BEFORE THE COLORADO WATER CONSERVATION BOARD

STATE OF COLORADO

IN THE MATTER OF PROPOSED INSTREAM FLOW APPROPRIATIONS IN WATER DIVISION 6:

TROUT CREEK

ROUTT COUNTY, COLORADO

PREHEARING STATEMENT OF KNOTT LAND AND LIVESTOCK COMPANY, INC.

Knott Land and Livestock Company, Inc. ("Knott Land and Livestock"), by and through its undersigned attorneys, Holsinger Law, LLC, submits the following Prehearing Statement concerning the Increased Instream Flow ("Increased ISF"; CWCB Id. No. 19/6/A-009) in accordance with Rule 5(n) of the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program, 2 C.C.R. 408-2 ("ISF Rules").

I. <u>INTRODUCTION</u>

Knott Land and Livestock is a family-owned ranch that has been in the Knott family for four generations of management, with the fifth generation learning the trade now. Throughout this time, Knott Land and Livestock has acted as a proud steward of the land and environment. As a testament to its commitment to preserving the land and the ranching way of life in perpetuity, Knott Land and Livestock entered into two conservation easements with the Colorado Cattlemen's Agricultural Land Trust on 1,310 and 630 acres, respectively, encompassing approximately ninety-five percent of their irrigated lands and water use.[1]

One of the many outstanding natural resources on Knott Land and Livestock's ranch is Trout Creek. Protecting Trout Creek is integral to Knott Land and Livestock's operations now and in the future. Indeed, the reverse is also true – Knott Land and Livestock's operations are vital to Trout Creek. This is because much of the flow in Trout Creek within the proposed Increased ISF reach ("Proposed Reach") is attributable to return flows from irrigation by Knott Land and Livestock, both during the irrigation season and into the fall and winter.

These interests are fundamental to Knott Land and Livestock's current opposition to the Increased ISF. Knott Land and Livestock's complex water rights serve Knott Land and Livestock's property as an integrated unit. Not only have such operations historically required flexibility, but changing climatic and

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[1] Importantly, Knott Land and Livestock's water rights are tied to the land pursuant to the Conservation Easements and as a result will be used in the valley for all time.

other conditions may require additional flexibility in the future. As such, Knott Land and Livestock believes the Increased ISF should take into account actual conditions throughout the Proposed Reach, both year-round and in average years, and ensure Knott Land and Livestock retains and maintains the flexibility in its water management necessary to continue to thrive.

To be clear, Knott Land and Livestock is not opposed to an instream flow ("ISF") on Trout Creek and shares the CWCB's goal of protecting the Proposed Reach. As discussed herein, however, the actual data relied upon is insufficient to meet the applicable standards and the CWCB has failed to take into consideration certain factors required by law.

II. STATEMENT OF FACTUAL CLAIMS

ISF Rule 5(n)(2)(a) requires "a specific statement of the factual… claims… upon which the Party will rely."[2] By this reference, Knott Land and Livestock incorporates all factual claims set forth in its Notice to Contest dated March 29, 2019 (**EXHIBIT A**).[3] In addition, Knott Land and Livestock makes the following statements of fact.[4]

A. Knott Land and Livestock's Water Rights and Operations

1. Knott Land and Livestock owns a total of 2,394 acres in Routt County, Colorado, located approximately 10 miles South and West of Oak Creek, Colorado.

2. Knott Land and Livestock owns approximately 76% of the privately-owned land in which the Proposed Reach is located.[5]

3. Knott Land and Livestock owns and operates a number of water rights ("Knott Water Rights"), including those set forth in the table below.

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2 ISF Rule 5(n)(2)(a).

3 Knott Land and Livestock Company, Inc., Notice to Contest Instream Flow Appropriation, Trout Creek Increased Instream Flow CWCB ID: 19/6/A-009 (Mar. 29, 2019) ("Notice to Contest").

4 The factual claims stated herein are to the best of Knott Land and Livestock's current knowledge and understanding. Knott Land and Livestock reserves the right to amend or modify its statement of facts and identify additional factual claims prior to a hearing in this matter.

5 This percentage does not include acreage leased to and/or used by Knott Land and Livestock, in which case, the total percentage of acreage owned or used by Knott Land and Livestock within the Proposed Reach would total more than 76%.

Table 1 - SUMMARY OF KNOTT WATER RIGHTS

Structure	Amount	Adjudication Date	Appropriation Date	Source
Male Moore and Company Ditch	4.83 cfs	6/19/1914	10/7/1909	Trout Creek
	2.08 cfs	7/12/1948	6/1/1930	Trout Creek
David M. Chapman Ditch	2.66 cfs	9/15/1902	6/1/1891	Trout Creek
	2.66 cfs	7/12/1948	5/1/1936	
	4.00 cfs	12/31/1995	6/1/1944	Purington Draw
David M. Chapman Ditch 2	0.66 cfs	7/2/1912	5/1/1910	Trout Creek
	1.50 cfs	11/15/1962	6/1/1932	Trout Creek
Knott Ditch	2.00 cfs	12/31/1979	8/1/1938	Trout Creek
Knott Pond 1	1.44 AF	12/31/1979	10/11/1979	Trout Creek
Knott Pond 2	1.75 AF	12/31/1979	10/11/1979	Trout Creek
Knott Pond 3	2.2 AF	12/31/1979	10/11/1979	Trout Creek
Knott Pond 4	5.13 AF	12/31/1979	10/11/1979	Trout Creek
Knott Spring 1	0.06 cfs	12/31/1979	10/11/1979	Yampa River
Knott Spring 2	0.10 cfs	12/31/1973	7/1/1940	Yampa River
Knott Spring 3	0.20 cfs	12/31/1973	6/1/1932	Yampa River
Knott Spring 4	0.10 cfs	12/31/1973	8/1/1948	Yampa River
Knott Spring 5	0.30 cfs	12/31/1973	7/15/1952	Yampa River
Knott Spring 6	0.10 cfs	12/31/1973	7/1/1940	Yampa River
Orno Ditch	1.83 cfs	9/22/1892	5/11/1888	Trout Creek
	0.58 cfs	6/19/1914	6/17/1908	Trout Creek
	3.6 cfs	11/15/1962	5/5/1946	Trout Creek
	2.30 cfs	12/31/1995	1/1/1944	Trout Creek
Slough Ditch	1.28 cfs	7/12/1948	5/5/1910	Trout Creek/ Purington Draw
Knott Wastewater Ditch	8.00 cfs	8/26/1996	6/1/1944	Purington Draw
Alex Ditch	1.28 cfs	7/12/1948	5/5/1910	Trout Creek

4. The Proposed Reach is a gaining stream. A substantial portion of the flow gained throughout the course of the Proposed Reach is from Knott Land and Livestock irrigation return flow, springs, and runoff from steep impermeable terrain.

B. Existing Trout Creek ISF

5. In 1982, the CWCB was decreed an ISF right in Trout Creek in Case No. W-1338-77 ("Existing ISF"; **EXHIBIT B**).[6]

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[6] *In re Colorado Water Conservation Board to Preserve the Natural Environment to a Reasonable Degree in Trout Creek*, Case No. W-1338-77 (Water Division No. 6 May 27, 1982) ("Existing ISF Decree").

6. The Trout Creek Existing ISF was awarded a priority date of September 23, 1977 and a year-round flow rate of 5 cfs.[7]
7. The Existing ISF's reach extends approximately 24 miles, beginning at Sheriff Reservoir downstream to the confluence of Trout Creek and Middle Creek.[8]
8. The Proposed Reach is within the reach for the Existing ISF; as such, the Increased ISF is on top of and in addition to the Existing ISF.

C. Recommendation for Increased ISF

9. The Increased ISF, above and beyond the Existing ISF, is based upon ISF quantification methodology developed subsequent to the Existing ISF.

10. In a letter date-stamped December 19, 2018, the BLM recommended ("BLM Recommendation"; **EXHIBIT C**)[9] that the CWCB appropriate an increase to the Existing ISF. By this reference, the BLM Recommendation is incorporated as though set forth herein.

11. The BLM Recommendation includes the results from its R2Cross Analysis ("BLM's R2Cross Results"), as set forth in the table below.[10]

Table 2 – R2CROSS RESULTS FROM BLM RECOMMENDATION

R2Cross Analysis. The BLM collected the following R2Cross data from Trout Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
08/12/2017 #1	9.43 cfs	39.42 feet	9.27 cfs	13.28 cfs
08/12/2017 #2	8.58 cfs	35.17 feet	5.79 cfs	12.80 cfs
		Averages:	7.53 cfs	13.04 cfs

12. The BLM Recommendation concludes that the Existing ISF is insufficient and recommends increasing the ISF based upon the BLM's R2Cross Analysis.[11]

13. In the CWCB Staff's Instream Flow Recommendation ("CWCB Staff Recommendation"; **EXHIBIT D**)[12] the CWCB Staff adopted the BLM'S R2Cross Results as set forth in the table

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[7] *Id.* at 3.
[8] *Id.*
[9] Letter from Brian St. George, Deputy State Director Resources and Fire, Bureau of Land Management, to Linda Bassi, Section Chief, Stream and Lake Protection Section, Colorado Water Conservation Board (date stamped Dec. 19, 2018) ("BLM Recommendation").
[10] *Id.* at 2.
[11] *Id.* at 2 – 3.
[12] CWCB Staff Instream Flow Recommendation, CWCB ID: 19/6/A-009, Trout Creek Executive Summary (Jan. 17, 2019) ("CWCB Staff Recommendation").

below.[13] By this reference, the CWCB Staff Recommendation is incorporated as though set forth herein.

Table 3 – R2CROSS RESULTS FROM CWCB STAFF RECOMMENDATION

Table 2. Summary of R2Cross transect measurements and results for Trout Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	08/12/2017 #1	9.43	3.77 - 23.58	9.27	13.28
BLM	08/12/2017 #2	8.58	3.43 - 21.45	5.79	12.80
			Mean	7.53	13.04

14. The Existing ISF, Increased ISF, and resulting total ISF as proposed by the BLM Recommendation and CWCB Staff Recommendation (together, "Recommendations") are summarized in the table below.

Table 4 - SUMMARY OF BLM AND CWCB STAFF RECOMMENDED TROUT CREEK INSTREAM FLOWS

Existing ISF	Increased ISF	Total ISF (Existing + Increased ISF)
Winter Flow (11/01 - 03/31) 5.0 cfs	Winter Flow (11/01 - 03/31) 2.0 cfs	Winter Flow (11/01 - 03/31) 7.0 cfs
Spring Flow (04/01 - 07/31) 5.0 cfs	Spring Flow (04/01 - 07/31) 8.0 cfs	Spring Flow (04/01 - 07/31) 13.0 cfs
Summer Flow (08/01 - 10/31) 5.0 cfs	Summer Flow (08/01 - 10/31) 7.0 cfs	Summer Flow (08/01 - 10/31) 12.0 cfs

D. Evidence Supporting the Recommendations

15. The Recommendations relied upon data that was collected in the field by the BLM and/or CWCB and obtained from other sources. Based upon the information contained in the Recommendations, the evidence supporting the Recommendations is as follows:

    a. On August 2, 2017,[14] the BLM collected transect data at a location generally described as "0.5 mile upstr fr confl w Little Trout Ck" within SW1/4, NW1/4, Section

[13] *Id.* at 6.

[14] The Tables in the bodies of the BLM and CWCB Staff Recommendations identify an R2Cross sampling date of August 12, 2017. BLM Recommendation, at 2; CWCB Staff Recommendation, at 6. However, examination of the data inputs included with the BLM Recommendation identify this R2Cross sampling date as August 2, 2017. BLM Recommendation, at 22, 38. August 2, 2017 is assumed to be correct for the purposes of this Prehearing Statement and use of August 12, 2017 in the body of the BLM and CWCB Staff Recommendations is assumed to be a scrivener's error.

23, T86W, R86W, 6th PM 9" ("BLM R2Cross Transect No. 1").[15] No field notes were included with the BLM Recommendation for this transect; therefore, information that should have been in the field notes—including the specific location of this transect—was missing. Upon request for the specific location of this transect, the location was described as "close" to the other transect taken on the same date.[16] The data taken from this transect resulted in the first of the two R2Cross results cited in the Recommendations.[17]

b. On the same date, August 2, 2017, the BLM collected transect data from a second location also "0.5 mile upstr fr confl w Little Trout Ck" within SW1/4, NW1/4, Section 23, T86W, R86W, 6th PM ("BLM R2Cross Transect No. 2").[18] However, here Universal Transverse Mercator ("UTM") coordinates were taken, locating the transect at "Zone 13 4463647 N 328647 E."[19] The data taken from this transect resulted in the second of the two R2Cross results cited in the Recommendations.[20]

c. On May 7, 2018, CWCB Staff collected streamflow data at a location described as "Trout Creek – D6" at the UTM coordinates "13N 328640 4463623."[21] The flow was measured at 64.5796 cfs ("CWCB Streamflow Measurement No. 1").[22] It appears no transect data for use in an R2Cross analysis were collected at this location. Field notes at this location indicate the presence of nearby beaver ponds.[23]

d. On October 9 or 10, 2018,[24] CWCB Staff collected streamflow data at a location described as "Trout Creek and beaver ponds" at the UTM coordinates "13N 328736 4463735" ("CWCB Streamflow Measurement No. 2"). [25] Flow was measured at 9.59 cfs.[26] It appears no transect data for use in an R2Cross analysis were collected at this location.

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[15] BLM Recommendation, at 22.
[16] Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (July 3, 2019) (on file with counsel for Knott Land and Livestock).
[17] See *supra*, ¶¶ 11, 13 (Tables 2, 3).
[18] BLM Recommendation, at 38.
[19] *Id.* at 34.
[20] See supra fn. 17.
[21] BLM Recommendation, at 54.
[22] BLM Recommendation, at 54, 57.
[23] BLM Recommendation, at 54.
[24] A sampling event occurred in mid-October 2018; both October 9 and October 10, 2018 are identified as the date on which such sampling occurred. *Id.* at 55 (October 10, 2018), 56 (October 9, 2018). It is assumed one sampling event occurred on one of the two days, although it is not clear which; therefore, this date will be referred to as "October 9/10, 2018."
[25] *Id.* at 55.
[26] *Id.* at 55 – 56.

e. A water quality monitoring program was conducted at the Edna Mine that resulted in a hydrology report for Trout Creek dated February 2010 ("Edna Mine Report").[27] Among the data in the Edna Mine Report is streamflow data from Trout Creek collected monthly between April 1989 and October 2009 ("Edna Mine Streamflow Data").[28] The Edna Mine Streamflow Data is relied upon in the CWCB Staff Recommendation.[29] The location of collection of the Edna Mine Streamflow Data is referred to as "TR-a" and is understood to be located on Trout Creek near the Koll Ditch Diversion.[30]

f. On September 8, 1993, a fish survey was conducted by Colorado Parks and Wildlife ("CPW").[31] The specific location of this survey is identified as "ABV CO RD 29."[32] Upon request for the specific location of the sampling location, it was described as a "short distance upstream from the proposed upper terminus" of the Proposed Reach.[33]

g. On July 19, 2007, another fish survey was conducted by CPW.[34] The specific location of this survey is identified as "4.5 Km BLWCO RD 29."[35] Upon request for the specific location of the sampling location, it was described as being "within" the Proposed Reach.[36]

16. With the exception of the 1993 and 2007 Fish Surveys, all data relied upon in the Recommendations was taken from locations near the lower terminus of the Proposed Reach (downstream of Knott Land and Livestock's property). The figure below shows the relative locations of the data points relied upon in the Recommendations.[37]

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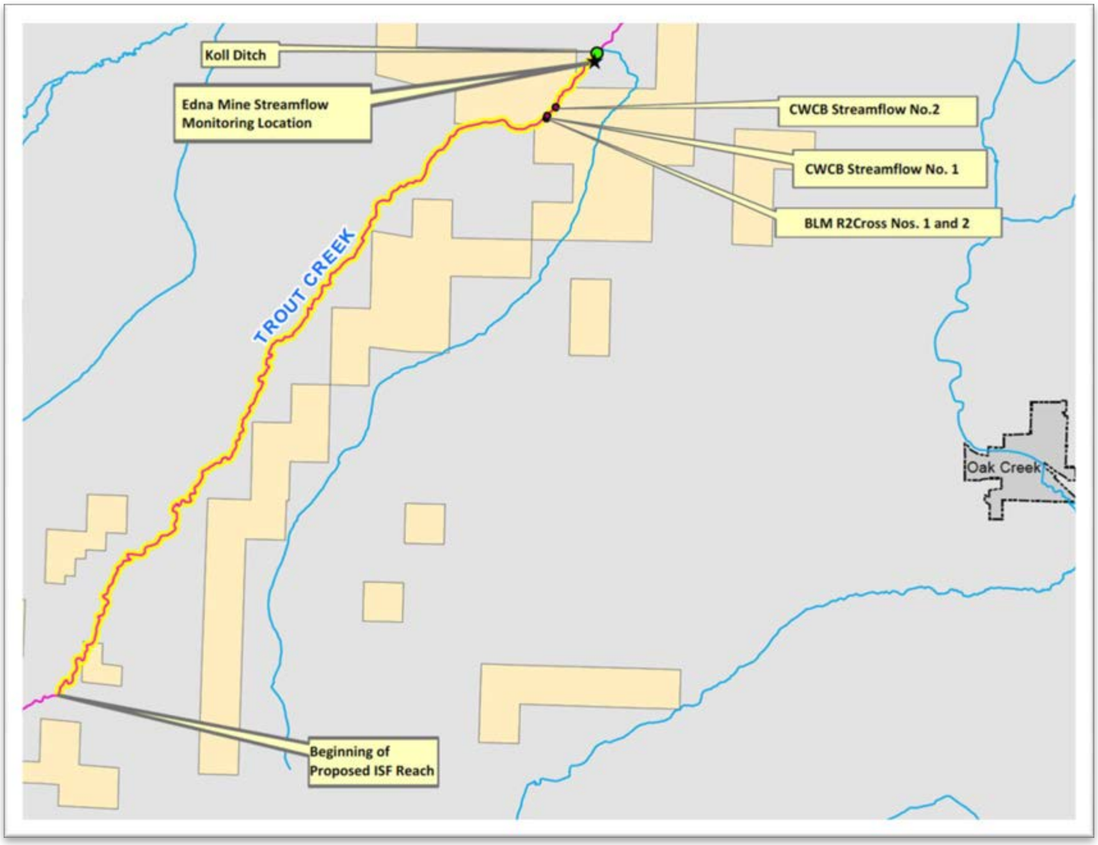
[27] *Id.* at 63, 67.
[28] *Id.* at 107 – 10.
[29] CWCB Staff Recommendation, 6.
[30] The location of the TR-a sampling location is unclear. While the CWCB confirmed their understanding that the stream gage is above the Koll Ditch Diversion, on-the-ground observations by Knott Land and Livestock locate it below the Koll Ditch Diversion. Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (Aug. 29, 2019) (on file with counsel for Knott Land and Livestock); cf. onsite inspection by Tyler Knott, Knott Land and Livestock, Aug. 30, 2019. It is important that this location be established conclusively as the flow rate measured at TR-a is substantially affected by its location above or below the Koll Ditch Diversion.
[31] BLM Recommendation, at 5.
[32] *Id.*
[33] Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (May 28, 2019) (on file with counsel for Knott Land and Livestock).
[34] BLM Recommendation, at 5 – 21.
[35] *Id.*
[36] Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (May 28, 2019) (on file with counsel for Knott Land and Livestock).
[37] This figure was adapted from a figure provided by CWCB Staff's counsel to Knott Land and Livestock's counsel on June 28, 2019. Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (June 28, 2019) (on file with counsel for Knott Land and Livestock).The labels therein were modified

Figure 1 - Locations of Data Collection Sites Within Proposed ISF Reach



E. Engineering Conclusions

17. ISF Rule 5(n)(2) requires the prehearing statement to identify all engineering data and reports that the Party shall rely upon at the hearing. Knott Land and Livestock engaged Quantum Water and Environment ("Quantum") in this matter. Quantum produced a report dated September 3, 2019 ("Quantum Report", **EXHIBIT E**)[38] that is included herewith as an Exhibit as required by ISF Rule 5(n)(2)(b). By this reference, Knott Land and Livestock incorporates the Quantum Report as though set forth herein.

consistent with the nomenclature used herein, but the relative locations of the data collection sites are unchanged from the figure provided by CWCB Staff's counsel.

[38] Theresa, Jehn-Dellaport, P.G.; Rochelle Ann Hoover, P.E.; John W. Anthony, R.G., C.E.G., C.P.H.; Quantum Water & Environment, Re: Quantum Review of U.S. Bureau of Land Management's In-Stream Flow Calculations for 7-Mile Reach of Trout Creek, Routt County, Colorado (Sept. 3, 2019) ("Quantum Report").

III. STATEMENT OF LEGAL CLAIMS

ISF Rule 5(n)(2)(a) requires "a specific statement of… legal claims asserted (issues to be resolved) and the legal basis upon which the Party will rely."[39] In addition, ISF Rule 5(n)(2)(f) requires the prehearing statement to include any legal memoranda that will be relied upon at the hearing. This Section III shall address both requirements in combination.

A. LEGAL FRAMEWORK

Relevant portions of the legal framework governing the CWCB's ISF determinations is set forth below.

1. Statutory Law

Colorado's ISF program was established pursuant to C.R.S. § 37-92-102(3).[40] C.R.S. § 37-92-102(3) provides that the CWCB may appropriate "such waters of natural streams and lakes as the board determines may be required for minimum stream flows or for natural surface water levels or volumes for natural lakes to preserve the natural environment to a reasonable degree."[41]

The Colorado Supreme Court has held that the statutory authority:

> [G]rants the Board the right to determine and appropriate only the minimum amount of water necessary for the preservation of the environment… Because the Board has the duty to appropriate only the minimum amount of water necessary to reasonably preserve the environment, its water rights, as determined by the water court, and its actual appropriation must comport with that duty.[42]

C.R.S. § 37-92-102(3)(c) goes on to set forth three criteria that must be met:

> Before initiating a water rights filing, the board shall determine that the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made; that there is a natural environment that can be preserved to a reasonable degree with the board's water right, if granted; and that such environment can exist without material injury to water rights.[43]

C.R.S. § 37-92-102(3) further clarifies limitations on ISF appropriations in relation to other water users. First, "[n]othing in this article shall be construed as to authorizing any state agency to acquire water by

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[39] ISF Rule 5(n)(2)(a).
[40] C.R.S. § 37-92-102(3) (2019).
[41] *Id.* (emphasis added).
[42] *Aspen Wilderness Workshop, Inc. v. Colorado Water Conservation Bd.*, 901 P.2d 1251, 1257 (Colo. 1995) (emphasis added).
[43] C.R.S. § 37-92-102(3)(c)(emphasis added).

eminent domain or to deprive the people of the state of Colorado of the beneficial use of those waters available by law and interstate compact."[44]

Second, "[a]ny such appropriation shall be subject to the present uses or exchanges of water being made by other water users pursuant to appropriation or practices in existence on the date of such appropriation, whether or not previously confirmed by court order or decree."[45] Thus, ISF appropriations are subject to additional limitations inapplicable to other appropriations.

2. ISF Rules

Consistent with C.R.S. § 37-92-102(3)(c), ISF Rule 5(i) requires the CWCB to make three determinations before initiating a water right filing to confirm an ISF appropriation:

1. That there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted ("Natural Environment Requirement");
2. That the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made ("Water Availability Requirement"); and
3. That such environment can exist without material injury to water rights ("No-Injury Requirement") (collectively, "ISF Requirements").[46]

Each of these determinations are subject to judicial review in the water court application and decree proceedings initiated by the CWCB.[47]

3. CWCB Staff Procedure for ISF Recommendations

To address the ISF Requirements, the CWCB Staff has developed standardized procedures to ensure final ISF recommendations meet the ISF Requirements.[48] As described below, these procedures correspond

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[44] *Id.* at -102(3). Similarly, C.R.S. § 37-92-102(3)(d) provides that "[n]othing in this section is intended or shall be construed to allow condemnation by this state or any person of easements or rights-of-way across private lands to gain access to a segment of a stream or lake where a water right decree has been awarded to the [CWCB]." *Id.* at (3)(d).
[45] *Id.* at -102(3)(b).
[46] ISF Rule 5(i).
[47] ISF Rule 5(j)(3) limits the issues raised in a hearing to only those issues relevant to statutory determinations required by C.R.S. § 37-92-102(3)(b) and the required findings in Rule 5(i). Accordingly, the legal claims asserted in this Prehearing Statement are necessarily limited in scope. Should the Increased ISF proceed to Water Court for adjudication, Knott Land and Livestock reserves the right to raise additional factual and legal claims.
[48] Gregory Espergen, Senior Water Resources Specialist, Colorado Water Conservation Board, Development of Instream Flow Recommendations in Colorado Using R2Cross (Jan. 1996) (cited in CWCB Staff Recommendation, at 7) ("1996 R2Cross Guidance"; **EXHIBIT F**); *see also* Colorado Water Conservation Board, Colorado's Instream Flow and Natural Lake Level Program, PowerPoint Presentation to AWRA (Mar. 3, 2017) (available at: http://www.awracolorado.org/wp-content/uploads/2017/03/AWRA-Presentation.pdf) ("CWCB Presentation to AWRA"; **EXHIBIT G**); Linda Bassi & Brandy Logan, Colorado Conservation Board, Overview of Colorado's Instream Flow Program & Analysis Tools, PowerPoint Presentation to GRAD 595 (Nov. 6, 2017) (available at

to each ISF Requirement.

a. Natural Environment Requirement

The Natural Environment Requirement has two components: 1) the flow quantification component and 2) the biological component.[49] The flow quantification component involves fieldwork in the form of hydraulic data collection consisting of setting up a transect, surveying stream channel geometry, and measuring hydraulic features of the channel/stream complex (e.g., water depth and water flow velocity at several points along the transect) which can be used to calculate total discharge of water through the transect at the point in time at which measurements were made.[50] The transect location is important because it must be located within a "stream segment controlled by stream geometry rather than a downstream flow control"; such a stream segment is referred to as a "riffle."[51]

Hydraulic engineers then use the hydraulic data collected in the field to "model hydraulic parameters of average depth, velocity and percent of wetted perimeter."[52] The model used by the CWCB relies on the Manning's equation, which is "well-suited to the riffle stream habitat."[53] Accepted methodologies are then applied to recommend certain hydraulic parameters for fish habitat.[54] Accepted methodologies include PHAPSIM,[55] River 2D,[56] and R2Cross. The R2Cross method is discussed in detail in Quantum's Report.[57] In general, "[t]he R2Cross methodology provides the biological quantification of the amount of water needed for summer and winter periods based on empirical studies of fish species preferences."[58]

The biological component of the natural environment requirement involves gathering "biologic data to document the existence of a natural environment" and usually consists of fish population surveys, aquatic invertebrate sample, botanical investigations, and field observations.[59] "The biologic samples are not tied directly to the R2Cross hydraulic modeling, but may be used to <u>refine</u> the biologic ISF recommendation to meet the specific habitat requirements of unique populations."[60]

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http://cwi.colostate.edu/media/files/Seminars/GRAD592/2017/214_Presentation.pdf) ("CWCB Presentation to GRAD 595"; **EXHIBIT H**).

[49] 1996 R2Cross Guidance, at 3, 5, 18 - 19; CWCB Presentation to GRAD 595, 20 – 21.

[50] 1996 R2Cross Guidance, at 2.

[51] *Id.* at 2 – 3 ("The transect represents the average stream width, depth and cross-sectional area within the riffle being characterized.")

[52] CWCB Presentation to AWRA, at 17; 1996 R2Cross Guidance, at 10.

[53] 1996 R2Cross Guidance, at 3.

[54] CWCB Presentation to AWRA, at 19, 23.

[55] Which is: "Used to simulate a relationship between stream flow and physical habitat for various life stages of species of fish." *Id.* at 20.

[56] Described as a: "Two-dimensional depth averaged finite element hydrodynamic model that has been customized for fish habitat evaluation studies." *Id.*

[57] *See* Quantum Report, at 5 – 7.

[58] CWCB Staff Recommendation, at 3.

[59] 1996 R2Cross Guidance, at 2; CWCB Presentation to AWRA, at 14 – 15; CWCB Presentation to GRAD 595, at 11, 19 – 20.

[60] 1996 R2Cross Guidance, at 5 (emphasis added), at 18 – 19.

The CWCB relies upon the biological expertise of the cooperating agencies to interpret the output from the R2Cross and develop an initial, biologic ISF recommendation.[61] However, the CWCB Staff "review[s] and analy[zes] the data provided by the recommending entity" and "perform[s] a site investigation of each stream and collect[s] additional data as necessary."[62] As stated in the CWCB Staff Recommendation, "CWCB staff performs a thorough review of the quantification analyses completed by the recommending entity to ensure consistency with accepted standards."[63]

b. Water Availability Requirement

The Water Availability Requirement evaluates stream hydrology and existing water rights to determine whether water is physically available for an ISF appropriation.[64] This is based upon the best available data, which may include: streamflow gages, diversion records, StreamStats, temporary streamflow gages, spot measurements, and anecdotal information from commissioners, land owners, ditch or reservoir operators, or other resource managers.[65]

> The water availability analyses may lead the CWCB staff to conclude that sufficient water is not available to meet the biologic recommendation. In that situation, the CWCB staff may request that the cooperating agency reconsider the biologic recommendation and determine whether the natural environment can be preserved with the amount of water available. If the natural environment can be preserved with the available water, the instream flow recommendation may be revised to reflect the lower available flow amounts. If the statutory water availability requirement cannot be satisfied, the CWCB must reject the instream flow recommendation.[66]

In other words, the "[w]ater availability can be viewed as a necessary refinement that may impose limitations on the biological quantification model findings."[67]

c. No-Injury Requirement

Last, the No-Injury Requirement takes into consideration injury to other water rights. In addition, due to the additional limitations unique to ISF, the No-Injury Requirement should also take into account two other considerations. First, it must take into account undecreed "present uses or exchanges of water being made by other water users pursuant to appropriation or practices in existence on the date of such

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[61] 1996 R2Cross Guidance, at 10; CWCB Presentation to AWRA, at 30; CWCB Staff Recommendation, at 3.
[62] CWCB R2Cross Guidance, at 31.
[63] CWCB Staff Recommendation, at 3.
[64] 1996 R2Cross Guidance, at 19.
[65] *Id*.; CWCB Presentation to AWRA, at 22; CWCB Presentation to Grad 595, at 23; 1996 R2Cross Guidance, at 19.
[66] 1996 R2Cross Guidance, 19.
[67] CWCB Presentation to AWRA, at 22.

appropriation."[68] Second, it must consider whether the proposed ISF appropriation will "deprive the people of the state of Colorado of the beneficial use of those waters available by law…."[69]

B. LEGAL ARGUMENT

As set forth above, the statutory and ISF Requirements must be met before initiating an ISF appropriation. Here, the evidence relied upon in the Recommendations fails to support the ISF Requirements. Therefore, the Increased ISF appropriation should not be initiated as proposed.

