CRESTED BUTTE MUNICIPAL WATER DIVERSION RECONSTRUCTION PROJECT

PREPARED FOR:

Coal Creek Watershed Coalition
Crested Butte, Colorado

PREPARED BY:

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January 2013

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Prepared for:

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January 14, 2011

Crested Butte Municipal Water Diversion Reconstruction Project

Location & Background

The headwaters of Coal Creek begin north of the top of Kebler Pass near the historic Irwin Townsight and east of Lake Irwin and the Ruby Range at approximately 10,000 feet above sea level in northwest Gunnison County in the Gunnison National Forest. The creek flows east along County Road 12 (Kebler Pass Road) toward the Town of Crested Butte. Tributaries to Coal Creek before it reaches Crested Butte include Elk Creek, Splains Gulch and Wilcat Creek. The stream segment to be investigated begins approximately 6.5 miles downstream of Lake Irwin and approximately 1 ½ miles before it enters the Town of Crested Butte at approximately 9,200 above sea level. (See Figure 1).

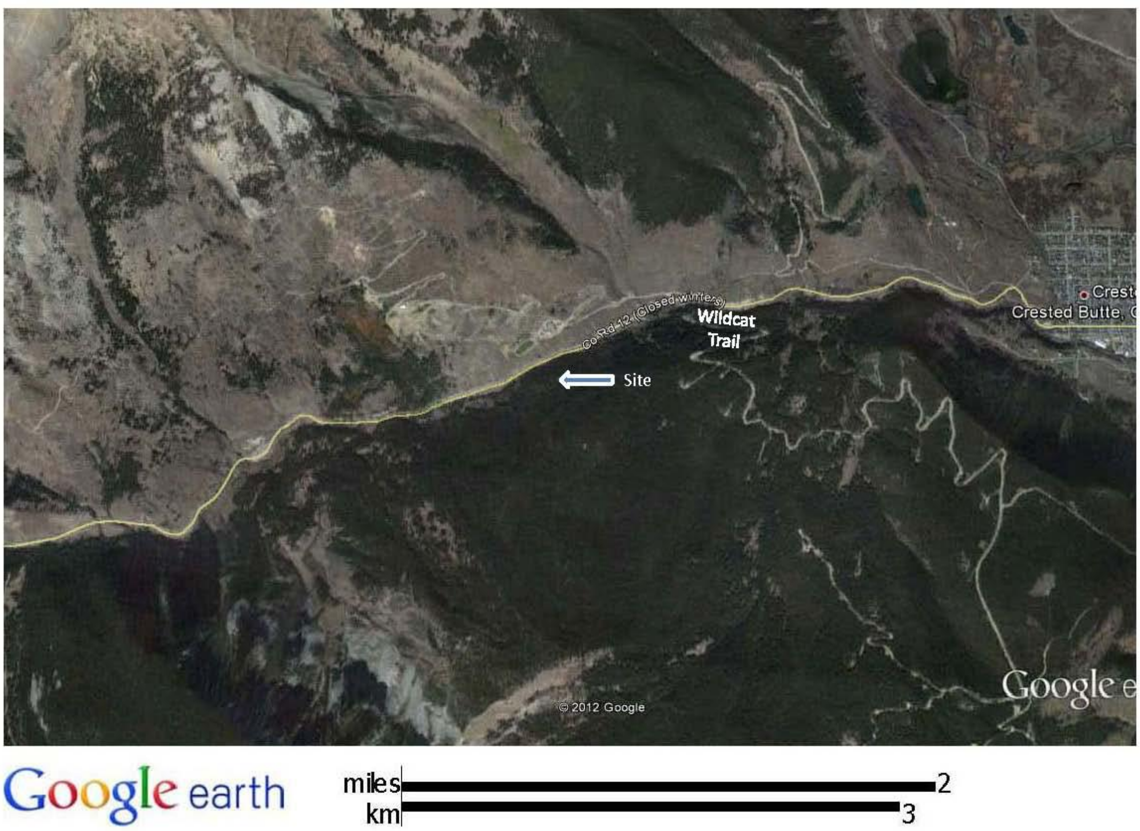


Figure 1. Vicinity Map

The Coal Creek Watershed Coalition in Crested Butte contracted with Crane Associates in Carbondale, CO to produce a design package and budget for a sustainable irrigation diversion structure for the Town diversion. The water right is owned and maintained by the Town of Crested Butte and has a 6 cfs direct flow right from Coal Creek and Wildcat Creek with a 1893 appropriation date and a 1933 administrative date with a 367 acre-foot storage right in Lake Irwin. The legal point of diversion on Coal Creek is located SE ¼ of the SW ¼ of the NE ¼ of

Section 5 in Township 14 South, Range 86 West. The structure ID number is 842 in Water District 59.

Crane Associates did an initial site visit on August 17, 2012 and reviewed the objectives of the project with Anthony Poponi, previous director of the Coal Creek Watershed Coalition. It is understood that under the current conditions, the Crested Butte Water Ditch diversion is accumulating sediment and requiring frequent maintenance to keep water in the Wildcat Pipeline. Diversions are attained through modifications of a gravel push up dam used to divert water into the existing concrete diversion box. The frequent modifications to the gravel pushup dam cause significant and regular releases of sediment to Coal Creek and destabilizes the stream bed and banks. Sediment loading upstream of the diversion reduces water quality and increases the likelihood of the addition of sediment into the municipal water supply and exaserbates the existing listing on the Clean Water Act Section 303(d) list of impairments for this creek. Destabilization of the creek bed causes accelerated degradation and requires continual excavation in the channel in order to divert irrigation water thus promulgating an unsustainable cycle of disruption.

