPM	793.9
692	Large Gravel and Cobble	5200.1...	PF 10	MPM	0
693					
694	Large Gravel and Cobble	5100	PF 1	MPM	.2587
695	Large Gravel and Cobble	5100	PF 2	MPM	14.93
696	Large Gravel and Cobble	5100	PF 3	MPM	81.96
697	Large Gravel and Cobble	5100	PF 4	MPM	169.5
698	Large Gravel and Cobble	5100	PF 5	MPM	246.0
699	Large Gravel and Cobble	5100	PF 6	MPM	451.9
700	Large Gravel and Cobble	5100	PF 7	MPM	763.9
701	Large Gravel and Cobble	5100	PF 8	MPM	1730
702	Large Gravel and Cobble	5100	PF 9	MPM	7998
703	Large Gravel and Cobble	5100	PF 10	MPM	15670
704					
705	Large Gravel and Cobble	5052.7...	PF 1	MPM	523.7
706	Large Gravel and Cobble	5052.7...	PF 2	MPM	796.7
707	Large Gravel and Cobble	5052.7...	PF 3	MPM	1558
708	Large Gravel and Cobble	5052.7...	PF 4	MPM	3266
709	Large Gravel and Cobble	5052.7...	PF 5	MPM	4489
710	Large Gravel and Cobble	5052.7...	PF 6	MPM	2030
711	Large Gravel and Cobble	5052.7...	PF 7	MPM	2191
712	Large Gravel and Cobble	5052.7...	PF 8	MPM	2663
713	Large Gravel and Cobble	5052.7...	PF 9	MPM	4204

714	Large Gravel and Cobble	5052.7...	PF 10	MPM	27890
715					
716	Large Gravel and Cobble	4998.9...	PF 1	MPM	425.6
717	Large Gravel and Cobble	4998.9...	PF 2	MPM	484.3
718	Large Gravel and Cobble	4998.9...	PF 3	MPM	4606
719	Large Gravel and Cobble	4998.9...	PF 4	MPM	27060
720	Large Gravel and Cobble	4998.9...	PF 5	MPM	72140
721	Large Gravel and Cobble	4998.9...	PF 6	MPM	279.2
722	Large Gravel and Cobble	4998.9...	PF 7	MPM	181.0
723	Large Gravel and Cobble	4998.9...	PF 8	MPM	131.0
724	Large Gravel and Cobble	4998.9...	PF 9	MPM	135.9
725	Large Gravel and Cobble	4998.9...	PF 10	MPM	184.3
726					
727	Large Gravel and Cobble	4899.9...	PF 1	MPM	0
728	Large Gravel and Cobble	4899.9...	PF 2	MPM	0
729	Large Gravel and Cobble	4899.9...	PF 3	MPM	1.000
730	Large Gravel and Cobble	4899.9...	PF 4	MPM	7.252
731	Large Gravel and Cobble	4899.9...	PF 5	MPM	15.98
732	Large Gravel and Cobble	4899.9...	PF 6	MPM	18.85
733	Large Gravel and Cobble	4899.9...	PF 7	MPM	21.31
734	Large Gravel and Cobble	4899.9...	PF 8	MPM	27.71
735	Large Gravel and Cobble	4899.9...	PF 9	MPM	69.43
736	Large Gravel and Cobble	4899.9...	PF 10	MPM	128.7
737					
738	Large Gravel and Cobble	4699.7...	PF 1	MPM	0
739	Large Gravel and Cobble	4699.7...	PF 2	MPM	0
740	Large Gravel and Cobble	4699.7...	PF 3	MPM	0
741	Large Gravel and Cobble	4699.7...	PF 4	MPM	.9744
742	Large Gravel and Cobble	4699.7...	PF 5	MPM	15.79
743	Large Gravel and Cobble	4699.7...	PF 6	MPM	33.08
744	Large Gravel and Cobble	4699.7...	PF 7	MPM	53.15
745	Large Gravel and Cobble	4699.7...	PF 8	MPM	90.88
746	Large Gravel and Cobble	4699.7...	PF 9	MPM	267.4
747	Large Gravel and Cobble	4699.7...	PF 10	MPM	510.1
748					
749	Large Gravel and Cobble	4600	PF 1	MPM	0
750	Large Gravel and Cobble	4600	PF 2	MPM	0
751	Large Gravel and Cobble	4600	PF 3	MPM	0
752	Large Gravel and Cobble	4600	PF 4	MPM	0
753	Large Gravel and Cobble	4600	PF 5	MPM	6.228
754	Large Gravel and Cobble	4600	PF 6	MPM	20.04
755	Large Gravel and Cobble	4600	PF 7	MPM	36.23
756	Large Gravel and Cobble	4600	PF 8	MPM	62.34
757	Large Gravel and Cobble	4600	PF 9	MPM	0
758	Large Gravel and Cobble	4600	PF 10	MPM	0
759					
760	Large Gravel and Cobble	4510.0...	PF 1	MPM	0
761	Large Gravel and Cobble	4510.0...	PF 2	MPM	13.58

762	Large Gravel and Cobble	4510.0...	PF 3	MPM	111.1
763	Large Gravel and Cobble	4510.0...	PF 4	MPM	400.2
764	Large Gravel and Cobble	4510.0...	PF 5	MPM	1403
765	Large Gravel and Cobble	4510.0...	PF 6	MPM	3849
766	Large Gravel and Cobble	4510.0...	PF 7	MPM	5271
767	Large Gravel and Cobble	4510.0...	PF 8	MPM	6155
768	Large Gravel and Cobble	4510.0...	PF 9	MPM	5765
769	Large Gravel and Cobble	4510.0...	PF 10	MPM	1319
770					
771	Large Gravel and Cobble	4400.2...	PF 1	MPM	877.3
772	Large Gravel and Cobble	4400.2...	PF 2	MPM	1160
773	Large Gravel and Cobble	4400.2...	PF 3	MPM	1983
774	Large Gravel and Cobble	4400.2...	PF 4	MPM	2804
775	Large Gravel and Cobble	4400.2...	PF 5	MPM	1227
776	Large Gravel and Cobble	4400.2...	PF 6	MPM	1057
777	Large Gravel and Cobble	4400.2...	PF 7	MPM	1029
778	Large Gravel and Cobble	4400.2...	PF 8	MPM	1062
779	Large Gravel and Cobble	4400.2...	PF 9	MPM	1455
780	Large Gravel and Cobble	4400.2...	PF 10	MPM	2102
781					
782	Large Gravel and Cobble	4194.2...	PF 1	MPM	0
783	Large Gravel and Cobble	4194.2...	PF 2	MPM	0
784	Large Gravel and Cobble	4194.2...	PF 3	MPM	0
785	Large Gravel and Cobble	4194.2...	PF 4	MPM	4.601
786	Large Gravel and Cobble	4194.2...	PF 5	MPM	31.60
787	Large Gravel and Cobble	4194.2...	PF 6	MPM	69.77
788	Large Gravel and Cobble	4194.2...	PF 7	MPM	115.4
789	Large Gravel and Cobble	4194.2...	PF 8	MPM	187.3
790	Large Gravel and Cobble	4194.2...	PF 9	MPM	460.6
791	Large Gravel and Cobble	4194.2...	PF 10	MPM	758.3
792					
793	Large Gravel and Cobble	4103.1...	PF 1	MPM	0
794	Large Gravel and Cobble	4103.1...	PF 2	MPM	0
795	Large Gravel and Cobble	4103.1...	PF 3	MPM	.00633...
796	Large Gravel and Cobble	4103.1...	PF 4	MPM	9.493
797	Large Gravel and Cobble	4103.1...	PF 5	MPM	20.84
798	Large Gravel and Cobble	4103.1...	PF 6	MPM	32.50
799	Large Gravel and Cobble	4103.1...	PF 7	MPM	43.28
800	Large Gravel and Cobble	4103.1...	PF 8	MPM	54.94
801	Large Gravel and Cobble	4103.1...	PF 9	MPM	103.0
802	Large Gravel and Cobble	4103.1...	PF 10	MPM	154.6
803					
804	Large Gravel and Cobble	4016.1...	PF 1	MPM	0
805	Large Gravel and Cobble	4016.1...	PF 2	MPM	0
806	Large Gravel and Cobble	4016.1...	PF 3	MPM	0
807	Large Gravel and Cobble	4016.1...	PF 4	MPM	0
808	Large Gravel and Cobble	4016.1...	PF 5	MPM	0
809	Large Gravel and Cobble	4016.1...	PF 6	MPM	0

810	Large Gravel and Cobble	4016.1...	PF 7	MPM	2.292
811	Large Gravel and Cobble	4016.1...	PF 8	MPM	8.308
812	Large Gravel and Cobble	4016.1...	PF 9	MPM	39.34
813	Large Gravel and Cobble	4016.1...	PF 10	MPM	81.54
814					
815	Large Gravel and Cobble	3901.4...	PF 1	MPM	0
816	Large Gravel and Cobble	3901.4...	PF 2	MPM	0
817	Large Gravel and Cobble	3901.4...	PF 3	MPM	0
818	Large Gravel and Cobble	3901.4...	PF 4	MPM	0
819	Large Gravel and Cobble	3901.4...	PF 5	MPM	6.894
820	Large Gravel and Cobble	3901.4...	PF 6	MPM	31.37
821	Large Gravel and Cobble	3901.4...	PF 7	MPM	66.13
822	Large Gravel and Cobble	3901.4...	PF 8	MPM	125.2
823	Large Gravel and Cobble	3901.4...	PF 9	MPM	331.6
824	Large Gravel and Cobble	3901.4...	PF 10	MPM	345.2
825					
826	Large Gravel and Cobble	3801.2...	PF 1	MPM	0
827	Large Gravel and Cobble	3801.2...	PF 2	MPM	0
828	Large Gravel and Cobble	3801.2...	PF 3	MPM	0
829	Large Gravel and Cobble	3801.2...	PF 4	MPM	0
830	Large Gravel and Cobble	3801.2...	PF 5	MPM	1.210
831	Large Gravel and Cobble	3801.2...	PF 6	MPM	4.520
832	Large Gravel and Cobble	3801.2...	PF 7	MPM	8.498
833	Large Gravel and Cobble	3801.2...	PF 8	MPM	31.86
834	Large Gravel and Cobble	3801.2...	PF 9	MPM	37.16
835	Large Gravel and Cobble	3801.2...	PF 10	MPM	24.62
836					
837	Large Gravel and Cobble	3700.0...	PF 1	MPM	0
838	Large Gravel and Cobble	3700.0...	PF 2	MPM	0
839	Large Gravel and Cobble	3700.0...	PF 3	MPM	0
840	Large Gravel and Cobble	3700.0...	PF 4	MPM	0
841	Large Gravel and Cobble	3700.0...	PF 5	MPM	0
842	Large Gravel and Cobble	3700.0...	PF 6	MPM	0
843	Large Gravel and Cobble	3700.0...	PF 7	MPM	0
844	Large Gravel and Cobble	3700.0...	PF 8	MPM	0
845	Large Gravel and Cobble	3700.0...	PF 9	MPM	.01099
846	Large Gravel and Cobble	3700.0...	PF 10	MPM	.3342
847					
848	Large Gravel and Cobble	3599.3...	PF 1	MPM	0
849	Large Gravel and Cobble	3599.3...	PF 2	MPM	0
850	Large Gravel and Cobble	3599.3...	PF 3	MPM	0
851	Large Gravel and Cobble	3599.3...	PF 4	MPM	0
852	Large Gravel and Cobble	3599.3...	PF 5	MPM	2.485
853	Large Gravel and Cobble	3599.3...	PF 6	MPM	12.38
854	Large Gravel and Cobble	3599.3...	PF 7	MPM	21.15
855	Large Gravel and Cobble	3599.3...	PF 8	MPM	30.70
856	Large Gravel and Cobble	3599.3...	PF 9	MPM	44.74
857	Large Gravel and Cobble	3599.3...	PF 10	MPM	53.26

858					
859	Large Gravel and Cobble	3526.6...	PF 1	MPM	0
860	Large Gravel and Cobble	3526.6...	PF 2	MPM	0
861	Large Gravel and Cobble	3526.6...	PF 3	MPM	0
862	Large Gravel and Cobble	3526.6...	PF 4	MPM	0
863	Large Gravel and Cobble	3526.6...	PF 5	MPM	0
864	Large Gravel and Cobble	3526.6...	PF 6	MPM	0
865	Large Gravel and Cobble	3526.6...	PF 7	MPM	0
866	Large Gravel and Cobble	3526.6...	PF 8	MPM	0
867	Large Gravel and Cobble	3526.6...	PF 9	MPM	0
868	Large Gravel and Cobble	3526.6...	PF 10	MPM	2.933
869					
870	Large Gravel and Cobble	3399.0...	PF 1	MPM	0
871	Large Gravel and Cobble	3399.0...	PF 2	MPM	0
872	Large Gravel and Cobble	3399.0...	PF 3	MPM	0
873	Large Gravel and Cobble	3399.0...	PF 4	MPM	0
874	Large Gravel and Cobble	3399.0...	PF 5	MPM	13.38
875	Large Gravel and Cobble	3399.0...	PF 6	MPM	43.89
876	Large Gravel and Cobble	3399.0...	PF 7	MPM	73.77
877	Large Gravel and Cobble	3399.0...	PF 8	MPM	109.0
878	Large Gravel and Cobble	3399.0...	PF 9	MPM	164.7
879	Large Gravel and Cobble	3399.0...	PF 10	MPM	0
880					
881	Large Gravel and Cobble	3299.8...	PF 1	MPM	0
882	Large Gravel and Cobble	3299.8...	PF 2	MPM	0
883	Large Gravel and Cobble	3299.8...	PF 3	MPM	0
884	Large Gravel and Cobble	3299.8...	PF 4	MPM	0
885	Large Gravel and Cobble	3299.8...	PF 5	MPM	0
886	Large Gravel and Cobble	3299.8...	PF 6	MPM	0
887	Large Gravel and Cobble	3299.8...	PF 7	MPM	0
888	Large Gravel and Cobble	3299.8...	PF 8	MPM	0
889	Large Gravel and Cobble	3299.8...	PF 9	MPM	0
890	Large Gravel and Cobble	3299.8...	PF 10	MPM	0
891					
892	Large Gravel and Cobble	3214.6...	PF 1	MPM	0
893	Large Gravel and Cobble	3214.6...	PF 2	MPM	0
894	Large Gravel and Cobble	3214.6...	PF 3	MPM	0
895	Large Gravel and Cobble	3214.6...	PF 4	MPM	0
896	Large Gravel and Cobble	3214.6...	PF 5	MPM	0
897	Large Gravel and Cobble	3214.6...	PF 6	MPM	0
898	Large Gravel and Cobble	3214.6...	PF 7	MPM	0
899	Large Gravel and Cobble	3214.6...	PF 8	MPM	.08640
900	Large Gravel and Cobble	3214.6...	PF 9	MPM	22.77
901	Large Gravel and Cobble	3214.6...	PF 10	MPM	29.84
902					
903	Large Gravel and Cobble	3148.1...	PF 1	MPM	0
904	Large Gravel and Cobble	3148.1...	PF 2	MPM	0
905	Large Gravel and Cobble	3148.1...	PF 3	MPM	0

906	Large Gravel and Cobble	3148.1...	PF 4	MPM	0
907	Large Gravel and Cobble	3148.1...	PF 5	MPM	0
908	Large Gravel and Cobble	3148.1...	PF 6	MPM	0
909	Large Gravel and Cobble	3148.1...	PF 7	MPM	0
910	Large Gravel and Cobble	3148.1...	PF 8	MPM	0
911	Large Gravel and Cobble	3148.1...	PF 9	MPM	0
912	Large Gravel and Cobble	3148.1...	PF 10	MPM	0
913					
914	Large Gravel and Cobble	3110.3...	PF 1	MPM	0
915	Large Gravel and Cobble	3110.3...	PF 2	MPM	0
916	Large Gravel and Cobble	3110.3...	PF 3	MPM	0
917	Large Gravel and Cobble	3110.3...	PF 4	MPM	0
918	Large Gravel and Cobble	3110.3...	PF 5	MPM	0
919	Large Gravel and Cobble	3110.3...	PF 6	MPM	0
920	Large Gravel and Cobble	3110.3...	PF 7	MPM	0
921	Large Gravel and Cobble	3110.3...	PF 8	MPM	0
922	Large Gravel and Cobble	3110.3...	PF 9	MPM	0
923	Large Gravel and Cobble	3110.3...	PF 10	MPM	0
924					
925	Large Gravel and Cobble	3078.7...	PF 1	MPM	0
926	Large Gravel and Cobble	3078.7...	PF 2	MPM	.05195
927	Large Gravel and Cobble	3078.7...	PF 3	MPM	57.82
928	Large Gravel and Cobble	3078.7...	PF 4	MPM	157.7
929	Large Gravel and Cobble	3078.7...	PF 5	MPM	249.1
930	Large Gravel and Cobble	3078.7...	PF 6	MPM	325.0
931	Large Gravel and Cobble	3078.7...	PF 7	MPM	398.2
932	Large Gravel and Cobble	3078.7...	PF 8	MPM	488.2
933	Large Gravel and Cobble	3078.7...	PF 9	MPM	711.5
934	Large Gravel and Cobble	3078.7...	PF 10	MPM	877.6
935					
936	Large Gravel and Cobble	3076.7...	PF 1	MPM	766.0
937	Large Gravel and Cobble	3076.7...	PF 2	MPM	794.9
938	Large Gravel and Cobble	3076.7...	PF 3	MPM	1148
939	Large Gravel and Cobble	3076.7...	PF 4	MPM	1880
940	Large Gravel and Cobble	3076.7...	PF 5	MPM	2421
941	Large Gravel and Cobble	3076.7...	PF 6	MPM	3064
942	Large Gravel and Cobble	3076.7...	PF 7	MPM	3681
943	Large Gravel and Cobble	3076.7...	PF 8	MPM	4708
944	Large Gravel and Cobble	3076.7...	PF 9	MPM	7188
945	Large Gravel and Cobble	3076.7...	PF 10	MPM	10220
946					
947	Large Gravel and Cobble	3076.2...	PF 1	MPM	648.3
948	Large Gravel and Cobble	3076.2...	PF 2	MPM	892.3
949	Large Gravel and Cobble	3076.2...	PF 3	MPM	1147
950	Large Gravel and Cobble	3076.2...	PF 4	MPM	1721
951	Large Gravel and Cobble	3076.2...	PF 5	MPM	2587
952	Large Gravel and Cobble	3076.2...	PF 6	MPM	3015
953	Large Gravel and Cobble	3076.2...	PF 7	MPM	3865

954	Large Gravel and Cobble	3076.2...	PF 8	MPM	4414
955	Large Gravel and Cobble	3076.2...	PF 9	MPM	7005
956	Large Gravel and Cobble	3076.2...	PF 10	MPM	10490
957					
958	Large Gravel and Cobble	3075.6...	PF 1	MPM	718.8
959	Large Gravel and Cobble	3075.6...	PF 2	MPM	826.5
960	Large Gravel and Cobble	3075.6...	PF 3	MPM	1159
961	Large Gravel and Cobble	3075.6...	PF 4	MPM	1797
962	Large Gravel and Cobble	3075.6...	PF 5	MPM	2436
963	Large Gravel and Cobble	3075.6...	PF 6	MPM	3248
964	Large Gravel and Cobble	3075.6...	PF 7	MPM	3933
965	Large Gravel and Cobble	3075.6...	PF 8	MPM	4414
966	Large Gravel and Cobble	3075.6...	PF 9	MPM	7305
967	Large Gravel and Cobble	3075.6...	PF 10	MPM	10490
968					
969	Large Gravel and Cobble	3075.1...	PF 1	MPM	645.8
970	Large Gravel and Cobble	3075.1...	PF 2	MPM	857.6
971	Large Gravel and Cobble	3075.1...	PF 3	MPM	1197
972	Large Gravel and Cobble	3075.1...	PF 4	MPM	1795
973	Large Gravel and Cobble	3075.1...	PF 5	MPM	2356
974	Large Gravel and Cobble	3075.1...	PF 6	MPM	3095
975	Large Gravel and Cobble	3075.1...	PF 7	MPM	3552
976	Large Gravel and Cobble	3075.1...	PF 8	MPM	4557
977	Large Gravel and Cobble	3075.1...	PF 9	MPM	8038
978	Large Gravel and Cobble	3075.1...	PF 10	MPM	10270
979					
980	Large Gravel and Cobble	3074.5...	PF 1	MPM	645.2
981	Large Gravel and Cobble	3074.5...	PF 2	MPM	829.3
982	Large Gravel and Cobble	3074.5...	PF 3	MPM	1225
983	Large Gravel and Cobble	3074.5...	PF 4	MPM	1693
984	Large Gravel and Cobble	3074.5...	PF 5	MPM	2590
985	Large Gravel and Cobble	3074.5...	PF 6	MPM	2972
986	Large Gravel and Cobble	3074.5...	PF 7	MPM	3589
987	Large Gravel and Cobble	3074.5...	PF 8	MPM	4403
988	Large Gravel and Cobble	3074.5...	PF 9	MPM	7105
989	Large Gravel and Cobble	3074.5...	PF 10	MPM	11290
990					
991	Large Gravel and Cobble	3074.0...	PF 1	MPM	693.3
992	Large Gravel and Cobble	3074.0...	PF 2	MPM	812.4
993	Large Gravel and Cobble	3074.0...	PF 3	MPM	1244
994	Large Gravel and Cobble	3074.0...	PF 4	MPM	1698
995	Large Gravel and Cobble	3074.0...	PF 5	MPM	2321
996	Large Gravel and Cobble	3074.0...	PF 6	MPM	2901
997	Large Gravel and Cobble	3074.0...	PF 7	MPM	3533
998	Large Gravel and Cobble	3074.0...	PF 8	MPM	4332
999	Large Gravel and Cobble	3074.0...	PF 9	MPM	7092
1000	Large Gravel and Cobble	3074.0...	PF 10	MPM	34780
1001					

1002	Large Gravel and Cobble	3073.4...	PF 1	MPM	543.0
1003	Large Gravel and Cobble	3073.4...	PF 2	MPM	1027
1004	Large Gravel and Cobble	3073.4...	PF 3	MPM	1223
1005	Large Gravel and Cobble	3073.4...	PF 4	MPM	1802
1006	Large Gravel and Cobble	3073.4...	PF 5	MPM	2493
1007	Large Gravel and Cobble	3073.4...	PF 6	MPM	2992
1008	Large Gravel and Cobble	3073.4...	PF 7	MPM	3594
1009	Large Gravel and Cobble	3073.4...	PF 8	MPM	24970
1010	Large Gravel and Cobble	3073.4...	PF 9	MPM	29550
1011	Large Gravel and Cobble	3073.4...	PF 10	MPM	61550
1012					
1013	Large Gravel and Cobble	3072.9...	PF 1	MPM	65800
1014	Large Gravel and Cobble	3072.9...	PF 2	MPM	49540
1015	Large Gravel and Cobble	3072.9...	PF 3	MPM	30180
1016	Large Gravel and Cobble	3072.9...	PF 4	MPM	24510
1017	Large Gravel and Cobble	3072.9...	PF 5	MPM	23570
1018	Large Gravel and Cobble	3072.9...	PF 6	MPM	23430
1019	Large Gravel and Cobble	3072.9...	PF 7	MPM	23980
1020	Large Gravel and Cobble	3072.9...	PF 8	MPM	51400
1021	Large Gravel and Cobble	3072.9...	PF 9	MPM	56160
1022	Large Gravel and Cobble	3072.9...	PF 10	MPM	91220
1023					
1024	Large Gravel and Cobble	3072.3...	PF 1	MPM	141600
1025	Large Gravel and Cobble	3072.3...	PF 2	MPM	124300
1026	Large Gravel and Cobble	3072.3...	PF 3	MPM	88560
1027	Large Gravel and Cobble	3072.3...	PF 4	MPM	65150
1028	Large Gravel and Cobble	3072.3...	PF 5	MPM	57940
1029	Large Gravel and Cobble	3072.3...	PF 6	MPM	54690
1030	Large Gravel and Cobble	3072.3...	PF 7	MPM	52170
1031	Large Gravel and Cobble	3072.3...	PF 8	MPM	85420
1032	Large Gravel and Cobble	3072.3...	PF 9	MPM	87240
1033	Large Gravel and Cobble	3072.3...	PF 10	MPM	123500
1034					
1035	Large Gravel and Cobble	3071.8...	PF 1	MPM	188900
1036	Large Gravel and Cobble	3071.8...	PF 2	MPM	162300
1037	Large Gravel and Cobble	3071.8...	PF 3	MPM	158600
1038	Large Gravel and Cobble	3071.8...	PF 4	MPM	119800
1039	Large Gravel and Cobble	3071.8...	PF 5	MPM	103100
1040	Large Gravel and Cobble	3071.8...	PF 6	MPM	94930
1041	Large Gravel and Cobble	3071.8...	PF 7	MPM	88980
1042	Large Gravel and Cobble	3071.8...	PF 8	MPM	123700
1043	Large Gravel and Cobble	3071.8...	PF 9	MPM	121200
1044	Large Gravel and Cobble	3071.8...	PF 10	MPM	157900
1045					
1046	Large Gravel and Cobble	3071.2...	PF 1	MPM	246600
1047	Large Gravel and Cobble	3071.2...	PF 2	MPM	184300
1048	Large Gravel and Cobble	3071.2...	PF 3	MPM	213300
1049	Large Gravel and Cobble	3071.2...	PF 4	MPM	180200

1050	Large Gravel and Cobble	3071.2...	PF 5	MPM	153600
1051	Large Gravel and Cobble	3071.2...	PF 6	MPM	142400
1052	Large Gravel and Cobble	3071.2...	PF 7	MPM	131600
1053	Large Gravel and Cobble	3071.2...	PF 8	MPM	167400
1054	Large Gravel and Cobble	3071.2...	PF 9	MPM	159400
1055	Large Gravel and Cobble	3071.2...	PF 10	MPM	196800
1056					
1057	Large Gravel and Cobble	3070.7...	PF 1	MPM	316000
1058	Large Gravel and Cobble	3070.7...	PF 2	MPM	222200
1059	Large Gravel and Cobble	3070.7...	PF 3	MPM	267800
1060	Large Gravel and Cobble	3070.7...	PF 4	MPM	245200
1061	Large Gravel and Cobble	3070.7...	PF 5	MPM	213400
1062	Large Gravel and Cobble	3070.7...	PF 6	MPM	194300
1063	Large Gravel and Cobble	3070.7...	PF 7	MPM	180200
1064	Large Gravel and Cobble	3070.7...	PF 8	MPM	215200
1065	Large Gravel and Cobble	3070.7...	PF 9	MPM	199600
1066	Large Gravel and Cobble	3070.7...	PF 10	MPM	235900
1067					
1068	Large Gravel and Cobble	3070.1...	PF 1	MPM	361000
1069	Large Gravel and Cobble	3070.1...	PF 2	MPM	239100
1070	Large Gravel and Cobble	3070.1...	PF 3	MPM	295800
1071	Large Gravel and Cobble	3070.1...	PF 4	MPM	297000
1072	Large Gravel and Cobble	3070.1...	PF 5	MPM	271600
1073	Large Gravel and Cobble	3070.1...	PF 6	MPM	251300
1074	Large Gravel and Cobble	3070.1...	PF 7	MPM	230900
1075	Large Gravel and Cobble	3070.1...	PF 8	MPM	265700
1076	Large Gravel and Cobble	3070.1...	PF 9	MPM	241800
1077	Large Gravel and Cobble	3070.1...	PF 10	MPM	277600
1078					
1079	Large Gravel and Cobble	3069.6...	PF 1	MPM	425400
1080	Large Gravel and Cobble	3069.6...	PF 2	MPM	265600
1081	Large Gravel and Cobble	3069.6...	PF 3	MPM	318300
1082	Large Gravel and Cobble	3069.6...	PF 4	MPM	353800
1083	Large Gravel and Cobble	3069.6...	PF 5	MPM	332500
1084	Large Gravel and Cobble	3069.6...	PF 6	MPM	308700
1085	Large Gravel and Cobble	3069.6...	PF 7	MPM	283800
1086	Large Gravel and Cobble	3069.6...	PF 8	MPM	317000
1087	Large Gravel and Cobble	3069.6...	PF 9	MPM	286800
1088	Large Gravel and Cobble	3069.6...	PF 10	MPM	321400
1089					
1090	Large Gravel and Cobble	3069.0...	PF 1	MPM	462600
1091	Large Gravel and Cobble	3069.0...	PF 2	MPM	299800
1092	Large Gravel and Cobble	3069.0...	PF 3	MPM	346600
1093	Large Gravel and Cobble	3069.0...	PF 4	MPM	408700
1094	Large Gravel and Cobble	3069.0...	PF 5	MPM	392100
1095	Large Gravel and Cobble	3069.0...	PF 6	MPM	364200
1096	Large Gravel and Cobble	3069.0...	PF 7	MPM	340500
1097	Large Gravel and Cobble	3069.0...	PF 8	MPM	373500

1098	Large Gravel and Cobble	3069.0...	PF 9	MPM	334500
1099	Large Gravel and Cobble	3069.0...	PF 10	MPM	366000
1100					
1101	Large Gravel and Cobble	3068.5...	PF 1	MPM	503700
1102	Large Gravel and Cobble	3068.5...	PF 2	MPM	324800
1103	Large Gravel and Cobble	3068.5...	PF 3	MPM	332400
1104	Large Gravel and Cobble	3068.5...	PF 4	MPM	446400
1105	Large Gravel and Cobble	3068.5...	PF 5	MPM	440800
1106	Large Gravel and Cobble	3068.5...	PF 6	MPM	420100
1107	Large Gravel and Cobble	3068.5...	PF 7	MPM	395000
1108	Large Gravel and Cobble	3068.5...	PF 8	MPM	425600
1109	Large Gravel and Cobble	3068.5...	PF 9	MPM	382800
1110	Large Gravel and Cobble	3068.5...	PF 10	MPM	412400
1111					
1112	Large Gravel and Cobble	3067.9...	PF 1	MPM	530500
1113	Large Gravel and Cobble	3067.9...	PF 2	MPM	343100
1114	Large Gravel and Cobble	3067.9...	PF 3	MPM	360100
1115	Large Gravel and Cobble	3067.9...	PF 4	MPM	486500
1116	Large Gravel and Cobble	3067.9...	PF 5	MPM	498900
1117	Large Gravel and Cobble	3067.9...	PF 6	MPM	475200
1118	Large Gravel and Cobble	3067.9...	PF 7	MPM	454700
1119	Large Gravel and Cobble	3067.9...	PF 8	MPM	485100
1120	Large Gravel and Cobble	3067.9...	PF 9	MPM	433600
1121	Large Gravel and Cobble	3067.9...	PF 10	MPM	459200
1122					
1123	Large Gravel and Cobble	3067.4...	PF 1	MPM	561900
1124	Large Gravel and Cobble	3067.4...	PF 2	MPM	375700
1125	Large Gravel and Cobble	3067.4...	PF 3	MPM	367000
1126	Large Gravel and Cobble	3067.4...	PF 4	MPM	514600
1127	Large Gravel and Cobble	3067.4...	PF 5	MPM	546300
1128	Large Gravel and Cobble	3067.4...	PF 6	MPM	530900
1129	Large Gravel and Cobble	3067.4...	PF 7	MPM	509200
1130	Large Gravel and Cobble	3067.4...	PF 8	MPM	537100
1131	Large Gravel and Cobble	3067.4...	PF 9	MPM	485400
1132	Large Gravel and Cobble	3067.4...	PF 10	MPM	506800
1133					
1134	Large Gravel and Cobble	3066.8...	PF 1	MPM	606000
1135	Large Gravel and Cobble	3066.8...	PF 2	MPM	408300
1136	Large Gravel and Cobble	3066.8...	PF 3	MPM	366900
1137	Large Gravel and Cobble	3066.8...	PF 4	MPM	527900
1138	Large Gravel and Cobble	3066.8...	PF 5	MPM	576900
1139	Large Gravel and Cobble	3066.8...	PF 6	MPM	577500
1140	Large Gravel and Cobble	3066.8...	PF 7	MPM	564200
1141	Large Gravel and Cobble	3066.8...	PF 8	MPM	590200
1142	Large Gravel and Cobble	3066.8...	PF 9	MPM	536300
1143	Large Gravel and Cobble	3066.8...	PF 10	MPM	556300
1144					
1145	Large Gravel and Cobble	3066.3...	PF 1	MPM	658400

1146	Large Gravel and Cobble	3066.3...	PF 2	MPM	443600
1147	Large Gravel and Cobble	3066.3...	PF 3	MPM	384900
1148	Large Gravel and Cobble	3066.3...	PF 4	MPM	553200
1149	Large Gravel and Cobble	3066.3...	PF 5	MPM	625200
1150	Large Gravel and Cobble	3066.3...	PF 6	MPM	632000
1151	Large Gravel and Cobble	3066.3...	PF 7	MPM	621100
1152	Large Gravel and Cobble	3066.3...	PF 8	MPM	649300
1153	Large Gravel and Cobble	3066.3...	PF 9	MPM	589200
1154	Large Gravel and Cobble	3066.3...	PF 10	MPM	607800
1155					
1156	Large Gravel and Cobble	3065.7...	PF 1	MPM	706300
1157	Large Gravel and Cobble	3065.7...	PF 2	MPM	489200
1158	Large Gravel and Cobble	3065.7...	PF 3	MPM	386400
1159	Large Gravel and Cobble	3065.7...	PF 4	MPM	548100
1160	Large Gravel and Cobble	3065.7...	PF 5	MPM	639400
1161	Large Gravel and Cobble	3065.7...	PF 6	MPM	670000
1162	Large Gravel and Cobble	3065.7...	PF 7	MPM	667600
1163	Large Gravel and Cobble	3065.7...	PF 8	MPM	702300
1164	Large Gravel and Cobble	3065.7...	PF 9	MPM	642100
1165	Large Gravel and Cobble	3065.7...	PF 10	MPM	657900
1166					
1167	Large Gravel and Cobble	3065.2...	PF 1	MPM	749400
1168	Large Gravel and Cobble	3065.2...	PF 2	MPM	514100
1169	Large Gravel and Cobble	3065.2...	PF 3	MPM	405300
1170	Large Gravel and Cobble	3065.2...	PF 4	MPM	545200
1171	Large Gravel and Cobble	3065.2...	PF 5	MPM	667600
1172	Large Gravel and Cobble	3065.2...	PF 6	MPM	704200
1173	Large Gravel and Cobble	3065.2...	PF 7	MPM	711800
1174	Large Gravel and Cobble	3065.2...	PF 8	MPM	753900
1175	Large Gravel and Cobble	3065.2...	PF 9	MPM	696100
1176	Large Gravel and Cobble	3065.2...	PF 10	MPM	709100
1177					
1178	Large Gravel and Cobble	3064.6...	PF 1	MPM	787400
1179	Large Gravel and Cobble	3064.6...	PF 2	MPM	539000
1180	Large Gravel and Cobble	3064.6...	PF 3	MPM	423000
1181	Large Gravel and Cobble	3064.6...	PF 4	MPM	555300
1182	Large Gravel and Cobble	3064.6...	PF 5	MPM	702200
1183	Large Gravel and Cobble	3064.6...	PF 6	MPM	743500
1184	Large Gravel and Cobble	3064.6...	PF 7	MPM	761100
1185	Large Gravel and Cobble	3064.6...	PF 8	MPM	804100
1186	Large Gravel and Cobble	3064.6...	PF 9	MPM	750900
1187	Large Gravel and Cobble	3064.6...	PF 10	MPM	764600
1188					
1189	Large Gravel and Cobble	3064.1...	PF 1	MPM	787400
1190	Large Gravel and Cobble	3064.1...	PF 2	MPM	565200
1191	Large Gravel and Cobble	3064.1...	PF 3	MPM	436700
1192	Large Gravel and Cobble	3064.1...	PF 4	MPM	551000
1193	Large Gravel and Cobble	3064.1...	PF 5	MPM	706100

1194	Large Gravel and Cobble	3064.1...	PF 6	MPM	767200
1195	Large Gravel and Cobble	3064.1...	PF 7	MPM	800100
1196	Large Gravel and Cobble	3064.1...	PF 8	MPM	847500
1197	Large Gravel and Cobble	3064.1...	PF 9	MPM	802000
1198	Large Gravel and Cobble	3064.1...	PF 10	MPM	815600
1199					
1200	Large Gravel and Cobble	3063.5...	PF 1	MPM	848300
1201	Large Gravel and Cobble	3063.5...	PF 2	MPM	567900
1202	Large Gravel and Cobble	3063.5...	PF 3	MPM	448800
1203	Large Gravel and Cobble	3063.5...	PF 4	MPM	549800
1204	Large Gravel and Cobble	3063.5...	PF 5	MPM	715700
1205	Large Gravel and Cobble	3063.5...	PF 6	MPM	795400
1206	Large Gravel and Cobble	3063.5...	PF 7	MPM	834900
1207	Large Gravel and Cobble	3063.5...	PF 8	MPM	894600
1208	Large Gravel and Cobble	3063.5...	PF 9	MPM	852100
1209	Large Gravel and Cobble	3063.5...	PF 10	MPM	869900
1210					
1211	Large Gravel and Cobble	3062.9...	PF 1	MPM	871400
1212	Large Gravel and Cobble	3062.9...	PF 2	MPM	577800
1213	Large Gravel and Cobble	3062.9...	PF 3	MPM	465600
1214	Large Gravel and Cobble	3062.9...	PF 4	MPM	568200
1215	Large Gravel and Cobble	3062.9...	PF 5	MPM	731200
1216	Large Gravel and Cobble	3062.9...	PF 6	MPM	829300
1217	Large Gravel and Cobble	3062.9...	PF 7	MPM	874700
1218	Large Gravel and Cobble	3062.9...	PF 8	MPM	938500
1219	Large Gravel and Cobble	3062.9...	PF 9	MPM	905700
1220	Large Gravel and Cobble	3062.9...	PF 10	MPM	924100
1221					
1222	Large Gravel and Cobble	3062.4...	PF 1	MPM	932100
1223	Large Gravel and Cobble	3062.4...	PF 2	MPM	604300
1224	Large Gravel and Cobble	3062.4...	PF 3	MPM	486200
1225	Large Gravel and Cobble	3062.4...	PF 4	MPM	560900
1226	Large Gravel and Cobble	3062.4...	PF 5	MPM	713800
1227	Large Gravel and Cobble	3062.4...	PF 6	MPM	833900
1228	Large Gravel and Cobble	3062.4...	PF 7	MPM	889800
1229	Large Gravel and Cobble	3062.4...	PF 8	MPM	971000
1230	Large Gravel and Cobble	3062.4...	PF 9	MPM	951600
1231	Large Gravel and Cobble	3062.4...	PF 10	MPM	974100
1232					
1233	Large Gravel and Cobble	3061.8...	PF 1	MPM	950600
1234	Large Gravel and Cobble	3061.8...	PF 2	MPM	638900
1235	Large Gravel and Cobble	3061.8...	PF 3	MPM	501200
1236	Large Gravel and Cobble	3061.8...	PF 4	MPM	572200
1237	Large Gravel and Cobble	3061.8...	PF 5	MPM	720900
1238	Large Gravel and Cobble	3061.8...	PF 6	MPM	843500
1239	Large Gravel and Cobble	3061.8...	PF 7	MPM	918000
1240	Large Gravel and Cobble	3061.8...	PF 8	MPM	100700...
1241	Large Gravel and Cobble	3061.8...	PF 9	MPM	100000...

1242	Large Gravel and Cobble	3061.8...	PF 10	MPM	102700...
1243					
1244	Large Gravel and Cobble	3061.3...	PF 1	MPM	0
1245	Large Gravel and Cobble	3061.3...	PF 2	MPM	0
1246	Large Gravel and Cobble	3061.3...	PF 3	MPM	0
1247	Large Gravel and Cobble	3061.3...	PF 4	MPM	573600
1248	Large Gravel and Cobble	3061.3...	PF 5	MPM	717700
1249	Large Gravel and Cobble	3061.3...	PF 6	MPM	863400
1250	Large Gravel and Cobble	3061.3...	PF 7	MPM	937200
1251	Large Gravel and Cobble	3061.3...	PF 8	MPM	103500...
1252	Large Gravel and Cobble	3061.3...	PF 9	MPM	105100...
1253	Large Gravel and Cobble	3061.3...	PF 10	MPM	108300...
1254					
1255	Large Gravel and Cobble	3060.7...	PF 1	MPM	0
1256	Large Gravel and Cobble	3060.7...	PF 2	MPM	0
1257	Large Gravel and Cobble	3060.7...	PF 3	MPM	0
1258	Large Gravel and Cobble	3060.7...	PF 4	MPM	0
1259	Large Gravel and Cobble	3060.7...	PF 5	MPM	1.929
1260	Large Gravel and Cobble	3060.7...	PF 6	MPM	873400
1261	Large Gravel and Cobble	3060.7...	PF 7	MPM	956600
1262	Large Gravel and Cobble	3060.7...	PF 8	MPM	106300...
1263	Large Gravel and Cobble	3060.7...	PF 9	MPM	109900...
1264	Large Gravel and Cobble	3060.7...	PF 10	MPM	113200...
1265					
1266	Large Gravel and Cobble	3050.4...	PF 1	MPM	0
1267	Large Gravel and Cobble	3050.4...	PF 2	MPM	0
1268	Large Gravel and Cobble	3050.4...	PF 3	MPM	0
1269	Large Gravel and Cobble	3050.4...	PF 4	MPM	0
1270	Large Gravel and Cobble	3050.4...	PF 5	MPM	0
1271	Large Gravel and Cobble	3050.4...	PF 6	MPM	0
1272	Large Gravel and Cobble	3050.4...	PF 7	MPM	4.443
1273	Large Gravel and Cobble	3050.4...	PF 8	MPM	39.09
1274	Large Gravel and Cobble	3050.4...	PF 9	MPM	217.0
1275	Large Gravel and Cobble	3050.4...	PF 10	MPM	448.1
1276					
1277	Large Gravel and Cobble	3000.7...	PF 1	MPM	267.3
1278	Large Gravel and Cobble	3000.7...	PF 2	MPM	501.0
1279	Large Gravel and Cobble	3000.7...	PF 3	MPM	1125
1280	Large Gravel and Cobble	3000.7...	PF 4	MPM	2022
1281	Large Gravel and Cobble	3000.7...	PF 5	MPM	2763
1282	Large Gravel and Cobble	3000.7...	PF 6	MPM	2684
1283	Large Gravel and Cobble	3000.7...	PF 7	MPM	2738
1284	Large Gravel and Cobble	3000.7...	PF 8	MPM	2918
1285	Large Gravel and Cobble	3000.7...	PF 9	MPM	3624
1286	Large Gravel and Cobble	3000.7...	PF 10	MPM	4154
1287					
1288	Large Gravel and Cobble	2899.4...	PF 1	MPM	843.9
1289	Large Gravel and Cobble	2899.4...	PF 2	MPM	967.0

1290	Large Gravel and Cobble	2899.4...	PF 3	MPM	1316
1291	Large Gravel and Cobble	2899.4...	PF 4	MPM	1516
1292	Large Gravel and Cobble	2899.4...	PF 5	MPM	2003
1293	Large Gravel and Cobble	2899.4...	PF 6	MPM	2434
1294	Large Gravel and Cobble	2899.4...	PF 7	MPM	2716
1295	Large Gravel and Cobble	2899.4...	PF 8	MPM	3118
1296	Large Gravel and Cobble	2899.4...	PF 9	MPM	5688
1297	Large Gravel and Cobble	2899.4...	PF 10	MPM	10170
1298					
1299	Large Gravel and Cobble	2800	PF 1	MPM	0
1300	Large Gravel and Cobble	2800	PF 2	MPM	7.531
1301	Large Gravel and Cobble	2800	PF 3	MPM	78.02
1302	Large Gravel and Cobble	2800	PF 4	MPM	264.2
1303	Large Gravel and Cobble	2800	PF 5	MPM	495.3
1304	Large Gravel and Cobble	2800	PF 6	MPM	749.8
1305	Large Gravel and Cobble	2800	PF 7	MPM	1080
1306	Large Gravel and Cobble	2800	PF 8	MPM	1664
1307	Large Gravel and Cobble	2800	PF 9	MPM	3509
1308	Large Gravel and Cobble	2800	PF 10	MPM	4559
1309					
1310	Large Gravel and Cobble	2700	PF 1	MPM	321.4
1311	Large Gravel and Cobble	2700	PF 2	MPM	686.1
1312	Large Gravel and Cobble	2700	PF 3	MPM	1722
1313	Large Gravel and Cobble	2700	PF 4	MPM	3014
1314	Large Gravel and Cobble	2700	PF 5	MPM	4132
1315	Large Gravel and Cobble	2700	PF 6	MPM	5263
1316	Large Gravel and Cobble	2700	PF 7	MPM	6568
1317	Large Gravel and Cobble	2700	PF 8	MPM	8324
1318	Large Gravel and Cobble	2700	PF 9	MPM	12770
1319	Large Gravel and Cobble	2700	PF 10	MPM	17240
1320					
1321	Large Gravel and Cobble	2598.8...	PF 1	MPM	0
1322	Large Gravel and Cobble	2598.8...	PF 2	MPM	.1510
1323	Large Gravel and Cobble	2598.8...	PF 3	MPM	32.91
1324	Large Gravel and Cobble	2598.8...	PF 4	MPM	130.1
1325	Large Gravel and Cobble	2598.8...	PF 5	MPM	299.6
1326	Large Gravel and Cobble	2598.8...	PF 6	MPM	517.3
1327	Large Gravel and Cobble	2598.8...	PF 7	MPM	778.0
1328	Large Gravel and Cobble	2598.8...	PF 8	MPM	1312
1329	Large Gravel and Cobble	2598.8...	PF 9	MPM	4168
1330	Large Gravel and Cobble	2598.8...	PF 10	MPM	9613
1331					
1332	Large Gravel and Cobble	2499.5...	PF 1	MPM	604.3
1333	Large Gravel and Cobble	2499.5...	PF 2	MPM	700.2
1334	Large Gravel and Cobble	2499.5...	PF 3	MPM	1629
1335	Large Gravel and Cobble	2499.5...	PF 4	MPM	2680
1336	Large Gravel and Cobble	2499.5...	PF 5	MPM	2372
1337	Large Gravel and Cobble	2499.5...	PF 6	MPM	2901

1338	Large Gravel and Cobble	2499.5...	PF 7	MPM	3682
1339	Large Gravel and Cobble	2499.5...	PF 8	MPM	4757
1340	Large Gravel and Cobble	2499.5...	PF 9	MPM	8410
1341	Large Gravel and Cobble	2499.5...	PF 10	MPM	12820
1342					
1343	Large Gravel and Cobble	2400.3 ...	PF 1	MPM	0
1344	Large Gravel and Cobble	2400.3 ...	PF 2	MPM	0
1345	Large Gravel and Cobble	2400.3 ...	PF 3	MPM	10.28
1346	Large Gravel and Cobble	2400.3 ...	PF 4	MPM	56.94
1347	Large Gravel and Cobble	2400.3 ...	PF 5	MPM	110.9
1348	Large Gravel and Cobble	2400.3 ...	PF 6	MPM	161.8
1349	Large Gravel and Cobble	2400.3 ...	PF 7	MPM	211.3
1350	Large Gravel and Cobble	2400.3 ...	PF 8	MPM	277.0
1351	Large Gravel and Cobble	2400.3 ...	PF 9	MPM	450.9
1352	Large Gravel and Cobble	2400.3 ...	PF 10	MPM	596.2
1353					
1354	Large Gravel and Cobble	2300.2...	PF 1	MPM	0
1355	Large Gravel and Cobble	2300.2...	PF 2	MPM	2.560
1356	Large Gravel and Cobble	2300.2...	PF 3	MPM	48.69
1357	Large Gravel and Cobble	2300.2...	PF 4	MPM	178.6
1358	Large Gravel and Cobble	2300.2...	PF 5	MPM	342.0
1359	Large Gravel and Cobble	2300.2...	PF 6	MPM	530.5
1360	Large Gravel and Cobble	2300.2...	PF 7	MPM	748.0
1361	Large Gravel and Cobble	2300.2...	PF 8	MPM	1163
1362	Large Gravel and Cobble	2300.2...	PF 9	MPM	3157
1363	Large Gravel and Cobble	2300.2...	PF 10	MPM	6423
1364					
1365	Large Gravel and Cobble	2201	PF 1	MPM	424.8
1366	Large Gravel and Cobble	2201	PF 2	MPM	694.9
1367	Large Gravel and Cobble	2201	PF 3	MPM	1571
1368	Large Gravel and Cobble	2201	PF 4	MPM	2813
1369	Large Gravel and Cobble	2201	PF 5	MPM	3838
1370	Large Gravel and Cobble	2201	PF 6	MPM	4986
1371	Large Gravel and Cobble	2201	PF 7	MPM	6348
1372	Large Gravel and Cobble	2201	PF 8	MPM	8188
1373	Large Gravel and Cobble	2201	PF 9	MPM	11750
1374	Large Gravel and Cobble	2201	PF 10	MPM	15740
1375					
1376	Large Gravel and Cobble	2101.8...	PF 1	MPM	142.3
1377	Large Gravel and Cobble	2101.8...	PF 2	MPM	108.3
1378	Large Gravel and Cobble	2101.8...	PF 3	MPM	121.2
1379	Large Gravel and Cobble	2101.8...	PF 4	MPM	173.0
1380	Large Gravel and Cobble	2101.8...	PF 5	MPM	225.7
1381	Large Gravel and Cobble	2101.8...	PF 6	MPM	284.8
1382	Large Gravel and Cobble	2101.8...	PF 7	MPM	348.8
1383	Large Gravel and Cobble	2101.8...	PF 8	MPM	445.4
1384	Large Gravel and Cobble	2101.8...	PF 9	MPM	777.2
1385	Large Gravel and Cobble	2101.8...	PF 10	MPM	1034

1386					
1387	Large Gravel and Cobble	2000.7...	PF 1	MPM	0
1388	Large Gravel and Cobble	2000.7...	PF 2	MPM	4.056
1389	Large Gravel and Cobble	2000.7...	PF 3	MPM	49.19
1390	Large Gravel and Cobble	2000.7...	PF 4	MPM	155.4
1391	Large Gravel and Cobble	2000.7...	PF 5	MPM	284.9
1392	Large Gravel and Cobble	2000.7...	PF 6	MPM	434.6
1393	Large Gravel and Cobble	2000.7...	PF 7	MPM	605.3
1394	Large Gravel and Cobble	2000.7...	PF 8	MPM	876.8
1395	Large Gravel and Cobble	2000.7...	PF 9	MPM	2548
1396	Large Gravel and Cobble	2000.7...	PF 10	MPM	5255
1397					
1398	Large Gravel and Cobble	1900	PF 1	MPM	562.9
1399	Large Gravel and Cobble	1900	PF 2	MPM	819.8
1400	Large Gravel and Cobble	1900	PF 3	MPM	1439
1401	Large Gravel and Cobble	1900	PF 4	MPM	2286
1402	Large Gravel and Cobble	1900	PF 5	MPM	3204
1403	Large Gravel and Cobble	1900	PF 6	MPM	4185
1404	Large Gravel and Cobble	1900	PF 7	MPM	5248
1405	Large Gravel and Cobble	1900	PF 8	MPM	6953
1406	Large Gravel and Cobble	1900	PF 9	MPM	6781
1407	Large Gravel and Cobble	1900	PF 10	MPM	7571
1408					
1409	Large Gravel and Cobble	1800	PF 1	MPM	0
1410	Large Gravel and Cobble	1800	PF 2	MPM	0
1411	Large Gravel and Cobble	1800	PF 3	MPM	22.82
1412	Large Gravel and Cobble	1800	PF 4	MPM	100.5
1413	Large Gravel and Cobble	1800	PF 5	MPM	200.4
1414	Large Gravel and Cobble	1800	PF 6	MPM	318.1
1415	Large Gravel and Cobble	1800	PF 7	MPM	461.4
1416	Large Gravel and Cobble	1800	PF 8	MPM	691.4
1417	Large Gravel and Cobble	1800	PF 9	MPM	1670
1418	Large Gravel and Cobble	1800	PF 10	MPM	2988
1419					
1420	Large Gravel and Cobble	1700	PF 1	MPM	474.4
1421	Large Gravel and Cobble	1700	PF 2	MPM	290.0
1422	Large Gravel and Cobble	1700	PF 3	MPM	224.2
1423	Large Gravel and Cobble	1700	PF 4	MPM	350.1
1424	Large Gravel and Cobble	1700	PF 5	MPM	502.8
1425	Large Gravel and Cobble	1700	PF 6	MPM	655.2
1426	Large Gravel and Cobble	1700	PF 7	MPM	820.7
1427	Large Gravel and Cobble	1700	PF 8	MPM	1088
1428	Large Gravel and Cobble	1700	PF 9	MPM	2475
1429	Large Gravel and Cobble	1700	PF 10	MPM	4191
1430					
1431	Large Gravel and Cobble	1600	PF 1	MPM	0
1432	Large Gravel and Cobble	1600	PF 2	MPM	0
1433	Large Gravel and Cobble	1600	PF 3	MPM	19.98

1434	Large Gravel and Cobble	1600	PF 4	MPM	114.8
1435	Large Gravel and Cobble	1600	PF 5	MPM	247.8
1436	Large Gravel and Cobble	1600	PF 6	MPM	404.5
1437	Large Gravel and Cobble	1600	PF 7	MPM	587.0
1438	Large Gravel and Cobble	1600	PF 8	MPM	888.7
1439	Large Gravel and Cobble	1600	PF 9	MPM	2405
1440	Large Gravel and Cobble	1600	PF 10	MPM	5197
1441					
1442	Large Gravel and Cobble	1540.1...	PF 1	MPM	454.1
1443	Large Gravel and Cobble	1540.1...	PF 2	MPM	698.2
1444	Large Gravel and Cobble	1540.1...	PF 3	MPM	1643
1445	Large Gravel and Cobble	1540.1...	PF 4	MPM	2939
1446	Large Gravel and Cobble	1540.1...	PF 5	MPM	3989
1447	Large Gravel and Cobble	1540.1...	PF 6	MPM	5132
1448	Large Gravel and Cobble	1540.1...	PF 7	MPM	5876
1449	Large Gravel and Cobble	1540.1...	PF 8	MPM	6681
1450	Large Gravel and Cobble	1540.1...	PF 9	MPM	10140
1451	Large Gravel and Cobble	1540.1...	PF 10	MPM	12910
1452					
1453	Large Gravel and Cobble	1500.0...	PF 1	MPM	1040
1454	Large Gravel and Cobble	1500.0...	PF 2	MPM	2087
1455	Large Gravel and Cobble	1500.0...	PF 3	MPM	445.7
1456	Large Gravel and Cobble	1500.0...	PF 4	MPM	795.8
1457	Large Gravel and Cobble	1500.0...	PF 5	MPM	1177
1458	Large Gravel and Cobble	1500.0...	PF 6	MPM	1033
1459	Large Gravel and Cobble	1500.0...	PF 7	MPM	881.3
1460	Large Gravel and Cobble	1500.0...	PF 8	MPM	907.8
1461	Large Gravel and Cobble	1500.0...	PF 9	MPM	1453
1462	Large Gravel and Cobble	1500.0...	PF 10	MPM	2332
1463					
1464	Large Gravel and Cobble	1465.1 ...	PF 1	MPM	0
1465	Large Gravel and Cobble	1465.1 ...	PF 2	MPM	0
1466	Large Gravel and Cobble	1465.1 ...	PF 3	MPM	5.599
1467	Large Gravel and Cobble	1465.1 ...	PF 4	MPM	28.78
1468	Large Gravel and Cobble	1465.1 ...	PF 5	MPM	72.83
1469	Large Gravel and Cobble	1465.1 ...	PF 6	MPM	128.4
1470	Large Gravel and Cobble	1465.1 ...	PF 7	MPM	198.1
1471	Large Gravel and Cobble	1465.1 ...	PF 8	MPM	293.9
1472	Large Gravel and Cobble	1465.1 ...	PF 9	MPM	662.5
1473	Large Gravel and Cobble	1465.1 ...	PF 10	MPM	1114
1474					
1475	Large Gravel and Cobble	1414.9...	PF 1	MPM	0
1476	Large Gravel and Cobble	1414.9...	PF 2	MPM	0
1477	Large Gravel and Cobble	1414.9...	PF 3	MPM	5.955
1478	Large Gravel and Cobble	1414.9...	PF 4	MPM	54.27
1479	Large Gravel and Cobble	1414.9...	PF 5	MPM	138.6
1480	Large Gravel and Cobble	1414.9...	PF 6	MPM	242.1
1481	Large Gravel and Cobble	1414.9...	PF 7	MPM	365.0

1482	Large Gravel and Cobble	1414.9...	PF 8	MPM	535.4
1483	Large Gravel and Cobble	1414.9...	PF 9	MPM	994.1
1484	Large Gravel and Cobble	1414.9...	PF 10	MPM	1744
1485					
1486	Large Gravel and Cobble	1397.1...	PF 1	MPM	58.24
1487	Large Gravel and Cobble	1397.1...	PF 2	MPM	225.5
1488	Large Gravel and Cobble	1397.1...	PF 3	MPM	1160
1489	Large Gravel and Cobble	1397.1...	PF 4	MPM	1872
1490	Large Gravel and Cobble	1397.1...	PF 5	MPM	2570
1491	Large Gravel and Cobble	1397.1...	PF 6	MPM	3818
1492	Large Gravel and Cobble	1397.1...	PF 7	MPM	4980
1493	Large Gravel and Cobble	1397.1...	PF 8	MPM	6490
1494	Large Gravel and Cobble	1397.1...	PF 9	MPM	6982
1495	Large Gravel and Cobble	1397.1...	PF 10	MPM	9725
1496					
1497	Large Gravel and Cobble	1382.6...	PF 1	MPM	71.44
1498	Large Gravel and Cobble	1382.6...	PF 2	MPM	180.4
1499	Large Gravel and Cobble	1382.6...	PF 3	MPM	560.7
1500	Large Gravel and Cobble	1382.6...	PF 4	MPM	6182
1501	Large Gravel and Cobble	1382.6...	PF 5	MPM	9284
1502	Large Gravel and Cobble	1382.6...	PF 6	MPM	12360
1503	Large Gravel and Cobble	1382.6...	PF 7	MPM	15940
1504	Large Gravel and Cobble	1382.6...	PF 8	MPM	20760
1505	Large Gravel and Cobble	1382.6...	PF 9	MPM	27880
1506	Large Gravel and Cobble	1382.6...	PF 10	MPM	28330
1507					
1508	Large Gravel and Cobble	1350.2...	PF 1	MPM	526.3
1509	Large Gravel and Cobble	1350.2...	PF 2	MPM	906.6
1510	Large Gravel and Cobble	1350.2...	PF 3	MPM	1553
1511	Large Gravel and Cobble	1350.2...	PF 4	MPM	2630
1512	Large Gravel and Cobble	1350.2...	PF 5	MPM	3649
1513	Large Gravel and Cobble	1350.2...	PF 6	MPM	4764
1514	Large Gravel and Cobble	1350.2...	PF 7	MPM	5014
1515	Large Gravel and Cobble	1350.2...	PF 8	MPM	5002
1516	Large Gravel and Cobble	1350.2...	PF 9	MPM	4976
1517	Large Gravel and Cobble	1350.2...	PF 10	MPM	4398
1518					
1519	Large Gravel and Cobble	1312.9...	PF 1	MPM	0
1520	Large Gravel and Cobble	1312.9...	PF 2	MPM	0
1521	Large Gravel and Cobble	1312.9...	PF 3	MPM	15.50
1522	Large Gravel and Cobble	1312.9...	PF 4	MPM	82.34
1523	Large Gravel and Cobble	1312.9...	PF 5	MPM	160.6
1524	Large Gravel and Cobble	1312.9...	PF 6	MPM	247.2
1525	Large Gravel and Cobble	1312.9...	PF 7	MPM	348.5
1526	Large Gravel and Cobble	1312.9...	PF 8	MPM	525.0
1527	Large Gravel and Cobble	1312.9...	PF 9	MPM	886.6
1528	Large Gravel and Cobble	1312.9...	PF 10	MPM	1032
1529					

1530	Large Gravel and Cobble	1273.7...	PF 1	MPM	43.91
1531	Large Gravel and Cobble	1273.7...	PF 2	MPM	111.3
1532	Large Gravel and Cobble	1273.7...	PF 3	MPM	373.7
1533	Large Gravel and Cobble	1273.7...	PF 4	MPM	822.9
1534	Large Gravel and Cobble	1273.7...	PF 5	MPM	1243
1535	Large Gravel and Cobble	1273.7...	PF 6	MPM	1685
1536	Large Gravel and Cobble	1273.7...	PF 7	MPM	2056
1537	Large Gravel and Cobble	1273.7...	PF 8	MPM	2096
1538	Large Gravel and Cobble	1273.7...	PF 9	MPM	1946
1539	Large Gravel and Cobble	1273.7...	PF 10	MPM	1955
1540					
1541	Large Gravel and Cobble	1200	PF 1	MPM	37.97
1542	Large Gravel and Cobble	1200	PF 2	MPM	95.55
1543	Large Gravel and Cobble	1200	PF 3	MPM	276.0
1544	Large Gravel and Cobble	1200	PF 4	MPM	534.6
1545	Large Gravel and Cobble	1200	PF 5	MPM	787.7
1546	Large Gravel and Cobble	1200	PF 6	MPM	1339
1547	Large Gravel and Cobble	1200	PF 7	MPM	1934
1548	Large Gravel and Cobble	1200	PF 8	MPM	2805
1549	Large Gravel and Cobble	1200	PF 9	MPM	5611
1550	Large Gravel and Cobble	1200	PF 10	MPM	8959
1551					
1552	Large Gravel and Cobble	1100	PF 1	MPM	520.3
1553	Large Gravel and Cobble	1100	PF 2	MPM	809.7
1554	Large Gravel and Cobble	1100	PF 3	MPM	1520
1555	Large Gravel and Cobble	1100	PF 4	MPM	2513
1556	Large Gravel and Cobble	1100	PF 5	MPM	3579
1557	Large Gravel and Cobble	1100	PF 6	MPM	2710
1558	Large Gravel and Cobble	1100	PF 7	MPM	2621
1559	Large Gravel and Cobble	1100	PF 8	MPM	2896
1560	Large Gravel and Cobble	1100	PF 9	MPM	4180
1561	Large Gravel and Cobble	1100	PF 10	MPM	6231
1562					
1563	Large Gravel and Cobble	977.24 ...	PF 1	MPM	0
1564	Large Gravel and Cobble	977.24 ...	PF 2	MPM	0
1565	Large Gravel and Cobble	977.24 ...	PF 3	MPM	10.92
1566	Large Gravel and Cobble	977.24 ...	PF 4	MPM	67.46
1567	Large Gravel and Cobble	977.24 ...	PF 5	MPM	139.3
1568	Large Gravel and Cobble	977.24 ...	PF 6	MPM	220.7
1569	Large Gravel and Cobble	977.24 ...	PF 7	MPM	321.6
1570	Large Gravel and Cobble	977.24 ...	PF 8	MPM	495.7
1571	Large Gravel and Cobble	977.24 ...	PF 9	MPM	1062
1572	Large Gravel and Cobble	977.24 ...	PF 10	MPM	1522
1573					
1574	Large Gravel and Cobble	901.03 ...	PF 1	MPM	448.2
1575	Large Gravel and Cobble	901.03 ...	PF 2	MPM	821.4
1576	Large Gravel and Cobble	901.03 ...	PF 3	MPM	1558
1577	Large Gravel and Cobble	901.03 ...	PF 4	MPM	2618