1. Data Insufficient to Support Natural Environment Requirement

The data relied upon in the Recommendations is insufficient to support the Natural Environment Requirement for the Increased ISF flow rate recommenced by the BLM/CWCB Staff.

a. Flow Quantification Based on R2Cross Result Not Replicable

The first component of the Natural Environment Requirement is flow quantification. Here, the BLM and CWCB Staff used the R2Cross method to quantify flow. As set forth in Tables 2 and 3 above, the BLM/CWCB Staffs' results were an average of 7.53 cfs for the Winter Flow and 13.04 cfs for the Summer Flow. As explained in Quantum's Report, it is not clear how the BLM/CWCB Staff arrived at these rates.[70]

Despite using the same data inputs and methodology used by the BLM/CWCB Staff, the Quantum Report arrived at substantially different R2Cross results than the BLM/CWCB Staff. On average, the BLM/CWCB Staff Winter Rate is 3.61 cfs higher than Quantum's results and the BLM/CWCB Staff Summer Rate is 5.20 cfs higher than Quantum's results. A comparison of the BLM/CWCB Staffs' R2Cross results versus Quantum's results is set forth in the table below.

Table 5 – BLM & CWCB R2CROSS RESULTS VERSUS QUANTUM R2CROSS RESULTS

R2CROSS Transects	BLM/CWCB STAFF R2CROSS RESULTS		QUANTUM R2CROSS RESULTS	
BLM R2Cross No. 1	Winter Rate 9.27 cfs	Summer Rate 13.28 cfs	Winter Rate 3.50 cfs	Summer Rate 9.43 cfs
BLM R2Cross No. 2	Winter Rate 5.79 cfs	Summer Rate 12.80 cfs	Winter Rate 4.33 cfs	Summer Rate 6.25 cfs
Average	Winter Rate 7.53 cfs	Summer Rate 13.04 cfs	Winter Rate 3.92 cfs	Summer Rate 7.84 cfs

[68] C.R.S. § 37-92-102(3)(b).
[69] -102(3).
[70] Quantum Report, at 12 - 13.

To summarize the conclusions from the Quantum Report concerning the flow quantification analysis, it appears the R2Cross results were misinterpreted by BLM/CWCB Staff resulting in inflated flow quantification. In addition, the location of the transect for BLM R2Cross Transect No. 1 is unknown and no documentation concerning site selection, data collection, or other field documentation is available in the Recommendations. Therefore, the results of the BLM R2Cross Transect No. 1 cannot be verified or replicated and should be excluded from consideration. Furthermore, although the CWCB Staff made two site visits during which they conducted streamflow measurements, they collected no data that could be used in an R2Cross analysis. As a consequence, the only R2Cross measurements that should be used are from BLM R2Cross Transect No. 2. Assuming the R2Cross methodology is appropriate at the site where the BLM R2Cross No. 2 was performed – despite the nearby hydraulic controls (beaver ponds) – the resulting flow quantification should be: 4.33 cfs (Winter Flow) and 6.25 cfs (Summer Flow).

b. Unclear Application of Biological Component

It is unclear from the Recommendations what role the biological component played in the flow quantification. When explaining the rational for the recommended Increased ISF, the BLM/CWCB Staff state "[t]he R2Cross data summarized above clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning."[71] From this, it appears the R2Cross Results were the primary driver for the flow quantification and the biological component played only a negligible role.

This conclusion is supported by examination of the Recommendations and inquiry into one of the biological factors repeatedly referenced therein—water temperature.[72] Although water temperature is frequently mentioned, the Recommendations do not reference actual stream temperature data.[73] Upon requesting clarification of this apparent disconnect, CWCB Staff responded through counsel: "Regarding temperature readings, there is some temperature data in the tables of the Edna Mine report. However,… [the] CWCB's recommendation for the appropriation is based on the hydraulic criteria of average depth, average velocity, and percent wetted perimeter, not on this temperature data."[74]

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[71] BLM Recommendation, at 2; CWCB Staff Recommendation, at 4.

[72] For example: "[D]uring July and August, temperatures can approach the maximum temperatures that can be tolerated by trout." BLM Recommendation, at 1; CWCB Staff Recommendation, at 2. And: "This flow rate will maintain sufficient physical habitat in the creek for the fish population to complete important parts of their life cycle before cold temperatures reduce fish activity for the winter." BLM Recommendation, at 2, CWCB Staff Recommendation, at 2. Also: "[D]uring the cold temperature of the year… this flow rate should prevent complete icing of the numerous pools in this reach, allowing the fish population to overwinter." BLM Recommendation, at 2; CWCB Staff Recommendation, at 4.

[73] Examination of the Recommendations reveals one water temperature reading taken by the CWCB on May 7, 2018, 6:00:52 pm (52.252 degrees farenheit measured at Trout Creek – D6 transect, reported in CWCB Streamflow Measurement No. 1). BLM Recommendation, at 57. There is no acknowledgement of this temperature measurement in the Recommendations or CWCB's response to inquiry; therefore, it appears it was not considered.

[74] Email from Andy Nicewicz, Counsel to CWCB Staff, to Alyson Gould, Counsel for Knott Land and Livestock (May 28, 2019) (on file with counsel for Knott Land and Livestock).

Accordingly, although water temperature data was available from a location relied upon for streamflow measurements, it did not enter into consideration in the Recommendations. Rather, water temperature was indirectly imputed pursuant to the R2Cross Results.

The primacy of the BLM/CWCB Staff's R2Cross Results is further reinforced by how closely the recommended Increased ISF rates adhere to the R2Cross Results. To the extent the biological component was used to "refine" the flow quantitation, it may have been used to further divide the two annual flow periods (Winter versus Summer) into three annual flows periods (Winter versus Spring versus Summer).[75] Also, it appears the recommended flow was reduced slightly downward from the average R2Cross results. That is, 13.04 cfs for Summer Flow became 13 cfs for Spring Flow and 12 cfs for Summer Flow; and 7.53 cfs for Winter Flow became 7 cfs for Winter Flow. Nevertheless, these adjustments are minor and may represent rounding to the nearest whole number rather than a refinement based on unique biological factors.

Perhaps the limited reliance upon biological factors to refine the flow quantification is due to the fact that the Recommendations rely upon two fish surveys that are significantly dated: one survey was taken well over 20 years ago and the other over 10 years ago.[76] Moreover, although the specific location of the fish surveys is undisclosed, it appears they were at the opposite (upstream) end of the Proposed Reach from the measurements taken by the BLM and CWCB (2007 Fish Survey), or upstream of the Proposed Reach altogether (1993 Fish Survey).[77] There is little to nothing in the Recommendations, however, indicating contemporaneous biological observations at the sites at which the BLM and CWCB took their hydraulic measurements.[78]

In any event, it appears the Recommendations relied primarily upon the BLM/CWCB R2Cross Results in making its flow recommendation. But, as explained above, the BLM/CWCB Staff R2Cross Results are

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[75] BLM Recommendation, at 2; CWCB Staff Recommendation, at 4. This division could also be due to limited water availability from August 1 to October 31. BLM Recommendation, at 2; CWCB Staff Recommendation, at 4 ("This recommendation is driven by limited water availability."). However, the water availability analysis should have been performed by the CWCB <u>after</u> it received the BLM's Recommendation. Regardless, it should be noted that by dividing the two BLM/CWCB R2Cross results periods (Winter versus Summer) into three periods (Winter versus Spring versus Summer), a higher flow rate (BLM/CWCB R2Cross result's Summer Flow) is applied for two-thirds of the year (Spring and Summer Flow) rather than one-half of the year.

[76] BLM Recommendation, at 5 – 21. See Quantum Report, at 13, ("It is not clear that biological surveys completed 24 years (in 1993) and 10 years (in 2007) prior to the hydraulic survey of the subject stream reach (in 2017) are representative of current biologic conditions in the stream.")

[77] See *supra*, text accompanying fn. 31 – 36. See Quantum Report, at 17 ("…[A] biological survey of the subject stream reach [should] be conducted in conjunction with a survey of hydraulic conditions in the same reach, to ensure that the hydraulic and biologic surveys are representative of conditions in the subject stream reach at the time of the surveys.")

[78] There appear to be two contemporaneous biological observations. First, the BLM Field notes for BLM R2Cross Transect No. 2 note: "mayfly, caddisfly, stonefly" under the heading aquatic sampling summary. BLM Recommendation, at 34. Second, the CWCB the survey for CWCB Streamflow No. 1 states "lots of beaver ponds and old dams in area." BLM Recommendation, at 54. No other such biological observations are evident in the Recommendations.

problematic in and of themselves. As a consequence, the evidence contained in the Recommendations appears unreliable and insufficient to support the Natural Environment Requirement.

2. Water Availability Based on Unrepresentative Data

The Water Availability Requirement evaluates stream hydrology to determine whether sufficient water supply is physically available to meet the recommended flow quantification.[79] In considering water availability, the CWCB relied upon long term monitoring data from the Edna Mine, streamflow measurements taken in the field by BLM and CWCB Staff, and StreamStats.[80] Under the circumstances, these data either do not reflect water availability throughout the reach, are unrepresentative of flows during the period they are intended to represent, or both.

a. Edna Mine Streamflow Data Unrepresentative of Flow Throughout Proposed Reach

The primary source of long-term streamflow data in the Recommendations is the Edna Mine Streamflow Data.[81] It is important to note that this data were collected from near the downstream terminus of the Proposed Reach.[82] The Proposed Reach, however, is a <u>gaining stream</u>.[83] As a result, the flow in Trout Creek at the bottom of the reach represents the combination of the streamflow at the upper terminus of the Proposed Reach in addition to the flow the stream gained during transit along the reach.[84] Accordingly, the Edna Mine Streamflow Data are likely to display generally higher rates than the flow rates at other locations upstream, and therefore represent an unsuitable proxy for flow throughout the Proposed Reach.

b. Streamflow Measurements Unrepresentative of Flow Throughout Reach and For Applicable Flow Period

As described above, the proposed Increased ISF is divided into three annual periods: November 1 to March 31 (Winter Flow); April 1 to July 31 (Spring Flow); and August 1 to October 31 (Summer Flow).

For the period August 1 – October 31 (Summer Flow), the Recommendations' evidence includes three streamflow samples. Two measurements were taken at the beginning of August 2017. These are: BLM R2Cross Transect No. 1: 9.43 cfs[85] and BLM R2Cross Transect No. 2: 8.58 cfs.[86] However, measurements

[79] See, *supra* fn. 64.
[80] CWCB Staff Recommendation, at 5 – 6.
[81] *Id.* at 6.
[82] See *supra*, fn. 30.
[83] This conclusion is supported by the Edna Mine Report, which documents contributions to Trout Creek on the order of 4 cfs from Springs and Seeps in May 2009. BLM Recommendation, at 84, 155 (Table 14). *See also* Quantum Report, at 4 – 5.
[84] As refined by other relevant factors. See, *infra* fn. 96.
[85] BLM Recommendation, at 2, 26.
[86] *Id.* at 2, 42.

at the beginning of August are not representative of the period August 1 – October 31 because of the convergence of two factors affecting flow: 1) recent cessation of upstream diversions, and 2) maximum accrual of return flows to Trout Creek from irrigation by Knott Land and Livestock. As a result, the two streamflow measurements taken at the beginning of August are unlikely to be representative of flows at the end of October.

The third measurement was taken on October 9/10, 2018.[87] This measurement recorded a flow of 9.59 cfs.[88] On the surface, this measurement arguably supports the idea that the flow rate is fairly consistent between August 1 and October 31. However, this measurement is subject to unusually high flow due to extraordinary releases from Sheriff Reservoir.[89] On September 27, 2018, Sheriff Reservoir, an upstream, on-channel reservoir, was drained for maintenance and repair.[90] The result of the draining was the addition of approximately 986 af to the flow to Trout Creek at the end of September through the beginning of October 2018 that would not exist under normal conditions. Thus, the third measurement taken on October 9/10, 2018 is unlikely to be representative of flows in October in an average year.[91]

For the period April 1 to July 31 (Spring Flow), one measurement was taken on May 7, 2018 that measured a flow rate of 64.58 cfs.[92] As with the Edna Mine Measurement Data, this measurement was taken near the downstream terminus of the Proposed Reach. Therefore, it is likely higher than contemporaneous measurements would be further upstream in the Proposed Reach.

For the period November 1 – March 31 (Winter Flow) the Recommendations contain no measurement whatsoever.

Thus, the streamflow measurements taken by the BLM and CWCB Staff are not representative of the flow conditions throughout the Proposed Reach (Spring Flow and Summer Flow), are not representative of the period which they are intended to represent (Summer Flow), or are absent altogether (Winter Flow)

c. StreamStats Does not Meet Applicable Legal Standards

StreamStats (U.S. Geological Survey on-line tool) represents the final remaining indicator of physical streamflow availability relied upon in CWCB's Recommendation. However, as cautioned in the BLM

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[87] See, *supra* fn. 24.

[88] *Id.*

[89] In addition, although the Edna Mine Streamflow Data were collected using continuous recording devices, the data are reported as monthly averages through the period of record. See BLM Recommendation, at 68. Monthly average stream discharge data are not directly comparable to the "instantaneous" measurements represented by the BLM and CWCB transect data used to support the R2Cross hydraulic recommendations.

[90] See, *infra* ¶ V.4 (expected testimony of T. Holliday, Town Manager of the Town of Oak Creek, Colorado).

[91] Despite the fact that the three streamflow measurements for the Summer Period are likely higher than conditions at other times during this period due to the return flows and releases from Sheriff Reservoir, they are on average 2.80 cfs less than the Increased ISF recommended for this period.

[92] BLM Recommendation, at 54, 57.

Recommendation, "StreamStats can provide an estimate of natural hydrology, but this estimate may have to be modified by adjusting for reservoir storage and for irrigation diversions."[93] Likewise, CWCB's Recommendation recognizes, "StreamStats is generally higher, which is not unexpected given that StreamStats does not explicitly account for water diversions."[94] Consequently, these data alone are insufficient to support a water availability analysis[95] and should not be relied upon here.[96]

3. Injury to Water Rights Not Fully Considered

The final ISF Requirement, the No-Injury Requirement, is addressed in the CWCB Staff Recommendation as follows:

> Because the proposed ISF on Trout Creek is a new junior water right, the ISF can exist without material injury to other water rights. Under the provisions of section 37-92-102(3)(b), C.R.S. (2018), the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.[97]

These two conclusory sentences are insufficient to satisfy the No-Injury Requirement. As outlined above, the Non-Injury Requirement requires consideration of undecreed present uses or exchanges of water being made by other water users and whether the proposed ISF appropriation will deprive the people of the state of Colorado of the beneficial use of those waters available by law.[98]

First, although the CWCB Staff Recommendation states that it will recognize any uses or exchanges of water in existence, the analysis does not consider what these uses/exchanges might consist of in reality. Knott Land and Livestock respectfully suggests that such consideration should be made based on discussion with water users owning land and having decreed water rights within a proposed reach before any recommendation is made.[99]

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[93] BLM Recommendation, at 3.
[94] CWCB Staff Recommendation, at 6.
[95] See e.g., *Buffalo Park Development Co. v. Mountain Mut. Reservoir Co.*, 195 P.3d 674, 683 (2008) (citing, *Bd. of Arapahoe County Comm'rs v. United States*, 891 P.2d 952, 962 (Colo.1995)("The applicant must prove that unappropriated water is available based upon conditions existing at the time of the application, in priority, in sufficient quantities, and on sufficiently frequent occasions to enable the applicant to complete the appropriation with diligence and within a reasonable time." (internal citations omitted).)).
[96] The Quantum Report recommends the following be taken into account in a water availability analysis: "1) A description of seasonal stream-discharge conditions in the subject reach of Trout Creek … 2) A summary listing of existing water rights along the full length of Trout Creek, from its headwaters through the subject stream reach….3) A call analysis of existing water rights along Trout Creek and its tributaries, and in Sheriff Reservoir; and 4) A firm-yield analysis of water availability along Trout Creek, from Sheriff Reservoir through the subject reach of Trout Creek." Quantum Report, at 17 – 18.
[97] CWCB Staff's Recommendation, p. 7.
[98] See, *supra* fn. 44 – 45.
[99] Knott Land and Livestock only became aware of the Increased ISF when a neighboring landowner sent a draft of the BLM's Recommendation to Knott Land and Livestock on January 29, 2019.

Second, the CWCB Staff Recommendation makes no reference to consideration of whether the Increased ISF will deprive the people of the State of the beneficial uses of water available by law. While an ISF may result in more consistent flow at the bottom of a reach, it effectively limits water users within, and upstream of the reach. As is the case here, such limits on water users within the reach are especially restrictive when the flow sought to be appropriated is equal to the available supply.[100]

This can be illustrated by two examples based on the assumption that the Increased ISF is decreed by a water court as recommended by the BLM/CWCB Staff. First, if Knott Land and Livestock wanted to reclaim some of its tailwater at Alex Ditch (an existing point of diversion within the reach), Knott Land and Livestock could not make such appropriation because the August 1 – October 31 Increased ISF flow rate would already have appropriated all available water and all of this water must remain in the stream as it flows through Knott Land and Livestock's property.[101] Similarly, if Knott Land and Livestock wanted to make the Alex Ditch an alternate point of diversion for one of its senior upstream rights, Knott Land and Livestock might be prevented from doing so because such change might alter the stream conditions to the detriment of the Increased ISF by changing the return flow patterns (in time, in location, or both) to Trout Creek. In both of these situations, Knott Land and Livestock could be deprived of beneficial uses of waters available to it by law, but for the Increased ISF. Nevertheless, such considerations were omitted from the Recommendations.

In sum, further consideration must be given to existing and future water uses potentially affected by the Increased ISF before the No-Injury Requirement is met.

4. Conclusion

As explained in detail above, three requirements must be met before an ISF flow appropriation can be made. Here, the data in the Recommendations fail to meet the requirements.

First, in regard to the Natural Environment Requirement, data is absent or omitted, the stream conditions at the sampling location appear inappropriate for the methodology applied, application of the methodology appears to result in flow rates far less than the flow rates proposed by the Increased ISF, and the biological data does not correspond to the other sampling data in location and timing.

Second, concerning the Water Availability Requirement, the data relied upon does not reflect water availability throughout the reach, is unrepresentative of flows during the period they are intended to represent, and/or is based upon a tool that is recognized to be skewed.

Last, the No-Injury Requirement is not met because it fails to take into account potential impact and impairment to other water users, including Knott Land and Livestock.

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[100] BLM Recommendation, at 2; CWCB Staff Recommendation, at 4 ("This recommendation is driven by limited water availability.").

[101] *Id.*

In sum, appropriation of the Increased ISF as proposed is not consistent with the requirements, and consequently, contrary to relevant law.

IV. HEARING EXHIBITS

ISF Rule 5(n)(2) requires a Party to identify all exhibits, engineering data, biological data and reports or other information that the Party will rely on at the hearing. Knott Land and Livestock's exhibits referenced in this Prehearing Statement are identified below and are provided herewith pursuant to ISF Rule 5(n)(2)(b). Knott Land and Livestock may rely upon all exhibits, data, and other information duly introduced or disclosed by other parties in this matter. Knott Land and Livestock reserves the right to introduce additional exhibits in its rebuttal statement and at the hearing.

EXHIBIT A	Knott Land and Livestock Company, Inc., Notice to Contest Instream Flow Appropriation, Trout Creek Increased Instream Flow CWCB ID: 19/6/A-009 (Mar. 29, 2019) ("Notice to Contest")
EXHIBIT B	*In re Colorado Water Conservation Board to Preserve the Natural Environment to a Reasonable Degree in Trout Creek*, Case No. W-1338-77 (Water Division No. 6 May 27, 1982) ("Existing ISF Decree").
EXHIBIT C	Letter from Brian St. George, Deputy State Director Resources and Fire, Bureau of Land Management, to Linda Bassi, Section Chief, Stream and Lake Protection Section, Colorado Water Conservation Board (date stamped Dec. 19, 2018) ("BLM Recommendation").
EXHIBIT D	CWCB Staff Instream Flow Recommendation, CWCB ID: 19/6/A-009, Trout Creek Executive Summary (Jan. 17, 2019) ("CWCB Staff Recommendation")
EXHIBIT E	Theresa, Jehn-Dellaport, P.G., Rochelle Ann Hoover, P.E., John W. Anthony, R.G., C.E.G., C.P.H.; Quantum Water & Environment, Re: Quantum Review of U.S. Bureau of Land Management's In-Stream Flow Calculations for 7-Mile Reach of Trout Creek, Routt County, Colorado (Sept. 3, 2019) ("Quantum Report")
EXHIBIT F	Gregory Espergen, Senior Water Resources Specialist, Colorado Water Conservation Board, Development of Instream Flow Recommendations in Colorado Using R2Cross (Jan. 1996) ("1996 R2Cross Guidance")
EXHIBIT G	Colorado Water Conservation Board, Colorado's Instream Flow and Natural Lake Level Program, PowerPoint Presentation to AWRA (Mar. 3, 2017) (available at: http://www.awracolorado.org/wp-content/uploads/2017/03/AWRA-Presentation.pdf) ("CWCB Presentation to AWRA")
EXHIBIT H	Linda Bassi & Brandy Logan, Colorado Conservation Board, Overview of Colorado's Instream Flow Program & Analysis Tools, PowerPoint Presentation to GRAD 595 (Nov. 6, 2017) (available at http://cwi.colostate.edu/media/files/Seminars/GRAD592/2017/214_Presentation.pdf) ("CWCB Presentation to GRAD 595").

V. WITNESSES

ISF Rule5(n)(2)(c) requires a Party to include in a Prehearing Statement a list of the witnesses to be called, with a brief description of their testimony. Knott Land and Livestock may call as witnesses the following individuals to testify at the hearing as described below:

1. Tyler Knott, Manager, Knott Land and Livestock Company, Inc. Mr. Knott may testify with regard to Knott Land and Livestock's Water Rights, ranch operations, water management and use concerning and related to Trout Creek.

2. Theresa Jehn-Dellaport, P.G., Principal, Quantum Water and Environment. Ms. Jehn-Dellaport may testify with regard to the opinions expressed in the Quantum Report. (Resume available upon request.)

3. Shelly Hoover, P.E., Senior Engineer, Quantum Water and Environment. Ms. Hoover may testify with regard to the opinions expressed in the Quantum Report. (Resume available upon request.)

4. Tom Holliday, Public Works Director, Town of Oak Creek, Colorado. Mr. Holliday may testify with regard to the operations and management of Sheriff Reservoir.

5. Brian Romig, Water Commissioner. Mr. Romig may testify with regard to water administration within Division 6 relevant to Trout Creek.

6. Andrea Schaffner, former Water Commissioner. Ms. Schaffner may testify with regard to water administration during her tenure as Water Commissioner for Division 6 relevant to Trout Creek.

7. Brian St. George, Deputy State Director of Colorado, Resources and Fire, BLM. Mr. St. George may testify regarding the BLM's Recommendation.

8. Eric Scherff, Hydrologist, Little Snake Field Office, BLM. Mr. Scherff may testify regarding the BLM's Recommendation.

9. Roy Smith, Water Rights Specialist in the Colorado State Office, BLM. Mr. Smith may testify regarding the BLM Recommendation and coordination with the CWCB Staff regarding the CWCB Staff Recommendation.

10. Brandy Logan, Hydrologist, Stream and Lake Protection Section, CWCB. Ms. Logan may testify regarding the CWCB Staff Recommendation and the CWCB's ISF program.

11. Jack Landers, Hydrologist, Stream and Lake Protection Section, CWCB. Mr. Landers may testify regarding the CWCB Staff Recommendation.

12. Jay Skinner, Instream Flow Specialist, Stream and Lake Protection Section, CWCB. Mr. Skinner may testify regarding the CWCB Staff Recommendation.

13. Linda Bassi, Section Chief, Stream and Lake Protection Section, CWCB. Ms. Bassi may testify regarding the Recommendations and the CWCB's ISF program.

14. Rob Viehl, Senior Water Rights Specialist, Stream and Lake Protection Section, CWCB. Mr. Viehl may testify regarding the CWCB Staff Recommendation.

15. Jason Musick, Colorado Division of Reclamation, Mining and Safety. Mr. Musick may testify regarding the Edna Mine Report.

16. Troy Summers, Energy/Environmental Department Manager, WWC Engineering. Mr. Summers may testify regarding the Edna Mine Report.

17. Knott Land and Livestock may call any witness identified by any other party to the hearing.

18. Knott Land and Livestock reserves the right to identify additional witnesses in its rebuttal statement.

VI. WRITTEN TESTIMONY

This Prehearing Statement shall serve as Knott Land and Livestock's written testimony in accordance with ISF Rule 5(n)(2)(e). Knott Land and Livestock reserves the right to introduce written testimony of any witness whose availability to appear in person at the hearing may become limited.

VII. LEGAL MEMORANDA

As referenced herein, Section III of this Prehearing Statement shall serve as Knott Land and Livestock's legal memoranda. Knott Land and Livestock reserves the right to rely upon and/or adopt legal memoranda introduced by other parties in this matter.

VIII. ALTERNATIVE PROPOSAL

ISF Rule 5(n)(2)(d) requires a Party to include in a Prehearing Statement any alternative proposal to the proposed ISF appropriation at issue. Because the current recommended Increased ISF relies upon incomplete data and does not take into account actual conditions within the Reach, Knott Land and Livestock respectfully requests that CWCB consider the following Alternative Proposals to the Increased ISF:

1. Reduce existing ISF for Winter Flow pursuant to C.R.S. 37-92-102(b) and ISF Rule 9 by 0.77 cfs to a total ISF of 4.33 cfs.

2. Reduce claim for Increased ISF for Spring/Summer Flow to 1.25 cfs (total ISF of 6.25 cfs).

3. Knott Land and Livestock requests the CWCB withdraw the current Increased ISF and return to CWCB Staff for further consideration and evaluation consistent with C.R.S. § 37-92-102(3) and ISF Rule 5(i).

4. Discuss terms and conditions with Knott Land and Livestock that may be included in ISF Decree that will protect Knott Land and Livestock's present and future operations pursuant to authority under C.R.S. 37-92-102(4)(a).

Knott Land and Livestock reserves the right to modify the above proposals or make additional proposals.

Respectfully submitted September 3, 2019.

HOLSINGER LAW, LLC
By: */s/ Alyson Meyer Gould*
Alyson Meyer Gould (42672)

ATTORNEYS FOR KNOTT LAND AND LIVESTOCK COMPANY, INC.

CERTIFICATE OF SERVICE

I hereby certify that on September 3, 2019, a true and correct copy of the foregoing **Prehearing Statement of Knott Land and Livestock Company, Inc.** was delivered via email, as follows:

Hearing Officer

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HOLSINGER LAW, LLC

By: /s/ Sarah Ostby
Sarah Ostby
Paralegal

BEFORE THE COLORADO WATER CONSERVATION BOARD
STATE OF COLORADO

IN THE MATTER OF PROPOSED INSTREAM FLOW APPROPRIATIONS IN WATER DIVISION 6:

TROUT CREEK

ROUTT COUNTY, COLORADO

NOTICE TO CONTEST INSTREAM FLOW APPROPRIATION

Knott Land and Livestock Company, Inc. ("Knott Land and Livestock"), by and through its undersigned attorneys, submits the following Notice to Contest in accordance with Rule 5(k) of the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program, 2 C.C.R. 408-2 ("ISF Rules").

I. Identification of Person Requesting Hearing:

Knott Land and Livestock Company, Inc.
18300 RCR 29
Oak Creek, Colorado 80467
Attn: Mr. Tyler and Mrs. Megan Knott

Please direct all notices, pleadings, and correspondence to counsel for Knott Land and Livestock:

Kent Holsinger, Esq.
Alyson Meyer Gould, Esq.
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II. Identification of Proposed Instream Flow Appropriation at Issue

CWCB ID. Number	Stream	Watershed	Upper Terminus	Lower Terminus	Length	Amount
19/6/A-009	Trout Creek	Upper Yampa	Confluence with unnamed tributary at UTM North: 4457645.23 UTM East: 323578.92	Koll Ditch headgate UTM North: 4464276.41 UTM East: 329133.88	6.64 miles	2.0 cfs (11/01 - 03/31) 8.0 cfs (04/01 - 07/31) 7.0 cfs (08/01 - 10/31)

Hereinafter, the instream flow appropriation at issue shall be referred to as the "Trout Creek Increased ISF."

III. Background, Contested Facts, and a General Description of the Data Upon Which Knott Land and Livestock Will Rely to the Extent Known

A. Background

Knott Land and Livestock owns a total of 2,394 acres in Routt County, Colorado, located approximately 10 miles South and West of Oak Creek, Colorado. As noted in the Colorado Water Conservation Board's ("CWCB") recommendation concerning the Trout Creek Increased ISF, the U.S. Bureau of Land Management ("BLM") manages 11 percent of the 6.64 mile Trout Creek Increased ISF's proposed reach, while 89 percent of this proposed reach is privately owned. As depicted in EXHIBIT A (attached), an estimated 76 percent of the privately-owned land in which the Trout Creek Increased ISF's proposed reach is located is owned by Knott Land and Livestock.