The objectives of the conceptual irrigation diversion reconstruction design are to:

- Reduce the frequent maintenance of the structure which disturbs instream habitat by releasing accumulated sediment into Coal Creek and disrupts adjacent riparian habitat;
- To construct a more reliable diversion structure to withstand changing flows and improve water quality, instream habitat and adjacent riparian habitat;
- To certify no-rise structures using HEC-RAS modeling, and
- Improve longitudinal connectivity of Coal Creek.

Existing Conditions

A field survey was performed on September 21st to measure the morphological characteristics of the creek in the vicinity of the diversion. Five permanent cross sections were also established for hydrologic modeling and long-term monitoring. The stream segment in the vicinity of the existing diversion structure is a perennial single thread channel with low to moderate sinuosity and an average channel slope of 2.69%. It is a relatively steep and continuous grade from the headwaters through the project and into town. The channel material is predominately large gravel and a healthy riparian community of willows, 3-leaf sumac and other native species is mostly continuous through the reach. The floodplain is thick with native vegetation and the channel is moderately entrenched. The creek is a second order stream situated in a moderately steep colluvial valley with average bankfull widths of 30 to 50 feet. Seasonal variation of streamflow is dominated by snowmelt runoff and depositional features are primarily point bars with no mid channel bars except in the vicinity of the gravel dam. The area surrounding the diversion is over-wide with significantly disturbed riparian habitat. The stream is classified under the Rosgen classification system as a B-4 stream type.

Coal Creek is classified by the Water Quality Control Commission as Recreation E, aquatic life cold, agriculture. The creek is listed on the 303(d) list of impaired streams for cadmium and zinc and has a temporary modification on for cadmium (2.3 ug/L) and zinc (518 ug/L) expiring 12/31/2012. Magnesium chloride and sediment are issues of concern from Kebler Pass Road.

Hydrologic Analysis

Coal Creek below is a high mountain stream with a drainage area of approximately 20 square miles and an average basin slope of 31%. The peak flows on this stream are dominated by late spring / early summer snow melt runoff. The stream does not have any reported stream measurements or gaging stations. Mean annual precipitation is 31.83 inches at a mean basin elevation of 10,400 feet.

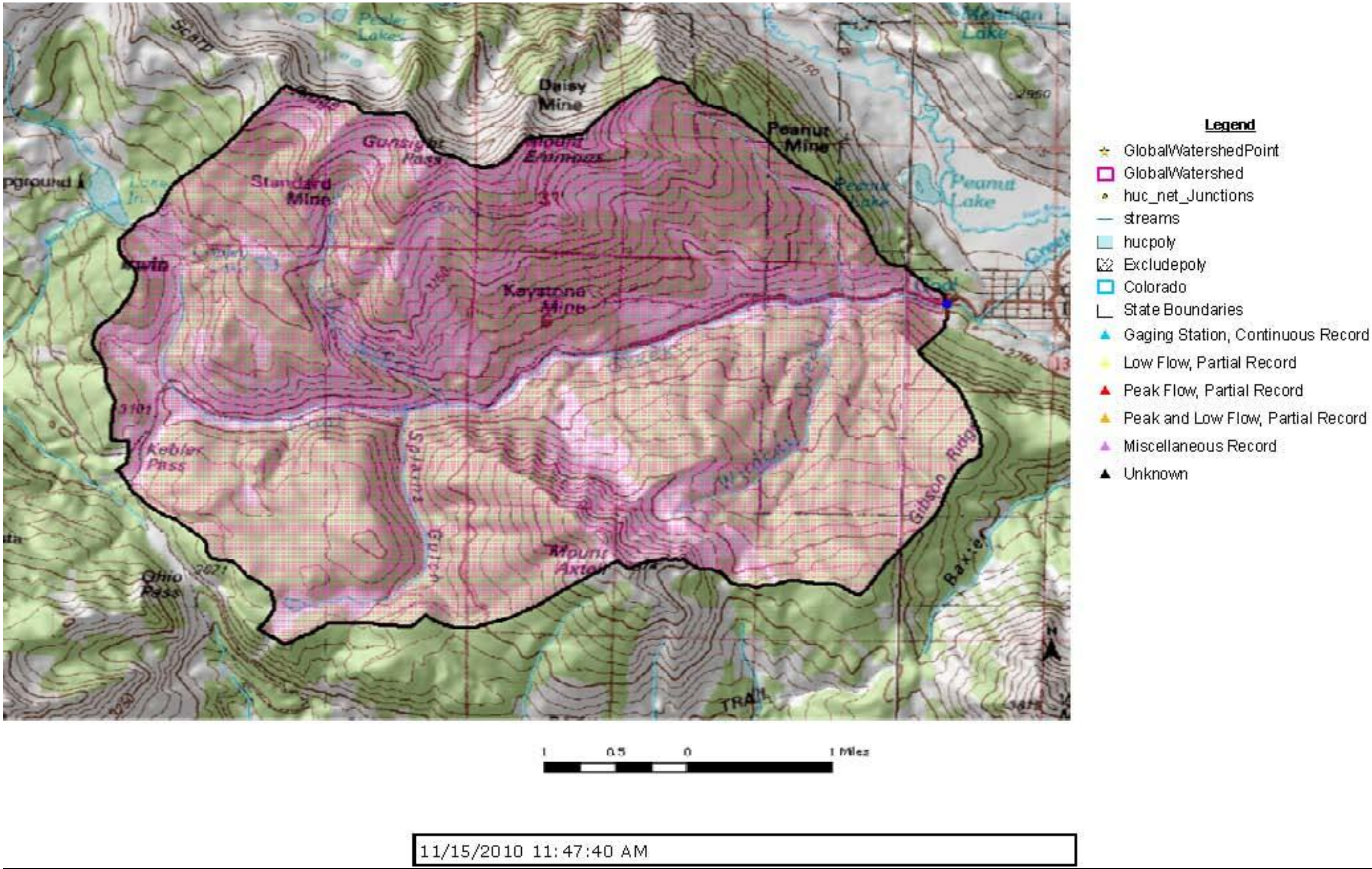
StreamStats was used to develop basin hydrology and stream flow statistics for the 2, 5, 10, 25, 50, 100, 200 and 500 year return events. StreamStats is an integrated GIS application developed through a cooperative effort of the USGS and ESRI, Inc. StreamStats makes the process of computing streamflow statistics for ungaged sites much faster, more accurate, and more consistent than previously used manual methods. The equations used to estimate streamflow statistics for ungaged sites were developed through a process known as regionalization. This process involves use of regression analysis to relate streamflow statistics computed for a group of selected streamgaging stations (usually within a state) to basin characteristics measured for the stations. Basin characteristics measured for ungaged sites can be entered into the resulting equations to obtain estimates of the streamflow statistics.