1578	Large Gravel and Cobble	901.03 ...	PF 5	MPM	3889
1579	Large Gravel and Cobble	901.03 ...	PF 6	MPM	4456
1580	Large Gravel and Cobble	901.03 ...	PF 7	MPM	4958
1581	Large Gravel and Cobble	901.03 ...	PF 8	MPM	6485
1582	Large Gravel and Cobble	901.03 ...	PF 9	MPM	11010
1583	Large Gravel and Cobble	901.03 ...	PF 10	MPM	15870
1584					
1585	Large Gravel and Cobble	794.36 ...	PF 1	MPM	9.390
1586	Large Gravel and Cobble	794.36 ...	PF 2	MPM	27.80
1587	Large Gravel and Cobble	794.36 ...	PF 3	MPM	111.5
1588	Large Gravel and Cobble	794.36 ...	PF 4	MPM	310.5
1589	Large Gravel and Cobble	794.36 ...	PF 5	MPM	534.7
1590	Large Gravel and Cobble	794.36 ...	PF 6	MPM	767.4
1591	Large Gravel and Cobble	794.36 ...	PF 7	MPM	1050
1592	Large Gravel and Cobble	794.36 ...	PF 8	MPM	1561
1593	Large Gravel and Cobble	794.36 ...	PF 9	MPM	3086
1594	Large Gravel and Cobble	794.36 ...	PF 10	MPM	4258
1595					
1596	Large Gravel and Cobble	702.95 ...	PF 1	MPM	53.62
1597	Large Gravel and Cobble	702.95 ...	PF 2	MPM	221.8
1598	Large Gravel and Cobble	702.95 ...	PF 3	MPM	842.2
1599	Large Gravel and Cobble	702.95 ...	PF 4	MPM	1555
1600	Large Gravel and Cobble	702.95 ...	PF 5	MPM	2131
1601	Large Gravel and Cobble	702.95 ...	PF 6	MPM	2738
1602	Large Gravel and Cobble	702.95 ...	PF 7	MPM	3366
1603	Large Gravel and Cobble	702.95 ...	PF 8	MPM	4399
1604	Large Gravel and Cobble	702.95 ...	PF 9	MPM	8963
1605	Large Gravel and Cobble	702.95 ...	PF 10	MPM	15310
1606					
1607	Large Gravel and Cobble	599.9	PF 1	MPM	143.6
1608	Large Gravel and Cobble	599.9	PF 2	MPM	86.22
1609	Large Gravel and Cobble	599.9	PF 3	MPM	74.54
1610	Large Gravel and Cobble	599.9	PF 4	MPM	106.1
1611	Large Gravel and Cobble	599.9	PF 5	MPM	133.7
1612	Large Gravel and Cobble	599.9	PF 6	MPM	159.5
1613	Large Gravel and Cobble	599.9	PF 7	MPM	181.9
1614	Large Gravel and Cobble	599.9	PF 8	MPM	210.3
1615	Large Gravel and Cobble	599.9	PF 9	MPM	272.7
1616	Large Gravel and Cobble	599.9	PF 10	MPM	303.3
1617					
1618	Large Gravel and Cobble	504.08 ...	PF 1	MPM	0
1619	Large Gravel and Cobble	504.08 ...	PF 2	MPM	3.714
1620	Large Gravel and Cobble	504.08 ...	PF 3	MPM	46.10
1621	Large Gravel and Cobble	504.08 ...	PF 4	MPM	145.1
1622	Large Gravel and Cobble	504.08 ...	PF 5	MPM	258.2
1623	Large Gravel and Cobble	504.08 ...	PF 6	MPM	390.9
1624	Large Gravel and Cobble	504.08 ...	PF 7	MPM	531.7
1625	Large Gravel and Cobble	504.08 ...	PF 8	MPM	740.6

1626	Large Gravel and Cobble	504.08 ...	PF 9	MPM	1459
1627	Large Gravel and Cobble	504.08 ...	PF 10	MPM	2202
1628					
1629	Large Gravel and Cobble	405.1	PF 1	MPM	226.6
1630	Large Gravel and Cobble	405.1	PF 2	MPM	295.1
1631	Large Gravel and Cobble	405.1	PF 3	MPM	493.1
1632	Large Gravel and Cobble	405.1	PF 4	MPM	748.1
1633	Large Gravel and Cobble	405.1	PF 5	MPM	922.7
1634	Large Gravel and Cobble	405.1	PF 6	MPM	1045
1635	Large Gravel and Cobble	405.1	PF 7	MPM	1144
1636	Large Gravel and Cobble	405.1	PF 8	MPM	1280
1637	Large Gravel and Cobble	405.1	PF 9	MPM	1588
1638	Large Gravel and Cobble	405.1	PF 10	MPM	1971
1639					
1640	Large Gravel and Cobble	299.4	PF 1	MPM	4.495
1641	Large Gravel and Cobble	299.4	PF 2	MPM	19.57
1642	Large Gravel and Cobble	299.4	PF 3	MPM	75.79
1643	Large Gravel and Cobble	299.4	PF 4	MPM	173.5
1644	Large Gravel and Cobble	299.4	PF 5	MPM	262.4
1645	Large Gravel and Cobble	299.4	PF 6	MPM	344.4
1646	Large Gravel and Cobble	299.4	PF 7	MPM	423.8
1647	Large Gravel and Cobble	299.4	PF 8	MPM	542.0
1648	Large Gravel and Cobble	299.4	PF 9	MPM	839.2
1649	Large Gravel and Cobble	299.4	PF 10	MPM	1134
1650					
1651	Large Gravel and Cobble	199.35 ...	PF 1	MPM	417.5
1652	Large Gravel and Cobble	199.35 ...	PF 2	MPM	683.2
1653	Large Gravel and Cobble	199.35 ...	PF 3	MPM	1358
1654	Large Gravel and Cobble	199.35 ...	PF 4	MPM	2552
1655	Large Gravel and Cobble	199.35 ...	PF 5	MPM	3945
1656	Large Gravel and Cobble	199.35 ...	PF 6	MPM	5269
1657	Large Gravel and Cobble	199.35 ...	PF 7	MPM	6377
1658	Large Gravel and Cobble	199.35 ...	PF 8	MPM	7735
1659	Large Gravel and Cobble	199.35 ...	PF 9	MPM	11070
1660	Large Gravel and Cobble	199.35 ...	PF 10	MPM	12910

ATTACHMENT C

Reach 1 Gravels

Design Flowrate, cfs	Geometric Mean TPD	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Transport Potential (Tons)
10	42				
20	120	81	0.109	40.00	3246
50	375	248	0.543	198.20	49081
100	880	627	0.222	81.10	50886
150	1393	1137	0.055	20.20	22960
200	1898	1646	0.034	12.40	20405
252	2416	2157	0.020	7.30	15744
328	3179	2797	0.011	4.00	11190
545	5410	4295	0.004	1.60	6872
750	7598	6504	0.001	0.30	1951
					182334

365.10

Reach 1 - Cobbles

Design Flowrate, cfs	Geometric Mean TPD	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Transport Potential (Tons)
10	16				
20	76	46	0.109	40.00	1841
50	318	197	0.543	198.20	39004
100	676	497	0.222	81.10	40288
150	999	838	0.055	20.20	16918
200	1292	1145	0.034	12.40	14202
252	2536	1914	0.020	7.30	13972
328	1991	2264	0.011	4.00	9054
545	3138	2565	0.004	1.60	4103
750	4260	3699	0.001	0.30	1110
					140,493

365.10

Reach 2 Gravels

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.32				
20	1.73	1.03	0.109	40.00	41.06
50	18.67	10.20	0.543	198.20	2022.43
100	82.83	50.75	0.222	81.10	4116.13
150	172.42	127.63	0.055	20.20	2578.10
200	220.03	196.23	0.034	12.40	2433.21
252	122.71	171.37	0.020	7.30	1251.01
328	107.00	114.86	0.011	4.00	459.43
545	142.91	124.95	0.004	1.60	199.92
750	77.75	110.33	0.001	0.30	33.10
					13134.39

Reach 2 - Cobbles

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.01				
20	0.03	0.02	0.109	40.00	0.96
50	0.10	0.07	0.543	198.20	13.29
100	0.40	0.248486994	0.222	81.10	20.15
150	4.25	2.322273503	0.055	20.20	46.91
200	5.19	4.718942979	0.034	12.40	58.51
252	9.41	7.29880294	0.020	7.30	53.28
328	16.31	12.8608671	0.011	4.00	51.44
545	22.78	19.54734686	0.004	1.60	31.28
750	22.45	22.61555629	0.001	0.30	6.78
					282.60

Reach 3 Gravels

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	25.64				
20	57.08	41.36	0.109	40.00	1654.46
50	184.77	120.92	0.543	198.20	23967.30
100	349.41	267.09	0.222	81.10	21661.18
150	518.08	433.75	0.055	20.20	8761.69
200	707.73	612.91	0.034	12.40	7600.04
252	900.82	804.28	0.020	7.30	5871.22
328	1137.15	1018.99	0.011	4.00	4075.94
545	28.63	582.89	0.004	1.60	932.63
750	0.26	14.45	0.001	0.30	4.33
					74528.79

Reach 3 - Cobbles

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.27				
20	1.17	0.72	0.109	40.00	28.72
50	16.57	8.87	0.543	198.20	1758.05
100	132.80	74.68816513	0.222	81.10	6,057.21
150	231.87	182.3387055	0.055	20.20	3,683.24
200	334.50	283.1859505	0.034	12.40	3,511.51
252	433.05	383.7730029	0.020	7.30	2,801.54
329	545.73	489.3895169	0.011	4.00	1,957.56
750	4.78	275.2546077	0.004	1.60	440.41
751	0.03	2.401735239	0.001	0.30	0.72
					20,238.96

Reach 4 Gravels					
Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	20.59				
20	62.29	41.44	0.109	40.00	1657.67
50	204.39	133.34	0.543	198.20	26427.98
100	508.47	356.43	0.222	81.10	28906.46
150	779.18	643.83	0.055	20.20	13005.33
200	1051.87	915.53	0.034	12.40	11352.54
252	1329.49	1190.68	0.020	7.30	8691.96
328	1743.45	1536.47	0.011	4.00	6145.88
545	2460.98	2102.22	0.004	1.60	3363.55
750	1359.87	1910.42	0.001	0.30	573.13
					100124.49

Reach 4- Cobbles					
Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.31				
20	2.28	1.30	0.109	40.00	51.89
50	30.09	16.19	0.543	198.20	3208.07
100	146.54	88.31	0.222	81.10	7,162.26
150	224.05	185.29	0.055	20.20	3,742.90
200	490.72	357.38	0.034	12.40	4,431.55
252	634.85	562.78	0.020	7.30	4,108.31
328	842.14	738.49	0.011	4.00	2,953.96
545	1197.08	1019.61	0.004	1.60	1,631.37
750	180.93	689.00	0.001	0.30	206.70
					27,497.02

Reach 5 Gravels

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	26.54				
20	64.35	45.44	0.109	40.00	1817.76
50	181.98	123.16	0.543	198.20	24411.17
100	423.84	302.91	0.222	81.10	24565.85
150	696.36	560.10	0.055	20.20	11314.02
200	970.93	833.64	0.034	12.40	10337.19
252	1247.88	1109.40	0.020	7.30	8098.66
328	1630.64	1439.26	0.011	4.00	5757.05
545	2907.69	2269.17	0.004	1.60	3630.67
750	3886.41	3397.05	0.001	0.30	1019.12
					90951.47

Reach 5- Cobbles

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.29				
20	1.27	0.78	0.109	40.00	31.18
50	20.71	10.99	0.543	198.20	2177.81
100	180.30	100.503438	0.222	81.10	8,150.83
150	323.53	251.9174085	0.055	20.20	5,088.73
200	458.83	391.1818503	0.034	12.40	4,850.65
252	592.21	525.5211553	0.020	7.30	3,836.30
328	775.22	683.7179263	0.011	4.00	2,734.87
545	1405.30	1090.259567	0.004	1.60	1,744.42
750	1885.83	1645.563398	0.001	0.30	493.67
					29,108.47

Reach 6 Gravels

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	15.21				
20	43.83	29.52	0.109	40.00	1180.88
50	181.47	112.65	0.543	198.20	22327.59
100	481.92	331.70	0.222	81.10	26900.66
150	822.58	652.25	0.055	20.20	13175.46
200	1177.54	1000.06	0.034	12.40	12400.75
252	1565.65	1371.60	0.020	7.30	10012.65
328	2114.10	1839.88	0.011	4.00	7359.51
545	3867.10	2990.60	0.004	1.60	4784.96
750	5681.86	4774.48	0.001	0.30	1432.34
					99574.79

Reach 6- Cobbles

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Tansport Potential (Tons)
10	0.13				
20	0.15	0.14	0.109	40.00	5.56
50	24.48	12.32	0.543	198.20	2440.89
100	215.20	119.8426729	0.222	81.10	9,719.24
150	398.08	306.639308	0.055	20.20	6,194.11
200	398.08	398.0769747	0.034	12.40	4,936.15
252	779.04	588.5583725	0.020	7.30	4,296.48
328	1038.95	908.9924654	0.011	4.00	3,635.97
545	1893.69	1466.319969	0.004	1.60	2,346.11
750	2814.17	2353.934319	0.001	0.30	706.18
					34,280.70

Appendix D: Engineering Criteria Summary

Final Report

July 27, 2013

Prickly Pear Creek Realignment
Proposed Engineering Criteria Summary
Former East Helena Smelter Facility
East Helena, Montana

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Attachment B – Incipient Motion Calculations
Attachment C – Sediment Transport Calculations
Attachment D – Hydraulic Geometry Calculations

DOCUMENT REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	Team	Draft	For Internal Pioneer Review	3/22/13
Rev 1	Team	Draft	Revised per Internal Review	3/29/13
Rev 2	Team	Final	Revised per Team Comments	6/21/13
Rev3	Team	Final	Addresses Additional Team Comments	7/26/13

1 Purpose/Objective

The purpose of this document is to summarize the channel and floodplain engineering criteria proposed for the realignment of Prickly Pear Creek (PPC) at the Former East Helena Smelter Facility near East Helena, Montana. The PPC realignment is one component of the South Plant Interim Measure remedial activities that include removal of impounded smelter waste material and removal of Smelter Dam. Development of the engineering criteria is based on the existing conditions stream assessment completed in 2011 (METG, 2012a) and the hydrologic analysis, existing conditions hydraulic analysis, preliminary hydro-geologic analysis, and the existing conditions channel stability analyses (sediment transport capacity estimates) included as appendices in the Channel Stability Analysis and Engineering Design Report (EDR).

The goals/objectives developed at the team chartering meeting state that the PPC realignment project should:

1. Support the implementation of the cleanup management strategy for the East Helena Smelter RCRA site.
2. Reduce groundwater levels beneath the site as part of the overall SPHC Interim Measure.
3. Facilitate stabilization of the slag pile.
4. Provide habitat restoration and/or replacement as needed to comply with natural resource (NR) protection permitting requirements for remediation work.
5. Serve as a source of materials for use in other IM construction actions (such as ET Cover).
6. Facilitate elimination of the HDS Plant discharge to PPC (through negotiated modification of the plant MPDES discharge location).

The primary design criteria for the PPC realignment address the goals/objectives stated above to ensure protection of human health and the environment. These primary criteria include the following:

- Modify the hydraulic regime at the site to reduce the mass and rate of contaminant transport away from the site.
- Realign PPC to support the modification of groundwater paths.
- Realign PPC to prevent entrainment of slag materials into the creek.

Secondary design criteria support the development of a process-based realignment design (the application of fluvial geomorphologic processes such as sediment transport and deformable boundaries in the design practice) for the stream and its bounding floodplain. These criteria include the following:

- The design discharge (bankfull hydraulic capacity) should be the dominant or bankfull discharge for PPC.

- The bankfull channel should be competent to transport the estimated incoming sediment load without reach-scale aggradation.
- The stream bed should be vertically stable at the scale of the entire project reach.
- The channel should be designed with a meandering planform and deformable banks where geomorphically appropriate and incorporate pool, riffle, and run sequences.
- Floodplains should incorporate wetlands where hydrologically feasible and geomorphically stable; Grade controls and/or non-deformable bank treatments should be used where vertical stability and/or horizontal stability is required for the protection of infrastructure, buildings or contaminated materials.
- Riparian vegetation should consist of native species suitable for the hydrologic and climatic regimes at the project site.
- Deformable bank treatments should allow for some undercutting.
- Deformable bank treatments should incorporate woody vegetation.
- Fish Passage should provide upstream passage for adult native species and downstream passage for all salmonid age classes.

The design criteria provide a framework for developing design parameter values, referred to as engineering criteria. The engineering criteria addressed within this document include the following:

- Bankfull discharge
- Channel slope
- Channel width to depth ratios
- Channel cross-section dimensions
- Channel planform
- Bed material gradations
- Infrastructure protection
- Bank construction
- Bank revegetation
- Generalized floodplain slope and grading
- Instream habitat
- Fish passage

This document summarizes the information and process used to develop channel design parameters; and presents individual subsections listing proposed engineering criteria related to bankfull discharge, bank treatments, wetland and floodplain design, revegetation, instream habitat, fish passage, and infrastructure protection. This document is included in the EDR and is supported by the other portions, appendices, drawings, and components of the EDR. Any additional analyses undertaken to develop criteria are described in relevant subsections of this document.

2 Development of Proposed Engineering Criteria

This section presents the engineering criteria proposed to complete a realignment channel design for PPC. The realignment will not only include moving the channel laterally, but reconfiguring the channel capacity, dimensions, length, profile, and pattern; reconstructing the streambanks on the realigned channel; and grading a new floodplain. As the existing channel that is to be realigned has been strongly impacted by channelization and instream structures, it does not provide internal reference conditions that can be used in analog design. Consequently, the engineering criteria presented here are based on a combination of selected reference conditions from upstream, minimally modified reaches, and analytical solutions. Because information continues to be gathered on site, and because of inherent uncertainties in existing and long-term site conditions, these criteria reflect a channel design effort made with the best available information as of March 2013. As additional data or other input becomes available in further design phases, there may be some changes to the overall design criteria and specific engineering design parameters. However, the design process described in this document integrates project goals and design components into a series of design criteria, articulates the specific parameters relevant to the design process, and provides quantitative proposed values for those parameters as much as possible. The design criteria therefore provide a strong foundation for continued channel design execution and refinement as additional information becomes available.

2.1 Existing Conditions: Geomorphology

The following summary of PPC geomorphology provides a brief site overview and lists specific existing conditions data that were used to develop design parameters. The information is largely compiled from a topographic survey and a supporting field assessment performed in October/November of 2011 (METG, 2012a). The 2011 assessment consisted of topographic surveying of channel cross sections and profiles, and inventorying of geomorphologic features related to bed morphology, riparian conditions, and channel substrate; and a summary of the results (METG, 2012a). The assessment extended from Highway (Hwy) 12 (Station 0+00) upstream to station 110+00, approximately 1 mile upstream of the project area (Figure 1). In order to capture the variability of stream conditions throughout the project, the assessment divided the creek into six reaches based on trends in channel slope, cross section, pattern, and substrate. Reach-averaged summary data from this assessment that were used to help develop the engineering criteria are summarized in Table 1.

The realignment segment of PPC extends from approximately Station 10+00 to Station 62+00. This encompasses the upper 2,000 feet (ft) of Reach 1, the entire 2,050-ft length of Reach 2, and the entire 900-ft length of Reach 3. The realignment segment includes Smelter Dam at the Reach 1/2 boundary, and the Wilson Ditch diversion site at the Reach 2/3 boundary.

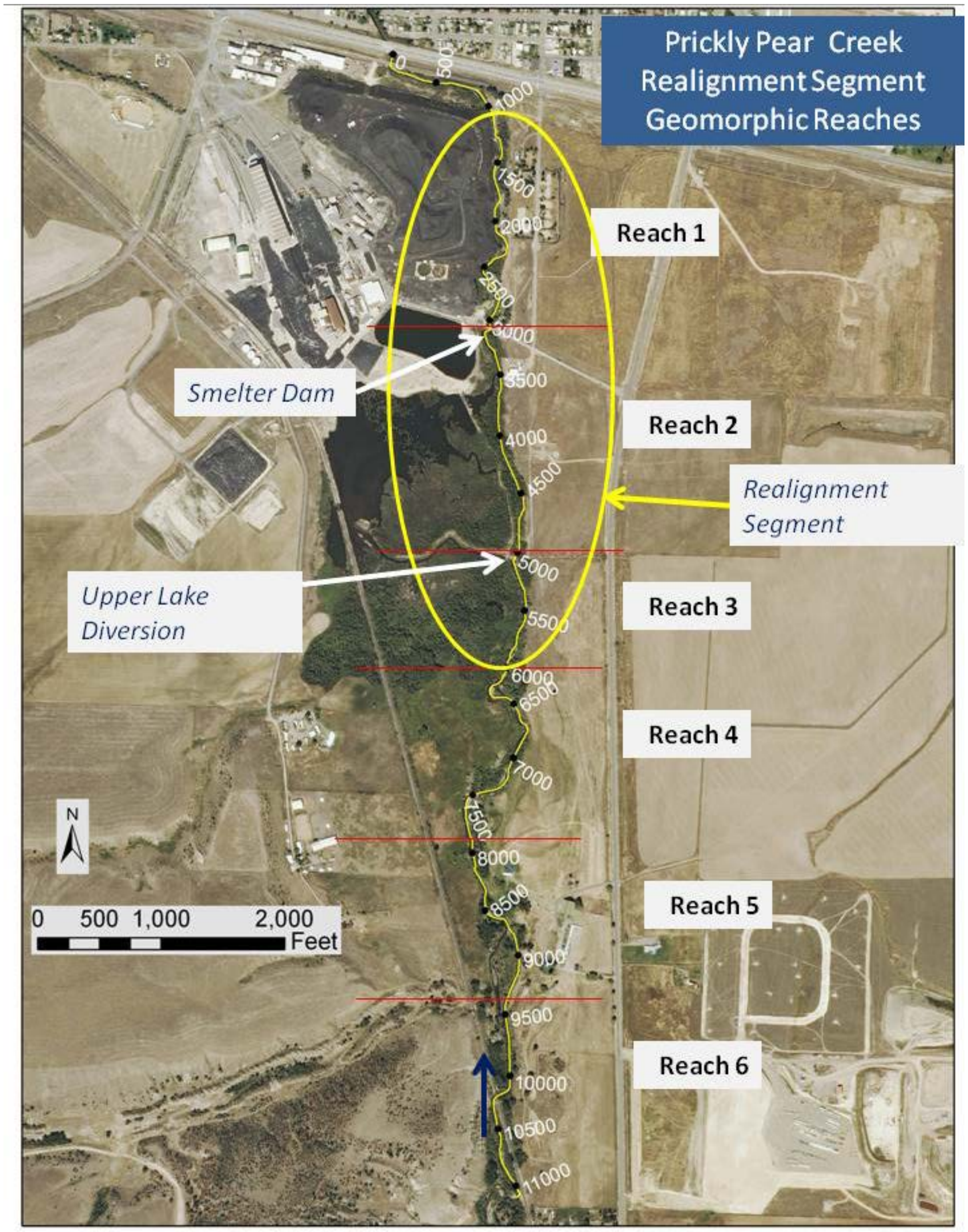


Figure 1. Prickly Pear Creek Project Area Showing Geomorphic Reach Breaks and Channel Realignment Segment.

Table 1. Summary of Morphologic Parameters for Existing Condition (METG, 2012a).

Parameter Type	Parameter	Reach					
		1	2	3	4	5	6
	Length (ft)	3050	2050	900	1850	1650	1600
	Average Channel Slope (%)	0.87	0.29	0.28	0.51	0.55	0.46
Bankfull Cross-Section Morphology	Mean Depth (ft)	1.82	1.68	2.14	1.5	1.99	2
	Maximum Depth (ft)	2.9	2.8	3.4	2.5	3.1	3.1
	Topwidth (ft)	33.8	39.0	43.8	43.2	34.1	42.4
	Width/Depth	18.6	23.2	20.5	28.8	17.1	21.2
Riffle Substrate	D16 (mm)	3	---	---	29	3	---
	D50 (mm)	63	---	---	51	46	---
	D84 (mm)	140	---	---	75	80	---
	Mean Residual Pool Depth (ft)	1.8	1.7	2	2.5	2.5	2.6
	Pool Density (pools/mile)	10.4	15.5	29.3	20	6.4	13.2
	Riffle Spacing (riffles/mile)	22.5	12.9	29.3	28.5	19.2	16.5

*Bankfull positions are derived from the primary field bankfull indicator at each cross section.
Feet = ft

2.1.1 Channel Slope

Figure 2 shows a plot of the PPC channel profile. Just upstream of the realignment section, Reach 4 has a channel slope of 0.51%. At Station 60+00, which is the start of the Southern Realignment Segment, the gradient flattens to 0.28% to the Upper Lake Diversion, which creates an abrupt ~4-ft drop in the channel profile. From Upper Lake Diversion to Smelter Dam, the bed slope remains relatively flat at 0.29% to the Smelter Dam Crest, which holds approximately 13 ft of grade. Below the dam, PPC maintains a constant average slope of ~0.87% for 3,000 ft as it closely follows the slag pile before turning west to follow the rail grade towards the Hwy 12 bridge crossing at Station 0+00.

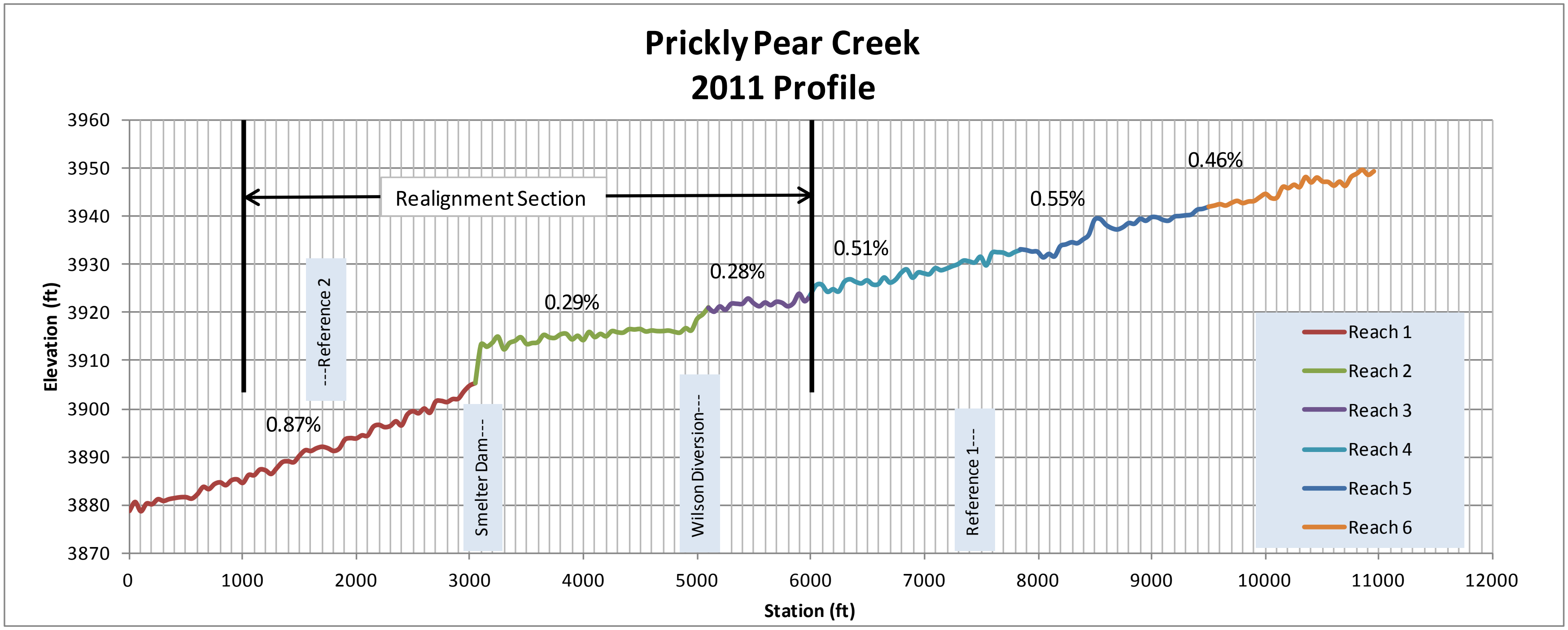


Figure 2. Fall 2011 Surveyed Bed Profile, PPC.

2.1.2 Bankfull Width

Bankfull width is an important design parameter that is used to help meet design criteria related to both channel dimensions and planform. For this effort, the existing reach-average bankfull topwidth on PPC was determined from the 2011 survey (Table 1, METG, 2012a). Because the reach has been historically impacted, however, it is important that this 2011 condition reflect a fairly stable configuration if it is used in design. As no historic survey data are available, historic air photos were used to estimate mean bankfull topwidth through time. This was performed by dividing bankfull channel area by the centerline reach length on imagery from 1950, 1995, 2008, and 2011. Bankfull channel area was determined as the area digitized within bankfull channel polygons, which basically define the unvegetated channel footprint. Errors potentially associated with these calculations stem from poor visibility due to canopy cover, subjective interpretation of the bankfull edge, and photo distortion. Nelson (2007) used this approach on the Snake River in Grand Teton National Park and assumed a 6% maximum error in bankfull topwidth estimates. The team did not perform an error analysis for this effort, largely because the results are not intended to provide a high level of precision, but to highlight any dramatic shifts or consistent trends in channel width through time.

Figure 3 shows reach-average bankfull topwidths estimated from aerial imagery. The data show that channel topwidth has varied through time, but that there are no system-wide temporal trends in topwidth values. This indicates that PPC is not currently in any long-term, system-wide process of cross-section adjustment that could confound design parameter development. In Reach 5, PPC was channelized and mechanically widened sometime just prior to the 1955 imagery (METG, 2012a), which is reflected by the anomalously wide 1955 channel condition. The reach subsequently narrowed to more typical values. The surveyed mean bankfull topwidth for Reach 5 is even smaller at 34.1 ft (Table 1), which is due to the fact that the channelized reach now has multiple channels that result in low-surveyed topwidths relative to the estimation via bankfull area.

What is most important to note is that in Reach 4, which is the reach just upstream of the realignment section, estimated bankfull topwidths have remained fairly consistent through time. As described in subsequent sections of this document, the existing condition of Reach 4 was used extensively in developing realignment dimensions for PPC.

A more complete description of existing morphologic parameters on PPC is contained in the Existing Conditions Stream Assessment Report (METG, 2012a).

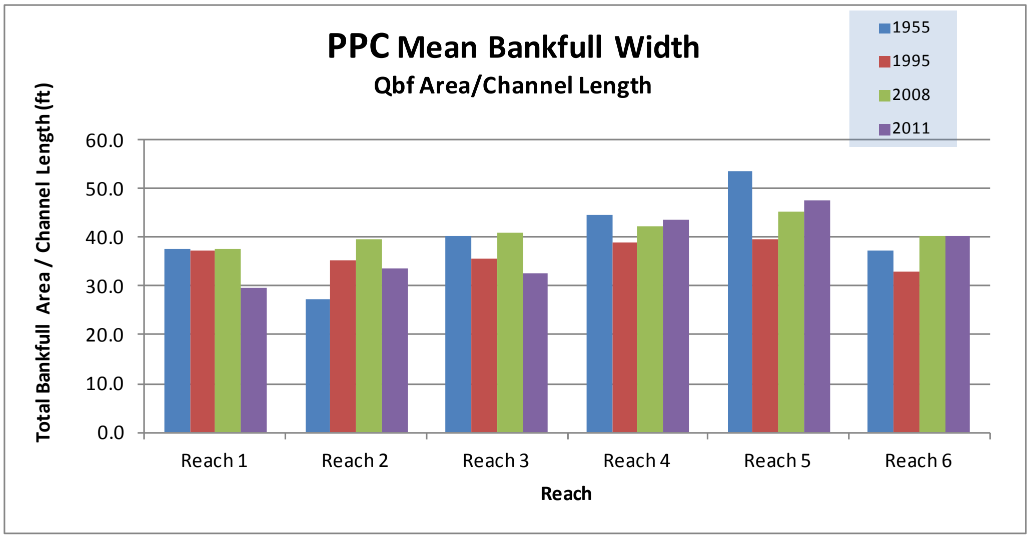


Figure 3. Mean Reach-Averaged Bankfull Topwidth Estimates Based on Historic Imagery Bankfull Area/Channel Length Calculations.

2.1.3 Substrate

Bed materials within the project reach were characterized from pebble counts and bulk sampling sieve analysis. Channel bed materials include coarse gravel/cobble riffle crests that contribute to bed stability and bedform complexity. Point bars typically consist of a grave/cobble surficial layer overlying poorly sorted sands, gravels, and cobbles.

A total of four pebble counts were collected at riffle crests in Reaches 1, 4, and 5 as part of the 2011 assessment (METG, 2012a). The Pebble count gradations reflect the measurement of 100 particles in each riffle. The pebble count data show that the riffle D50 value ranges from 46 millimeter (mm) to 51 mm in Reaches 4 and 5, with notable coarsening downstream in Reach 1 (Table 2). More significant is the very coarse D84 value in Reach 1 (140 mm), which reflects coarse sediment inputs in this reach from the terrace on the east side of the channel and the slag pile from the west side of the channel (METG, 2012a).

To better quantify incoming sediment load, three bulk sediment samples were collected from a point bar in Reach 4 at Station 75+00 that was deposited during the 2011 flood (METG, 2012a). Because of the size, height, and shape of this bar deposit, it is thought to represent the overall incoming sediment load, as it has the form of a flood deposit that has not been reworked. The results of that gradation analysis are shown in Table 3. Figure 4 shows the plotted gradation curves for all the samples. The curves show the finer sediment representation in the bulk samples, which contain on the order of 20% sand and finer sediment.

Table 2. Pebble Count Gradation Summary.

Sample ID	Station (ft)	D16 (mm)	D50 (mm)	D84 (mm)	Dominant Particle Sizes
Reach 1 (Riffle)	15+00	3	63	140	Coarse gravel\Cobble
Reach 4 (Riffle)	64+00	29	51	72	Coarse gravel\Cobble
Reach 4 (Riffle)	75+00	28	51	79	Coarse gravel\Cobble
Reach 5 (Riffle)	85+75	3	46	80	Coarse gravel\Cobble
Reach 4&5 Ave		20	50	77	Coarse gravel\Cobble

Table 3. Sand and Gravel Bulk Gradation Data, Reach 4.

Sieve Size	Sieve Opening mm	Sample ID			Average % Finer
		TP-01 0-18 % Finer	TP-01 18-24 % Finer	TP-02 0-18 % Finer	
5	127	100		100	100
4	101.6	97		96	97
3	76.2	89	100	93	94
2	50.8	79	97	83	86
1.5	38.1	73	91	71	78
1	25.4	62	82	60	68
0.75	19.05	55	74	51	60
0.5	12.7	44	61	41	49
0.375	9.525	40	55	37	44
#4	4.75	33	42	30	35
#10	2	23	27	20	23
#20	0.85	11	8	8	9
#40	0.425	5	2	3	3
#60	0.25	3	1	1	2
#100	0.15	2	0.0	1	1
#200	0.075	1	0.3	0.3	1

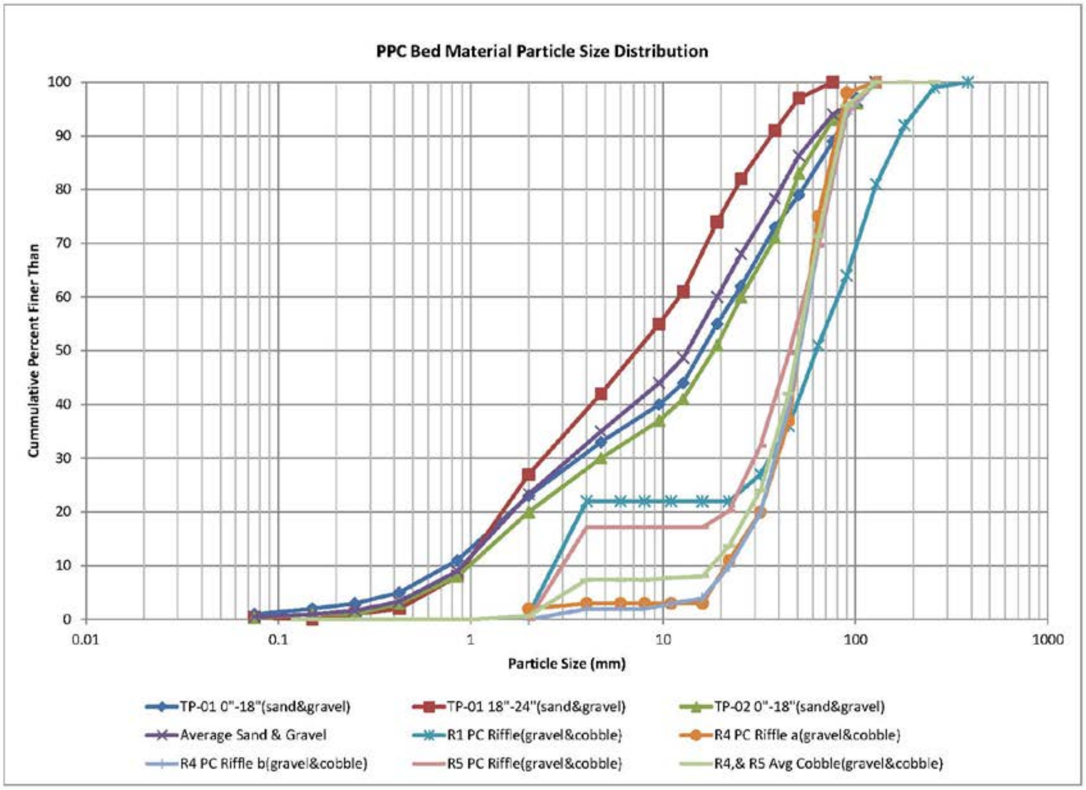


Figure 4. The PPC-Bed Material Particle Size Distribution.

2.2 Proposed Bankfull Discharge

A primary hydrologic design criteria is for the design discharge to be equal to the estimated dominant or bankfull discharge on PPC. Bankfull discharge is generally defined as the discharge that is responsible for forming the channel geometry or active stream channel. One qualitative generally accepted definition of bankfull discharge was provided by Dunne and Leopold (1978):

> "The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work results in the average morphologic characteristics of channels."

There is a large body of evidence that indicates that bankfull discharge is the dominant or channel-forming discharge (Hey, 1997). As such, it is a primary design parameter that helps to define primary channel capacity. The determination of an appropriate bankfull discharge requires integration of hydrologic, existing conditions hydraulic calculations, sediment transport calculations (Attachment C), and geomorphological interpretation of bankfull indicators.

Bankfull discharges typically have a return frequency of 1.5 to 2 years, although there is considerable scatter around this number (Hey, 1997). Flow frequency estimates developed in the PPC hydrology analysis (Appendix A, EDR) place the bankfull discharge estimate in the approximate range of 250 to 330 cubic feet per second (cfs), corresponding to a recurrence interval of 1.5 to 2 years.

Another method of estimating bankfull discharge is associated with flow-duration characteristics developed from hydrologic analysis of the watershed. Bankfull discharge in snowmelt-dominated basins typically occurs between 7 and 14 days per year (Wilkerson, 2008). Based on the flow-duration curve developed in the PPC hydrologic analysis calculation summary (Appendix A, EDR), the 7-14 day duration approximately corresponds to a flow range of 200 to 300 cfs (METG, 2012b).

Lawlor (Lawlor 2004) completed a detailed analysis of United States Geological Survey (USGS) gaging data at 41 sites in western Montana and proposed the bankfull discharge was approximately 84% of the 2-year discharge (Appendix A, EDR), which is:

$$Q_{bf} = 0.84(328) = 276 \text{ cfs}$$

Results from the existing condition hydraulic analysis and the field surveyed bankfull stage indicators for Reference Site 1, indicate the 2-year discharge (Q_2 = 328 cfs) is within ± 0.5 ft of the field bankfull stage indicators for eight of the nine cross sections. Therefore the 2-year discharge is fairly consistent with the bankfull stage field indicators at Reference Site 1.

Incipient motion calculations conducted as part of the existing condition channel stability analysis, indicate critical discharge for the riffle size material in Reaches 4, 5, and 6 range from 210 cfs to 240 cfs (similar in magnitude to the 1.5-year discharge**).**

Based on the results of the analyses discussed above, the team determined that the channel forming discharge in the project reach is between the 1.5- year and 2-year discharges derived from the hydrologic analysis (Appendix A, EDR). The 1.5- and 2-year recurrence interval discharges estimated for the project reach by hydrologic analysis are 252 and 328 cfs, respectively. Because of uncertainties with regard to overall sediment transport quantification in the system, and to prevent under sizing the channel, **the team selected the 2-year discharge of 328 cfs to meet criteria for design discharge.** Designing the channel capacity to the larger end of the bankfull range estimates will allow the channel to adjust to a smaller size in the event the dominant discharge is less.

2.3 Proposed Channel Slope, Geometry, and Planform

Design criteria for channel slope, capacity, and dimensions include the following:

- A bankfull channel that will competently transport the incoming sediment load.
- A bankfull channel that will convey the design discharge.
- A variable channel planform that is appropriate for the channel dimensions.

To determine design parameter values to meet these criteria, the team followed the approach below:

1. Identify reference reaches that demonstrate indicators of dynamic equilibrium.
2. Use reach-scale reference conditions to identify a target channel slope/profile that will minimize discontinuities between reaches and accommodate spatial site constraints.
3. Evaluate detailed channel segments as potential design templates or sediment transport analogs.
4. Apply hydraulic geometry relationships to help define dimensions based on the proposed design discharge/slope configuration.
5. Modify dimensions based on results of sediment transport analyses to meet transport competence criteria.

The realignment reach of PPC consists of two discreet realignment segments, which are separated by Smelter Dam (Figure 5). The Southern Realignment Segment, which is upstream of Smelter Dam, will be located in a broad floodplain area that allows for significant channel lengthening. Below the dam, the corridor is much narrower, such that the channel cannot be similarly lengthened. As a result, the two realignment segments have to be considered separately in the development of quantitative design parameters that meet design criteria.

2.3.1 Reference Reach Identification and Channel Slope Determination

During the spring of 2011, approximately 6 months prior to the geomorphic assessment, the mean daily peak discharge on PPC exceeded a 10-year recurrence interval discharge at the USGS stream gage at Clancy (785 cfs). At the Clancy gage site, which is upstream of the project reach, the USGS-derived, 2-year discharge (254 cfs) was exceeded for 38 days, and the 1.5-year discharge (197 cfs) was exceeded for 46 days. This event was notable in terms of both magnitude and duration, and resulted in high volumes of bed load transport on PPC. In Reach 4, which is just upstream of the Southern Realignment Segment, point bar deposition drove opposite bank erosion, shifting the channel laterally and leaving high, unvegetated point bars. In straighter channel segments, no lateral or vertical changes were discernible from either field observations or air photo analysis. The channel response to the 2011 event indicated that in Reach 4, the stream was dynamically depositing material on point bars, eroding opposite cutbanks, and leaving straighter channel cross segments essentially unchanged. Reach 4 also shows historically stable bankfull topwidths (Section 2.1.2), supporting the interpretation of dynamic stability in the reach. This type of dynamic equilibrium, where the stream is deformable yet stable with respect to sediment transport competency and resulting form, is a realignment design criterion. In areas where site constraints require a non-deformable channel, sediment transport competency criteria will still apply.

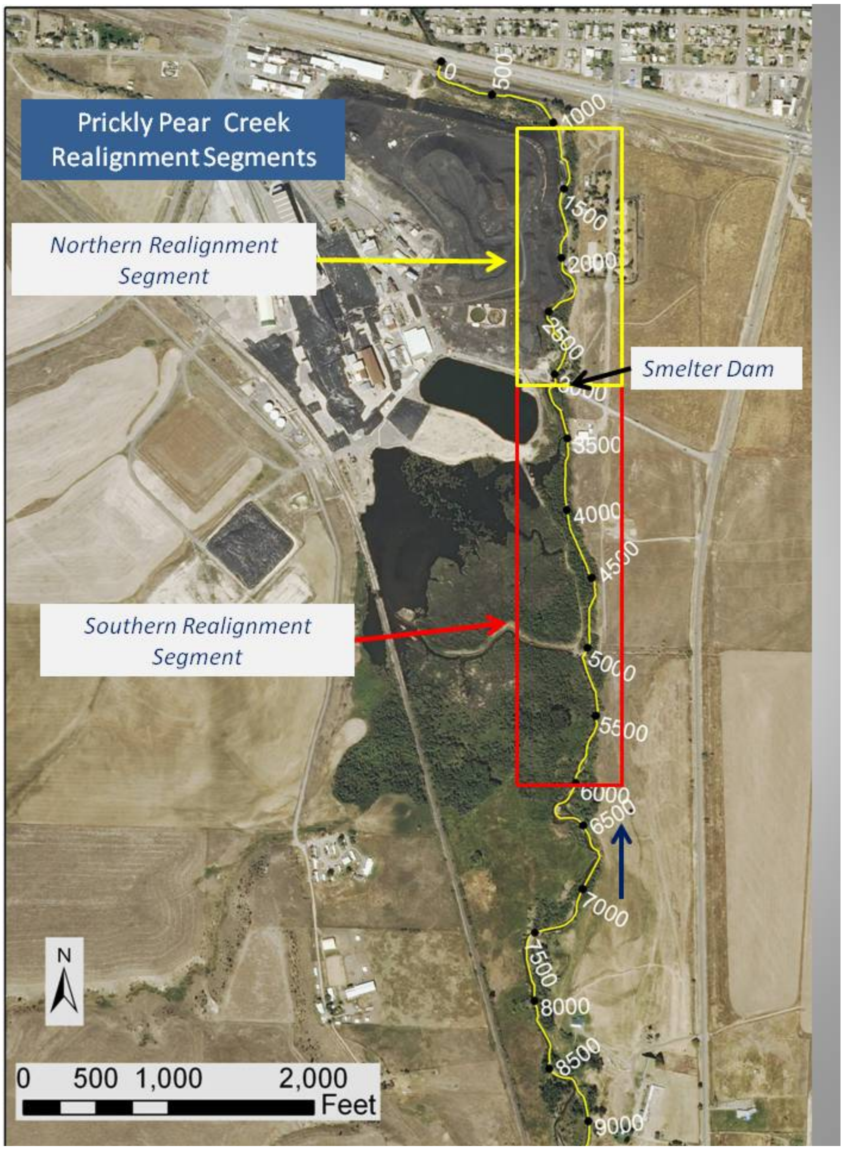


Figure 5. The PPC Realignment Segments.

Based on the above observations, the Reach 4 channel was chosen to define a reference slope and sediment transport condition for the PPC Southern Realignment Segment. The extension of the Reach 4 channel configuration (to the extent feasible) through the Southern Realignment would allow the downstream continuation of Reach 4 discharge and sediment transport capacities while minimizing a change in gradient at entrance to the realignment. The average slope of Reach 4 is ~0.5%, and continuing that ~0.5% slope from the head of the southern realignment segment to the base of Smelter Dam requires adding approximately 675 ft to the existing channel length. This additional channel length provides opportunity to increase planform complexity and associated habitat through the realignment reach, which is currently straight (Figure 5).

Downstream of Smelter Dam in the Northern Realignment Segment, the slag pile west of the channel and the high bench/utility corridor on the east side of the channel limit the width of the meander belt that can be built. On the west side, the slag pile will remain in place, so that the meander belt cannot extend in that direction. On the east side, a utility corridor marks the edge of the available area for meander belt excavation. Consequently, the channel below the dam cannot be lengthened sufficiently to accommodate an average 0.5% slope. Considering the area available for channel lengthening, an assessment of alternative alignments indicates that the channel slope below Smelter Dam can be reduced from its current 0.9% condition to 0.7%. However, a sediment transport analysis of this 0.7% condition indicates that bankfull transport energy is relatively high for this reach, creating a risk of excessive bed scour.

Because of this finding, the Northern Realignment Segment will be constructed using a 0.5% slope to allow the continuation of channel dimensions from upstream, with small grade control/drop structures (less than 2 ft) to absorb excess channel grade. These small structures will be designed (during the post 30% design effort) to meet all fish passage criteria while contributing grade control in the naturally steep reach. As this portion of PPC has historically eroded into the slag pile, additional criteria regarding deformability and terrace construction will be applied.

2.3.2 Detailed Reference Site Evaluation

During the fall of 2012, two ~200-ft-long channel segments within the project reach were surveyed as they expressed bedform complexity, planform complexity, and sediment transport equilibrium indicators that could potentially provide detailed reference conditions for an analog design approach. These potential reference segments are located in Reach 1 (Station 17+00) and Reach 4 (Station 75+00) and shown on Figure 6. Cross sections were collected at riffle crest and pool locations, and supplemental thalweg elevations were collected to generate a longitudinal profile through each potential reference site. Although these sites displayed geomorphic characteristics that may meet geomorphic design criteria with respect to deformability and complexity, the survey data indicated they were locally oversteepened relative to reach-average conditions and the design slope, and as such were not useable as reference templates. As discussed above, reach-average conditions in the entirety of Reach 4 provide a better sediment transport analog for project design, as Reach 4 as a whole is characterized by field evidence of geomorphic equilibrium, floodplain connectivity, and a bed slope suitable for site conditions. For comparison, however, the detailed reference sites were analyzed for sediment transport competency and compared to the reach scale condition, as well as the proposed design template. The results of this analysis are described in Section 2.3.4.

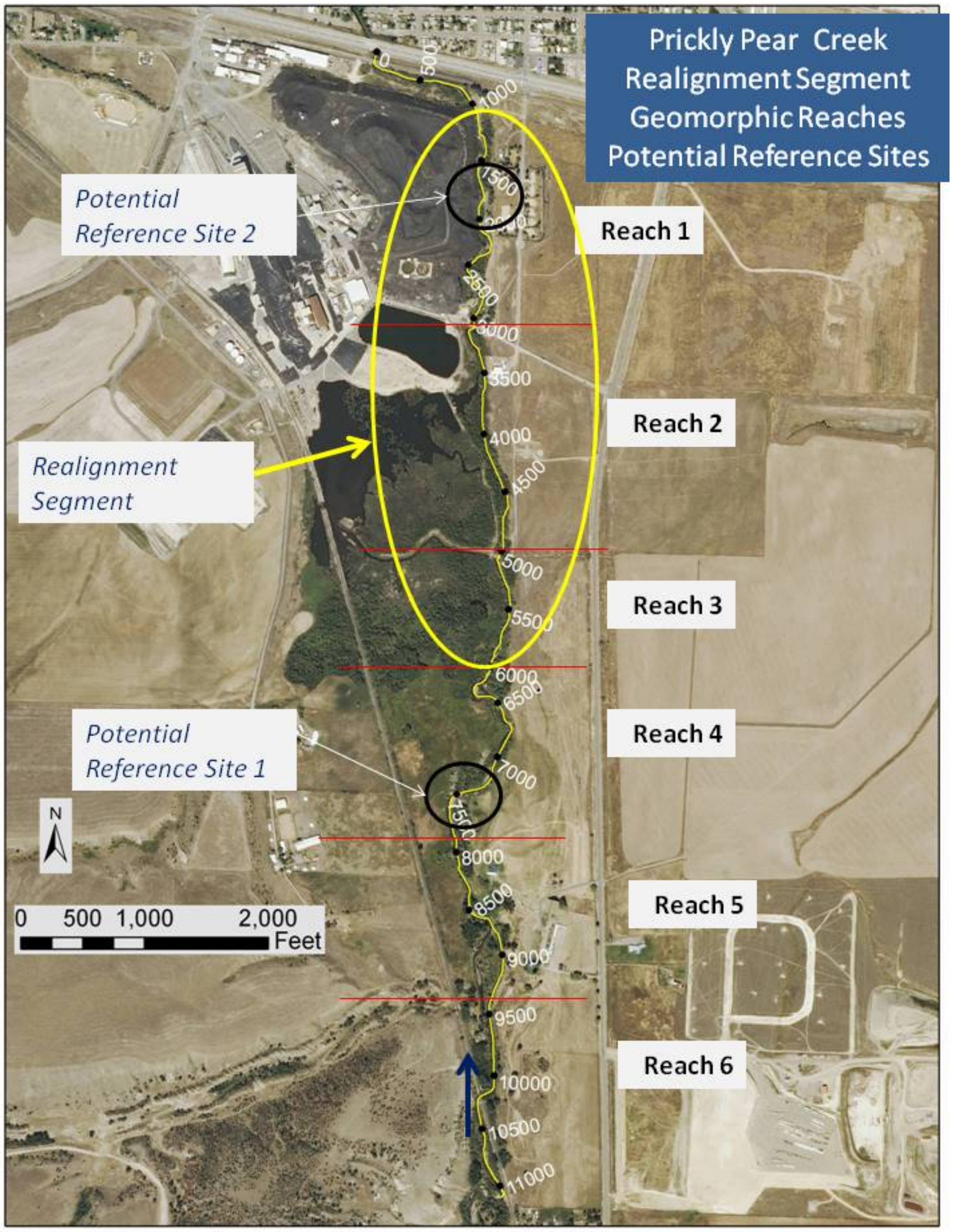


Figure 6. Realignment Segments, Geomorphic Reaches, and Potential Reverence Sites.

2.3.3 Hydraulic Geometry

A reference reach approach to channel design involves identifying an existing channel segment as a design analog, and then essentially replicating that channel condition. If an appropriate reference is available, this can be an effective means of design. Where streams have been modified, or where landscapes are complex, the reference channel may not provide the optimal channel condition with regard to geomorphic stability, riparian vegetation sustainability, or instream habitat value. In the case of PPC, the project is located where the creek emerges from a confined canyon into the Helena Valley creating a gradational landform, and the site and upstream reaches have been affected by channelization, placer mining, dam construction, and smelter operations. In order to further quantify parameters that will meet design criteria, the current condition of Reach 4 has been evaluated using hydraulic geometry calculations to determine if the proposed channel configuration is supported by regime theory.

In this design process, hydraulic geometry relations are used to compare predicted channel geometry to existing channel geometry. These results are then integrated to develop a channel design template used to quantify sediment transport and channel stability conditions. The results of these channel stability analyses then form the basis for modifying that basic template to meet design criteria.

Hydraulic geometry theory is based on the concept that a geomorphically stable river or stream reflects an equilibrium condition between the channel and the in-flowing water and sediment. Based on this concept, hydraulic geometry relationships were developed to characterize stable, natural river conditions (FISRWG, 1998). These mathematical relationships, which are empirically derived from large datasets, relate an independent variable such as discharge to dependent variables such as width, depth, slope, and velocity. The relationships are typically simple power functions (Leopold and Maddock, 1953). Independent variables include discharge, sediment load, sediment caliber (size), bank materials, and bank vegetation (Hey, 1997). Dependent variables include parameters such as width, depth, and velocity. Channel slope can be used as either a dependent or independent parameter. Therefore, applying hydraulic geometry equations allows the prediction of morphologic parameters based on defined independent variables.

Numerous hydraulic geometry relationships have been developed for alluvial rivers, based on work related to rational equation development, external hypotheses, and regime theory. Hydraulic geometry relationships should be applied in environments that are similar to those used to develop the relationship. Equations used in the PPC analysis are for gravel bed streams and are derived from Julien and Wargadalam (1995), Hey and Thorne (1986), Bray (1982), Parker et al. (1982), Kellerhalls (1967), and Thorne et al. (1998). Relationships for mean pool width and mean riffle width are from Hey (1997).

The results derived from hydraulic geometry equations for the PPC realignment reach are in Table 4. The collective inputs for these equations include bankfull discharge (328 cfs); existing bed material particle size fractions of D_{50} (51 mm) and D_{84} (75 mm); and slope (0.005 ft/ft or 0.5%). The results show that calculated bankfull topwidths range from 40.7 ft to 50.5 ft, with an average calculated topwidth of 44.0 ft. The Hey and Thorne (1996) and Thorne et al. (1998) equations include herbaceous bank vegetation to represent the Reach 4 existing condition. The results indicate that the current condition of Reach 4 is within the range of regime-based predictions, approximating the mean calculated values for channel width and depth. The existing condition of Reach 4 is therefore supported by regime equations as a conceptual design condition. Hydraulic geometry equations are provided in Attachment D.

Table 4. Results of Hydraulic Geometry Equations, South Realignment Segment (328 cfs).

Source	Mean Bankfull Topwidth (ft)	Mean Bankfull Depth (ft)	Width / Depth	Slope
Julien and Wargadalam (1995)	40.7	1.7	23.3	0.0048
Hey and Thorne (1996)	43.4	1.1	40.5	0.0049
Bray (1982)	50.5	1.9	26.7	0.0049
Thorne et al (1998)	41.6	2.2	18.8	0.0050
Mean Regime Value	44.0	1.7	27.4	0.0049
Reach 4 Existing Condition	43.2	1.5	28.8	0.0050

Once channel geometry is estimated using existing site conditions, analytical results, and hydraulic geometry relationships, these parameters can be used to identify appropriate ranges in meander features such as meander wavelength, bend length, belt width, and radius of curvature and sinuosity. For this effort, the team used empirical planform relationships developed by Williams (1986) to develop channel planform criteria for the design condition based on bankfull topwidth. The Williams (1986) equations provided a range of parameter outputs for meandering channels. PPC site conditions are consistent with data used in the development of the Williams equations and therefore applicable to this site. Figure 7 shows a graphic with various meander parameters.

The equations used for planform layout include the following (Williams, 1986):

$L = 6.5\ W^{1.12}$

$M_l = 4.4\ W^{1.12}$

$B = 3.7\ W^{1.12}$

$R_c = 1.3\ W^{1.12}$

Where: W = bankfull topwidth
L = meander wavelength
M_l = along-channel bend length
B = meander belt width
R_c = radius of curvature

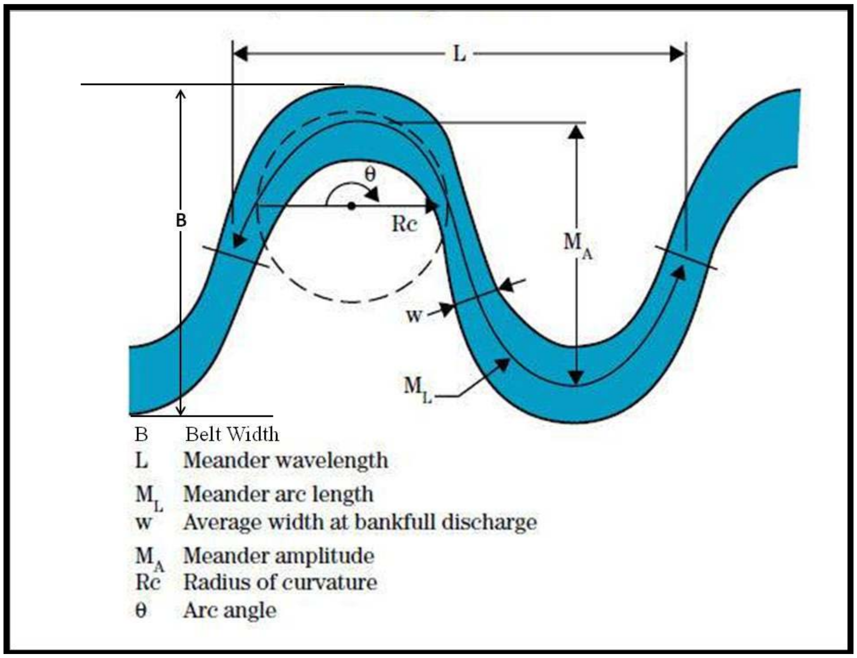


Figure 7. Variables used To Describe Channel Alignment and Planform (USACE, 2007).

Applying meander geometry equations provides a range of parameters that define channel layout. The ranges can be used to vary planform parameters through the design reach that produce planform variability consistent with natural systems. Determining specific design values for each planform element (e.g., a single bendway) requires consideration of spatial site constraints, as well as consideration of potential cutoff or avulsion risk associated with the newly constructed channel. It may be appropriate, for example, to apply fairly broad bendway parameters such as radius of curvature to lower the risk of bendway cutoff through a newly constructed, poorly vegetated floodplain. Table 5 shows a summary of preliminary channel dimension, substrate, and layout design values for the PPC 0.5% grade realignment. The following section describes how these preliminary values help develop a channel template for sediment transport analysis.

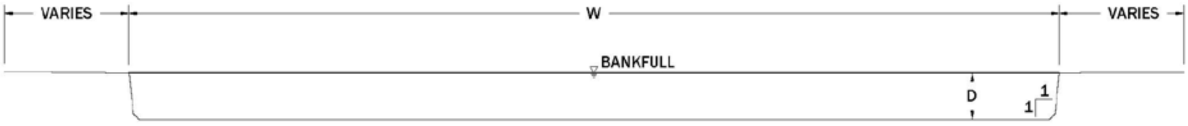
Table 5. Preliminary Quantitative Channel Design Parameters for Template Analysis, PPC.

Parameter	Units	Preliminary Design Criteria	Basis
Bankfull Discharge	cfs	328	2-Year Discharge
Channel Slope and Dimensions			
Slope	%	0.5	Existing Reach 4
Mean Bankfull Topwidth	ft	43.2	Existing Reach 4
Mean Depth	ft	1.5	Existing Reach 4
Mean Width to Depth Ratio	---	28.8	Existing Reach 4
Mean Bankfull Pool Width	ft	41.7	Hey and Thorne (1986)
Mean Bankfull Riffle Width	ft	44.7	Hey and Thorne (1986)
Channel Planform			
Rc	ft	Mean: 88 Range: 55-137	Williams (1986)
Rc/W	---	Mean: 2.0 Range: 1.3- 3.2	Williams (1986)
Meander Length	ft	Mean: 441 Range: 269-728	Williams (1986)
Meander wavelength	ft	Mean: 299 Range: 182 493	Williams (1986)
Belt Width	ft	Mean: 251 Range: 146-437	Williams (1986)

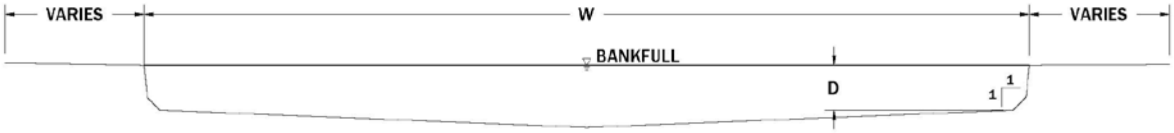
2.3.4 Channel Template Analysis: Hydraulics and Sediment Transport

The team conducted a channel template hydraulic analysis to evaluate and adjust the preliminary channel design parameter values as a basis to develop the full detailed design. During the detailed design phase (post 30%), hydraulic modeling and channel stability will be conducted for the entire PPC channel realignment proposed design.