Knott Land and Livestock possesses a number of water rights including rights associated with the following structures: Male Moore and Company Ditch, David M. Chapman Ditch, David M. Chapman Ditch No. 2, Knott Ditch, Knott Ponds 1 – 4, Knott Springs 1 – 6, Slough Ditch, Knott Wastewater Ditch, Orno Ditch, and Alex Ditch. Knott Land and Livestock's water rights are complex and are designed and operated to serve Knott Land and Livestock's property and ranching operations as an integrated unit. Knott Land and Livestock's water rights are located upstream or within the upstream portion of the Trout Creek Increased ISF's proposed reach (*see* EXHIBIT A).

In 1982, the CWCB was decreed an instream flow right in Trout Creek in Case No. W-1338-77 ("Trout Creek Original ISF"). The Trout Creek Original ISF was awarded a priority date of September 23, 1977 and a year-round flow rate of 5 c.f.s. The Trout Creek Original ISF's reach extends approximately 24 miles from Sherriff Reservoir downstream to the confluence of Trout Creek and Middle Creek. Knott Land and Livestock filed an objection in the Trout Creek Original ISF proceeding and subsequently stipulated out having reached a settlement with the CWCB.

The Trout Creek Increased ISF's proposed reach is intended to be on top of and in addition to that of the Trout Creek Original ISF.

B. Contested Facts

Knott Land and Livestock questions a number of facts asserted in the CWCB's recommendation regarding the Trout Creek Increased ISF. In particular, Knott Land and Livestock questions whether:

1. The natural environment will be preserved to a reasonable degree by the water available for the Trout Creek Increased ISF when Trout Creek is administered by the Division 6 Engineer upstream of the Orno Ditch as over-appropriated; Trout Creek is historically administered to honor a call at the Pine Grove Ditch resulting in a dry-up until return flows can accumulate downstream; and the historic call on Trout Creek is already significantly senior to the existing Trout Creek Original ISF.

2. There is a natural environment that can be preserved to a reasonable degree by the proposed Trout Creek Increased ISF without material injury to other water rights when, in fact, the collected data is unrepresentative of actual conditions:

    a. The dates of the stream flow measurements conducted by the CWCB are subject to unique circumstances rendering the data unrepresentative of actual conditions for the time period they are supposed to represent; and

    b. The primary source of long-term stream flow data is located below the bottom of the proposed reach which is a gaining stream largely attributable to return flows from upstream water rights, below the confluence of a number of tributaries, and is the recipient of considerable runoff due to steep and impermeable terrain rendering the data relied upon unrepresentative of actual conditions throughout the reach.

3. The Trout Creek Original ISF is already sufficiently representative of the minimum stream flow necessary to preserve the natural environment to a reasonable decree without material injury to other water rights.

4. The natural environment will be preserved to a reasonable degree by the Trout Creek Increased ISF given that the proposed reach is primarily located on private property and the CWCB is not vested with the authority to condemn a right-of-way across private land to gain access to a segment of a stream where a water right has been awarded to the CWCB.

5. The CWCB's recommendation has taken into consideration and will recognize and protect the present uses or exchanges of water being made by other water users pursuant to appropriations or practices in existence on the date of the Trout Creek Increased ISF appropriation, regardless of whether the other uses or exchanges were previously confirmed by court order or decree.

6. Knott Land and Livestock reserves the right to identify and raise other contested factual and legal issues.

C. General Description of Data to the Extent Known

In addition to the information identified above, Knott Land and Livestock intends to rely upon the following supporting data to the extent currently known:

1. All documents, facts, data, photographs, and other material in the records and files of the CWCB, Colorado Parks and Wildlife, and the BLM related to the Trout Creek Increased ISF and Trout Creek Original ISF;

2. All documents, facts, data, photographs, and other material in the records and files of Knott Land and Livestock and its consultants pertaining to water rights owned, used, or operated by Knott Land and Livestock;

3. Personal knowledge of individuals associated with Knott Land and Livestock pertaining to water rights owned, used, or operated by Knott Land and Livestock and other water users;

4. Personal knowledge of the Staff of the Colorado Division of Water Resources and other water users in the vicinity of the Trout Creek Increased ISF and Trout Creek Original ISF; and

5. All documents, facts, data, photographs, and other material offered in rebuttal.

Knott Land and Livestock reserves the right to present or rely upon other facts, data, documents, and factual and opinion testimony as it arises hereafter in this proceeding.

WHEREFORE, Knott Land and Livestock contests the proposed Trout Creek Increased ISF appropriation and requests that a hearing officer be appointed in accordance with Rule 5(n) of the ISF Rules.

Respectfully submitted on March 29, 2019.

HOLSINGER LAW, LLC

Original on file at Holsinger Law, LLC

By: /s/ *Kent Holsinger*
Kent Holsinger (33907)

By: /s/ *Alyson Meyer Gould*
Alyson Meyer Gould (42672)

Attorneys for Knott Land and Livestock Company, Inc.

EXHIBIT A

EXHIBIT A

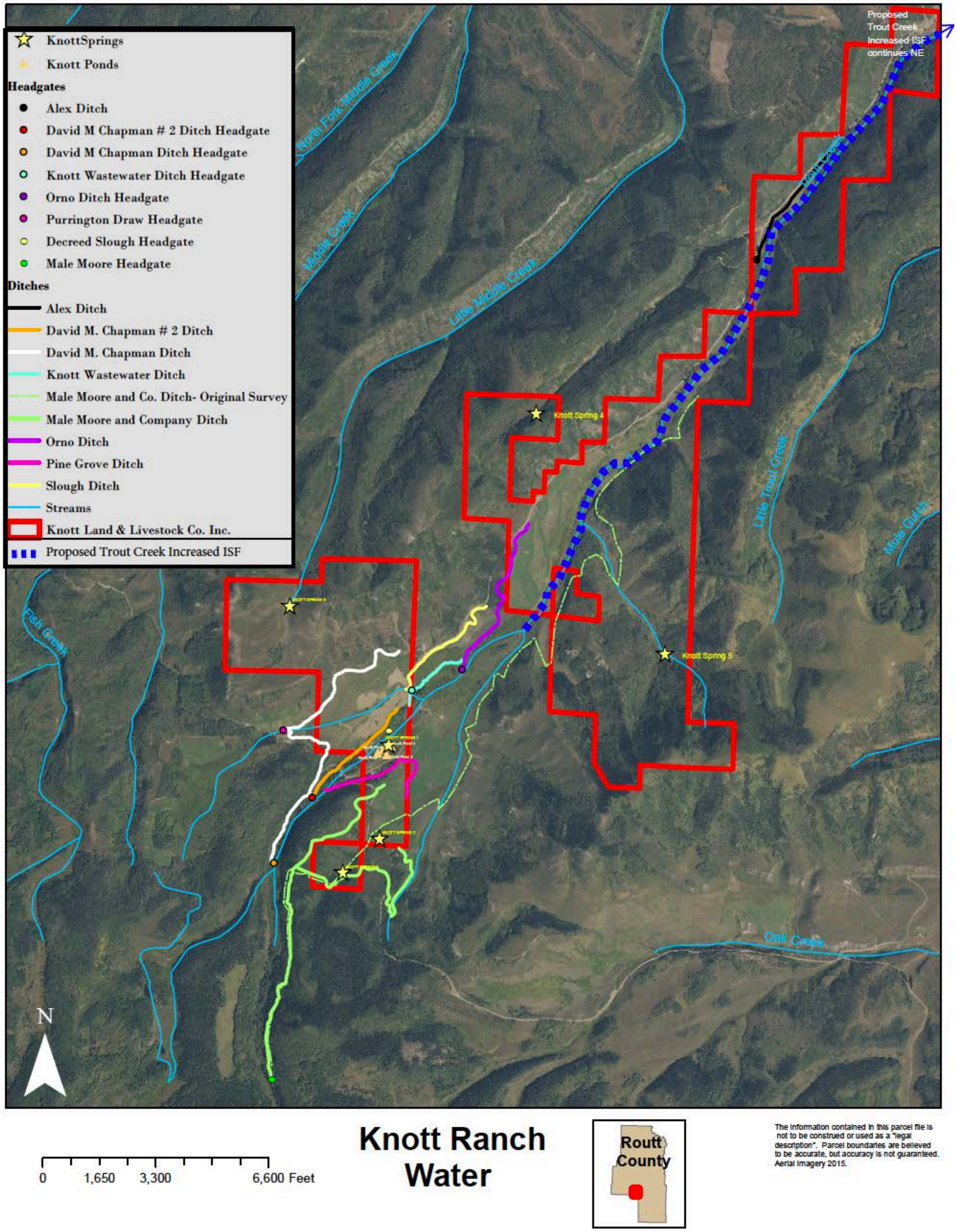


EXHIBIT B

FILED WATER COURT
DIV. 6
STATE OF COLORADO
APR 13 1982
Ruth Ann Mewborn
CLERK
BY ______ DEPUTY

FILED WATER COURT
DIV. 6
STATE OF COLORADO
MAR 17 1982
Ruth Ann Mewborn
CLERK
BY ______ DEPUTY

DISTRICT COURT, WATER DIVISION NO. 6, STATE OF COLORADO

Case No. W-1338-77

RULING OF REFEREE

CONCERNING THE APPLICATION FOR WATER RIGHTS OF THE COLORADO WATER CONSERVATION BOARD ON BEHALF OF THE PEOPLE OF THE STATE OF COLORADO TO PRESERVE THE NATURAL ENVIRONMENT TO A REASONABLE DEGREE IN TROUT CREEK

IN ROUTT COUNTY

The court being fully advised as to the matter of the application herein, hereby makes the following ruling:

All notices required by law of the filing of the application herein have been fulfilled and the court has jurisdiction over the subject matter and over all parties hereto.

The United States of America timely filed a statement of opposition. A stipulation has been reached between the United States and the applicant herein and such stipulation is made part of and incorporated into this ruling of referee, the terms of which are as follows:

1. Applicant's rights are subject to all senior rights of the United States of America in the subject source; including proprely decreed reserved rights, as are now or will hereafter be determined by law.

2. Applicant shall apply for any special use permits or rights-of-way, as the case may be, if the same are required by law for the use of public resources contemplated by the subject application and shall abide by the conditions set forth therein.

Knott Land and Livestock Company, Inc., timely filed a statement of opposition. A stipulation has been reached with Knott Land and Livestock Company, Inc., and such stipulation is made part of and incorporated into this ruling of referee, the terms of which are as follows:

1. The objector hereby withdraws its statement of opposition previously filed herein.

2. The applicant recognizes that the water rights of the objector which are the subject of adjudication in case No. 79 CW 148, Water Division No. 6, have been applied to consistent beneficial use since 1954 to supply four fish ponds.

3. The applicant hereby subordinates the water right which is the subject of the application herein to the water rights of the objector specified in 79 CW 148, Water Division No. 6 providing said water rights continue to be applied to their historic use.

4. Applicant does not waive its right to use the water right herein as a basis to object to any water right application, plan for augmentation, exchange or change in use or point of diversion.

The Energy Fuels Corporation also timely filed a statement of opposition and subsequently withdrew said opposition.

NAME AND ADDRESS OF CLAIMANT

Colorado Water Conservation Board
1313 Sherman Street, Room 823
Denver, Colorado 80203

EXHIBIT B

WATER RIGHT

Name of ditch, spring or other structure: Trout Creek, a natural stream.

Location: Legal description of beginning and end points of minimum stream flow claimed: The natural stream channel from Sheriff Reservoir at lat 40 08 56N long 107 08 08 W as the upstream terminus and confluence Middle Creek S6 T5N R85W 6th P.M. as the downstream terminus, being a distance of approximately 24 miles. This segment can be located on the Dunckley Pass, Cow Creek, U.S.G.S. quadrangle.

Priority date: September 23, 1977.

Amount of water: Flow in c.f.s.: 5 c.f.s.

Use of water: To maintain such minimum flows as are required to preserve the natural environment to a reasonable degree pursuant to C.R.S. 1973, 37-92-102 and 103. No diversion of the water right herein will be made from the natural stream channel.

IT IS FURTHER ORDERED that the applicant shall install and maintain such water measurement devices, recording devices, content gauges and inlet and outlet measurement and recording devices, as the case may be, as are deemed essential by the Office of the State Engineer, and the same shall be installed and operated in accordance with instructions from said office.

Dated this 9th day of April, 1982.

G. I. BUFFHAM II
Water Referee
Water Division No. 6

EXHIBIT B

No protest was filed in this matter. The foregoing ruling is confirmed and approved, and is made the judgment and decree of this court.

This 22 day of May, 1982.

CLAUS J. HUME Water Judge Water Division No. 6

FILED WATER COURT
DIV. 6
STATE OF COLORADO

MAY 27 1982

Ruth Ann Newlin
CLERK

BY ______ DEPUTY

AG Alpha No. NR WC WCM
AG File No. DNR/133877/1LW

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Colorado State Office
2850 Youngfield Street
Lakewood, Colorado 80215-7210
www.co.blm.gov

In Reply Refer To:
7250 (CO-932)

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

DEC 19 2018

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an increase to the instream flow water right on Trout Creek, located in Water Division 6.

Location and Land Status. Trout Creek originates in the Flattops Wilderness Area, approximately 11.0 miles southwest of the community of Yampa. Trout Creek flows into the Yampa River at the town of Milner. This recommendation addresses only the portion of Trout Creek that starts at the confluence with an unnamed tributary located in the SW ¼ NW ¼, Section 8, T3N R86W and ending at the headgate of the Koll Ditch, a distance of approximately 7.0 miles. The BLM manages 0.8 miles of this reach, while approximately 6.2 miles are in private ownership.

Existing Instream Flow Water Rights. In 1977, the Colorado Water Conservation Board appropriated an instream flow water right on Trout Creek that begins at the outlet of Sheriff Reservoir and ends at the confluence with Middle Creek. The protected flow rate is 5.0 cfs, year round.

Biological Summary. Trout Creek is a cold water, moderate gradient stream. The reach that is the subject of this recommendation flows through valley that ranges from 1/8 to ½ mile in width. The upper part of the reach flows through agricultural lands used for livestock grazing, while the lower part of the reach flows through a confined canyon that is in largely natural condition. Substrate is generally from medium to large size, ranging from 4-inch cobbles to small boulders. Water quality is good for supporting salmonid fish species, but during July and August, temperatures can approach the maximum temperatures that can be tolerated by trout.

Fish surveys indicate a diverse and self-sustaining fish community. Trout Creek provides habitat for brook trout, brown trout, cutthroat trout, mottled sculpin, speckled dace, and mountain sucker. Spot surveys have indicated abundant populations of stonefly and caddisfly.

The creek also supports a vigorous riparian community comprised of alder, dogwood, and narrowleaf cottonwood. When the creek flows through confined canyons, the riparian community provides good cover and shading for the creek, and contributes substantially to bank stability.

R2Cross Analysis. The BLM collected the following R2Cross data from Trout Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
08/12/2017 #1	9.43 cfs	39.42 feet	9.27 cfs	13.28 cfs
08/12/2017 #2	8.58 cfs	35.17 feet	5.79 cfs	12.80 cfs
		Averages:	7.53 cfs	13.04 cfs

BLM's analysis of this data, coordinated with Colorado Parks and Wildlife, indicates that the following flows are needed to protect the natural environment to a reasonable degree.

> 13.00 cubic feet per second is recommended during the snowmelt runoff period and early summer, from April 1 to July 31. This recommendation is driven by the average depth criteria. In many locations, the Trout Creek channel is wide with large substrate, so meeting the depth criteria is important for passage between rocks and between pools. Implementing this recommendation would require an increase of 8.0 cfs over the current instream flow water right.
>
> 12.00 cubic feet per second is recommended during late summer and early fall, from August 1 to October 31. This recommendation is driven by limited water availability. This flow rate will maintain sufficient physical habitat in the creek for the fish population to complete important parts of their life cycle before cold temperatures reduce fish activity for the winter. Implementing this recommendation would require an increase of 7.0 cfs over the current instream flow water right.
>
> 7.00 cubic feet per second is recommended during the cold temperature portion of the year, from November 1 through March 31. This recommendation is driven by limited water availability but comes very close to meeting the wetted perimeter criteria and the velocity criteria. This flow rate should prevent complete icing of the numerous pools in this reach, allowing the fish population to overwinter. Implementing this recommendation would require an increase of 2.0 cfs over the current instream flow water right.

Rationale for Instream Flow Increase. BLM believes an instream flow increase for Trout Creek is warranted because of physical habitat characteristics. The R2Cross data summarized above clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning. When the existing instream flow rights are applied to the cross sections that were collected, the stream would exhibit 40 percent to 66 percent wetted perimeter. However, this habitat is not highly usable by the fish population, because 5.0 cfs constrains the habitat to an average depth of 0.22 to 0.26 feet. An average habitat depth of 0.22 to 0.26 feet is not sufficient in a stream that averages 35 to 40 feet in top width. During the warm weather season, the fish populations need to have access to as much of the stream channel as possible for feeding, resting, and spawning if they are to survive the pronounced cold winters in this canyon. The increase in flow rates during winter is warranted because the average depths associated with 5.0 cfs make much of the physical habitat in the stream channel less susceptible to freezing.

Water Availability. The BLM recommends using a variety of data sources to confirm water availability, because BLM is not aware of any historical gage data on this creek. Use of Streamstats can provide an estimate of natural hydrology, but this estimate may have to be modified by adjusting for reservoir storage and for irrigation diversions. Two nearby gages may also provide an estimate of natural hydrology, because they are located on watersheds with similar characteristics. USGS Gage 0923800, on Oak Creek near the community of Oak Creek, is located on a smaller watershed, but appears to be relatively unaffected by diversion and storage operations. USGG Gage 09248500, on the East Fork of the Williams Fork near Willow Creek, is on a larger watershed, but this watershed has very similar altitude and aspect to the Trout Creek watershed. Neither of these gages is currently collecting data, but the period of record should be sufficient to help establish water availability for this recommendation. Finally, if reservoir storage and release records are available for Sheriff Reservoir, located upstream from the recommended reach, those records would assist would evaluating the impact of storage operations on stream flows.

The BLM is aware of the following water rights within the proposed instream flow reach:

Koll Ditch – 13.22 cfs
Alex Ditch – 1.28 cfs

The BLM is aware of the following water upstream from the recommended reach:

Orno Ditch – 8.31 cfs
Slough Ditch – 3.98 cfs
Knott Ditch – 2.00 cfs
Pine Grove Ditch – 3.98 cfs
David Chapman Ditch – 2.41 cfs
Male Move Ditch – 12.62 cfs
Last Chance Ditch – 19.29 cfs
Rich Ditch – 19.32 cfs
Sheriff Reservoir – 986.5 acre feet

Relationship to Land Management Plans. The BLM's management plan calls for improvement and recovery of current and historic fisheries as a means of increasing native fish populations. In addition, the BLM plan calls for making instream flow recommendations to the Colorado Water Conservation Board to meet minimum instream flow requirements to maintain native fisheries. Finally, the plan calls for maintaining and improving the function of riparian areas to achieve advanced ecological stage for the riparian community, and it also calls for protecting riparian and wetland systems from further sources of degradation. Establishing an instream flow water right would assist in meeting these objectives.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross section were included with BLM's draft recommendation in February 2018. We thank both Colorado Parks and Wildlife and the Colorado Water Conservation Board for their cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Brian St. George
Deputy State Director
Resources and Fire

Cc: Bruce Sillitoe, Little Snake FO
Eric Scherff, Little Snake FO
Andrew Archuleta, Northwest District Manager

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP0085	ABV CO RD 29	8-Sep-1993	21041	PRESENCE/ABSENCE	MOTTLED SCULPIN	8	70
23533	Trout Creek #2	YP0085	ABV CO RD 29	8-Sep-1993	21041	PRESENCE/ABSENCE	MOTTLED SCULPIN	2	30
23533	Trout Creek #2	YP0085	ABV CO RD 29	8-Sep-1993	21041	PRESENCE/ABSENCE	MOTTLED SCULPIN	2	90
23533	Trout Creek #2	YP0085	ABV CO RD 29	8-Sep-1993	21041	PRESENCE/ABSENCE	BROOK TROUT	1	130
23533	Trout Creek #2	YP0085	ABV CO RD 29	8-Sep-1993	21041	PRESENCE/ABSENCE	BROOK TROUT	1	30
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	121
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	151
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	152
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	65
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	192
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	51

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	127
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	161
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	215
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	137
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	161
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	226
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	269
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	181
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	129
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	233
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	163
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	208
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	60
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	122
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	60
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROOK TROUT	1	54

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	LONGNOSE DACE	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	LONGNOSE DACE	1	105
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	LONGNOSE DACE	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	322
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	404
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	234
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	143
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	344
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	329
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	266
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	170
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	235
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	373
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	265
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	326
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	122
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	228
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	145
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	134
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	302
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	405
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	219
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	136
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	215
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	131

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	318
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	131
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	169
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	223
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	246
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	BROWN TROUT	1	382
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	160
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	138
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	107
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	125
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	112
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	88
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	102
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	167
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOUNTAIN SUCKER	1	172
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	79
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	41
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	106
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	79
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	88
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	102
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	110
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	92
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	93
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	63
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	105
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	115
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	106
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	88
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	108
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	63
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	93
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	102
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	41
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	126

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	104
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	98
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	59
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	42
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	112
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	109
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	99
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	108
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	97
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	65
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	65
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	47
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	47
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	92
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	93
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	79
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	63
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	93
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	62

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	103
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	130
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	92

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	61
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	99
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	108
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	102
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	88
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	108
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	73
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	65
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	65
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	100
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	99
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	103
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	73

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	73
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	135
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	125
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	NULL
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	105
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	71
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	79
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	92
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	113
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	45
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	117
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	76
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	47
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	79
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	49
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	57
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	47
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	42
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	52
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	45
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	98
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	58
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	45
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	55
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	91
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	96
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	97
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	117
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	77
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	94
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	106
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	47
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	60
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	82
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	78
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	72
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	66
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	50
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	74

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	53
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	54
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	48
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	56
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	46
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	44
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	51
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	70
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	88
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	89
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	136
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	97
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	62
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	90
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	95
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	64
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	68
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	MOTTLED SCULPIN	1	75
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	CUTTHROAT TROUT (S.S.U.)	1	412
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	CUTTHROAT TROUT (S.S.U.)	1	80
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	CUTTHROAT TROUT (S.S.U.)	1	196
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	CUTTHROAT TROUT (S.S.U.)	1	208
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	RAINBOW TROUT	1	267
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	RAINBOW TROUT	1	249
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	RAINBOW X CUTTHROAT	1	277
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	83
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	84
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	101
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	86
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	69
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	81
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	67
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	90

WaterCode	WaterName	StationCode	StationLocation	SampleDate	SurveyID	Protocol	CommonName	Numfish	FishLength
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	87
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	74
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	85
23533	Trout Creek #2	YP1965	4.5 Km BLW CO RD 29	19-Jul-2007	23350	THREE-PASS REMOVAL	SPECKLED DACE	1	84

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Trout Creek
XS LOCATION:	0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER:	1
DATE:	2-Aug-17
OBSERVERS:	R. Smith, E. Scherff
1/4 SEC:	SW NW
SECTION:	23
TWP:	4N
RANGE:	86W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Yampa River
DIVISION:	6
DOW CODE:	23533
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

*** NOTE ***
Leave TAPE WT and TENSION
at defaults for data collected
with a survey level and rod

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE: 0.013

INPUT DATA CHECKED BY: ....DATE....................

ASSIGNED TO: …...............………............................DATE...................

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER: 1

DATA POINTS= 40

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
LS	1.30	3.92			0.00		0.00	0.00	0.0%
1 G	3.70	3.83			0.00		0.00	0.00	0.0%
	4.60	4.71			0.00		0.00	0.00	0.0%
W	6.70	5.05	0.00	0.00	0.00		0.00	0.00	0.0%
	8.00	5.25	0.20	0.45	1.32	0.20	0.23	0.10	1.1%
	9.00	5.20	0.15	0.67	1.00	0.15	0.15	0.10	1.1%
	10.00	5.45	0.40	1.22	1.03	0.40	0.30	0.37	3.9%
	10.50	5.40	0.35	1.67	0.50	0.35	0.18	0.29	3.1%
	11.00	5.50	0.45	1.65	0.51	0.45	0.23	0.37	3.9%
	11.50	5.45	0.40	2.20	0.50	0.40	0.20	0.44	4.7%
	12.00	5.45	0.40	1.98	0.50	0.40	0.20	0.40	4.2%
	12.50	5.45	0.40	1.72	0.50	0.40	0.20	0.34	3.6%
	13.00	5.50	0.45	1.95	0.50	0.45	0.23	0.44	4.7%
	13.50	5.50	0.45	1.61	0.50	0.45	0.23	0.36	3.8%
	14.00	5.55	0.50	1.24	0.50	0.50	0.25	0.31	3.3%
	14.50	5.55	0.50	1.48	0.50	0.50	0.25	0.37	3.9%
	15.00	5.45	0.40	1.40	0.51	0.40	0.20	0.28	3.0%
	15.50	5.50	0.45	1.76	0.50	0.45	0.23	0.40	4.2%
	16.00	5.50	0.45	1.61	0.50	0.45	0.23	0.36	3.8%
	16.50	5.55	0.50	2.01	0.50	0.50	0.25	0.50	5.3%
	17.00	5.45	0.40	2.34	0.51	0.40	0.20	0.47	5.0%
	17.50	5.60	0.55	2.05	0.52	0.55	0.28	0.56	6.0%
	18.00	5.65	0.60	1.63	0.50	0.60	0.30	0.49	5.2%
	18.50	5.70	0.65	1.42	0.50	0.65	0.33	0.46	4.9%
	19.00	5.75	0.70	1.84	0.50	0.70	0.53	0.97	10.2%
	20.00	5.55	0.50	0.00	1.02	0.50	0.50	0.00	0.0%
	21.00	5.45	0.40	0.49	1.00	0.40	0.40	0.20	2.1%
	22.00	5.30	0.25	2.07	1.01	0.25	0.25	0.52	5.5%
	23.00	5.35	0.30	1.01	1.00	0.30	0.30	0.30	3.2%
	24.00	5.05	0.00	0.00	1.04		0.00	0.00	0.0%
	25.00	5.15	0.10	0.28	1.00	0.10	0.10	0.03	0.3%
	26.00	5.15	0.10	0.02	1.00	0.10	0.09	0.00	0.0%
W	26.70	5.05	0.00	0.00	0.71		0.00	0.00	0.0%
	29.60	4.90			0.00		0.00	0.00	0.0%
	33.90	4.62			0.00		0.00	0.00	0.0%
	35.60	4.42			0.00		0.00	0.00	0.0%
	39.30	4.68			0.00		0.00	0.00	0.0%
	41.60	4.20			0.00		0.00	0.00	0.0%
	42.60	4.04			0.00		0.00	0.00	0.0%
1 RS & G	43.20	3.80			0.00		0.00	0.00	0.0%
TOTALS ----------------------					20.21	0.7 (Max.)	6.79	9.43	100.0%

Manning's n = 0.0589
Hydraulic Radius= 0.33589187

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	6.79	6.79	0.0%
4.80	6.79	12.57	85.1%
4.82	6.79	12.05	77.5%
4.84	6.79	11.55	70.0%
4.86	6.79	11.05	62.7%
4.88	6.79	10.56	55.5%
4.90	6.79	10.08	48.4%
4.92	6.79	9.61	41.5%
4.94	6.79	9.14	34.7%
4.96	6.79	8.69	28.0%
4.98	6.79	8.25	21.5%
5.00	6.79	7.82	15.2%
5.01	6.79	7.61	12.1%
5.02	6.79	7.40	9.0%
5.03	6.79	7.20	6.0%
5.04	6.79	6.99	3.0%
5.05	6.79	6.79	0.0%
5.06	6.79	6.59	-2.9%
5.07	6.79	6.40	-5.8%
5.08	6.79	6.20	-8.7%
5.09	6.79	6.01	-11.5%
5.10	6.79	5.82	-14.2%
5.12	6.79	5.46	-19.7%
5.14	6.79	5.10	-24.9%
5.16	6.79	4.76	-29.9%
5.18	6.79	4.44	-34.6%
5.20	6.79	4.12	-39.3%
5.22	6.79	3.81	-43.9%
5.24	6.79	3.51	-48.2%
5.26	6.79	3.23	-52.4%
5.28	6.79	2.95	-56.5%
5.30	6.79	2.67	-60.6%

WATERLINE AT ZERO
AREA ERROR = 5.050

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER: 1

Constant Manning's n

GL = lowest Grassline elevation corrected for sag

STAGING TABLE

WL = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	3.83	39.42	1.19	1.92	46.80	40.16	100.0%	1.17	148.97	3.18
	4.05	38.61	0.99	1.70	38.11	39.22	97.7%	0.97	107.45	2.82
	4.10	38.25	0.95	1.65	36.19	38.83	96.7%	0.93	99.23	2.74
	4.15	37.89	0.90	1.60	34.28	38.44	95.7%	0.89	91.29	2.66
	4.20	37.52	0.86	1.55	32.40	38.05	94.8%	0.85	83.64	2.58
	4.25	37.23	0.82	1.50	30.53	37.74	94.0%	0.81	76.18	2.50
	4.30	36.94	0.78	1.45	28.67	37.42	93.2%	0.77	69.01	2.41
	4.35	36.65	0.73	1.40	26.83	37.11	92.4%	0.72	62.14	2.32
	4.40	36.36	0.69	1.35	25.01	36.79	91.6%	0.68	55.57	2.22
	4.45	35.39	0.66	1.30	23.21	35.79	89.1%	0.65	49.98	2.15
	4.50	33.96	0.63	1.25	21.48	34.33	85.5%	0.63	45.15	2.10
	4.55	32.53	0.61	1.20	19.81	32.87	81.9%	0.60	40.63	2.05
	4.60	31.10	0.59	1.15	18.22	31.42	78.2%	0.58	36.43	2.00
	4.65	29.47	0.57	1.10	16.71	29.75	74.1%	0.56	32.68	1.96
	4.70	28.08	0.54	1.05	15.27	28.34	70.6%	0.54	29.07	1.90
	4.75	27.06	0.51	1.00	13.89	27.30	68.0%	0.51	25.45	1.83
	4.80	25.98	0.48	0.95	12.57	26.22	65.3%	0.48	22.12	1.76
	4.85	24.90	0.45	0.90	11.30	25.14	62.6%	0.45	19.04	1.69
	4.90	23.83	0.42	0.85	10.08	24.06	59.9%	0.42	16.21	1.61
	4.95	22.55	0.40	0.80	8.92	22.78	56.7%	0.39	13.72	1.54
	5.00	21.28	0.37	0.75	7.82	21.50	53.5%	0.36	11.46	1.46
WL	5.05	20.00	0.34	0.70	6.79	20.21	50.3%	0.34	9.43	1.39
	5.10	18.66	0.31	0.65	5.82	18.86	46.9%	0.31	7.65	1.31
	5.15	16.32	0.30	0.60	4.92	16.50	41.1%	0.30	6.32	1.28
	5.20	15.82	0.26	0.55	4.12	15.99	39.8%	0.26	4.80	1.16
	5.25	14.13	0.24	0.50	3.37	14.28	35.6%	0.24	3.70	1.10
	5.30	13.77	0.19	0.45	2.67	13.90	34.6%	0.19	2.56	0.96
	5.35	12.07	0.17	0.40	2.03	12.19	30.3%	0.17	1.76	0.87
	5.40	11.53	0.12	0.35	1.44	11.64	29.0%	0.12	1.03	0.71
	5.45	9.25	0.10	0.30	0.89	9.34	23.3%	0.10	0.54	0.60
	5.50	5.33	0.09	0.25	0.50	5.39	13.4%	0.09	0.30	0.59
	5.55	2.67	0.11	0.20	0.29	2.70	6.7%	0.11	0.19	0.65
	5.60	2.25	0.08	0.15	0.17	2.27	5.7%	0.07	0.09	0.51
	5.65	1.50	0.05	0.10	0.08	1.51	3.8%	0.05	0.03	0.39
	5.70	0.75	0.03	0.05	0.02	0.76	1.9%	0.02	0.00	0.24
	5.75	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	9.43	cfs
CALCULATED FLOW (Qc)=	9.43	cfs
(Qm-Qc)/Qm * 100 =	0.0	%
MEASURED WATERLINE (WLm)=	5.05	ft
CALCULATED WATERLINE (WLc)=	5.05	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.70	ft
MAX CALCULATED DEPTH (Dc)=	0.70	ft
(Dm-Dc)/Dm * 100	0.0	%
MEAN VELOCITY=	1.39	ft/sec
MANNING'S N=	0.059	
SLOPE=	0.013	ft/ft
.4 * Qm =	3.8	cfs
2.5 * Qm=	23.6	cfs

RECOMMENDED INSTREAM FLOW:
============================

FLOW (CFS)	PERIOD
___________	___________
___________	___________
___________	___________
___________	___________

RATIONALE FOR RECOMMENDATION:
============================

RECOMMENDATION BY: .... AGENCY.. DATE:....................