The StreamStats Web application provides access to automated procedures and very large, complex data sets. These data sets are known to contain occasional errors. Professional judgment based on bankfull field indicators had been exercised in evaluating the appropriateness and accuracy of the results for this application. Basin delineations, in particular, have been checked and verified. Estimates provided by StreamStats assume natural flow conditions at the site. There are no major human activities such as dam regulation and large water withdrawals that substantially affect the timing, magnitude, or duration of flows at a selected site.

Table 1: Summary of flow events calculated by StreamStats:

Peak-Flows Stream Flow Statistics		
Return event	Flow (cfs)	Prediction error (%)
Low flow	2	89
Mean flow	10.9	32
2	238	49
5	326	44
10	383	41
25	443	40
50	520	39
100	570	36
200	611	36
500	696	33

Figure 2: Coal Creek Watershed Map



Hydraulic Analysis

Software (HEC-RAS) is used to perform a hydraulic analysis of the existing and proposed conditions.

Geometry in the existing conditions model is based on 7 cross sections surveyed along the project reach in September 2012. The flows analyzed in the model are those listed in the hydrologic section above. This reach of Coal Creek is modeled with subcritical flows and the Manning's roughness coefficient selected for the channel is 0.038 and for the overbanks is 0.042. The USGS publication "Verified Roughness Characteristics of Natural Channels", which lists a variety of Manning's roughness values, was used along with engineering experience and judgment to help select these values. The Moyie River at Eastport, Idaho was selected from the USGS publication as the most representative of the Coal Creek project section. The Moyie River with a bed of gravel and well-rounded small boulders has a calibrated n-value of 0.038. (http://wwwrcamnl.wr.usgs.gov/sws/fieldmethods/Indirects/nvalues/0038.htm).

Moyie River (from USGS)

Coal Creek at Project Site (Jeff Crane, 2012)

The geometry for proposed conditions was determined by revising two existing cross sections and modeling the removal of the existing dam. Cross section 14 under the existing conditions illustrated the channel at the upstream face of the dam. That cross section was moved approximately 10' upstream to model the proposed diversion structure at a constant top of structure elevation of 9245'. Cross section 13 was revised in its existing location to model the removal of the dam. All other cross sections were unchanged from existing to proposed conditions.

The primary purpose of the HEC-RAS analysis for this project is to demonstrate that there is no more than 1' of rise in the calculated water surface during the 100-year event. Table 2 indicates a lowering of the water surface elevation during the 100-year event after replacing the existing dam with a low-head diversion structure upstream of the current one.

Table 2. Summary of Hydraulic Results of the 100-year Storm

Existing Conditions			**Proposed conditions**			**Water Surface Elev Difference (ft)**
River Station (ft)	Cross Section Name	Water Surface Elev (ft)	River Station (ft)	Cross Section Name	Water Surface Elev (ft)	
0+00	10	9240.83	0+00	10	9240.83	0.00
1+57	11	9243.38	1+57	11	9243.38	0.00
2+21	12	9244.22	2+21	12	9244.22	0.00
2+31	13	9247.58	2+31	13	9245.85	-1.73
2+41	14	9246.36	2+71	14	9248.16	-1.80
3+11	15	9247.93	3+11	15	9247.18	-0.75
3+75	16	9248.22	3+75	16	9248.21	-0.01

Purpose and Scope

The purpose of this project is to design a sustainable alternative to the existing in-stream diversion dam to minimize the need for regular disturbance of the creek substrate, deliver a full decree of irrigation water to the Crested Butte Water Ditch, reduce sedimentation at the diversion box, allow for fish passage at all flow regimes and improve the physical morphology of the stream.

Tasks include:

- Survey multiple cross sections across the river to develop channel togography and prepare for a hydraulic analysis.
- Develop an existing conditions and proposed conditions hydraulic model of the area up and downstream of the diversion using HEC-RAS.
- Present conceptual designs and preliminary and construction documents to the CCWC Board of Directors and Town of Crested Butte for review and comment.
- Develop final designs, cost estimates and construction schedules.

Recommended Solutions

The existing diversion structure is made from old concrete jersey barriers, random boulders, trees and gravel aligned perpendicular to the flow of the stream adjacent to the intake structure. It diverts water to the intake box and into a 12” PVC pipe that directs the water into town. The concrete diversion box has slots in the side of the box that can utilize drop boards but it does not appear that is is ever used.There is no trash rack either, however, the box is constructed with an 8” valve located in the side of the box that can be used to sluice out sediment back to the creek. The corrugated metal culvert is broken at the creek end and should be cut off at the break and channeled back to the creek. The existing in-stream diversion structure is over 5 feet high which makes it susceptible to high stress during times of high flows and has a history of washing out. It is then replaced with whatever material is convenient at the time requiring more disturbance in the stream. The diversion also creates an unnatural flattening of the longitudinal grade of the creek upstream of the diversion. This promotes sediment deposition and requires additional maintenance for the Town.