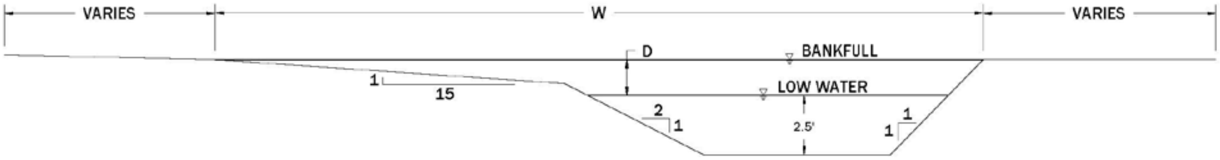
The preliminary criteria in Table 5, which are based on a combined reference, hydraulic geometry, and meander equation assessment, were used to develop the conceptual channel templates that reflect three basic types of cross sections: riffles, runs, and pools. The template geometries are based upon the geometry of natural channels but simplified for ease of construction. These cross sections were then hydraulically analyzed to quantify conveyance and sediment transport capacities. Based on the results, the templates have then been slightly modified to meet design criteria for sediment transport and channel conveyance. Figure 8 shows the three types of cross-section templates developed for the proposed PPC channel. The design templates were used to develop a Hydraulic Engineering Center River Analysis System (HEC-RAS) hydraulic model of a short reach (Template Reach Model) to represent average conditions in the proposed PPC channel.



.5% RIFFLE



.5% RUN



.5% POOL

Figure 8. Cross-Section Templates.

Figure 9 shows a plan view of the template reach model. The reach is approximately 800-ft long and includes two riffle-pool sequences. The model uses a Manning’s “n” roughness coefficient of 0.035, approximately equivalent to the existing condition roughness value, for the main channel; a valley width of 400 ft to represent the floodplain; and a floodplain roughness of 0.1 for the overbank areas to represent the expected condition of the overbank roughness. Hydraulic calculations were conducted for a range of flows from 10 cfs to 750 cfs, the same range used to evaluate existing main channel conditions.

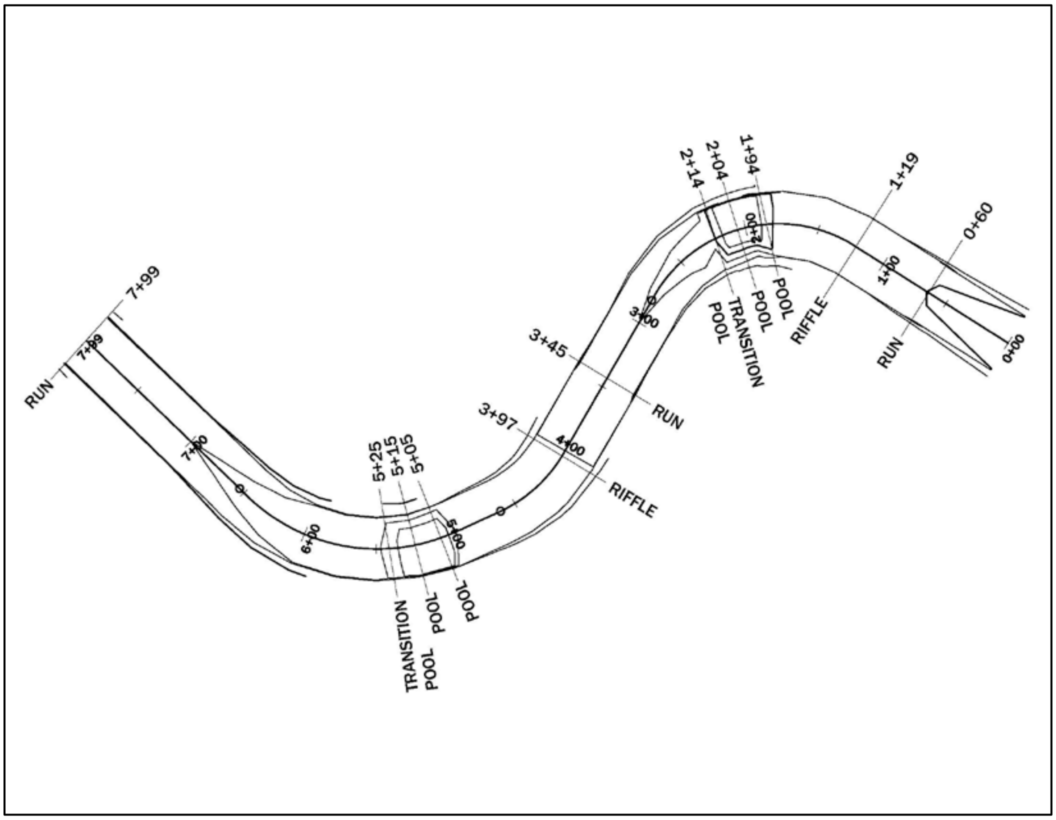


Figure 9. Design Template Plan View.

The team initially based the template model cross-section dimensions on Table 5 values, then modified the dimensions in an iterative process until resultant hydraulic parameters values from the template reach model were in relative agreement with the existing condition Reach 4 hydraulic parameter values (the analog reach). Figures 9-14 and Table 6 are based on the adjusted, final model run.

Figure 10 shows a profile view of the template reach model with the top of bank and water surface elevations for modeled flows. The plot shows that the design discharge (328 cfs) water surface is at or near the channel top of bank, indicating that the floodplain access will begin at or near the design discharge. At the low flow condition of 20 cfs (which equates to the 10th percentile or 90% exceedance flow), the water surface profiles are relatively flat across the pools and steeper across the riffles. At the design bankfull discharge (328), the water surface profile is steeper across the pools than at the low flow condition of 20 cfs.

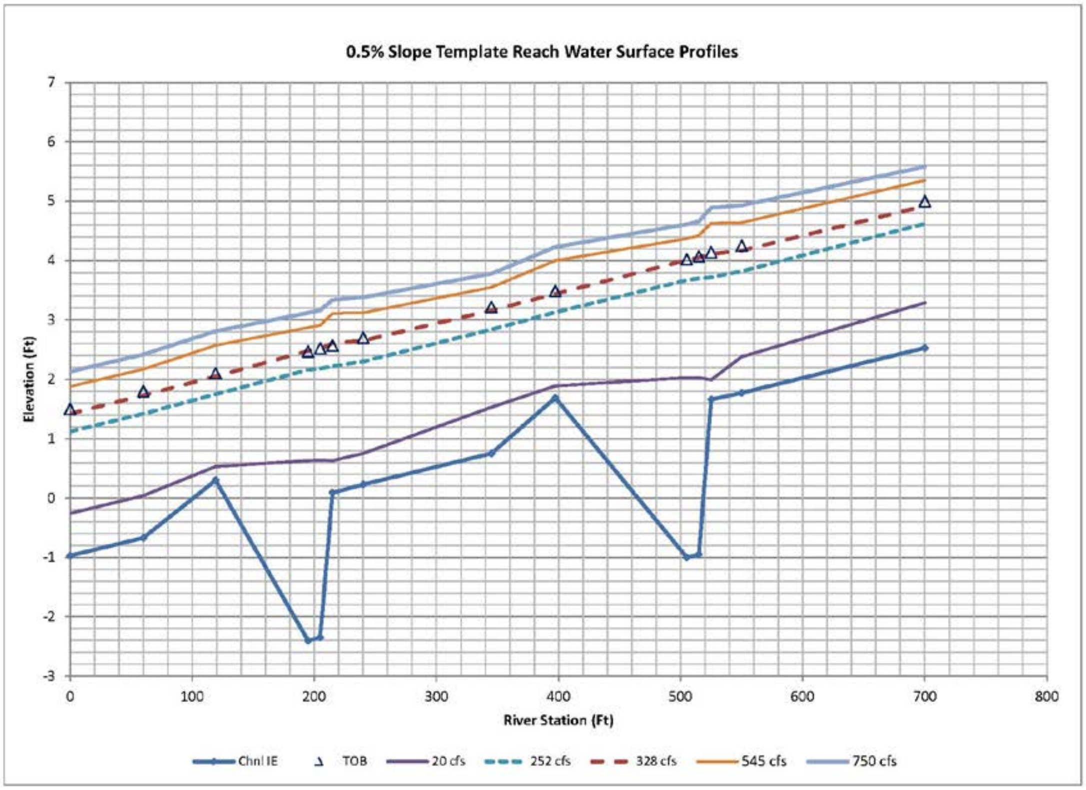


Figure 10. Template Water Surface Profiles.

Figure 11 plots the main channel velocity profiles for the 0.5% design template. Results indicate there is considerable variability in the velocity profiles between the riffles and the pools. As flows increase, a velocity reversal between the pools and riffles is observed starting at the bankfull discharge (328 cfs), which helps to transport sediment. During high flows pools scour, depositing coarse material on the riffles. During low flows, finer sediment deposits in the pools and is scoured from the riffles. Research supports this velocity reversal in riffle-pool systems (Seddon, 1990; Gilbert, 1914; Lane and Borland, 1954; Keller, 1971; Harvey et al., 1993, Caamano et al., 2009).

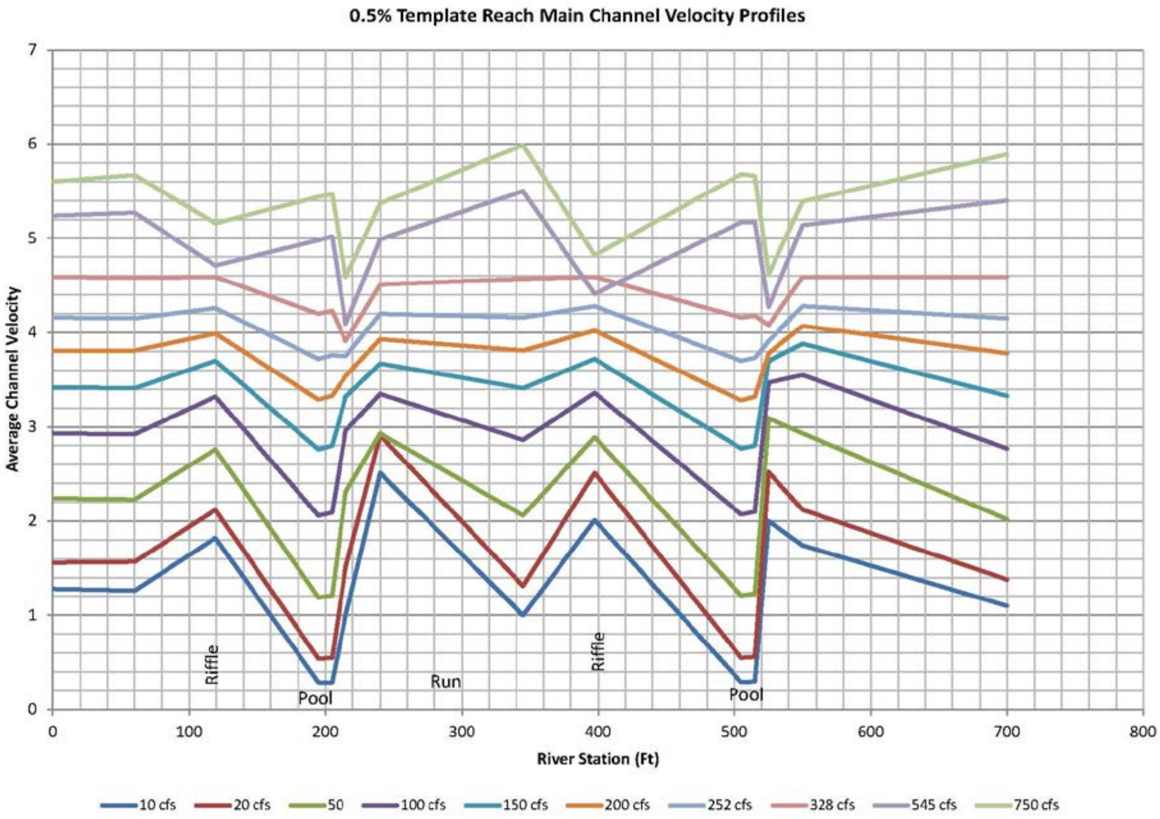


Figure 11. Template Velocity Profiles.

Detailed model output results are in Attachment A.

Figure 12 through Figure 15 plot reach average boundary shear stress, energy slope, hydraulic radius, and velocity estimates for the proposed template model along with the Reach 4 and Reference Site 1 (a steeper segment of Reach 4) reach average values. In Figures 12 thru 15, Reach 4 EC represents Reach 4 existing condition; EC Ref Site 1 represents the Reference Site 1 existing condition. Figure 12 indicates that the channel design template produces lower shear stress values at lower flows increasing gradually to equal the existing condition Reach 4 at bankfull discharge (328 cfs). This result is associated with the simplified channel template geometry, which results in larger flow areas at low stages than the existing condition Reach 4 geometry. Over time, the anticipation is that the channel geometry will adjust by narrowing during the lower discharge conditions and shear values will increase at the lower flows.

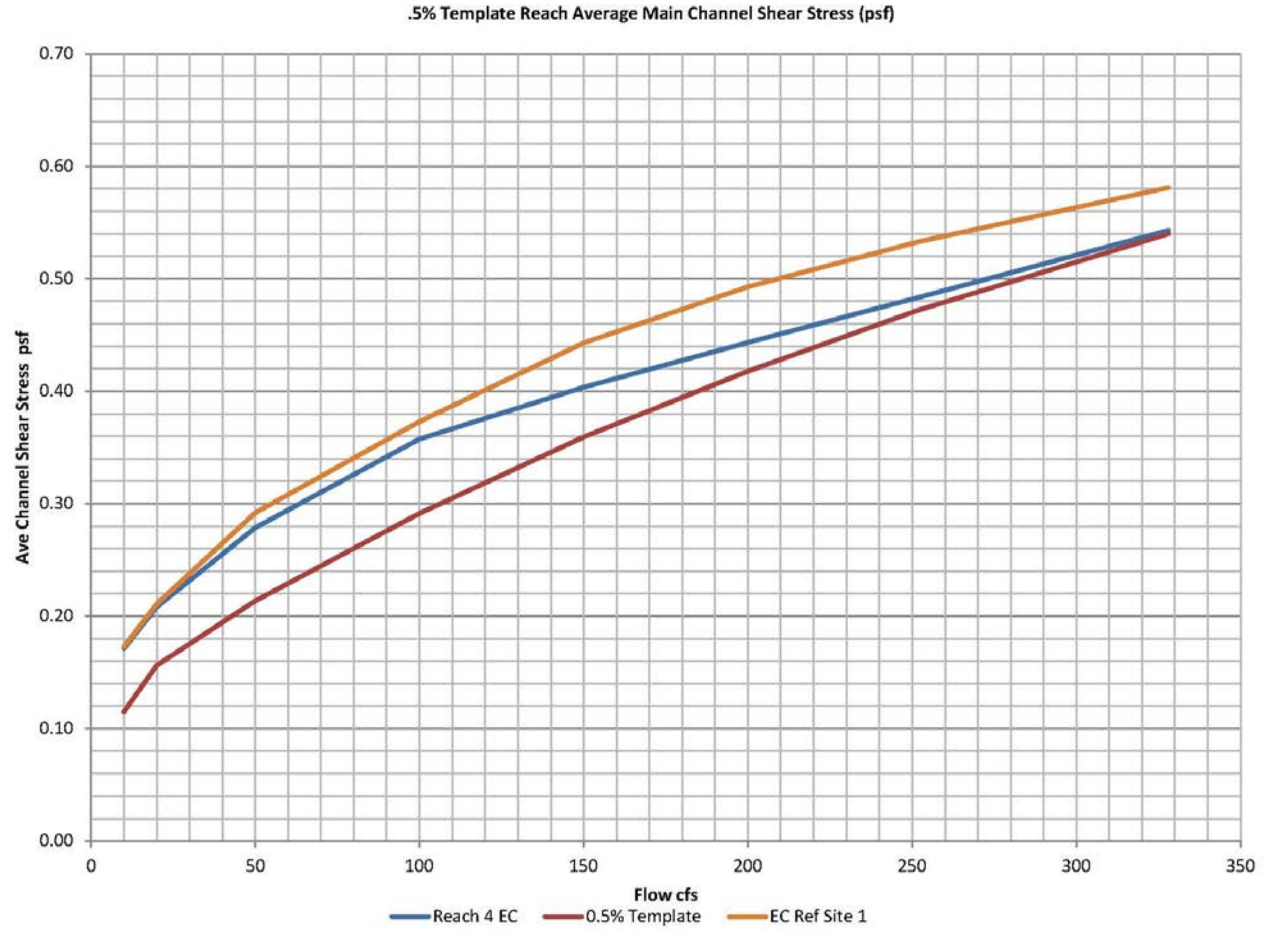


Figure 12. Reach Average Shear Stress.

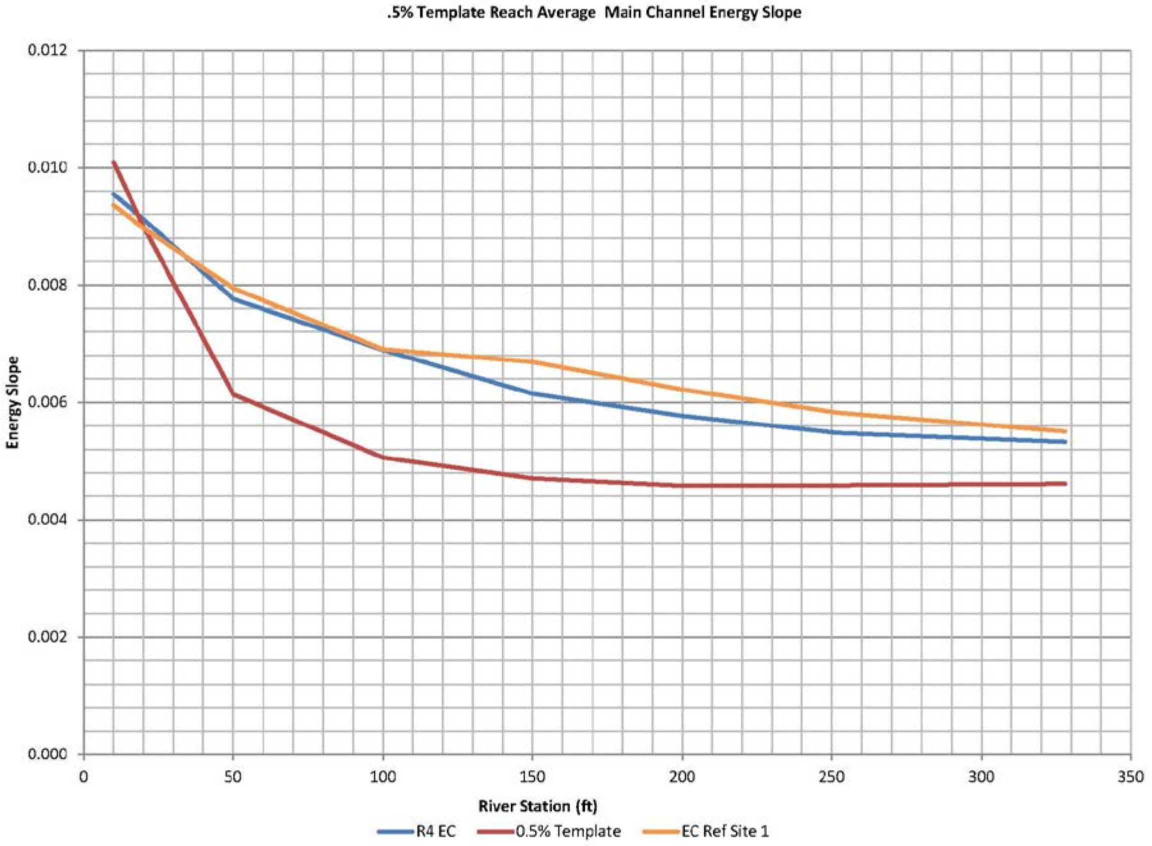


Figure 13. Reach Average Energy Slope.

Figure 13 plots the 0.5% slope design template reach average profile. As with the shear stress profiles (Figure 12), the design template produces lower values (26%-13%) than the design analog values (existing condition Reach 4) with the greatest discrepancy occurring 50 cfs to 150 cfs flow range. These lower template values are also likely a function of the simplified template geometry compared with analog geometry; anticipate channel geometry adjustment will result in energy slopes values approaching those of Reach 4.

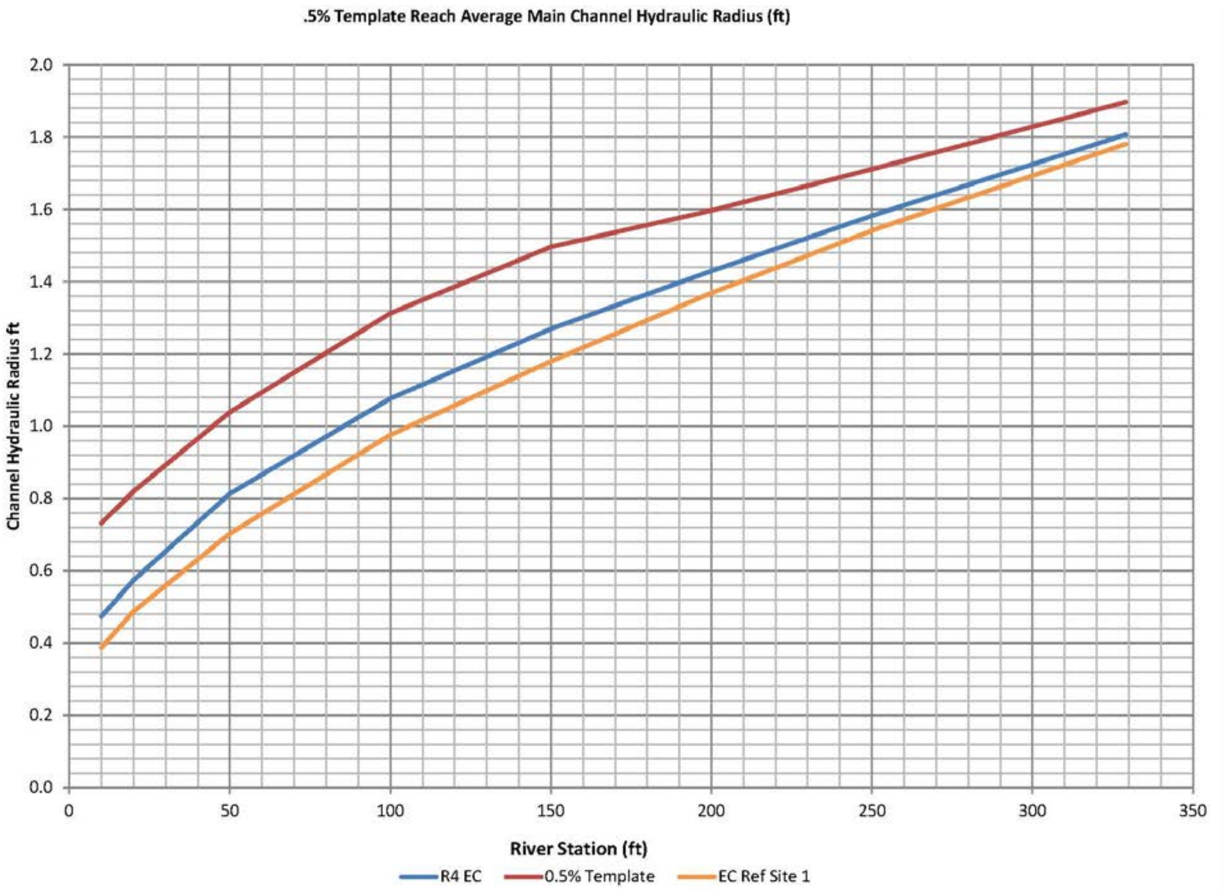


Figure 14. Reach Average Main Channel Hydraulic Radius.

Figure 14 plots the reach average hydraulic radius for the design template and the analog conditions. As discussed with the previous reach average plots, the discrepancy between the template values and the analog values are related to the simplified channel geometry and would be expected to converge once constructed as the channel geometry adjusts to the flow and sediment regimes.

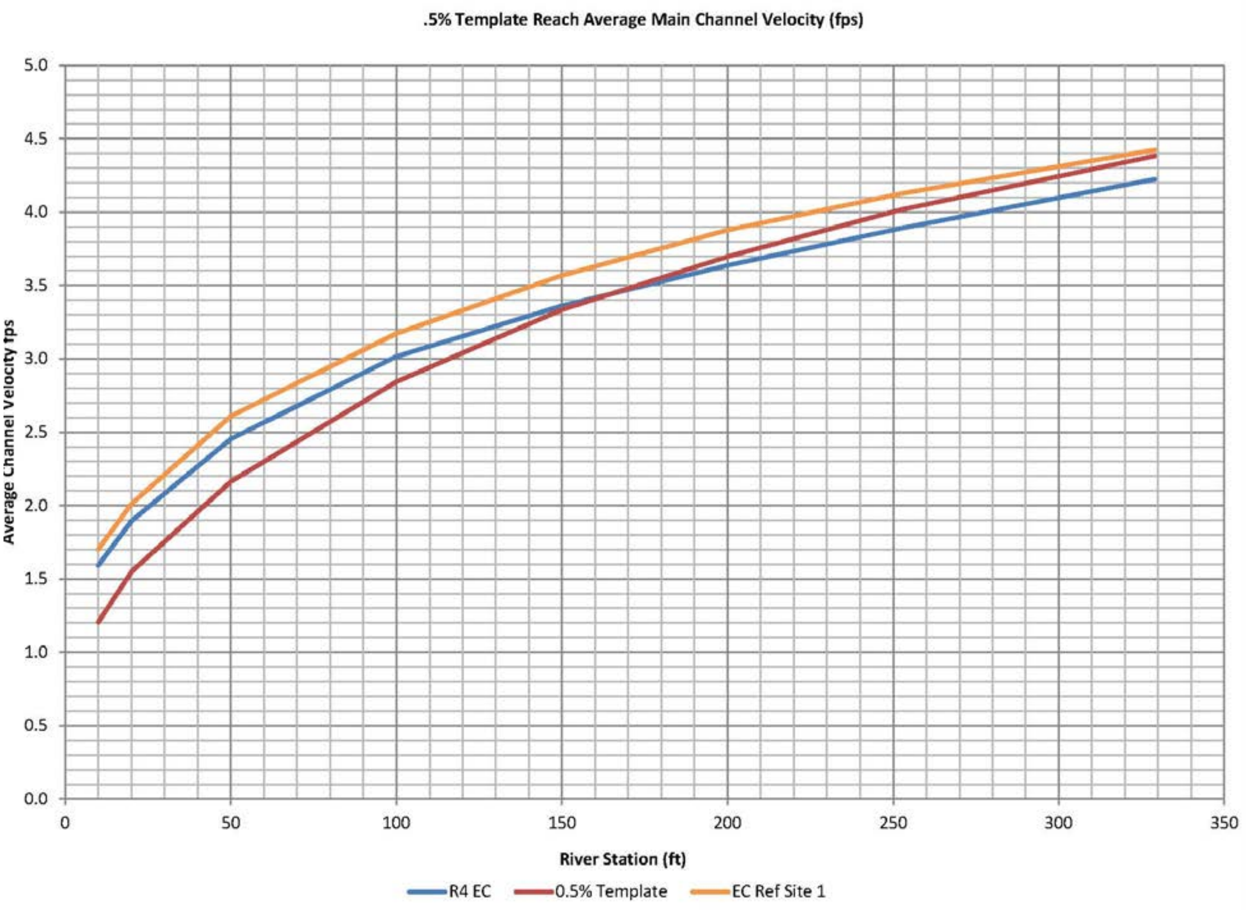


Figure 15. Reach Average Main Channel Velocity.

Figure 15 plots the reach average channel velocity for the design template and the analog geometry. For flow values in the range of 100 cfs to 328 cfs, the estimates are within 5%. At the lower flows the discrepancy grows slightly large to approximately 18% at low-base flow conditions (20 cfs). The greater discrepancy at the lower flows is likely attributed to the simplified template geometry. Table 6 summarizes the design template reach average values. Detailed model output results are in Attachment A.

Table 6. Summary of Reach Averaged Hydraulic Parameters.

0.5% Design Template Reach Averaged Hydraulic Parameters

	Modeled Flow Rates (cfs)															
	10		20		50		100		150		200		252		328	
Variable Description	Temp	R4	Temp	R4	Temp	R4	Temp	R4	Temp	R4	Temp	R4	Temp	R4	Temp	R4
Main Channel Velocity (ft/s)	1.2	1.6	1.6	1.9	2.2	2.5	2.8	3.0	3.3	3.4	3.7	3.6	4.0	3.9	4.4	4.2
Main Channel Max. Depth (ft)	1.1	0.9	1.2	1.2	1.5	1.5	1.9	1.9	2.2	2.3	2.5	2.5	2.7	2.7	3.0	3.0
Main Channel effective with (ft)	25.5	18.8	27.9	23.3	29.3	28.6	30.3	33.2	31.5	36.8	33.4	39.5	35.0	41.4	37.1	43.4
Energy Slope	0.010	0.010	0.009	0.009	0.006	0.008	0.005	0.007	0.005	0.006	0.005	0.006	0.005	0.005	0.005	0.005
Boundary Shear Stress (psf)	0.12	0.17	0.16	0.21	0.21	0.28	0.29	0.36	0.36	0.40	0.42	0.44	0.47	0.48	0.54	0.54
Chnl Hyd Radius	0.73	0.47	0.82	0.57	1.04	0.81	1.31	1.08	1.50	1.27	1.60	1.43	1.72	1.59	1.90	1.81

Temp = Template Reach Average Value

R4 = Reach 4 Existing Condition Reach Average Value

Ft = feet; psf = pounds per square foot; ft/s = feet/second.

An incipient motion analysis was conducted to evaluate the stability of the riffle material using the same methods as those used for existing conditions (Appendix C, EDR). Bed material gradations used in the analysis were the same as used for existing conditions under the assumption that similar substrate materials would be encountered or placed in the proposed channel alignment. If actual subgrade materials along the proposed channel realignment are different than those sampled in the existing channel, material sized to be consistent with the existing condition stream substrate will be used to construct the proposed stream corridor. Table 7 summarizes the calculation results. Detailed calculations are in Attachment B.

Table 7. Incipient Motion Calculations.

Results of Incipient Motion Calculations for PPC 0.5% Slope Design Template Reach			
Critical Discharge (cfs)			
Incipient Motion Sand and Gravel (T^*_c=0.03)	**Measurable Transport Sand and Gravel (T^*_c=0.047)**	**Incipient Motion Coarse Material (T^*_c=0.03)**	**Measurable Transport Coarse Material (T^*_c=0.047)**
<10	30	265	>750

Figure 16 plots channel grain shear with critical shear stress values for the sand and gravel and coarse material. Results indicate that the critical discharge for incipient motion of the sand and gravel is less than 10 cfs and 265 cfs for the coarse material. Critical discharge for measurable transport is 35 cfs for sand and gravel and greater than 750 cfs for the coarse material. These results for the sand and gravel material are consistent with the Reach 4 existing condition estimates of critical discharge. For the coarse material the incipient motion discharge is slightly greater for the template compared with existing condition Reach 4 (265 cfs compared with 240 cfs). Coarse material measurable transport critical discharge estimates are consistent with the existing condition Reach 4 values.

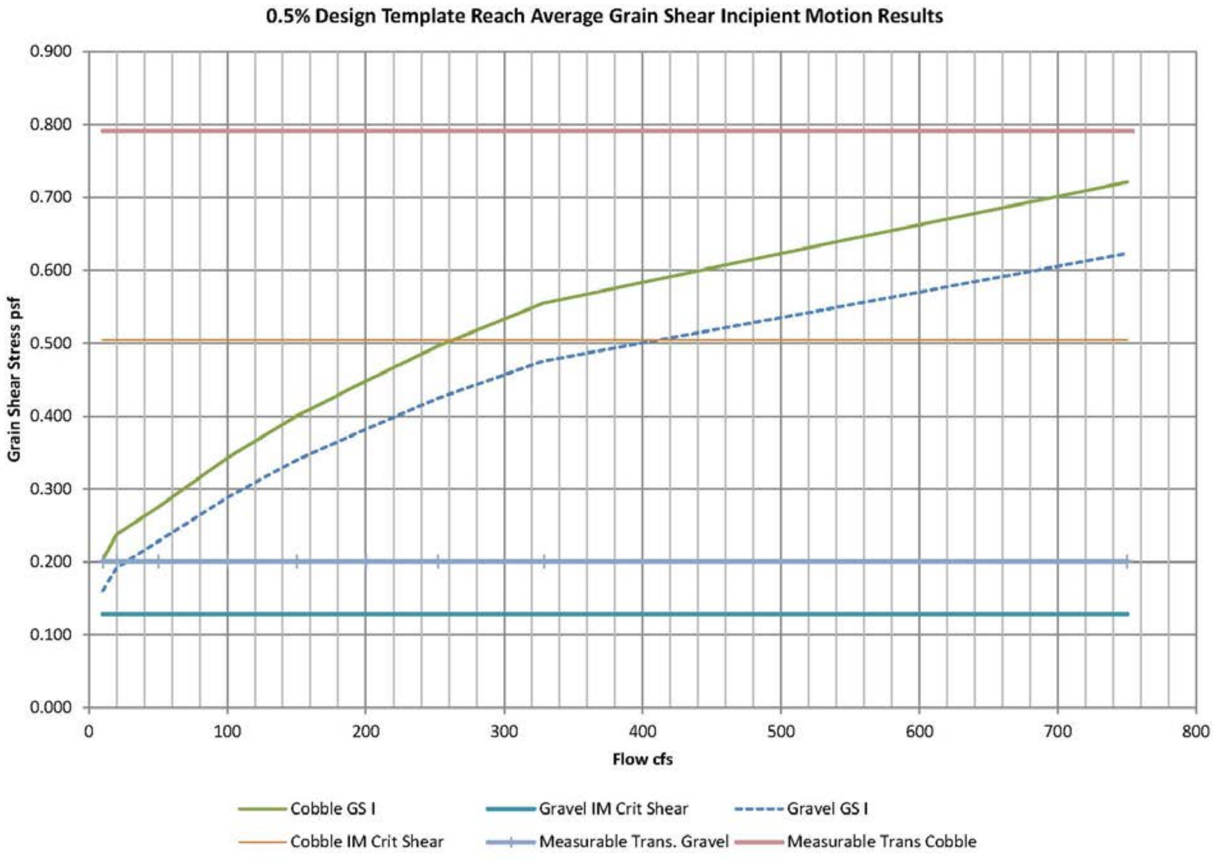


Figure 16. Reach Average Grain Shear Incipient Motion Results.

At the bankfull discharge of 328 cfs, the reach average grain shear stress is estimated at 0.56 pounds per square feet (psf). For incipient motion at the bankfull discharge, the critical particle size is 56 mm, which is approximately 5 mm larger than our representative D_{50} particle size from the pebble count data and approximately 20 mm smaller than the coarse material D84 particle size. Results from the design template calculations show that incipient motion of the riffle material will start at the bankfull discharge with measurable transport requiring greater than a 10-year event. Therefore, the riffles should remain vertically stable over the long term assuming the upstream cobble size material supply is not limited. The existing condition of Reach 4 indicates the upstream supply has been sufficient to maintain a vertically stable reach.

In addition to the hydraulic parameter estimates presented above, the team also conducted sediment continuity calculations for the design template reach following the methods used for existing conditions analysis. Figure 17 plots the sand and gravel sediment transport capacity at different flows for the design template and existing conditions. Results for the sand and gravel indicate the design template transport capacities are within the transport capacity envelope created by Reference Site 1 and the existing Reach 4 sediment transport capacity.

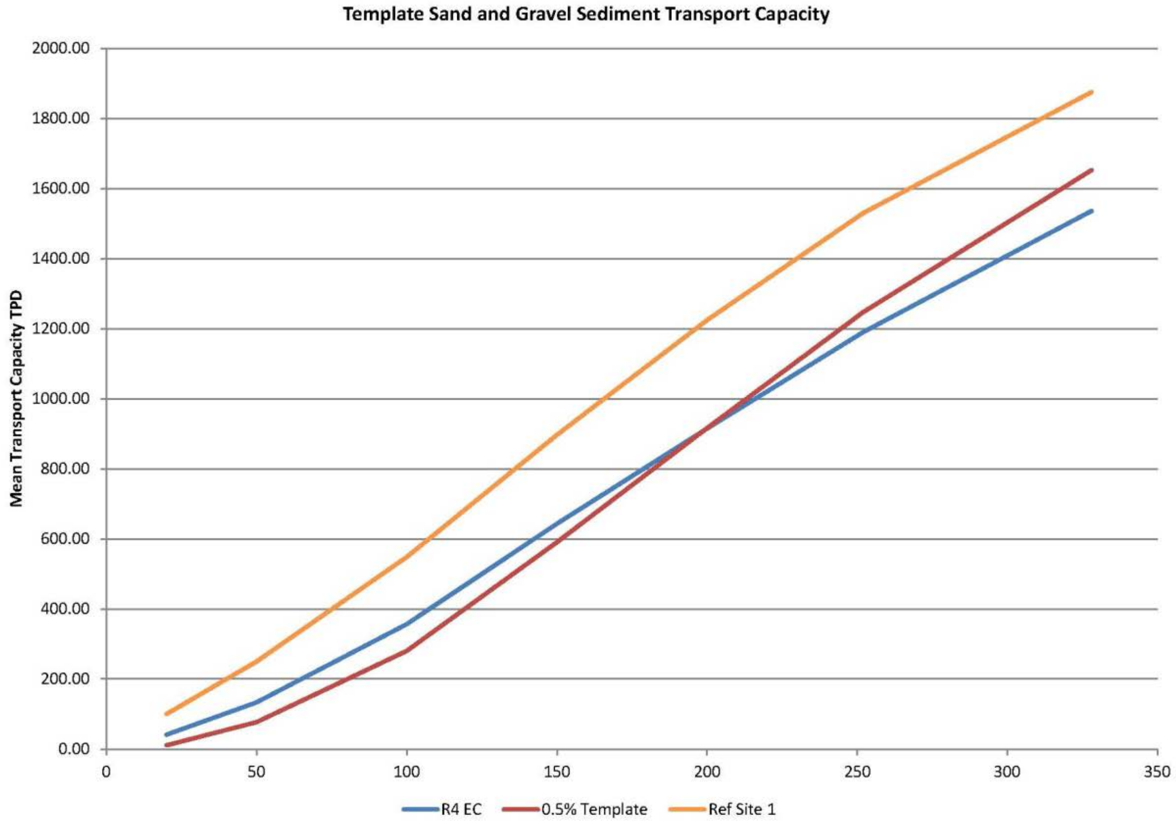


Figure 17. Sand and Gravel Sediment Transport Capacity Plot.

Figure 18 plots the cobble sediment transport capacity at different flows for the design template and existing conditions.

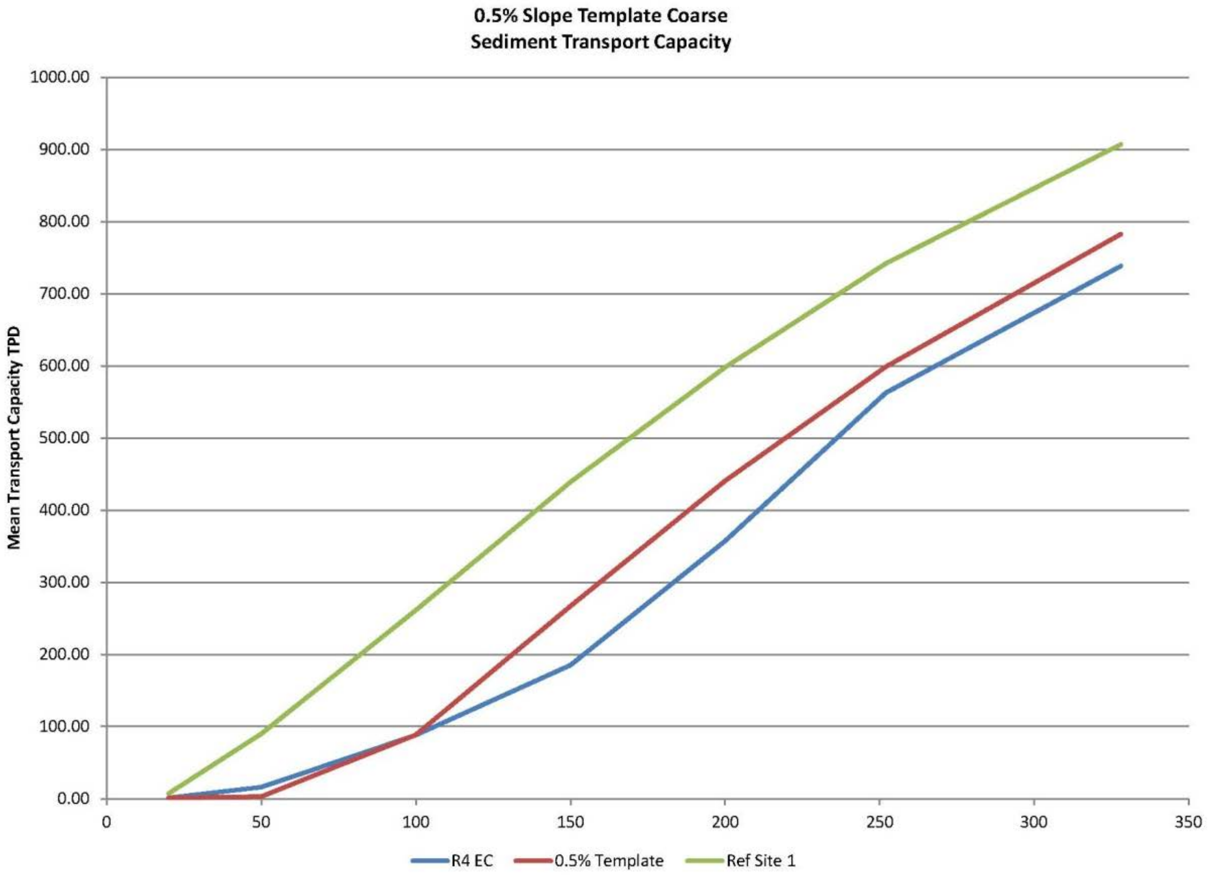


Figure 18. Template Coarse Sediment Transport Capacity Plot.

These results indicate the design template transport capacity is consistent with the existing condition Reach 4 reach average sediment transport but less than the Reference Reach Site 1 transport capacity (which has a locally steeper slope than Reach 4). Therefore, a channel design based on the template geometries and slope evaluated here should produce similar sediment transport performance as observed in Reach 4 (the analog reach).

The 0.5% slope channel template sediment transport capacity was integrated over the flow duration curve (Appendix A, EDR) to produce an annual sediment budget for relative comparison to the analog data (Reach 4). **Table 8** summarizes the reach average annual sediment capacity for the template reach along with the existing conditions Reach 4. Results show that the 0.5% template geometry annual sediment transport capacity is consistent with the analog data for both the sand and gravel material and the coarse alluvium material.

Table 8. Estimated Sediment Transport Capacity.

	Estimated Potential Sediment Transport Rate (1)	
Reach	**Transport of Sand & Gravel (2) (tons/year)**	**Transport of Representative Riffle Bed-material (3) (tons/year)**
0.5% Slope Template	81,825	28,249
EC Reach 4	100,124	27,497

Notes:

(1) Sediment sizes larger than 0.3 mm and assuming sediment transport is not limited by armoring or other controls.

(2) Bed-material size taken from coarsest sand and gravel gradations as determined by bulk samples for Reach 4.

(3) Bed-material size based on average pebble count gradation from Reach 4 and 5

The above analyses indicate that the proposed design template for 0.5% channel slope achieves the design goals in terms of flow conveyance, vertical stability, and sediment transport. Table 9 provides the proposed channel template dimensions. These dimensions have been slightly modified from those used to originally develop the template (Table 5) to improve sediment transport conditions based on modeling results.

Table 9. Proposed Channel Dimension and Layout Values.

Parameter	Units	Design Parameter Value	Basis
Bankfull Discharge	cfs	328	2-Year Discharge
Channel Slope and Dimensions			
Slope	%	0.5	Existing Reach 4
Bankfull Riffle Dimensions			
Topwidth	ft	41	Sediment Transport Analysis
Depth (max\mean)	ft	1.8\1.74	Sediment Transport Analysis
Width/Depth		23.6	Sediment Transport Analysis
Bankfull Pool Dimensions			
Topwidth	ft	35	Design Template Sediment Transport Analysis
Depth (max\mean)	ft	4.5\2.3	Design Template Sediment Transport Analysis
Width/Depth		15.2	Design Template Sediment Transport Analysis
Bankfull Run Dimensions			
Topwidth	ft	35	Design Template Sediment Transport Analysis
Depth (max\mean)	ft	2.5\2.0	Design Template Sediment Transport Analysis
Width/Depth		17.5	Design Template Sediment Transport Analysis
Channel Planform			
Sinuosity		1.5	30% Design Channel Length/Valley Distance
Rc	ft	Mean: 83 Range: 54-129	Williams (1986)
Rc/W	---	Mean: 2.0 Range: 1.3- 3.1	Williams (1986)
Meander Length	ft	Mean: 416 Range: 254-687	Williams (1986)
Meander wavelength	ft	Mean: 282 Range: 172 465	Williams (1986)
Belt Width	ft	Mean: 237 Range: 137-412	Williams (1986)
Substrate			
Particle size	mm	D16: 20mm D50: 51mm D84: 75mm	Existing Conditions Pebble Counts,
Pool Habitat			
Mean Residual Pool Depth	ft	2.5	Template Analysis
Pool Density	per mile	18-25	5-7 channel widths

Rc = radius of curvature; Rc/W = ratio of bend curvature to channel width; mm = millimeter

2.4 Deformability and Channel Migration: Bank Treatments

The long-term goal for PPC realignment is to allow for some level of bank deformability to support riparian vegetation rejuvenation, geomorphic adjustment, and instream habitat formation. In some areas, such as adjacent to the slag pile, channel migration presents an unacceptable risk of material entrainment or infrastructure damage and the limits of channel migration will be controlled.

Streambank deformability will be defined by the design criteria applied to constructed bank treatments. Where deformability is considered appropriate, such as on certain straight reaches or outer banks, the bank treatments will include toe protection designed to mobilize at the 10-year discharge. Upper bank treatments will consist of fabric-encapsulated soil lifts that will be planted with willow cuttings to promote vegetation establishment on the upper bank **(**Figure 19**).** This configuration will enhance short-term bank stability while vegetation re-establishes, without precluding long-term deformability that will include bank undercutting, bar formation and riparian colonization of those bars, and geomorphic adjustment of the channel.

Passive margins of the reconstructed channel will include passive bank treatments such as point bar features that will provide colonization sites for riparian vegetation.

Where the risk of channel migration is less acceptable, the bank treatments will be engineered for stability up to the 100-year flood event.

Design criteria for channel vertical stability or adjustments in bed profile is to maintain the reach average design slope.

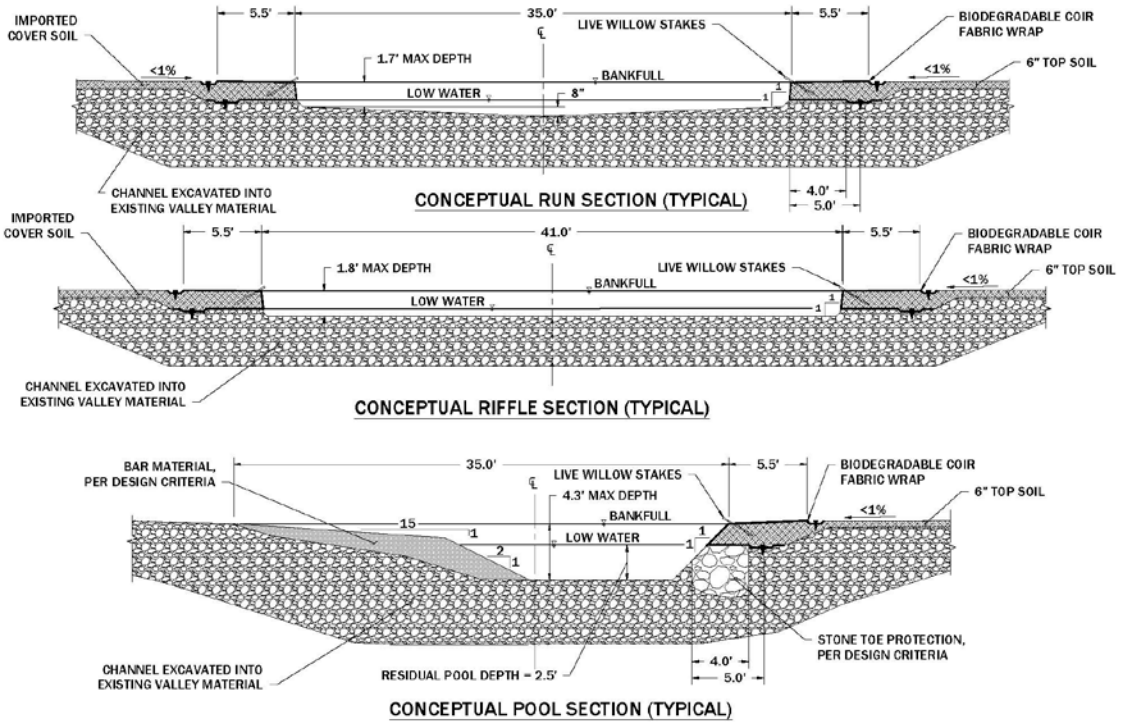


Figure 19. Fabric-Encapsulated Soil Lifts.

2.5 Floodplain and Wetland Design

2.5.1 Floodplain Design

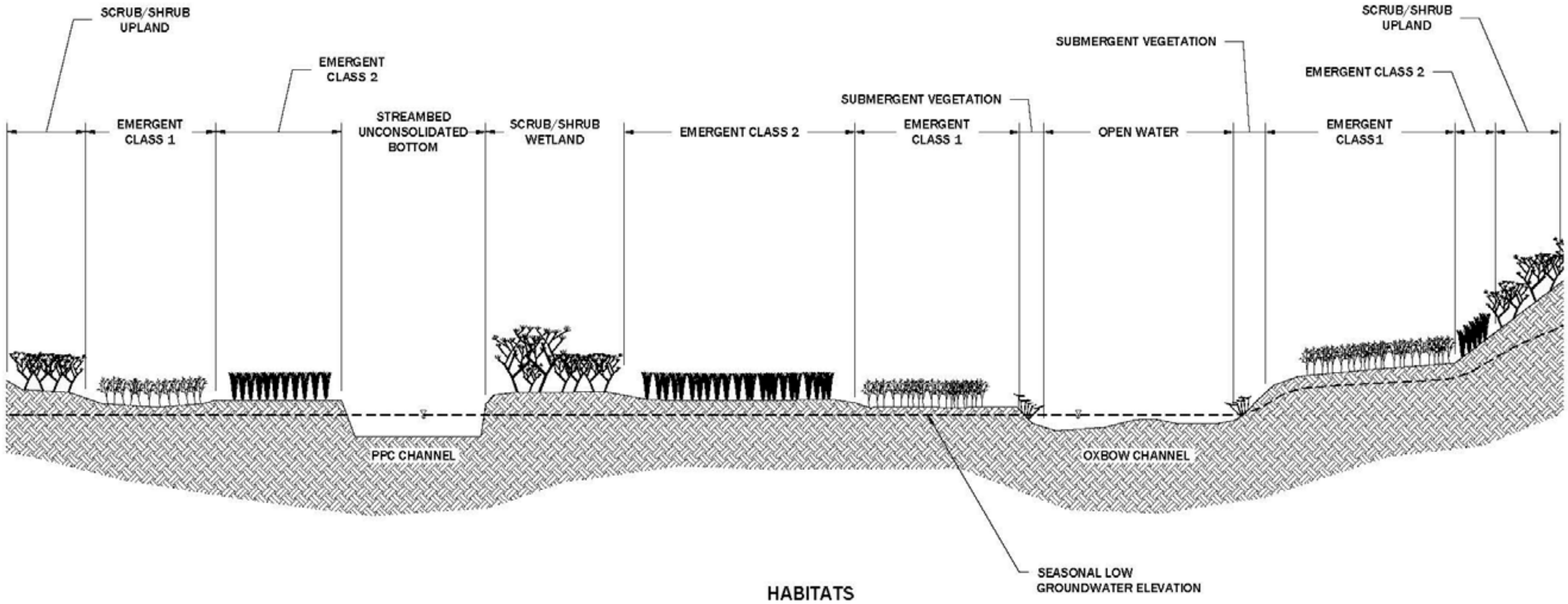
Floodplain design criteria relate primarily to the objectives of the South Plant Hydraulic Control Interim Measure (SPHC IM), described in detail in the Interim Measures Work Plan (IM Work Plan) (METG, 2012c), and secondarily to overall geomorphic and ecological wetland function. To that end, the floodplain design will include strategic floodplain grading to convey groundwater input from the west and to focus groundwater flow paths towards the realigned PPC channel. The grading may include strategically placed swales to collect and concentrate groundwater, and transport that water toward the realigned channel and away from the smelter site. These features will also be used to collect and convey water that currently seeps into the floodplain area from the toe of a terrace on the west edge of the site. Design criteria will consist of preserving or regrading floodplain surfaces that are within 0.5 ft of the predicted seasonal water table for the purpose of wetlands. This grading plan will include topographic diversity (high and low areas) to ensure appropriate wetland function with fluctuating a water table.

2.5.2 Wetland Design

Wetlands primary criteria will be to 1) stabilize (revegetate) the PPC streambank and floodplain, and 2) replace wetlands lost through the SPHC IMs. Secondary wetlands criteria will be to replace functions and values of areas disturbed by the project.

Criteria for the number of acres mitigated to those impacted will be 1:1 following the U.S. Army Corps of Engineers' (USACE) nationally mandated "no-net-loss of wetlands" policy. There is an assumption that the reviewing office will view the project as an improvement to the watershed not requiring a 1.5:1 ratio as required by Montana Regulatory Program's Wetland Compensatory Mitigation Ratios.

Preliminary groundwater estimates (Hydrometrics, 2013) suggest the realigned PPC channel will control groundwater elevations in the PPC stream corridor. The groundwater base elevation from which wetland hydrology will be based is the seasonal low elevation of PPC. Perennial streamflow in PPC as well as augmenting groundwater discharge from the west side of the site are anticipated to provide sufficient water to sustain wetlands in the realignment reach. Groundwater establishes a hydraulic gradient from sub-saturated soil to saturated soil to surface water, facilitating the establishment of heterogeneous wetland communities (Figure 20). The types of wetlands that will establish on the floodplain will be developed using swales, depressions, and rises. Variable topography creates interspersion of vegetation communities. Wetland communities are expected to take up to 10 years to mature and continue to undergo successional change thereafter.



HABITATS

LEGEND	DISTANCE FROM WATER TABLE AT 2YR FLOW
UPLAND	+1.0' AND UP
SHRUB	+1.0' TO +0.0'
EMERGENT 2	+0.5' TO +0.0'
EMERGENT 1	+0.0' TO +-1.0'
SUBMERGENT	-1.0' TO -2.0'

Figure 20. Proposed Riparian Corridor Habitats.

Project criteria for open water habitat include a maximum depth of 2 ft, and a maximum total area of 5 acres. Multiple open water areas totaling up to 5 acres will be created to enhance variability and complexity of the wetland complex. Wetland slopes will generally be graded to 5H:1V (horizontal:vertical) or shallower, except where incorporated into the streambank. Structural mechanisms (i.e., adjustable outflow weirs) will not be used.

Topsoil will be applied to a depth of 6 inches, tapering out to a depth of 0 inches near the low water surface elevation. Additional soil material will be applied with salvaged sod and reapplication operations as well. Wetland soils salvaged during construction are assumed to be suitable for reconstruction and no soil amendments will be required. Based on recent analysis, these soils are clayey-sand, and support robust wetland vegetation. Some special treatment or handling may be needed to address invasive species present in the wetland complex.

2.6 Revegetation

Overall, wetland areas will be developed in roughly a 60% Palustrine-Emergent to 40% Scrub/Shrub ratio. Plantings and seedlings will be limited to native, regional species. Planting Zones would be as follows (Table 10):

Table 10. Planting Zones and Classes Relative to Stream Elevation.

Vegetative Class	Elevation Relative to 2-Year Seasonal High Steam Elevation – Q2 (ft.)
Upland	>+1
Riparian	>+1
Scrub/Shrub class (wetland)	+1 to 0
Emergent class 2 (wetland)	+0.5 to 0
Emergent class 1 (wetland)	0 to -1.0
Submergent Wetlands	-1.0 to -2.0

The target number of graminoid species to be seeded/planted within each vegetative class will be 7 to 11. (This range is based on similar regional experience specifying reasonably available seed, covering a range of sites.) Spacing between individual plants will be based on the size and form of the plant material being installed, the rate of growth, and spread and form of the plant over a 5 to 10-year period. Table 11 summarizes the size/form, planting spacing, and seeding rates for each major planting regime:

Table 11. Proposed Seeding Rates and Plant Spacing

Planting Regime	Size/Form	Seeding*/Spacing Rate**
Upland Seeding	Seed	80 seeds / ft2
Wetland/Riparian Seeding	Seed	120 seeds / ft2
Shrubs	1 quart, 1 gallon	6-10 ft. on centers
Willows	10 cubic inches	4-8 ft. on centers
Willows	Cuttings	3-5 ft. on centers
Herbaceous Plugs	10 cubic inches	3-5 ft. on centers
Herbaceous Plugs	5 cubic inches	2-5 ft. on centers

* Seeding rate is for broadcast seeding and can be halved if drill seeded (Goodwin and Sheley, 2003).

** Planting densities are approximate and will vary dependent upon the first year seeding results.

The floodplain revegetation plan will be developed using vegetative classes shown in Table 10 and based on distance to groundwater. Each vegetative class will have a seeding and planting prescription. The seed and planting mixtures will have enough amplitude to cover a range of hydrologic conditions, reducing the risk of failure. Areas lacking the hydrologic conditions necessary to be classified as wetland will be classified as riparian and/or transitional plant communities.

All streambanks will be seeded and planted to scrub-shrub habitat for stabilization to a minimum width of 8 feet. To the extent practical, existing wetland plants and shrubs will be salvaged and reused from the disturbed wetland complex. Banks will incorporate live salvaged materials such as brush layers, willow bundles, and transplants to the extent feasible. Streambank vegetation will be designed (species and density) to produce thermal cover.

2.7 Instream Habitat

The primary design criteria for instream habitat is to provide aquatic habitat connectivity through the reach. Currently, connectivity is hampered by Smelter Dam and Upper Lake Diversion. Removal of these structures and channel design elements will ensure fish passage through the reach (described in the following section). With regard to habitat elements in the realigned segments, the creation and maintenance of these features will rely largely on geomorphic criteria describing bedform complexity (pool frequency and depth), planform complexity (radius of curvature), and bed gradations (local scour potential). Additionally, deformable bank toes and streambank vegetation will contribute to instream habitat. Where bank deformability is acceptable, bank toe material will be designed to mobilize at the 10-year discharge, which will allow for bank undercutting and associated habitat formation. Banks will incorporate live, salvaged willow materials such as brush layers, willow bundles, and live willow transplants to the extent feasible. Woody bank lines will provide shade and support bank undercutting. Woody debris recruitment will rely on natural inputs from upstream, as well as from the revegetated bank treatments. Woody debris recruitment will induce local scour and provide refugia.

2.8 Fish Passage

Primary fish passage design criteria for the PPC requires the proposed channel to be designed using a geomorphic process-based channel design process, which provides for variable depths, velocities, mobile boundaries (where the protection of property, infrastructure or source material is not required), and habitat zones, per MT FWP guidance. Drop structures shall provide variable crest elevations to provide flow slots and smaller jumping zones to promote juvenile upstream travel.

2.9 Infrastructure Protection

Infrastructure elements in the project reach include a bridge crossing at Smelter Dam, protection/isolation of the Slag Pile from PPC, protection of remaining irrigation diversions, and protection of the downstream highway and railroad bridges at Hwy 12. All infrastructure directly exposed to the stream channel will be protected to withstand erosion up to the 100-year flow event.

2.10 Summary of Engineering Criteria

Table 12 summarizes applicable engineering criteria developed above.

Table 12. Prickly Pear Creek Design Criteria Summary.

Primary Design Criteria: Protect Human Health and Environment

CRITERION	Design Representation
• Modify the hydraulic regime on the south end of the former smelter site to reduce both the mass and rate of contaminants transport away from the site.	
• Realign and regrade PPC to support the modification of groundwater flow paths.	
• Prevent entrainment of slag materials into PPC.	

Secondary Design Criteria: Develop Process-based Natural Channel Designs

CRITERION	30% Design Representation
Hydrology and Hydraulics	
• Design discharge for the primary channel will be the estimated dominant or bankfull discharge for PPC	Q_{bf} = 328 cfs
• Design discharge for infrastructure protection will be the estimated 100-year discharge	Q_{100} = 2190 cfs
• Design discharge for protection of contaminated materials	As required by EPA
Sediment Transport and Channel Deformability	
• The bankfull channel will be competent to transport the estimated incoming sediment load without reach scale aggradation	Channel sizing based on sediment transport analyses. See Table 9.
• The stream bed will be vertically stable at the scale of the entire project reach	To be addressed as part the detailed design (Post 30% EDR)
• Where long-term deformability is acceptable, long-term upper bank reinforcement will be enhanced by woody vegetation.	Willows will be incorporated into deformable bank design.
• Where long-term deformability is acceptable, bank toes will be constructed to mobilize at a 10-year flow event	To be addressed as part the detailed design (Post 30% EDR)
• Where long-term deformability is unacceptable, banks will be designed to remain stable up to the 100-year flow event.	To be addressed as part the detailed design (Post 30% EDR)
• Where the channel is realigned along the slag pile, a terrace will be constructed that will isolate flows up to the 100-year event from the slag.	Terrace height will be a minimum of 2 ft above the 100-year water surface elevation
• Where the channel is realigned along the slag pile, a terrace will be constructed to keep the channel at least 2 channel widths away from the slag.	To be addressed as part the detailed design (Post 30% EDR)
Channel Dimensions	
• Bankfull channel geometry will convey the estimated 1.5- to 2.0-year discharge	Channel geometry capacity based on hydraulic capacity analysis
• Channel slope will approximate existing condition of the channel just upstream of realignment reach (Reach 4)	Reach 4 = 0.5 %
• Channel planform will be variable, reflecting the ranges in radius of curvature, meander wavelength, and meander belt width provided by meander geometry equations (Williams, 1986).	See Table 9
• Sinuosity will be determined as channel length/valley distance	1.5 based on 30% design channel alignment
Substrate	
• Deformable riffles will reflect existing gradations in geomorphically stable reach (Reach 4).	D_{50} = 51 mm based on existing condition pebble count data.