CWCB REVIEW BY: .... DATE:....................

STREAM NAME:	Trout Creek
XS LOCATION:	0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER:	1

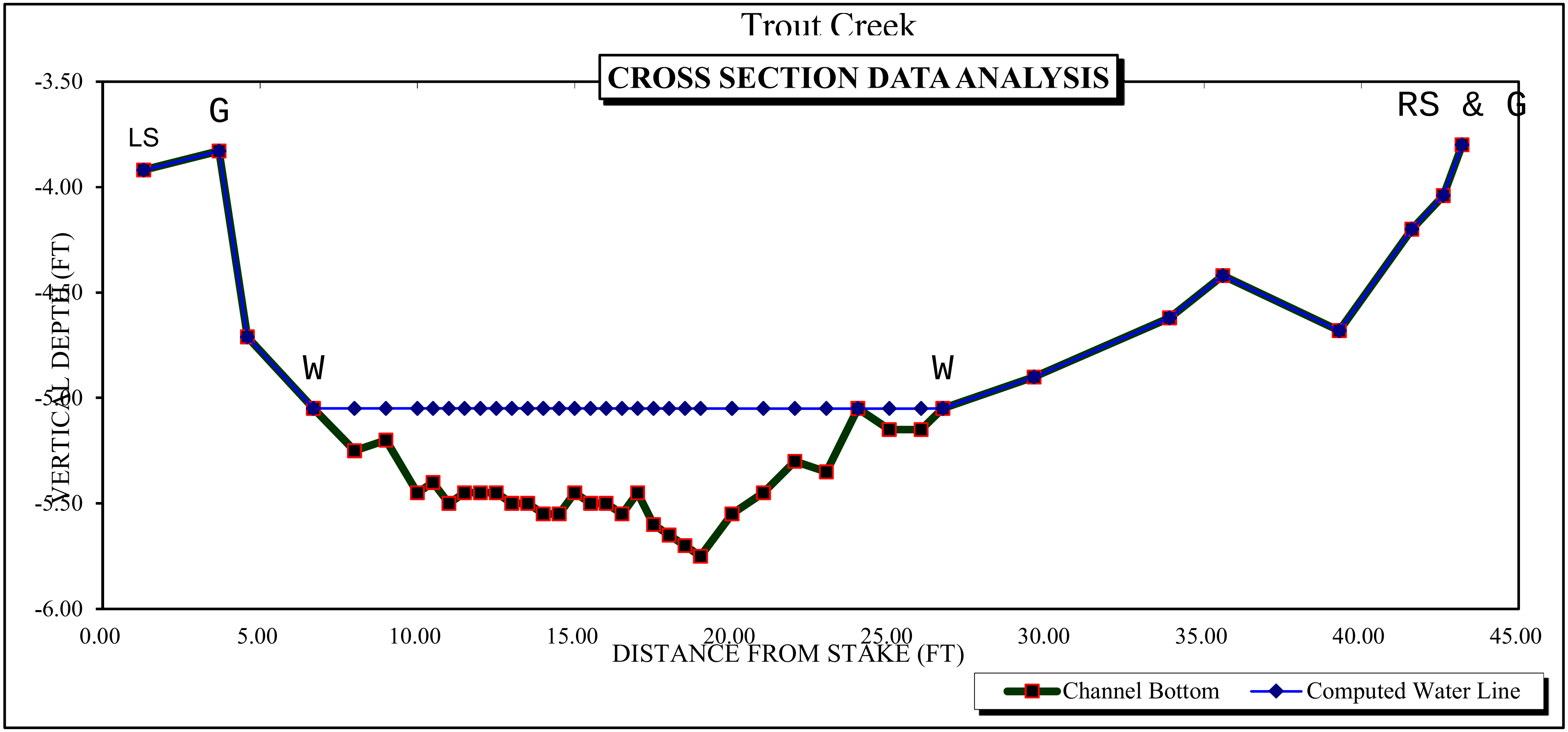
Jarrett Variable Manning's n Correction Applied

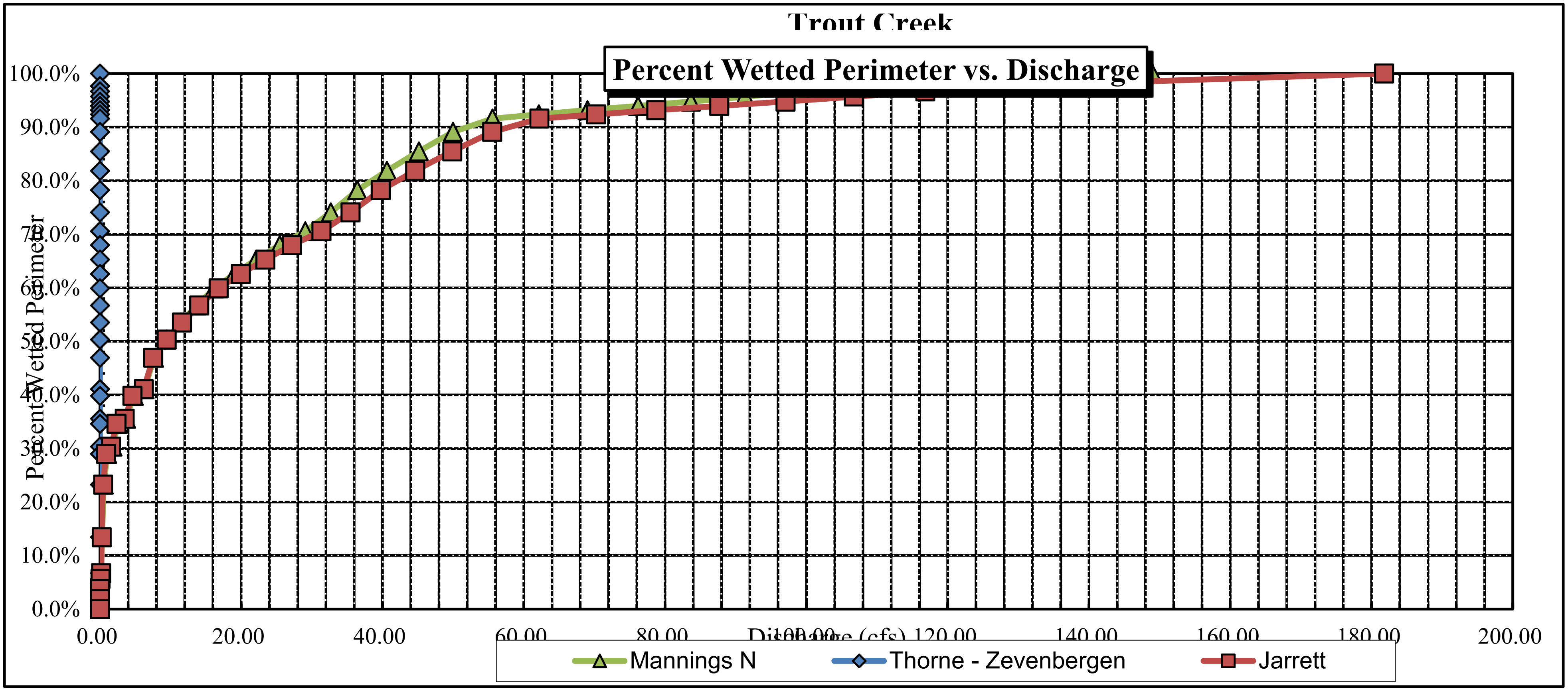
STAGING TABLE

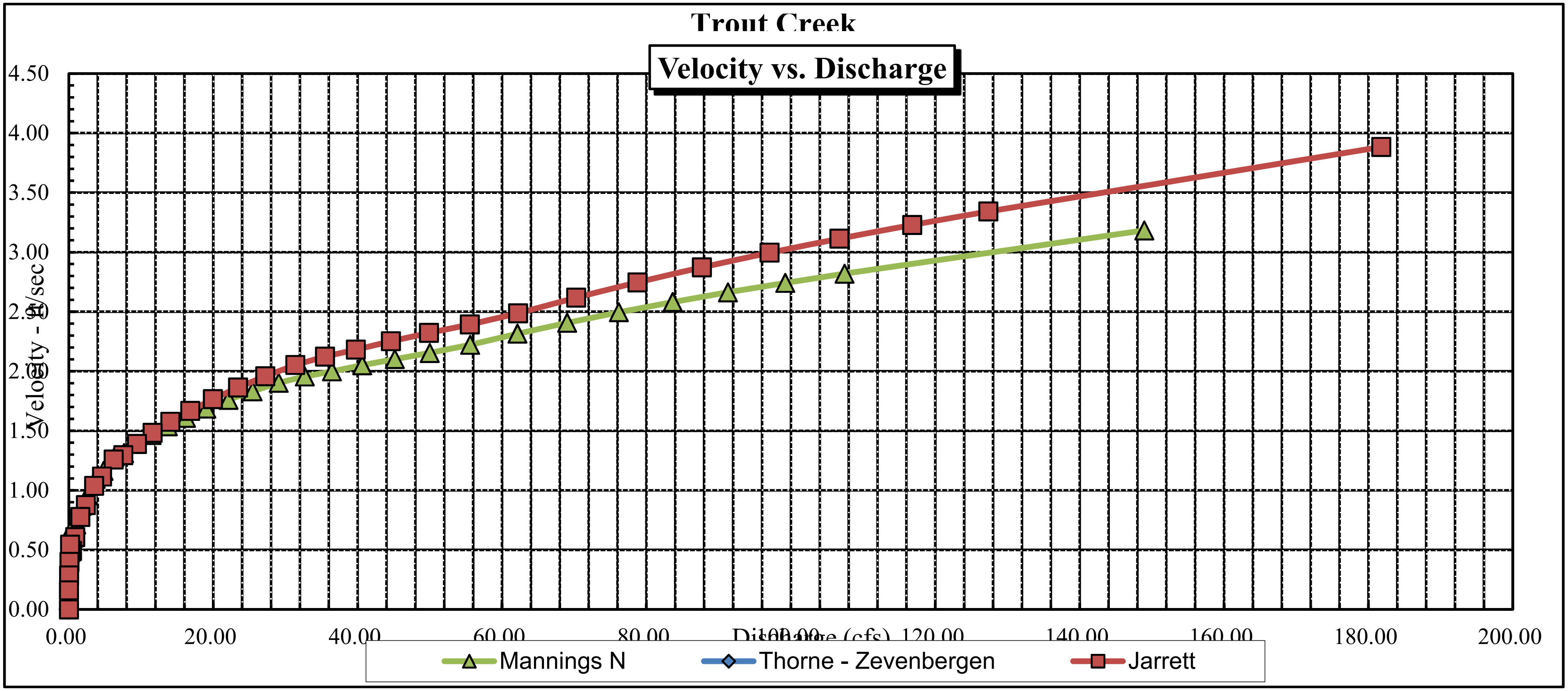
GL = lowest Grassline elevation corrected for sag

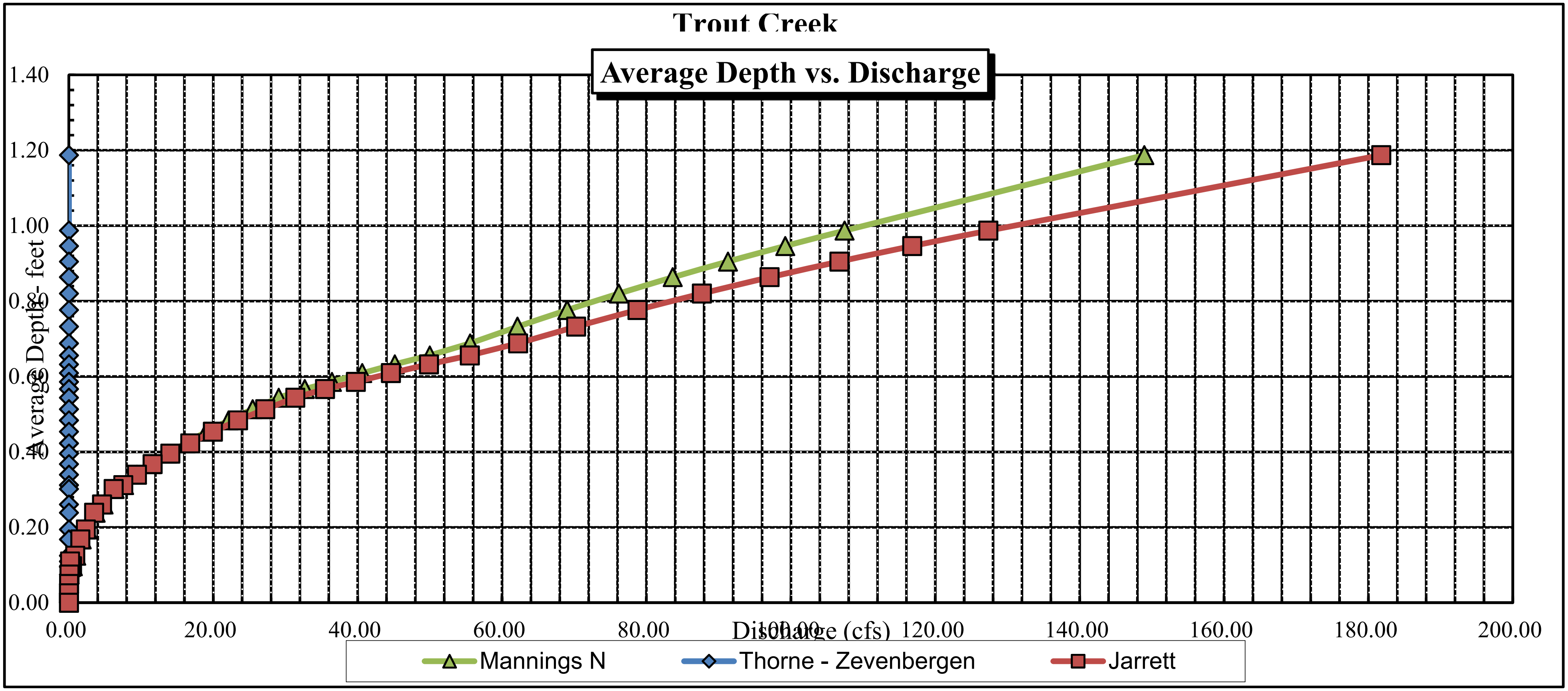
WL = Waterline corrected for variations in field measured water surface elevations and sag

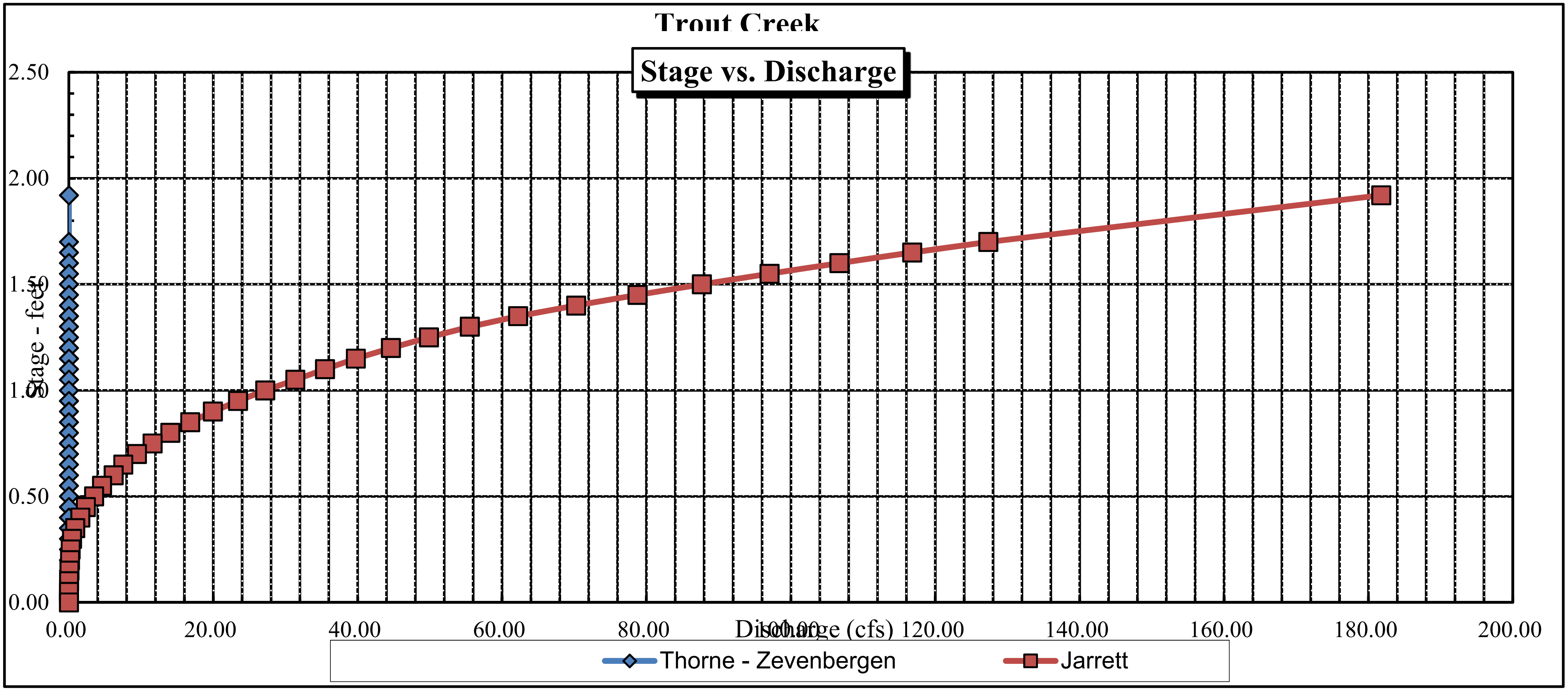
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	3.83	39.42	1.19	1.92	46.80	40.16	100.0%	1.17	181.78	3.88
	4.05	38.61	0.99	1.70	38.11	39.22	97.7%	0.97	127.35	3.34
	4.10	38.25	0.95	1.65	36.19	38.83	96.7%	0.93	116.82	3.23
	4.15	37.89	0.90	1.60	34.28	38.44	95.7%	0.89	106.73	3.11
	4.20	37.52	0.86	1.55	32.40	38.05	94.8%	0.85	97.06	3.00
	4.25	37.23	0.82	1.50	30.53	37.74	94.0%	0.81	87.68	2.87
	4.30	36.94	0.78	1.45	28.67	37.42	93.2%	0.77	78.74	2.75
	4.35	36.65	0.73	1.40	26.83	37.11	92.4%	0.72	70.25	2.62
	4.40	36.36	0.69	1.35	25.01	36.79	91.6%	0.68	62.21	2.49
	4.45	35.39	0.66	1.30	23.21	35.79	89.1%	0.65	55.52	2.39
	4.50	33.96	0.63	1.25	21.48	34.33	85.5%	0.63	49.87	2.32
	4.55	32.53	0.61	1.20	19.81	32.87	81.9%	0.60	44.62	2.25
	4.60	31.10	0.59	1.15	18.22	31.42	78.2%	0.58	39.75	2.18
	4.65	29.47	0.57	1.10	16.71	29.75	74.1%	0.56	35.48	2.12
	4.70	28.08	0.54	1.05	15.27	28.34	70.6%	0.54	31.35	2.05
	4.75	27.06	0.51	1.00	13.89	27.30	68.0%	0.51	27.20	1.96
	4.80	25.98	0.48	0.95	12.57	26.22	65.3%	0.48	23.42	1.86
	4.85	24.90	0.45	0.90	11.30	25.14	62.6%	0.45	19.95	1.77
	4.90	23.83	0.42	0.85	10.08	24.06	59.9%	0.42	16.80	1.67
	4.95	22.55	0.40	0.80	8.92	22.78	56.7%	0.39	14.06	1.58
	5.00	21.28	0.37	0.75	7.82	21.50	53.5%	0.36	11.61	1.48
WL	5.05	20.00	0.34	0.70	6.79	20.21	50.3%	0.34	9.43	1.39
	5.10	18.66	0.31	0.65	5.82	18.86	46.9%	0.31	7.55	1.30
	5.15	16.32	0.30	0.60	4.92	16.50	41.1%	0.30	6.20	1.26
	5.20	15.82	0.26	0.55	4.12	15.99	39.8%	0.26	4.60	1.12
	5.25	14.13	0.24	0.50	3.37	14.28	35.6%	0.24	3.50	1.04
	5.30	13.77	0.19	0.45	2.67	13.90	34.6%	0.19	2.34	0.88
	5.35	12.07	0.17	0.40	2.03	12.19	30.3%	0.17	1.58	0.78
	5.40	11.53	0.12	0.35	1.44	11.64	29.0%	0.12	0.87	0.61
	5.45	9.25	0.10	0.30	0.89	9.34	23.3%	0.10	0.44	0.49
	5.50	5.33	0.09	0.25	0.50	5.39	13.4%	0.09	0.24	0.48
	5.55	2.67	0.11	0.20	0.29	2.70	6.7%	0.11	0.16	0.54
	5.60	2.25	0.08	0.15	0.17	2.27	5.7%	0.07	0.07	0.40
	5.65	1.50	0.05	0.10	0.08	1.51	3.8%	0.05	0.02	0.29
	5.70	0.75	0.03	0.05	0.02	0.76	1.9%	0.02	0.00	0.16
	5.75	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!


Trout Creek
CROSS SECTION DATA ANALYSIS
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
VERTICAL DEPTH (FT)
LS
G
W
W
RS & G
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


Trout Creek
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Velocity vs. Discharge
Velocity - ft/sec
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Average Depth vs. Discharge
Average Depth - feet
Discharge (cfs)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Stage vs. Discharge
Stage - feet
2.50
2.00
1.50
1.00
0.50
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

Data Input & Proofing

STREAM NAME:	Trout Creek
XS LOCATION:	0.5 mile upstr fr confl w Little Trout Ck.
XS NUMBER:	1
DATE:	8/2/2017
OBSERVERS:	R. Smith, E. Scherff
1/4 SEC:	SW NW
SECTION:	23
TWP:	4N
RANGE:	86W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Yampa River
DIVISION:	6
DOW CODE:	23533
USGS MAP:	
USFS MAP:	
	Level and Rod Survey
TAPE WT:	0.0106 lbs / ft
TENSION:	99999 lbs
SLOPE:	0.013 ft / ft

CHECKED BY:...........……………………......DATE……………......

ASSIGNED TO: .....…………………….......DATE……………......

Total Data Points = 40

GL=1	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	A	Q	Tape to Water
	LS	1.30	3.92			0.00	0.00	0.00
1	G	3.70	3.83			0.00	0.00	0.00
		4.60	4.71			0.00	0.00	0.00
	W	6.70	5.05	0.00	0.00	0.00	0.00	0.00
		8.00	5.25	0.20	0.45	0.23	0.10	5.05
		9.00	5.20	0.15	0.67	0.15	0.10	5.05
		10.00	5.45	0.40	1.22	0.30	0.37	5.05
		10.50	5.40	0.35	1.67	0.18	0.29	5.05
		11.00	5.50	0.45	1.65	0.23	0.37	5.05
		11.50	5.45	0.40	2.20	0.20	0.44	5.05
		12.00	5.45	0.40	1.98	0.20	0.40	5.05
		12.50	5.45	0.40	1.72	0.20	0.34	5.05
		13.00	5.50	0.45	1.95	0.23	0.44	5.05
		13.50	5.50	0.45	1.61	0.23	0.36	5.05
		14.00	5.55	0.50	1.24	0.25	0.31	5.05
		14.50	5.55	0.50	1.48	0.25	0.37	5.05
		15.00	5.45	0.40	1.40	0.20	0.28	5.05
		15.50	5.50	0.45	1.76	0.23	0.40	5.05
		16.00	5.50	0.45	1.61	0.23	0.36	5.05
		16.50	5.55	0.50	2.01	0.25	0.50	5.05
		17.00	5.45	0.40	2.34	0.20	0.47	5.05
		17.50	5.60	0.55	2.05	0.28	0.56	5.05
		18.00	5.65	0.60	1.63	0.30	0.49	5.05
		18.50	5.70	0.65	1.42	0.33	0.46	5.05
		19.00	5.75	0.70	1.84	0.53	0.97	5.05
		20.00	5.55	0.50	0.00	0.50	0.00	5.05
		21.00	5.45	0.40	0.49	0.40	0.20	5.05
		22.00	5.30	0.25	2.07	0.25	0.52	5.05
		23.00	5.35	0.30	1.01	0.30	0.30	5.05
		24.00	5.05	0.00	0.00	0.00	0.00	0.00
		25.00	5.15	0.10	0.28	0.10	0.03	5.05
		26.00	5.15	0.10	0.02	0.09	0.00	5.05
	W	26.70	5.05	0.00	0.00	0.00	0.00	0.00
		29.60	4.90			0.00	0.00	0.00
		33.90	4.62			0.00	0.00	0.00
		35.60	4.42			0.00	0.00	0.00
		39.30	4.68			0.00	0.00	0.00
		41.60	4.20			0.00	0.00	0.00
		42.60	4.04			0.00	0.00	0.00
1	RS & G	43.20	3.80			0.00	0.00	0.00
					Totals	6.79	9.43	

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Trout Creek	CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: 0.5 mile upstream from confluence with Little Trout Creek	
DATE: 8/2/17	OBSERVERS: Roy Smith, Eric Scherff
LEGAL DESCRIPTION	¼ SECTION: SW NW; SECTION: 23; TOWNSHIP: 4 (N)/S; RANGE: 86 E/W; PM: 6th
COUNTY: Routt	WATERSHED: Yampa R.; WATER DIVISION: 6; DOW WATER CODE: 23533
MAP(S): USGS:	Zone 13 4463647 N
MAP(S): USFS:	328647 E

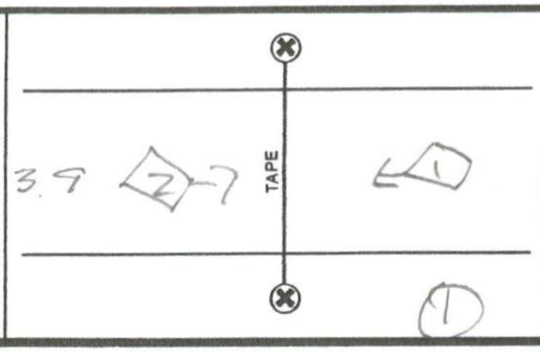
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES)/NO	METER TYPE: M-M
METER NUMBER:	DATE RATED: ; CALIB/SPIN: ____ sec; TAPE WEIGHT: surveyed lbs/foot; TAPE TENSION: surveyed lbs
CHANNEL BED MATERIAL SIZE RANGE: 4" cobble to 18" boulders	PHOTOGRAPHS TAKEN: (YES)/NO; NUMBER OF PHOTOGRAPHS: 3

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0 28.9	4.10 / 4.10
② WS Upstream	39.0	3.55
③ WS Downstream	88.8	5.22
SLOPE	1.67 / 127.8 = 0.013	

SKETCH



LEGEND: Stake ⊗; Station ①; Photo ◇→; Direction of Flow ←

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES/(NO)	DISTANCE ELECTROFISHED: ____ ft	FISH CAUGHT: YES/NO	WATER CHEMISTRY SAMPLED: YES/(NO)

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

mayfly, caddisfly, stonefly

COMMENTS

DISCHARGE/CROSS-SECTION NOTES

EXHIBIT C

TREAM NAME: Trout Creek | CROSS-SECTION NO.: 2 | DATE: 8-2-17 | SHEET 1 OF 2

GINNING OF MEASUREMENT | EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT | Gage Reading: ____ ft | TIME: 2:40 PM

Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft²)	Discharge (cfs)
RS	1.2		1.38								
	1.6		1.95								
G	1.8		2.38								
	2.4		4.04								
RW	3.9		4.10								
	5.0		4.4	0.30				0.09			
	6.0		4.6	0.50				0.70			
	7.0		4.4	0.30				1.02			
	8.0		4.5	0.40				1.59			
	9.0		4.3	0.20				0.23			
	9.5		4.65	0.55				1.41			
	10.0		4.5	0.40				1.85			
	10.5		4.5	0.40				1.09			
	11.0		4.6	0.50				0.88			
	11.5		4.45	0.35				1.39			
	12.0		4.35	0.25				1.56			
	12.5		4.35	0.25				1.94			
	13.0		4.55	0.45				1.07			
	13.5		4.5	0.40				0.94			
	14.0		4.45	0.35				1.13			
	14.5		4.15	0.05				0.60			
	15.0		4.4	0.30				0.67			
	15.5		4.55	0.45				1.09			
	16.0		4.15	0.05				0.76			
	16.5		4.35	0.25				0.23			
	17.0		4.3	0.20				0.49			
	18.0		4.4	0.30				1.55			
	19.0		4.6	0.50				1.66	23		
	19.5		4.65	0.55				1.56			
	20.0		4.6	0.50				1.44			
	20.5		4.5	0.40				1.99			
	21.0		4.50	0.40				1.26			
	22.0		4.35	0.25				1.67			
	23.0		4.35	0.25				1.63			
	24.0		4.35	0.25				0.71			
		see continuation sheet									
LW	28.9		4.10								
	30.3		4.01								
	31.8		3.42								
	33.0		2.84								
	35.0		2.52								
LS+G	37.0		2.46								
TOTALS:											

End of Measurement | Time: | Gage Reading: ____ ft | CALCULATIONS PERFORMED BY: | CALCULATIONS CHECKED BY:

continued next page →

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Little Trout Creek - continuation sheet

CROSS-SECTION NO.: 2

CROSS-SECTION LOCATION:

DATE: 8-2-17

OBSERVERS: R. Smith, E. Scharff

LEGAL DESCRIPTION: ¼ SECTION: SECTION: TOWNSHIP: N/S RANGE: E/W PM:

COUNTY: WATERSHED: WATER DIVISION: DOW WATER CODE:

MAP(S): USGS: USFS:

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO

METER TYPE:

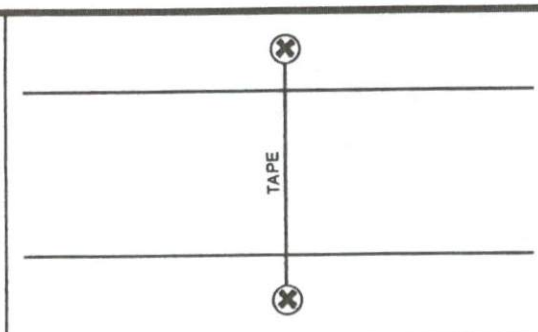
METER NUMBER: DATE RATED: CALIB/SPIN: ______ sec TAPE WEIGHT: ______ lbs/foot TAPE TENSION: ______ lbs

CHANNEL BED MATERIAL SIZE RANGE: PHOTOGRAPHS TAKEN: YES/NO NUMBER OF PHOTOGRAPHS:

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
Tape @ Stake LB	0.0	
Tape @ Stake RB	0.0	
(1) WS @ Tape LB/RB	0.0	
(2) WS Upstream		
(3) WS Downstream		
SLOPE		

SKETCH



LEGEND: Stake Station Photo Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES/NO DISTANCE ELECTROFISHED: ______ ft FISH CAUGHT: YES/NO WATER CHEMISTRY SAMPLED: YES/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

COMMENTS

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Trout Creek	CROSS-SECTION NO.: 2	DATE: 8/2	SHEET 2 OF 2

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: ____ ft	TIME: continued from previous sheet

Features	Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft²)	Discharge (cfs)
		25.0		4.3	0.20				1.15			
		26.0		4.2	0.10				0.76			
		27.0		4.3	0.20				0.92			
		28.0		4.25	0.15				0.69			
TOTALS:												

End of Measurement	Time: 3:10 PM	Gage Reading: ____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Trout Creek
XS LOCATION:	0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER:	2
DATE:	2-Aug-17
OBSERVERS:	R. Smith, E. Scherff
1/4 SEC:	SW NW
SECTION:	23
TWP:	4N
RANGE:	86W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Yampa River
DIVISION:	6
DOW CODE:	23533
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

*** NOTE ***
Leave TAPE WT and TENSION at defaults for data collected with a survey level and rod

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE: 0.013

INPUT DATA CHECKED BY: ....DATE....................

ASSIGNED TO: …..............………............................DATE....................

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER: 2

DATA POINTS= 45

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
RS	1.20	1.38			0.00		0.00	0.00	0.0%
	1.60	1.95			0.00		0.00	0.00	0.0%
1 G	1.80	2.38			0.00		0.00	0.00	0.0%
	2.40	4.04			0.00		0.00	0.00	0.0%
RW	3.90	4.10	0.00	0.00	0.00		0.00	0.00	0.0%
	5.00	4.40	0.30	0.09	1.14	0.30	0.32	0.03	0.3%
	6.00	4.60	0.50	0.70	1.02	0.50	0.50	0.35	4.1%
	7.00	4.40	0.30	1.02	1.02	0.30	0.30	0.31	3.6%
	8.00	4.50	0.40	1.59	1.00	0.40	0.40	0.64	7.4%
	9.00	4.30	0.20	0.23	1.02	0.20	0.15	0.03	0.4%
	9.50	4.65	0.55	1.41	0.61	0.55	0.28	0.39	4.5%
	10.00	4.50	0.40	1.85	0.52	0.40	0.20	0.37	4.3%
	10.50	4.50	0.40	1.09	0.50	0.40	0.20	0.22	2.5%
	11.00	4.60	0.50	0.88	0.51	0.50	0.25	0.22	2.6%
	11.50	4.45	0.35	1.39	0.52	0.35	0.18	0.24	2.8%
	12.00	4.35	0.25	1.56	0.51	0.25	0.13	0.20	2.3%
	12.50	4.35	0.25	1.94	0.50	0.25	0.13	0.24	2.8%
	13.00	4.55	0.45	1.07	0.54	0.45	0.23	0.24	2.8%
	13.50	4.50	0.40	0.94	0.50	0.40	0.20	0.19	2.2%
	14.00	4.45	0.35	1.13	0.50	0.35	0.18	0.20	2.3%
	14.50	4.15	0.05	0.60	0.58	0.05	0.03	0.02	0.2%
	15.00	4.40	0.30	0.67	0.56	0.30	0.15	0.10	1.2%
	15.50	4.55	0.45	1.09	0.52	0.45	0.23	0.25	2.9%
	16.00	4.15	0.05	0.76	0.64	0.05	0.03	0.02	0.2%
	16.50	4.35	0.25	0.23	0.54	0.25	0.13	0.03	0.3%
	17.00	4.30	0.20	0.49	0.50	0.20	0.15	0.07	0.9%
	18.00	4.40	0.30	1.55	1.00	0.30	0.30	0.47	5.4%
	19.00	4.60	0.50	1.66	1.02	0.50	0.38	0.62	7.3%
	19.50	4.65	0.55	1.56	0.50	0.55	0.28	0.43	5.0%
	20.00	4.60	0.50	1.44	0.50	0.50	0.25	0.36	4.2%
	20.50	4.50	0.40	1.99	0.51	0.40	0.20	0.40	4.6%
	21.00	4.50	0.40	1.26	0.50	0.40	0.30	0.38	4.4%
	22.00	4.35	0.25	1.67	1.01	0.25	0.25	0.42	4.9%
	23.00	4.35	0.25	1.63	1.00	0.25	0.25	0.41	4.7%
	24.00	4.35	0.25	0.71	1.00	0.25	0.25	0.18	2.1%
	25.00	4.30	0.20	1.15	1.00	0.20	0.20	0.23	2.7%
	26.00	4.20	0.10	0.76	1.00	0.10	0.10	0.08	0.9%
	27.00	4.30	0.20	0.92	1.00	0.20	0.20	0.18	2.1%
	28.00	4.25	0.15	0.69	1.00	0.15	0.14	0.10	1.1%
LW	28.90	4.10	0.00	0.00	0.91		0.00	0.00	0.0%
	30.30	4.01			0.00		0.00	0.00	0.0%
	31.80	3.42			0.00		0.00	0.00	0.0%
	33.00	2.84			0.00		0.00	0.00	0.0%
	35.00	2.52			0.00		0.00	0.00	0.0%
1 LS & G	37.00	2.46			0.00		0.00	0.00	0.0%
TOTALS ----------------------					25.74	0.55 (Max.)	7.41	8.58	100.0%

Manning's n = 0.0637
Hydraulic Radius= 0.28774312

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	7.41	7.41	0.0%
3.85	7.41	14.31	93.2%
3.87	7.41	13.75	85.6%
3.89	7.41	13.18	77.9%
3.91	7.41	12.62	70.3%
3.93	7.41	12.05	62.7%
3.95	7.41	11.49	55.1%
3.97	7.41	10.93	47.5%
3.99	7.41	10.37	40.0%
4.01	7.41	9.81	32.4%
4.03	7.41	9.26	25.0%
4.05	7.41	8.71	17.6%
4.06	7.41	8.44	13.9%
4.07	7.41	8.18	10.4%
4.08	7.41	7.92	6.9%
4.09	7.41	7.66	3.4%
4.10	7.41	7.41	0.0%
4.11	7.41	7.16	-3.4%
4.12	7.41	6.91	-6.7%
4.13	7.41	6.66	-10.1%
4.14	7.41	6.42	-13.4%
4.15	7.41	6.17	-16.7%
4.17	7.41	5.68	-23.3%
4.19	7.41	5.20	-29.8%
4.21	7.41	4.73	-36.1%
4.23	7.41	4.27	-42.3%
4.25	7.41	3.83	-48.3%
4.27	7.41	3.40	-54.1%
4.29	7.41	3.00	-59.5%
4.31	7.41	2.61	-64.7%
4.33	7.41	2.25	-69.6%
4.35	7.41	1.91	-74.2%

WATERLINE AT ZERO
AREA ERROR = 4.100

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER: 2

Constant Manning's n

GL = lowest Grassline elevation corrected for sag

STAGING TABLE

WL = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	2.46	35.17	1.61	2.19	56.69	37.30	100.0%	1.52	199.26	3.51
	3.10	30.40	1.20	1.55	36.39	31.99	85.8%	1.14	105.41	2.90
	3.15	30.28	1.15	1.50	34.87	31.83	85.3%	1.10	98.53	2.83
	3.20	30.16	1.11	1.45	33.36	31.66	84.9%	1.05	91.84	2.75
	3.25	30.04	1.06	1.40	31.85	31.49	84.4%	1.01	85.34	2.68
	3.30	29.92	1.01	1.35	30.36	31.32	84.0%	0.97	79.04	2.60
	3.35	29.79	0.97	1.30	28.86	31.15	83.5%	0.93	72.93	2.53
	3.40	29.67	0.92	1.25	27.38	30.99	83.1%	0.88	67.02	2.45
	3.45	29.54	0.88	1.20	25.90	30.80	82.6%	0.84	61.32	2.37
	3.50	29.39	0.83	1.15	24.42	30.62	82.1%	0.80	55.85	2.29
	3.55	29.25	0.78	1.10	22.96	30.43	81.6%	0.75	50.58	2.20
	3.60	29.10	0.74	1.05	21.50	30.24	81.1%	0.71	45.53	2.12
	3.65	28.96	0.69	1.00	20.05	30.05	80.6%	0.67	40.69	2.03
	3.70	28.81	0.65	0.95	18.60	29.86	80.0%	0.62	36.08	1.94
	3.75	28.67	0.60	0.90	17.17	29.67	79.5%	0.58	31.69	1.85
	3.80	28.52	0.55	0.85	15.74	29.48	79.0%	0.53	27.53	1.75
	3.85	28.38	0.50	0.80	14.31	29.29	78.5%	0.49	23.61	1.65
	3.90	28.23	0.46	0.75	12.90	29.10	78.0%	0.44	19.94	1.55
	3.95	28.09	0.41	0.70	11.49	28.91	77.5%	0.40	16.51	1.44
	4.00	27.94	0.36	0.65	10.09	28.72	77.0%	0.35	13.36	1.32
	4.05	27.03	0.32	0.60	8.71	27.77	74.5%	0.31	10.68	1.23
WL	4.10	25.00	0.30	0.55	7.41	25.74	69.0%	0.29	8.58	1.16
	4.15	24.52	0.25	0.50	6.17	25.25	67.7%	0.24	6.41	1.04
	4.20	23.66	0.21	0.45	4.97	24.33	65.2%	0.20	4.58	0.92
	4.25	21.81	0.18	0.40	3.83	22.41	60.1%	0.17	3.13	0.82
	4.30	19.25	0.15	0.35	2.80	19.79	53.1%	0.14	2.02	0.72
	4.35	13.88	0.14	0.30	1.91	14.33	38.4%	0.13	1.33	0.69
	4.40	11.92	0.11	0.25	1.27	12.28	32.9%	0.10	0.74	0.58
	4.45	9.33	0.08	0.20	0.73	9.59	25.7%	0.08	0.35	0.48
	4.50	5.40	0.06	0.15	0.34	5.58	15.0%	0.06	0.14	0.41
	4.55	2.89	0.05	0.10	0.13	2.98	8.0%	0.05	0.05	0.34
	4.60	1.24	0.03	0.05	0.03	1.27	3.4%	0.02	0.01	0.22
	4.65	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	8.58	cfs
CALCULATED FLOW (Qc)=	8.58	cfs
(Qm-Qc)/Qm * 100 =	0.0	%
MEASURED WATERLINE (WLm)=	4.10	ft
CALCULATED WATERLINE (WLc)=	4.10	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.55	ft
MAX CALCULATED DEPTH (Dc)=	0.55	ft
(Dm-Dc)/Dm * 100	0.0	%
MEAN VELOCITY=	1.16	ft/sec
MANNING'S N=	0.064	
SLOPE=	0.013	ft/ft
.4 * Qm =	3.4	cfs
2.5 * Qm=	21.5	cfs

RECOMMENDED INSTREAM FLOW:
============================

FLOW (CFS)	PERIOD
___________________	___________________
___________________	___________________
___________________	___________________
___________________	___________________

RATIONALE FOR RECOMMENDATION:
============================

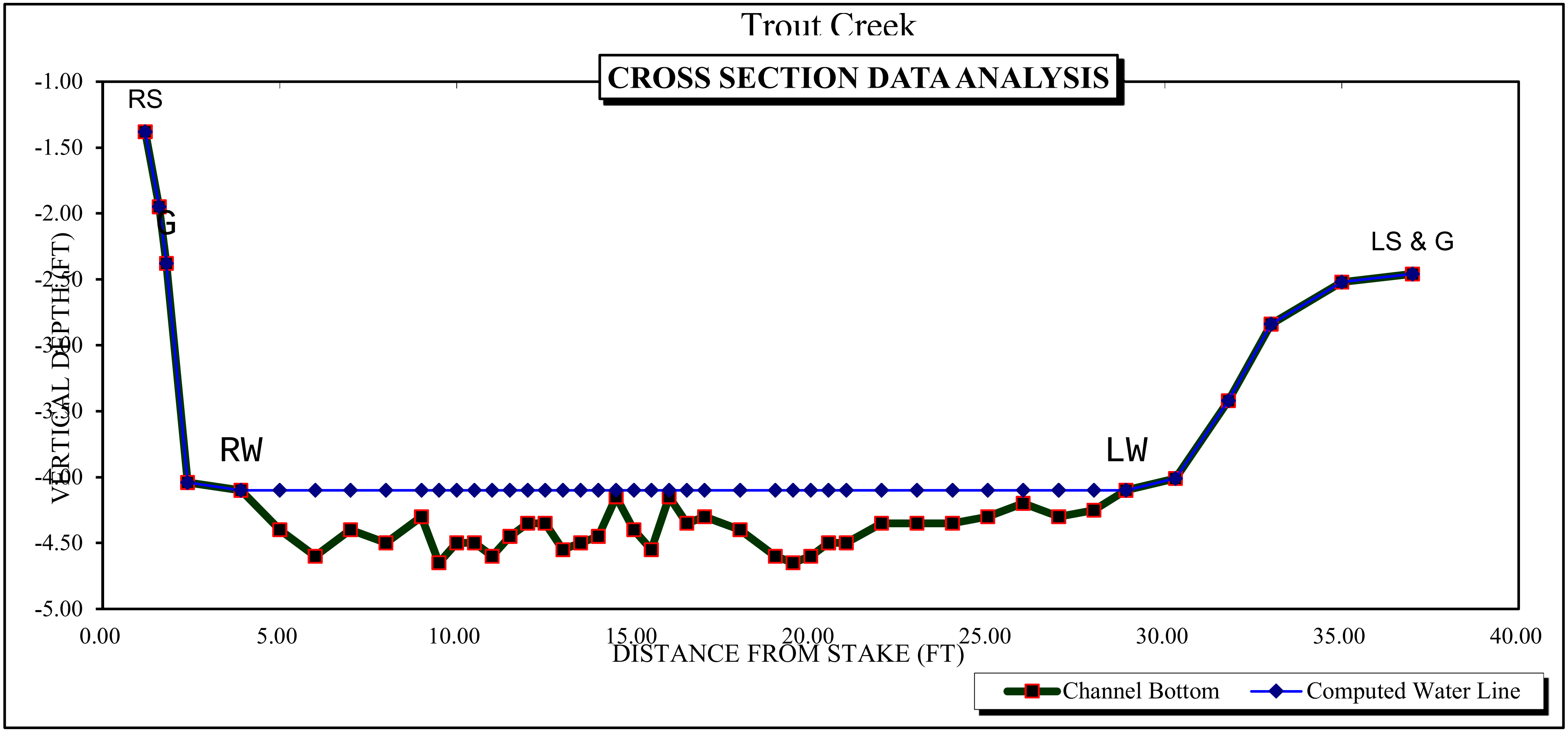
RECOMMENDATION BY: ………………...………..……............................... AGENCY...……………………......…......…....….…....... DATE:.......…...…......……………

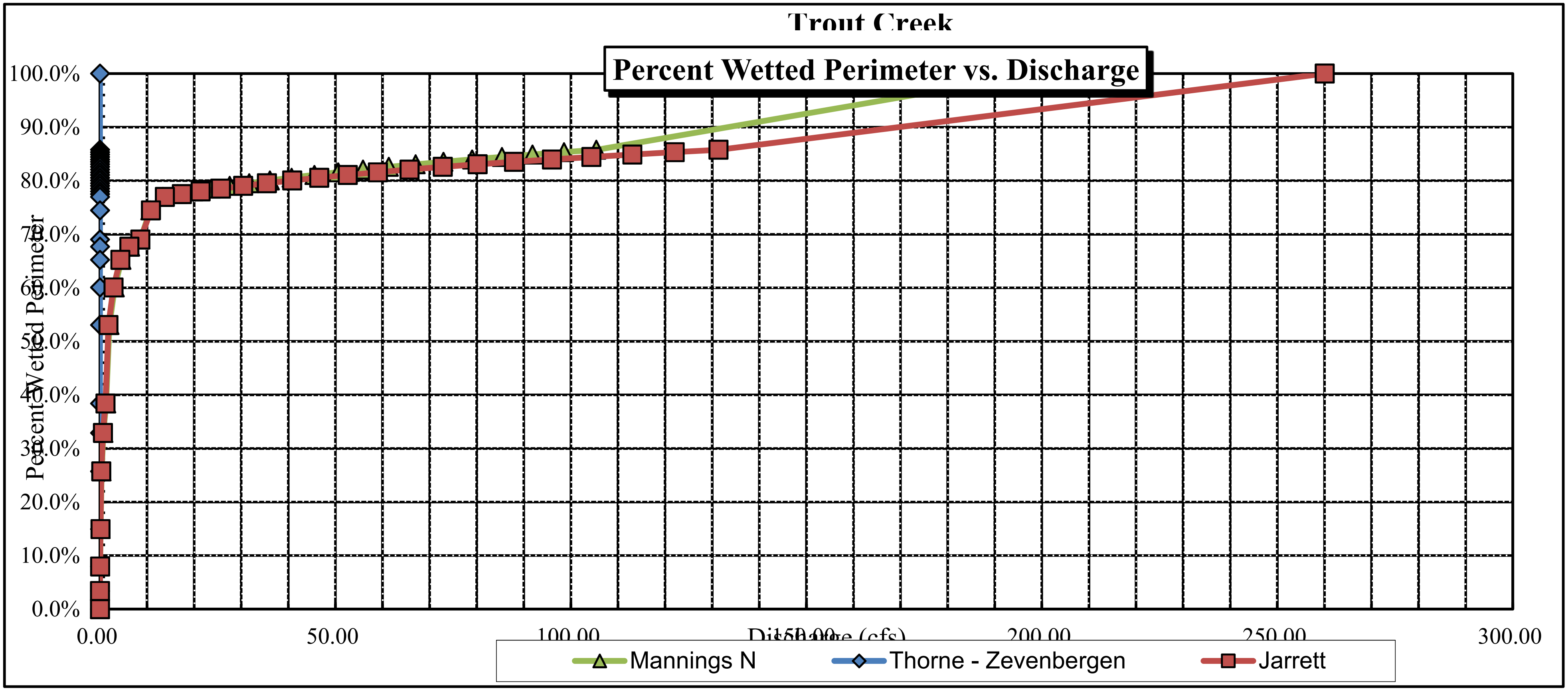
CWCB REVIEW BY: ..…………………………....………………………………………………...…............... DATE:.................…………….....…

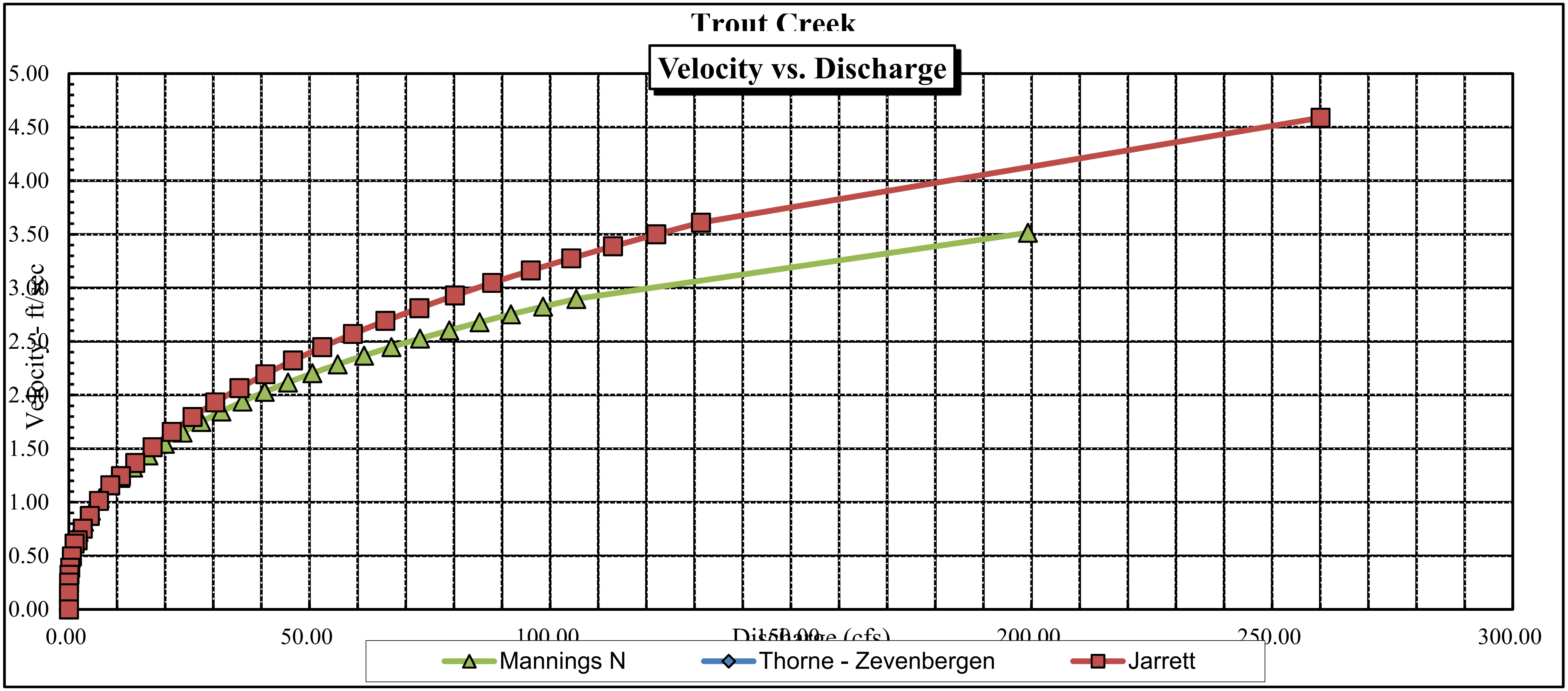
STREAM NAME: Trout Creek
XS LOCATION: 0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER: 2 Jarrett Variable Manning's n Correction Applied

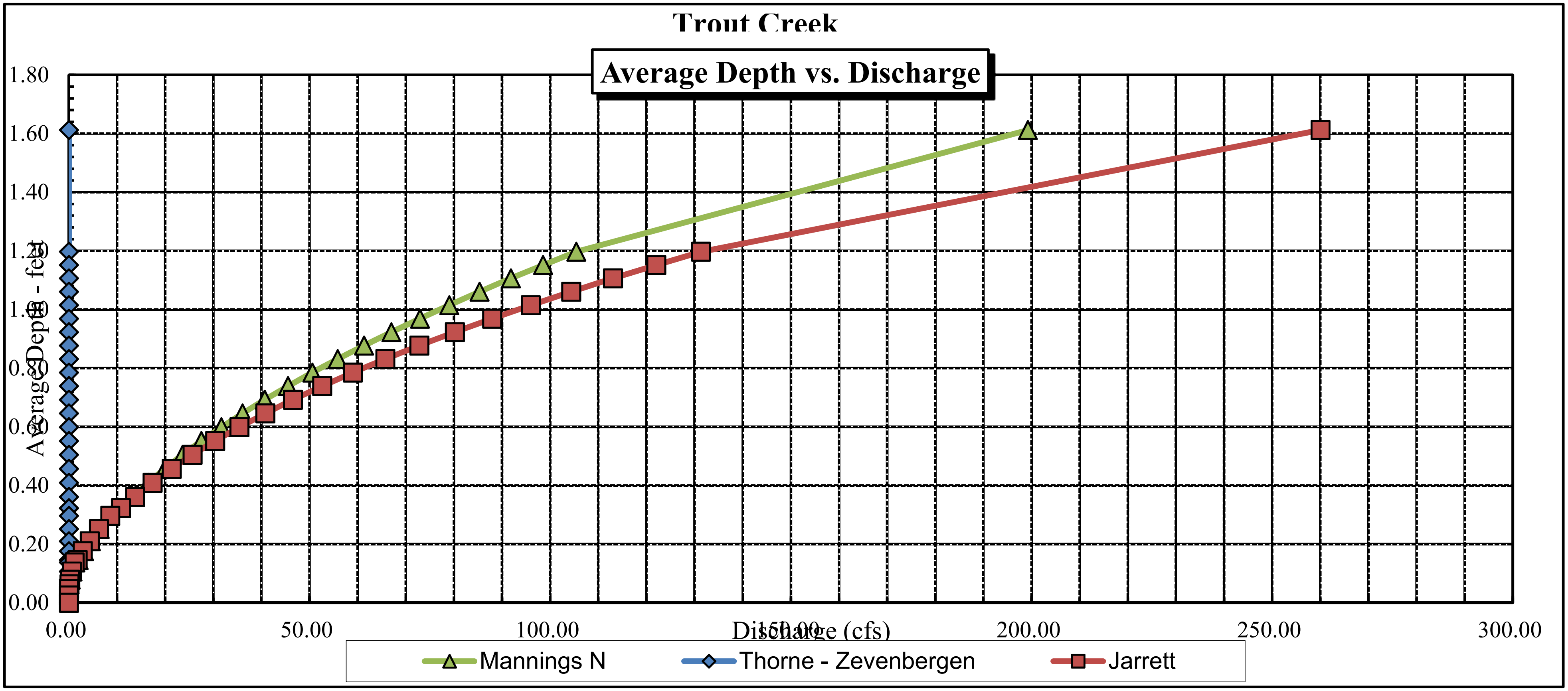
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