The recommendation of this study and design is to remove the existing dam and replace it with a boulder structure with a constant top grade elevation of 9245 feet. That elevation is similar to the elevation of the top of the diversion box and would deliver the same head at the intake. The location of the proposed structure would be moved upstream and divert water gradually to the right side of the channel and into the existing irrigation intake structure. The existing intake structure is sound and does not require any improvements except for possibly a trash rack. The existing 8" sluice pipe exiting the north side of the diversion box needs to be redirected back to the creek at the point where it has been broken.

The proposed diagonal alignment of the diversion structure will provide an opportunity to grade 100' of the channel upstream of the diversion at a constant slope of 0.75% and reduce sediment deposition in front of the box. The nature of the low-head structure will improve sustainability by reducing shear stress and allowing for fish migration past the diversion.

Substantial erosion has taken place on the left bank immediately downstream of the existing structure and along the right bank of the diversion channel into the intake box. In order to develop a natural balance to the dimensions of the channel and improve aquatic habitat those areas will need to be filled. Toe rocks approximately 24" to 30" in diameter should be placed at the perimeter of the fill areas. The area on the right bank will only require approximately 20 cubic yards of native material and will be seeded with a native grass mix. A coir erosion control mat should be installed over the fill until vegetation is established.

The left bank has a more substantial fill area and will be more susceptible to high erosive forces during spring runoff events. In this case the fill area will be shallow and used primarily as a floodplain adjacent to the terrace on the north. I propose cabling pine logs inside of the toe rocks and backfilling with approximately 40 cubic yards of native bedload material. The cabled logs with branched left on will provide enough flow resistance to allow for natural deposition of sediment and the regeneration of native riparian vegetation. This will narrow the width of the channel back to a more natural morphology, make for a deeper channel and improve fish habitat.

The location and alignment of the proposed in-stream diversion structure will substantially reduce stresses and forces from high water flow events because most of the structure will be buried into the bottom of the channel. In essence, two thirds of the structure will be buried and act primarily as grade control to prevent headcutting up the stream. The structure along the right one third of the channel will have more exposure to high flow forces but the closer the structure is to the right bank the less the velocity of the water and thus the less stress on the structure. This is evidenced by the incremental velocity calculations provided by the HEC-RAS analysis.

The structure will incorporate an average of 3' diameter boulders laid two across. This will reduce the chances of high flows scouring the downstream face of the structure and washing it out. In areas where 50% or more of the boulder is not buried, footer rocks will be installed. This will occur in the river right (facing downstream) 1/3 of the structure. If necessary, concrete grout at 3000 psi can also be added to the entire structure and placed up to two thirds the height of the rock. This will provide some void space at the top of the structure for potential fish habitat. It is unknown at this time the location of bedrock below the surface of the channel bed. The excavation of a couple of “pot holes” in the location of the proposed diversion structure is recommended to determine if a 3’ boulder can be placed in the creek at the designed elevation. It may be necessary to use a hammer drill on a trackhoe to excavate a trench deep enough to install the boulders or more angular and rectangular dimensioned boulders may need to be sought out that are broad and flat in nature while still meeting the size requirements. Each boulder should have its greatest dimension not greater than 3 times its least dimension and the stone is recommended to have a specific gravity of at least 2.5. Harder rocks such as granite and basalt are preferred over sandstone.

It is recommended that a surveyed monitoring program be established for this structure to determine any movement over time and to gauge the overall success of the project. There have been several rebar pins installed at the end points of five cross sections. These can be used as horizontal control and benchmark elevations to accurately measure the structure following major flow events. Photo points with date stamps have been established relative to the established benchmarks.