Bedforms and Instream Habitat	
• Pool frequency	See Table 9
• Where bank deformability is acceptable, bank reconstruction will allow for development of undercut banks by mobilization of toe material at 10-year discharge event.	To be addressed as part the detailed design (Post 30% EDR)
• Woody vegetation will be incorporated into bank treatments to provide shade, stability, and recruitment source.	To be addressed as part the detailed design (Post 30% EDR)
Floodplain and Wetlands	
• Floodplain inundation will begin at discharges exceeding bankfull	To be addressed as part the detailed design (Post 30% EDR)
• Floodplain topography will be variable and will incorporate swales and oxbow features to increase habitat diversity	To be addressed as part the detailed design (Post 30% EDR)
• Floodplain groundwater hydrology and grading will support wetlands such that no net loss of wetland occurs relative to existing conditions	To be addressed as part the detailed design (Post 30% EDR) based on projected post-dam removal groundwater elevations.
• Wetland habitat will include shallow open water areas.	To be addressed as part the detailed design (Post 30% EDR)
Vegetation	
• Riparian and floodplain vegetation will consist of plant species native to the project site	To be addressed as part the detailed design (Post 30% EDR)
• The density and distribution of riparian and floodplain vegetation will be variable and will reflect micro-site soil and hydrologic conditions	To be addressed as part the detailed design (Post 30% EDR)

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Attachment A
HEC RAS Output Summary Tables

HEC-RAS Plan: Plan 32   River: Sample Reach .5%   Reach: Sample Reach .5%

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl	Hydr Radius C
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)		(ft)
Sample Reach .5%	700	10	10.00	2.53	3.12	0.59	0.30	1.10	0.003396	30.59	0.06	0.36	0.30
Sample Reach .5%	700	20	20.00	2.53	3.29	0.76	0.43	1.38	0.003315	34.08	0.09	0.37	0.42
Sample Reach .5%	700	50	50.00	2.53	3.59	1.06	0.72	2.02	0.003553	34.35	0.16	0.42	0.71
Sample Reach .5%	700	100	100.00	2.53	3.91	1.38	1.04	2.77	0.004193	34.66	0.27	0.48	1.01
Sample Reach .5%	700	150	150.00	2.53	4.17	1.64	1.29	3.33	0.004607	34.99	0.36	0.52	1.24
Sample Reach .5%	700	200	200.00	2.53	4.39	1.86	1.50	3.78	0.004890	35.16	0.44	0.54	1.44
Sample Reach .5%	700	252	252.00	2.53	4.62	2.09	1.72	4.15	0.004986	35.27	0.51	0.56	1.63
Sample Reach .5%	700	328	328.00	2.53	4.92	2.39	2.02	4.59	0.005009	35.34	0.59	0.57	1.89
Sample Reach .5%	700	545	545.00	2.53	5.35	2.82	2.44	5.40	0.005395	35.36	0.77	0.61	2.28
Sample Reach .5%	700	750	750.00	2.53	5.58	3.05	2.68	5.89	0.005680	35.36	0.89	0.63	2.50
Sample Reach .5%	550	10	10.00	1.77	2.25	0.48	0.24	1.74	0.011315	24.15	0.17	0.63	0.24
Sample Reach .5%	550	20	20.00	1.77	2.38	0.61	0.31	2.12	0.012186	30.88	0.23	0.68	0.30
Sample Reach .5%	550	50	50.00	1.77	2.61	0.84	0.50	2.93	0.012109	34.06	0.38	0.73	0.50
Sample Reach .5%	550	100	100.00	1.77	2.93	1.16	0.82	3.55	0.009381	34.35	0.47	0.69	0.80
Sample Reach .5%	550	150	150.00	1.77	3.24	1.47	1.12	3.88	0.007485	34.67	0.51	0.65	1.08
Sample Reach .5%	550	200	200.00	1.77	3.54	1.77	1.41	4.07	0.006142	35.01	0.52	0.60	1.35
Sample Reach .5%	550	252	252.00	1.77	3.82	2.05	1.68	4.28	0.005457	35.16	0.54	0.58	1.59
Sample Reach .5%	550	328	328.00	1.77	4.17	2.40	2.03	4.59	0.004997	35.25	0.59	0.57	1.89
Sample Reach .5%	550	545	545.00	1.77	4.64	2.87	2.50	5.14	0.004756	35.27	0.69	0.57	2.33
Sample Reach .5%	550	750	750.00	1.77	4.93	3.16	2.78	5.39	0.004530	35.27	0.73	0.57	2.59
Sample Reach .5%	525	10	10.00	1.66	1.87	0.21	0.21	2.00	0.018426	24.31	0.24	0.78	0.20
Sample Reach .5%	525	20	20.00	1.66	1.99	0.33	0.31	2.52	0.016694	25.31	0.32	0.79	0.31
Sample Reach .5%	525	50	50.00	1.66	2.30	0.64	0.58	3.09	0.011177	27.94	0.40	0.72	0.57
Sample Reach .5%	525	100	100.00	1.66	2.73	1.07	0.91	3.47	0.007711	31.56	0.43	0.64	0.90
Sample Reach .5%	525	150	150.00	1.66	3.08	1.42	1.17	3.70	0.006290	34.58	0.45	0.60	1.15
Sample Reach .5%	525	200	200.00	1.66	3.42	1.76	1.41	3.78	0.005164	37.49	0.45	0.56	1.38
Sample Reach .5%	525	252	252.00	1.66	3.72	2.06	1.61	3.91	0.004627	40.04	0.45	0.54	1.57
Sample Reach .5%	525	328	328.00	1.66	4.11	2.45	1.86	4.08	0.004179	43.29	0.47	0.53	1.81
Sample Reach .5%	525	545	545.00	1.66	4.63	2.97	2.37	4.27	0.003321	43.59	0.48	0.49	2.31
Sample Reach .5%	525	750	750.00	1.66	4.89	3.23	2.63	4.62	0.003373	43.59	0.54	0.50	2.56
Sample Reach .5%	515	10	10.00	-0.95	1.90	2.85	2.21	0.30	0.000020	15.19	0.00	0.04	1.93
Sample Reach .5%	515	20	20.00	-0.95	2.03	2.98	2.30	0.56	0.000069	15.51	0.01	0.07	2.00
Sample Reach .5%	515	50	50.00	-0.95	2.35	3.30	2.50	1.23	0.000299	16.28	0.04	0.14	2.17
Sample Reach .5%	515	100	100.00	-0.95	2.77	3.72	2.76	2.10	0.000774	17.27	0.11	0.22	2.37
Sample Reach .5%	515	150	150.00	-0.95	3.10	4.05	2.89	2.80	0.001298	18.53	0.20	0.29	2.48
Sample Reach .5%	515	200	200.00	-0.95	3.42	4.37	2.54	3.32	0.002096	23.75	0.29	0.37	2.23
Sample Reach .5%	515	252	252.00	-0.95	3.70	4.65	2.38	3.73	0.002824	28.37	0.38	0.43	2.13
Sample Reach .5%	515	328	328.00	-0.95	4.05	5.00	2.29	4.18	0.003657	34.26	0.47	0.49	2.08
Sample Reach .5%	515	545	545.00	-0.95	4.42	5.37	2.62	5.17	0.004670	34.84	0.69	0.56	2.38
Sample Reach .5%	515	750	750.00	-0.95	4.66	5.61	2.86	5.66	0.004975	34.84	0.81	0.59	2.60
Sample Reach .5%	505	10	10.00	-1.00	1.90	2.90	2.24	0.29	0.000019	15.30	0.00	0.03	1.96
Sample Reach .5%	505	20	20.00	-1.00	2.03	3.03	2.33	0.55	0.000065	15.62	0.01	0.06	2.03
Sample Reach .5%	505	50	50.00	-1.00	2.35	3.35	2.53	1.21	0.000284	16.37	0.04	0.13	2.19
Sample Reach .5%	505	100	100.00	-1.00	2.76	3.76	2.78	2.07	0.000743	17.36	0.11	0.22	2.39
Sample Reach .5%	505	150	150.00	-1.00	3.09	4.09	2.83	2.77	0.001293	19.14	0.20	0.29	2.44
Sample Reach .5%	505	200	200.00	-1.00	3.40	4.40	2.51	3.28	0.002069	24.24	0.29	0.36	2.22
Sample Reach .5%	505	252	252.00	-1.00	3.67	4.67	2.37	3.70	0.002785	28.73	0.37	0.42	2.12
Sample Reach .5%	505	328	328.00	-1.00	4.01	5.01	2.30	4.16	0.003607	34.37	0.47	0.48	2.08
Sample Reach .5%	505	545	545.00	-1.00	4.37	5.37	2.64	5.17	0.004616	34.48	0.69	0.56	2.40
Sample Reach .5%	505	750	750.00	-1.00	4.61	5.61	2.89	5.68	0.004957	34.48	0.81	0.59	2.62
Sample Reach .5%	397.4	10	10.00	1.69	1.81	0.12	0.12	2.01	0.036675	40.48	0.28	1.01	0.12
Sample Reach .5%	397.4	20	20.00	1.69	1.89	0.20	0.20	2.51	0.030913	40.52	0.38	1.00	0.20
Sample Reach .5%	397.4	50	50.00	1.69	2.12	0.43	0.43	2.89	0.014763	40.69	0.39	0.78	0.42
Sample Reach .5%	397.4	100	100.00	1.69	2.42	0.73	0.73	3.36	0.009900	40.89	0.44	0.69	0.71
Sample Reach .5%	397.4	150	150.00	1.69	2.68	0.99	0.98	3.72	0.008270	40.93	0.49	0.66	0.95
Sample Reach .5%	397.4	200	200.00	1.69	2.91	1.22	1.21	4.02	0.007389	40.98	0.53	0.64	1.16
Sample Reach .5%	397.4	252	252.00	1.69	3.13	1.44	1.43	4.28	0.006785	41.02	0.57	0.63	1.36
Sample Reach .5%	397.4	328	328.00	1.69	3.44	1.75	1.74	4.59	0.006115	41.09	0.62	0.61	1.62
Sample Reach .5%	397.4	545	545.00	1.69	4.00	2.31	2.30	4.41	0.003920	41.10	0.52	0.51	2.14
Sample Reach .5%	397.4	750	750.00	1.69	4.23	2.54	2.53	4.82	0.004101	41.10	0.60	0.53	2.36
Sample Reach .5%	345	10	10.00	0.75	1.38	0.63	0.31	1.00	0.002608	31.84	0.05	0.31	0.31
Sample Reach .5%	345	20	20.00	0.75	1.53	0.78	0.45	1.31	0.002784	34.09	0.08	0.34	0.45
Sample Reach .5%	345	50	50.00	0.75	1.80	1.05	0.71	2.06	0.003815	34.34	0.17	0.43	0.70
Sample Reach .5%	345	100	100.00	0.75	2.11	1.36	1.01	2.86	0.004654	34.64	0.29	0.50	0.98
Sample Reach .5%	345	150	150.00	0.75	2.37	1.62	1.26	3.41	0.004962	35.02	0.38	0.54	1.22
Sample Reach .5%	345	200	200.00	0.75	2.61	1.86	1.49	3.81	0.005013	35.21	0.45	0.55	1.43
Sample Reach .5%	345	252	252.00	0.75	2.84	2.09	1.72	4.16	0.005015	35.27	0.51	0.56	1.63
Sample Reach .5%	345	328	328.00	0.75	3.16	2.41	2.03	4.57	0.004920	35.34	0.58	0.56	1.90
Sample Reach .5%	345	545	545.00	0.75	3.55	2.80	2.42	5.50	0.005675	35.35	0.80	0.62	2.26
Sample Reach .5%	345	750	750.00	0.75	3.78	3.03	2.66	5.99	0.005948	35.35	0.92	0.65	2.48
Sample Reach .5%	240	10	10.00	0.23	0.62	0.39	0.20	2.51	0.030487	20.27	0.37	1.00	0.20
Sample Reach .5%	240	20	20.00	0.23	0.75	0.52	0.26	2.91	0.028702	26.58	0.46	1.01	0.26
Sample Reach .5%	240	50	50.00	0.23	1.06	0.83	0.50	2.93	0.012069	34.14	0.37	0.73	0.50
Sample Reach .5%	240	100	100.00	0.23	1.43	1.20	0.87	3.35	0.007741	34.50	0.41	0.63	0.85
Sample Reach .5%	240	150	150.00	0.23	1.75	1.52	1.17	3.67	0.006310	34.89	0.45	0.60	1.14
Sample Reach .5%	240	200	200.00	0.23	2.04	1.81	1.45	3.93	0.005527	35.19	0.48	0.58	1.39
Sample Reach .5%	240	252	252.00	0.23	2.30	2.07	1.70	4.20	0.005145	35.26	0.52	0.57	1.62
Sample Reach .5%	240	328	328.00	0.23	2.65	2.42	2.06	4.51	0.004741	35.34	0.57	0.55	1.92
Sample Reach .5%	240	545	545.00	0.23	3.12	2.89	2.52	4.99	0.004414	35.35	0.65	0.55	2.35
Sample Reach .5%	240	750	750.00	0.23	3.38	3.15	2.78	5.37	0.004496	35.35	0.73	0.57	2.59
Sample Reach .5%	214.84	10	10.00	0.09	0.50	0.41	0.38	1.00	0.002018	25.99	0.05	0.29	0.38
Sample Reach .5%	214.84	20	20.00	0.09	0.63	0.54	0.49	1.51	0.003307	27.04	0.10	0.38	0.49
Sample Reach .5%	214.84	50	50.00	0.09	0.92	0.83	0.73	2.31	0.004569	29.56	0.21	0.48	0.72
Sample Reach .5%	214.84	100	100.00	0.09	1.31	1.22	1.03	2.96	0.004793	32.87	0.30	0.51	1.01
Sample Reach .5%	214.84	150	150.00	0.09	1.64	1.55	1.27	3.32	0.004568	35.72	0.35	0.52	1.24
Sample Reach .5%	214.84	200	200.00	0.09	1.95	1.86	1.47	3.54	0.004272	38.29	0.38	0.51	1.44
Sample Reach .5%	214.84	252	252.00	0.09	2.22	2.13	1.66	3.75	0.004099	40.63	0.41	0.51	1.62
Sample Reach .5%	214.84	328	328.00	0.09	2.61	2.52	1.92	3.91	0.003684	43.59	0.43	0.50	1.87
Sample Reach .5%	214.84	545	545.00	0.09	3.11	3.02	2.42	4.09	0.002953	43.59	0.43	0.46	2.36
Sample Reach .5%	214.84	750	750.00	0.09	3.34	3.25	2.65	4.59	0.003302	43.59	0.53	0.50	2.58
Sample Reach .5%	204.84	10	10.00	-2.35	0.51	2.86	2.20	0.29	0.000020	15.57	0.00	0.03	1.94
Sample Reach .5%	204.84	20	20.00	-2.35	0.64	2.99	2.28	0.55	0.000067	15.89	0.01	0.06	2.01

HEC-RAS Plan: Plan 32   River: Sample Reach .5%   Reach: Sample Reach .5% (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Hydr Depth C	Vel Chnl	E.G. Slope	Top W Act Chan	Shear Chan	Froude # Chl	Hydr Radius C
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/ft)	(ft)	(lb/sq ft)		(ft)
Sample Reach .5%	204.84	50	50.00	-2.35	0.94	3.29	2.48	1.21	0.000292	16.65	0.04	0.14	2.16
Sample Reach .5%	204.84	100	100.00	-2.35	1.32	3.67	2.71	2.09	0.000776	17.61	0.11	0.22	2.35
Sample Reach .5%	204.84	150	150.00	-2.35	1.64	3.99	2.67	2.80	0.001405	20.12	0.20	0.30	2.33
Sample Reach .5%	204.84	200	200.00	-2.35	1.93	4.28	2.41	3.33	0.002215	24.89	0.30	0.38	2.15
Sample Reach .5%	204.84	252	252.00	-2.35	2.18	4.53	2.30	3.76	0.002966	29.19	0.38	0.44	2.07
Sample Reach .5%	204.84	328	328.00	-2.35	2.51	4.86	2.24	4.23	0.003836	34.67	0.49	0.50	2.04
Sample Reach .5%	204.84	545	545.00	-2.35	2.91	5.26	2.63	5.02	0.004364	34.78	0.65	0.55	2.40
Sample Reach .5%	204.84	750	750.00	-2.35	3.16	5.51	2.88	5.47	0.004577	34.78	0.75	0.57	2.63
Sample Reach .5%	194.84	10	10.00	-2.40	0.51	2.91	2.23	0.29	0.000018	15.69	0.00	0.03	1.96
Sample Reach .5%	194.84	20	20.00	-2.40	0.63	3.03	2.32	0.54	0.000063	16.02	0.01	0.06	2.03
Sample Reach .5%	194.84	50	50.00	-2.40	0.94	3.34	2.51	1.19	0.000277	16.77	0.04	0.13	2.19
Sample Reach .5%	194.84	100	100.00	-2.40	1.32	3.72	2.74	2.06	0.000743	17.72	0.11	0.22	2.37
Sample Reach .5%	194.84	150	150.00	-2.40	1.63	4.03	2.62	2.76	0.001390	20.75	0.20	0.30	2.30
Sample Reach .5%	194.84	200	200.00	-2.40	1.91	4.31	2.40	3.29	0.002177	25.38	0.29	0.37	2.14
Sample Reach .5%	194.84	252	252.00	-2.40	2.16	4.56	2.29	3.72	0.002918	29.56	0.38	0.43	2.07
Sample Reach .5%	194.84	328	328.00	-2.40	2.48	4.88	2.24	4.20	0.003774	34.78	0.48	0.49	2.05
Sample Reach .5%	194.84	545	545.00	-2.40	2.87	5.27	2.63	4.98	0.004281	34.78	0.64	0.54	2.40
Sample Reach .5%	194.84	750	750.00	-2.40	3.12	5.52	2.88	5.44	0.004512	34.78	0.74	0.56	2.63
Sample Reach .5%	119.19	10	10.00	0.30	0.44	0.14	0.14	1.82	0.026443	40.50	0.22	0.87	0.14
Sample Reach .5%	119.19	20	20.00	0.30	0.53	0.23	0.23	2.12	0.017661	40.58	0.25	0.78	0.23
Sample Reach .5%	119.19	50	50.00	0.30	0.75	0.45	0.44	2.76	0.012717	40.75	0.35	0.73	0.44
Sample Reach .5%	119.19	100	100.00	0.30	1.04	0.74	0.74	3.32	0.009475	40.87	0.43	0.68	0.72
Sample Reach .5%	119.19	150	150.00	0.30	1.30	1.00	0.99	3.70	0.008063	40.92	0.48	0.65	0.96
Sample Reach .5%	119.19	200	200.00	0.30	1.53	1.23	1.22	3.99	0.007215	40.96	0.53	0.64	1.17
Sample Reach .5%	119.19	252	252.00	0.30	1.75	1.45	1.44	4.26	0.006672	41.00	0.57	0.63	1.36
Sample Reach .5%	119.19	328	328.00	0.30	2.05	1.75	1.74	4.59	0.006106	41.05	0.62	0.61	1.63
Sample Reach .5%	119.19	545	545.00	0.30	2.57	2.27	2.26	4.71	0.004560	41.06	0.60	0.55	2.11
Sample Reach .5%	119.19	750	750.00	0.30	2.81	2.51	2.50	5.16	0.004804	41.06	0.70	0.58	2.33
Sample Reach .5%	60	10	10.00	-0.67	-0.11	0.56	0.28	1.26	0.004822	28.38	0.08	0.42	0.28
Sample Reach .5%	60	20	20.00	-0.67	0.04	0.71	0.37	1.57	0.005084	34.04	0.12	0.45	0.37
Sample Reach .5%	60	50	50.00	-0.67	0.32	0.99	0.65	2.23	0.004983	34.37	0.20	0.49	0.64
Sample Reach .5%	60	100	100.00	-0.67	0.66	1.33	0.98	2.92	0.004978	34.77	0.30	0.52	0.96
Sample Reach .5%	60	150	150.00	-0.67	0.94	1.61	1.25	3.41	0.004981	35.10	0.38	0.54	1.21
Sample Reach .5%	60	200	200.00	-0.67	1.19	1.86	1.49	3.81	0.004983	35.25	0.45	0.55	1.43
Sample Reach .5%	60	252	252.00	-0.67	1.42	2.09	1.72	4.15	0.004981	35.29	0.51	0.56	1.63
Sample Reach .5%	60	328	328.00	-0.67	1.73	2.40	2.02	4.58	0.004981	35.35	0.59	0.57	1.89
Sample Reach .5%	60	545	545.00	-0.67	2.17	2.84	2.47	5.27	0.005084	35.36	0.73	0.59	2.30
Sample Reach .5%	60	750	750.00	-0.67	2.42	3.09	2.72	5.67	0.005170	35.36	0.82	0.61	2.53
Sample Reach .5%	0	10	10.00	-0.97	-0.41	0.55	0.28	1.28	0.005006	28.26	0.09	0.43	0.28
Sample Reach .5%	0	20	20.00	-0.97	-0.26	0.71	0.38	1.56	0.005000	34.04	0.12	0.45	0.38
Sample Reach .5%	0	50	50.00	-0.97	0.02	0.99	0.65	2.24	0.005008	34.37	0.20	0.49	0.64
Sample Reach .5%	0	100	100.00	-0.97	0.36	1.33	0.98	2.93	0.005005	34.77	0.30	0.52	0.96
Sample Reach .5%	0	150	150.00	-0.97	0.64	1.61	1.25	3.42	0.005002	35.10	0.38	0.54	1.21
Sample Reach .5%	0	200	200.00	-0.97	0.89	1.85	1.49	3.81	0.005001	35.25	0.45	0.55	1.43
Sample Reach .5%	0	252	252.00	-0.97	1.12	2.08	1.72	4.16	0.005005	35.29	0.51	0.56	1.63
Sample Reach .5%	0	328	328.00	-0.97	1.42	2.39	2.02	4.59	0.005000	35.35	0.59	0.57	1.89
Sample Reach .5%	0	545	545.00	-0.97	1.88	2.84	2.47	5.24	0.005000	35.36	0.72	0.59	2.30
Sample Reach .5%	0	750	750.00	-0.97	2.13	3.10	2.73	5.60	0.005009	35.36	0.80	0.60	2.54

Attachment B
Incipient Motion Calculations

.5% Slope Template Reach Grain Shear Calculations

Hydraulic Reach	Variable Description	Modeled Flow Rate(cfs)									
		10	20	50	100	150	200	252	328	545	750
1	Main Channel Velocity (ft/s)	1.21	1.55	2.16	2.84	3.34	3.70	4.02	4.38	4.95	5.38
1	Main Channel Max Depth (ft)	1.11	1.24	1.53	1.89	2.19	2.46	2.71	3.05	3.49	3.74
1	Main Channel Effective Width (ft)	25.47	27.87	29.33	30.27	31.46	33.36	35.01	37.08	37.16	37.16
1	Energy Slope	1.01%	0.90%	0.61%	0.51%	0.47%	0.46%	0.46%	0.46%	0.45%	0.47%
1	Hyd Radius Channel	0.73	0.82	1.04	1.31	1.50	1.60	1.72	1.90	2.31	2.54
1	Calculated Ave Channel Boundary Shear (lbs/sf)	0.46	0.46	0.40	0.42	0.44	0.46	0.49	0.55	0.65	0.74
	Max Boundary Shear (lbs/sf)	0.70	0.70	0.59	0.60	0.64	0.70	0.78	0.88	0.98	1.09

3.5 D84 Gravel (ft)	0.583
3.5 D84 Cobble (ft)	0.884
	lbs/sf
IM Critical Shear Gravel	0.128
MT Critical Shear Gravel	0.201
IM Critical Shear Cobble	0.505
MT Critical Shear Cobble	0.791

Method I

Gravel Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τo	τo/τ	φ'
10	0.255	0.288	4.194	4.191	-0.003	0.161	35%	1.25
20	0.342	0.315	4.927	4.927	0.000	0.192	42%	1.50
50	0.595	0.343	6.310	6.312	0.002	0.228	57%	1.78
100	0.912	0.386	7.377	7.375	-0.001	0.288	69%	2.25
150	1.155	0.418	7.967	7.969	0.003	0.340	77%	2.65
200	1.335	0.444	8.328	8.330	0.002	0.382	84%	2.98
252	1.48	0.468	8.586	8.584	-0.002	0.424	86%	3.31
328	1.65	0.495	8.857	8.853	-0.004	0.476	87%	3.71
545	1.96	0.533	9.287	9.296	0.009	0.551	85%	4.30
750	2.135	0.567	9.501	9.495	-0.006	0.623	84%	4.86

Cobble Grain Shear Calculations

Q	R'	V*	V/V* Log Fxn I	V/V*	Diff	τo	τo/τ	φ'
10	0.322	0.323	3.738	3.730	-0.009	0.203	44%	0.40
20	0.4235	0.350	4.423	4.428	0.005	0.238	52%	0.47
50	0.718	0.377	5.741	5.746	0.005	0.275	69%	0.55
100	1.084	0.420	6.770	6.765	-0.005	0.343	83%	0.68
150	1.36	0.454	7.336	7.344	0.008	0.400	91%	0.79
200	1.565	0.481	7.687	7.694	0.007	0.448	98%	0.89
252	1.73	0.506	7.937	7.940	0.003	0.496	101%	0.98
328	1.925	0.535	8.204	8.196	-0.008	0.555	101%	1.10
545	2.28	0.575	8.626	8.619	-0.008	0.641	99%	1.27
750	2.47	0.610	8.826	8.828	0.001	0.721	97%	1.43

Attachment C
Sediment Transport Calculations

Sediment Reach Sand and Gravel

River: Sample Reach .5%, Reach: Sample Reach .5%
RS: 700 to 0
Sediment Transport Functions: MPM
Temperature: 55
Specific Gravity of Sediment: 2.65
Concentration of Fine Sediment: 0
Fall Velocity Method: Default
Depth/Width Type: Default

Gradation	Left Overbank	Main Channel	Right Overbank			
	Diameter	% Finer	Diameter	% Finer	Diameter	% Finer
	127	100	127	100	127100	
	102	96	102	96	10296	
	76.2	93	76.2	93	76.2	93
	50.8	83	50.8	83	50.8	83
	38.1	71	38.1	71	38.1	71
	25.4	60	25.4	60	25.4	60
	19.0	51	19.0	51	19.0	51
	12.7	41	12.7	41	12.7	41
	9.52	37	9.52	37	9.52	37
	4.75	30	4.75	30	4.75	30
	2.00	20	2.00	20	2.00	20
	.850	8	.850	8	.850	8
	.425	3	.425	3	.425	3
	.250	1	.250	1	.250	1
	.150	1	.150	1	.150	1
	.0750	0.3	.0750	0.3	.0750	0.3
d90	67.5		67.5		67.5	
d84	53.0		53.0		53.0	
d50	18.2		18.2		18.2	

Bed Material Fraction by Standard Grade Size

Class	dm (mm)	Left	Main	Right
1	.003	0.000	0.000	0.000
2	.006	0.000	0.000	0.000
3	.011	0.000	0.000	0.000
4	.023	0.000	0.000	0.000
5	.045	0.000	0.000	0.000
6	.088	0.008	0.008	0.008
7	.177	0.002	0.002	0.002
8	.354	0.032	0.032	0.032
9	.707	0.061	0.061	0.061
10	1.41	0.097	0.097	0.097
11	2.83	0.080	0.080	0.080
12	5.64	0.073	0.073	0.073
13	11.3	0.115	0.115	0.115
14	22.6	0.195	0.195	0.195
15	45.1	0.224	0.224	0.224
16	90.5	0.083	0.083	0.083
17	181	0.030	0.030	0.030
18	362	0.000	0.000	0.000
19	724	0.000	0.000	0.000

20	1448	0.000	0.000	0.000

Sediment Transport Potential (tons/day) Sand and Gravel 700 MPM Total All Grains (tons/day)

	Sed Reach	RS	Profile	Function	All Grains	
1	Sand and Gravel		700	10	MPM	55.76
2	Sand and Gravel		700	20	MPM	92.02
3	Sand and Gravel		700	50	MPM	259.0
4	Sand and Gravel		700	100	MPM	665.6
5	Sand and Gravel		700	150	MPM	1144
6	Sand and Gravel		700	200	MPM	1677
7	Sand and Gravel		700	252	MPM	2176
8	Sand and Gravel		700	328	MPM	2842
9	Sand and Gravel		700	545	MPM	2307
10	Sand and Gravel		700	750	MPM	2648
11						
12	Sand and Gravel		550	10	MPM	608.0
13	Sand and Gravel		550	20	MPM	815.0
14	Sand and Gravel		550	50	MPM	1615
15	Sand and Gravel		550	100	MPM	2143
16	Sand and Gravel		550	150	MPM	2308
17	Sand and Gravel		550	200	MPM	2322
18	Sand and Gravel		550	252	MPM	2480
19	Sand and Gravel		550	328	MPM	2851
20	Sand and Gravel		550	545	MPM	3847
21	Sand and Gravel		550	750	MPM	4323
22						
23	Sand and Gravel		525	10	MPM	667.4
24	Sand and Gravel		525	20	MPM	994.8
25	Sand and Gravel		525	50	MPM	1215
26	Sand and Gravel		525	100	MPM	1361
27	Sand and Gravel		525	150	MPM	1519
28	Sand and Gravel		525	200	MPM	1537
29	Sand and Gravel		525	252	MPM	1669
30	Sand and Gravel		525	328	MPM	1894
31	Sand and Gravel		525	545	MPM	2046
32	Sand and Gravel		525	750	MPM	2616
33						
34	Sand and Gravel		515	10	MPM	.00001...
35	Sand and Gravel		515	20	MPM	.02897
36	Sand and Gravel		515	50	MPM	2.937
37	Sand and Gravel		515	100	MPM	41.45
38	Sand and Gravel		515	150	MPM	138.7
39	Sand and Gravel		515	200	MPM	300.0
40	Sand and Gravel		515	252	MPM	507.4
41	Sand and Gravel		515	328	MPM	864.5
42	Sand and Gravel		515	545	MPM	1846
43	Sand and Gravel		515	750	MPM	2607
44						
45	Sand and Gravel		505	10	MPM	0
46	Sand and Gravel		505	20	MPM	.02630
47	Sand and Gravel		505	50	MPM	2.655
48	Sand and Gravel		505	100	MPM	38.70
49	Sand and Gravel		505	150	MPM	133.6

50	Sand and Gravel	505	200	MPM	289.4
51	Sand and Gravel	505	252	MPM	491.8
52	Sand and Gravel	505	328	MPM	847.2
53	Sand and Gravel	505	545	MPM	1824
54	Sand and Gravel	505	750	MPM	2604
55					
56	Sand and Gravel	397.4	10	MPM	2579
57	Sand and Gravel	397.4	20	MPM	3090
58	Sand and Gravel	397.4	50	MPM	2166
59	Sand and Gravel	397.4	100	MPM	2307
60	Sand and Gravel	397.4	150	MPM	2642
61	Sand and Gravel	397.4	200	MPM	2985
62	Sand and Gravel	397.4	252	MPM	3322
63	Sand and Gravel	397.4	328	MPM	3728
64	Sand and Gravel	397.4	545	MPM	2565
65	Sand and Gravel	397.4	750	MPM	3303
66					
67	Sand and Gravel	345	10	MPM	32.32
68	Sand and Gravel	345	20	MPM	67.71
69	Sand and Gravel	345	50	MPM	289.5
70	Sand and Gravel	345	100	MPM	769.9
71	Sand and Gravel	345	150	MPM	1276
72	Sand and Gravel	345	200	MPM	1738
73	Sand and Gravel	345	252	MPM	2197
74	Sand and Gravel	345	328	MPM	2777
75	Sand and Gravel	345	545	MPM	4800
76	Sand and Gravel	345	750	MPM	6184
77					
78	Sand and Gravel	240	10	MPM	3000
79	Sand and Gravel	240	20	MPM	3004
80	Sand and Gravel	240	50	MPM	1482
81	Sand and Gravel	240	100	MPM	1526
82	Sand and Gravel	240	150	MPM	1702
83	Sand and Gravel	240	200	MPM	1882
84	Sand and Gravel	240	252	MPM	2149
85	Sand and Gravel	240	328	MPM	2499
86	Sand and Gravel	240	545	MPM	3164
87	Sand and Gravel	240	750	MPM	3963
88					
89	Sand and Gravel	214.84 ...	10	MPM	15.87
90	Sand and Gravel	214.84 ...	20	MPM	79.45
91	Sand and Gravel	214.84 ...	50	MPM	323.0
92	Sand and Gravel	214.84 ...	100	MPM	675.4
93	Sand and Gravel	214.84 ...	150	MPM	957.0
94	Sand and Gravel	214.84 ...	200	MPM	1174
95	Sand and Gravel	214.84 ...	252	MPM	1408
96	Sand and Gravel	214.84 ...	328	MPM	1600
97	Sand and Gravel	214.84 ...	545	MPM	1726
98	Sand and Gravel	214.84 ...	750	MPM	2573
99					
100	Sand and Gravel	204.84 ...	10	MPM	0
101	Sand and Gravel	204.84 ...	20	MPM	.02721
102	Sand and Gravel	204.84 ...	50	MPM	2.800
103	Sand and Gravel	204.84 ...	100	MPM	41.80

104	Sand and Gravel	204.84 ...	150	MPM	146.2
105	Sand and Gravel	204.84 ...	200	MPM	315.1
106	Sand and Gravel	204.84 ...	252	MPM	539.6
107	Sand and Gravel	204.84 ...	328	MPM	931.2
108	Sand and Gravel	204.84 ...	545	MPM	1678
109	Sand and Gravel	204.84 ...	750	MPM	2299
110					
111	Sand and Gravel	194.84 ...	10	MPM	0
112	Sand and Gravel	194.84 ...	20	MPM	.02459
113	Sand and Gravel	194.84 ...	50	MPM	2.546
114	Sand and Gravel	194.84 ...	100	MPM	38.89
115	Sand and Gravel	194.84 ...	150	MPM	139.8
116	Sand and Gravel	194.84 ...	200	MPM	303.2
117	Sand and Gravel	194.84 ...	252	MPM	522.2
118	Sand and Gravel	194.84 ...	328	MPM	909.5
119	Sand and Gravel	194.84 ...	545	MPM	1631
120	Sand and Gravel	194.84 ...	750	MPM	2246
121					
122	Sand and Gravel	119.19 ...	10	MPM	1510
123	Sand and Gravel	119.19 ...	20	MPM	1299
124	Sand and Gravel	119.19 ...	50	MPM	1738
125	Sand and Gravel	119.19 ...	100	MPM	2172
126	Sand and Gravel	119.19 ...	150	MPM	2555
127	Sand and Gravel	119.19 ...	200	MPM	2894
128	Sand and Gravel	119.19 ...	252	MPM	3252
129	Sand and Gravel	119.19 ...	328	MPM	3727
130	Sand and Gravel	119.19 ...	545	MPM	3306
131	Sand and Gravel	119.19 ...	750	MPM	4353
132					
133	Sand and Gravel	60	10	MPM	92.75
134	Sand and Gravel	60	20	MPM	163.6
135	Sand and Gravel	60	50	MPM	403.2
136	Sand and Gravel	60	100	MPM	789.8
137	Sand and Gravel	60	150	MPM	1202
138	Sand and Gravel	60	200	MPM	1615
139	Sand and Gravel	60	252	MPM	2039
140	Sand and Gravel	60	328	MPM	2649
141	Sand and Gravel	60	545	MPM	3998
142	Sand and Gravel	60	750	MPM	4992

Sediment Reach Coarse

River: Sample Reach .5%, Reach: Sample Reach .5%
RS: 700 to 0
Sediment Transport Functions: MPM
Temperature: 55
Specific Gravity of Sediment: 2.65
Concentration of Fine Sediment: 0
Fall Velocity Method: Default
Depth/Width Type: Default

Gradation	Left Overbank	Main Channel	Right Overbank			
	Diameter	% Finer	Diameter	% Finer	Diameter	% Finer
	128	100	128	100	128100	
	90.0	95	90.0	95	90.0	95
	64.0	70	64.0	70	64.0	70
	45.0	49	45.0	49	45.0	49
	32.0	32	32.0	32	32.0	32
	22.0	20	22.0	20	22.0	20
	16.0	17	16.0	17	16.0	17
	11.0	17	11.0	17	11.0	17
	8.00	17	8.00	17	8.00	17
	6.00	17	6.00	17	6.00	17
	4.00	17	4.00	17	4.00	17
	2.00	0	2.00	0	2.00	0
d90	84.0		84.0		84.0	
d84	77.4		77.4		77.4	
d50	45.9		45.9		45.9	

Bed Material Fraction by Standard Grade Size

Class	dm (mm)	Left	Main	Right
1	.003	0.000	0.000	0.000
2	.006	0.000	0.000	0.000
3	.011	0.000	0.000	0.000
4	.023	0.000	0.000	0.000
5	.045	0.000	0.000	0.000
6	.088	0.000	0.000	0.000
7	.177	0.000	0.000	0.000
8	.354	0.000	0.000	0.000
9	.707	0.000	0.000	0.000
10	1.41	0.000	0.000	0.000
11	2.83	0.170	0.170	0.170
12	5.64	0.000	0.000	0.000
13	11.3	0.000	0.000	0.000
14	22.6	0.150	0.150	0.150
15	45.1	0.380	0.380	0.380
16	90.5	0.267	0.267	0.267
17	181	0.033	0.033	0.033
18	362	0.000	0.000	0.000
19	724	0.000	0.000	0.000
20	1448	0.000	0.000	0.000

Sediment Transport Potential (tons/day) Sand and Gravel 700 MPM Total All Grains (tons/day)

	Sed Reach	RS	Profile	Function	All Grains	
1	Coarse		700	10	MPM	9.152
2	Coarse		700	20	MPM	26.55
3	Coarse		700	50	MPM	120.2
4	Coarse		700	100	MPM	338.1
5	Coarse		700	150	MPM	573.9
6	Coarse		700	200	MPM	813.5
7	Coarse		700	252	MPM	1031
8	Coarse		700	328	MPM	1322
9	Coarse		700	545	MPM	1105
10	Coarse		700	750	MPM	1278
11						
12	Coarse		550	10	MPM	351.3
13	Coarse		550	20	MPM	451.7
14	Coarse		550	50	MPM	820.4
15	Coarse		550	100	MPM	1040
16	Coarse		550	150	MPM	1101
17	Coarse		550	200	MPM	1099
18	Coarse		550	252	MPM	1162
19	Coarse		550	328	MPM	1328
20	Coarse		550	545	MPM	1825
21	Coarse		550	750	MPM	2060
22						
23	Coarse		525	10	MPM	375.8
24	Coarse		525	20	MPM	523.4
25	Coarse		525	50	MPM	608.2
26	Coarse		525	100	MPM	666.4
27	Coarse		525	150	MPM	734.5
28	Coarse		525	200	MPM	742.1
29	Coarse		525	252	MPM	800.8
30	Coarse		525	328	MPM	900.9
31	Coarse		525	545	MPM	967.8
32	Coarse		525	750	MPM	1214
33						
34	Coarse		515	10	MPM	0
35	Coarse		515	20	MPM	0
36	Coarse		515	50	MPM	0
37	Coarse		515	100	MPM	11.05
38	Coarse		515	150	MPM	62.89
39	Coarse		515	200	MPM	146.8
40	Coarse		515	252	MPM	247.5
41	Coarse		515	328	MPM	407.5
42	Coarse		515	545	MPM	855.5
43	Coarse		515	750	MPM	1229
44						
45	Coarse		505	10	MPM	0
46	Coarse		505	20	MPM	0
47	Coarse		505	50	MPM	0
48	Coarse		505	100	MPM	9.612
49	Coarse		505	150	MPM	60.14
50	Coarse		505	200	MPM	141.2
51	Coarse		505	252	MPM	240.4
52	Coarse		505	328	MPM	400.0
53	Coarse		505	545	MPM	844.7

54	Coarse	505	750	MPM	1228
55					
56	Coarse	397.4	10	MPM	1452
57	Coarse	397.4	20	MPM	1642
58	Coarse	397.4	50	MPM	1100
59	Coarse	397.4	100	MPM	1135
60	Coarse	397.4	150	MPM	1271
61	Coarse	397.4	200	MPM	1413
62	Coarse	397.4	252	MPM	1562
63	Coarse	397.4	328	MPM	1763
64	Coarse	397.4	545	MPM	1208
65	Coarse	397.4	750	MPM	1525
66					
67	Coarse	345	10	MPM	0
68	Coarse	345	20	MPM	13.62
69	Coarse	345	50	MPM	137.3
70	Coarse	345	100	MPM	394.9
71	Coarse	345	150	MPM	635.4
72	Coarse	345	200	MPM	841.0
73	Coarse	345	252	MPM	1040
74	Coarse	345	328	MPM	1290
75	Coarse	345	545	MPM	2307
76	Coarse	345	750	MPM	3006
77					
78	Coarse	240	10	MPM	1750
79	Coarse	240	20	MPM	1623
80	Coarse	240	50	MPM	748.4
81	Coarse	240	100	MPM	751.4
82	Coarse	240	150	MPM	822.5
83	Coarse	240	200	MPM	896.7
84	Coarse	240	252	MPM	1009
85	Coarse	240	328	MPM	1161
86	Coarse	240	545	MPM	1491
87	Coarse	240	750	MPM	1891
88					
89	Coarse	214.84 ...	10	MPM	0
90	Coarse	214.84 ...	20	MPM	26.33
91	Coarse	214.84 ...	50	MPM	160.6
92	Coarse	214.84 ...	100	MPM	345.5
93	Coarse	214.84 ...	150	MPM	479.8
94	Coarse	214.84 ...	200	MPM	580.1
95	Coarse	214.84 ...	252	MPM	686.7
96	Coarse	214.84 ...	328	MPM	772.7
97	Coarse	214.84 ...	545	MPM	828.1
98	Coarse	214.84 ...	750	MPM	1197
99					
100	Coarse	204.84 ...	10	MPM	0
101	Coarse	204.84 ...	20	MPM	0
102	Coarse	204.84 ...	50	MPM	0
103	Coarse	204.84 ...	100	MPM	11.04
104	Coarse	204.84 ...	150	MPM	66.69
105	Coarse	204.84 ...	200	MPM	154.6
106	Coarse	204.84 ...	252	MPM	262.6
107	Coarse	204.84 ...	328	MPM	437.2

108	Coarse	204.84 ...	545	MPM	770.3
109	Coarse	204.84 ...	750	MPM	1074
110					
111	Coarse	194.84 ...	10	MPM	0
112	Coarse	194.84 ...	20	MPM	0
113	Coarse	194.84 ...	50	MPM	0
114	Coarse	194.84 ...	100	MPM	9.510
115	Coarse	194.84 ...	150	MPM	63.25
116	Coarse	194.84 ...	200	MPM	148.3
117	Coarse	194.84 ...	252	MPM	254.7
118	Coarse	194.84 ...	328	MPM	427.9
119	Coarse	194.84 ...	545	MPM	746.2
120	Coarse	194.84 ...	750	MPM	1047
121					
122	Coarse	119.19 ...	10	MPM	880.8
123	Coarse	119.19 ...	20	MPM	719.8
124	Coarse	119.19 ...	50	MPM	897.0
125	Coarse	119.19 ...	100	MPM	1073
126	Coarse	119.19 ...	150	MPM	1232
127	Coarse	119.19 ...	200	MPM	1372
128	Coarse	119.19 ...	252	MPM	1527
129	Coarse	119.19 ...	328	MPM	1762
130	Coarse	119.19 ...	545	MPM	1531
131	Coarse	119.19 ...	750	MPM	2056
132					
133	Coarse	60	10	MPM	32.67
134	Coarse	60	20	MPM	72.55
135	Coarse	60	50	MPM	203.0
136	Coarse	60	100	MPM	404.9
137	Coarse	60	150	MPM	595.0
138	Coarse	60	200	MPM	777.6
139	Coarse	60	252	MPM	960.4
140	Coarse	60	328	MPM	1239
141	Coarse	60	545	MPM	1916
142	Coarse	60	750	MPM	2417

.5% Slope Template Sediment Transport S&G

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Transport Potential (Tons)
10	2.47				
20	20	11	0.109	40	452
50	134	77	0.543	198	15233
100	427	281	0.222	81	22750
150	754	591	0.055	20	11936
200	1078	916	0.034	12	11362
252	1417	1248	0.020	7	9107
328	1889	1653	0.011	4	6611
545	2500	2194	0.004	2	3511
750	3263	2881	0.001	0.30	864
					81825
				365	

.5% Slope Template Sediment Transport - Coarse Material

Design Flowrate, cfs	Geometric Mean	Geometric Mean Transport Potential TPD	Percent of Time that flow range occurs	Days Per year that flow range occurs	Geometric Mean Annual Sediment Transport Potential (Tons)
10	0.29				
20	2.22	1.25	0.109	40.00	50.08
50	3.64	2.93	0.543	198.20	580.65
100	173.81	88.724654	0.222	81.10	7,195.57
150	360.39	267.097212	0.055	20.20	5,395.36
200	520.91	440.649071	0.034	12.40	5,464.05
252	677.22	599.0655141	0.020	7.30	4,373.18
328	888.43	782.823102	0.011	4.00	3,131.29
545	1175.50	1031.963152	0.004	1.60	1,651.14
750	1542.43	1358.963781	0.001	0.30	407.69
					28,249.01
				365	

Attachment D
Hydraulic Geometry Calculations

Hydraulic Geometry Output

Julien and Wargadalam (1995)

Julien, P. Y., and J. Wargadalam, 1995. Alluvial Channel Geometry: Theory and Applications. ASCE Journal of Hydraulic Engineering, vol. 121, No 4, pl 312-325							
1. Input							
	Estimate h in meters	**D50 in meters**	**Shields #**	**Dom Q (cms)**	**Slope**	**Calculated m**	**Calculated h**
	0.53	0.051	0.03	9.29	0.005	0.207	0.53
2. Calculate width and compare calculated slope to objective							
	Depth	Width	Velocity	Slope			
	(meters)	(meters)	(m/s)				
	0.53	**12.4**	1.4	**0.0048**			
	(ft)	(ft)	(ft)				
	1.7	**40.7**	4.6				

Hey and Thorne (1986)

Input					
Dom Q (cms)	**D50 (mm)**	**D84 (mm)**			
9.32	**51.1**	**74.9**			
Output					
	Mean Width (meters)	Bankfull Mean Depth (meters)	Slope	Mean Width (ft)	Mean Depth (ft)
grassy banks	13.2	0.33	0.0049	43.4	1.1

Hey, R.D. and Thorne, C.R. 1986. Stable channels with mobile gravel beds: ASCE Journal of Hydraulic Engineering, 112(6), 671-689

Bray (1982)

Bray 1982 (see Brookes and Shields, 1996)		
Based on gavel-bed rivers in Canada		
Input		
Dom Q	**D50**	
(cms)	**(mm)**	
9.32	**51.1**	
Output		
Width	Depth	Slope
(m)	(m)	
15.4	0.6	0.00487
(ft)	(ft)	
50.5	1.9	
Applicability: median bed material size between 1.9 and 145 mm, Q between 5.5 and 3,920 cms, 'mobile bed, and slope between 0.0022 and 0.015		
Bray, D. I., 1982. Flow resistance in gravel-bed rivers, IN Gravel-Bed Rivers, John Wiley and Sons, Inc., New York, N.Y., 109-137.		

Thorne et al (1988)

Based on Thorne et al. (1988), see Brookes and Shields (1996) pg. 46.					
Based on gravel bed rivers in the UK.					
	Input				
	Dom Q (cms)	**D50 (mm)**	**Slope**		
	9.32	**51.1**	**0.005**		
	Output				
		Width	Depth	Width	Depth
		(meters)	(meters)	(ft)	(ft)
	grassy banks	12.7	0.66	41.6	2.2

Hey and Thorne equations

Bankfull Riffle Width = 1.034 * Mean bankfull width

Bankfull Pool Width = 0.966 * Mean bankfull width

Appendix E: Groundwater Investigations Summary Memorandum

Hydrometrics, Inc.
consulting scientists and engineers

MEMORANDUM

DATE: September 20, 2012

TO: Jim Ford, Montana Environmental Trust Group

FROM: Bob Anderson, Hydrometrics, Inc.
Mark Walker, Hydrometrics, Inc.

SUBJECT: Upper Lake Drawdown Test Technical Memorandum –DRAFT

EXECUTIVE SUMMARY

The Montana Environmental Trust Group is conducting an Upper Lake drawdown test at the former Asarco smelter site (the plant site) in East Helena, Montana. Upper Lake is a relatively large surface water feature at the south (topographically and hydrologically upgradient) margin of the plant site. Leakage from Upper Lake has long been recognized as a source of recharge to the plant site groundwater system, where the interaction of groundwater with metals-contaminated soils has negatively impacted groundwater quality. The purpose of the Upper Lake drawdown test is to simulate, at least partially, the effects of eliminating recharge from Upper Lake on plant site groundwater levels, flow rates, and contaminant loading to groundwater. This information is being used in planning and implementation of remedial measures for the site.

The Upper Lake drawdown test has involved three distinct phases, including passive lake dewatering achieved by shutting off the diversion inflow from Prickly Pear Creek, lowering Prickly Pear Creek adjacent to the plant site, and pumping from the lake to expedite lake level drawdown. The first phase of the test began on 11/1/2011 and continued through 3/26/12. The creek lowering phase overlapped with the passive dewatering phase and occurred from 12/21/11 through 2/24/12. The third (lake pumping) phase was initiated on 3/26/12 and continues to date. Data collection during the test has included continuous water level monitoring at a total of 35 groundwater and surface water sites instrumented with pressure sensitive transducers, and manual measurements at an additional 20 sites. The water level data is intended to quantify the groundwater level declines across the plant site, and determine effects of the lake drawdown on hydraulic gradients and groundwater flow rates across the plant site.

As of September 13, 2012, the water level in Upper Lake had declined by 4.9 feet since the November 1, 2011 test startup. Groundwater levels during this time have declined by four to five feet in the south portion of the plant site, three to four feet in the central plant site, and four to six feet in the northwest portion of the plant site. Water level declines in the south plant site are attributable to the proximity of this area to Upper Lake while the larger declines in the northwest plant site are attributable to the Upper Lake drawdown, as well as a lack of flow in Wilson Ditch. The lack of ditch flow in 2012 is related to the Upper Lake drawdown test as Wilson Ditch is fed by a headgate on Upper Lake. Water levels in the northeast portion of the plant site (beneath the slag pile) declined by less than one foot, suggesting the shallow groundwater system in this area has limited interaction with water levels in Upper Lake and the south plant area.

Current plans for the East Helena Smelter site include permanent elimination or reduction of recharge from Upper Lake to the plant site groundwater system, lowering the water level in Prickly Pear Creek adjacent to the plant site by removing a small dam, excavation of contaminated soils in the south plant area, placement of a low permeability zone to further limit groundwater flow through the plant site, and possible elimination of Wilson Ditch. Collectively, these actions are referred to as the South Plant Hydraulic Control (SPHC) project. In order to assess the effectiveness of the proposed SPHC, information gained from the Upper Lake drawdown test to date was used to estimate total declines in groundwater levels expected through implementation of the SPHC. Projected water level declines range from approximately ten feet in the south plant area, four to five feet in the central plant area, and up to six feet in the northwest plant area. Groundwater levels in the northeast plant area (beneath the slag pile), are expected to decline by two feet or less. Lowering the water table will not only reduce the total groundwater flow rate or flux through the plant site, but will also significantly reduce the magnitude of groundwater interaction with the most highly contaminated soils on the plant site. These two effects should combine to reduce the load (pounds/day) of contaminants in plant site and downgradient groundwater

Additional information gained from the Upper Lake drawdown test to date includes identification of potential preferential groundwater flow paths through the plant site, portions of the plant site where groundwater is more closely connected to Prickly Pear Creek, and general groundwater flow patterns through the site. Following completion of the water level recovery phase of the test (Fall 2012), effects of the Upper Lake drawdown test and projected effects of the SPHC on groundwater levels, flow rates and patterns, and groundwater quality will be evaluated further.

1.0 INTRODUCTION

Upper Lake has previously been identified as a source of recharge to the Upper Aquifer, or unconfined groundwater system overlying the Tertiary ash/clay layer at the former East Helena smelter site (the plant site). Indications that Upper Lake provides recharge to the plant site groundwater system include its location at the extreme southern (upgradient) end of the plant site, and the elevated lake level resulting from construction of raised ground levels and berms around the lake perimeter. Although these physical attributes indicate that Upper Lake increases recharge to the plant site Upper Aquifer (as compared to pre-lake conditions), the magnitude of recharge attributable to Upper Lake has not previously been quantified. In order to assess the rate of groundwater recharge from Upper Lake to the plant site groundwater system, METG initiated an Upper Lake drawdown test to document the plant site groundwater system response to variations in the Upper Lake water level. The Upper Lake drawdown test was initiated in fall 2011 and continues to date. This technical memorandum describes the Upper Lake drawdown testing procedures and results to date. Interpretation of the test results is also presented along with preliminary implications of the potential effectiveness of the proposed South Plant Hydraulic Control (SPHC) interim measures. Additional data review and interpretation will occur following the water level recovery (partial lake refilling) phase of the test, scheduled to begin in October 2012.

1.1 DRAWDOWN TEST OBJECTIVES

Design and planning of the Upper Lake drawdown test is covered in two memoranda submitted to METG by Hydrometrics (dated August 5, 2011 and October 19, 2011), with subsequent input from the project team. Besides quantifying effects of Upper Lake dewatering on plant site groundwater levels, the drawdown test is also intended to provide additional information on the overall plant site hydrogeologic system. Specific objectives of the drawdown test as outlined in the August 5th memorandum include:

1. Quantify the Plant Site groundwater system response to lowering of the Upper Lake water level.

2. Identify potential preferential groundwater flow paths through the plant site based on the magnitude and timing of groundwater level responses in individual wells.

3. Refine plant site aquifer hydraulic conductivity estimates based on the groundwater level response to lake dewatering in various portions of the site, if test data allows.

This memorandum focuses on objective #1 to aid in planning and implementation of the SPHC activities. Objectives 2 and 3 are also discussed as relevant to the SPHC project, and will be evaluated further in support of other interim and corrective measures activities and as available information allows.

1.2 BACKGROUND

Upper Lake lies within the Prickly Pear Creek floodplain at the south end of the former smelter or plant site (Figure 1). The lake area and associated marsh system to the immediate south lie within an area of recent active channel migration, resulting in the lake/marsh area being largely underlain by alluvial sands and gravels. Based on available information, the sand/gravel is overlain by 2 to 5 feet of silt/clay. Since the lake/marsh area is part of the active creek floodplain, Prickly Pear Creek has meandered through the area in the recent past. Based on review of historic aerial photos and observations of the lake at its current drawn down level, two former creek channels are evident in the lake/marsh area as shown on Figure 1. Due to the relatively high permeability of former channel sediments, the channels may represent preferential flow paths for shallow groundwater through the lake/marsh area and northward through the plant site. One of these channels extends through the west half of the lake and projects northwestward through the west plant site while the second former channel traverses the east half of the lake and projects through Tito Park (Figure 1).

Upper Lake was initially formed by diversion of water from Prickly Pear Creek into what originally was most likely a large marsh complex with limited open water. The original lake was considerably smaller in size than its present day configuration, with the lake area (and elevation) increased through continued placement of fill north of the lake (Tito Park area), and construction of an earthen berm (east berm) between the lake and Prickly Pear Creek around 1985. These “improvements” were implemented in part to provide a suitable water source for operation of the Acid Plant and other facility processes. The Upper Lake water level is controlled by two large outlet culverts in the east berm, with outflow through the culverts returning to Prickly Pear Creek. During the irrigation season, lake water typically is also diverted into Wilson Ditch through a headgate on the west side of the lake. Figure 1 shows the present-day (pre-drawdown test) Upper Lake configuration and various features relevant to this discussion.

With enlargement and raising of the lake level during (and prior to) the mid-1980s, leakage from the lake to the plant site is expected to have increased due to the greater hydraulic gradient and wetted surface area of the lake. Regular dredging of sediments from the northwest portion of the lake (to facilitate pumping for plant make-up water) would also have increased the leakage rate as compared to current conditions. Since the 2001 plant shutdown, Upper Lake has partially filled in with fine grained (low permeability) sediments, reducing the rate of leakage as compared to pre-2001 conditions. Thus, the rate of leakage and groundwater recharge from Upper Lake to the plant site groundwater system has most likely varied over time.

1.3 DEVELOPMENT OF UPPER AND LOWER LAKE

The earliest records uncovered to date regarding Upper Lake include reference to 1938 and 1959 measurements of the lake depth, and various activities associated with sediment control from upstream placer mining activities. At that time, Upper Lake and Lower Lake were physically connected as one lake with the two sections referred to as the south and north lakes, respectively. In the 1930s, upstream placer mining operations on Prickly Pear Creek caused turbidity problems in the creek and the plant site water system. In 1934, a ten-foot wide ditch was excavated from Prickly Pear Creek to the south end of Upper Lake to utilize the lake as a settling basin. This resulted in infilling of Upper Lake with sediment and a reduction in the lake depth and area. This information shows that Upper Lake was a significant water feature as far back as the 1930s with the lake depth, surface area and lakebed conditions varying over time. These variations in lake conditions would have affected leakage from the lake to the plant site groundwater system over the past several decades.

In 1985, the inlet channel and diversion structure on Prickly Pear Creek were improved by Asarco to better control inflow to Upper Lake. The east berm and outflow culverts were also constructed at that time resulting in an increase in the normal operating level of the lake, and presumably increased leakage from the lake to the plant site groundwater system. With shutdown of the smelter in 2001 and cessation of lake dredging, siltation of the lake bottom increased, thereby causing a reduction in the rate of leakage from the lake.

Figure 2 includes a sequence of aerial photographs from 1955 to 2011 showing the Upper Lake expansion over time. Key points of interest in the photos include:

- In 1955, Upper Lake and Lower Lake were connected by a narrow channel. Upper Lake was significantly smaller in size and restricted to the far western portion of the current lake area as compared to the later photos.
- By 1964, the area between the two lakes had been filled in. The Upper Lake surface area is notably larger than in 1955.
- The 1976, 1978 and 1980 photos look very similar to 1964 with no significant changes apparent in Upper or Lower Lake.
- Between 1980 and 1987, the enlarged inlet channel and east berm become evident and the Upper Lake level increases as shown by the expanded surface area.
- Between 1987 and 2011 the surface area (and water level) in Upper Lake shows a steady increase, possibly due to siltation of the lake bottom after the 2001 plant shutdown.

This evolution of the Upper (and Lower) Lake surface area and water level has undoubtedly affected groundwater flow through the plant site over the past several decades.

1.4 GENERAL LAKE HYDROLOGY

Figure 3 shows the three general flow paths by which seepage exits Upper Lake. The first flow path is located in the northwest corner of the lake upgradient of the former acid plant. This location corresponds to one of the former creek channels noted in Figure 1 and is believed to represent a preferential flow path from Upper Lake to the plant site. Lake seepage along this flow path flows northwestward through the former acid plant area and associated contaminated soils. The second flow path occurs northward through Tito Park to Lower Lake. Although flow between the two lakes most likely occurs throughout Tito Park, the rate of flow is probably greatest along any preferential flow paths, such as the former creek channel shown in Figure 1, and in the eastern part of Tito Park where the hydraulic gradient would be greatest due to the shorter distance between the two lakes. Installation of the acid plant sediment drying area (APSD) slurry wall (Figure 3) has undoubtedly altered the direction and possibly the rate of recharge from Upper Lake to the plant site since construction of the slurry wall in 2006.

The third main route for seepage out of the lake is through the east berm to Prickly Pear Creek. Seepage through this area is potentially significant due to the presumably coarse and permeable nature of the fill material used to construct the berm, and the potentially high gradient from the lake to the creek. Under normal conditions, The Upper Lake water level is three to five feet higher than the adjacent creek level, resulting in hydraulic gradients on the order of 0.1 feet/feet from Upper Lake to the creek. Based on the east dike dimensions (350 feet long and 3 feet high below the water level) and an assumed hydraulic conductivity of 200 ft/day, seepage rates through the dike may be on the order of 100 gallons per minute (gpm) or more when the lake is at full pool, or about 3920 feet elevation. An additional component of direct seepage from the lake when at full pool is westward seepage into the tertiary sediments forming the west lake shoreline. This seepage component is expected to be relatively small due to the lower hydraulic conductivity of the tertiary sediments as compared to the alluvial sediments or fill material present in the other seepage areas.

Figure 4 shows a schematic cross section from south to north through the Upper Lake area (see cross section trace on Figure 3). Key points on this figure include the alluvial (Qal) gravel underlying Upper Lake, and the continuous silt/clay layer (lake sediments) separating Upper Lake from the underlying gravels. The documented thickness of the silt/clay layer ranges from about 60 inches at the deeper north end of the lake, to about 40 inches at piezometer ULM-PZ-1 near the head of Upper Lake. Based on available information, the low permeability lakebed sediments are believed to inhibit downward leakage of the lake water to the underlying groundwater system, or upward seepage into the lake. Therefore, recharge from the lake to the plant site groundwater system occurs primarily via seepage through the north lake shoreline. As shown in Figure 4, the composition of the lake shoreline varies from relatively high permeability fill material on the upper bank, to low permeability silt/clay on the lower portion of the bank. This causes the rate of leakage to decrease as the lake level drops below the fill/silt contact.

The lack of subsurface leakage into or out of Upper Lake (at least at lower lake levels) is confirmed by measurements recorded on July 11, 2012. At that time, the lake water level was relatively stable at 3915.75 feet, similar to that shown for 7/24/12 on Figure 4. Upper Lake was being dewatered through pumping at that time with the pumping rate at 30 gpm. Surface water inflow from a small creek into the south end of the lake was measured at 36 gpm. The close correlation between the creek inflow rate and the pumping outflow rate under steady state water level conditions suggests minimal seepage into or out of the lake was occurring at that time (evaporation is assumed to be negligible given the small surface area of the lake at that time). Based on the saturated conditions in the alluvial gravels immediately north of Upper Lake (i.e., well DH-20 in Figure 4), this information suggests that groundwater underflow through the alluvial gravels underlying Upper Lake may persist even after Upper Lake has been permanently dewatered.