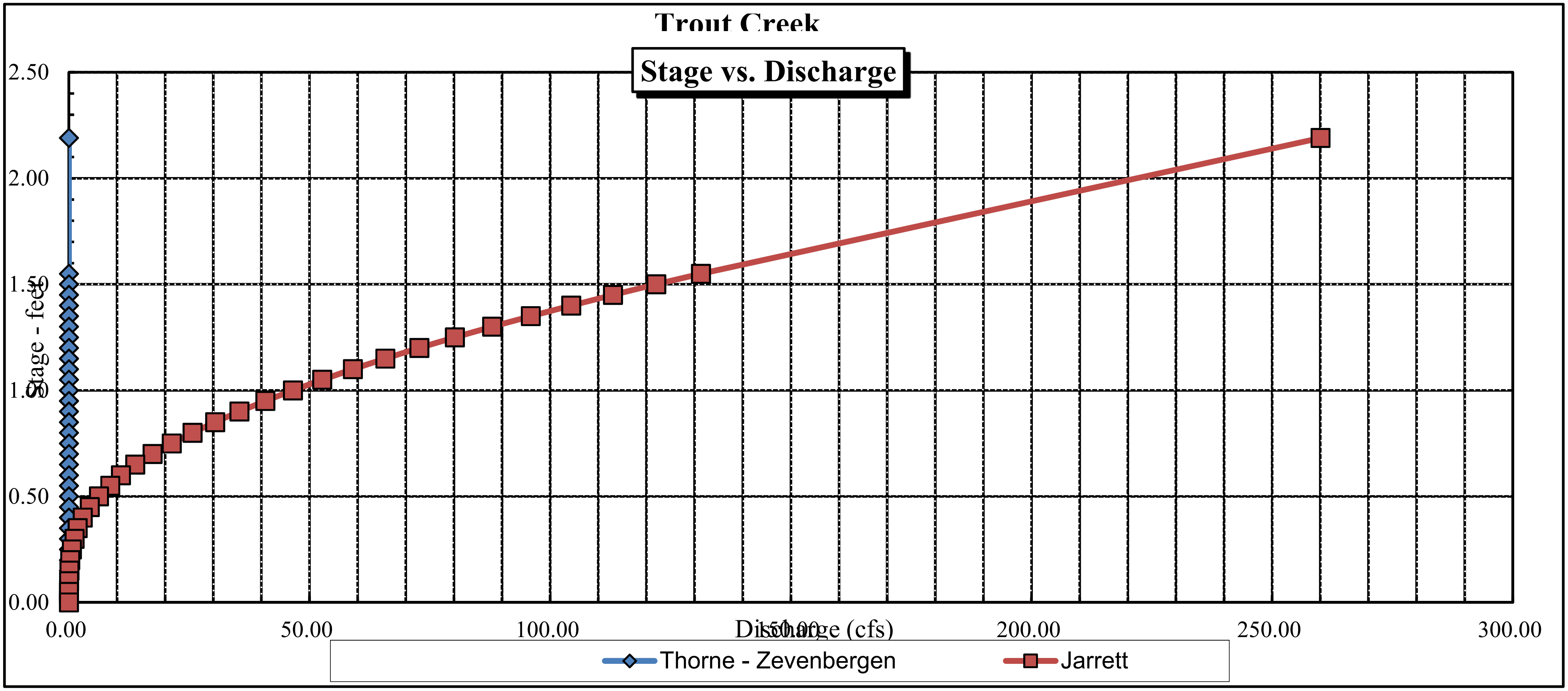
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	2.46	35.17	1.61	2.19	56.69	37.30	100.0%	1.52	260.06	4.59
	3.10	30.40	1.20	1.55	36.39	31.99	85.8%	1.14	131.33	3.61
	3.15	30.28	1.15	1.50	34.87	31.83	85.3%	1.10	122.03	3.50
	3.20	30.16	1.11	1.45	33.36	31.66	84.9%	1.05	113.04	3.39
	3.25	30.04	1.06	1.40	31.85	31.49	84.4%	1.01	104.36	3.28
	3.30	29.92	1.01	1.35	30.36	31.32	84.0%	0.97	95.99	3.16
	3.35	29.79	0.97	1.30	28.86	31.15	83.5%	0.93	87.93	3.05
	3.40	29.67	0.92	1.25	27.38	30.99	83.1%	0.88	80.19	2.93
	3.45	29.54	0.88	1.20	25.90	30.80	82.6%	0.84	72.80	2.81
	3.50	29.39	0.83	1.15	24.42	30.62	82.1%	0.80	65.75	2.69
	3.55	29.25	0.78	1.10	22.96	30.43	81.6%	0.75	59.02	2.57
	3.60	29.10	0.74	1.05	21.50	30.24	81.1%	0.71	52.62	2.45
	3.65	28.96	0.69	1.00	20.05	30.05	80.6%	0.67	46.56	2.32
	3.70	28.81	0.65	0.95	18.60	29.86	80.0%	0.62	40.83	2.19
	3.75	28.67	0.60	0.90	17.17	29.67	79.5%	0.58	35.44	2.06
	3.80	28.52	0.55	0.85	15.74	29.48	79.0%	0.53	30.39	1.93
	3.85	28.38	0.50	0.80	14.31	29.29	78.5%	0.49	25.70	1.80
	3.90	28.23	0.46	0.75	12.90	29.10	78.0%	0.44	21.36	1.66
	3.95	28.09	0.41	0.70	11.49	28.91	77.5%	0.40	17.39	1.51
	4.00	27.94	0.36	0.65	10.09	28.72	77.0%	0.35	13.79	1.37
	4.05	27.03	0.32	0.60	8.71	27.77	74.5%	0.31	10.83	1.24
WL	4.10	25.00	0.30	0.55	7.41	25.74	69.0%	0.29	8.58	1.16
	4.15	24.52	0.25	0.50	6.17	25.25	67.7%	0.24	6.25	1.01
	4.20	23.66	0.21	0.45	4.97	24.33	65.2%	0.20	4.33	0.87
	4.25	21.81	0.18	0.40	3.83	22.41	60.1%	0.17	2.88	0.75
	4.30	19.25	0.15	0.35	2.80	19.79	53.1%	0.14	1.81	0.64
	4.35	13.88	0.14	0.30	1.91	14.33	38.4%	0.13	1.17	0.61
	4.40	11.92	0.11	0.25	1.27	12.28	32.9%	0.10	0.63	0.50
	4.45	9.33	0.08	0.20	0.73	9.59	25.7%	0.08	0.29	0.39
	4.50	5.40	0.06	0.15	0.34	5.58	15.0%	0.06	0.11	0.32
	4.55	2.89	0.05	0.10	0.13	2.98	8.0%	0.05	0.03	0.25
	4.60	1.24	0.03	0.05	0.03	1.27	3.4%	0.02	0.00	0.15
	4.65	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!


Trout Creek
CROSS SECTION DATA ANALYSIS
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
DISTANCE FROM STAKE (FT)
RS
G
RW
LW
LS & G
Channel Bottom
Computed Water Line


Trout Creek
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
Discharge (cfs)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Velocity vs. Discharge
Velocity - ft/sec
Discharge (cfs)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Average Depth vs. Discharge
Average Depth - feet
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Trout Creek
Stage vs. Discharge
2.50
2.00
1.50
1.00
0.50
0.00
Stage - feet
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

Data Input & Proofing

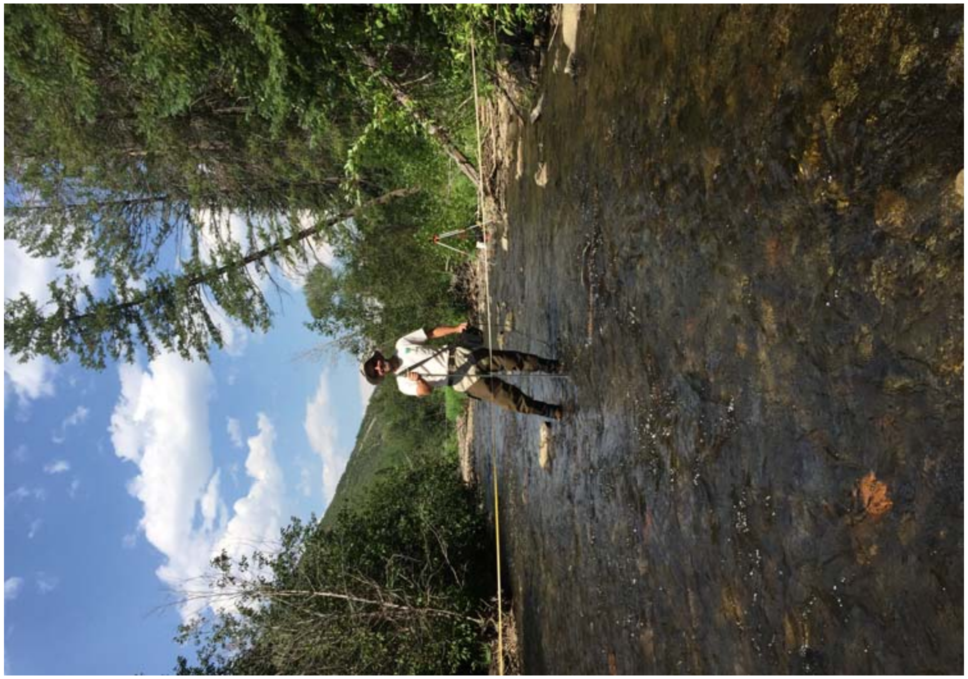
STREAM NAME:	Trout Creek
XS LOCATION:	0.5 mile upst fr conf w Little Trout Ck.
XS NUMBER:	2
DATE:	8/2/2017
OBSERVERS:	R. Smith, E. Scherff
1/4 SEC:	SW NW
SECTION:	23
TWP:	4N
RANGE:	86W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Yampa River
DIVISION:	6
DOW CODE:	23533
USGS MAP:	
USFS MAP:	
	Level and Rod Survey
TAPE WT:	0.0106 lbs / ft
TENSION:	99999 lbs
SLOPE:	0.013 ft / ft

CHECKED BY:.........……………………......DATE……………......

ASSIGNED TO: ......…………………….......DATE……………......

Total Data Points = 45

GL=1	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	A	Q	Tape to Water
	RS	1.20	1.38			0.00	0.00	0.00
		1.60	1.95			0.00	0.00	0.00
1	G	1.80	2.38			0.00	0.00	0.00
		2.40	4.04			0.00	0.00	0.00
	RW	3.90	4.10	0.00	0.00	0.00	0.00	0.00
		5.00	4.40	0.30	0.09	0.32	0.03	4.10
		6.00	4.60	0.50	0.70	0.50	0.35	4.10
		7.00	4.40	0.30	1.02	0.30	0.31	4.10
		8.00	4.50	0.40	1.59	0.40	0.64	4.10
		9.00	4.30	0.20	0.23	0.15	0.03	4.10
		9.50	4.65	0.55	1.41	0.28	0.39	4.10
		10.00	4.50	0.40	1.85	0.20	0.37	4.10
		10.50	4.50	0.40	1.09	0.20	0.22	4.10
		11.00	4.60	0.50	0.88	0.25	0.22	4.10
		11.50	4.45	0.35	1.39	0.18	0.24	4.10
		12.00	4.35	0.25	1.56	0.13	0.20	4.10
		12.50	4.35	0.25	1.94	0.13	0.24	4.10
		13.00	4.55	0.45	1.07	0.23	0.24	4.10
		13.50	4.50	0.40	0.94	0.20	0.19	4.10
		14.00	4.45	0.35	1.13	0.18	0.20	4.10
		14.50	4.15	0.05	0.60	0.03	0.02	4.10
		15.00	4.40	0.30	0.67	0.15	0.10	4.10
		15.50	4.55	0.45	1.09	0.23	0.25	4.10
		16.00	4.15	0.05	0.76	0.03	0.02	4.10
		16.50	4.35	0.25	0.23	0.13	0.03	4.10
		17.00	4.30	0.20	0.49	0.15	0.07	4.10
		18.00	4.40	0.30	1.55	0.30	0.47	4.10
		19.00	4.60	0.50	1.66	0.38	0.62	4.10
		19.50	4.65	0.55	1.56	0.28	0.43	4.10
		20.00	4.60	0.50	1.44	0.25	0.36	4.10
		20.50	4.50	0.40	1.99	0.20	0.40	4.10
		21.00	4.50	0.40	1.26	0.30	0.38	4.10
		22.00	4.35	0.25	1.67	0.25	0.42	4.10
		23.00	4.35	0.25	1.63	0.25	0.41	4.10
		24.00	4.35	0.25	0.71	0.25	0.18	4.10
		25.00	4.30	0.20	1.15	0.20	0.23	4.10
		26.00	4.20	0.10	0.76	0.10	0.08	4.10
		27.00	4.30	0.20	0.92	0.20	0.18	4.10
		28.00	4.25	0.15	0.69	0.14	0.10	4.10
	LW	28.90	4.10	0.00	0.00	0.00	0.00	0.00
		30.30	4.01			0.00	0.00	0.00
		31.80	3.42			0.00	0.00	0.00
		33.00	2.84			0.00	0.00	0.00
		35.00	2.52			0.00	0.00	0.00
1	LS & G	37.00	2.46			0.00	0.00	0.00
					Totals	7.41	8.58	



COLORADO
Colorado Water Conservation Board
Department of Natural Resources

CWCB discharge measurement data
Collected using the ESRI Survey123 app on a Samsung tablet

Stream name	Trout Creek
Location description	Trout Creek - D6
Water division	6
Visit date	5/7/2018
Collected by CWCB staff	Jack Landers
Collected by non-CWCB staff	N/A
Non-CWCB entity	N/A
Measurement method	wadingADV
Equipment	Flowtracker2_sn_2H1747037
Site name	Trout Creek - D6
Measurement number	507
Weather	overcast, no recent precip
Wind	calm
Cross-section description	run, cobble substrate, confined by valley wall to south
Flow conditions	turbulent
Measurement start time	17:53
Flow amount	64.5796
Measurement rating	Good(5%)
Discharge comments:	Lots of beaver ponds and old dams in area, this xsec one of few good spots for measurement.
Location	13N 328640 4463623

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

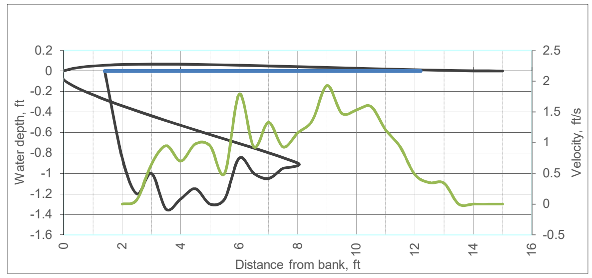
CWCB discharge measurement data
Collected using the ESRI Survey123 app on a Samsung tablet

Stream name	Trout Creek
Location description	Trout Creek and beaver ponds
Water division	6
Visit date	10/10/2018
Collected by CWCB staff	Other, Rob Viehl
Collected by non-CWCB staff	Jay Skinner
Non-CWCB entity	CPW
Measurement method	wadingMMcB
Equipment	Marsh McBirney
Site name	
Measurement number	2
Weather	cold cloudy,misty
Wind	No wind
Cross-section description	
Flow conditions	slightly turbulent
Measurement start time	09:45
Flow amount	9.59
Measurement rating	Good(5%)
Discharge comments:	
Location	13N 328736 4463735

Flow Measurement Calculations

Stream:Trout Creek
Date: 10/9/2018 **Time:945 AM**
Observers: Rob Viehl Jay Skinner
County: Routt
Water Division: 6
Latitude:
Longitude:
Location Description: above LT Beaver Ponds
Comments:
Other:

Station, ft	Width, ft	Depth, ft	Velocity, ft/s	Area, ft2	Discharge, cfs	%
1.4	water line	0	0			
2	0.5	0.85	0	0.425	0	0.0%
2.5	0.5	1.2	0.07	0.6	0.042	0.4%
3	0.5	1	0.65	0.5	0.325	3.4%
3.5	0.5	1.35	0.95	0.675	0.64125	6.7%
4	0.5	1.25	0.7	0.625	0.4375	4.6%
4.5	0.5	1.15	0.98	0.575	0.5635	5.9%
5	0.5	1.3	0.95	0.65	0.6175	6.4%
5.5	0.5	1.25	0.5	0.625	0.3125	3.3%
6	0.5	0.85	1.79	0.425	0.76075	7.9%
6.5	0.5	1	0.93	0.5	0.465	4.8%
7	0.5	1.05	1.33	0.525	0.69825	7.3%
7.5	0.5	0.95	0.93	0.475	0.44175	4.6%
8	0.5	0.9	1.16	0.45	0.522	5.4%
8.5	0.5	0.75	1.36	0.375	0.51	5.3%
9	0.5	0.7	1.93	0.35	0.6755	7.0%
9.5	0.5	0.9	1.48	0.45	0.666	6.9%
10	0.5	0.8	1.53	0.4	0.612	6.4%
10.5	0.5	0.7	1.59	0.35	0.5565	5.8%
11	0.5	0.6	1.21	0.3	0.363	3.8%
11.5	0.5	0.45	0.93	0.225	0.20925	2.2%
12	0.5	0.4	0.48	0.2	0.096	1.0%
12.5	0.5	0.2	0.35	0.1	0.035	0.4%
13	0.5	0.25	0.34	0.125	0.0425	0.4%
13.5	0.5	0.2	0	0.1	0	0.0%
14	0.5	0.1	0	0.05	0	0.0%
14.5	0.5	0.05	0	0.025	0	0.0%
15	water line	0	0	0	0	0.0%
				FLOW =	9.59	



Graph Data

Bed elevation		Waterline	
1.4	0	1.4	0
2	-0.85	12.2	0
2.5	-1.2		
3	-1		
3.5	-1.35		
4	-1.25		
4.5	-1.15		
5	-1.3		
5.5	-1.25		
6	-0.85		
6.5	-1		
7	-1.05		
7.5	-0.95		
8	-0.9		
#REF!	#REF!		
15	0		

Discharge Measurement Summary

File Information

File name	20180507_Trout Creek - D6.ft
Start date and time	5/7/2018 5:58 PM
Calculations engine	FlowTracker2
Data collection mode	Discharge

Discharge Summary

Start time	5/7/2018 6:00:52 PM	End time	5/7/2018 6:29:18 PM
# Stations	24	Avg interval	40
Mean depth	0.849 ft		
Mean velocity	3.3509 ft/s	Total width	22.700 ft
Mean SNR	47 dB	Total area	19.2725 ft²
Mean temp	52.252 °F	Total discharge	64.5796 ft³/s

System Information

Sensor type	Top Setting
Handheld serial number	FT2H1747037
Probe serial number	FT2P1747048
Probe firmware	1.23
Handheld software	1.4

Site Details

Site name	Trout Creek
Site number	0507
Operator(s)	Jack Landers
Comment	BLM land

Discharge Uncertainty

Category	ISO	IVE
Accuracy	1.0%	1.0%
Depth	0.2%	2.4%
Velocity	0.6%	2.2%
Width	0.1%	0.1%
Method	1.8%	
# Stations	2.1%	
Overall	3.0%	3.4%

Discharge Settings

Discharge equation	Mid Section
Discharge uncertainty	IVE
Discharge reference	Rated

Station Warning Settings

Station discharge caution	5.00	%
Station discharge warning	10.00	%
Maximum depth change	50.00	%
Maximum spacing change	100.00	%

Summary overview

No changes were made to this file
Quality control warnings

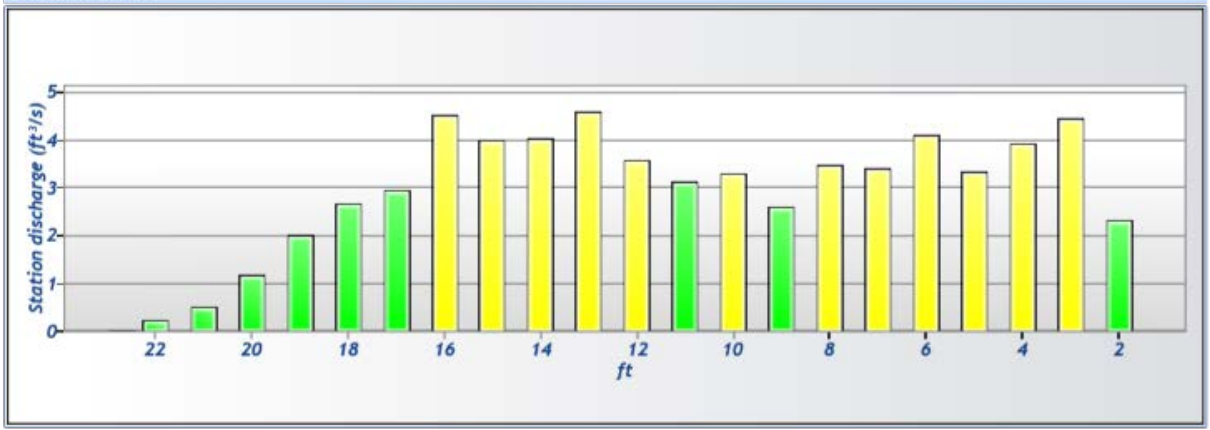
Data Collection Settings

Salinity	0.000	PSS-78
Temperature		°F
Sound speed		ft/s
Mounting correction	0.00	%

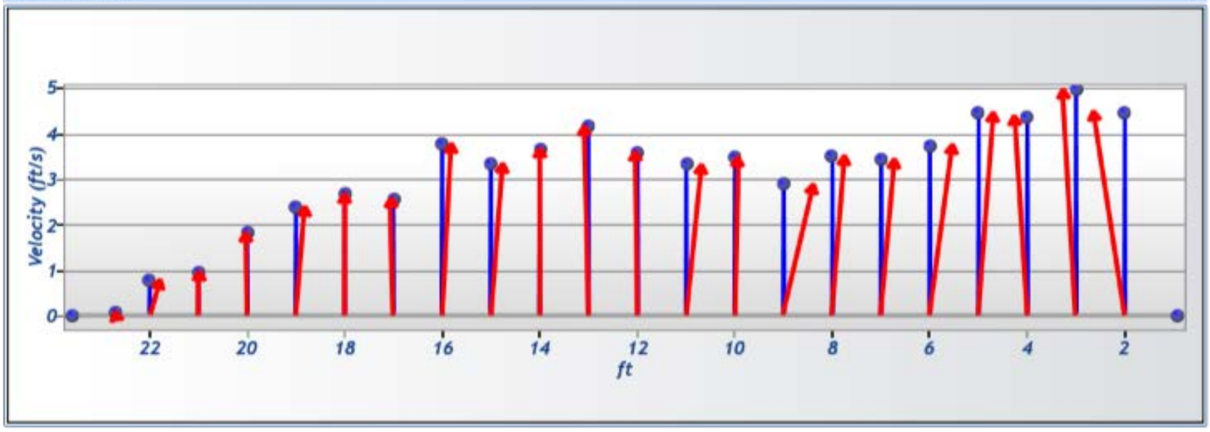
Quality Control Settings

SNR threshold	10	dB
Standard error threshold	0.0328	ft/s
Spike threshold	10.00	%
Maximum velocity angle	20.0	deg
Maximum tilt angle	5.0	deg

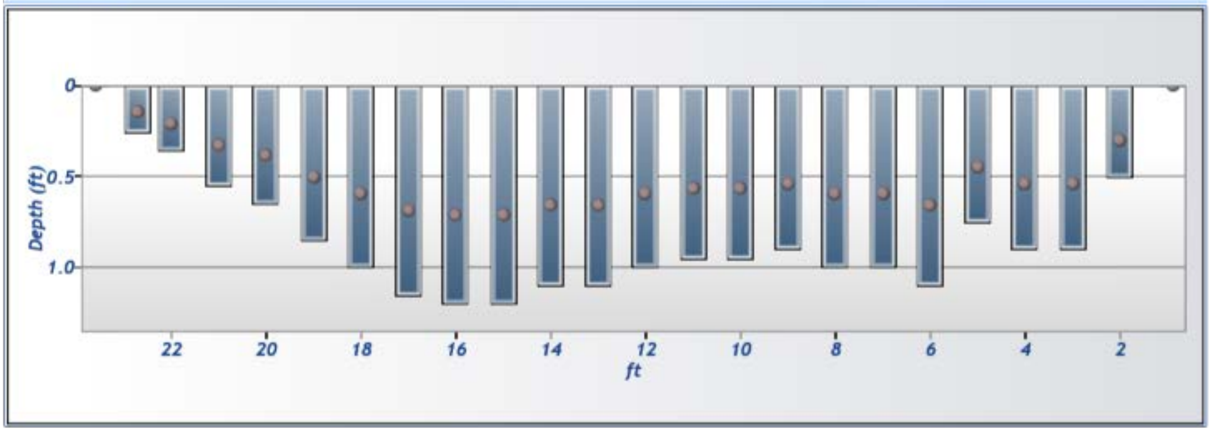
Discharge chart



Velocity chart



Depth chart



Measurement results

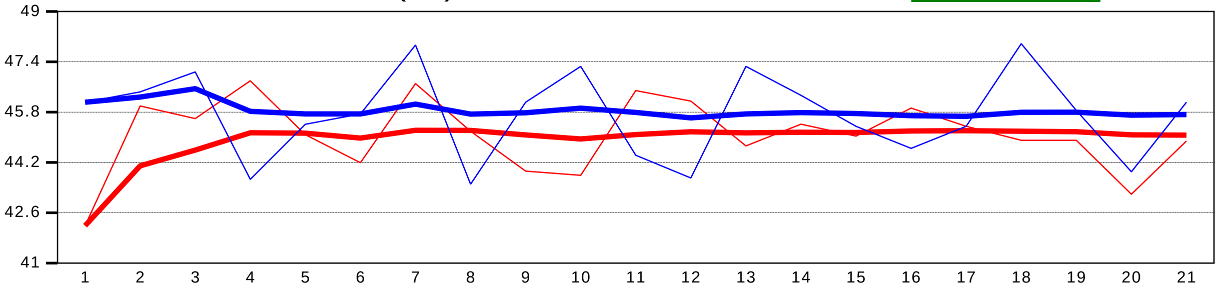
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (ft/s)	Correction	Mean Velocity (ft/s)	Area (ft²)	Flow (ft³/s)	%Q	
0	6:00 PM	0.900	None	0.000	0.0000	0.000	0	0.0000	1.0000	4.4756	0.0000	0.0000	0.00	✓
1	6:01 PM	2.000	0.6	0.500	0.6000	0.300	80	4.4756	1.0000	4.4756	0.5250	2.3497	3.64	✓
2	6:03 PM	3.000	0.6	0.900	0.6000	0.540	80	4.9628	1.0000	4.9628	0.9000	4.4665	6.92	✓
3	6:04 PM	4.000	0.6	0.900	0.6000	0.540	80	4.3701	1.0000	4.3701	0.9000	3.9330	6.09	✓
4	6:06 PM	5.000	0.6	0.750	0.6000	0.450	80	4.4476	1.0000	4.4476	0.7500	3.3357	5.17	✓
5	6:07 PM	6.000	0.6	1.100	0.6000	0.660	80	3.7418	1.0000	3.7418	1.1000	4.1160	6.37	✓
6	6:08 PM	7.000	0.6	1.000	0.6000	0.600	80	3.4217	1.0000	3.4217	1.0000	3.4217	5.30	✓
7	6:09 PM	8.000	0.6	1.000	0.6000	0.600	80	3.4958	1.0000	3.4958	1.0000	3.4958	5.41	✓
8	6:11 PM	9.000	0.6	0.900	0.6000	0.540	80	2.8852	1.0000	2.8852	0.9000	2.5967	4.02	✓
9	6:12 PM	10.000	0.6	0.950	0.6000	0.570	80	3.4803	1.0000	3.4803	0.9500	3.3063	5.12	✓
10	6:13 PM	11.000	0.6	0.950	0.6000	0.570	80	3.3131	1.0000	3.3131	0.9500	3.1475	4.87	✓
11	6:14 PM	12.000	0.6	1.000	0.6000	0.600	80	3.5992	1.0000	3.5992	1.0000	3.5992	5.57	✓
12	6:16 PM	13.000	0.6	1.100	0.6000	0.660	80	4.1705	1.0000	4.1705	1.1000	4.5875	7.10	✓
13	6:17 PM	14.000	0.6	1.100	0.6000	0.660	80	3.6746	1.0000	3.6746	1.1000	4.0420	6.26	✓
14	6:18 PM	15.000	0.6	1.200	0.6000	0.720	80	3.3443	1.0000	3.3443	1.2000	4.0131	6.21	✓
15	6:19 PM	16.000	0.6	1.200	0.6000	0.720	80	3.7660	1.0000	3.7660	1.2000	4.5192	7.00	✓
16	6:20 PM	17.000	0.6	1.150	0.6000	0.690	80	2.5697	1.0000	2.5697	1.1500	2.9551	4.58	✓
17	6:22 PM	18.000	0.6	1.000	0.6000	0.600	80	2.6790	1.0000	2.6790	1.0000	2.6790	4.15	✓
18	6:23 PM	19.000	0.6	0.850	0.6000	0.510	80	2.3974	1.0000	2.3974	0.8500	2.0378	3.16	✓
19	6:24 PM	20.000	0.6	0.650	0.6000	0.390	80	1.8309	1.0000	1.8309	0.6500	1.1901	1.84	✓
20	6:25 PM	21.000	0.6	0.550	0.6000	0.330	80	0.9734	1.0000	0.9734	0.5500	0.5353	0.83	✓
21	6:26 PM	22.000	0.6	0.350	0.6000	0.210	80	0.7892	1.0000	0.7892	0.2975	0.2348	0.36	✓
22	6:28 PM	22.700	0.6	0.250	0.6000	0.150	80	0.0884	1.0000	0.0884	0.2000	0.0177	0.03	✓
23	6:29 PM	23.600	None	0.000	0.0000	0.000	0	0.0000	1.0000	0.0884	0.0000	0.0000	0.00	✓