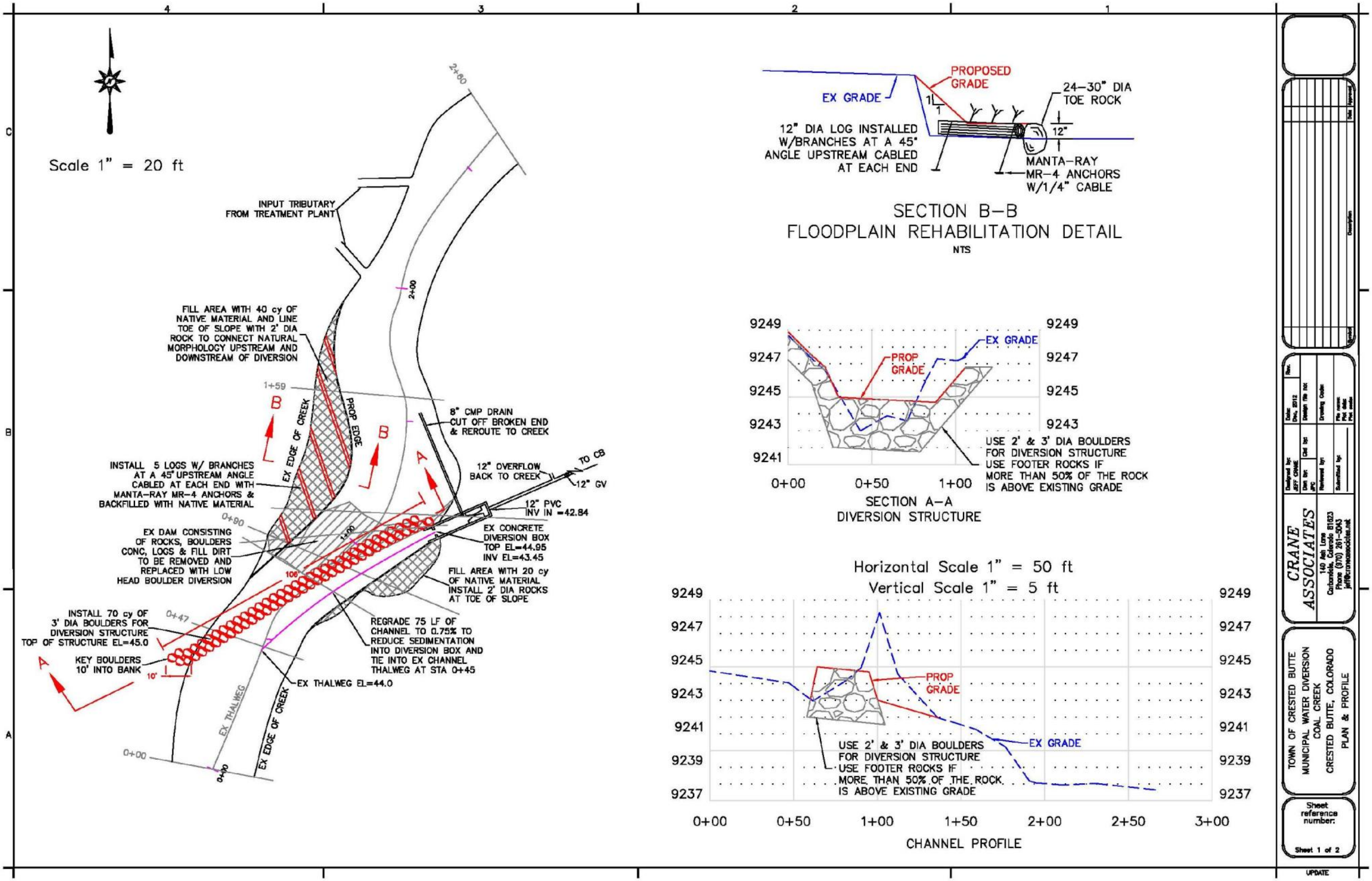


Figure 3 – Proposed Conditions

Construction Scheduling

A comprehensive construction schedule can be developed once funding is secured for construction of this project. In general, it is recommended that construction begin in late summer when stream flows are low. It should be noted that construction may interrupt water delivery for a day. A well organized construction schedule should take two to three weeks with the following tasks:

1. Mobilization and stockpiling of rock — 1 week
2. Removal of existing dam and development of water control — 1-2 days
3. Installation of rock structure and grout — 1-2 weeks
4. Implement monitoring plan — 1 day

Conclusion

Moving bedload through the system has been a challenge with the current dam in place and has required substantial maintenance. The proposed design will pass most of this bedload but a percentage of it may still be diverted toward the intake structure. However, this design will minimize maintenance and allow most of the mobilized bedload to pass.

The implementation of this design will reduce susceptibility of structural failure, minimize in-stream mechanical maintenance and improve the habitat and morphological characteristics of the channel.

References

H.H. Barnes, Jr., *Verified Roughness Characteristics of Natural Channels*
USGS Water Supply Paper 1849

Stream Classification and Water Quality Standards, Region 12, Water Quality Control Division 2009

Rosgen, Dave. *Applied River Morphology*, 1996

APPENDIX A(1)

Construction Budget

	Crested Butte Water Ditch Diversion Project Budget					
				UNIT	EST	SUB TOT
	ITEM DESCRIPTION	UNIT	QTY	COST	COST	COST
1	Mobilization/Demobilization					
	Equipment Transport (12)	LS	1	$1,000	$1,000	
	Best Management Practices					
	Repair Staging Area	Acre	1	500	$500	$1,500
2	Diversion Structure					
	Demo and remove ex structure	CY	150	$5	$750	
	Excavation w/rock hammer	CY	70	$15	$1,050	
	3' boulders delivered & placed for structure	CY	75	$100	$7,500	
	Grout boulders	CY	15	$250	$3,750	
	2' boulders delivered and installed for toe rock	CY	25	$100	$2,500	
	Cabled logs	EA	5	$200	$1,000	
	Floodplain backfill	CY	60	$5	$300	
	Water control	LS	1	$2,000	$2,000	
						$18,850
	SUBTOTAL					$20,350
	CONTINGENCY (15%)					$3,053
	CONSTRUCTION SUBTOTAL					$23,403
	Project supervision (10%)					$2,340
	PRELIMINARY PROJECT COST					**$25,743**

APPENDIX B(1)