2.0 UPPER LAKE DRAWDOWN TEST PROCEDURES

The Upper Lake drawdown test involved three distinct phases, including passive lake dewatering achieved by shutting off the diversion inflow from Prickly Pear Creek, temporarily lowering Prickly Pear Creek adjacent to the plant site, and pumping from the lake to expedite lake level drawdown. The drawdown test schedule and monitoring program are summarized below.

2.1 UPPER LAKE DRAWDOWN TEST SCHEDULE

The Upper Lake Drawdown Test was initiated in fall 2011 with background (pre-drawdown) water level monitoring conducted in October. Following background data collection, the “passive” dewatering phase of the test began on 11/01/11 when the inlet diversion from Prickly Pear Creek to Upper Lake was shut off. Immediately prior to closing the diversion gates, measured inflow to Upper Lake from the creek was 30 cfs (13,440 gpm), which represents about half of the creek flow above the diversion gate at that time. Following closure of the diversion gates about 20 gpm flow remained in the Upper Lake inlet channel due to minor leakage around the gates. The diversion gates have remained closed with about 20 gpm leakage or less since 11/01/11 (Table 1).

The second phase of the test included lowering the Prickly Pear Creek stage above the Smelter Dam to assess the plant site groundwater and Upper Lake level response. The creek level was lowered by as much as eight feet (3915 feet to 3907 feet elevation) by incrementally opening the lower gates on the smelter dam. The creek lowering phase began on 12/21/11 and ended (by closing the lower gates) on 2/24/12. The creek level at the smelter dam has remained at 3915 to 3916 feet since 2/24.

The third phase of the drawdown test involved pumping water from Upper Lake to expedite the lake drawdown. After several months of passive dewatering, the rate of lake level decline slowed considerably leading to the need for pumping. Pumping was initiated on March 26, 2012 with the primary pump intake located in the west half of Upper Lake and a secondary pump located in the east half of the lake. The primary pump has operated more or less continuously since 3/26/12 with relatively few interruptions. The secondary pump was operated on a periodic schedule (typically during normal working hours each day) from 3/26/12 through 4/9/12, after which use of the secondary pump was discontinued. For the

TABLE 1. UPPER LAKE DRAWDOWN TEST SCHEDULE

Test Phase/Milestone	Begin	End	Comments
Background Monitoring	10/1/11	10/31/11	Documents background water level trends leading up to test.
Shut Off Prickly Pear Creek Inflow	11/01/11		Closed PP Ck diversion to Upper Lake inlet channel
Passive Drawdown Phase	11/01/11	3/26/12	Prickly Pear Ck inlet diversion shut off and lake allowed to passively dewater through seepage to subsurface.
Prickly Pear Creek Drawdown Phase	12/21/11	2/24/12	Prickly Pear Creek stage lowered at smelter dam on 12/21/11 to assess effect on groundwater levels. Creek level raised back up on 2/24/12. PP Ck diversion inlet remains closed.
Upper Lake Pumping	3/26/12	Ongoing	Includes continuous pumping from Upper Lake to expedite lake dewatering with diversion inlet remaining closed.

majority of the pumping period, each pump typically discharged between 80 to 120 gpm, with the discharge water piped to an infiltration basin near Prickly Pear Creek. Currently, the primary pump is operating continuously at approximately 15 gpm to maintain a steady state lake level.

2.2 MONITORING PROGRAM

The drawdown test monitoring program is focused primarily on measurement of water levels throughout and peripheral to the plant site. Water levels are measured continuously at a total of approximately 35 groundwater and surface water sites instrumented with pressure sensitive transducers. The continuous water level data is augmented with bi-weekly manual measurements at an additional 20 sites. The water level data is intended to quantify the groundwater level declines across the plant site, and determine effects of the lake drawdown on hydraulic gradients and groundwater flow rates across the plant site. Figure 5 shows the drawdown test monitoring network.

3.0 DRAWDOWN TEST RESULTS

The drawdown test water level monitoring results (to date) are summarized below, with data evaluation and interpretation presented in the following section (Section 4.0). For discussion purposes, the water level data are discussed separately by area, including the south plant area or south zone (Tito Park, Upper Lake, Lower Lake and Phase I/II CAMU area), the central plant zone, and the north plant zone (Figure 5). Water level declines measured during the course of the drawdown test (10/31/11 to 9/13/12) are discussed for each area. The plant site water level changes measured since the start of the test are referred to as water level declines as opposed to water level drawdown, since the measured water level changes likely include some component of seasonal (and potentially longer-term) water level trends, in addition to any lake drawdown-induced water level changes. As discussed in the following section, water level data from late summer/fall 2012 as well as water level recovery data will be required prior to full evaluation of lake drawdown-induced groundwater level changes on portions of the plant site.

3.1 SOUTH PLANT AREA

Primary water level monitoring sites in the south plant area include Upper and Lower Lake, Prickly Pear Creek at (immediately upstream of) the smelter dam, and nine monitoring wells in and around Tito Park. In addition, all 11 CAMU monitoring wells (MW wells on Figure 5) are included in the south plant area for discussion purposes. The primary water level monitoring sites are described in Table 2.

Water level declines measured between 11/01/11 (when diversion inflow to Upper Lake was shut off) through 9/13/12 in the south plant area ranged from 5.10 feet at well APSD-9 (located immediately north of Upper Lake), to 0.93 feet at well APSD-8 (between Lower Lake and Prickly Pear Creek). Water level declines at other notable sites include 4.84 feet at Upper Lake, 3.46 feet at Lower Lake, 3.58 feet at well DH-20 (between Upper Lake and the Acid Plant area), and 3.29 feet in well DH-3 (west of Upper Lake). Hydrographs for select south zone wells are included in Figure 6.

As shown on Figure 6, south plant water levels responded very quickly to the onset of Upper Lake dewatering, especially at wells APSD-9 and APSD-10 along the north Upper Lake shoreline. By mid-November, the Upper Lake water level stabilized at about 3918 feet and remained stable through December, while Lower Lake and groundwater levels throughout the south plant area continued to decrease.

Lowering Prickly Pear Creek above the smelter dam as of 12/20/11 had a notable effect on water levels. Most notable is well APSD-8 (located between Lower Lake and the creek, Figure 5), which dropped about 3.5 feet during the creek lowering phase of the test and fully recovered within about a week after the creek level was raised back up on 2/24/12. As shown on Figure 6, water levels at all other sites were influenced by the creek lowering including well DH-20, located on the west side of the plant site. Interestingly, the Upper Lake water level showed very little response to creek lowering, indicating leakage from the lake to the creek through the east berm is minimal, at least at reduced lake levels of about 3918 feet or lower.

The Upper Lake water level was generally stable from mid-November (about two weeks after inflow to the lake was shut off) through mid-March. With the onset of pumping from the lake on March 26, 2012, the Upper Lake level again began to drop, followed by similar declines in Lower Lake and the south plant monitoring wells. As shown on Figure 6, Upper Lake, Lower Lake and groundwater within Tito Park (APSD wells on Figure 6) have all

TABLE 2. DRAWDOWN TEST WATER LEVEL MONITORING SITES AND WATER LEVEL DECLINES FROM 10/31/11 THROUGH 9/13/12

Monitoring Site	Location	Depth Below Ground Surface (feet)	Net Water Level Decline (feet) 10/31/11 -9/13/12
South Plant Site			
Upper Lake	South Plant Area	NA	4.84
Lower Lake	South Plant Area	NA	3.46
APSD-8	Between Lower Lake and PP Ck	15	0.93
APSD-9	Tito Park	16	5.10
APSD-10	Tito Park	16	4.99
APSD-12	Tito Park	15.5	3.79
DH-3	West of Upper Lake	54	3.29
DH-20	Northwest of Upper Lake	31	3.58
MW-6	Between Plant Site and Phase I CAMU	40	3.88
MW-11	West of Phase II CAMU	70	0.38
Central Plant Site			
DH-19R	Former Acid Plant	25	3.35
DH-4	North of Lower Lake	23	0.95
DH-42	Former Acid Plant	34	3.55
DH-2	West of Plant Site	65.5	3.62
DH-71	North of Former Acid Plant	34	3.78
DH-73	Former Zinc Plant area	48	3.52
DH-68	South end of slag pile	50	0.42
EH-204	West of Plant Site	65	5.48
North Plant Site			
DH-17	Northcentral Plant Site	41	5.18
DH-66	NW of Ore Storage Building	48	5.50
DH-49	North Plant Site	34	5.55
DH-51	North Plant Site	34	5.02
DH-6	Between slag pile and Highway 12	25	3.65
DH-15	Between slag pile and Highway 12	50	3.65

NA-Not Applicable

converged to a similar elevation of about 3915 feet. This convergence of water levels has greatly reduced the hydraulic gradient, and thus groundwater flow, through Tito Park.

3.2 CENTRAL PLANT AREA

The central plant area covers the majority of the former plant site including the acid plant, speiss-dross plant, and the majority of the slag pile (Figure 5). Primary water level monitoring sites in this area are listed in Table 2 with hydrographs for select sites shown in Figure 7. Water level declines between 10/31/11 and 9/13/12 in this area ranged from 5.48 feet at well EH-204 (west of the Lower Ore Storage area), to 0.42 feet at DH-68 (south end of slag pile). Significant water level declines were also recorded at well DH-71 (3.78 feet) located between the acid plant and lower ore storage area, DH-2 (3.62 feet), completed in tertiary sediments west of the plant site, and DH-42 (3.55 feet) completed in the former acid plant area. Generally, water level declines are greatest on the west side of the plant site compared to the east side (beneath the slag pile). In fact, the water level at slag pile well DH-68 showed virtually no response to the Upper Lake or Prickly Pear Creek drawdown (Figure 7). Likewise, water levels at well DH-4, also located on the east side of the plant and only a few tens of feet north of Lower Lake, has also shown minimal response to the Upper Lake dewatering although DH-4 did show some response to the creek lowering phase of the test (Figure 7). The general lack of water level response at DH-4 and DH-68 suggests limited hydraulic interaction between the south plant groundwater system and the east side of the plant site. The lack of hydraulic continuity to the north of Lower Lake has previously been noted by the steep hydraulic gradients mapped in this area. These results suggest that the SPHC may have a lesser impact on groundwater levels beneath the east portion of the site (beneath the slag pile) as compared to the south and west portions of the plant site.

Groundwater levels in the former acid plant area (DH-19R and DH-42, Figure 7) have declined about 3.5 feet as of 9/13/12 and continue to decline to date. Post-SPHC groundwater levels in this area are of particular interest since the former acid plant contains some of the highest subsurface soil contaminant concentrations on the site.

3.3 NORTH PLANT AREA

North zone wells are shown on Figure 5 and listed in Table 2. Hydrographs for select wells are shown in Figure 8. Groundwater levels in the northern portion of the plant site show a steady decline from prior to the onset of the Upper Lake drawdown through mid-September 2012, although water levels at all sites increased temporarily in June in response to spring runoff. Overall water level declines in this area range from 3.30 feet at wells DH-6/15 near Prickly Pear Creek, to 5.55 feet at DH-49 in the northwest corner of the site.

Besides being some of the largest water level declines recorded during the lake drawdown test, the 2012 north plant site water level trends are notable in their contrast from previous years. Figure 9 shows long-term water level trends at north plant site wells DH-66 and DH-17. Water levels in these wells, and throughout the northwest portion of the site, have historically been lowest in winter and spring, and highest during late summer and fall. In contrast, water levels on the east side of the plant site are typically highest in spring and early summer, consistent with Prickly Pear Creek water levels. Continuous water level hydrographs from several wells located immediately north and west of the plant site, including EH-205/210, SP-4, EH-60/61/103 (Figure 5), show a definite correlation in groundwater levels and the presence or absence of flow in Wilson Ditch (Figure 10). Therefore, the lack of a late summer water level rise in in the northwest plant site wells in 2012 is attributable to the lack of flow in Wilson Ditch. Thus, in evaluating results of the Upper Lake drawdown test and ramifications of the SPHC, the effects of lake removal and creek lowering as well as possible elimination of flow in Wilson Ditch must be taken into account.

One other potential influence on the 2012 water level trends and drawdown test results is the lack of precipitation during summer 2012. The lack of precipitation has undoubtedly had some influence on groundwater levels, along with dewatering of Upper Lake and Wilson Ditch. To assess the possibility that climatic conditions are a primary cause of the significant water level declines in the northwest plant site, long-term water levels from north plant site well DH-66 were plotted against corresponding water levels from County monitoring well "Airport N-N" located north of the plant site near the Helena Airport. The Airport N-N well is located near the Helena Valley irrigation canal and historically has exhibited similar summer season water level increases as the northwest plant site wells. As shown in Figure 11, 2012 water level trends at the Airport N-N well exhibit the same summer season increase as seen in previous years, while the DH-66 trend does not. The consistent trends at Airport N-N in 2012 suggest that climatic conditions have not significantly affected seasonal trends at this well, and climatic conditions most likely are not responsible for the lack of late summer water level increases in DH-66 and other northwest plant site wells. Thus, the Upper Lake drawdown and lack of flow in Wilson Ditch are the most likely causes of the significantly lower northwest plant site groundwater levels in 2012.

Groundwater levels in the north plant site showed no apparent response to lowering of Prickly Pear Creek above the smelter dam, although they do correlate closely with creek levels downstream of the dam. Wells DH-6/DH-15 exhibit a strong correlation with the Prickly Pear Creek water level due to their proximity to the creek. As shown in Figure 8, all the north area wells correlate fairly well with DH-6/15. For example, an increase in the creek level during January 2012 due to an ice jam just upstream of Highway 12 caused water levels to rise about one foot in DH-6/15, with a similar although more subdued response apparent in all the north plant site wells. The groundwater level response to spring runoff (June) is also apparent in the north plant site hydrographs. This information shows the close interaction of the north plant site groundwater with the segment of Prickly Pear Creek downstream of the Smelter Dam.

Figure 12 shows the magnitude of measured water level declines as of 9/13/12 throughout the plant site. As presented above, water level declines have been greatest (4 to 5 feet) in the south plant site (due to the proximity to Upper Lake), and in the north plant site (up to 6 feet) due in part to the lack of flow in Wilson Ditch. Water level declines in the 3 to 4-foot range extend from Lower Lake and Tito Park on the east, westward through the acid plant area and west of the plant site. Conversely, measured water level declines are less than one foot in the east plant site beneath the slag pile. With the possible exception of the north plant site, the water level patterns shown on Figure 12 highlight those areas most sensitive to the Upper Lake drawdown. These areas, namely the south and west portions of the plant site, are expected to show the greatest response in water level drawdown from the SPHC. Water level declines will also be greatest in the northwest portion of the site if recharge from Wilson Ditch is eliminated through the SPHC. The water level declines plotted on Figure 12 reflect the net change in water levels between 10/31/11 and 9/13/12. As such, effects of lowering Prickly Pear Creek at the smelter dam, which ended on 2/24/12, are not reflected in Figure 12. If the creek had remained at the lowered stage, measured water declines would have been greater than the currently measured levels.

4.0 EVALUATION OF TEST RESULTS

The drawdown test data collected to date has undergone a preliminary evaluation with respect to insights into the plant site groundwater system and implications for the SPHC activities. Projections of plant site groundwater levels under permanent lake dewatering and Prickly Pear Creek relocation/lowering as proposed under the SPHC program have been made, and possible effects on groundwater flow rates and patterns through the plant site assessed.

4.1 PROJECTED WATER LEVELS

Relocation and lowering of Prickly Pear Creek through removal of the smelter dam is a key component of the SPHC and will have significant impacts on south plant site groundwater levels. Although the creek lowering phase of the Upper Lake drawdown test lasted for only about two months (from 12/20/11 through 2/24/12), information obtained during that period provided insight into the combined effects of lake dewatering and creek lowering on groundwater levels. Figure 13 shows the south plant site hydrographs along with the Prickly Pear Creek stage at the smelter dam from 12/20/11 (start of creek lowering) through 7/24/12. During the latter half of the creek lowering phase (1/30/12 through 2/20/12), the creek level was maintained at a relatively steady elevation of about 3911 feet. Water levels at well APSD-8, located between the creek and Lower Lake, stabilized around 3913 feet during this period, or about 2 feet higher than the creek. Based on this relationship, it can be assumed that the APSD-8 water level will stabilize about 2 feet higher than the post-SPHC creek level of 3906 feet at the current dam location, or at about 3908 feet. In actuality, the APSD-8 water level may stabilize less than 2 feet above the creek level since the 2-foot difference recorded during the drawdown test was most likely affected by water levels in adjacent Lower Lake. With elimination of Lower Lake, water levels at APSD-8 will most likely stabilize less than 2 feet above the creek level. Therefore, the groundwater level at APSD-8 is estimated to be between 3906 and 3908 feet following lake dewatering and permanent creek lowering.

After raising the creek level back to normal dam operating levels (about 3915.5 feet), water levels in Lower Lake and the Tito Park wells continued to decline in response to the Upper Lake drawdown. As of July 2012, groundwater levels in the Tito Park area had all fallen to within 0.5 feet of the creek level (Figure 13). Therefore, with long-term elimination of groundwater recharge from Upper and Lower Lake, groundwater levels throughout the Tito Park area are expected to stabilize close to or slightly higher than the final Prickly Pear Creek water level. Projected overall post-SPHC water level declines are shown for select sites on Figure 12.

Figures 14 and 15 show two east-west schematic cross sections through the south plant area. Both cross sections show the site stratigraphy, the pre-drawdown test (10/31/11) groundwater levels, the 7/24/12 groundwater levels, and the range of projected post-SPHC groundwater levels. Figure 14 also shows total arsenic and selenium (where available) soil concentrations with depth. As shown on Figure 14 (and discussed above), groundwater levels to date have declined on the order of five feet from Upper Lake dewatering alone, with an additional five feet of decline expected from permanent lowering of the creek. The water level declines measured to date have already lowered the groundwater table below the zone of highest soil contaminant concentrations, and achieving the final projected groundwater levels would further dewater the contaminated soils. The Figure 15 cross section lies slightly north of Figure 14 and includes Lower Lake (note that cross section traces for Figures 14 through 17 are shown on an inset map on Figure 14). Following the Prickly Pear Creek relocation and lowering, groundwater levels are expected to stabilize near the bottom of Lower Lake.

It is important to note that the projected post-SPHC water levels in the south plant area are based on preliminary post-SPHC creek channel locations and elevations upstream of the current dam location. If final creek elevations or locations change appreciably from the preliminary plans, the post-SPHC groundwater levels may be affected. Also, water level drawdown in response to the temporary bypass channel may be different from that estimated for the final creek relocation. The greater distance of the proposed bypass channel from the plant site, as compared to the final creek channel location, may reduce the observed level of groundwater drawdown on the plant site while the temporary bypass is in operation.

Figure 16 shows similar information along a cross section extending from Upper Lake northwestward through the west side of the plant and the former acid plant. As expected, projected post-SPHC water level declines will be greatest in the south plant area and are expected to decrease overall to the north. Water level declines as of 9/13/12 have already dewatered some of the most highly contaminated soils in the acid plant area (see abandoned well DH-19, Figure 16), with additional water level declines expected in this area. As mentioned in the previous section, post-SPHC water levels in the northwest plant site will depend on the presence or absence of flow in Wilson Ditch in the future.

Figure 17 includes a cross section extending due north from Upper Lake through Lower Lake and the slag pile. In contrast to the significant drawdown projected in the south plant area, this figure also shows the lack of measured and projected groundwater drawdown on the east plant site beneath the slag pile. Also of note is the very steep hydraulic gradient between Lower Lake and well DH-4 to the immediate north. As previously mentioned, a zone of low permeability material is believed to be present in this area restricting northward flow from Lower Lake towards DH-4.

It should be noted that the projected water levels through the west side of the plant site and through the acid plant do not take into account potential effects of a low permeability zone or cutoff wall around the south plant area as proposed in the SPHC plans. Placement of a cutoff wall downgradient of the south plant could further reduce groundwater flow rates and water levels in the acid plant area depending on the system design, and on the magnitude of groundwater underflow from the Upper Lake area towards the plant site.

4.2 EFFECTS ON GROUNDWATER FLOW PATTERNS

In addition to changes in groundwater levels, potential alterations in groundwater flow patterns and rates have been evaluated from the preliminary drawdown test data. Figures 18 and 19 present the plant site groundwater potentiometric surface for October 2010 and July 24, 2012, respectively. Although the two maps show a similar overall pattern to the potentiometric surface, a few key differences are apparent. As expected, the most obvious differences occur in the south plant site. For instance, the 3920 foot potentiometric contour on the October 2010 map extends northward around the north shoreline of Upper Lake with the Upper Lake water level at 3920.6 feet (Figure 18). In July 2012 (Figure 19) the 3920 contour is located approximately 1700 feet further south. This change alone has resulted in a significant decrease in the hydraulic gradient through Tito Park and an apparent corresponding decrease in the groundwater flux.

Although much less dramatic, the potentiometric contours on the west plant site have also shifted southward from October 2010 to July 2012 due to the water level declines documented in this area. This pattern is evident in the 3900 and 3905 potentiometric contours. Although subtle, these patterns do reflect real changes in the acid plant area groundwater levels. Also of note is the lack of change in the potentiometric surface in the eastern portion of the plant site beneath the slag pile. This is consistent with previous observations suggesting relatively little change in groundwater levels in this area in response to the lake dewatering and creek lowering.

It should be noted that the July 2012 potentiometric surface only reflects the effects of partial dewatering of Upper Lake, and does not account for future creek lowering and placement of a low permeability zone downgradient of the south plant area. These components of the SPHC program will result in significant differences in the post-SPHC potentiometric surface as compared to the July 2012 surface. As previously noted, groundwater levels in the south plant area are expected to closely approximate the final creek levels following permanent lowering of the creek. This will effectively eliminate the northward “bulge” in the potentiometric surface caused by Upper and Lower Lake and the elevated creek level behind the smelter dam.

Another possible effect of the SPHC on plant site groundwater flow patterns is a more westward component of groundwater flow through the northern portion of the plant site. Currently, groundwater flows in a northwesterly direction beneath the slag pile and northwest portion of the site. With little impact expected for water levels in the eastern portion of the site and additional drawdown expected for the western portion of the site, groundwater flow in the north plant area may assume a more westerly orientation. Indications of an increased gradient towards the west can already be seen in the current drawdown test results. As shown on Figure 7, water level declines on the west plant site (see well DH-42, Figure 7), and the lack of response in well DH-68 located on the south portion of the slag pile, have resulted in a reversal in hydraulic gradients between these areas.

A third possible effect of the SPHC is a decrease in apparent westward flow from the south plant area towards the Phase I CAMU. Drawdown test water level trends at CAMU wells

MW-6, MW-2 and MW-3 correlate closely with those at south plant site monitoring well DH-20, while other CAMU wells (with the possible exception of MW-10) show no correlation. Figure 20 shows this relationship for select CAMU wells. Lowering the south plant groundwater levels should reduce or possibly eliminate potential westward flow in this area, depending on the post-SPHC groundwater levels on the south plant site.

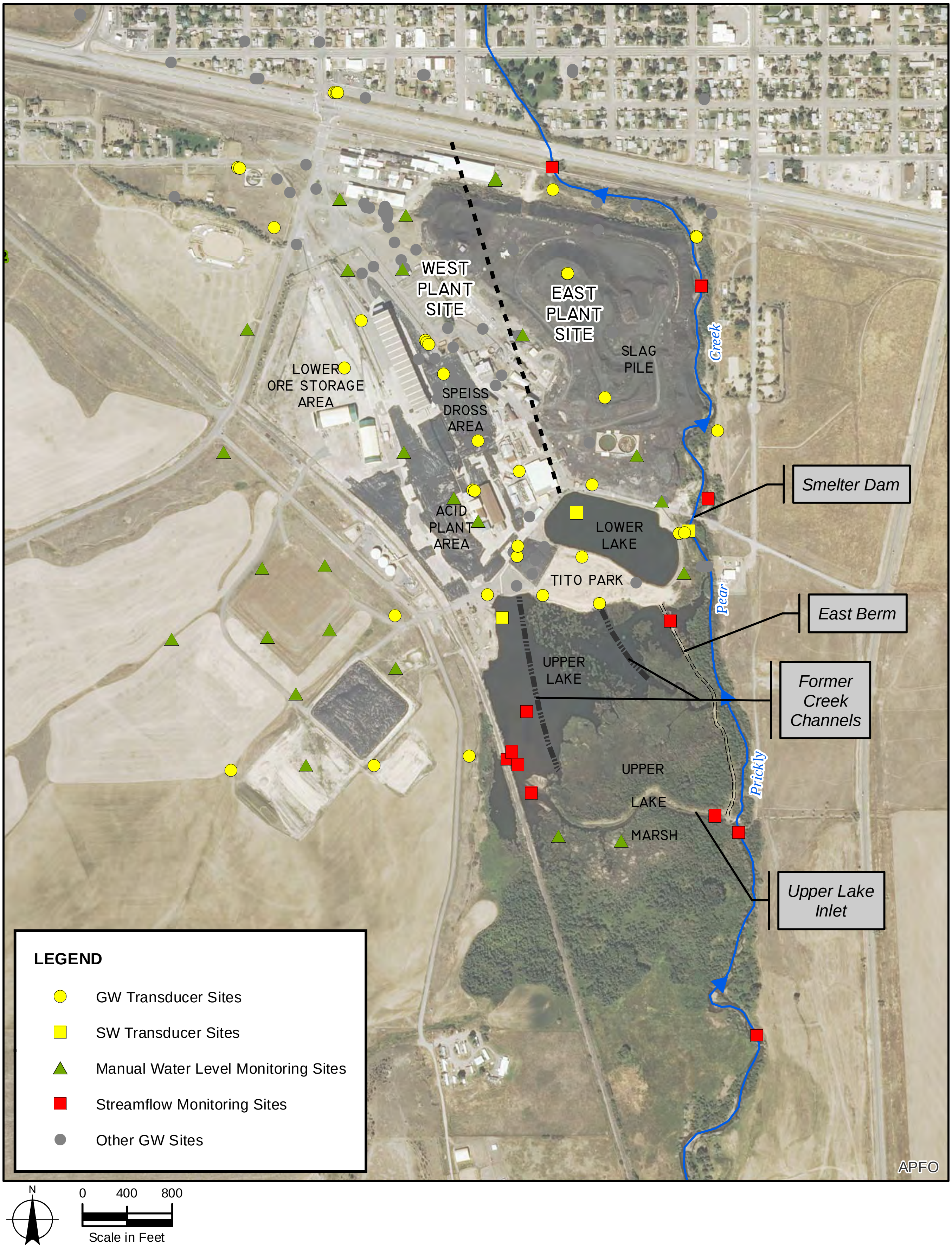
5.0 SUMMARY AND RECOMMENDATIONS

The Upper Lake drawdown test results to date show groundwater levels have declined on the order of 3 to 5 feet in the south, west and northwest plant areas, and less than a foot on the east side of the plant beneath the slag pile. As of mid-September, water levels continue to decline across the site. Water level declines of an additional five feet or more are expected in the south plant area in response to dewatering of Upper Lake and permanent lowering of Prickly Pear Creek under the SPHC project. The groundwater level declines already realized through the lake drawdown test have dropped the water table below the zone of highest soil contaminant levels in certain areas, with post-SPHC water level drawdown expected to further dewater contaminated soils in the south plant and acid plant areas. Lowering of the water table is not only expected to reduce contact between the plant site groundwater and soil contaminants, but should also reduce the rate of groundwater flow, or flux, through the plant site. Together, these two factors should result in a reduction of contaminant leaching to groundwater and contaminant loads, in pounds per day, emanating from the plant site.

Dewatering of Upper Lake/Lower Lake and lowering the Prickly Pear Creek level by approximately 8 feet at the current smelter dam location as proposed under the SPHC project will result in a more uniform potentiometric surface through the south plant area and eliminate the northward “bulge” in the potentiometric surface caused by Upper and Lower Lake. The result will be a reduction in seepage from the northwest portion of Upper Lake to the west plant site, and a reduction in seepage from the east and west ends of Lower Lake which currently provides recharge to Prickly Pear Creek and the west plant site, respectively. Other potential changes in the plant site groundwater flow patterns include an increased westerly component to groundwater flow in the northern portion of the site (due to greater effect on groundwater levels in the west plant area than the east), and a reduction in potential westward flow from the south plant site towards the Phase I CAMU cell. Effects on northwest plant site groundwater levels will depend in large part on future flow conditions in Wilson Ditch.

One outstanding question related to the Upper Lake drawdown test is the volume and fate of groundwater underflow beneath Upper Lake onto the plant site. The rate of groundwater underflow from beneath Upper Lake towards the plant site should be evaluated further to determine how this source may affect post-SPHC groundwater flow through the plant site. Depending on the results, appropriate measures could be incorporated into design of the low permeability zone/groundwater cutoff wall proposed in the SPHC to further reduce groundwater flow through the plant site, if necessary. Gaining a better understanding of this groundwater underflow component will also prove useful in assessing construction dewatering requirements for the SPHC.

Based on the findings to date, continuation of the pumping phase of the Upper Lake drawdown test through September 2012 is recommended. Continuing the test through September will provide a full year of drawdown test data, which will aid in discerning seasonal (and longer-term) water level trends from lake drawdown-induced effects. With cessation of pumping, the Upper Lake water level should recover from the current 3916 level to about 3918 feet. Plant site groundwater levels should be recorded during the lake recovery period to provide additional information on the groundwater response to lake dewatering. Groundwater level trends recorded during both the lake drawdown and recovery phase of the test will help delineate possible areas of increased permeability, preferential groundwater flow paths, and post-SPHC hydraulic gradients and groundwater fluxes through the site. Information presented in this memorandum can be updated following the water level recovery phase of the test. Based on information collected to date however, the Upper Lake drawdown test results indicate that the SPHC project will effectively lower plant site groundwater levels, thus reducing potential leaching of contaminants from soils to groundwater, and will most likely reduce overall groundwater flow rates through the plant site.



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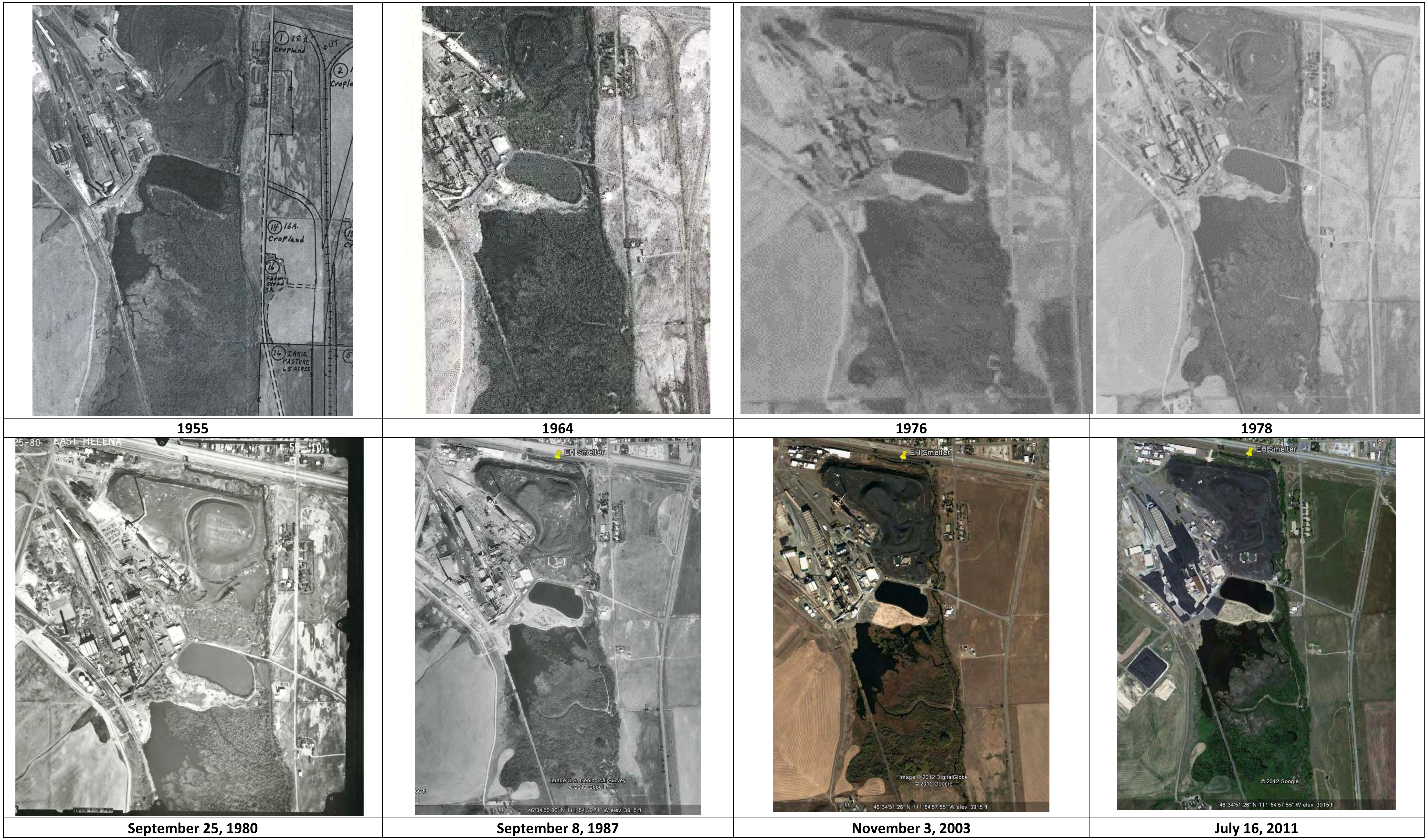
PRIMARY SITE FEATURES FOR UPPER LAKE DRAWDOWN TEST EAST HELENA FACILITY

FIGURE

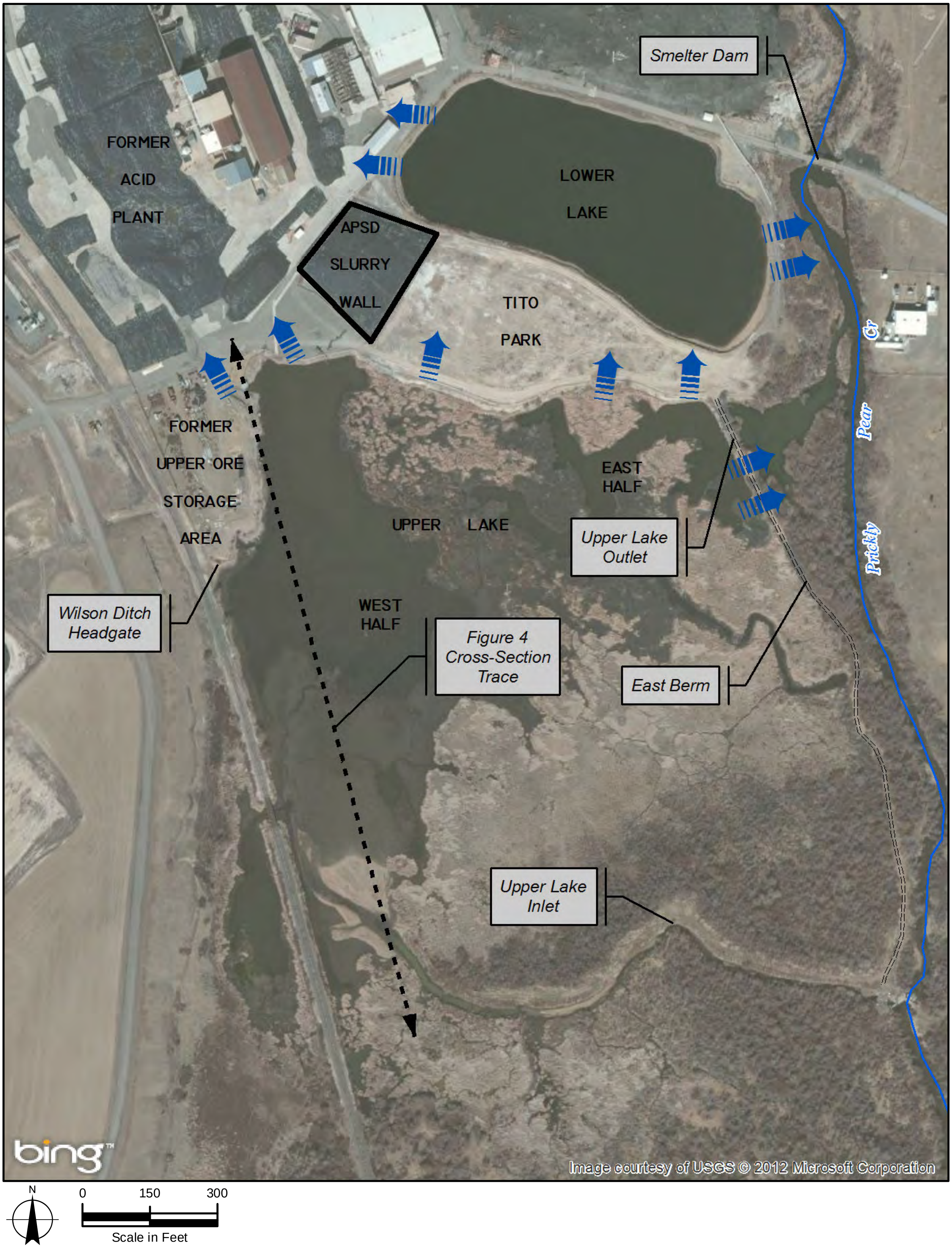
1



1955 | 1964 | 1976 | 1978

September 25, 1980 | September 8, 1987 | November 3, 2003 | July 16, 2011

FIGURE 2. PROGRESSION OF UPPER LAKE EXPANSION SINCE 1955.



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PRIMARY UPPER (AND LOWER) LAKE LEAKAGE PATHWAYS AT MAXIMUM LAKE LEVELS EAST HELENA FACILITY

FIGURE
3

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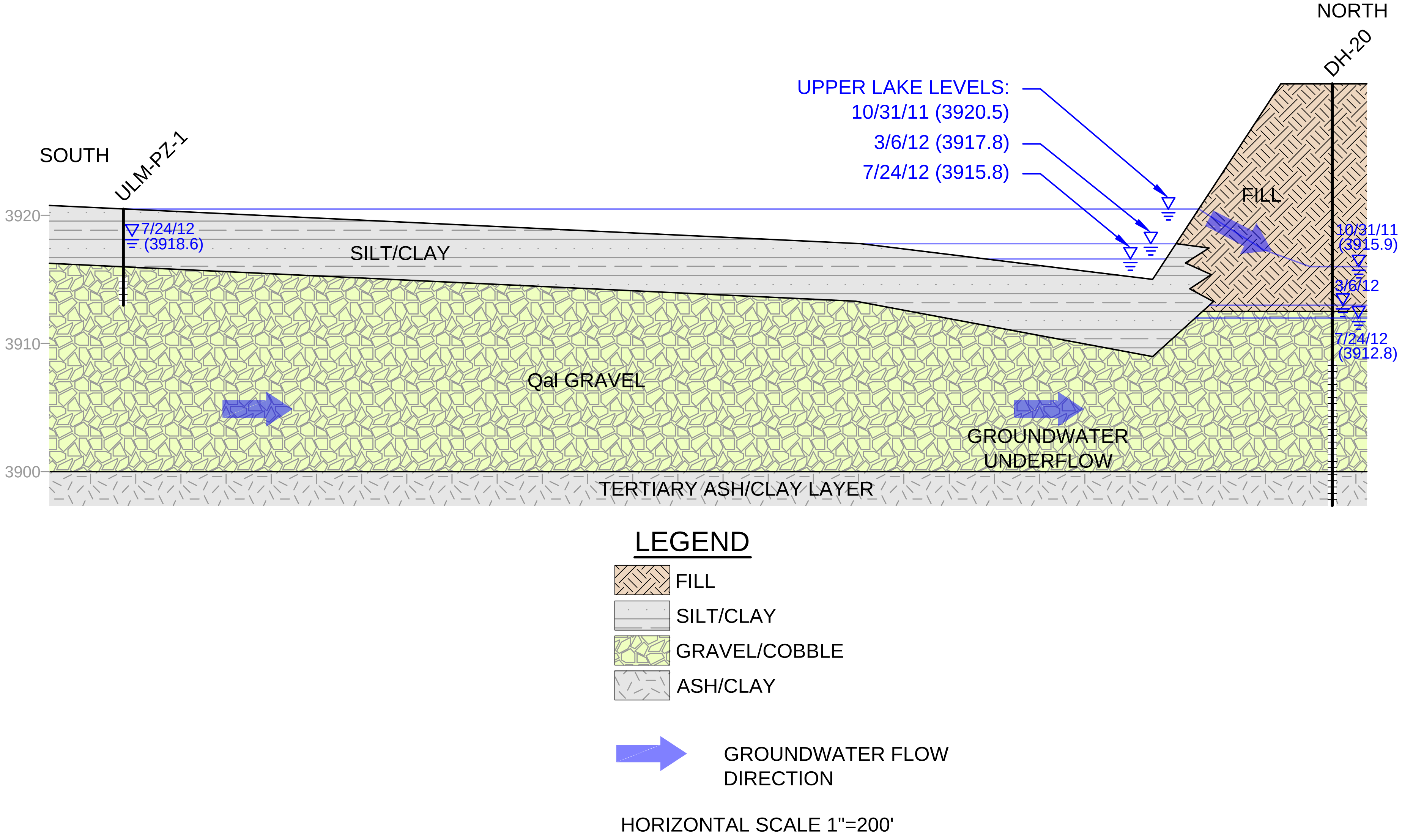

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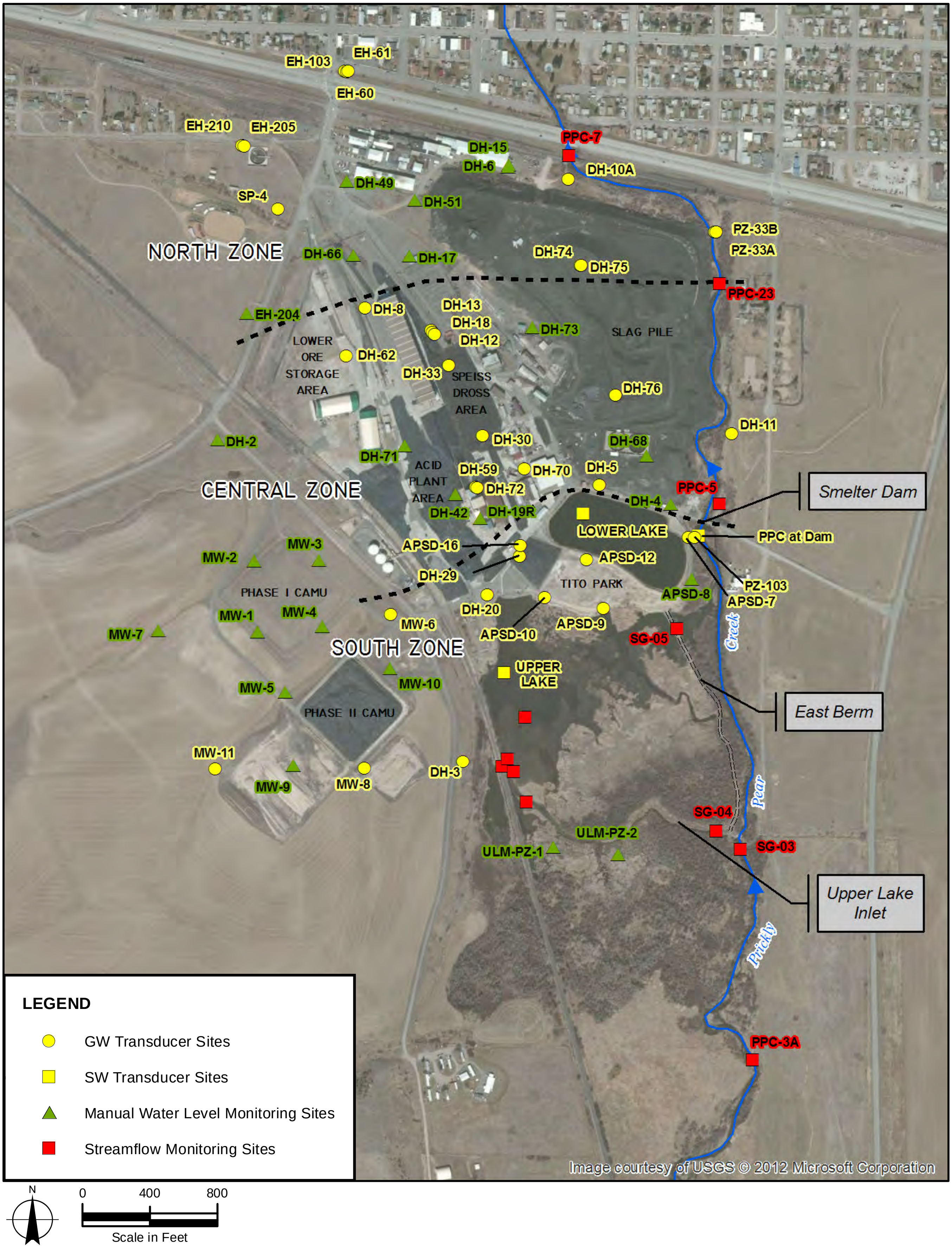
SCHEMATIC CROSS SECTION THROUGH UPPER LAKE - WEST HALF

FIGURE
4



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WATER LEVEL MONITORING SITES
FOR UPPER LAKE DRAWDOWN TEST
EAST HELENA FACILITY

FIGURE

5

Figure 6. South Plant Site Groundwater Levels

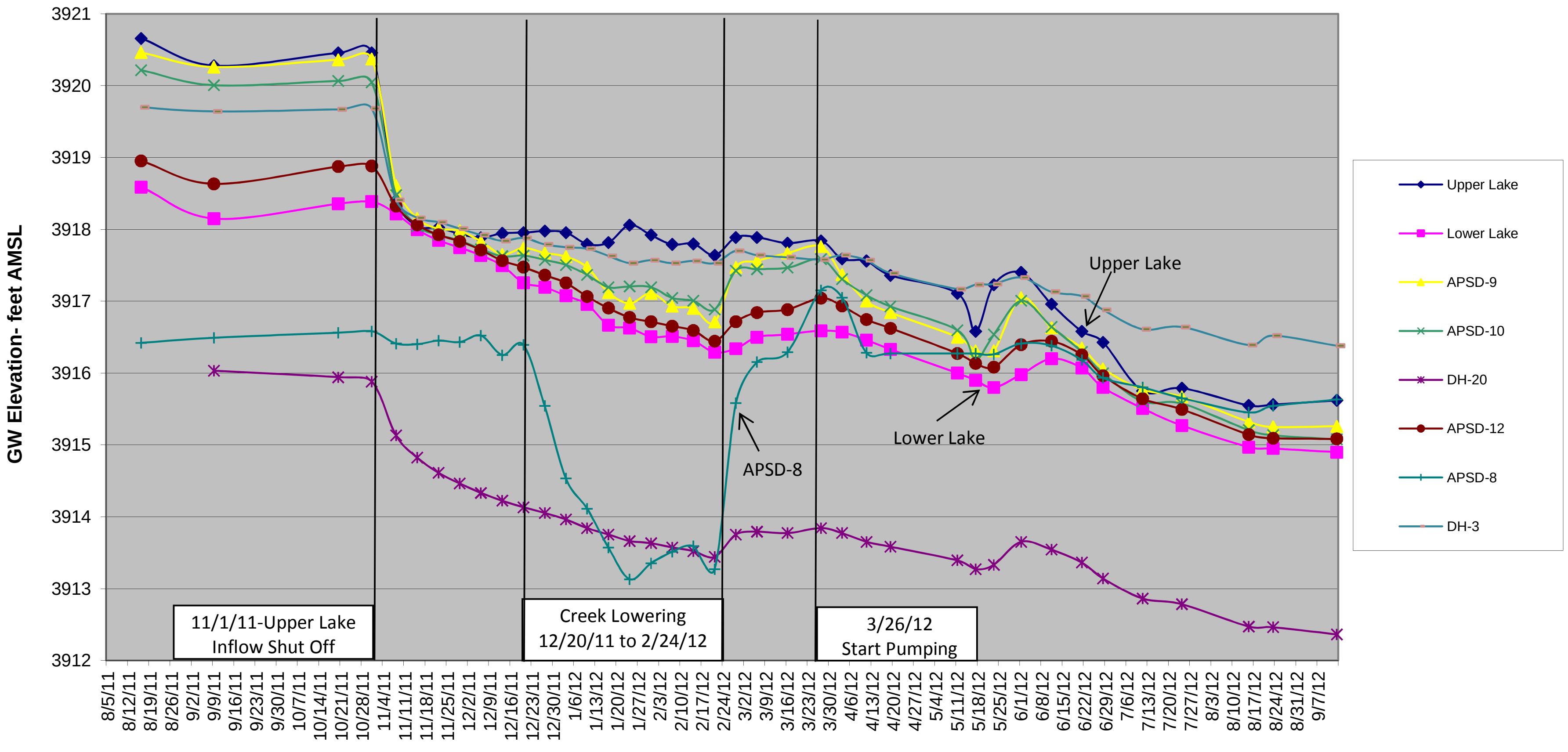
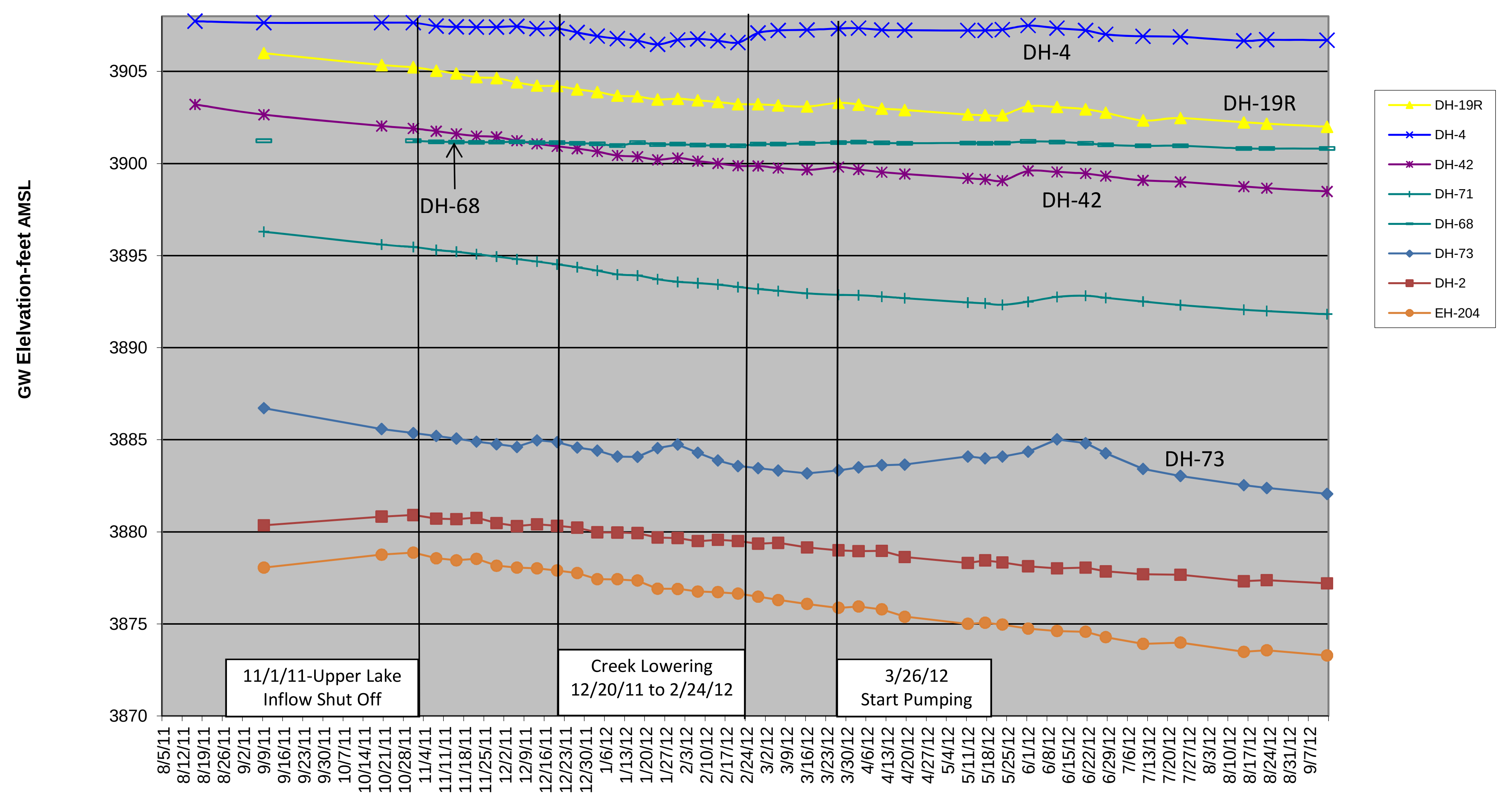


Figure 7. Central Plant Site Groundwater Levels



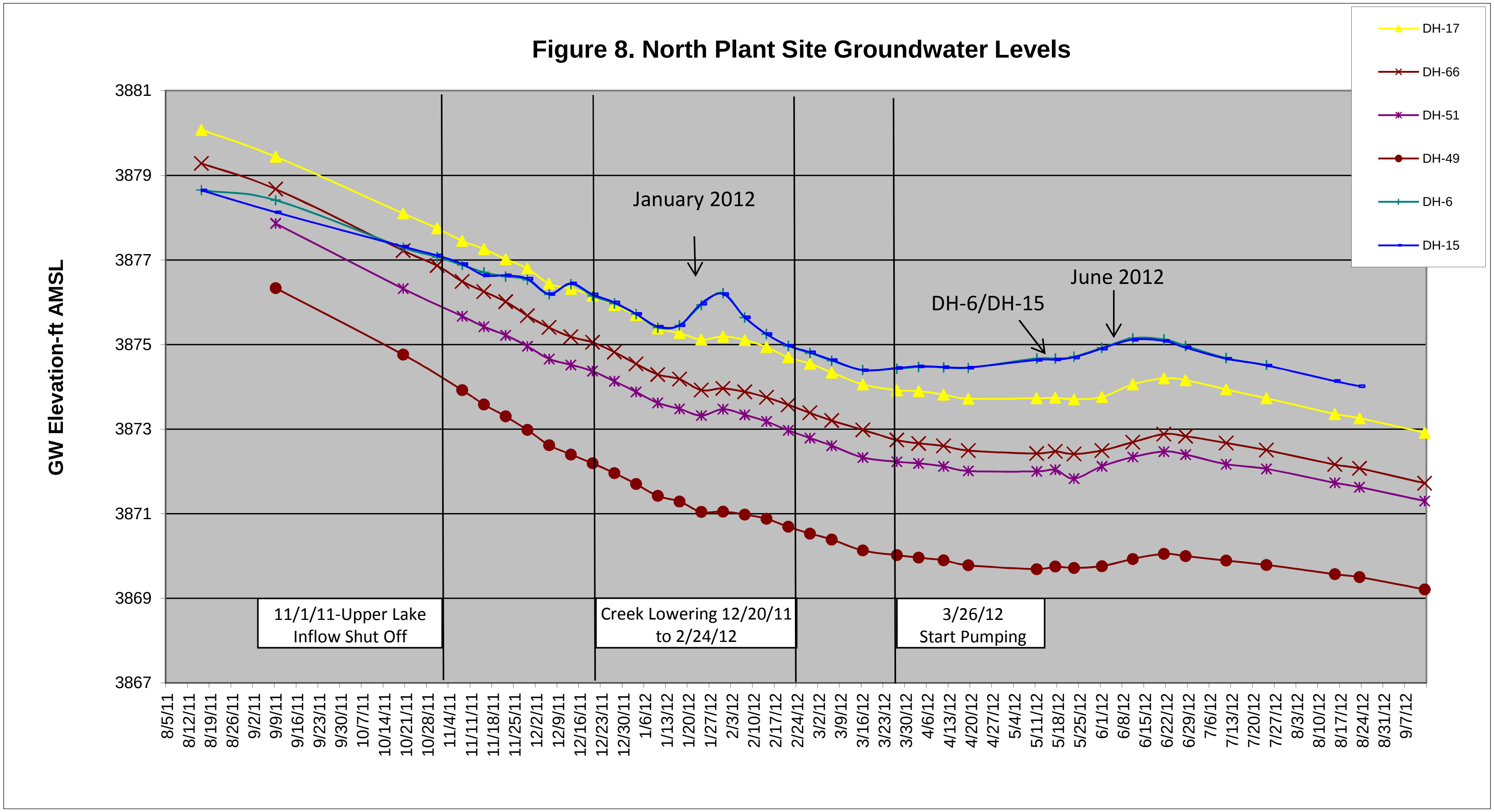


Figure 8. North Plant Site Groundwater Levels
GW Elevation-ft AMSL
3881
3879
3877
3875
3873
3871
3869
3867
8/5/11
8/12/11
8/19/11
8/26/11
9/2/11
9/9/11
9/16/11
9/23/11
9/30/11
10/7/11
10/14/11
10/21/11
10/28/11
11/4/11
11/11/11
11/18/11
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12/2/11
12/9/11
12/16/11
12/23/11
12/30/11
1/6/12
1/13/12
1/20/12
1/27/12
2/3/12
2/10/12
2/17/12
2/24/12
3/2/12
3/9/12
3/16/12
3/23/12
3/30/12
4/6/12
4/13/12
4/20/12
4/27/12
5/4/12
5/11/12
5/18/12
5/25/12
6/1/12
6/8/12
6/15/12
6/22/12
6/29/12
7/6/12
7/13/12
7/20/12
7/27/12
8/3/12
8/10/12
8/17/12
8/24/12
8/31/12
9/7/12
DH-17
DH-66
DH-51
DH-49
DH-6
DH-15
January 2012
June 2012
DH-6/DH-15
11/1/11-Upper Lake Inflow Shut Off
Creek Lowering 12/20/11 to 2/24/12
3/26/12 Start Pumping