Quality control warnings

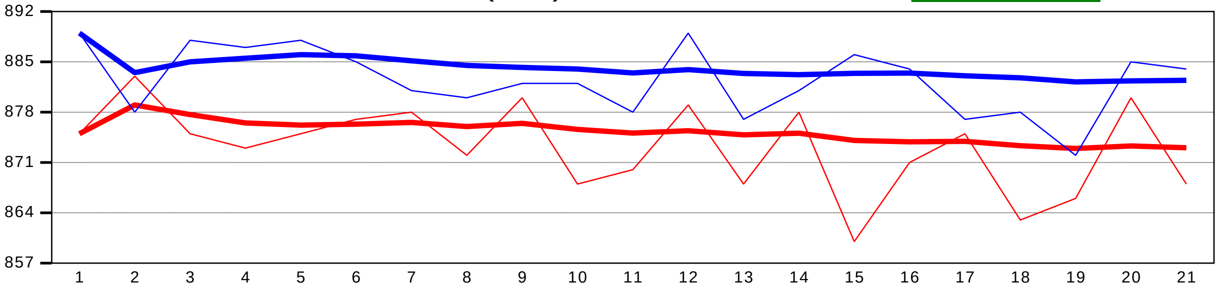
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings
1	6:01 PM	2.000	0.6	0.500	0.6000	0.300	Standard Error > QC
2	6:03 PM	3.000	0.6	0.900	0.6000	0.540	Standard Error > QC
3	6:04 PM	4.000	0.6	0.900	0.6000	0.540	Standard Error > QC
4	6:06 PM	5.000	0.6	0.750	0.6000	0.450	Standard Error > QC
5	6:07 PM	6.000	0.6	1.100	0.6000	0.660	Standard Error > QC
6	6:08 PM	7.000	0.6	1.000	0.6000	0.600	Standard Error > QC
7	6:09 PM	8.000	0.6	1.000	0.6000	0.600	Standard Error > QC
8	6:11 PM	9.000	0.6	0.900	0.6000	0.540	Standard Error > QC
9	6:12 PM	10.000	0.6	0.950	0.6000	0.570	Standard Error > QC
10	6:13 PM	11.000	0.6	0.950	0.6000	0.570	Standard Error > QC
11	6:14 PM	12.000	0.6	1.000	0.6000	0.600	Standard Error > QC
12	6:16 PM	13.000	0.6	1.100	0.6000	0.660	Standard Error > QC
13	6:17 PM	14.000	0.6	1.100	0.6000	0.660	Standard Error > QC
14	6:18 PM	15.000	0.6	1.200	0.6000	0.720	Standard Error > QC
15	6:19 PM	16.000	0.6	1.200	0.6000	0.720	Standard Error > QC
16	6:20 PM	17.000	0.6	1.150	0.6000	0.690	Standard Error > QC
17	6:22 PM	18.000	0.6	1.000	0.6000	0.600	Standard Error > QC
18	6:23 PM	19.000	0.6	0.850	0.6000	0.510	Standard Error > QC
19	6:24 PM	20.000	0.6	0.650	0.6000	0.390	Standard Error > QC
20	6:25 PM	21.000	0.6	0.550	0.6000	0.330	Standard Error > QC

Automated beam check Start time 5/7/2018 6:00:09 PM

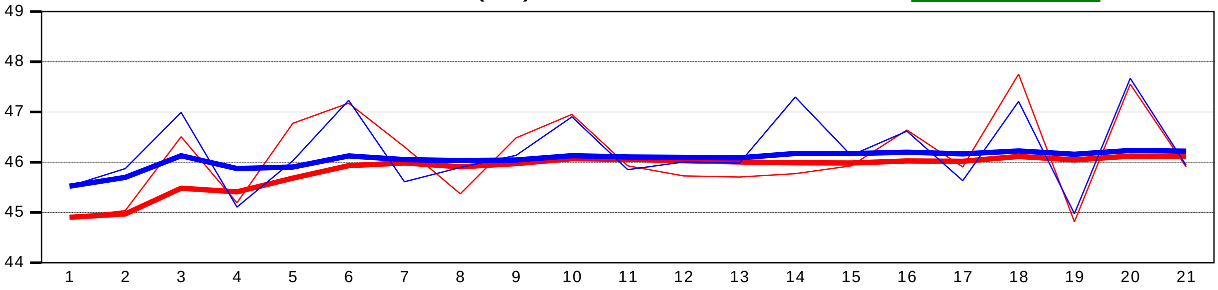
Automated beam check SNR(dB) PASS



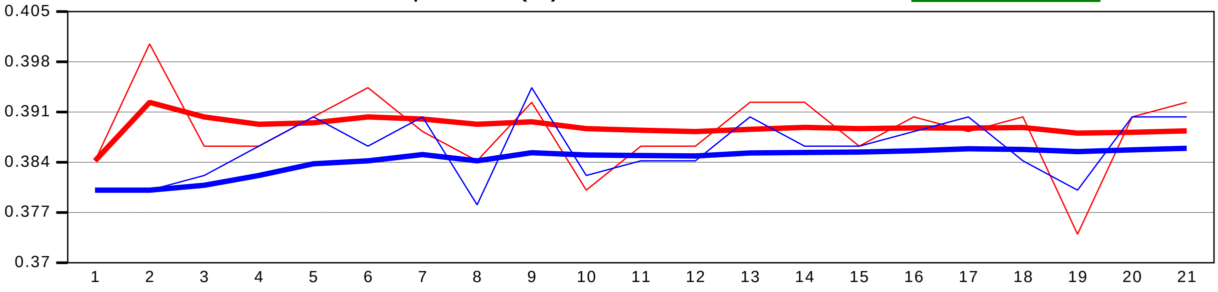
Automated beam check Noise level(cnts) PASS



Automated beam check Peak level(dB) PASS



Automated beam check Peak position(ft) PASS



Automated beam check Quality control warnings

No quality control warnings

WWC ENGINEERING

611 Skyline Road - Laramie, WY 82070 - (307) 742-0031
FAX (307) 721-2913 - E-mail: infolar@wwcengineering.com

February 18, 2010

Permit C-1980-001
Annual Hydrology Report

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Division of Reclamation, Mining and Safety

Mr. Jason Musick
Colorado Division of Reclamation, Mining and Safety
1313 Sherman Street
Room 215
Denver, Colorado 80203-2273

RE: Edna Mine 2009 Annual Hydrology Report

Dear Mr. Musick:

Enclosed is the 2009 Annual Hydrology Report for the Edna Mine. Should the Colorado Division of Reclamation, Mining and Safety have any comments or concerns regarding this submittal, please contact me at your convenience.

Sincerely,

Troy Summers
Project Manager

TNS
Enclosures
File: 99-144

cc: Chevron (Leach)
Permit (Weinman)

2009 Annual Hydrology Report

Edna Mine
Permit CO-80-001
Routt County, CO

February 2010

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1.0 INTRODUCTION

A water quality monitoring program was initiated at the Edna Mine to monitor specific chemical characteristics of Trout Creek and the alluvium associated with Trout Creek which may be affected by mining and reclamation operations. This program is detailed enough to describe seasonal variations in concentration levels of the parameters monitored, as well as indicate if mining activities and/or reclamation activities are impacting the natural seasonal fluctuations.

The purpose of this report is to provide updated information pertaining to the on-going hydrologic monitoring program developed for the Edna Mine and discuss trends in surface and ground water quality. The previous report, dated February 2009, reported monitoring activities up through the end of 2008. This report provides a discussion on each of the parameters monitored which have been collected through 2009.

The report is divided into several sections including: Hydrologic Monitoring Network; Surface Water; Ground Water; Surface Water and Ground Water Interactions; Quality Assurance; Spring and Seep Survey; and Moffat Stability Monuments.

2.0 HYDROLOGIC MONITORING NETWORK

The present monitoring network is a modification of the network used during baseline monitoring. Continuous streamflow records are made for Trout Creek above the mine (TR-a) from May through October (periods of freezing sometimes necessitate the records to be of shorter duration). Instantaneous streamflow was recorded on Trout Creek below the Moffat mining area at TR-b prior to July 1994. During June 1994, a continuous streamflow recorder was installed at TR-b. Therefore, monitoring data after June 1994 has been collected on the same schedule as at TR-a. Surface water samples are collected above and below the mine at TR-A and TR-D, respectively. Additional surface water sampling sites along Trout Creek are TR-B (located adjacent to the East Ridge area) and TR-C (located adjacent to the Moffat area).

Ground water levels and samples are collected from four wells. Three wells are completed in the alluvium along Trout Creek (TR-1.5, TR-3 and TR-4) and one well is completed in the spoils (WR-1) located at the base of the West Ridge area. An additional water quality well is completed in the Trout Creek Sandstone (TCS-1) monitored downdip of mining activity. Water monitoring locations are shown on Plate 1.

The samples are analyzed for the parameters listed in Table 4.6-54, Section 4.6.8.4 of the permit. Sampling frequency at the various sites is also listed in Table 4.6-54. Parameters measured in the field include: pH, temperature, and specific conductivity. All other parameters measured are analytically derived at an independent laboratory.

The monitoring program has been altered via Technical Revisions 47 and 48. Monitoring wells 215W, 215L, 218W, 218L, M892S and M892L were discontinued September 21, 2007 in accordance with TR-47. Monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1, surface water flow monitoring sites TR-a and TR-b and surface water quality monitoring sites TR-A, TR-B, TR-C and TR-D were discontinued September 2, 2009 in accordance with TR-48.

3.0 SURFACE WATER

As previously mentioned, Trout Creek is monitored for water quality at sites TR-A, TR-B, TR-C and TR-D and for flow at sites TR-a and TR-b. The following section discusses quantity and quality of surface water at the Edna Mine.

3.1 Gauging Stations

Chart 1 shows the continuous streamflow records for Trout Creek at TR-a and TR-b. The flow measurements along Trout Creek indicate that the monitoring program is being placed on-line early enough in the year to record flow prior to the peak runoff period for each year. The individual data points show the monthly average flows and give some indication of the variability between mild winters (winters of less snow accumulation) and harsh winters (winters of greater snow accumulation). The streamflow during 2009 is elevated compared with previous years with a slight decline from 2008. The chart indicates that 2009 was an average/harsh winter for the past two decades.

The flow record for 2009 shows a peak flow to have occurred in May. The peak flow historically occurs in either May or June. The runoff from the mine site was higher in 2009 than the majority of previous years probably due to more snowpack on the mine site and the on-set of warmer temperatures occurring later in the spring.

The flow data presented in Chart 1 consists only of information derived from continuous flow records. Instantaneous flow measurements obtained between 1989 and June 1994 for TR-b are provided in Table 1. Prior to 1994, instability of the stream channel caused by a 1984 flood precluded the installation of any type of monitoring station in the vicinity of TR-b. The Stevens chart recorders were replaced with electronic streamflow recorders in April 2003.

The bridge located immediately downstream of TR-a was replaced in the fall of 2001 potentially altering the stage rating curve. Therefore, the decision was made to update the stage/discharge curves for TR-a and TR-b. Over the 2001 season, a total of nine cross-sections and associated velocities were measured at each cross section location. This data was used to compute a stage rating curve at each location.

The stage rating curve for TR-a was developed from flows ranging from 11 cfs to 145 cfs. The curve equation and r^2 for the curve are as follows: $y = 44.469x^{3.2806}$, where y = flow in cfs and x = depth of flow; $r^2 = 0.98$. Flows for 2009 are in accordance with the range used to develop the rating curve; therefore, the calculated flow is considered accurate.

The stage rating curve for TR-b was developed from flows ranging from 13 cfs to 144 cfs. The curve equation and r^2 for the curve are as follows: $y = 65.049x^{2.431}$, where y = flow in cfs and x = depth of flow; $r^2 = 0.99$. Flows for May of 2009 were above the 144 cfs used to develop the rating curve; therefore, this calculated flow may to be high. The stream flow data appears to indicate a good correlation between the upstream and downstream flows along Trout Creek.

To ensure the accuracy of the stream flow data, channel cross-sections at Site TR-a and TR-b are surveyed annually to verify streambed stability. Figure 1 shows channel cross-sections that were developed as part of an annual survey. These results confirm that the streambed configuration has remained fairly constant and therefore verify streambed stability.

Irrigation ditch flow observations (flowing/not flowing and approximate flow) were made monthly from April through September of 2009 at Site TR-A. Flow was observed in the irrigation ditch at site TR-A during June of 2009. Instantaneous flow observations are provided in Table 2.

3.2 NPDES Monitoring

Monitoring of point discharges from sedimentation impoundments is accomplished under Colorado Department of Public Health and Environment Colorado Permit Discharge System Permit CO-0032638. Copies of required Discharge Monitoring Reports are provided to the Colorado Division of Reclamation, Mining and Safety under separate cover, and are included in this report by reference.

3.3 Surface Water Quality

Surface water sampling is performed in accordance with EPA approved methods and instrumentation. As previously mentioned, the water quality along Trout Creek is monitored via the parameters listed on Table 4.6-54, Section 4.6.8.4 of the permit. Tabular analyses results for monitoring sites TR-A, TR-B, TR-C and TR-D are found in Tables 3, 4, 5 and 6. Results of the analyses are discussed below.

3.3.1 Surface Water Temperature

Chart 2 shows temperature values for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Temperature exhibited the same trends in 2009 as found during baseline studies and previous years monitoring. Specifically, patterns in temperature are seasonal, warming until July or August and than cooling throughout the remaining sampling season. Surface water temperature for 2009 was colder than average for the period of record due to a harsh winter and cool ambient temperatures. The lowest temperature in 2009 was recorded at monitoring site TR-A in April with a reading of 4.8 °C and the high was recorded at monitoring site TR-B in August with a reading of 17.0 °C.

3.3.2 Surface Water pH

Chart 3 shows pH concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Values of pH during 2009 were consistent with baseline studies and previous monitoring. There is no apparent trend regarding pH although only slight variations occur during the monitoring season. Overall, Trout Creek has remained slightly alkaline throughout the period of record. The lowest pH value in 2009 was recorded at monitoring site TR-D in April with a reading of 7.05 standard units and the high was recorded at monitoring site TR-A in August with a reading of 8.65 standard units.

3.3.3 Surface Water Total Suspended Solids

Chart 4 shows total suspended solids (TSS) concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Since 1989, TSS concentrations have remained relatively constant. The relatively constant TSS values observed over much of the period appear to be the result of two conditions. First, the stream channel, significantly altered during a 1984 flood, has stabilized and the stream banks have reestablished vegetation. Second, the section of the creek between TR-A and TR-B has become an inundated marsh as result of a continuous string of beaver ponds. Additionally, several long stretches of the creek between TR-B and TR-D have also become marshes due to numerous beaver dams.

Periodically, this general pattern is interrupted, as occurred in 1991, 1993, 1995, 2003, 2005 and 2006. The "spikes" in TSS levels during these years appear to be related to peak flow conditions along Trout Creek. TSS concentrations during the 2009 sampling season closely resemble the general pattern, decreasing as the season lengthens. The TSS concentrations remained fairly static in 2009 and consistent with previous sampling. The lowest TSS concentration in 2009 was <5 mg/L at numerous monitoring sites during numerous events, the high was recorded at monitoring site TR-D in April with a reading of 11 mg/L.

3.3.4 Surface Water Specific Conductivity

Chart 5 shows specific conductivity concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Specific conductivity from September 1992 through the end of the report period was similar to values obtained prior to October 1990. Data taken between October 1990 and August 1992 are believed to be invalid due to instrument errors. TDS values obtained during these same periods do not reflect the increases; therefore it is believed that the data excursions can be attributed to errors with the instrumentation rather than a reflection of actual field conditions.

New field equipment has been used since September 1992 along with laboratory verification. The values shown in past reports from 1992 through 1994 are the laboratory values. Since the field values and laboratory values have been in close agreement since 1994, values provided beginning in 1995 are field values. Specific conductivity has exhibited the same trends in 2009 as found during baseline studies and previous years monitoring. The lowest specific conductivity concentration in 2009 was recorded at monitoring site TR-A in June with a reading of 100 umhos/cm @ 25 °C and the high was recorded at monitoring site TR-C in April with a reading of 1010 umhos/cm @ 25 °C.

3.3.5 Surface Water Total Dissolved Solids

Chart 6 shows total dissolved solids (TDS) concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. TDS concentrations in Trout Creek exhibit an expected pattern. As stream flow passes the mine, TDS levels increase while adjacent to the mined areas and then begin to decline downstream due to inflow from undisturbed lands below the active mine. Peak TDS levels in Trout Creek adjacent to the mine occur in early spring prior to the period of peak flow. This is caused by the spring runoff from the portion of the watershed in which the Edna Mine is located. Although TDS concentrations in the mine runoff may be quite high when compared to concentrations occurring above the mine, generally the mine runoff is small relative to Trout Creek's total flow. Therefore, a significant increase in Trout Creek TDS levels is observed only during the initial stages of spring runoff. A comparison of the TDS and flow data indicate that TDS concentrations appear to be directly related to flow volume.

The dilution of TDS concentrations in downstream flow for the past decade has not been as pronounced as in the previous decade. Beginning in 1990, mining and reclamation occurred in close proximity to TR-C. As such, dilution of TDS concentrations probably occurs farther downstream of TR-D as runoff from undisturbed areas enters into Trout Creek. Although elevated TDS concentrations have moved downstream in conjunction with mining and reclamation activities, all values for TDS are consistent with the probable hydrologic consequences projections. TDS concentrations seem to have peaked during the 1996 sampling season and have been steadily decreasing to the current year of sampling. TDS concentrations exhibited the same trends in 2009 as found during previous years monitoring. The lowest TDS concentration in 2009 was recorded at monitoring site TR-A in June with a value of 80 mg/L and the high was recorded at monitoring site TR-C in April with a value of 740 mg/L.

3.3.6 Surface Water Calcium, Magnesium and Sodium

Charts 7, 8 and 9 show calcium, magnesium and sodium concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Calcium is the dominant cation in Trout Creek with magnesium and sodium occurring in lesser concentrations. While the relative proportions of these parameters change slightly between the sampling points, all show peak concentrations coinciding with spring runoff, as would be expected. As with TDS, all three cations show general increases in concentration as the water passes the mine area. Additionally, the relative proportion of each constituent remains constant to the other constituents. While trends in their subsequent dilution downstream have yet to form a consistent pattern, little or no dilution in any of the concentrations have occurred between sampling points TR-C and TR-D since 1989. For the last decade, it is believed that this was due in part to the Moffat area mining and reclamation activities and, as such, the pattern is anticipated to continue. However, since this occurrence existed prior to the initiation of Moffat mining activity, the trend may also suggest that inflow from undisturbed areas upstream and downstream of TR-C contains approximately the same concentrations of these parameters as runoff from the mine.

Calcium, magnesium and sodium concentrations exhibited similar trends in 2009 as found during baseline studies and previous years monitoring. All three parameters show a slight increase in concentration from the 2008 sampling season and an overall decreasing trend since the 1996 sampling season in agreement with the TDS trend. The lowest calcium concentration in 2009 was recorded at monitoring site TR-A in April with a value of 27 mg/L and the high was recorded at monitoring sites TR-C and TR-D in April with a value of 100.0 mg/L. The lowest magnesium concentration in 2009 was recorded at monitoring site TR-A in April a value of 10.0 mg/L and the high was recorded at monitoring site TR-C in April with a value of 71.0 mg/L. The lowest sodium concentration in 2009 was recorded at monitoring site TR-A in August with a value of 3.0 mg/L and the high was recorded at monitoring sites TR-C and TR-D in April with a value of 16.0 mg/L.

3.3.7 Surface Water Bicarbonate and Sulfate

Charts 10, 11 and 12 show bicarbonate and sulfate concentrations and the sulfate/bicarbonate ratio for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. As noted in previous annual hydrology reports, upstream of the mine on Trout Creek, bicarbonate is the major anion with sulfate concentrations increasing rapidly along the mine area to become predominating downstream. The sulfate level increase is most markedly noticed prior to the peak flow period of Trout Creek and adjacent to where mining activity took place, as are TDS levels in general. This increase is probably caused by early runoff at the mine site leaching pyritic and organic sulfur as flow passes over and through the spoils. Since the flow of Trout Creek is low at that time, the amount of sulfur is sufficient to cause an ionic shift from a bicarbonate type water to a sulfate type. During periods of higher flow and late in the season when runoff from the mine is small relative to total Trout Creek flow, the sulfate component is less able to shift the anion balance to a sulfate type with concentrations of bicarbonate and sulfate being approximately equal downstream.

The 2009 data is similar to previous monitoring data indicating a trend that shows a topological change occurring generally at TR-B. This is believed to be the result of the spoil spring, which has developed at the base of the West Ridge mining area. As reclamation of West Ridge matures, the high levels of sulfur exhibited in the spring are anticipated to decrease. The recent trend showing peak sulfate levels at TR-C and TR-D are expected to continue for some time as spoil springs in the Moffat area have developed after the completion of mining in that area. Like the West Ridge area the sulfate sources within the Moffat area are anticipated to diminish as vegetation establishes and matures. An overall trend indicates a decrease in sulfate since the 1996 sampling season.

While peak levels of individual constituents may be shifting as flow proceeds past the mine, they do not seem to be increasing overall. It is believed that an equalization in the sulfate-bicarbonate balance or a reversal (similar to the balance at TR-A) occurs downstream as the source of available sulfate (mining areas) is unavailable and dilution by runoff from undisturbed areas is introduced. The lowest bicarbonate concentration in 2009 was recorded at monitoring site TR-A in April with a value of 105 mg/L and the high was recorded at monitoring site TR-C in August with a value of 134 mg/L. The lowest sulfate concentration in 2009 was recorded at monitoring site TR-A in August with a value of 8 mg/L and the high was recorded at monitoring site TR-C in April with a value of 420 mg/L. The lowest sulfate/bicarbonate ratio in 2009 was recorded at monitoring site TR-A in August with a value of 0.10 SO4 (meq)/HCO3 (meq) and the high was recorded at monitoring site TR-C in April with a value of 5.21 SO4 (meq)/HCO3 (meq).

3.3.8 Surface Water Manganese

Chart 13 shows manganese concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Manganese shows fairly consistent values since 1989. Most of the manganese values observed are consistent with baseline values. Manganese values appear to be developing a trend, which may be directly related to flow in Trout Creek as are the TDS concentrations. Sampling in October of 2005, at site TR-D, produced an inconsistent spike of manganese up to 0.248 mg/L. Manganese remained within historical levels at all other sites along Trout Creek in October 2005. The October water quality data was re-analyzed and the original values were confirmed. There is no apparent reason for this sudden rise in value.

Site TR-D normalized over the last few years, regarding the October 2005 spike, and concentrations on average for all sites are low in comparison with the past decade. The concentration trend seemed to have reversed during 2006 with higher concentrations resulting during low flow in Trout Creek, however the 2007 to 2009 values fall back to the expected trend of decreasing concentrations according to flow. The lowest manganese concentration in 2009 was recorded at monitoring site TR-A in April with a value of 0.02 mg/L and the high was recorded at monitoring site TR-D in April with a value of 0.08 mg/L.

3.3.9 Surface Water Aluminum

Chart 14 shows aluminum concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Aluminum concentrations have been low with most being below detection limits throughout the duration of monitoring. The apparent elevated aluminum levels shown in 1995 were due to the laboratory lower detection limit being set at 0.2 ppm instead of 0.05 ppm. Aluminum was elevated at TR-C during the April 2002 sampling period. However, concentrations downstream of TR-C are consistent with previous sampling results. Therefore, either sample contamination or laboratory error is suspected. Aluminum was slightly elevated during the 2004 and 2005 sampling periods. The 2009 sampling period shows consistent sampling results with the past decade. The lowest and highest aluminum concentration in 2009 was the lower detection limit of <0.03 mg/L at all sites for all events.

3.3.10 Surface Water Unionized Ammonia

Chart 15 shows unionized ammonia concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Unionized ammonia concentrations have been consistently below detection limits. The unionized ammonia concentration appeared to drop for the 1997 through 1999 monitoring periods due to the laboratory lowering the detection limit from 0.05 ppm to 0.01 ppm. In 2000, the laboratory raised the detection limit for unionized ammonia back to 0.05 ppm, then lowered the detection back to 0.01 ppm in 2001. The 2009 sampling period shows detections in April at monitoring sites TR-B, TR-C and TR-D. The high was recorded at monitoring site TR-C in April with a value of 0.06 mg/L. Unionized ammonia concentrations were below the detection limit of <0.02 mg/L at all sites for the August 2009 sampling date.

3.3.11 Surface Water Nitrite

Chart 16 shows nitrite concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Nitrite concentrations have been consistently below detection limits with few exceptions. Nitrite was elevated at site TR-D with a value 0.32 mg/L in April 1999. This value is not consistent with historical data or the other monitoring sites during the April 1999 monitoring event. The April 1999 TR-D value is considered to be a sampling/laboratory error.

The nitrite concentration upstream of the mine at TR-A was 0.06 ppm in the July 2001 sample. The concentration decreased as it passed by the mine site as a result of dilution. Samples collected in May and October 2001 show nitrite levels at TR-A below the detection limit. The 2009 sampling period shows consistent sampling results compared to all previous events. Nitrite concentrations were below the detection limit of <0.01 mg/L at all sites for all sampling dates of 2009.

3.3.12 Surface Water Orthophosphate

Chart 17 shows orthophosphate concentrations for monitoring sites TR-A, TR-B, TR-C and TR-D for the period of record. Values obtained for orthophosphate have been low with most being below detection limits throughout the duration of monitoring. Orthophosphate showed some perturbation during the 2001 sampling period at TR-B. However, concentrations downstream of TR-B are consistent with previous sampling results. Therefore, either sample contamination or laboratory error is suspected. The 2009 sampling period shows slightly elevated sampling results compared to the period of record. The lowest orthophosphate concentration in 2009 was the lower detection limit of <0.01 mg/L recorded at all sites in April and the high was recorded at all monitoring site TR-C in August with a value of 0.04 mg/L.

3.3.13 Surface Water Chloride, Potassium and Iron

Charts 18, 19 and 20 show chloride, potassium and iron concentrations for monitoring sites TR-

A, TR-B, TR-C and TR-D for the period of record. Chloride and potassium were added to the monitoring program in 1993 while iron was added in 1994. The concentrations of all of these parameters in Trout Creek water are generally low. The 2009 sampling period shows consistent sampling results to the previous monitoring events regarding these constituents. Chloride and potassium have shown a trend decrease and stabilization over the past decade. Iron levels during the past few monitoring periods slightly decreased relative to those since 2004 showing a general relation to flow in Trout Creek. The lowest chloride concentration in 2009 was <1.0 mg/L at monitoring site TR-A in April and TR-A and TR-B in August and the high was recorded at monitoring sites TR-B, TR-C and TR-D in April and TR-C and TR-D in August with a value of 2.0 mg/L. The lowest potassium concentration in 2009 was recorded at monitoring site TR-A in August with a value of 1.0 mg/L and the high was recorded at monitoring sites TR-C and TR-D in April with a value of 2.6 mg/L. The lowest iron concentration in 2009 was recorded at monitoring site TR-D in August with a value of 0.07 mg/L and the high was recorded at monitoring site TR-D in April with a value of 0.42 mg/L.

4.0 GROUND WATER

As previously mentioned, ground water is monitored for water quality and static water level elevations at monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1. The following section discusses quality and static water level elevations of ground water at the Edna Mine.

4.1 Ground Water Elevations

Water levels in the alluvial wells at the Edna Mine have remained constant over the period of record with minor fluctuations occurring seasonally. Elevations of the static water level in the alluvial wells (TR-1.5, TR-3 and TR-4) and the West Ridge spoils well (WR-1) are shown in Chart 21. In reviewing the data, it is apparent that WR-1 has reached steady state and exhibits consistent seasonal fluctuations. The seasonal fluctuations result from spring snowmelt causing a mounding of water in the perched aquifer which drains over the summer via discharge from a spring on the lower portion of West Ridge near the elevation of Trout Creek. Monitoring Well TR-4 was broken off and plugged by livestock in July 2002, preventing monitoring for the remainder of 2002. The well was repaired in the spring of 2003.

Ground water wells TR-1.5, TR-3, TR-4 and WR-1 all maintained levels and trends, a slight decrease of water level during the annual sampling season, similar to historical data during 2009. Ground water well elevations are provided in tabular format in Table 7.

4.2 Ground Water Quality

Comparisons of water quality data gathered from the alluvial wells at the Edna Mine must be exercised with caution due to the differing stratigraphic units intersected along Trout Creek adjacent to the various wells. The alluvium in the vicinity of Well TR-1.5 intersects stratigraphy above the Wadge coal seam while the alluvium in the vicinity of TR-3 intersects stratigraphy below the Wadge coal seam. Alluvium in the vicinity of TR-4 intersects even lower stratigraphic units than those at TR-3. The influence from contact with the differing lithology can not be quantified; therefore, differences between the wells may not be responses to mining related activities.

As previously mentioned, TR-4 was repaired in 2003. Groundwater samples from TR-4 show an increase in several parameters directly after repair, some of which have begun to stabilize and decrease to historical levels. Prior to 2003, parameters at the well had stabilized. Therefore, it is assumed that this increase is due to the well repairs.

Monitoring of Well TCS-1 was initiated in 1995 to ensure the absence of mining impacts on the Trout Creek Sandstone aquifer. To date, no impacts from mining activity are evident in Well TCS-1. TCS-1 was not sampled in 2004 due to equipment problems. The demolition of an adjacent house removed power from the site. During demolition the well sustained damage.

Sampling was attempted using a generator but the well was deemed not functional. TCS-1 was refurbished in the fall of 2005 and sampled thereafter.

Ground water sampling is performed in accordance with EPA approved methods and instrumentation. The ground water quality at the Edna Mine is monitored via the parameters, locations and frequency listed in Table 4.6-54, Section 4.6.8.4 of the permit. Analyses results for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 are found in Tables 8, 9, 10, 11 and 12. Results of the analyses are discussed below.

4.2.1 Ground Water Temperature

Chart 22 shows temperature values for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Temperature exhibited the same trends in 2009 as found during baseline studies and previous years monitoring. Specifically, patterns in temperature are seasonal, warming until July or August and than cooling throughout the remaining sampling season. The amount of temperature fluctuation in Well TR-4 has been historically somewhat greater than expected suggesting the flow to the perched aquifer, although subsurface, is very shallow. The lowest temperature in 2009 was recorded at monitoring well TR-3 in May with a reading of 7.1 °C and the high was recorded at monitoring site TR-1.5 in July with a reading of 15.2 °C.

4.2.2 Ground Water pH

Chart 23 shows pH concentrations for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Values of pH during 2009 remained relatively constant over the monitoring period. There is no apparent trend regarding pH. Overall, the groundwater has tended to be alkaline throughout the period of record. The lowest pH value in 2009 was recorded at monitoring well TR-1.5 in August with a reading of 6.75 standard units and the high was recorded at monitoring well TCS-1 in August with a reading of 8.42 standard units.

4.2.3 Ground Water Specific Conductivity and Total Dissolved Solids

Charts 24 and 25 show specific conductivity and TDS concentrations for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Specific conductivity and TDS values for the three alluvial wells have remained fairly constant over the majority of the period of record. While specific conductivity and TDS values at sites TR-3 and TR-4 are consistent with values obtained during the baseline studies, these parameters and several others have elevated rapidly and remained elevated at TR-1.5 since 1995. The source of the elevated values is not readily identifiable. A few factors which may have contributed to the elevated values were mentioned in the 1996 Report (i.e., inundation of the area in late spring of 1995 and the laying of telephone cable immediately upstream of the area during the summer of 1995). If the elevated values resulted from those activities, the values should have returned to more historic levels during the past decade. However, the values have remained elevated. It appears that the alluvium in this area is reflecting upstream alluvial water containing high levels of TDS, possibly from an old abandoned underground mine up the Little Trout Creek drainage. This conclusion is based partially on the similarity of the water quality between TR-1.5 and WR-1. The location of the underground mine is shown on Exhibit 3.1-1 of the permit.