Existing Conditions HEC-RAS Report

HEC-RAS Plan: Plan 02 River: Coal Creek Reach: Lower Kebler

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower Kebler	16	PF 1	2.00	9244.70	9245.23		9245.23	0.000514	0.42	4.71	13.09	0.12
Lower Kebler	16	PF 2	10.90	9244.70	9245.44		9245.47	0.004507	1.38	7.89	18.97	0.38
Lower Kebler	16	PF 3	238.00	9244.70	9247.36		9247.68	0.006073	4.50	52.84	24.78	0.54
Lower Kebler	16	PF 4	326.00	9244.70	9247.64		9248.10	0.008011	5.45	59.86	25.88	0.63
Lower Kebler	16	PF 5	383.00	9244.70	9247.80		9248.35	0.009194	5.99	63.93	26.49	0.68
Lower Kebler	16	PF 6	443.00	9244.70	9247.95		9248.61	0.010376	6.52	67.93	27.08	0.73
Lower Kebler	16	PF 7	520.00	9244.70	9248.11		9248.91	0.011863	7.17	72.74	30.65	0.78
Lower Kebler	16	PF 8	570.00	9244.70	9248.22	9247.80	9249.10	0.012729	7.55	76.02	32.20	0.81
Lower Kebler	16	PF 9	696.00	9244.70	9248.47	9248.23	9249.56	0.014559	8.38	84.71	37.67	0.88
Lower Kebler	15	PF 1	2.00	9244.00	9245.23		9245.23	0.000009	0.10	19.41	21.08	0.02
Lower Kebler	15	PF 2	10.90	9244.00	9245.44		9245.44	0.000136	0.46	23.86	21.49	0.08
Lower Kebler	15	PF 3	238.00	9244.00	9247.27		9247.46	0.002644	3.56	69.80	32.46	0.38
Lower Kebler	15	PF 4	326.00	9244.00	9247.50		9247.81	0.003695	4.45	77.65	33.74	0.46
Lower Kebler	15	PF 5	383.00	9244.00	9247.63		9248.01	0.004389	4.99	82.02	34.43	0.50
Lower Kebler	15	PF 6	443.00	9244.00	9247.75		9248.21	0.005142	5.54	86.09	35.07	0.55
Lower Kebler	15	PF 7	520.00	9244.00	9247.87		9248.45	0.006224	6.24	90.27	35.71	0.60
Lower Kebler	15	PF 8	570.00	9244.00	9247.93		9248.61	0.006980	6.69	92.58	36.06	0.64
Lower Kebler	15	PF 9	696.00	9244.00	9248.04		9248.97	0.009284	7.88	96.56	36.65	0.74
Lower Kebler	14	PF 1	2.00	9243.30	9245.23		9245.23	0.000001	0.05	44.38	31.55	0.01
Lower Kebler	14	PF 2	10.90	9243.30	9245.44		9245.44	0.000019	0.21	51.08	32.28	0.03
Lower Kebler	14	PF 3	238.00	9243.30	9247.32		9247.39	0.000700	2.02	118.01	40.28	0.20
Lower Kebler	14	PF 4	326.00	9243.30	9247.59		9247.69	0.000988	2.54	130.45	47.76	0.24
Lower Kebler	14	PF 5	383.00	9243.30	9247.75		9247.87	0.001171	2.85	137.89	49.35	0.27
Lower Kebler	14	PF 6	443.00	9243.30	9247.90		9248.05	0.001359	3.15	145.28	50.87	0.29
Lower Kebler	14	PF 7	520.00	9243.30	9248.06		9248.25	0.001609	3.53	153.77	52.57	0.32
Lower Kebler	14	PF 8	570.00	9243.30	9248.16		9248.37	0.001770	3.76	158.95	53.58	0.33
Lower Kebler	14	PF 9	696.00	9243.30	9248.37		9248.66	0.002189	4.34	170.65	55.79	0.38
Lower Kebler	13	PF 1	2.00	9245.00	9245.16	9245.16	9245.22	0.041448	2.04	0.98	6.99	0.96
Lower Kebler	13	PF 2	5.90	9245.00	9245.30	9245.30	9245.43	0.037849	2.84	2.08	8.35	1.00
Lower Kebler	13	PF 3	233.00	9245.00	9246.87	9246.87	9247.30	0.026998	5.24	44.42	55.16	1.03
Lower Kebler	13	PF 4	321.00	9245.00	9247.08	9247.08	9247.58	0.024936	5.69	56.38	58.22	1.02
Lower Kebler	13	PF 5	378.00	9245.00	9247.21	9247.21	9247.75	0.023792	5.92	63.89	60.06	1.01
Lower Kebler	13	PF 6	438.00	9245.00	9247.33	9247.33	9247.91	0.023122	6.15	71.29	63.72	1.01
Lower Kebler	13	PF 7	515.00	9245.00	9247.49	9247.49	9248.11	0.021361	6.28	82.85	72.24	0.98
Lower Kebler	13	PF 8	565.00	9245.00	9247.58	9247.58	9248.22	0.021390	6.46	88.79	74.28	0.99
Lower Kebler	13	PF 9	691.00	9245.00	9247.78	9247.78	9248.49	0.020671	6.77	104.63	79.48	0.99
Lower Kebler	12	PF 1	2.00	9240.70	9241.36		9241.36	0.000633	0.47	4.23	11.64	0.14
Lower Kebler	12	PF 2	5.90	9240.70	9241.56		9241.57	0.001475	0.87	6.81	14.25	0.22
Lower Kebler	12	PF 3	233.00	9240.70	9243.38		9243.83	0.011256	5.39	43.24	25.54	0.73
Lower Kebler	12	PF 4	321.00	9240.70	9243.64		9244.27	0.014254	6.41	50.11	27.15	0.83
Lower Kebler	12	PF 5	378.00	9240.70	9243.79	9243.59	9244.54	0.015920	6.97	54.23	28.08	0.88
Lower Kebler	12	PF 6	438.00	9240.70	9243.93	9243.82	9244.81	0.017455	7.50	58.41	28.99	0.93
Lower Kebler	12	PF 7	515.00	9240.70	9244.11	9244.07	9245.13	0.019065	8.09	63.69	30.10	0.98
Lower Kebler	12	PF 8	565.00	9240.70	9244.22	9244.22	9245.32	0.020002	8.43	66.99	30.78	1.01
Lower Kebler	12	PF 9	691.00	9240.70	9244.59	9244.59	9245.78	0.019343	8.78	78.68	33.06	1.00
Lower Kebler	11	PF 1	2.00	9241.00	9241.25		9241.27	0.024645	1.27	1.57	15.28	0.70
Lower Kebler	11	PF 2	5.90	9241.00	9241.35		9241.39	0.020422	1.58	3.74	22.87	0.69
Lower Kebler	11	PF 3	233.00	9241.00	9242.50	9242.50	9243.05	0.024438	5.94	39.20	37.35	1.02
Lower Kebler	11	PF 4	321.00	9241.00	9242.77	9242.77	9243.43	0.022343	6.50	49.41	38.41	1.01
Lower Kebler	11	PF 5	378.00	9241.00	9242.93	9242.93	9243.65	0.021415	6.80	55.57	38.98	1.00
Lower Kebler	11	PF 6	438.00	9241.00	9243.09	9243.09	9243.87	0.020668	7.10	61.65	39.33	1.00
Lower Kebler	11	PF 7	515.00	9241.00	9243.26	9243.26	9244.14	0.020558	7.53	68.41	39.72	1.01
Lower Kebler	11	PF 8	565.00	9241.00	9243.38	9243.38	9244.30	0.019854	7.70	73.35	40.01	1.00
Lower Kebler	11	PF 9	691.00	9241.00	9243.65	9243.65	9244.70	0.019359	8.22	84.06	40.61	1.01
Lower Kebler	10	PF 1	2.00	9237.60	9237.86	9237.86	9237.93	0.046567	2.05	0.98	7.52	1.00
Lower Kebler	10	PF 2	5.90	9237.60	9238.00	9238.00	9238.10	0.042451	2.58	2.29	11.69	1.03
Lower Kebler	10	PF 3	233.00	9237.60	9239.81	9239.77	9240.43	0.020810	6.35	36.69	27.72	0.97
Lower Kebler	10	PF 4	321.00	9237.60	9240.11	9240.11	9240.89	0.020808	7.09	45.34	29.49	1.00
Lower Kebler	10	PF 5	378.00	9237.60	9240.28	9240.28	9241.16	0.020356	7.51	50.47	30.17	1.01
Lower Kebler	10	PF 6	438.00	9237.60	9240.46	9240.46	9241.43	0.019640	7.88	55.95	30.88	1.00
Lower Kebler	10	PF 7	515.00	9237.60	9240.69	9240.69	9241.75	0.018547	8.26	63.14	31.77	0.99
Lower Kebler	10	PF 8	565.00	9237.60	9240.83	9240.83	9241.95	0.018142	8.51	67.49	32.28	0.99
Lower Kebler	10	PF 9	691.00	9237.60	9241.16	9241.16	9242.42	0.016999	9.03	78.58	33.53	0.98