Figure 9. Long-Term Seasonal Trends in Select North Plant Site Wells

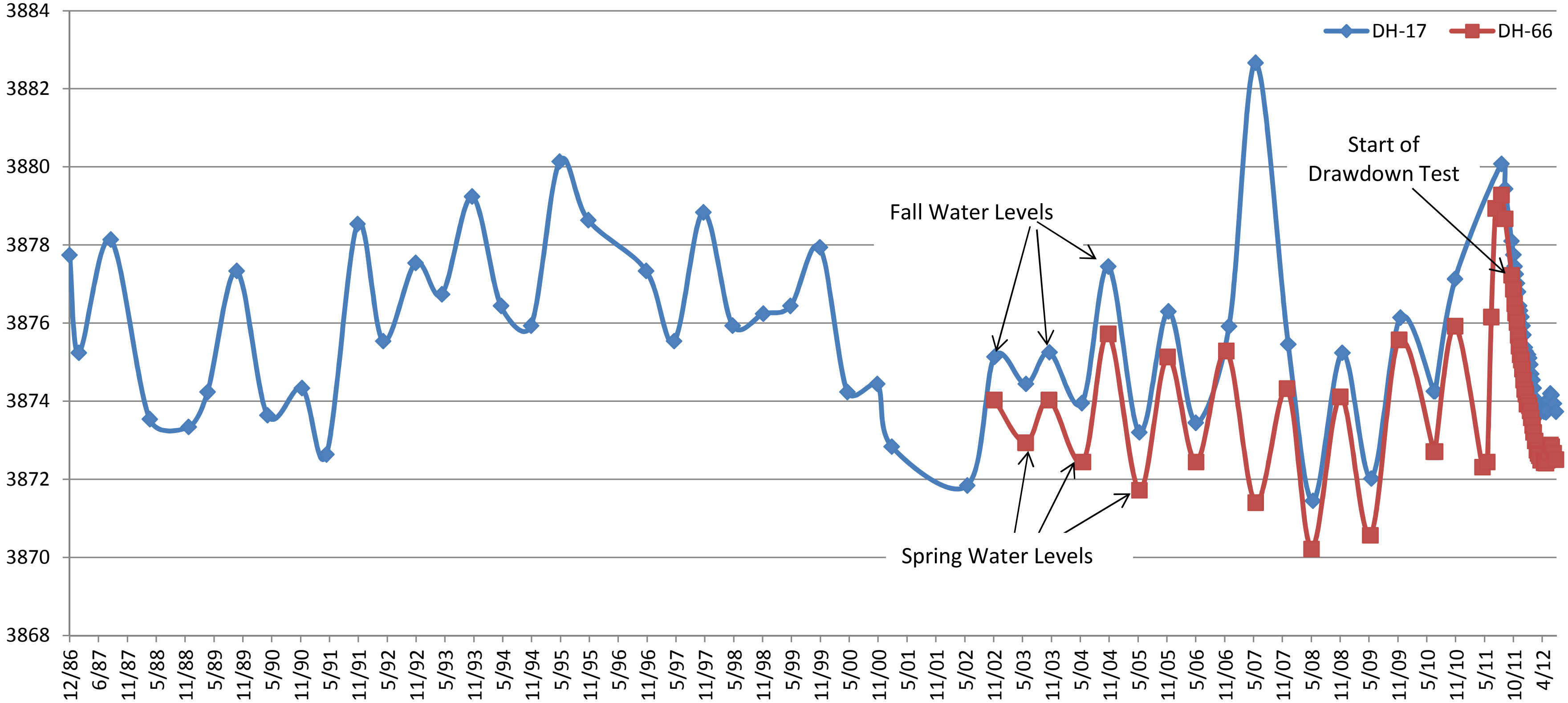


FIGURE 10. CONTINUOUS WATER LEVEL HYDROGRAPH FOR MONITORING WELL EH-210

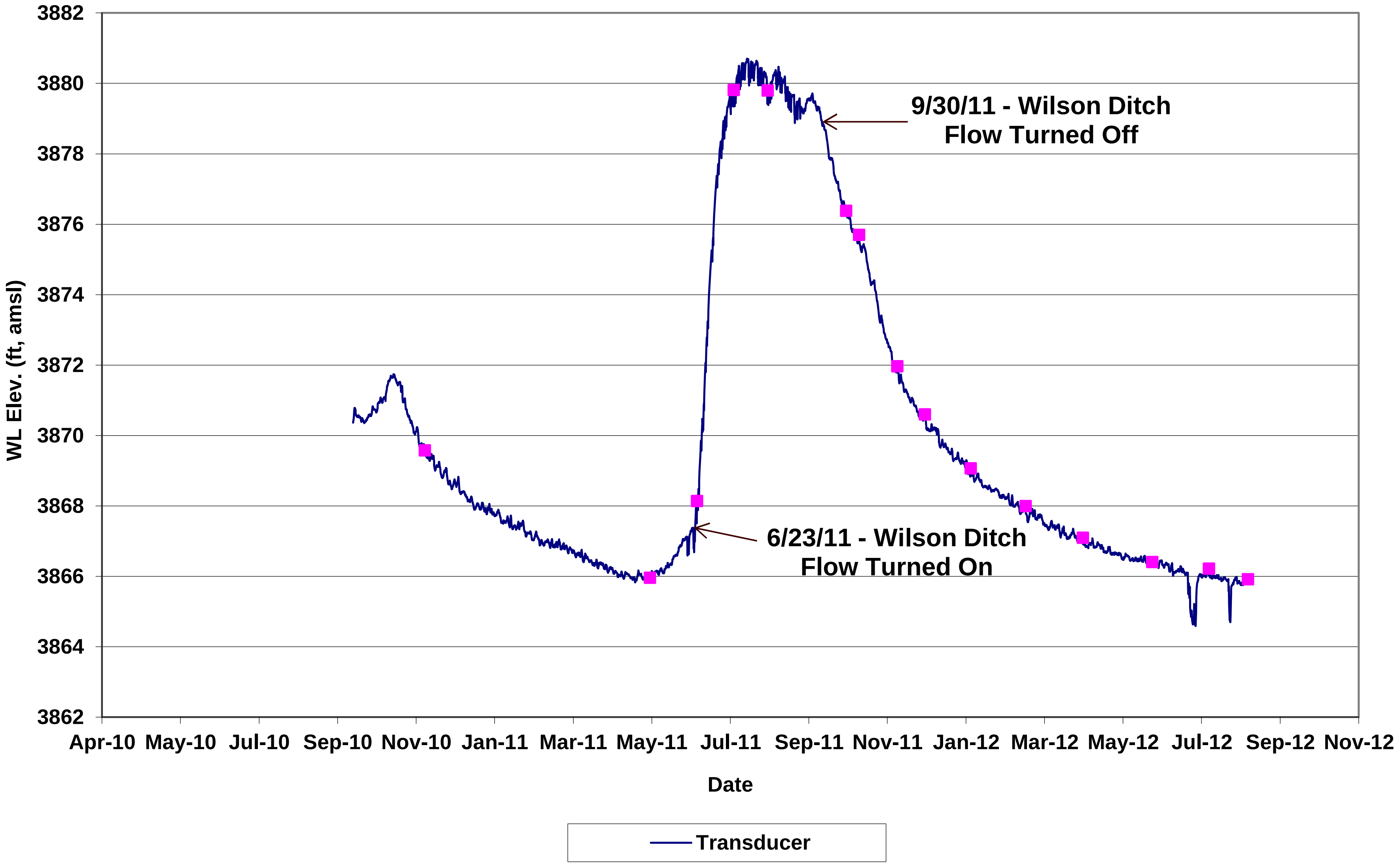
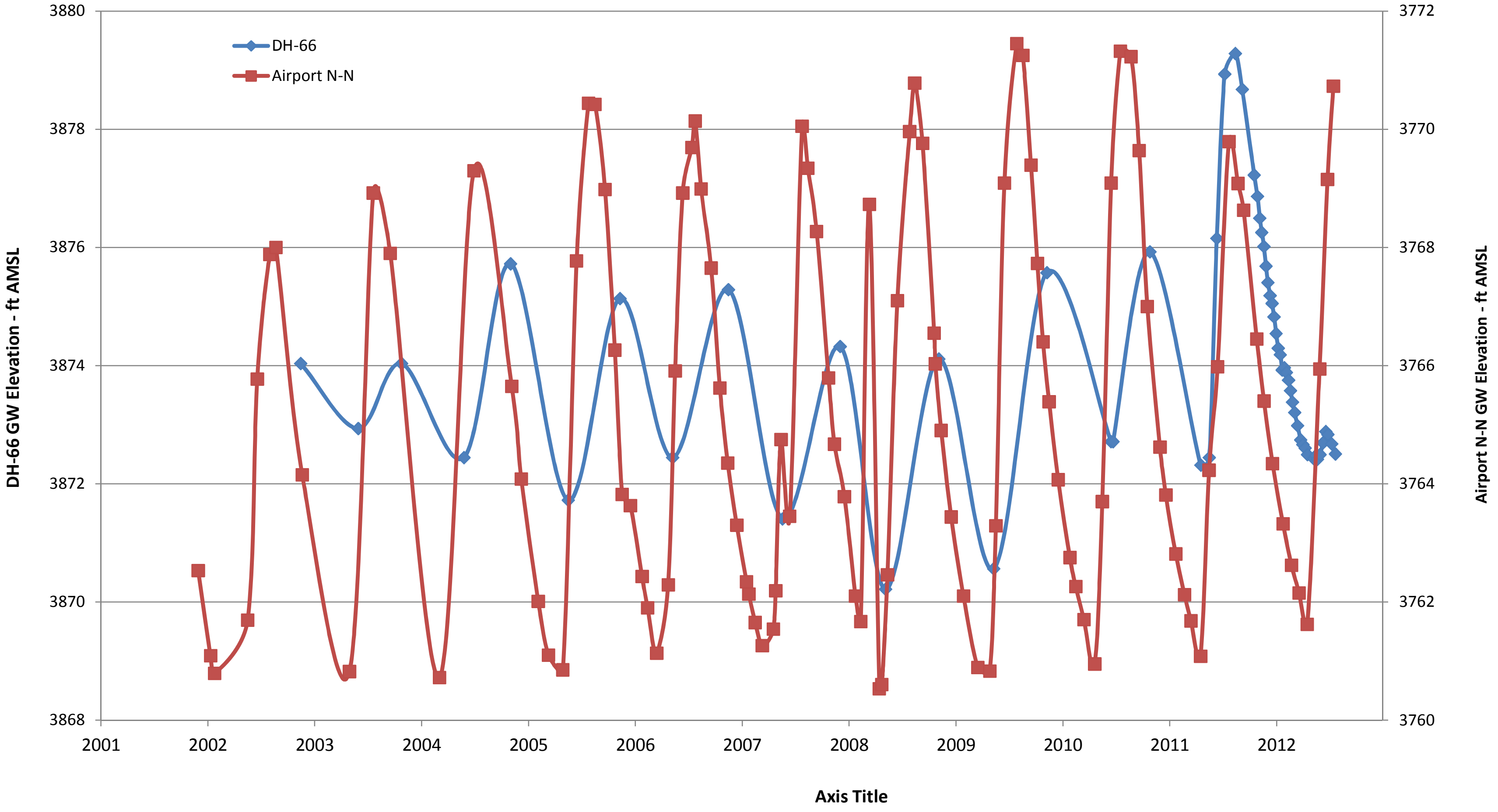
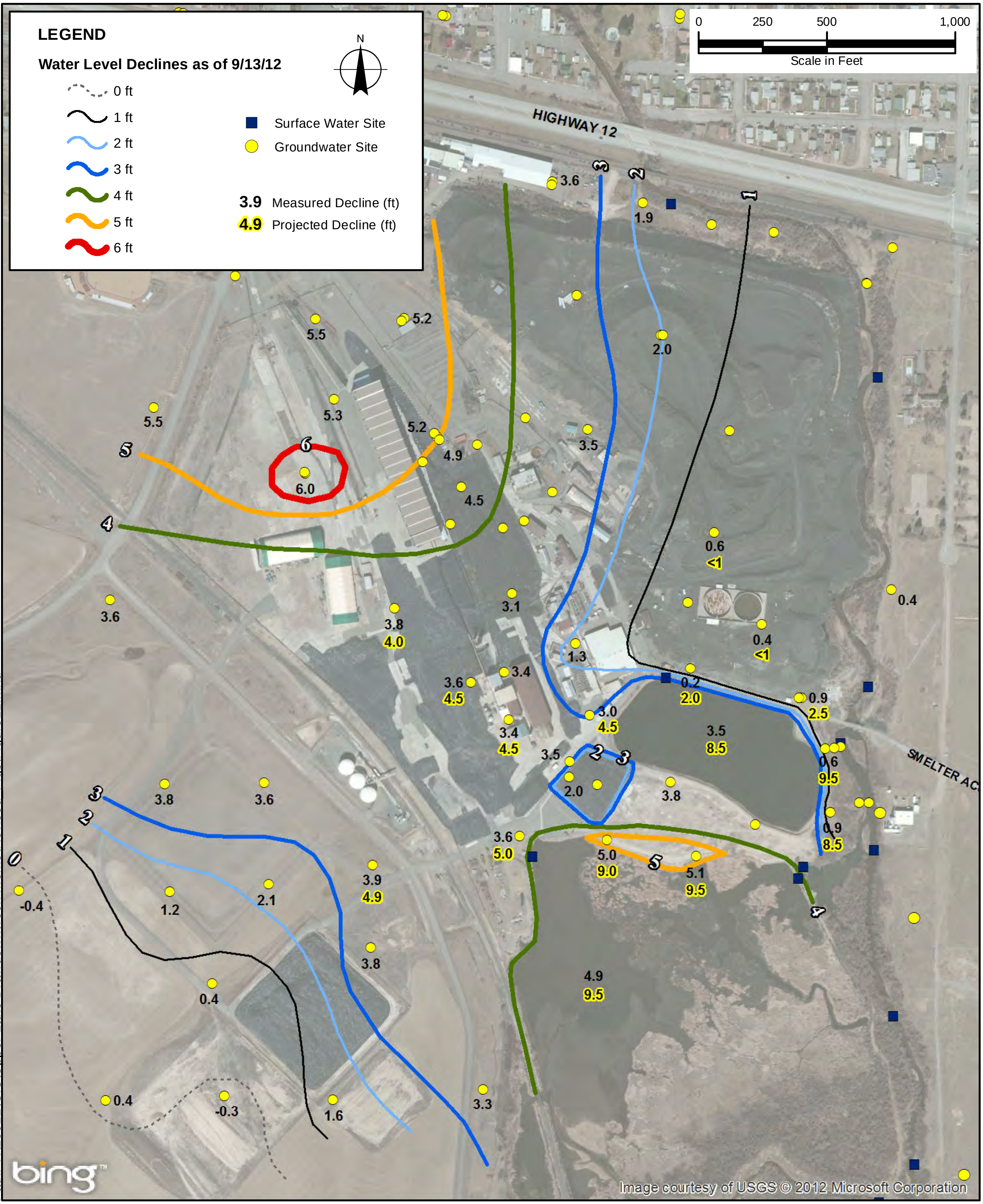


Figure 11. DH-66 and Airport Well Hydrographs





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MEASURED WATER LEVEL DECLINES AS OF 9/13/12 AND PROJECTED DECLINES WITH PERMANENT CREEK LOWERING AND UPPER LAKE REMOVAL UPPER LAKE DRAWDOWN TEST - EAST HELENA FACILITY

FIGURE
12

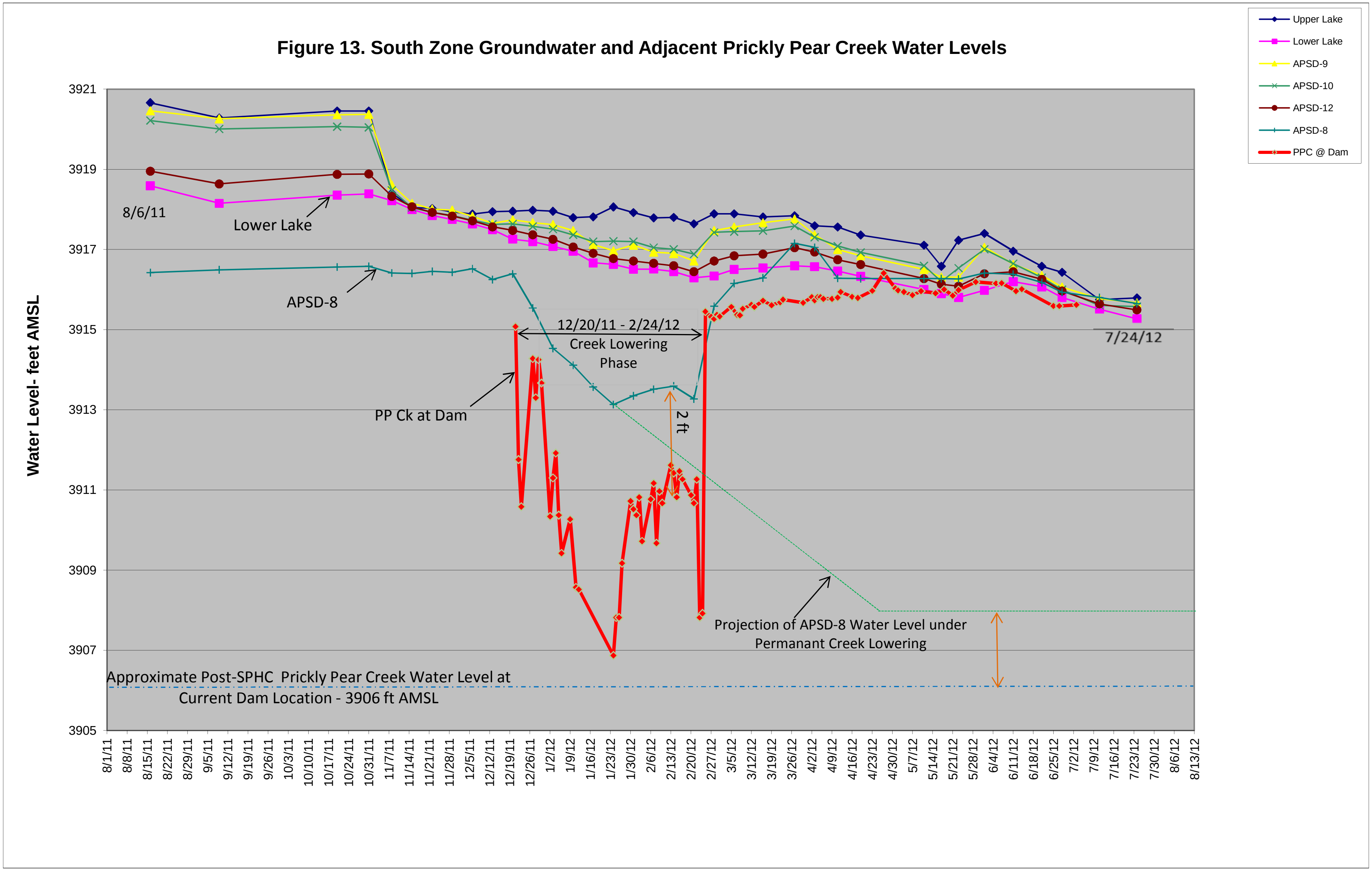

Figure 13. South Zone Groundwater and Adjacent Prickly Pear Creek Water Levels

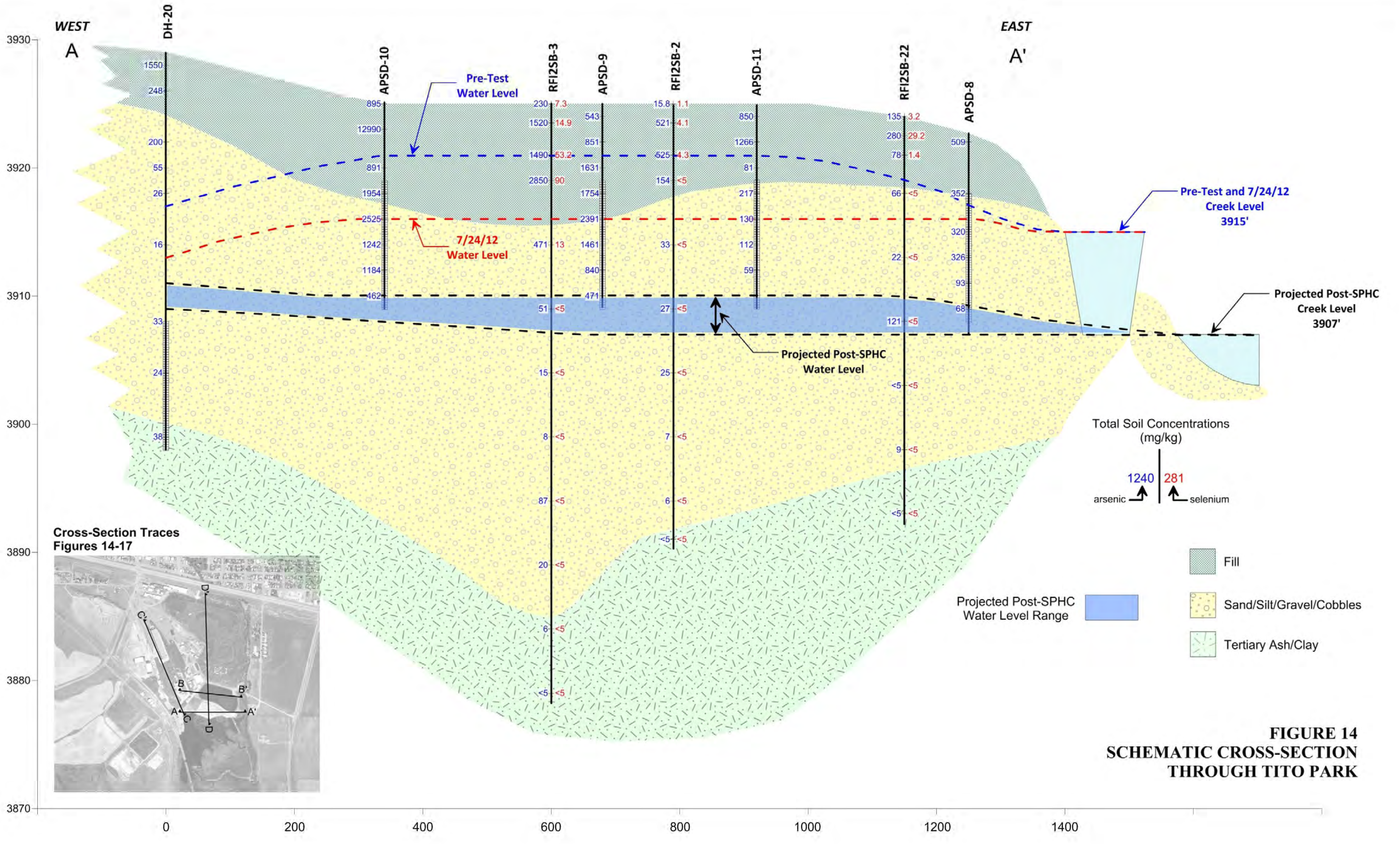

FIGURE 14
SCHEMATIC CROSS-SECTION
THROUGH TITO PARK

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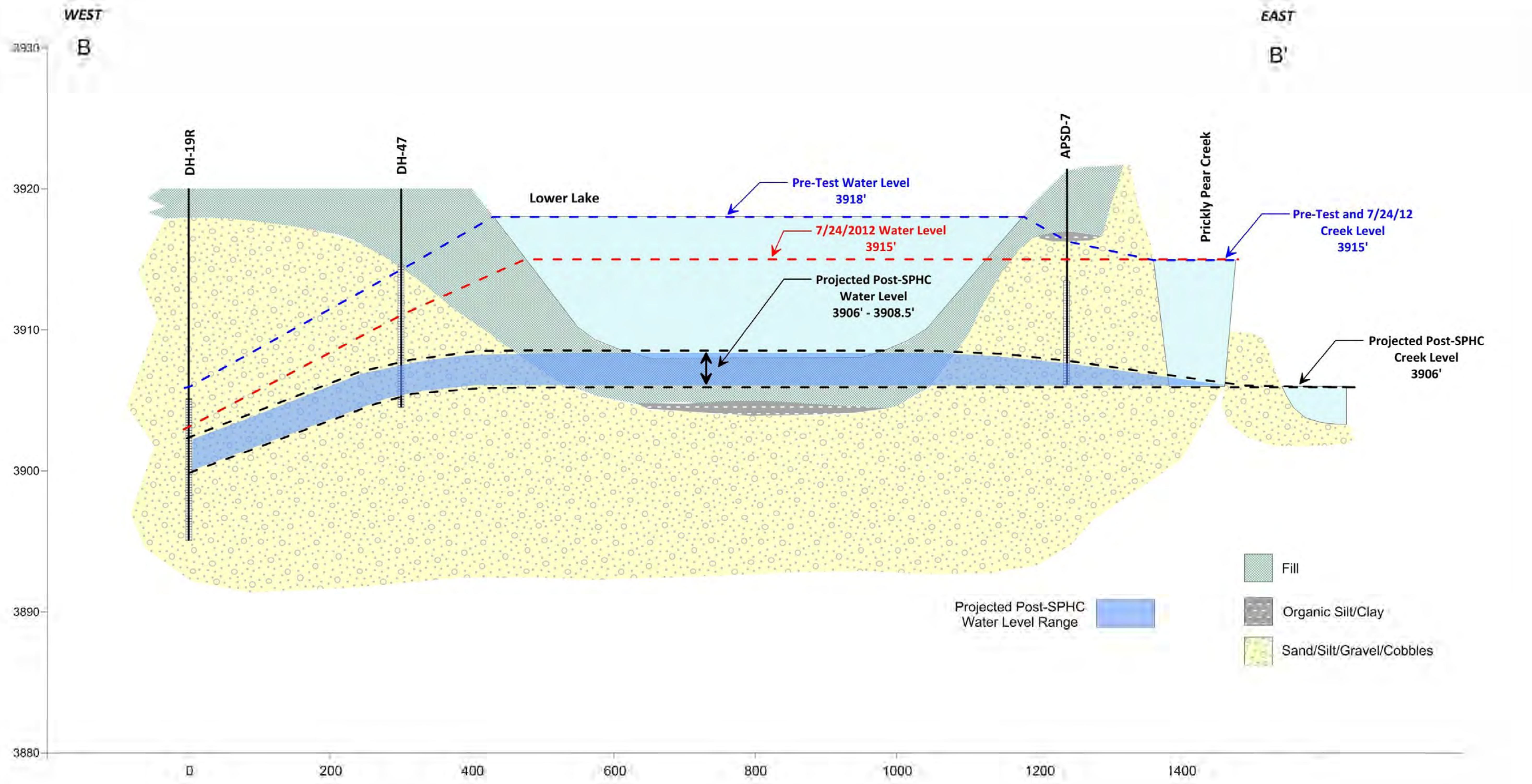

FIGURE 15
SCHEMATIC CROSS-SECTION
THROUGH LOWER LAKE

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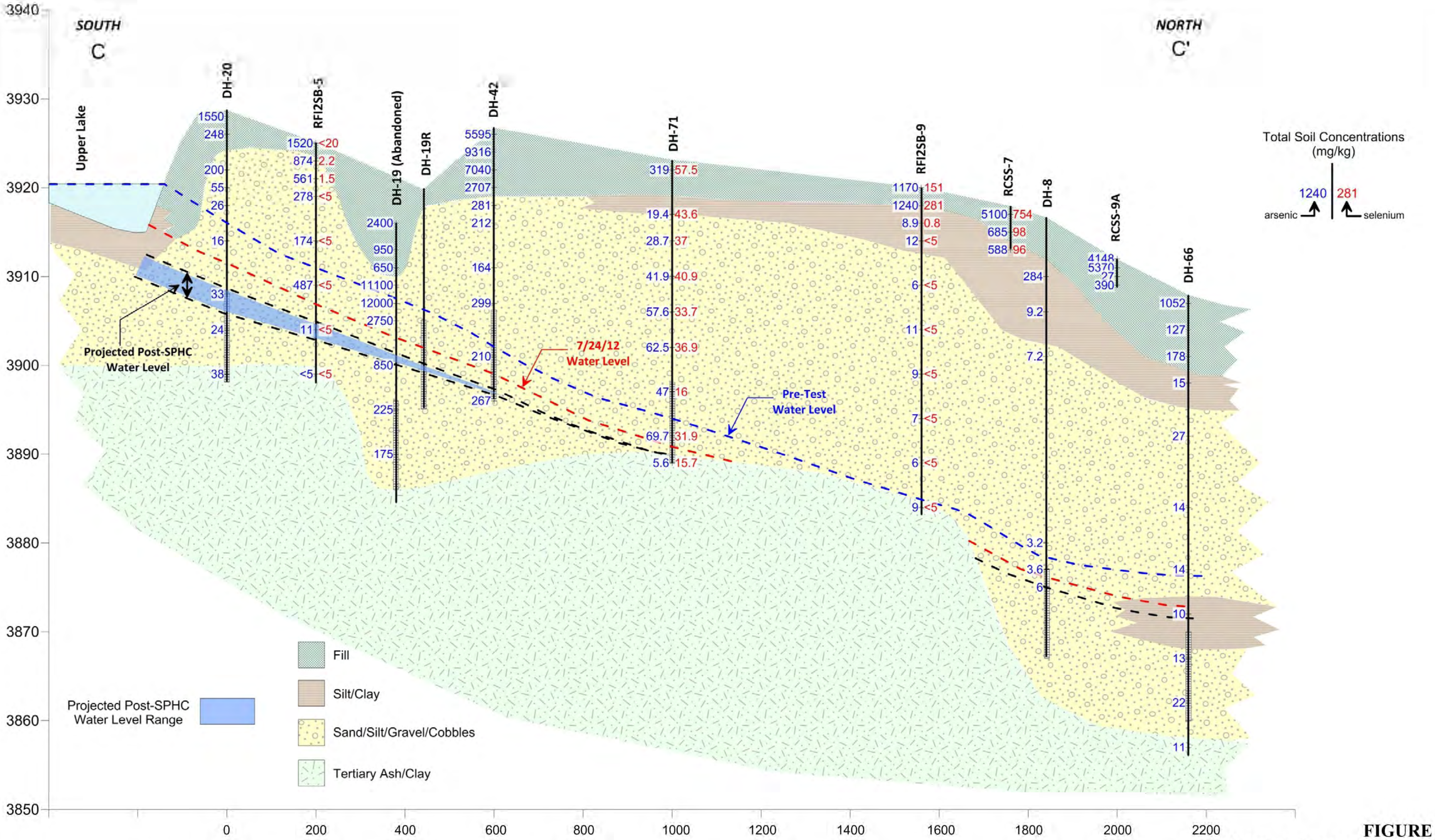

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FIGURE 16
SCHEMATIC CROSS-SECTION
UPPER LAKE NORTHWEST
THROUGH WEST SE/LOSA AREA

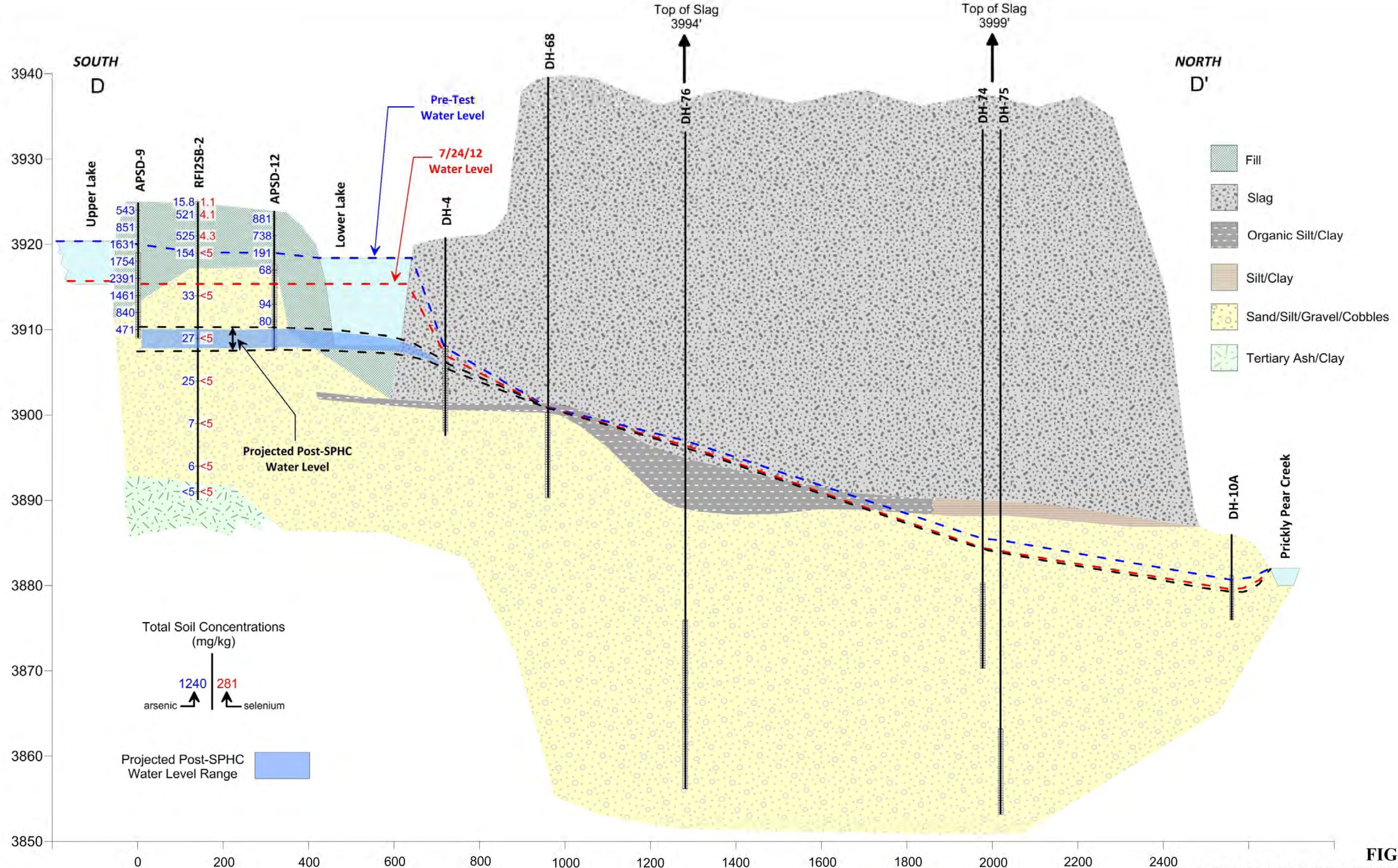

FIGURE 17
SCHEMATIC CROSS-SECTION UPPER LAKE NORTH THROUGH SLAG PILE

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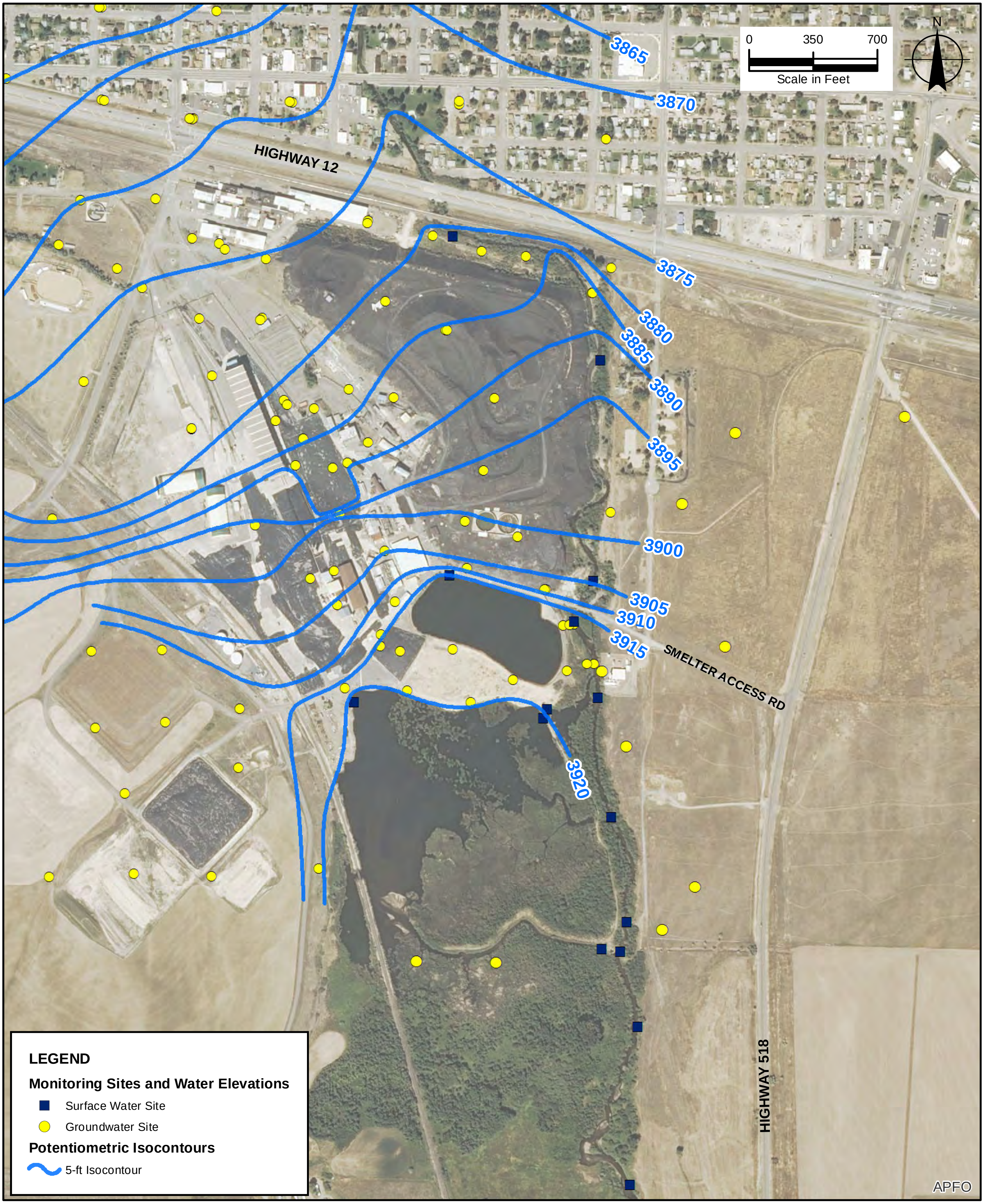

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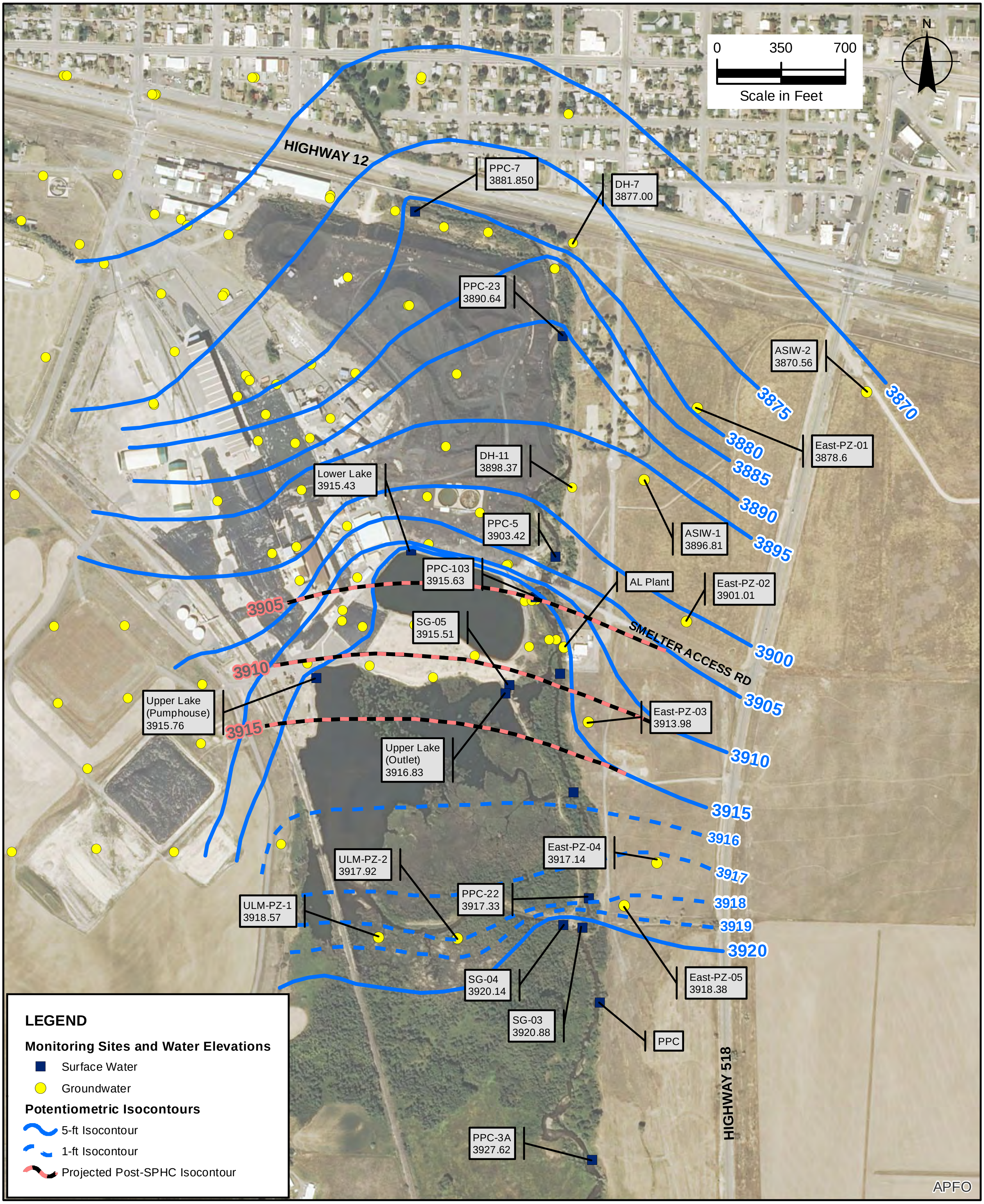
OCTOBER 2010 POTENTIOMETRIC MAP
UPPER LAKE DRAWDOWN TEST
EAST HELENA FACILITY

FIGURE

18



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Consulting Scientists and Engineers

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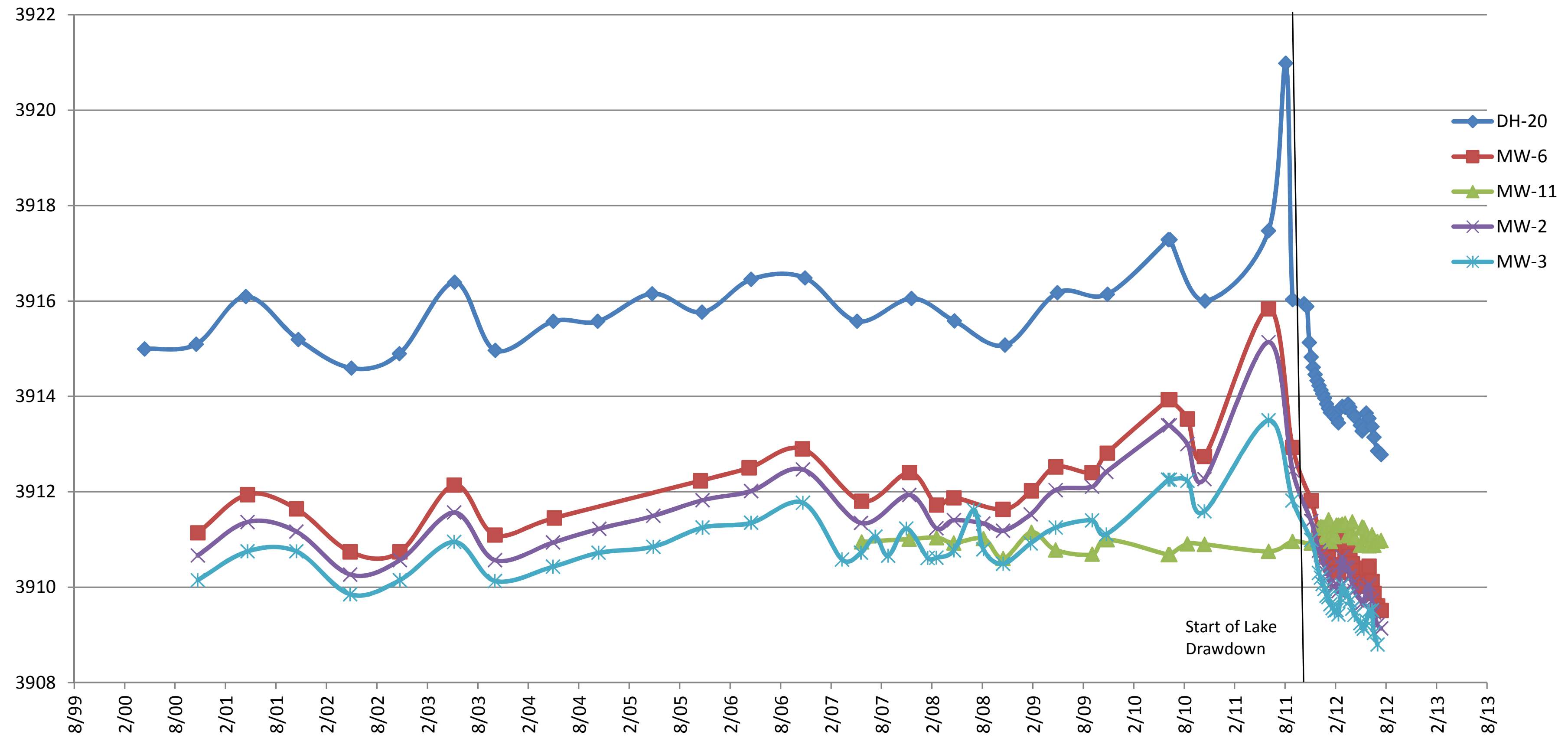
JULY 24, 2012 POTENTIOMETRIC MAP
UPPER LAKE DRAWDOWN TEST
EAST HELENA FACILITY

FIGURE
19

Figure 20. Water Level Trends at Wells DH-20, MW-6 and MW-11



Appendix F: Geotechnical Investigations Summary Memorandum

Hydrometrics, Inc.
consulting scientists and engineers

MEMORANDUM

DATE: March 28, 2013

TO: George Austiguy, PE

FROM: Josh Gilstrap, PE

COPY: Bob Anderson

SUBJECT: East Helena Facility East Bench and Upper Lake Marsh Test Pits Related to Prickly Pear Creek Realignment

This memo provides a summary of the geotechnical data collected from seven test pits excavated along the East Bench in 2012 and seven test pits excavated in the Upper Lake marsh complex in 2013. The East Bench test pits were excavated to support planning and design of the Prickly Pear Creek temporary bypass channel and final channel realignment, while the Upper Lake marsh test pits were excavated to support design of the south creek realignment.

BACKGROUND

The Prickly Pear Creek (PPC) temporary bypass channel will be constructed along the 'East Bench' in order to divert stream flow for the duration of channel realignment construction. The bypass will begin upstream of the existing diversion from PPC to Upper Lake, run north along the East Bench, and then divert back into the main stem of PPC just downstream of the Smelter Dam.

The realigned Prickly Pear Creek channel will run from upstream of the existing Upper Lake inlet diversion, through the Upper Lake marsh area, and along the east side of the slag pile.

INVESTIGATION/EXPLORATION

Hydrometrics conducted two separate geotechnical investigations in support of these projects. In January 2012, five test pits were excavated and logged by a geotechnical engineer along the alignment of the bypass channel, and two more test pits were excavated and logged east of Prickly Pear Creek in the former Asarco housing area. Locations for these test pits are shown on Attachment 1.

In February 2013, seven test pits were excavated and logged in the Upper Lake Marsh complex (also shown on Attachment 1), with the test pits designated as PPCRTP-01 through PPCRTP-07. PPCRTP is an acronym for Prickly Pear Creek Realignment Test Pit. These test pits were intended to assist with planning and design of the Prickly Pear Creek realignment design and their locations correspond to the proposed alignment at the time of the investigation. For both series of investigations, the test pit depths correspond to the invert elevation of the respective channel (i.e., bypass or realigned Prickly Pear Creek).

Besides logging of soil stratigraphy, soil characteristics and groundwater conditions, multiple soil samples were collected during each investigation. Bulk five-gallon bucket samples were collected to characterize the materials, and Ziploc grab samples were collected in varying, less dominant strata. High groundwater in the Upper Lake Marsh area created difficult logging conditions below the water table.

SOILS

East Bench

Based on field observations and soil testing, soils encountered along the bypass channel alignment (East Bench test pits) can be categorized into four main groups: 1) topsoil; 2) subsoil; 3) gravelly/cobble alluvium; and 4) Tertiary-aged sediments. The East Bench test pit logs are included in Attachment 2.

A topsoil unit was encountered at all seven test pits and ranged from 0.5 to 1.2 feet thick. The topsoil is described as dark brown, stiff, clayey sand with slightly plastic fines and occasional gravel and abundant roots/plant fragments. This material classified as SC-Clayey Sand to SC-SM-Silty Clayey Sand in the Unified Soil Classification System (USCS) according to laboratory testing.

Immediately below the topsoil was a subsoil unit at all seven test pits, ranging from 0.7 to 1.7 feet thick (Attachment 2). The subsoil is described as buff, dry, stiff/dense, silty sand to silty sand and gravel with slightly plastic fines. Samples of this material classified as SM-Silty Sand, SC-SM-Silty Clayey Sand, and GP-GM-Poorly Graded Gravel with Silt and Sand.

Underlying the subsoil at all seven locations is gravel and cobble alluvium with varying amounts of sand. The alluvium ranges in thickness from approximately 10 feet in the south (East TP-7), to 15 feet or more in the northern test pits. Based on nearby well logs, the alluvium is known to extend to at least 38 feet below ground surface in the northern portion of the East Bench. The alluvium is generally described as reddish brown, moist, dry to slightly moist, medium dense to dense, with subangular and subround gravel and cobble, and stratified. Samples of this material classified as GW-Well Graded Gravel to GP-Poorly Graded Gravel.

The Tertiary sediments were only encountered at depth in the southern-most pits (East TP-6 and TP-7); samples of this material classified as SC-Clayey Sand, CL-Sandy Lean Clay, GW-GC-Well Graded Gravel with Clay and Sand, and SM-Silty Sand. Tertiary sediments were encountered at 16.5 feet below ground surface at test pit East TP-6 and 12.5 feet at test pit East TP-7.

Upper Lake Marsh

Based on field observations and soil testing soils in the Upper Lake Marsh area are categorized into two main groups corresponding to lithology beginning at the ground surface: 1) marsh sediments; and 2) alluvium. The alluvium can be further categorized into two subgroups – sand and sand with gravel and cobble to sandy gravel and cobble. The material with gravel and cobble is present at depth, specifically south of the diversion channel from Prickly Pear Creek to Upper Lake. The Upper Lake marsh test pit logs are included in Attachment 3.

The marsh sediments were generally described as brown to dark brown, very soft to soft, slightly plastic, with trace fine sand and abundant organic debris. The marsh sediments are on the order of one to two feet thick.

The underlying sandy alluvium is described as orange and gray/dark brown, wet, and loose to medium dense fine to coarse grained sand with relatively low silt content. Laboratory data for this material is discussed below and is tabulated in detail in Attachment 5. North of the Upper Lake inlet channel the sandy alluvium extends down to the depth of the realigned channel bottom.

The coarser alluvium (sand/gravel/cobbles) was encountered at test pits PPCRTP-5, -6 and -7, all located south of the Upper Lake inlet channel (Attachment 1). The coarser material is present at depths of six to seven feet below the ground surface, and is generally described as dark gray, wet, medium dense, and contains subangular and subround gravel and cobble.

GROUNDWATER

Groundwater was encountered in two of the East Bench test pits during excavation: test pit East TP-6 at 14.7 feet below the ground surface, and East TP-7 at 12.5 feet below the ground surface. For more detailed groundwater information, data is available for the east piezometers (East PZ-01 to EAST PZ-05) and groundwater is discussed in detail under separate cover.

Groundwater was encountered in each of the Upper Lake Marsh test pits ranging from 1.7 to 4.5 feet below the ground surface. Two-inch PVC temporary standpipe piezometers were installed in each of the test pits following logging and sampling to allow for future groundwater level monitoring.

LABORATORY TESTING

Geotechnical laboratory testing was performed on selected samples in order to classify the soils and to establish design criteria. The testing included grain size analysis and liquid and plastic limit testing. For the East Bench, soil samples from test pits East TP-2, TP-4, TP-6 and TP-7 were chosen to characterize the topsoil, subsoil, alluvium and tertiary materials.

For the Upper Lake Marsh, soil samples were chosen from each of the test pits (except for PPCRTP-4) in order to characterize the sand and gravelly alluvium. Samples from PPCRTP-

04 were not tested due to concerns about the material not being representative due to difficult excavation, logging, and sampling of the test pit resulting from groundwater and caving.

Results of the laboratory testing and classification have been tabulated and are included in Attachments 4 and 5. Due to the low fines-content of the Upper Lake Marsh test pit samples (two to 13 percent) liquid and plastic limit testing was not performed since at that range the fines content has little influence on the behavior of the material; therefore, the classifications indicated in the table are estimates.

ATTACHMENT 1

TEST PITS AND WELL LOCATIONS IN PRICKLY PEAR CREEK REALIGNMENT AREA

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

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Test Pits and Well Locations
Prickly Pear Creek Realignment Area

ATTACHMENT 2

EAST BENCH TEST PIT LOGS

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-1

Date Hole Started: 1/19/2012 Date Hole Finished: 1/19/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: NE, SE, S36, T10N, R3W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 15.5 feet. No groundwater, no seepage. Difficult digging. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 0.5'		**0.0 - 0.5' Silty Clayey Sand with Gravel** Dark brown, moist, frozen, very stiff, slightly plastic, estimated up to 40% sand, abundant roots, approximately 25% angular to subround gravel to 1 inch diameter. [SC/SM]
1	D2	GRAB		0.5 - 1.2' Estimated 5 to 10% oversize excluded from sample.		**0.5 - 1.2' Silty Sand with Gravel** Buff, dry, stiff to medium stiff, estimated 30% subrounded gravel to 3 inch diameter, 40% sand, massive, grades into below. [SM]
2	D3	GRAB		2.0 - 4.0' Estimated 25% oversize excluded from sample.		**1.2 - 8.0' Sandy Gravel and Cobble** Reddish brown and brown, dry to slightly moist, dense, estimated 25 to 40% cobble, 35 to 50% gravel, 25% sand, hard digging, stratified, 1 foot lens of gravel and cobble to 4 inches at 5.5 feet. [GW]
3	B1	BULK		3.0 - 15.5'		
8						**8.0 - 15.5' Sandy Gravel and Cobble to Sand with Gravel and Cobble** Brown/reddish brown, moist, medium dense to dense (caves more than above), 25 to 30% cobble, 5 to 10% fines, 30% sand, 30% gravel. [SW/GW]
10	D4	GRAB		10.0 - 12.0' Estimated 20% oversize excluded from sample.		

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-2

Date Hole Started: 1/18/2012 Date Hole Finished: 1/19/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: NE, NE, S36, T10N, R3W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 17 feet. No seepage or groundwater. Difficult digging. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 1.0'			0.0 - 1.0' **Clayey Sand** Dark brown, moist, frozen, very stiff, slightly plastic, estimated up to 15% sand and 10% round gravel to 3 inch diameter, abundant roots. [SC]
1	D2	GRAB		1.0 - 2.3'	1		1.0 - 2.3' **Silty Sand** Buff, dry, stiff, slightly plastic, up to 60% fine sand, trace fine gravel, low dry strength, lower contact slopes to northeast to 3.5 feet deep at northeast end of pit. [SM]
2	D3	GRAB		2.3 - 6.0' Estimated 20% oversize excluded from sample.	2		2.3 - 7.5' **Sandy Gravel and Cobble** Reddish brown and brown, dry to slightly moist, medium dense to dense, estimated 30% sand, 45% subrounded gravel, stratified gray and red lenses, estimated 20 to 25% cobble to 1 foot diameter. [GW]
3					3		
4	B1	BULK		4.0 - 17.0' Estimated 5 to 10% oversize excluded from sample.	4		
5					5		
6					6		
7					7		7.5 - 8.5' **Sand** Brown, moist, dense, medium, lens thickens slightly and slopes to the northeast. [SP]
8					8		8.5 - 10.5' **Sandy Gravel and Cobble** Reddish brown and brown, dry to slightly moist, medium dense to dense, estimated 25% sand, 35% subrounded gravel, estimated up to 40% cobble to 1 foot diameter. [GW]
9					9		
10					10		10.5 - 17.0' **Sandy Gravel and Cobble to Sand with Gravel and Cobble** Brown/reddish brown, moist, medium dense (caves more than above), estimated 25% cobble, 5 to 10% fines, 30% sand, 35% gravel. [SW/GW]
11					11		
12					12		
13					13		
14					14		
15	D4	GRAB		15.0 - 16.5' Estimated 10 to 15% oversize excluded from sample.	15		
16					16		
17					17		
18					18		
19					19		

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-3

Date Hole Started: 1/18/2012 Date Hole Finished: 1/18/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: SE, NE, S36, T10N, R3W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 15.5 feet. No seepage or groundwater. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 0.7'		**0.0 - 0.7' Clayey Sand** Dark brown, moist, frozen, very stiff, slightly plastic, estimated up to 50% sand and 10% round gravel to 3 inch diameter, abundant roots. [SC]
1	D2	GRAB		0.7 - 2.3' Estimated 10% oversize excluded from sample.		**0.7 - 2.3' Gravel and Cobble with Sand and Silt** Buff, dry, dense, estimated 60% subround gravel and cobble to 6 inch diameter, 20% slightly plastic silt, 20% fine and medium sand, calcium precipitate on clasts. [GW/GM]
2						
3	D3	GRAB		3.0 - 4.0' Estimated 20% oversize excluded from sample.		**2.3 - 10.5' Sandy Gravel and Cobble** Reddish brown and brown, dry to moist with depth, medium dense to dense, estimated 30% sand, 45% subrounded gravel, approximately 25% cobble to 1 foot diameter, stratified gray and red lenses, average cobble size increases slightly at approximately 7 feet to approximately 6 inch diameter. [GW]
4	B1	BULK		4.0 - 15.5' Estimated 5% oversize excluded from sample.		
5						
6						
7						
8						
9						
10						**10.5 - 15.5' Sandy Gravel and Cobble to Sand with Gravel and Cobble** Brown/reddish brown, moist, medium dense (caves more than above), estimated 35% subround gravel, 15% cobble to 1 foot diameter, up to 10% fines, 40% sand. [SW/GW]
11	D4	GRAB		11.0 - 13.0' Estimated 10% oversize excluded from sample.		
12						
13						
14						
15						
16						
17						

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-4

Date Hole Started: 1/18/2012 Date Hole Finished: 1/18/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: SW, NW, S31, T10N, R2W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 19.5 feet. Water at 17 feet. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 0.6'			0.0 - 0.6' **Silty Clayey Sand** Dark brown, moist, frozen, very stiff, slightly plastic, estimated up to 40% sand and 15% round gravel to 3 inch diameter, abundant roots. [SM/SC]
1	D2	GRAB		0.6 - 2.2'			0.6 - 2.2' **Silty Clayey Sand** Buff, dry, stiff, blocky/shattered, slightly plastic, up to 50% fine sand, trace round gravel, contact grades into below. [SM/SC]
2							
3	D3	GRAB		3.0 - 5.0' Estimated 20% oversize excluded from sample.			2.2 - 15.0' **Sandy Gravel and Cobble** Reddish brown and brown, dry to moist grading with depth, medium dense to dense, estimated 30% sand, 45% subrounded gravel, approximately 25% cobble to 1 foot diameter, stratified gray and red lenses. [GW]
4	B1	BULK		3.5 - 15.0'			
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							15.0 - 19.5' **Sandy Gravel and Cobble to Sand with Gravel and Cobble** Brown, moist, medium dense, estimated 40% sand, 35% gravel, 15% cobble to approximately 8 inch diameter, 10% fines. [SW/GW]
16	D4	GRAB		15.5 - 16.5' Estimated 15% oversize excluded from sample. Water seeping in at approximately 17 feet.			
17							
18							
19							
20							
21							

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-5

Date Hole Started: 1/17/2012 Date Hole Finished: 1/18/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: NE, SE, S36, T10N, R3W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 18 feet, no significant change in material from 2.5 to 15 feet other than mild stratification. Water at 15.3 feet. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 0.8'			0.0 - 0.8' **Clayey Sand** Dark brown, very stiff, frozen, slightly moist, slightly plastic, abundant roots and organics, trace gravel and cobble to 4 inch diameter, grades into below. [SC]
1	D2	GRAB		0.8 - 2.5'	1		
2					2		0.8 - 2.5' **Silty Sand** Buff, very stiff (cemented), dry, slightly plastic, up to 60% fine sand and trace fine rounded gravel, abundant roots. [SM]
3	D3	GRAB		3.0 - 5.0' Estimated 15% oversize excluded from sample.	3		2.5 - 15.0' **Sandy Gravel and Cobble** Brown and reddish brown, dry to slightly moist, dense, stratified (6 inch to 1 foot layers), estimated 35% sand and 65% gravel and cobble to 1.5 foot diameter, subangular to subrounded, pockets and zones of sandier and rockier material, estimated 20 to 30% over 3 inches. [GW]
4	B1	BULK		3.5 - 12.0' Aproximately 15% oversize excluded from sample. Water seeping into pit at approximately 15.3 feet.	4		
5					5		
6					6		
7					7		
8					8		
9					9		
10					10		
11					11		
12					12		
13					13		
14					14		
15					15		15.0 - 18.0' **Sandy Gravel and Cobbles** Reddish brown, wet, medium dense, estimated sand to 35 to 45%, matrix is silty/clayey sand (approximately 10% fines), 45 to 55% gravel and cobble, caves moderately. [GW]
16					16		
17					17		
18					18		
19					19		
20					20		

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-6

Date Hole Started: 1/17/2012 Date Hole Finished: 1/17/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: NE, SE, S36, T10N, R3W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area
Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 19.5 feet. Water perched on tertiary sediments at 14.7 feet. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 0.5'			**0.0 - 0.5' Silty Clayey Sand** Dark brown, very stiff, frozen, slightly moist, slightly plastic, abundant roots and organics, occasional gravel and cobble (rounded) to 4 inch diameter, grades into below. [SM-SC]
1	D2	GRAB		0.5 - 1.2'	1		**0.5 - 1.2' Silty Sandy Gravel** Buff, dry, very stiff/dense, slightly plastic, estimated 20% fines, 40% fine and medium sand, 40% gravel to 3 inch diameter, abundant roots and white precipitate, grades into below. [GP/GM]
2	D3	GRAB		1.5 - 3.0' Estimated 10 to 15% oversize excluded from sample.	2		**1.2 - 8.0' Sandy Gravel and Cobble** Reddish brown, dry to slightly moist, dense, estimated 75% subrounded and round gravel and cobble to 1.5 foot diameter and 25% fine to coarse sand, white precipitate, caves slightly to moderately stratified, 2 foot reddish lens at 6 feet, estimated 25% cobble. [GP]
	B1	BULK		2.0 - 7.0'			
3					3		
4					4		
5					5		
6					6		
7					7		
8	D4	GRAB		8.0 - 9.0' Estimated 10% oversize excluded from sample.	8		**8.0 - 16.5' Sandy Gravel and Cobble** Brown, slightly moist, damp, dense, estimated up to 10% clayey fines, 55% gravel and cobble, 35% sand, round and subrounded clasts to 1 foot diameter. [GW]
9					9		
10					10		
11					11		
12					12		
13					13		
14					14		
15					15		
16					16		
17	D5	GRAB		16.5 - 17.5' 14.7 - Water seeping in quickly, perched on tertiary sediments.	17		**16.5 - 19.5' Clayey Sand** Light yellowish-green, moist, soft to medium, stiff, plastic, some bright green pockets and gray streaks, trace coarse sand/fine gravel (Tertiary). [SC]
18					18		
19					19		
20					20		
21					21		

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Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: East TP-7

Date Hole Started: 1/17/2012 Date Hole Finished: 1/17/2012

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: NW, SW, S31, T10N, R2W
Descriptive Location: East of Prickly Pear Creek; Proposed Bypass Area

Recorded By: Josh Gilstrap

Equipment Owner: T&E Rental
Equipment Operator: T&S Consulting
Excavation Method: Trackhoe, CAT 320D

Remarks: Bottom of hole at 18.5 feet. Water seeping in at bottom of pit. Tertiary sediments at 12.5 feet. Estimates of oversize percentage excluded from samples are field estimates of the amount of material larger than 2 inches excluded from the sample, so that laboratory gradations could be corrected for loss of coarse-grained oversized material. Grab samples are one ziploc bag and bulk samples are 1 five gallon bucket.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1	GRAB		0.0 - 1.2'			0.0 - 1.2' **Silty Clayey Sand** Dark brown, slightly moist, very stiff (frozen), slightly plastic, trace rounded gravel to 2 inch diameter, abundant roots and organics. [SC/SM]
1	D2	GRAB		1.2 - 2.1'			1.2 - 2.1' **Silty Sand** Buff, dry, dense/stiff, slightly plastic fines, estimated 40% fines and 60% sand, trace rounded gravel to 1 inch diameter. [SM]
2	D3	GRAB		2.5 - 3.5' Estimated 20% oversize excluded from sample.			2.1 - 12.5' **Sandy Gravel and Cobbles** Brown to reddish brown, dry, medium dense, (brown upper 1 foot), estimated 65% subrounded gravel and cobbles to 1 foot diameter, 35% slightly silty fine to coarse subangular to subrounded sand, stratified/minor discontinuous lenses of higher sand content and finer gravel, estimated 20% cobble. [GW]
3							
4	B1	BULK		4.0 - 12.5'			
5							
6							
7							
8							
9							
10							
11							
12	D4	GRAB		12.5 - 15.0'			12.5 - 16.5' **Clay** Light yellowish-green, moist, soft to medium, stiff, plastic, some bright green pockets and gray streaks, trace coarse sand/fine gravel (Tertiary). [CL]
13							
14							
15							
16	D5	GRAB		16.5 - 18.0' Estimated 10% oversize excluded from sample.			16.5 - 18.0' **Clayey Sandy Gravel** Reddish brown, moist, dense, estimated 60% gravel, cobble to 6 inch diameter and 40% clayey sand. (Difficult contact and material to log due to depth and caving sidewalls.) [GW/GC]
17							
18	D6	GRAB		18.0 - 18.5' Water seeping in at bottom of pit.			18.0 - 18.5' **Silty Sand** Greenish gray, wet, medium dense, estimated 30 to 40% plastic fines and 60 to 70% medium sand, some grains readily break down. [SM]
19							
20							

ATTACHMENT 3

UPPER LAKE MARSH TEST PIT LOGS

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-01

Date Hole Started: 2/27/2013 Date Hole Finished: 2/27/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: Upper Lake Marsh - East

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at approximately 2.6 feet at time of excavation. Difficult logging due to high groundwater and caving pit wells. Bottom of hole based on estimate of excavator boom and bucket. 2 inch piezometer, screened from 2.8 to 7.8 feet BGS, 4.5 feet stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
0 - 1	D1			0.0 - 1.0' Ziploc bag			0.0 - 1.0' **Clayey SILT** Dark brown, very moist to wet, slight plasticity, abundant roots.
1 - 2.5	D2			1.0 - 2.5' Ziploc bag			1.0 - 2.5' **SAND** Brown/orange brown, very moist to wet, medium grained uniform sand (poorly graded).
2.5 - 10							2.5 - 11.0' **SAND** Dark brown, wet, subround fine to coarse sand, up to 15% pebbles/fine gravel, minor silt. (SW)
10 - 11	B1			10.0 - 11.0' 5-gallon bucket			
11 - 12							

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12

TEST PIT LOG K:\GINT\PROJECTS\10022.GPJ HYDHLN2.GDT 3/28/13

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-02

Date Hole Started: 2/27/2013 Date Hole Finished: 2/27/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: Upper Lake Marsh

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at 1.9 feet at time of excavation. Representative sample at bottom of hole not possible (caving/groundwater). Composite sample taken from spoils from 3 to 11 feet. 2 inch piezometer, screened from 1.0 to 6.0 feet BGS, 5.1 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 1.4' Ziploc bag			0.0 - 1.4' **Clayey SILT** Brown to dark brown, very soft (frozen top 8 inches), slight plastic, abundant organic debris and roots.
1							
							1.4 - 1.8' **SAND and ORGANICS** Discontinuous lens of organic debris and orange/brown sand. [Alluvium]
2	D2			1.8 - 3.0' Ziploc bag			1.8 - 11.0' **SAND** Dark brown to black, wet, fine to coarse grained, with some silt. (SW-SM) [Alluvium]
3	B1			3.0 - 11.0' 5-gallon bucket			
4							
5							
6							
7							
8							
9							
10							
11							
12							

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-03

Date Hole Started: 2/28/2013 Date Hole Finished: 2/28/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T10N R3W S36
Descriptive Location: Upper Lake Marsh

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater and 2.7 feet at time of excavation. Hole caving below approximately 2 feet, visual logging only. 2 inch piezometer, screened from 4.6 to 9.6 feet BGS, 5.1 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 1.3' Ziploc bag			0.0 - 1.3' **Clayey SILT and Organics** Dark brown, very soft (frozen to 4 inches), very moist, slight plasticity, trace fine, abundant organics, thin/2 inch sand lens at 0.9 feet.
1							
	D2			1.3 - 2.7' Ziploc bag			1.3 - 2.5' **SAND** Orange/brown, moist, loose, fine to medium subround, uniform and clean. [Alluvium]
2							
	D3			2.5 - 3.0' Ziploc bag			2.5 - 10.0' **SAND with Minor Silt** Black, wet, fine to coarse grained, 2 inch lens of silt at 3 feet, some thin lenses of silt. (SP-SM) [Alluvium]
3							
4							
5							
6							
7							
8							
	B1			8.5 - 9.5' 5-gallon bucket			
9							
10							
11							

Hydrometrics, Inc.

Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-04

Date Hole Started: 2/27/2013 Date Hole Finished: 2/27/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: Upper Lake Marsh

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at approximate 3.0 feet at time of excavation. Logging is very difficult due to high groundwater, caving walls, and homogenous color. 2 inch piezometer, screened from 4.5 to 9.5 feet BGS, 5.1 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 1.0' Ziploc bag			0.0 - 1.0' **Clayey SILT** Brown, moist (frozen), slight plasticity, trace fine sand, abundant organic debris.
1	D2			1.0 - 1.5' Ziploc bag			1.0 - 1.5' **SAND** Orange, moist, loose, subround medium grained. [Alluvium]
	D3			1.5 - 3.0' Ziploc bag			1.5 - 3.0' **SILT** Brown/dark brown, very moist to wet with depth, very soft, slight plasticity, some organics. [Alluvium]
2							
3	D4 B1			3.0 - 6.0' Ziploc bag 3.1 - 12.1' 5-gallon bucket			3.0 - 6.0' **Silty SAND** Dark brown, saturated, fine to medium sand, possibly stratified with lenses of silt, difficult logging in groundwater. [Alluvium]
4							
5	B2			5.5 - 6.5' 5-gallon bucket			
6							6.0 - 12.0' **Silty SAND** As above but higher silt content or finer sand (pit wells not caving as badly), some subround cobbles in spoils from very bottom of hole. [Alluvium]
7							
8							
9							
10							
11							
12							
13							

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Helena, Montana

Test Pit Log

Hole Name: PPCRTP-05

Date Hole Started: 2/28/2013 Date Hole Finished: 2/28/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: Upper Lake Marsh - South of Upper Lake Diversion Channel

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at 2.8 feet at time of excavation, but lens of sand at 1.8 feet is saturated and seeping. Hole caving significantly below 5 feet. 2 inch piezometer, screened from 2.7 to 7.4 feet BGS, 4.4 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 1.8' Ziplog bag			0.0 - 1.8' **SILT** Medium brown, very moist to wet, very soft, slight plasticity, with very fine sand and abundant organics (roots, some woody debris).
1							
							1.8 - 2.0' **SAND** Thin lens of medium uniform orange brown sand, thicker (6 inches) on south side of pit. [Alluvium]
2	D2			2.0 - 4.8' Ziplog bag			2.0 - 4.5' **SILT** Brown, dark brown, and gray (reduced), wet, very soft, slight plasticity. [Alluvium]
3							
4							
5	B1			5.0 - 6.0' 5-gallon bucket			5.0 - 7.0' **SAND** Gray and dark brown, saturated, medium dense, fine to medium grained sand, trace to approximately 10 percent silt. (SP-SM) [Alluvium]
6							
7							7.0 - 8.0' **SAND with Gravel and Cobble** Dark gray, saturated, medium dense, estimated 55 percent sand, 20 percent gravel, 25% cobble to 8 inch diameter, very few fines in sand. [Alluvium]
8							
9							

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-06

Date Hole Started: 2/28/2013 Date Hole Finished: 2/28/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: West of Prickly Pear Creek, South of Upper Lake Diversion Channel

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at 4.5 feet at time of excavation. Pit caving below 3 feet. 2 inch piezometer, screened from 1.6 to 6.6 feet BGS, 3.3 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 0.5' Ziploc bag			0.0 - 0.5' **Clayey SILT** Dark brown, moist, frozen upper 4 inches, slight plasticity.
							0.5 - 0.7' **SAND** Brown, moist, loose, uniform, fine to grained sand. [Alluvium]
							0.7 - 1.0' **Clayey SILT with Some Sand** Moist, very soft to soft, low plasticity, brown. [Alluvium]
	D2			1.0 - 1.7' Ziploc bag			1.0 - 1.7' **Silty CLAY** Tan, moist, medium stiff, low plasticity, white pockets and some organic material. [Alluvium]
	D3			1.7 - 3.1' Ziploc bag			1.7 - 3.1' **Sandy SILT to Silty Fine SAND** Interbedded, very wet, soft/loose, dark brown, low plasticity, thin lenses of very fine sand. [Alluvium]
							3.1 - 6.0' **SAND** Orange and brown, wet, loose, fine to medium grained, up to 15% fines. (SM-SC) [Alluvium]
	B1			5.0 - 6.0' 5-gallon bucket			
	B2			6.0 - 7.5' 5-gallon bucket			6.0 - 7.5' **SAND with Gravel and Cobble** Gray, wet, loose, subround gravel and cobble and medium sand, trace fines. (GP) [Alluvium]

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: PPCRTP-07

Date Hole Started: 2/28/2013 Date Hole Finished: 2/28/2013

Client: Montana Environmental Trust Group
Project: East Helena Facility
County: Lewis & Clark State: Montana
Property Owner: MT Environmental Trust
Legal Description: T10N R3W S36
Descriptive Location: West of Prickly Pear Creek, South of Upper Lake Diversion Channel

Recorded By: J. Gilstrap

Equipment Owner: Double Stud
Equipment Operator: Donnie
Excavation Method: Excavator

Remarks: Groundwater at 2.9 feet at time of excavation. Pit caving below 2 feet. 2 inch piezometer, screened from 4.0 to 8.0 feet BGS, 2.2 foot stickup.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE TIME	NOTES	GRAPHICS	USCS Symbol	GEOLOGICAL DESCRIPTION
	D1			0.0 - 1.9' Ziploc bag			0.0 - 1.9' **Clayey SILT with Sand to Very Fine Silty SAND** Medium brown, very moist, very soft, slight plasticity.
1							
2	D2			1.9 - 4.0' Ziploc bag			1.9 - 7.5' **SAND** Wet, orange, brown, and black (cross-bedded), loose to medium dense, clean to very few fines. (SW) [Alluvium]
3							
4							
5							
6	B1			6.0 - 7.0' 5-gallon bucket			
7							
							7.5 - 9.5' **SAND with Some Gravel and Cobble** Wet, orange, brown, and black (stratified), loose to medium dense, clean to very few fines, up to 10% gravel and up to 10% cobble to 8 inch diameter, clasts are subangular to subround. [Alluvium]
8							
9							
10							
11							

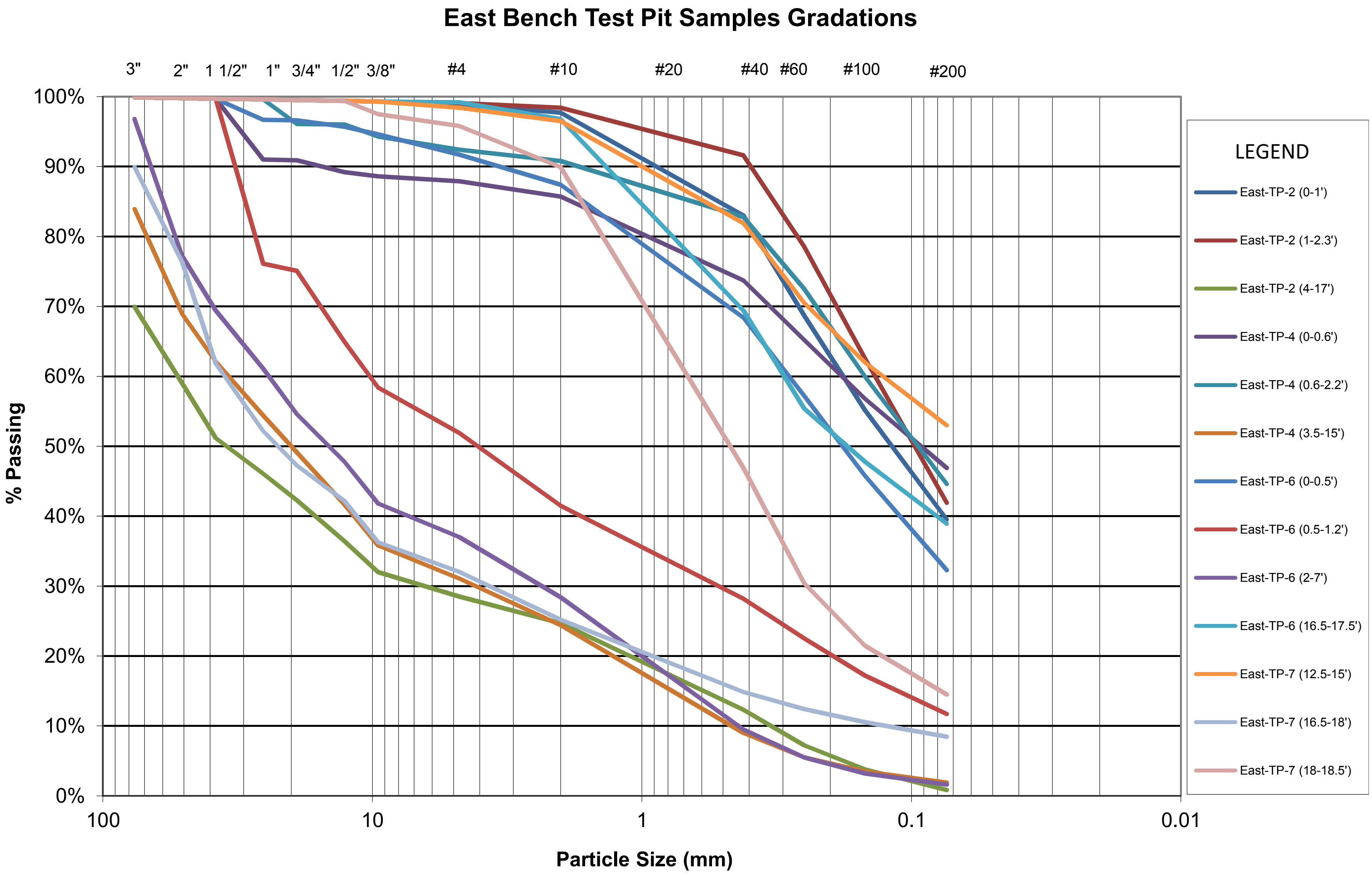
ATTACHMENT 4

EAST BENCH TEST PIT LABORATORY DATA

EAST BENCH TEST PIT GRADATIONS

		Cumulative Percent Passing												
Sieve Size	**Particle Size (mm)**	**East-TP-2 D1 (0-1')**	**East-TP-2 D2 (1-2.3')**	**East-TP-2 B1 (4-17')**	**East-TP-4 D1 (0-0.6')**	**East-TP-4 D2 (0.6-2.2')**	**East-TP-4 B1 (3.5-15')**	**East-TP-6 D1 (0-0.5')**	**East-TP-6 D2 (0.5-1.2')**	**East-TP-6 B1 (2-7')**	**East-TP-6 D5 (16.5-17.5')**	**East-TP-7 D4 (12.5-15')**	**East-TP-7 D5 (16.5-18')**	**East-TP-7 D6 (18-18.5')**
3	**76.2**	100%	100%	70%	100%	100%	84%	100%	100%	97%	100%	100%	90%	100%
2	**50.8**	100%	100%	59%	100%	100%	69%	100%	100%	77%	100%	100%	76%	100%
1 1/2	**38.1**	100%	100%	51%	100%	100%	62%	100%	100%	69%	100%	100%	62%	100%
1	**25.4**	100%	100%	46%	91%	100%	54%	97%	76%	61%	100%	100%	52%	100%
3/4	**19.05**	100%	100%	42%	91%	96%	49%	97%	75%	55%	100%	100%	47%	100%
1/2	**12.7**	99%	99%	36%	89%	96%	42%	96%	65%	48%	99%	99%	42%	99%
3/8	**9.525**	99%	99%	32%	89%	94%	36%	95%	58%	42%	99%	99%	36%	98%
#4	**4.76**	99%	99%	28%	88%	92%	31%	92%	52%	37%	99%	98%	32%	96%
#10	**2**	98%	98%	25%	86%	91%	24%	87%	42%	28%	97%	97%	25%	90%
#40	**0.42**	83%	92%	12%	74%	83%	9%	68%	28%	10%	69%	82%	15%	47%
#60	**0.25**	69%	79%	7%	65%	73%	6%	57%	23%	6%	55%	71%	12%	30%
#100	**0.149**	55%	63%	4%	57%	60%	4%	46%	17%	3%	48%	62%	11%	22%
#200	**0.074**	40%	42%	1%	47%	45%	2%	32%	12%	2%	39%	53%	8%	15%
Clay	**0.002**	-	18%	-	-	20%	-	-	-	-	-	-	-	-
Oversize excluded during sampling				7.5%									10.0%	

R200	61%	58%	99%	53%	55%	98%	68%	88%	98%	61%	47%	92%	86%
R4	1%	1%	72%	12%	8%	69%	8%	48%	63%	1%	2%	68%	4%
D60	0.185	0.140	52.391	0.187	0.149	34.636	0.293	10.295	24.325	0.306	0.132	35.687	0.901
D30	0.024	0.039	5.859	0.025	0.031	4.307	0.063	0.634	2.513	0.033	0.023	3.937	0.25
D10	0.013	0.025	0.343	0.01	0.02	0.523	0.023	0.06	0.420	0.01	0.01	0.130	0.04
Cu	14.22	5.58	152.72	18.75	7.45	66.28	12.72	171.58	57.92	30.59	13.23	274.94	22.53
Cz	0.24	0.43	1.91	0.33	0.33	1.02	0.59	0.65	0.62	0.36	0.40	3.35	1.73
LL	33.2	20.9	NP	24.5	26.6	NP	26.8	30.3	NP	54.7	52.3	35.1	31.3
PI	10.6	1.1	NP	5.4	4.9	NP	6.5	6.4	NP	8.1	10.5	11.3	3.6
R4/R200	0.0	0.0	0.7	0.2	0.1	0.7	0.1	0.5	0.6	0.0	0.0	0.7	0.0
USCS	SC	SM	GW	SM-SC	SM-SC	GW	SM-SC	GP-GM	GP	SC	CL	GW-GC	SM


East Bench Test Pit Samples Gradations
3"
2"
1 1/2"
1"
3/4"
1/2"
3/8"
#4
#10
#20
#40
#60
#100
#200
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Passing
100
10
1
0.1
0.01
Particle Size (mm)
LEGEND
East-TP-2 (0-1')
East-TP-2 (1-2.3')
East-TP-2 (4-17')
East-TP-4 (0-0.6')
East-TP-4 (0.6-2.2')
East-TP-4 (3.5-15')
East-TP-6 (0-0.5')
East-TP-6 (0.5-1.2')
East-TP-6 (2-7')
East-TP-6 (16.5-17.5')
East-TP-7 (12.5-15')
East-TP-7 (16.5-18')
East-TP-7 (18-18.5')

ATTACHMENT 5

UPPER LAKE MARSH TEST PIT LABORATORY DATA

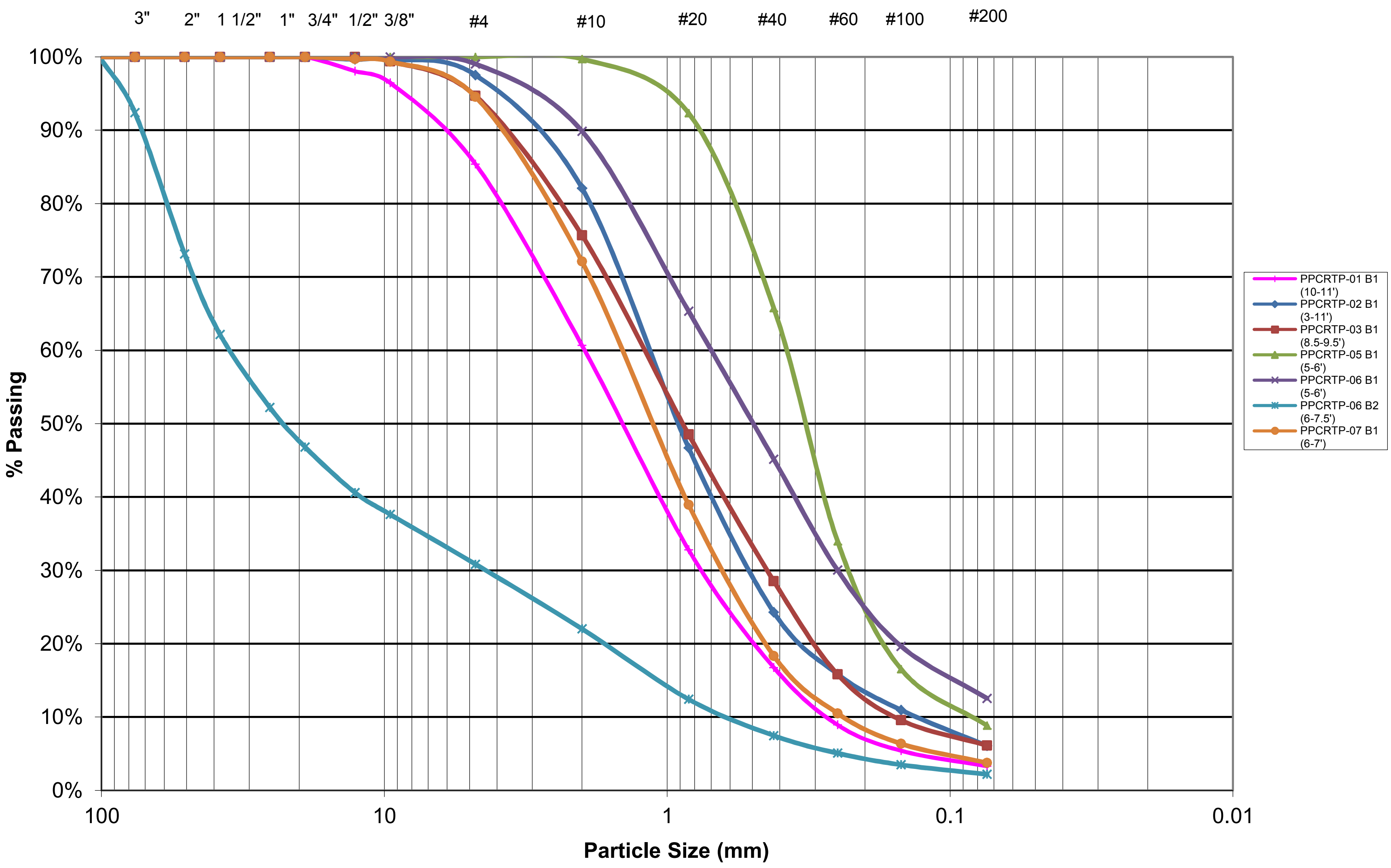
PRICKLY PEAR CREEK RELOCATE TEST PITS GRADATIONS

Sieve Size	**Particle Size (mm)**	Cumulative Percent Passing						
		PPCRTP-01 B1 (10-11')	**PPCRTP-02 B1 (3-11')**	**PPCRTP-03 B1 (8.5-9.5')**	**PPCRTP-05 B1 (5-6')**	**PPCRTP-06 B1 (5-6')**	**PPCRTP-06 B2 (6-7.5')**	**PPCRTP-07 B1 (6-7')**
3	**76.2**	100%	100%	100%	100%	100%	92%	100%
2	**50.8**	100%	100%	100%	100%	100%	73%	100%
1.5	**38.1**	100%	100%	100%	100%	100%	62%	100%
1	**25.4**	100%	100%	100%	100%	100%	52%	100%
0.75	**19.05**	100%	100%	100%	100%	100%	47%	100%
0.5	**12.7**	98%	100%	100%	100%	100%	41%	100%
0.375	**9.525**	96%	100%	99%	100%	100%	38%	99%
#4	**4.76**	85%	98%	95%	100%	99%	31%	95%
#10	**2**	61%	82%	76%	100%	90%	22%	72%
#20	**0.84**	33%	47%	49%	92%	65%	12%	39%
#40	**0.42**	17%	24%	29%	66%	45%	7%	18%
#60	**0.25**	9%	16%	16%	34%	30%	5%	11%
#100	**0.149**	5%	11%	10%	17%	20%	3%	6%
#200	**0.074**	3%	6%	6%	9%	13%	2%	4%

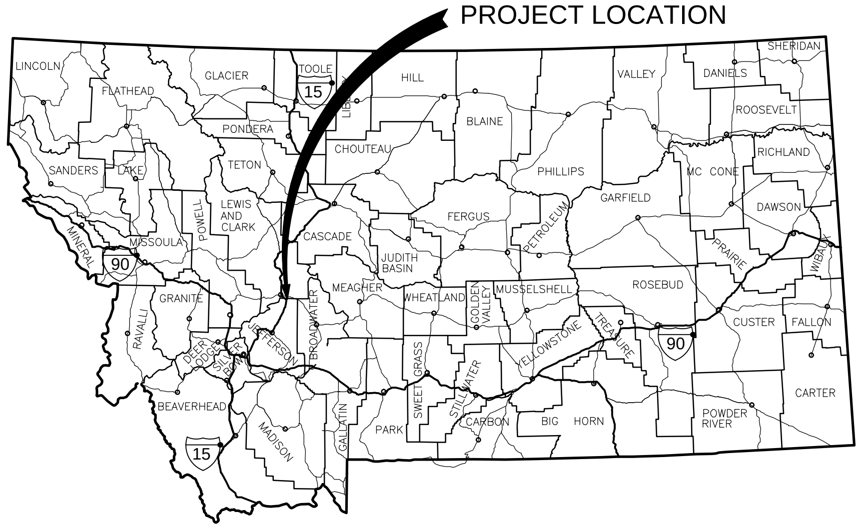
R200	97%	94%	94%	91%	87%	98%	96%
R4	15%	2%	5%	0%	1%	69%	5%
D60	1.97	1.28	1.33	0.39	0.73	35.34	1.58
D30	0.77	0.53	0.45	0.23	0.25	4.50	0.66
D10	0.27	0.13	0.16	0.09	0.05	0.63	0.24
Cu	7.22	9.49	8.52	4.56	15.50	55.68	6.63
Cz	1.09	1.62	0.98	1.55	1.82	0.90	1.15
PI*	-	-	-	-	-	-	-
R4/R200	0.2	0.0	0.1	0.0	0.0	0.7	0.1
USCS*	SW	SW-SM	SP-SM	SP-SM	SM-SC	GP	SW

*Liquid and plastic limits test not performed given low fines contents. Therefore, USCS classifications are estimates.

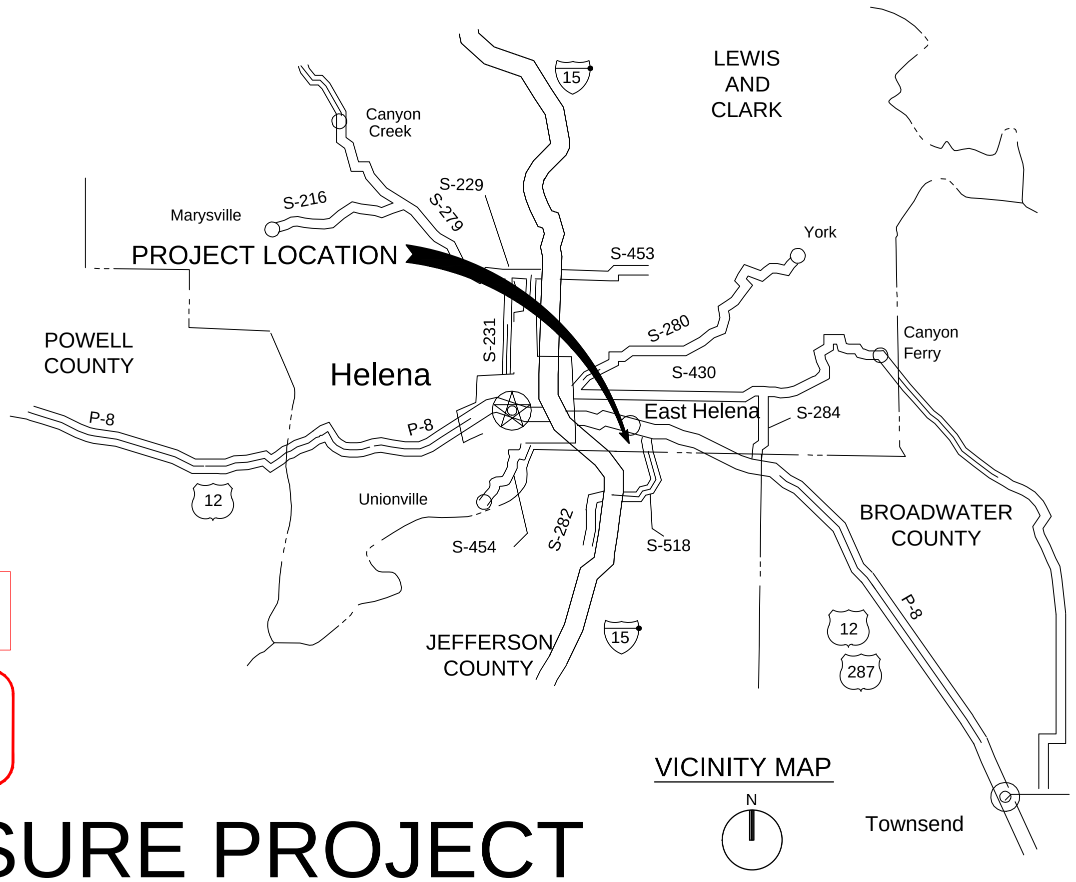
Prickly Pear Creek Relocate Test Pits Gradations



Appendix G: 30% Preliminary Design Drawings



LOCATION MAP



VICINITY MAP

30% DOCUMENTS

PRELIMINARY

NOT FOR CONSTRUCTION

EAST HELENA SMELTER CLOSURE PROJECT
PRICKLY PEAR CREEK REALIGNMENT

GENERAL

SHEET NO.	DRAWING NO.	DRAWING TITLE
*1	C1-1	TITLE, LOCATION AND VICINITY MAP, INDEX TO DRAWINGS
*2	C1-2	CIVIL LEGENDS, ABBREVIATIONS AND GENERAL NOTES (1 OF 2)
*3	C1-3	CIVIL LEGENDS, ABBREVIATIONS AND GENERAL NOTES (2 OF 2)
*4	C1-4	CIVIL SITE LAYOUT/EXISTING CONDITIONS

CONSTRUCTION STAGING

SHEET NO.	DRAWING NO.	DRAWING TITLE
5	C2-1	CONSTRUCTION STAGING (1 OF 2)
6	C2-2	CONSTRUCTION STAGING (2 OF 2)
7	C2-3	CONSTRUCTION STAGING DETAILS

HAUL ROADS

SHEET NO.	DRAWING NO.	DRAWING TITLE
8	C3-1	PROJECT OVERVIEW HAUL ROADS (1 OF 2)
9	C3-2	PROJECT OVERVIEW HAUL ROADS (2 OF 2)
10	C3-3	HAUL ROAD DETAILS

TRAFFIC CONTROL

SHEET NO.	DRAWING NO.	DRAWING TITLE
11	C4-1	TRAFFIC CONTROL PLAN
12	C4-2	TRAFFIC CONTROL DETAILS

* = INDICATES SHEET INCLUDED IN 30% SET

GROUNDWATER DEWWATERING

SHEET NO.	DRAWING NO.	DRAWING TITLE
13	C5-1	DEWATERING DETAILS
14	C5-2	SEDIMENT POND DETAILS

STORMWATER BMP'S

SHEET NO.	DRAWING NO.	DRAWING TITLE
15	C6-1	STORMWATER BMP DETAILS

EXCAVATION

SHEET NO.	DRAWING NO.	DRAWING TITLE
*16	C7-1	FLOODPLAIN EXISTING LITHOLOGY AND EXCAVATION PLAN AND PROFILE
*17	C7-2	EXCAVATION CROSS SECTIONS A AND B
*18	C7-3	EXCAVATION CROSS SECTIONS C AND D

FLOODPLAIN

SHEET NO.	DRAWING NO.	DRAWING TITLE
*19	C8-1	FLOODPLAIN CONSTRUCTION AND GRADING PLAN(1 OF 2)
*20	C8-2	FLOODPLAIN CONSTRUCTION AND GRADING PLAN (2 OF 2)
21	C8-3	FLOODPLAIN GRADING DETAILS
*22	C8-4	FLOODPLAIN GRADING CROSS SECTIONS F AND G
23	C8-5	FLOODPLAIN GRADING CROSS SECTIONS (2 OF 5)
24	C8-6	FLOODPLAIN GRADING CROSS SECTIONS (3 OF 5)
25	C8-7	FLOODPLAIN GRADING CROSS SECTIONS (4 OF 5)
26	C8-8	FLOODPLAIN GRADING CROSS SECTIONS (5 OF 5)

CHANNEL RECONSTRUCTION

SHEET NO.	DRAWING NO.	DRAWING TITLE
*27	C9-1	CHANNEL RECONSTRUCTION OVERVIEW
*28	C9-2	CHANNEL RECONSTRUCTION PLAN AND PROFILE (1 OF 5)
*29	C9-3	CHANNEL RECONSTRUCTION PLAN AND PROFILE (2 OF 5)
*30	C9-4	CHANNEL RECONSTRUCTION PLAN AND PROFILE (3 OF 5
31	C9-5	CHANNEL RECONSTRUCTION PLAN AND PROFILE (4 OF 5
32	C9-6	CHANNEL RECONSTRUCTION PLAN AND PROFILE (5 OF 5)
33	C9-7	CHANNEL SECTION AND STONE TOE TABLES
*34	C9-8	DEFORMABLE RUN, RIFFLE AND POOL SECTIONS
35	C9-9	POOL PLAN VIEW, BURIED ROCK TOE, LAND TRIBUTARY SWALE DETAILS
36	C9-10	NON-DEFORMABLE CHANNEL AND STREAM BANK DETAILS
37	C9-11	STREAM CONNECTION DETAILS
*38	C9-12	CHANNEL RECONSTRUCTION IMPORTED MATERIAL CROSS SECTIONS

WETLANDS

SHEET NO.	DRAWING NO.	DRAWING TITLE
*39	C10-1	EXISTING WETLAND PLAN VIEW
*40	C10-2	CONCEPTUAL WETLANDS PLAN VIEW
*41	C10-3	CONCEPTUAL WETLAND SWALE PLAN AND PROFILE
*42	C10-4	CONCEPTUAL WETLAND SWALE PROPOSED HABITATS
43	C10-5	WETLAND GRADING PLAN AND PROFILE (1 OF 3)
44	C10-6	WETLAND GRADING PLAN AND PROFILE (2 OF 3)
45	C10-7	WETLAND GRADING PLAN AND PROFILE (3 OF 3)
46	C10-8	WETLAND DETAILS
47	C10-9	WETLAND SECTIONS

VEGETATION

SHEET NO.	DRAWING NO.	DRAWING TITLE
48	C11-1	VEGETATIVE BACKFILL
49	C11-2	VEGETATION PLAN
50	C11-3	VEGETATION DETAILS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
G AUSTIGUY	J JUPKA	J EMMERT	J GERHART

METG Montana Environmental Trust Group

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East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

PIONEER TECHNICAL SERVICES, INC

CH2MHILL

PRICKLY PEAR CREEK REALIGNMENT

TITLE, LOCATION AND VICINITY MAP,
INDEX OF DRAWINGS

NTS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C1-1
SHEET	1 of 50

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FILENAME: P031C1-1.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 2:47 PM

ABBREVIATIONS

AB	ANCHOR BOLT, ABOVE
ABDN	ABANDON
AC	ASPHALTIC CONCRETE
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
AGGR	AGGREGATE
AHR	ANCHOR
AJ	ADJUSTABLE
APPROX	APPROXIMATE
APVD	APPROVED
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
@	AT
BETW	BETWEEN
BF	BLIND FLANGE, BOTTOM FACE
BG	BELOW GRADE
BLDG	BUILDING
BLK	BLOCK
BM	BEAM, BENCHMARK
BOT	BOTTOM
BRG	BEARING
BRKR	BREAKER
BVC	BEGINNING OF VERTICAL CURVE
C	CONDUIT, CASEMENT
C TO C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN, CIRCUIT BREAKER
CC	CONTROL CABLE
CCL	COMPACTED CLAY LAYER
CCP	CENTRAL CONTROL PANEL
CCS	CENTRAL CONTROL SYSTEM
CDN	COMPOSITE DRAINAGE NET
CIP	CAST IN PLACE
CIP	CULVERT INLET PROTECTION
CJ	CONSTRUCTION JOINT
CL	CENTERLINE
CLSF	CONTROLLED LOW STRENGTH FILL
CLR	CLEAR, CLEARANCE
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT, CARBON MONOXIDE
CONC	CONCRETE
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUED, CONTINUATION
COORD	COORDINATE
CRS	COLD ROLLED STEEL
CRS	CONSTRUCTION ROAD STABILIZATION
CTR	CENTER
CTRD	CENTERED
CU	CUBIC
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CY, CU YD	CUBIC YARD
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIR	DIRECTION
DISCH	DISCHARGE
DWG	DRAWING
△	DELTA
E	EAST, EMPTY
EA	EACH
EF	EACH FACE
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ESC	EROSION AND SEDIMENT CONTROL
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXP	EXPANSION, EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, EXIST	EXISTING
EXT	EXTERIOR
FC	FLEXIBLE CONDUIT/ CONNECTOR
FCA	FLANGED COUPLING ADAPTER
FDN	FOUNDATION
FG	FINISH GRADE
FHY	FIRE HYDRANT
FIG	FIGURE
FL	FLOW LINE
FLG	FLANGE
FL	FLOOR
FLEX	FLEXIBLE
FNSH	FINISH
FOB	FLAT ON BOTTOM
FP	FIELD PANEL
FPL	FROST PROTECTION LAYER
FPM	FEET PER MINUTE
FT	FOOT OR FEET
FWD	FORWARD
G, GND	GROUND
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GC	GROOVED COUPLING
GCL	GEOSYNTHETIC CLAY LINER
GVL	GRAVEL
HDPE	HIGH DENSITY POLYETHYLENE
HH	HANDHOLE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPT	HIGH POINT
HWL	HIGH WATER LEVEL
IE	INVERT ELEVATION
I.F.	INSIDE FACE
IN	INCH(ES)
INVT	INVERT
IP	INLET PROTECTION
IRRIG	IRRIGATION
JB	JUNCTION BOX
JCT	JUNCTION
JT	JOINT
L	ANGLE, LENGTH
LB(S)	POUND(S)
LCRS	LEACHATE COLLECTION AND RECOVERY SYSTEM
LDS	LEAK DETECTION SYSTEM
LF	LINEAR FEET
LG	LONG
LONG	LONGITUDINAL
LP	LIGHT POLE
LPT	LOW POINT
LR	LONG RADIUS
LT	LEFT
LTG, LTS	LIGHTS OR LIGHTING
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MH	MANHOLE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MS	MANUFACTURER'S STANDARD
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MU	MULCHING
MWS	MAXIMUM WATER SURFACE
N	NORTH
NA	NOT APPLICABLE
NEUT	NEUTRAL
NG	NATURAL GAS
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO., #	NUMBER
NOM	NOMINAL
N-S	NORTH - SOUTH
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OVERFLOW
O.F.	OUTSIDE FACE
OPNG	OPENING
OPP	OPPOSITE
OZ	OUNCE
PC	POINT OF CURVE
PCF	POUNDS PER CUBIC FOOT
PI	POINT OF INTERSECTION
PJF	PREMOULDED JOINT FILLER
PL	PROPERTY LINE
PLYWD	PLYWOOD
PMP	PUMP
PNL	PANEL
POE	POINT OF ENDING
PP	POWER POLE
PR	PAIR
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PRES	PRESSURE
PRI	PRIMARY
PROP	PROPERTY
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PT	PRESSURE TREATED
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
R OR RAD	RADIUS
RC	REINFORCED CONCRETE
RDCR	REDUCER
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RH	RIGHT HAND
RHR	RIGHT HAND REVERSE
RPE	REINFORCED POLYETHYLENE
RST	REINFORCING STEEL
RT	RIGHT
RTN	RETURN
R/W	RIGHT OF WAY
S	SWITCH
SB	SEDIMENT BASIN
SCHED	SCHEDULE
SEC	SECONDARY
SED	SEDIMENTATION
SH	SHEET
SIM	SIMILAR
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
ST	STRAIGHT
STA	STATION
STD	STANDARD
STL	STEEL
STRUCT	STRUCTURE
T&B	TOP AND BOTTOM
TAN	TANGENT
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
THK	THICKNESS
THRU	THROUGH
TOC	TOP OF CONCRETE
TOS	TOP OF SLAB
TP	TURNING POINT
TRANSV	TRANSVERSE
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
VC	VERTICAL CURVE
VERT	VERTICAL
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
W	WEST
W/	WITH

NOTES:

1. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

GENERAL SITE NOTES:

1. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS ARE BASE MAPS PROVIDED BY DJ&A, P.C. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
2. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED.
3. HORIZONTAL DATUM: NAD 83, MONTANA STATE PLANE COORDINATE SYSTEM, INTERNATIONAL FEET.
4. VERTICAL DATUM: N.A.V.D. 88, U.S. SURVEY FEET.
5. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
6. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS.
7. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
8. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE NOTED.
9. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
10. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED AND INSPECTED AS STATED IN THE APPROVED EROSION AND SEDIMENTATION PLAN APPROVED IN THE STORMWATER DISCHARGE PERMIT.
11. ALL CONTRACTORS AND SUBCONTRACTORS SHALL COMPLY WITH THE FIELD SAFETY INSTRUCTIONS APPROVED (FSI)FOR THIS SITE AT ALL TIMES.
12. EXISTING SITE DRAINAGE FLOW PATTERNS/DIRECTIONS SHALL BE MAINTAINED UNLESS OTHERWISE INDICATED ON THE PLANS.
13. CONSTRUCTION ACTIVITY BY OTHERS MAY IMPACT THE WORK CONTEMPLATED WITHIN THIS PACKAGE. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY IF A CONFLICT ARISES RELATING TO THE PROGRESS OF THE WORK. FINAL COORDINATION/RESOLUTION OF SUCH CONFLICTS SHALL BE THE RESPONSIBILITY OF THE CONTRACTORS INVOLVED.
14. EXISTING FEATURES AND UTILITIES ARE SHOWN ON THE PLANS BASED UPON INFORMATION AVAILABLE AT THE TIME THE PLANS WERE PREPARED. SHOULD UNIDENTIFIED UTILITY OR SERVICE ELEMENTS BE ENCOUNTERED, NOTIFY THE ENGINEER AND THE APPROPRIATE UTILITY OWNER IMMEDIATELY.
15. ACCESS TO THE GENERAL SITE, AND TO SPECIFIC WORK AREAS SHALL BE LIMITED TO THE LOCATIONS SHOWN ON THE PLANS.
16. WATER FOR CONSTRUCTION ACTIVITIES SHALL BE OBTAINED BY THE CONTRACTOR AT THEIR SOLE EXPENSE. ANY AND ALL PERMITS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

30% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
G AUSTIGUY	J JUPKA	J EMMERT	J GERHART

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Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

PIONEER
TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK REALIGNMENT

CIVIL LEGENDS, ABBREVIATIONS AND
GENERAL NOTES (1 OF 2)

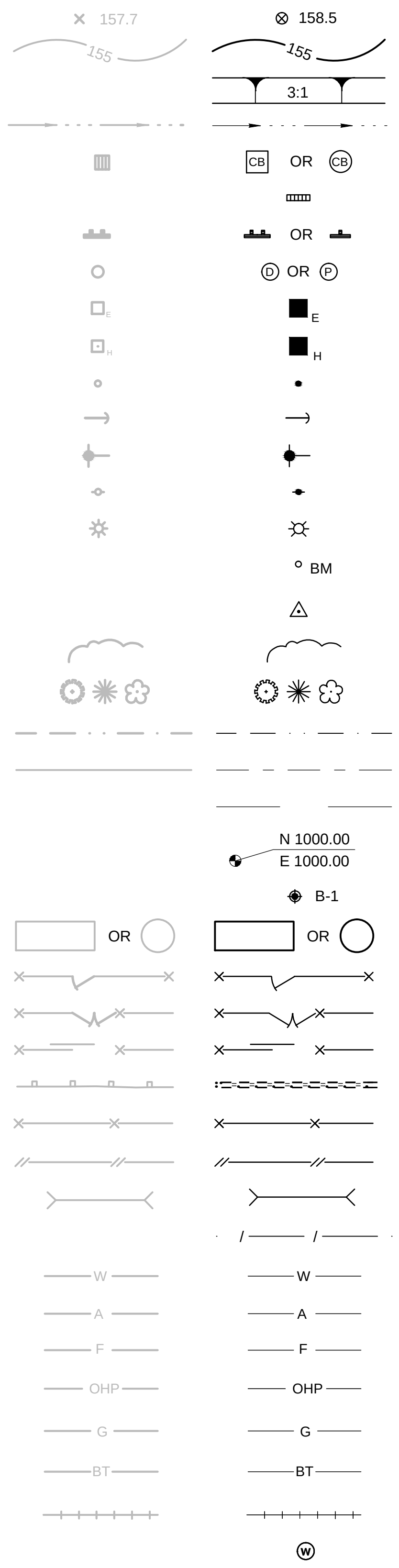
NTS

VERIFY SCALE

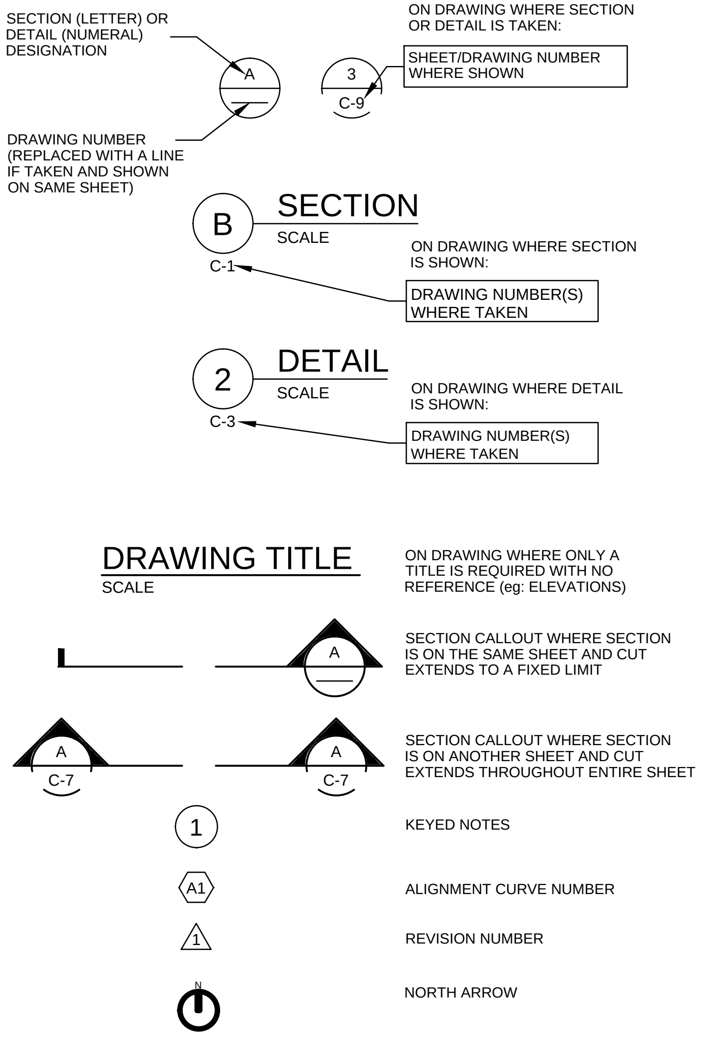
BAR IS ONE INCH ON
ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C1-2
SHEET	2 of 50

CIVIL LEGEND



EXISTING	THIS CONTRACT	
× 157.7	⊗ 158.5	SPOT ELEVATION
155	155	CONTOUR LINE
	3:1	EMBANKMENT AND SLOPE
		DRAINAGEWAY OR DITCH
	CB OR CB	CATCH BASIN OR INLET
		TRENCH DRAIN
	OR	SIGN
○	Ⓓ OR Ⓟ	MANHOLE D = STORM DRAIN P = PROCESS
E	■ E	ELECTRICAL MANHOLE
H	■ H	ELECTRIC HANDHOLE
		POST OR GUARD POST
		GUY ANCHOR
		FIRE HYDRANT
		UTILITY POLE
		LIGHT POLE
	BM	BENCH MARK
	△	SURVEY CONTROL POINT OR POINT OF INTERSECTION
		BRUSH/TREE LINE
		TREE
		PROPERTY LINE
		CENTER LINE, BUILDING, ROAD, ETC.
		STAGING OR WORK AREA LIMITS
	N 1000.00 E 1000.00	STRUCTURE, BUILDING OR FACILITY LOCATION POINT - COORDINATES
	B-1	BORING LOCATION AND NUMBER
OR	OR	STRUCTURE, BUILDING OR FACILITY
		SINGLE SWING GATE
		DOUBLE SWING GATE
		SLIDING GATE
		GUARD RAIL
		CHAIN LINK FENCE
		WIRE FENCE
		CULVERT
		TEMPORARY CONSTRUCTION FENCE
W	W	WATER LINE
A	A	AIR LIQUID LINE
F	F	FIBER OPTIC BURIED
OHP	OHP	POWER OVERHEAD
G	G	NATURAL GAS
BT	BT	TELEPHONE LINE BURIED
		TRACK LINE
	Ⓦ	GROUND MONITORING WELL



SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET)

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

SHEET/DRAWING NUMBER WHERE SHOWN

SECTION
SCALE

ON DRAWING WHERE SECTION IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN

DETAIL
SCALE

ON DRAWING WHERE DETAIL IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN

DRAWING TITLE
SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)

SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

KEYED NOTES

ALIGNMENT CURVE NUMBER

REVISION NUMBER

NORTH ARROW

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NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG
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East Helena, Montana

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PRICKLY PEAR CREEK REALIGNMENT
CIVIL LEGENDS, ABBREVIATIONS
AND GENERAL NOTES (2 OF2)

NTS
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0 1"

DATE	APRIL 2013
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SHEET	3 of 50

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PRELIMINARY

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NOTES:
1. DRAWING DEPICTS EXISTING CONDITION RATHER THAN CONDITIONS THAT WILL BE EXISTING AT THE START OF PPC REALIGNMENT CONSTRUCTION. THIS INFORMATION WILL BE UPDATED IN THE 60% DESIGN SUBMITTAL

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NO.	DATE	REVISION	BY	APVD

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PRICKLY PEAR CREEK REALIGNMENT

CIVIL SITE LAYOUT/ EXISTING CONDITIONS

NTS

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SHEET	4 of 50

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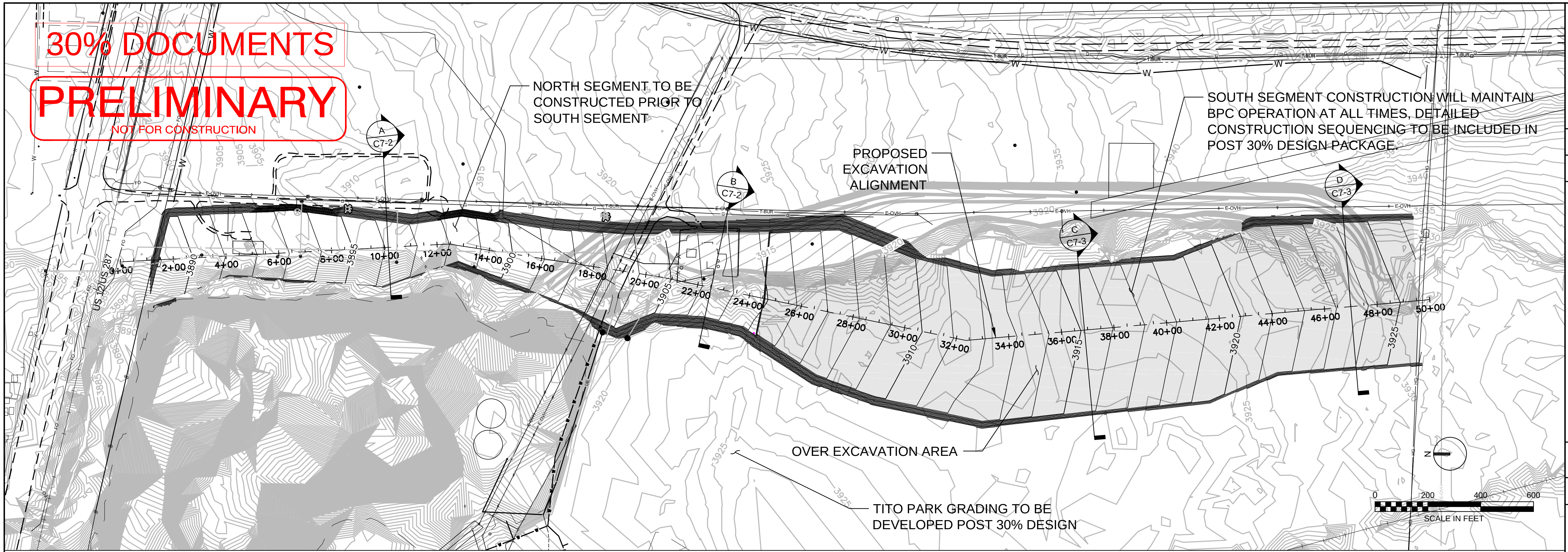

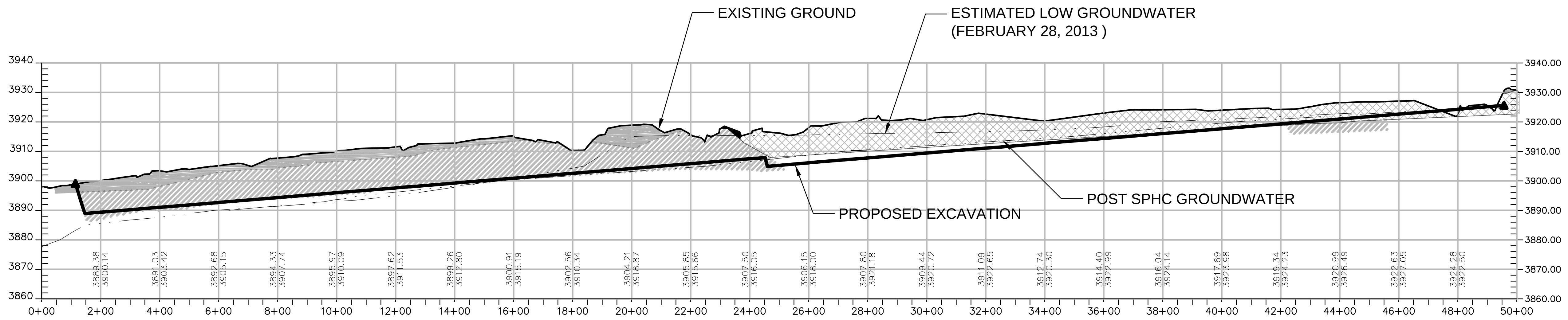

☒ SANDS

▨ GRAVELS

▩ SILTY SAND TOPSOIL

■ EXISTING FILL

PRELIMINARY REALIGNMENT EXCAVATION VOLUME = 651,720 CYD
(DOES NOT INCLUDE BYPASS CHANNEL EXCAVATION,
INCLUDES OVER-EXCAVATION FOR STREAM BED MATERIAL ¹)
PRELIMINARY BYPASS EXCAVATION TOTAL VOLUME = 205,520 CYD
PRELIMINARY TOTAL EXCAVATION VOLUME = 857,240 CYD

PRELIMINARY REALIGNMENT EXCAVATION VOLUME
UPSTREAM VOLUME = 495,120 CYD
(DOES NOT INCLUDE BYPASS CHANNEL EXCAVATION,
INCLUDES OVER-EXCAVTION FOR STREAM BED MATERIAL ¹)
DOWNSTREAM VOLUME = 156,600 CYD
TOTAL REALIGNMENT VOLUME = 651,720 CYD

NOTE:
1. REQUIRED FILL FOR STREAM BED MATERIAL = 155, 700CYD

SCALE IN FEET 20 200

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PRICKLY PEAR CREEK REALIGNMENT

FLOODPLAIN EXISTING LITHOLOGY AND EXCAVATION PLAN AND PROFILE

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C7-1
SHEET	16 of 50

FILENAME: P031C7-1_4-15-13.dwg PLOT DATE: 15-Apr-13 PLOT TIME: 11:29 AM

30% DOCUMENTS

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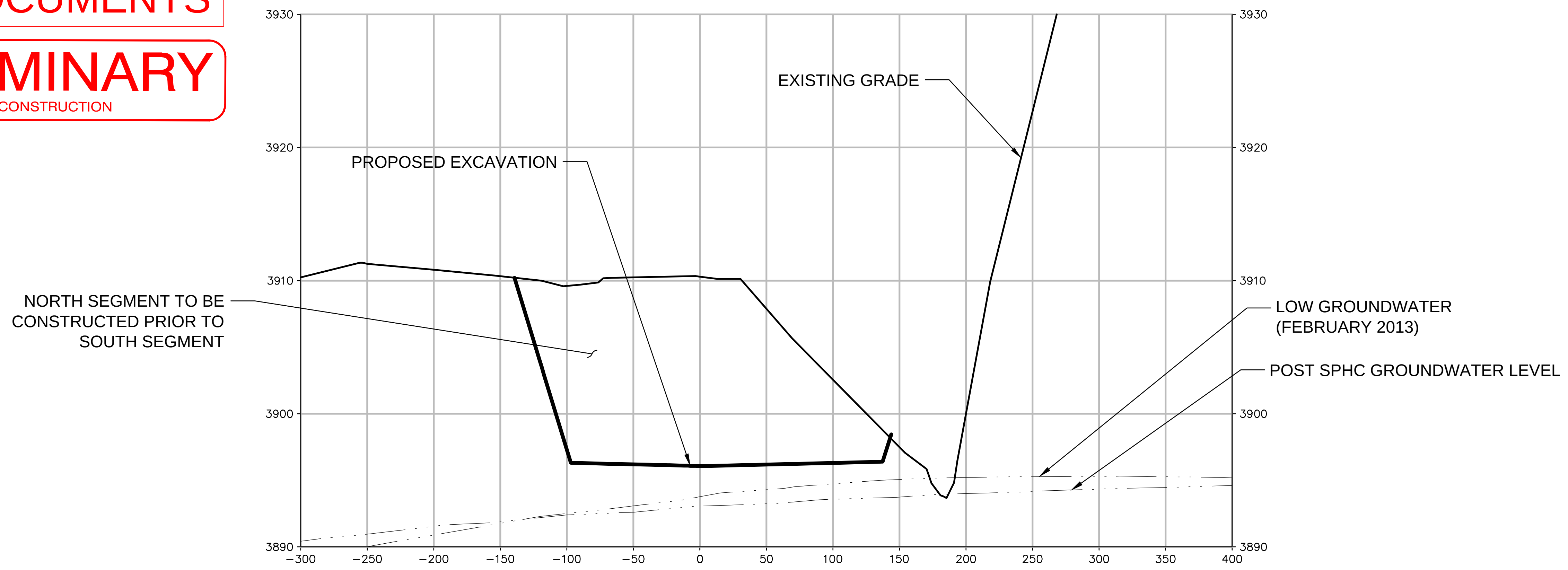
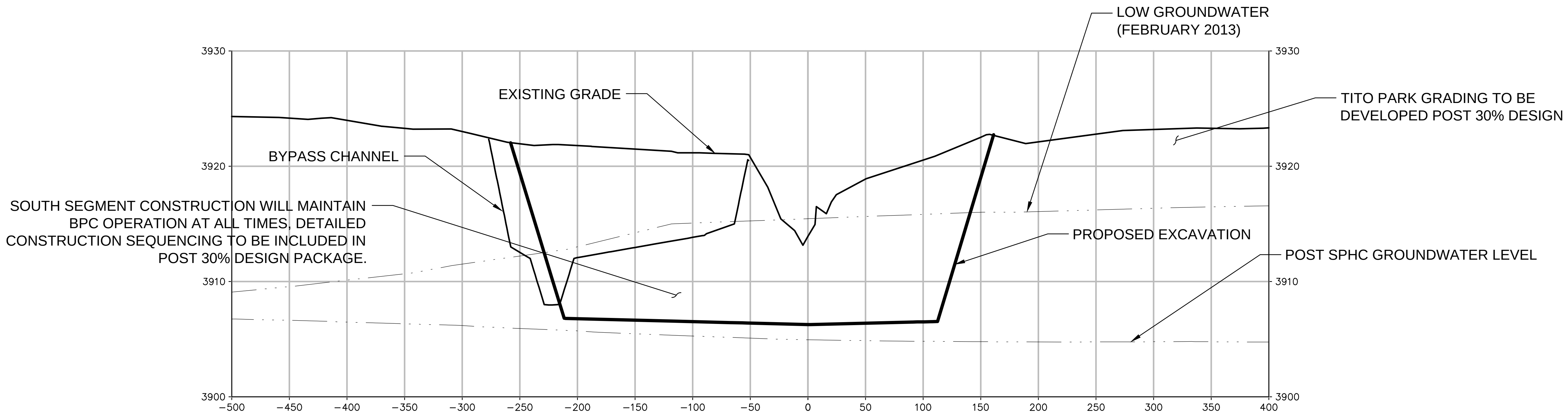


A
C7-1

EXCAVATION CROSS SECTION

SCALE: 1" =50'

SCALE IN FEET
5
50



B
C7-1

EXCAVATION CROSS SECTION

SCALE: 1" =50'

SCALE IN FEET
5
50

PRELIMINARY
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CONSTRUCTION

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PRICKLY PEAR CREEK REALIGNMENT

EXCAVATION
CROSS SECTIONS A AND B

NTS

VERIFY SCALE

BAR IS ONE INCH ON
ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C7-2
SHEET	17 of 50

FILENAME: P031C7-2.dwg
PLOT DATE: 1-Apr-13
PLOT TIME: 4:26 PM

30% DOCUMENTS

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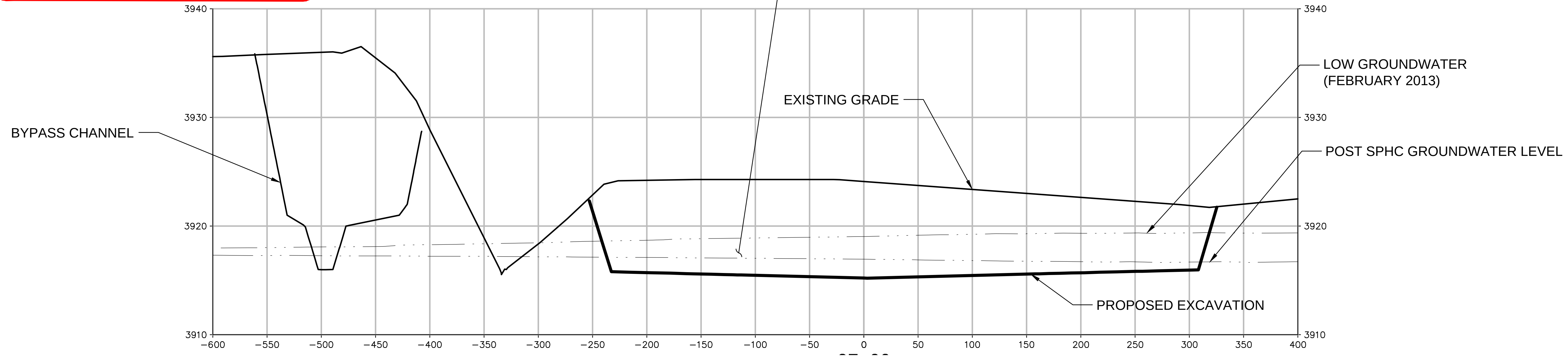
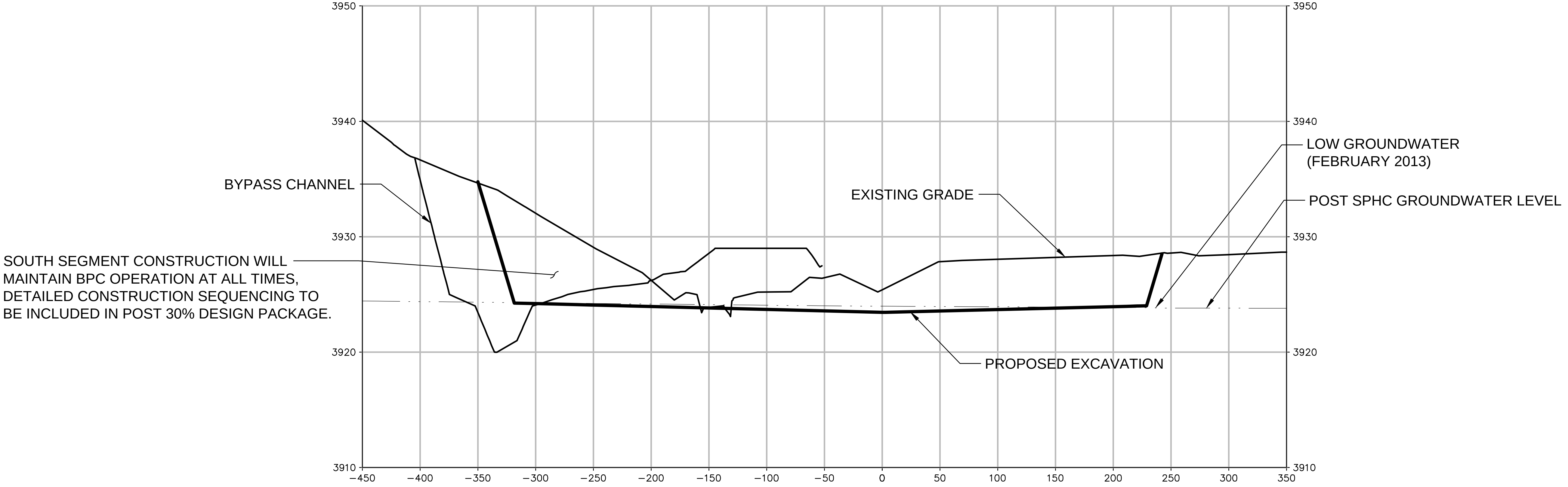
SOUTH SEGMENT CONSTRUCTION WILL MAINTAIN BPC OPERATION AT ALL TIMES, DETAILED CONSTRUCTION SEQUENCING TO BE INCLUDED IN POST 30% DESIGN PACKAGE.



C EXCAVATION CROSS SECTION
SCALE: 1" =50'
C7-1

SCALE IN FEET
5
50



SOUTH SEGMENT CONSTRUCTION WILL MAINTAIN BPC OPERATION AT ALL TIMES, DETAILED CONSTRUCTION SEQUENCING TO BE INCLUDED IN POST 30% DESIGN PACKAGE.

D EXCAVATION CROSS SECTION
SCALE: 1" =50'
C7-1

SCALE IN FEET
5
50

NOTE:
1. NORTH SEGMENT TO BE CONSTRUCTED PRIOR TO SOUTH SEGMENT

PRELIMINARY NOT FOR CONSTRUCTION

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PRICKLY PEAR CREEK REALIGNMENT

EXCAVATION CROSS SECTIONS C AND D

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C7-3
SHEET	18 of 50

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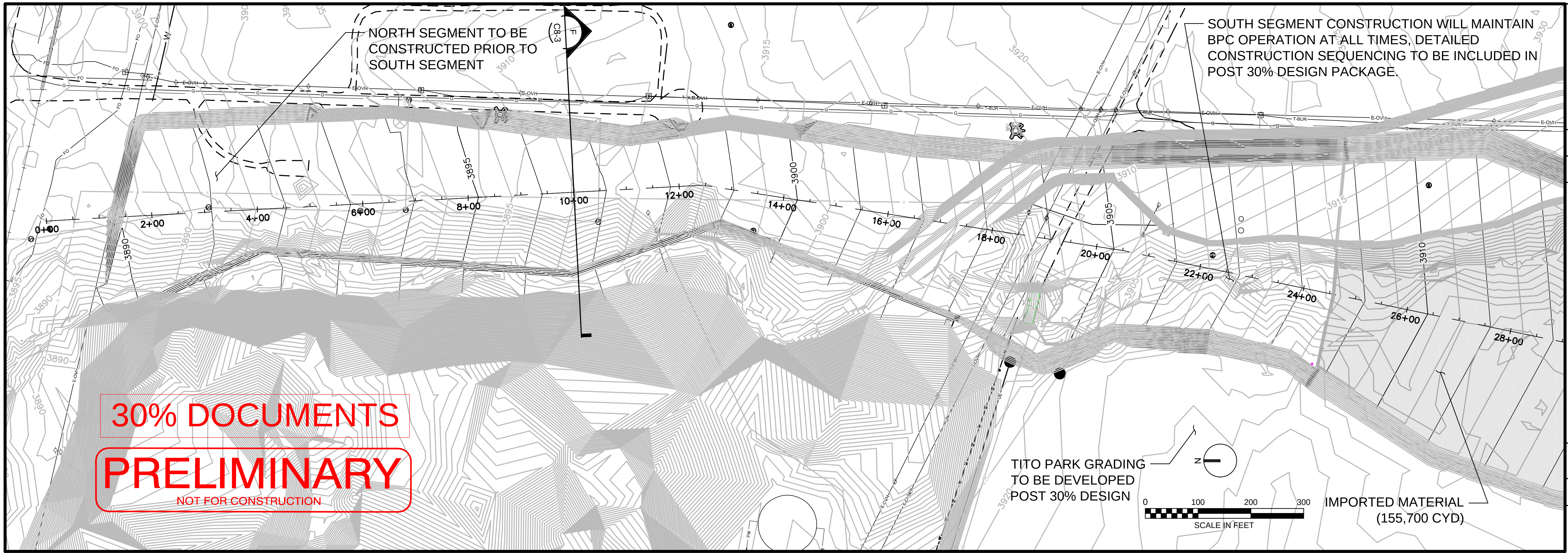

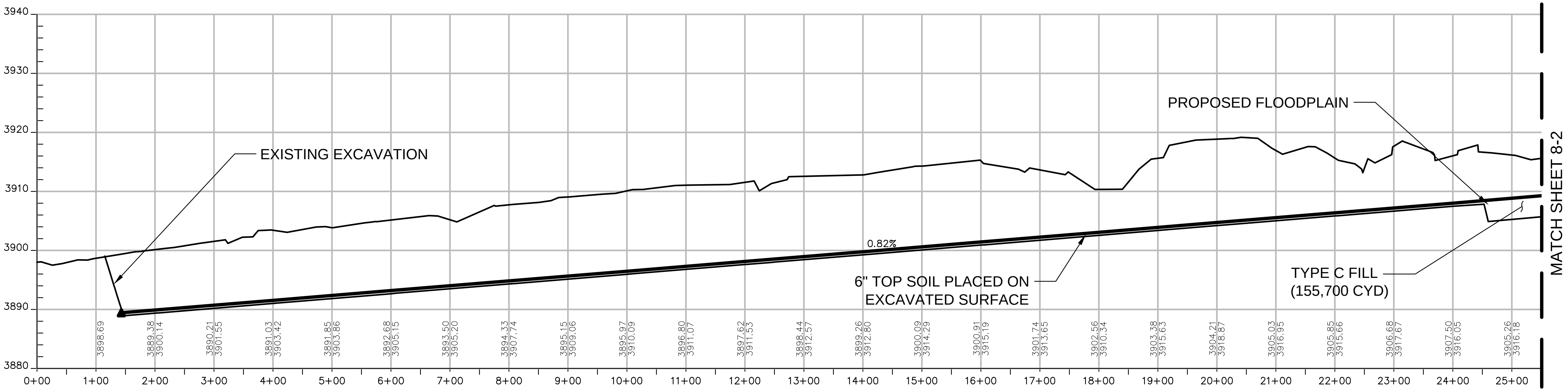

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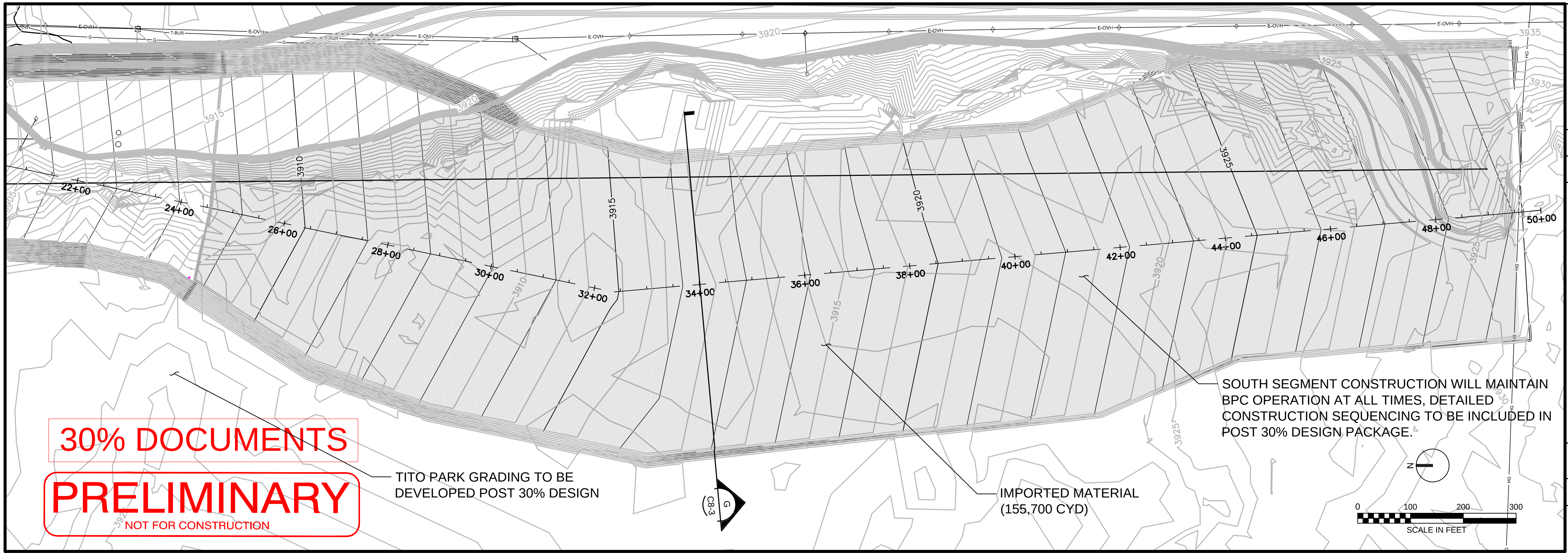
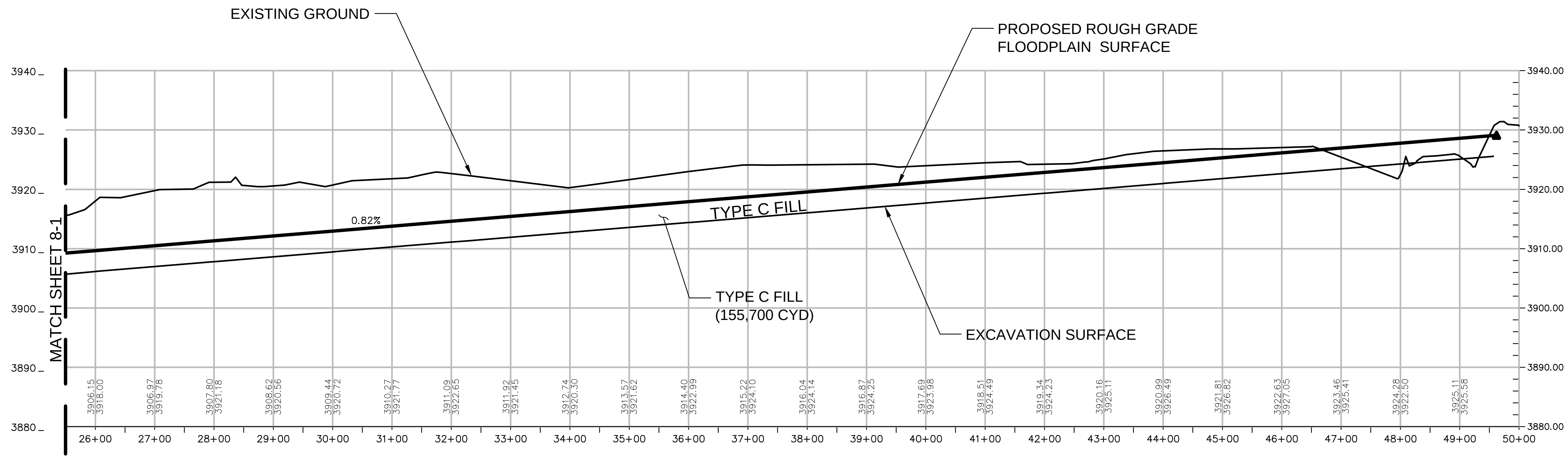
PRICKLY PEAR CREEK REALIGNMENT

FLOODPLAIN RECONSTRUCTION
PLAN AND PROFILE STA 0+00 TO 25+50

1" = 100'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C8-1
SHEET	20 of 50





NOTES:
1. NORTH SEGMENT TO BE CONSTRUCTED PRIOR TO SOUTH SEGMENT.

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG
Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

PIONEER
TECHNICAL SERVICES, INC

PRICKLY PEAR CREEK REALIGNMENT

FLOODPLAIN RECONSTRUCTION
PLAN AND PROFILE STA 25+50 TO 50+00

1" = 100'

VERIFY SCALE

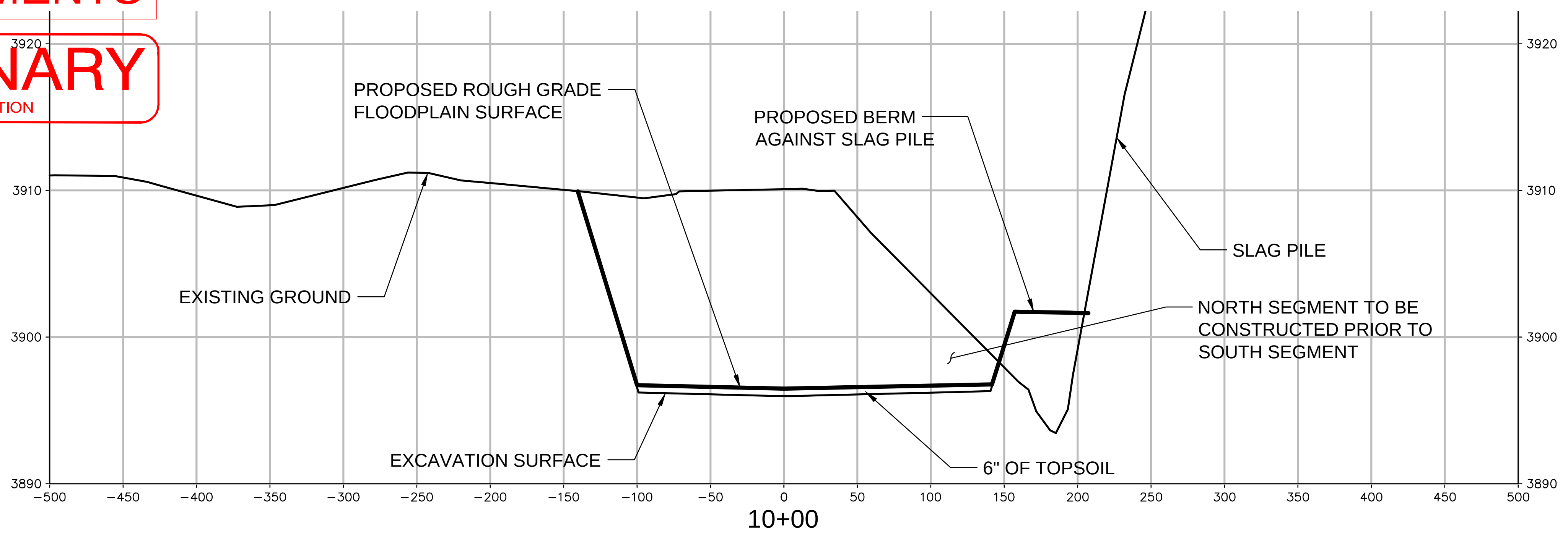
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C8-2
SHEET	21 of 50

FILENAME: P031C8-2_4-15-13.dwg PLOT DATE: 15-Apr-13 PLOT TIME: 11:22 AM

30% DOCUMENTS

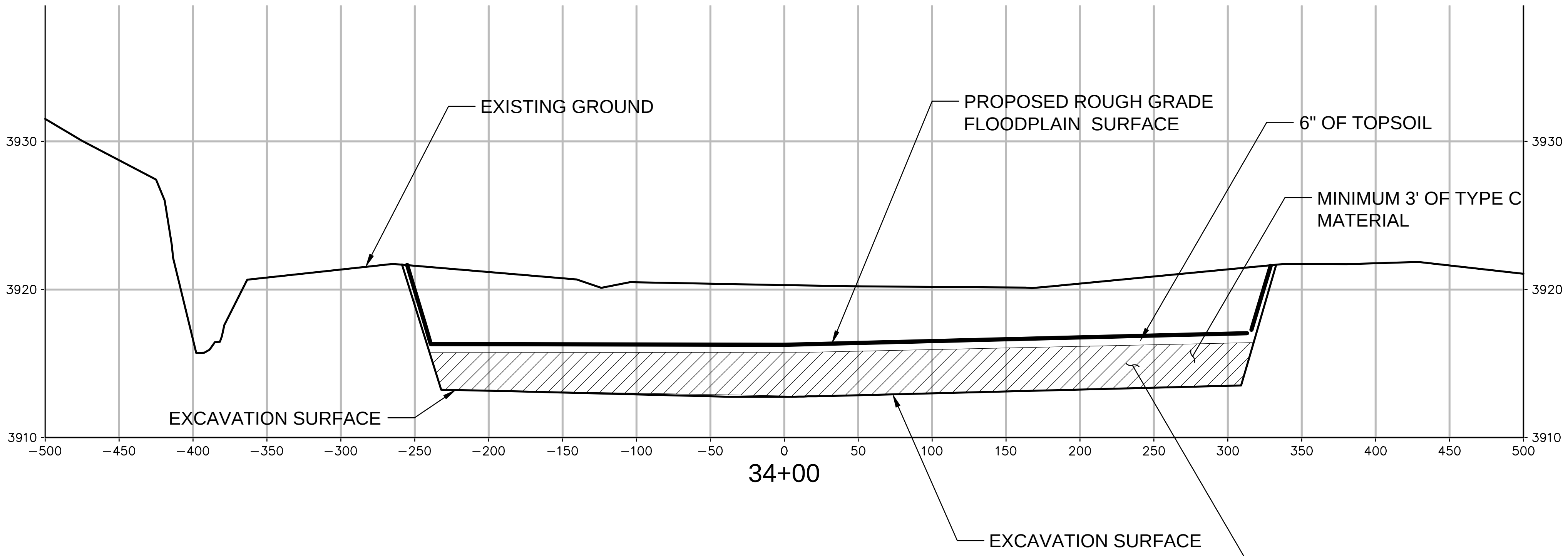
PRELIMINARY
NOT FOR CONSTRUCTION



F FLOODPLAIN CROSS SECTION

1" = 50'

C8-1



SOUTH SEGMENT CONSTRUCTION WILL MAINTAIN BPC OPERATION AT ALL TIMES, DETAILED CONSTRUCTION SEQUENCING TO BE INCLUDED IN POST 30% DESIGN PACKAGE.

G FLOODPLAIN CROSS SECTION

1" = 50'

C8-2

0 50 100 150
SCALE IN FEET

SCALE IN FEET 5 50

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

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DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

PIONEER TECHNICAL SERVICES, INC

PRICKLY PEAR CREEK REALIGNMENT

FLOODPLAIN RECONSTRUCTION CROSS SECTIONS F AND G

1" = 50'

VERIFY SCALE

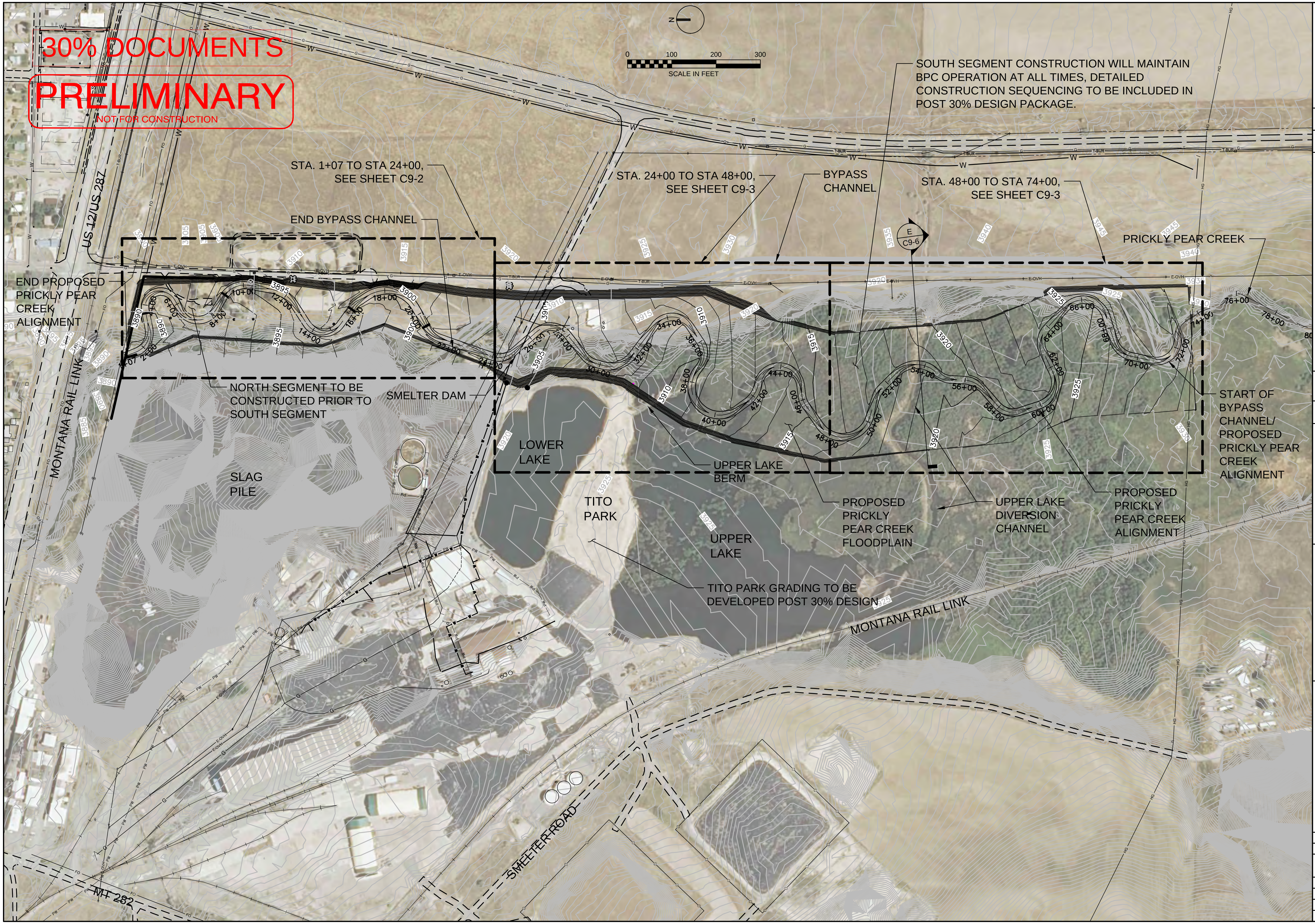
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C8-3
SHEET	22 of 50

FILENAME: P031C8-3.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 3:59 PM

30% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION



SOUTH SEGMENT CONSTRUCTION WILL MAINTAIN BPC OPERATION AT ALL TIMES, DETAILED CONSTRUCTION SEQUENCING TO BE INCLUDED IN POST 30% DESIGN PACKAGE.

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

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PIONEER TECHNICAL SERVICES, INC

PRICKLY PEAR CREEK REALIGNMENT

CHANNEL RECONSTRUCTION OVERVIEW

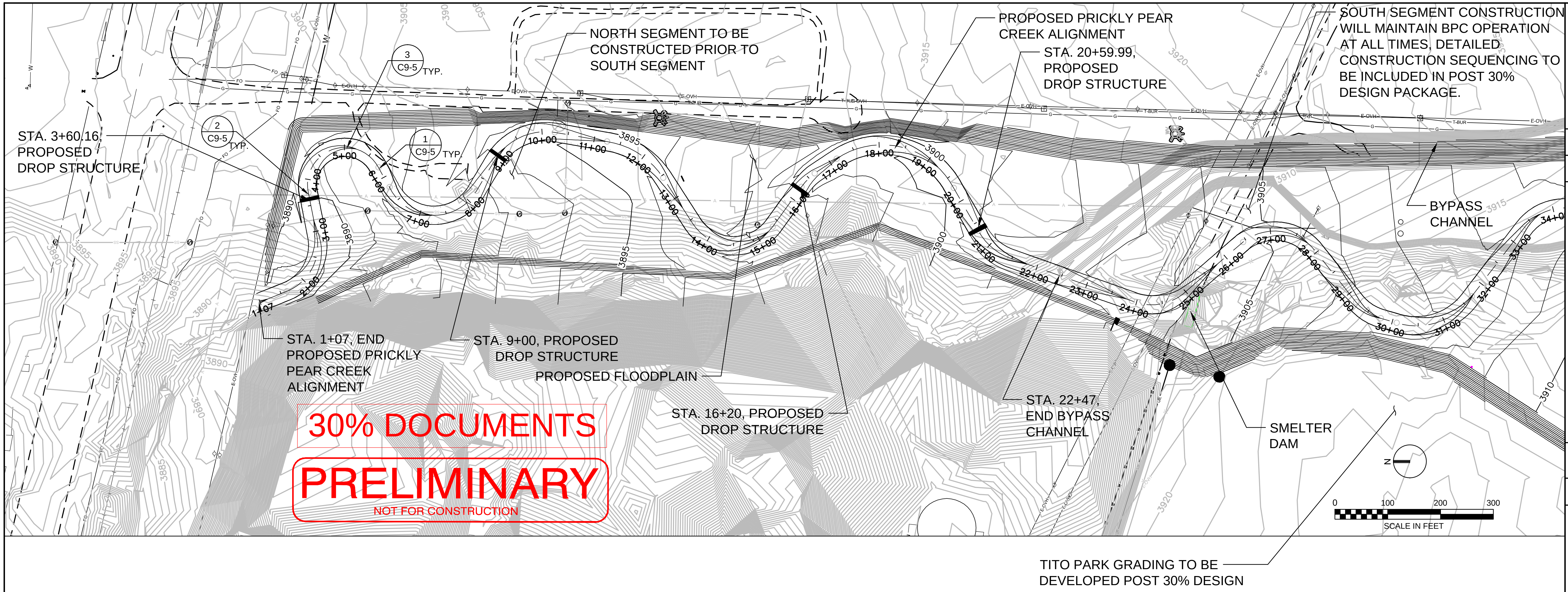
1" = 200'

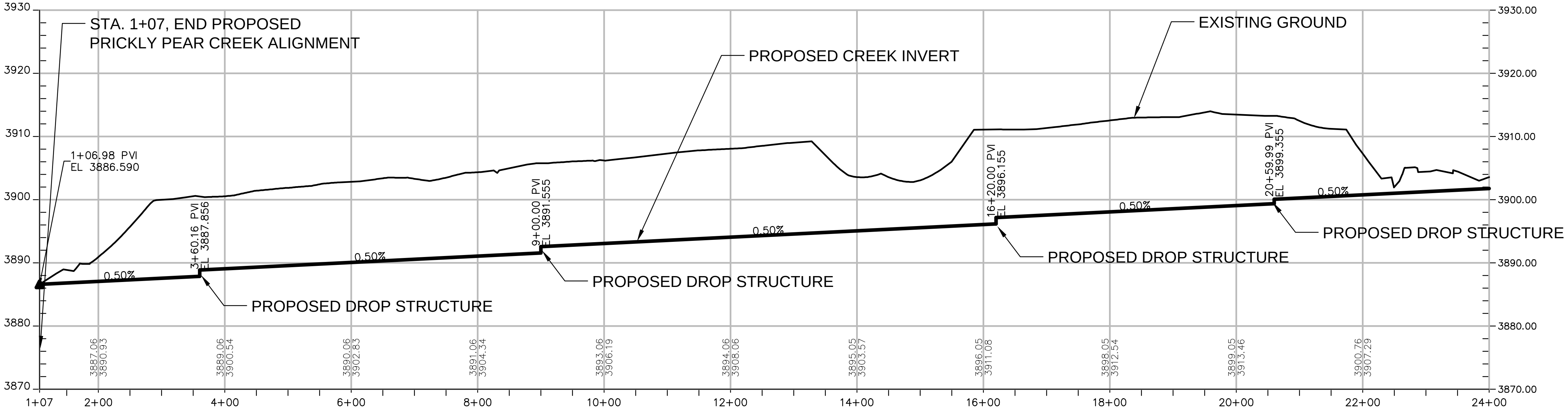
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C9-1
SHEET	27 of 50

FILENAME: P031C9-1.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 4:02 PM





SCALE IN FEET
100
10

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CHK J EMMERT
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Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

PIONEER TECHNICAL SERVICES, INC.

CH2MHILL

PRICKLY PEAR CREEK REALIGNMENT
CHANNEL RECONSTRUCTION
PLAN AND PROFILE STA 1+07 TO 24+00

1" = 100'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C9-2
SHEET	28 of 50

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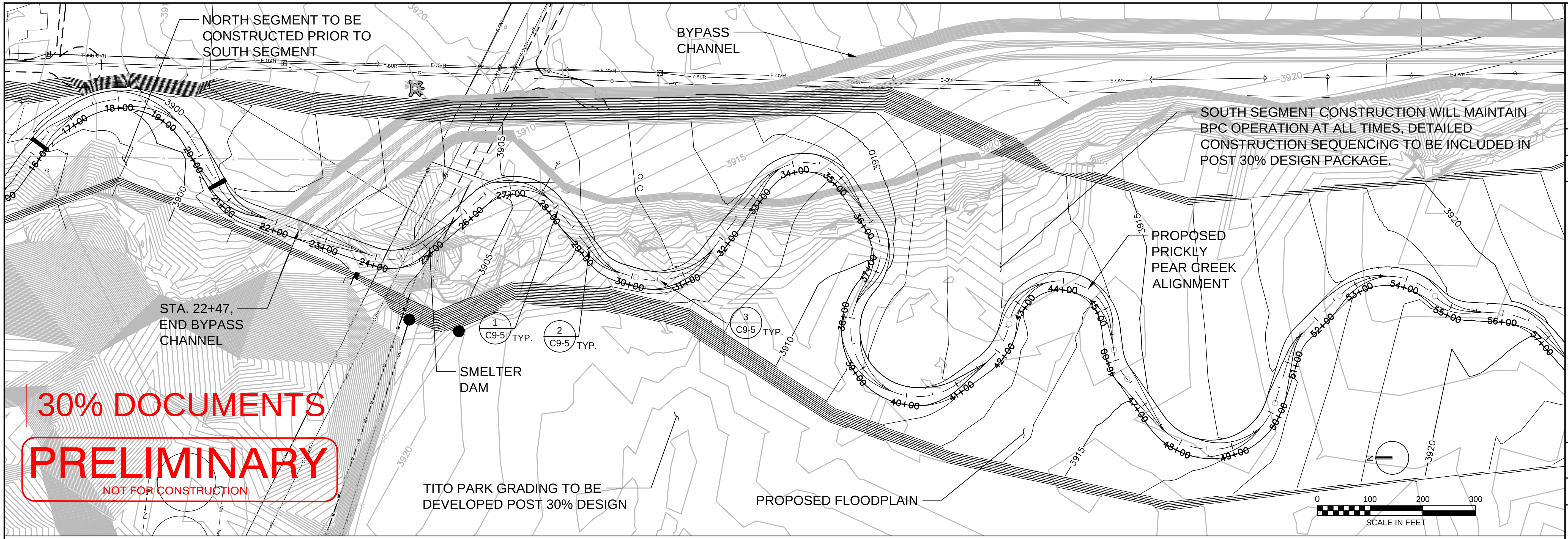
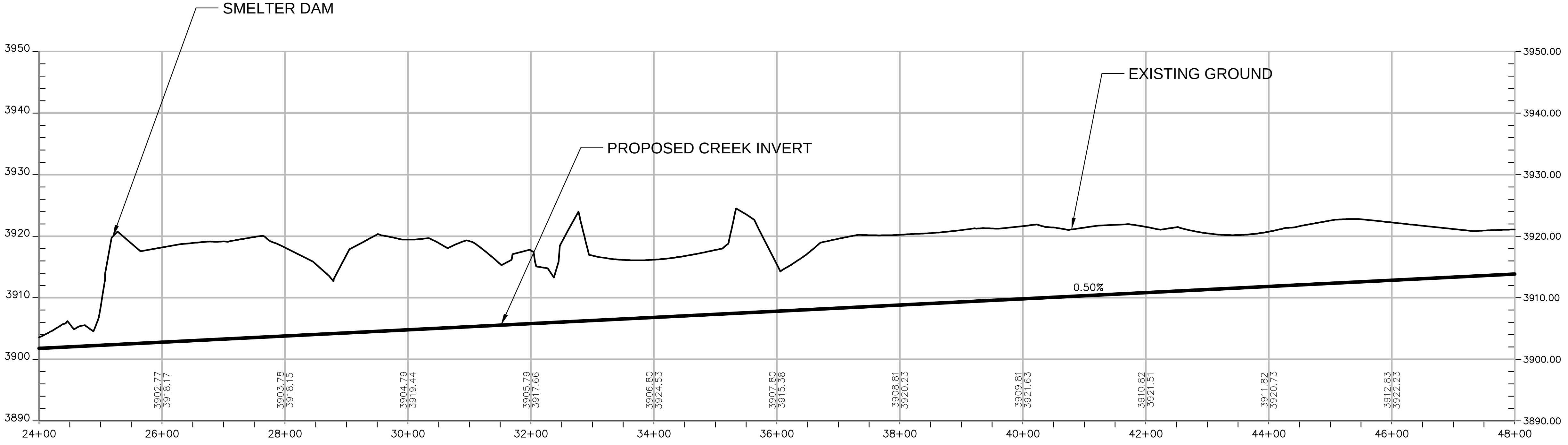
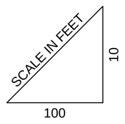
FILENAME: P031C9-2.dwg
PLOT DATE: 1-Apr-13
PLOT TIME: 6:57 PM







PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

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PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK REALIGNMENT

CHANNEL RECONSTRUCTION
PLAN AND PROFILE STA 24+00 TO 48+00

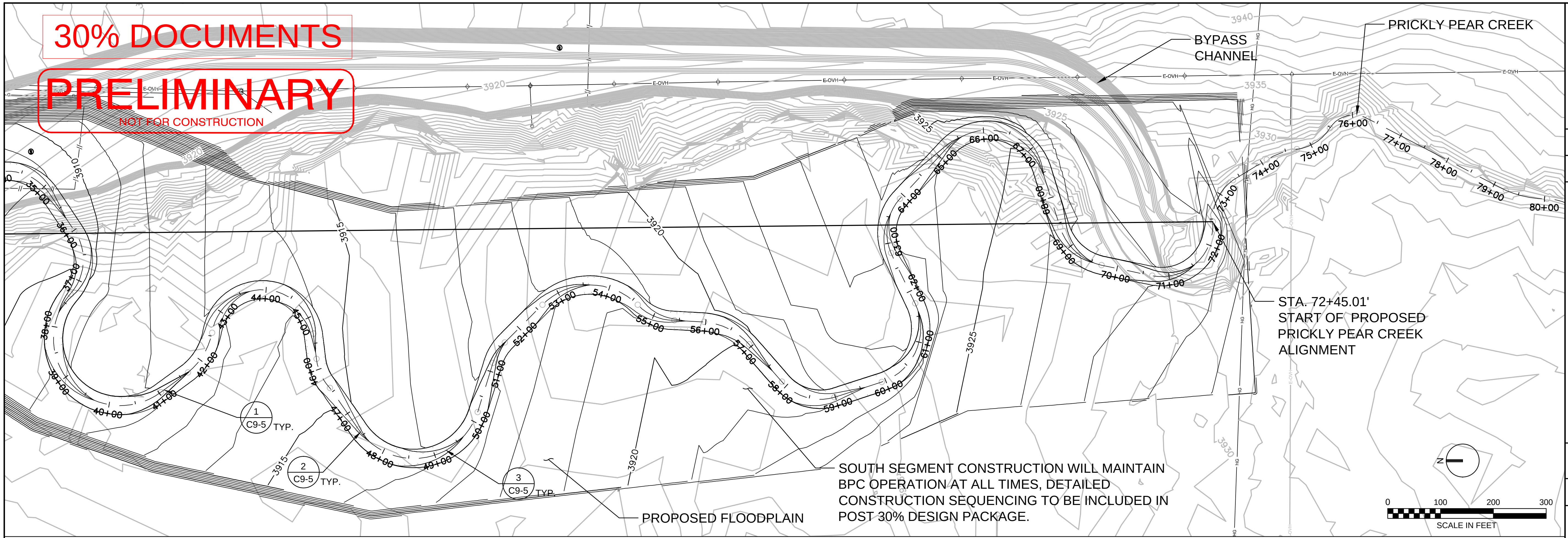
1" = 100'

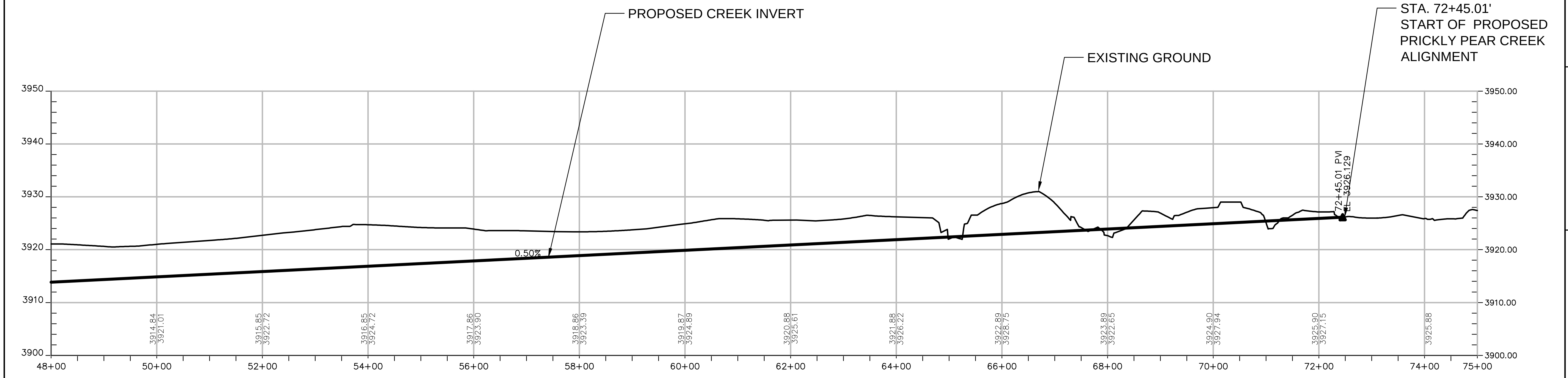
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 ▬ 1"

DATE	APRIL 2013
PROJ	420947
DWG	C9-3
SHEET	29 of 50

FILENAME: P031C9-3.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 4:07 PM





NOTES:
1. NORTH SEGMENT TO BE CONSTRUCTED PRIOR TO SOUTH SEGMENT

SCALE IN FEET
10
100

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG Montana Environmental Trust Group

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East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

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PIONEER TECHNICAL SERVICES, INC.

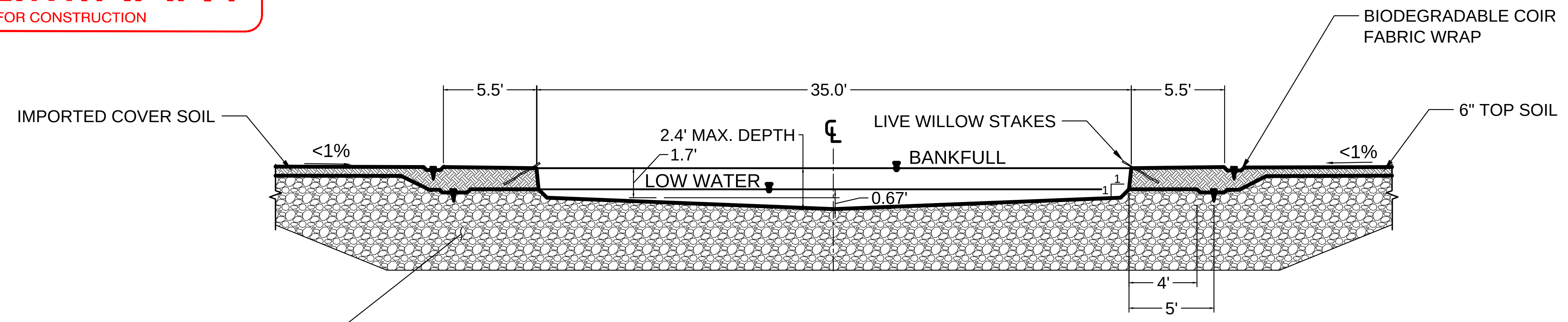
PRICKLY PEAR CREEK REALIGNMENT
CHANNEL RECONSTRUCTION
PLAN AND PROFILE STA 48+00 TO 75+00

1" = 100'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

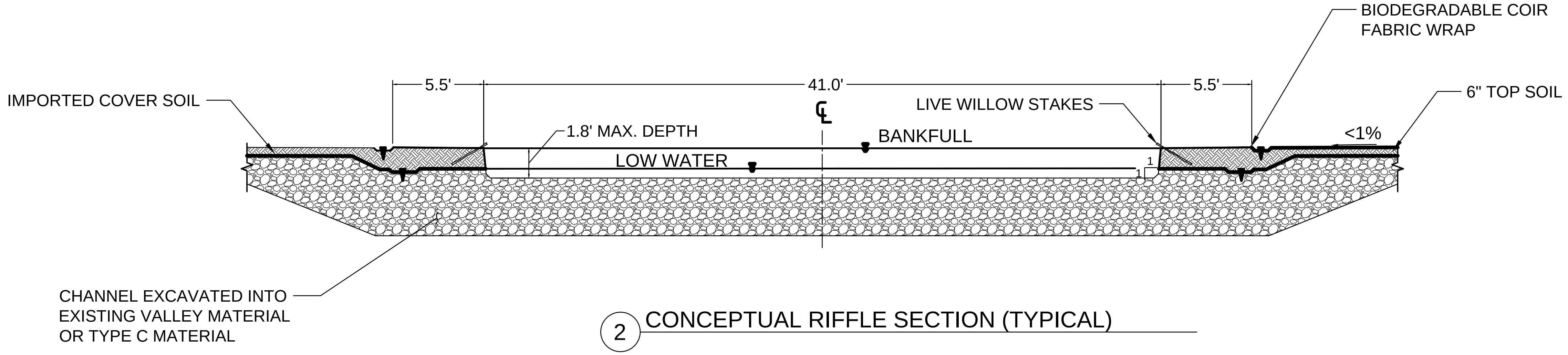
DATE	APRIL 2013
PROJ	420947
DWG	C9-4
SHEET	30 of 50

30% DOCUMENTS

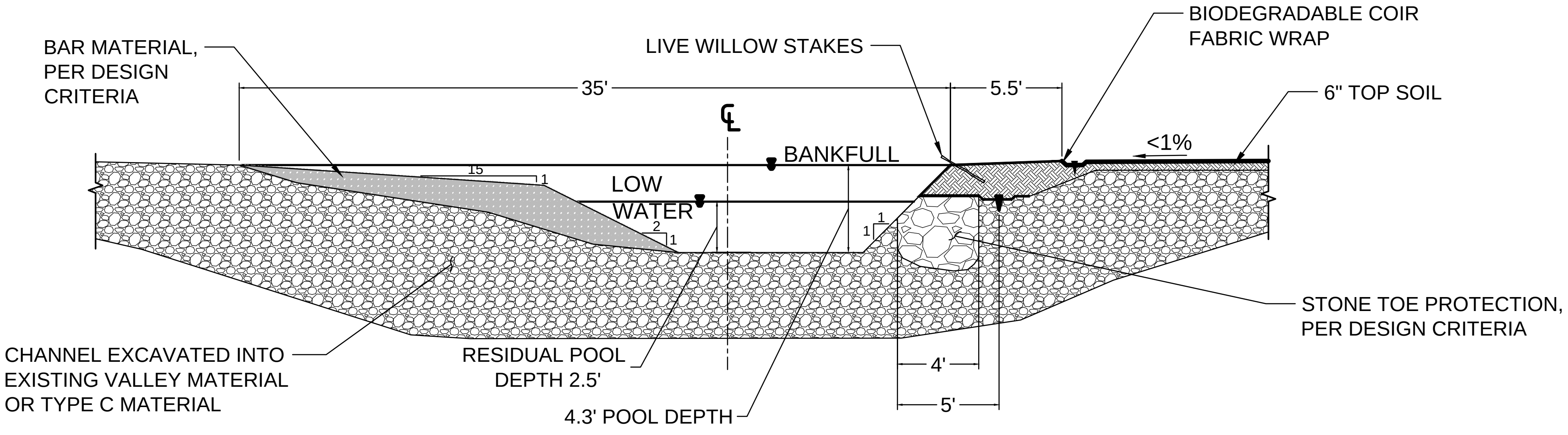
PRELIMINARY
NOT FOR CONSTRUCTION



1 CONCEPTUAL RUN SECTION (TYPICAL)



2 CONCEPTUAL RIFFLE SECTION (TYPICAL)



3 CONCEPTUAL POOL SECTION (TYPICAL)

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CONSTRUCTION

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DR J JUPKA
CHK J EMMERT
APVD J GERHART

MONTANA ENVIRONMENTAL TRUST GROUP
METG
Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

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PIONEER
TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK REALIGNMENT

DEFORMABLE RUN, RIFFLE, AND POOL SECTIONS

1" = 100'

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C9-5
SHEET	34 of 50

30% DOCUMENTS

PRELIMINARY
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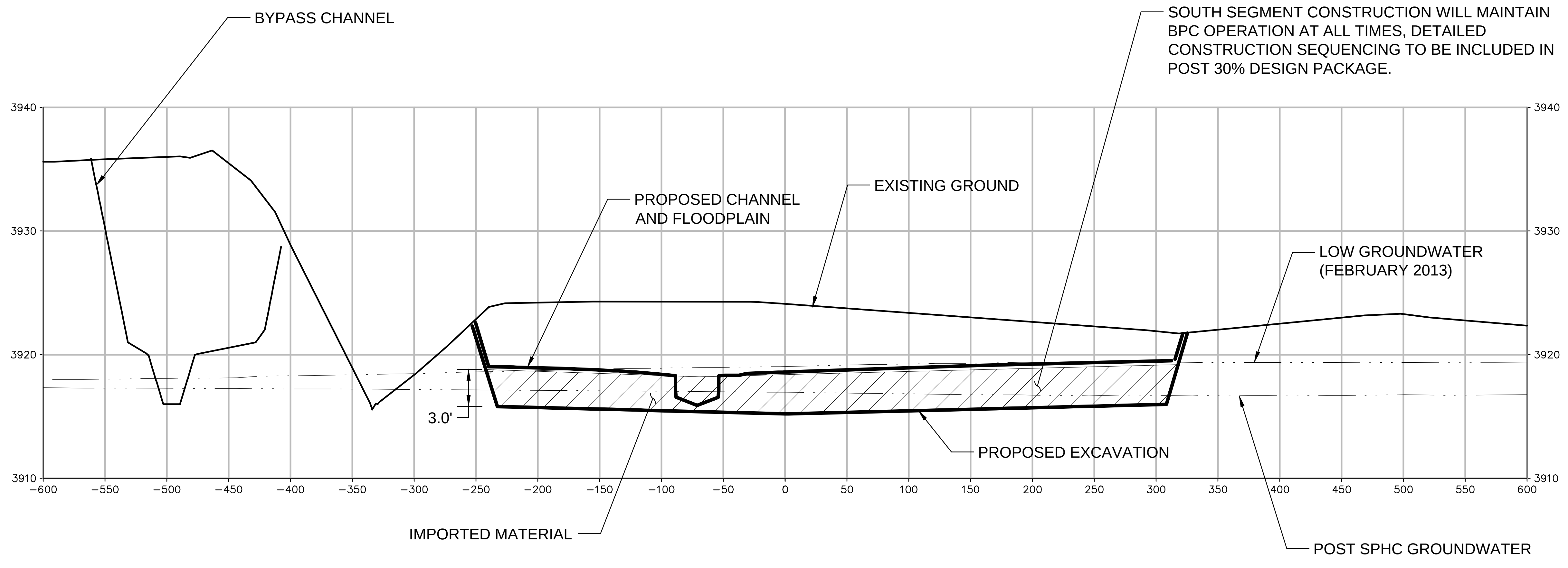
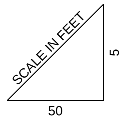


E IMPORTED MATERIAL CROSS SECTION

1" = 50'

C9-1

NOTE:
1. NORTH SEGMENT TO BE CONSTRUCTED PRIOR TO SOUTH SEGMENT.



FILENAME: P031C9-11.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 4:14 PM

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DSGN	DR	CHK	APVD
G AUSTIGUY	J JUPKA	J EMMERT	J GERHART

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

PIONEER TECHNICAL SERVICES, INC.

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PRICKLY PEAR CREEK REALIGNMENT

CHANNEL RECONSTRUCTION
IMPORTED MATEIRAL CROSS SECTION

1" = 50'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C9-11
SHEET	38 of 50

30% DOCUMENTS

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CONSTRUCTION

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DR J JUPKA
CHK J EMMERT
APVD J GERHART

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East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

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CH2MHILL

PRICKLY PEAR CREEK REALIGNMENT

EXISTING WETLAND
PLAN VIEW

1" = 200'

VERIFY SCALE

BAR IS ONE INCH ON
ORIGINAL DRAWING.
0 ▬ 1"

DATE	APRIL 2013
PROJ	420947
DWG	C10-1
SHEET	39 of 50

FILENAME: P031C10-1.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 5:56 PM

30% DOCUMENTS

PRELIMINARY
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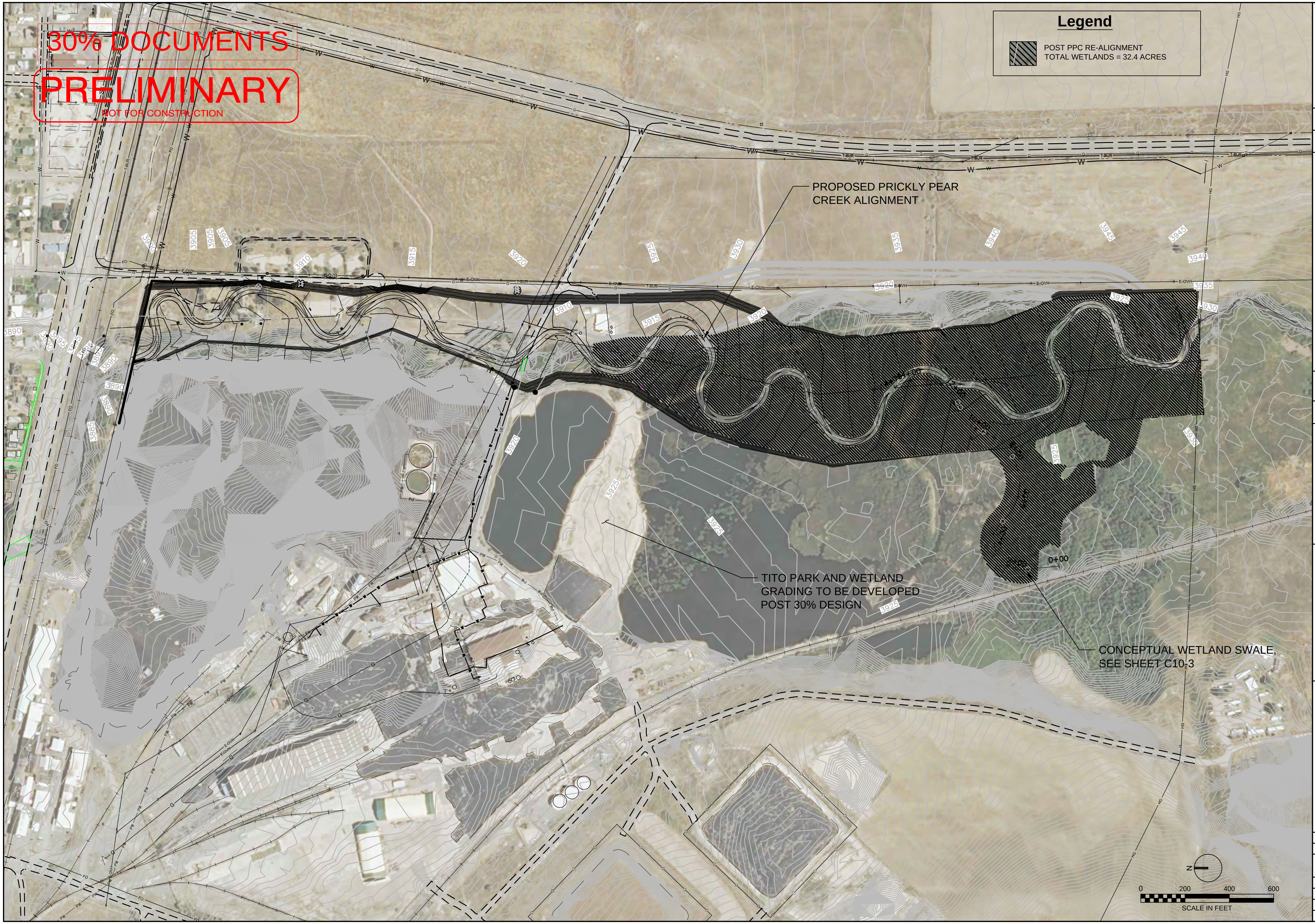

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

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CHK J EMMERT
APVD J GERHART

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Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

PIONEER TECHNICAL SERVICES, INC

PRICKLY PEAR CREEK REALIGNMENT
CONCEPTUAL WETLANDS
PLAN VIEW

1" = 200'

VERIFY SCALE

BAR IS ONE INCH ON
ORIGINAL DRAWING.
0 ▬ 1"

DATE	APRIL 2013
PROJ	420947
DWG	C10-2
SHEET	40 of 50

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FILENAME: P031C10-2.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 5:58 PM

30% DOCUMENTS

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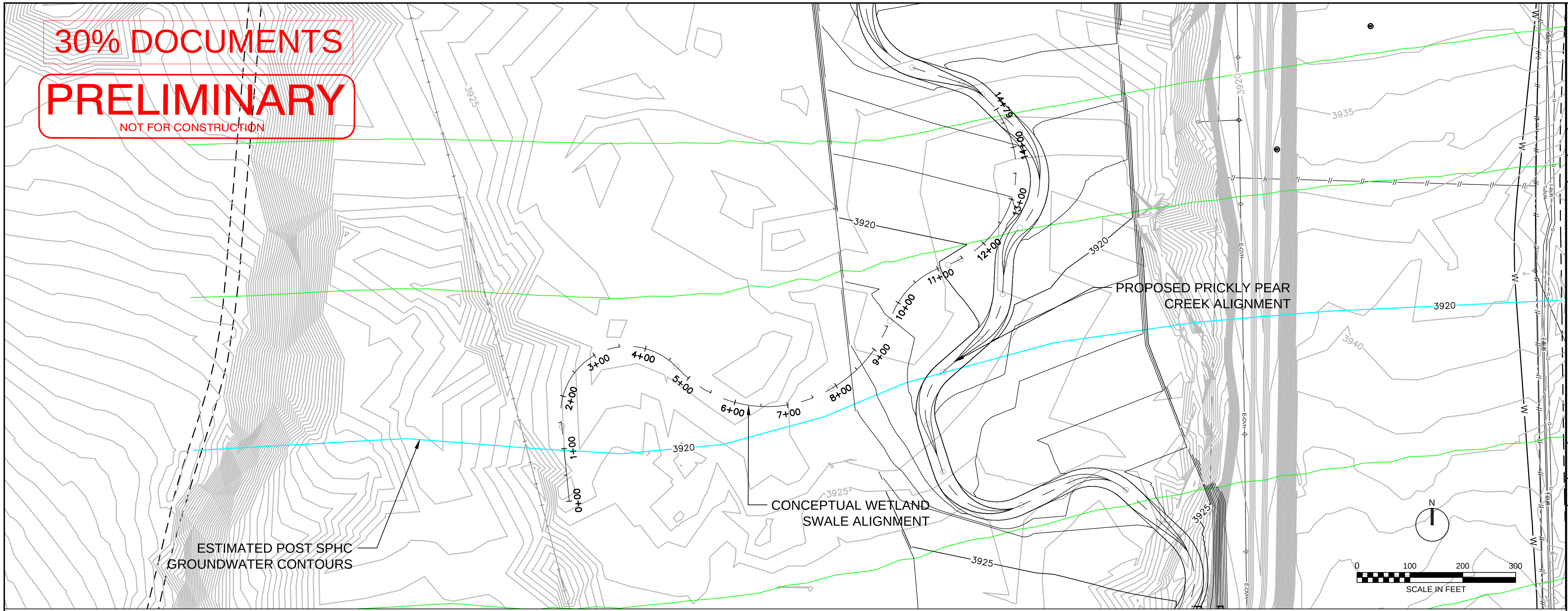
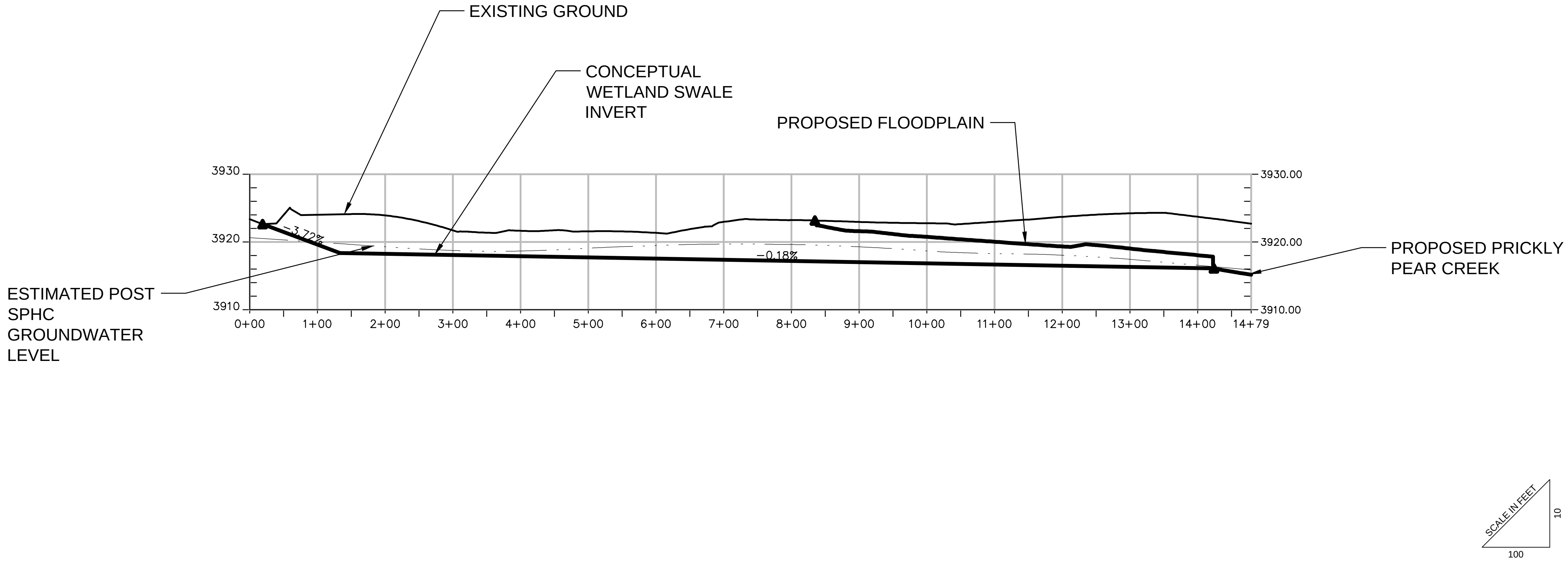




PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN	G AUSTIGUY
DR	J JUPKA
CHK	J EMMERT
APVD	J GERHART

Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

PIONEER TECHNICAL SERVICES, INC.

CH2MHILL

PRICKLY PEAR CREEK REALIGNMENT

CONCEPTUAL WETLAND SWALE PLAN AND PROFILE

1" = 100'

VERIFY SCALE

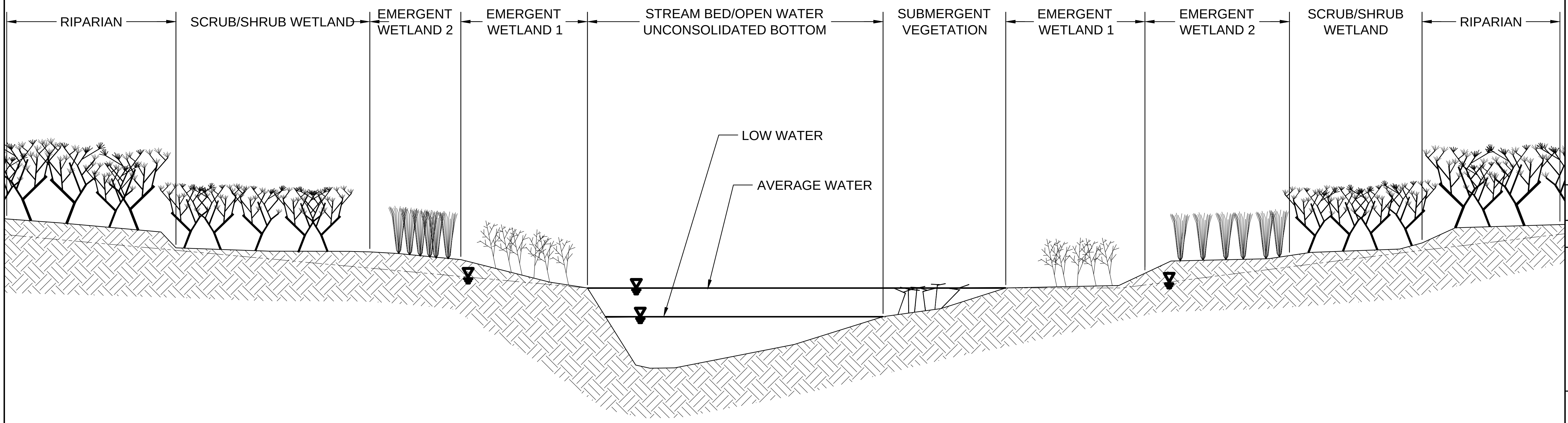
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C10-3
SHEET	41 of 50

FILENAME: P031C10-3.dwg
PLOT DATE: 1-Apr-13
PLOT TIME: 4:22 PM

30% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION



HABITATS

LEGEND	DISTANCE FROM WATER TABLE
RIPARIAN	+3.0'
SHRUB	+3.0' TO +2.0'
EMERGENT 2	+2.0' TO +1.0'
EMERGENT 1	+1.0' TO +0.0'
SUBMERGENT	0.0' TO -1.0'
OPEN WATER	-1.0' TO -2.0'

④ CONCEPTUAL PROPOSED HABITATS

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DSGN G AUSTIGUY
DR J JUPKA
CHK J EMMERT
APVD J GERHART

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

PIONEER TECHNICAL SERVICES, INC

PRICKLY PEAR CREEK REALIGNMENT
CONCEPTUAL WETLAND SWALE
PROPOSED HABITATS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2013
PROJ	420947
DWG	C10-4
SHEET	42 of 50

FILENAME: P031C10-4.dwg PLOT DATE: 1-Apr-13 PLOT TIME: 4:23 PM