APPENDIX B(2)

Proposed Conditions HEC-RAS Report

HEC-RAS Plan: prop conditions River: Coal Creek Reach: Lower Kebler

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower Kebler	16	PF 1	2.00	9244.70	9244.97	9244.88	9244.99	0.007934	1.09	1.83	9.62	0.44
Lower Kebler	16	PF 2	10.90	9244.70	9245.27		9245.34	0.010874	2.05	5.32	13.70	0.58
Lower Kebler	16	PF 3	238.00	9244.70	9246.93		9247.42	0.011836	5.62	42.37	23.93	0.74
Lower Kebler	16	PF 4	326.00	9244.70	9247.33		9247.94	0.011879	6.26	52.06	24.66	0.76
Lower Kebler	16	PF 5	383.00	9244.70	9247.57		9248.25	0.012027	6.59	58.10	25.61	0.77
Lower Kebler	16	PF 6	443.00	9244.70	9247.81		9248.55	0.012121	6.89	64.26	26.54	0.78
Lower Kebler	16	PF 7	520.00	9244.70	9248.06		9248.89	0.012529	7.30	71.24	29.32	0.80
Lower Kebler	16	PF 8	570.00	9244.70	9248.21	9247.81	9249.10	0.012822	7.57	75.80	32.10	0.82
Lower Kebler	16	PF 9	696.00	9244.70	9248.59	9248.23	9249.58	0.012956	8.04	89.26	42.09	0.83
Lower Kebler	15	PF 1	2.00	9244.00	9244.15	9244.15	9244.20	0.055056	1.82	1.10	11.53	1.04
Lower Kebler	15	PF 2	10.90	9244.00	9244.36	9244.36	9244.48	0.035381	2.85	3.83	14.64	0.98
Lower Kebler	15	PF 3	238.00	9244.00	9245.90	9245.89	9246.66	0.021447	6.99	34.05	22.38	1.00
Lower Kebler	15	PF 4	326.00	9244.00	9246.27	9246.27	9247.19	0.020627	7.70	42.33	23.08	1.00
Lower Kebler	15	PF 5	383.00	9244.00	9246.49	9246.49	9247.50	0.019863	8.07	47.57	24.57	1.00
Lower Kebler	15	PF 6	443.00	9244.00	9246.71	9246.71	9247.80	0.019173	8.41	53.15	26.61	0.99
Lower Kebler	15	PF 7	520.00	9244.00	9247.00	9247.00	9248.16	0.017754	8.68	61.39	29.85	0.97
Lower Kebler	15	PF 8	570.00	9244.00	9247.18	9247.18	9248.38	0.016915	8.82	67.06	31.89	0.96
Lower Kebler	15	PF 9	696.00	9244.00	9247.56	9247.56	9248.88	0.015838	9.32	79.41	34.02	0.95
Lower Kebler	14	PF 1	2.00	9243.30	9243.48		9243.49	0.006400	0.91	2.19	12.56	0.39
Lower Kebler	14	PF 2	10.90	9243.30	9243.72		9243.78	0.010907	2.08	5.24	12.63	0.57
Lower Kebler	14	PF 3	238.00	9243.30	9245.59		9246.03	0.014967	5.31	44.85	31.20	0.78
Lower Kebler	14	PF 4	326.00	9243.30	9245.84		9246.44	0.017180	6.19	52.66	32.28	0.85
Lower Kebler	14	PF 5	383.00	9243.30	9245.97	9245.83	9246.67	0.018620	6.72	57.02	32.87	0.90
Lower Kebler	14	PF 6	443.00	9243.30	9246.10	9246.01	9246.91	0.020274	7.26	61.03	33.40	0.95
Lower Kebler	14	PF 7	520.00	9243.30	9246.25	9246.23	9247.21	0.021723	7.84	66.34	34.10	0.99
Lower Kebler	14	PF 8	570.00	9243.30	9246.36	9246.36	9247.39	0.022314	8.16	69.89	34.55	1.01
Lower Kebler	14	PF 9	696.00	9243.30	9246.68	9246.68	9247.82	0.021154	8.56	81.33	35.98	1.00
Lower Kebler	13	PF 1	2.00	9242.70	9243.05	9243.05	9243.13	0.044712	2.34	0.85	4.90	0.99
Lower Kebler	13	PF 2	5.90	9242.70	9243.23	9243.23	9243.37	0.041156	2.98	1.98	7.46	1.02
Lower Kebler	13	PF 3	233.00	9242.70	9244.85	9244.85	9245.51	0.026086	6.51	35.81	27.67	1.01
Lower Kebler	13	PF 4	321.00	9242.70	9245.24	9245.24	9245.89	0.025507	6.49	49.44	38.65	1.01
Lower Kebler	13	PF 5	378.00	9242.70	9245.39	9245.39	9246.11	0.024860	6.84	55.30	39.25	1.01
Lower Kebler	13	PF 6	438.00	9242.70	9245.54	9245.54	9246.33	0.024088	7.14	61.36	39.86	1.01
Lower Kebler	13	PF 7	515.00	9242.70	9245.73	9245.73	9246.60	0.023236	7.48	68.87	40.61	1.01
Lower Kebler	13	PF 8	565.00	9242.70	9245.85	9245.85	9246.76	0.022662	7.67	73.70	41.08	1.01
Lower Kebler	13	PF 9	691.00	9242.70	9246.12	9246.12	9247.14	0.021782	8.13	85.04	42.17	1.01
Lower Kebler	12	PF 1	2.00	9240.70	9241.36		9241.36	0.000633	0.47	4.23	11.64	0.14
Lower Kebler	12	PF 2	5.90	9240.70	9241.56		9241.57	0.001475	0.87	6.81	14.25	0.22
Lower Kebler	12	PF 3	233.00	9240.70	9243.38		9243.83	0.011256	5.39	43.24	25.54	0.73
Lower Kebler	12	PF 4	321.00	9240.70	9243.64		9244.27	0.014234	6.40	50.13	27.16	0.83
Lower Kebler	12	PF 5	378.00	9240.70	9243.79	9243.59	9244.54	0.015920	6.97	54.23	28.08	0.88
Lower Kebler	12	PF 6	438.00	9240.70	9243.93	9243.82	9244.81	0.017455	7.50	58.41	28.99	0.93
Lower Kebler	12	PF 7	515.00	9240.70	9244.11	9244.07	9245.13	0.019065	8.09	63.69	30.10	0.98
Lower Kebler	12	PF 8	565.00	9240.70	9244.22	9244.22	9245.32	0.020002	8.43	66.99	30.78	1.01
Lower Kebler	12	PF 9	691.00	9240.70	9244.59	9244.59	9245.78	0.019343	8.78	78.68	33.06	1.00
Lower Kebler	11	PF 1	2.00	9241.00	9241.25		9241.27	0.024645	1.27	1.57	15.28	0.70
Lower Kebler	11	PF 2	5.90	9241.00	9241.35		9241.39	0.020422	1.58	3.74	22.87	0.69
Lower Kebler	11	PF 3	233.00	9241.00	9242.50	9242.50	9243.05	0.024438	5.94	39.20	37.35	1.02
Lower Kebler	11	PF 4	321.00	9241.00	9242.77	9242.77	9243.43	0.022397	6.50	49.37	38.40	1.01
Lower Kebler	11	PF 5	378.00	9241.00	9242.93	9242.93	9243.65	0.021415	6.80	55.57	38.98	1.00
Lower Kebler	11	PF 6	438.00	9241.00	9243.09	9243.09	9243.87	0.020668	7.10	61.65	39.33	1.00
Lower Kebler	11	PF 7	515.00	9241.00	9243.26	9243.26	9244.14	0.020558	7.53	68.41	39.72	1.01
Lower Kebler	11	PF 8	565.00	9241.00	9243.38	9243.38	9244.30	0.019854	7.70	73.35	40.01	1.00
Lower Kebler	11	PF 9	691.00	9241.00	9243.65	9243.65	9244.70	0.019359	8.22	84.06	40.61	1.01
Lower Kebler	10	PF 1	2.00	9237.60	9237.86	9237.86	9237.93	0.046567	2.05	0.98	7.52	1.00
Lower Kebler	10	PF 2	5.90	9237.60	9238.00	9238.00	9238.10	0.042451	2.58	2.29	11.69	1.03
Lower Kebler	10	PF 3	233.00	9237.60	9239.81	9239.77	9240.43	0.020810	6.35	36.69	27.72	0.97
Lower Kebler	10	PF 4	321.00	9237.60	9240.11	9240.10	9240.89	0.020808	7.09	45.34	29.49	1.00
Lower Kebler	10	PF 5	378.00	9237.60	9240.28	9240.28	9241.16	0.020356	7.51	50.47	30.17	1.01
Lower Kebler	10	PF 6	438.00	9237.60	9240.46	9240.46	9241.43	0.019640	7.88	55.95	30.88	1.00
Lower Kebler	10	PF 7	515.00	9237.60	9240.69	9240.69	9241.75	0.018547	8.26	63.14	31.77	0.99
Lower Kebler	10	PF 8	565.00	9237.60	9240.83	9240.83	9241.95	0.018142	8.51	67.49	32.28	0.99
Lower Kebler	10	PF 9	691.00	9237.60	9241.16	9241.16	9242.42	0.016999	9.03	78.58	33.53	0.98