Specific conductivity and TDS in Well WR-1 have tended to progress from an elevated state each spring to a lower state in the fall for the majority of the period of record. This phenomenon was caused by infiltration of snowmelt water leaching various minerals within the unsaturated zone of reclaimed spoil. As the enriched flow was released over the course of the summer, the conductivity values lessened to that of the stagnant saturated zone. The mounded aquifer exhibits a more diluted state each spring with a return to steady-state as the summer progresses.

Specific conductivity and TDS concentrations exhibited the same trends in 2009 as found during previous years of monitoring. Well TR-1.5 was low for both parameters when compared with the past decade. All concentrations were within the historical range. The lowest specific conductivity value in 2009 was recorded at monitoring well TR-3 in September with a reading of 680 umhos/cm @ 25 °C and the high was recorded at monitoring well WR-1 in May with a reading of 3950 umhos/cm @ 25 °C. The lowest TDS concentration in 2009 was recorded at monitoring well TR-3 in September with a value of 470 mg/L and the high was recorded at monitoring well WR-1 in May with a value of 4210 mg/L.

4.2.4 Ground Water Calcium, Magnesium and Sodium

Charts 26, 27 and 28 show calcium, magnesium and sodium concentrations for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Calcium is the major cation found in all of the wells, except TCS-1 which is sodium rich, with concentrations of sodium and magnesium occurring in lesser quantities. The sodium concentration at TR-1.5 in May 2001 was 179 ppm. This value is inconsistent with the historical sodium concentrations and the levels after May 2001. Therefore, either sample contamination or laboratory error is suspected. TR-1.5 generally contained the lowest concentrations of cations with a slight increase occurring downstream at TR-3 and TR-4 for the majority of the record. However, elevated levels of these parameters at TR-1.5 began to occur in 1995 consistent with the elevated specific conductivity and TDS levels previously mentioned. Elevated levels of sodium concentration occurred at TR-4 during the 2004 and 2005 sampling period compared with those of the last decade. However, the sodium concentration levels remain within historical levels found in Trout Creek.

Calcium, magnesium and sodium concentrations exhibited the same trends in 2009 as found during previous years of monitoring. The lowest calcium concentration in 2009 was recorded at monitoring well TCS-1 in May with a value of 39 mg/L and the high was recorded at monitoring well WR-1 in May with a value of 488 mg/L. The lowest magnesium concentration in 2009 was recorded at monitoring well TCS-1 in May with a value of 14.4 mg/L and the high was recorded at monitoring well WR-1 in May with a value of 445 mg/L. The lowest sodium concentration in 2009 was recorded at monitoring well TR-3 in May with a value of 12 mg/L and the high was recorded at monitoring well TCS-1 in August with a value of 293 mg/L.

4.2.5 Ground Water Bicarbonate and Sulfate

Charts 29, 30 and 31 show bicarbonate, sulfate and sodium concentrations and the sulfate/bicarbonate ratio for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Bicarbonate and sulfate concentrations show a consistent topological trend over the last 5 years. The sulfate/bicarbonate ratio during much of the previous decade showed the alluvial waters at TR-1.5, TR-3 and TR-4 and the backfill water at WR-1 to be sulfate type. Waters at TR-1.5 WR-1 and TR-3 have become slightly more sulfate over the period of record. The sulfate/bicarbonate ratio at TR-4 has resulted in a bicarbonate type over the last 5 years, differing from the period of record. During the last decade the sulfate/bicarbonate ratio at TR-1.5 was very similar to that found in WR-1 providing further evidence that the source of sulfate may be from a sulfur rich source such as leakage from an old abandoned underground mine.

Bicarbonate levels in TR-4 rose from 2003 to 2005 driving the sulfate/bicarbonate ratio lower, and shifting the water from a sulfate type to a bicarbonate type. This may be due to the well repairs performed in the spring of 2003. The bicarbonate concentrations at TR-4 seem to have peaked in 2004 and look as if they have stabilized and/or decreased in the past few years. Sulfate concentrations exhibited the same trends in 2009 as found during previous years of monitoring. The lowest bicarbonate concentration in 2009 was recorded at monitoring well TR-3 in May with a value of 111 mg/L and the high was recorded at monitoring well TR-4 in August with a value of 571 mg/L. The lowest sulfate concentration in 2009 was recorded at monitoring well TCS-1 in May with a value of 91 mg/L and the high was recorded at monitoring sites TR-1.5 and WR-1 in May with a value of 2700 mg/L. The lowest sulfate/bicarbonate ratio in 2009 was calculated for monitoring well TR-4 in May with a value of 0.25 SO4 (meq)/HCO3 (meq) and the high was calculated for monitoring well WR-1 in May with a value of 15.13 SO4 (meq)/HCO3 (meq).

4.2.6 Ground Water Dissolved Iron and Manganese

Charts 32 and 33 show dissolved iron and manganese concentrations for monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Overall, dissolved iron and manganese levels for the three alluvial wells TR-1.5, TR-3 and TR-4, and backfill well WR-1 remained low during 2009 as in previous years. Monitoring wells TR-1.5 and TR-3 showed spikes in May of 2009 that are uncharacteristic of the sites. The reason for these outliers is unknown. However, both sites returned to historic levels in August of 2009. Manganese concentrations in TR-4 have risen from 2003 to the 2009 sampling season. Once again, this may be due to the well repairs conducted in the spring of 2003. The lowest dissolved iron concentration in 2009 was recorded at monitoring wells WR-1 in August with a value of 0.02 mg/L and the high was recorded at monitoring well TR-1.5 in May with a value of 30.7 mg/L. The lowest manganese concentration in 2009 was recorded at monitoring well TCS-1 in August with a value of 0.015 mg/L and the high was recorded at monitoring well TR-4 in August with a value of 2.86 mg/L.

4.2.7 Ground Water Orthophosphate and Nitrite

Charts 34 and 35 show orthophosphate and nitrite concentrations for the monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Historically, orthophosphate and nitrite values obtained over the period of record have been low with most being below detection limits. Elevated orthophosphate readings occurred in the summers of 1998 through 2000, at up-gradient well TR-1.5, possibly due to nearby agricultural activity. In 2001, concentrations of orthophosphate returned to historically low levels. Site TR-4 had a slight rise in orthophosphate concentration during the 2005 monitoring period, but decreased to levels similar to previous sampling events during the past few years. Nitrite concentrations were again elevated at TR-1.5 in May 2000 and May 2001 and at WR-1 in May 2001, but decreased to historical levels as the year progressed. Nitrite levels remained at historical levels in the 2009 monitoring period. The lowest orthophosphate concentration in 2009 was recorded at monitoring well WR-1 with a value 0.01 mg/L and the high was recorded at monitoring well TR-4 in August with a value of 0.07 mg/L. The lowest nitrite concentration in 2009 was recorded at numerous monitoring wells during numerous events with a value of <0.01 mg/L and the high was recorded at monitoring well TR-4 in August with a value of 0.13 mg/L.

4.2.8 Ground Water Chloride and Potassium

Charts 36 and 37 show chloride and potassium concentrations for the monitoring wells TR-1.5, TR-3, TR-4, WR-1 and TCS-1 for the period of record. Chloride and Potassium were added to the parameters list in 1994. Potassium levels increased in TR-4 over the course of 2003, but have leveled off over the last few years. Chloride at TR-4 spiked in both October 2004 and May 2005, however concentrations returned to historical levels over the past few monitoring periods. Chloride has risen over the past 5 monitoring seasons at TCS-1. The lowest chloride concentration in 2009 was recorded at monitoring wells TR-3 and WR-1 in May with a value of 2 mg/L and the high was recorded at monitoring well TCS-1 in May with a value of 70 mg/L. The lowest potassium concentration in 2009 was recorded at monitoring well TR-3 in May with a value of 1.1 mg/L and the high was recorded at monitoring well WR-1 in May with a value of 11.3 mg/L.

5.0 SURFACE WATER AND GROUND WATER INTERACTIONS

The interrelationship in concentrations of chemical parameters between the surface waters and alluvial waters at the Edna Mine can only be suggested in very general terms. The primary reasons for this are the relative location of a given well to the creek, the source from which an alluvial well's water originates and the dynamics of alluvial flow.

Prior to 1995, a general trend evident in TDS and the major ions was that as one progressed downstream along the mine an increase in these parameters occurred in both the surface water and alluvial water. Beginning in 1995, the levels of all constituents in TR-1.5 increased dramatically. While the influence of this increase in upstream alluvial water is not clearly expressed in either surface or alluvial water downstream for the majority of the year, the elevated concentrations of surface water constituents observed in the early portion of the year are more pronounced than previously. This is probably a reflection of the co-mingling of alluvial water in the vicinity of TR-1.5 with creek water upstream of TR-B.

The independent nature of the observations and trends occurring within the creek water and alluvial water suggests the two water bodies have limited influence upon each other. The lack of influence is probably due to the slow exchange rate of water between the two bodies during most of the year.

6.0 QUALITY ASSURANCE

The quality assurance program is designed to check the precision and accuracy of the analytical results received from the laboratory providing the water quality analyses. During the collection of samples for analysis a duplicate sample from either a ground water or surface water monitoring site will be collected and analyzed. The duplicate sample analysis is compared with its paired sample for similarity.

Two duplicate samples were collected during 2009 for laboratory quality assurance purposes. The duplicate samples were taken at surface water monitoring sites TR-A in April and TR-B in August. Results of the duplicate analyses were favorable for most of the parameters tested.

The April duplicate for TR-A verified 10 of the 15 laboratory parameters to be within 5% of the original values obtained. The duplicate sample value for aluminum was 133% of the original value (0.03 mg/L-original vs. 0.04 mg/L-duplicate). The duplicate sample value for iron was 92% of the original value (0.25 mg/L-original vs. 0.23 mg/L-duplicate). The duplicate sample value for sodium was 139% of the original value (4.4 mg/L-original vs. 6.1 mg/L-duplicate). The duplicate sample value for chloride was 200% of the original value (1 mg/L-original vs. 2 mg/L-duplicate). The duplicate sample value for TSS was 120% of the original value (5 mg/L-original vs. 6 mg/L-duplicate).

The August duplicate for TR-B verified 13 of the 15 parameters to be within 5% of the original value obtained. The duplicate value for iron was 43% of the original value (0.21 mg/l-original vs. 0.09 mg/l-duplicate). The duplicate value for total suspended solids was 120% of the original value (5 mg/l-original vs. 6 mg/l-duplicate).

7.0 SPRING AND SEEP SURVEY

A spring and seep survey is performed annually in May, or as soon as practical after snowmelt, covering the base of reclaimed areas along Trout Creek. Flow from springs or seeps that exceed approximately 20 gpm are measured while flow from smaller expressions are visually estimated. Additionally, a sample will be taken annually from larger, exceeding 20 gpm, springs and seeps. The complete list of parameters used for surface water monitoring sites, except for TSS, is analyzed to characterize the type of flow.

A survey was conducted May 5, 2009 to May 6, 2009 to evaluate springs and seeps which existed during past surveys at the base of the ridge along Trout Creek from the northern Moffat boundary to the base of West Ridge. A total of 15 spring locations were surveyed. Of these 15 spring locations, 12 were either damp or had flowing water during the 2009 survey. A total of 21 seep locations were surveyed. Of these 21 seep locations, 5 were either damp or had flowing water during the 2009 survey. Table 13 contains a listing of the springs and seeps observed from 1993 through 2009. Spring and seep locations are shown on Plate 2.

Twelve of the 12 springs either damp or flowing exhibited sufficient discharge for flow to be estimated or calculated and field parameters measured during the 2009 monitoring period. Five of the 5 seeps either damp or flowing also exhibited sufficient discharge for flow to be estimated and field parameters measured. Several of the springs and seeps were sampled as single units due to their close proximity to each other and their apparent common origin. Flow estimates and field parameters for these springs and seeps are provided in Table 14.

Springs SPR-1, SPR-3, SPR-5 and SPR-11 and seep SE-23 had sufficient flow, singularly or in combination with other springs or seeps, to require additional laboratory water quality sampling in accordance with the mine's permit. Results of these analyses are provided in Table 15.

8.0 MOFFAT STABILITY MONUMENTS

A system of three control points and six monuments were established in the final Moffat pit area during the fourth quarter of 1997. The purpose of the monuments is to monitor the hillslope for long-term stability. The three control points were placed to form a large triangle. The reference control point was established along the top of the hillside in undisturbed ground above the final Moffat pit. The two additional control points (back-sites) were established in undisturbed ground northwest and south of the reference point. The back-sites were established to verify the location of the reference point. The monuments were installed in pairs with the first pair, SM-1 and SM-2, established in the lower third of the final pit area. SM-1 was placed approximately 130 feet south of the final pit highwall and SM-2 was placed approximately 340 feet south of the final pit highwall. The second pair, SM-3 and SM-4, were installed approximately mid-way along the pit. SM-3 was placed approximately 110 feet south of the highwall and SM-4 was placed approximately 325 feet south of the highwall. The last pair, SM-5 and SM-6 was installed in the upper third of final pit area. SM-5 was placed approximately 150 south of the highwall and SM-6 was placed approximately 350 feet south of the highwall. The monuments consist of 7' to 8' sections of 2-1/2" diameter drill steel driven 5-1/2' to 6-1/2' into the pit backfill material. Locations of the stability monuments are displayed on Plate 3.

The monuments were surveyed quarterly the first year and annually thereafter. In 2003, a level loop was surveyed providing elevation information. However, due to an equipment malfunction, x and y coordinates were lost. The 2009 stability monument survey was performed August 12, 2009. The coordinates of the initial monument survey and subsequent surveys are provided in Table 16.

CHARTS

Chart 1. Surface Water Flow

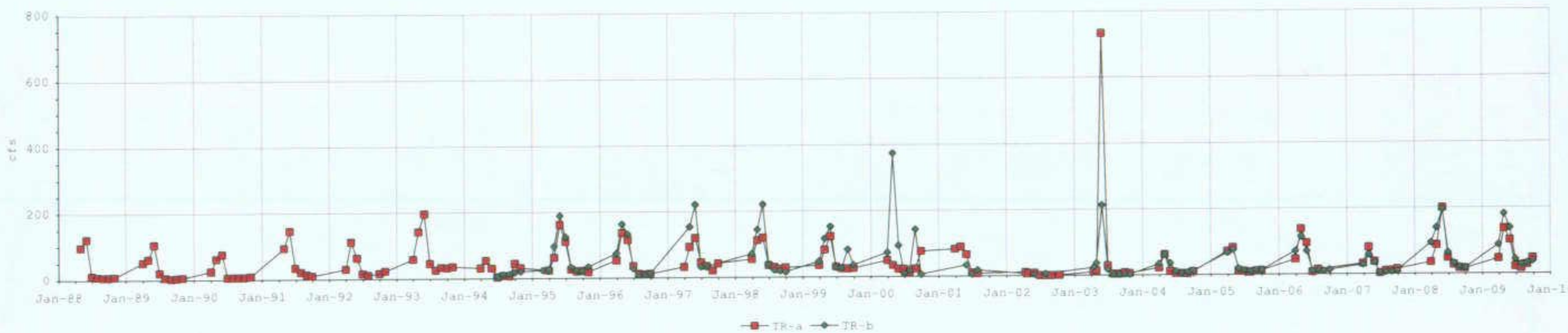


Chart 2. Surface Water Temperature

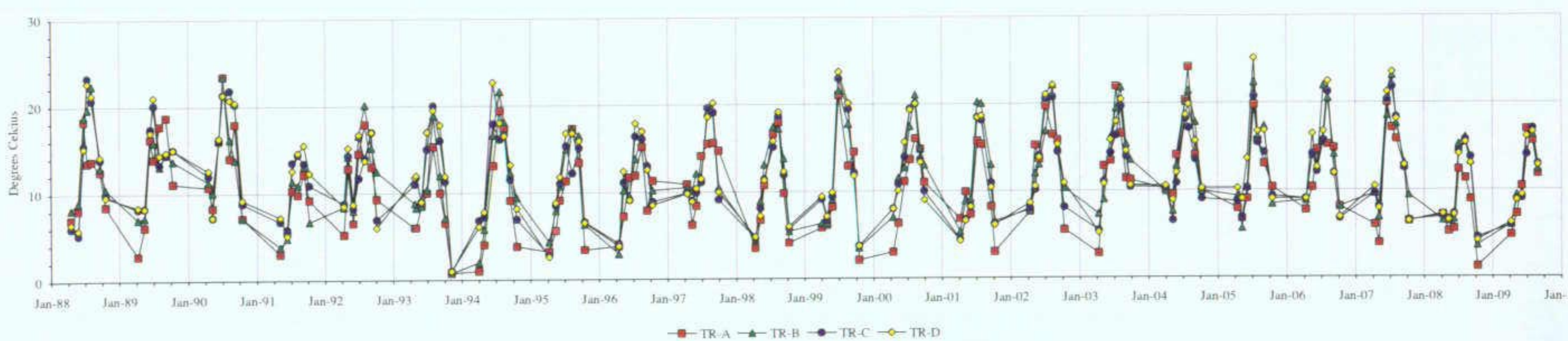


Chart 3. Surface Water pH

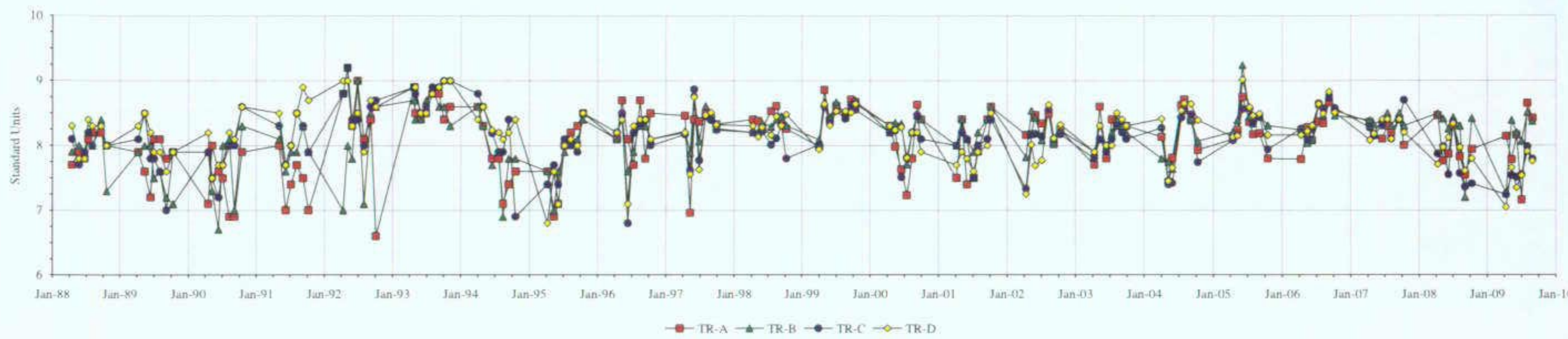


Chart 4. Surface Water Total Suspended Solids

Chart 5. Surface Water Specific Conductivity

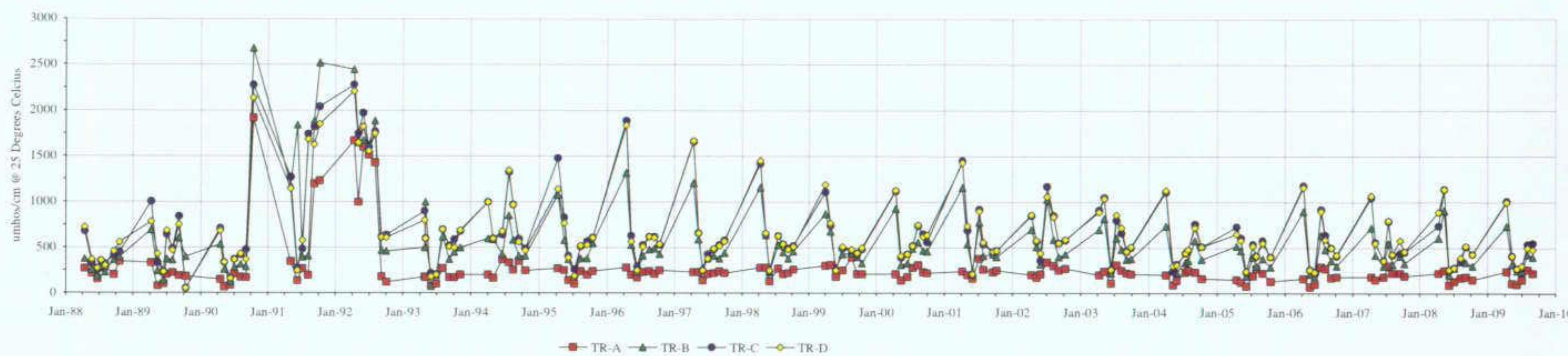


Chart 6. Surface Water Total Dissolved Solids

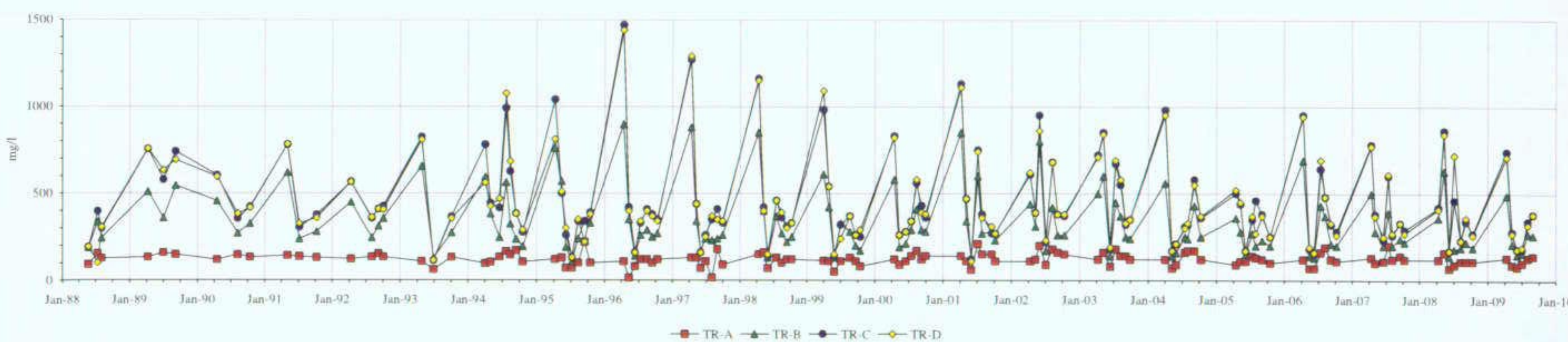


Chart 7. Surface Water Calcium

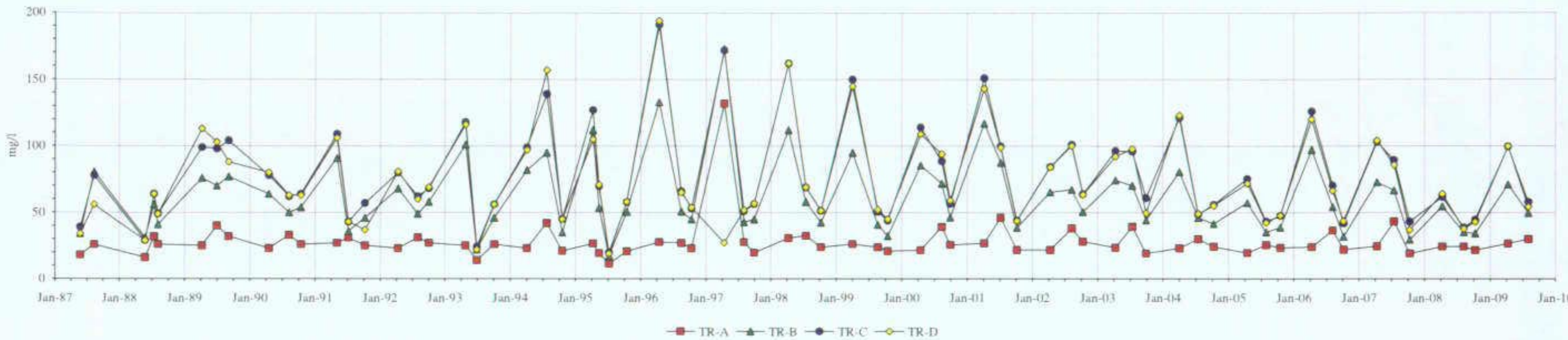


Chart 8. Surface Water Magnesium

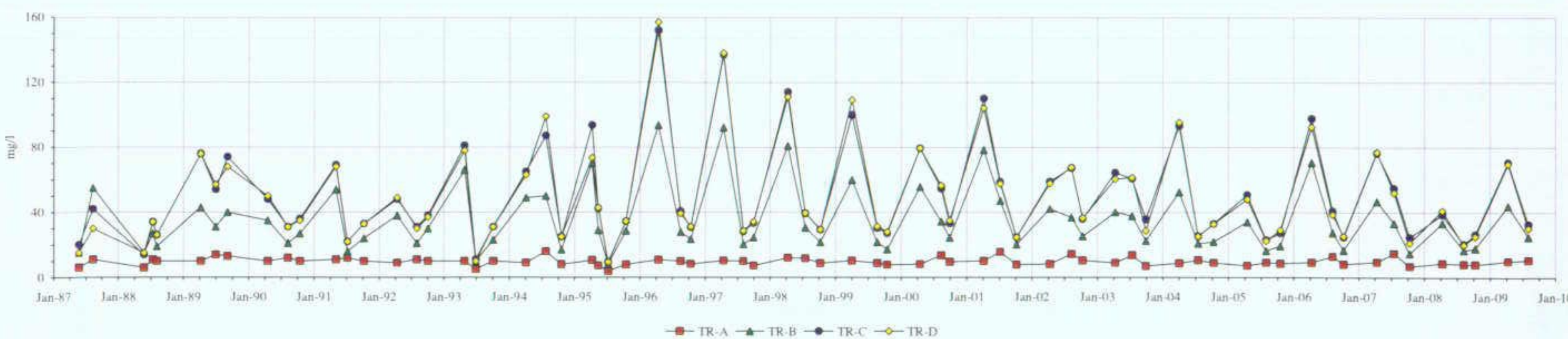


Chart 9. Surface Water Sodium

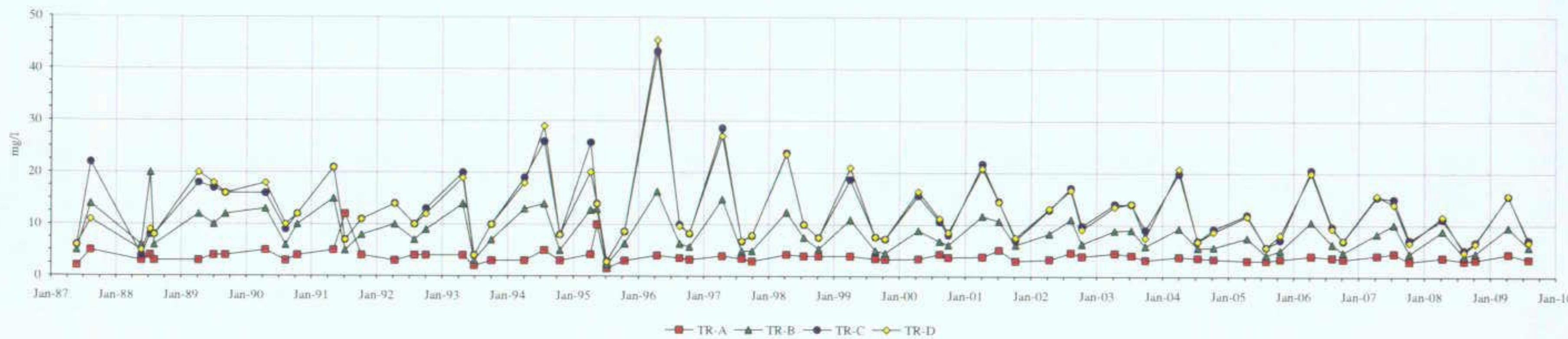


Chart 10. Surface Water Bicarbonate

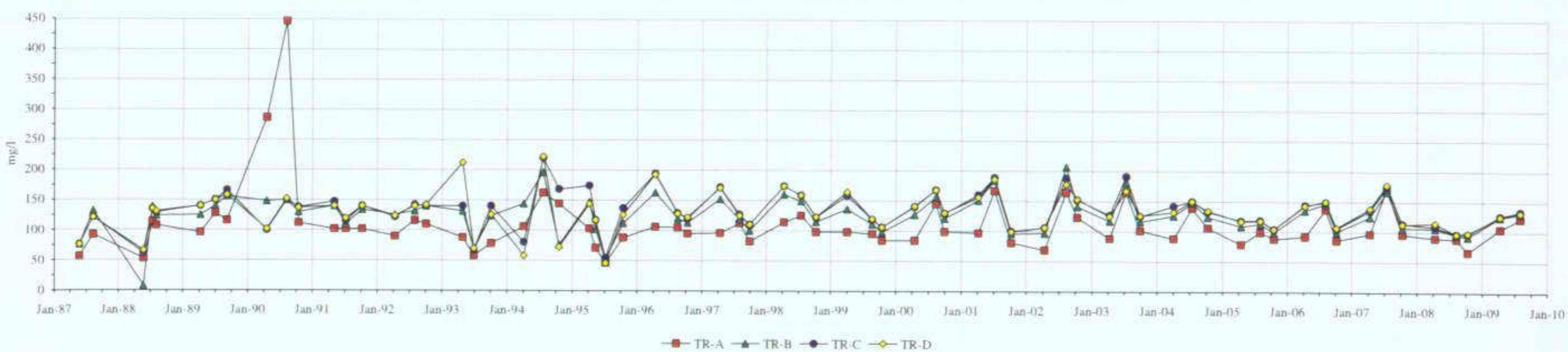


Chart 11. Surface Water Sulfate

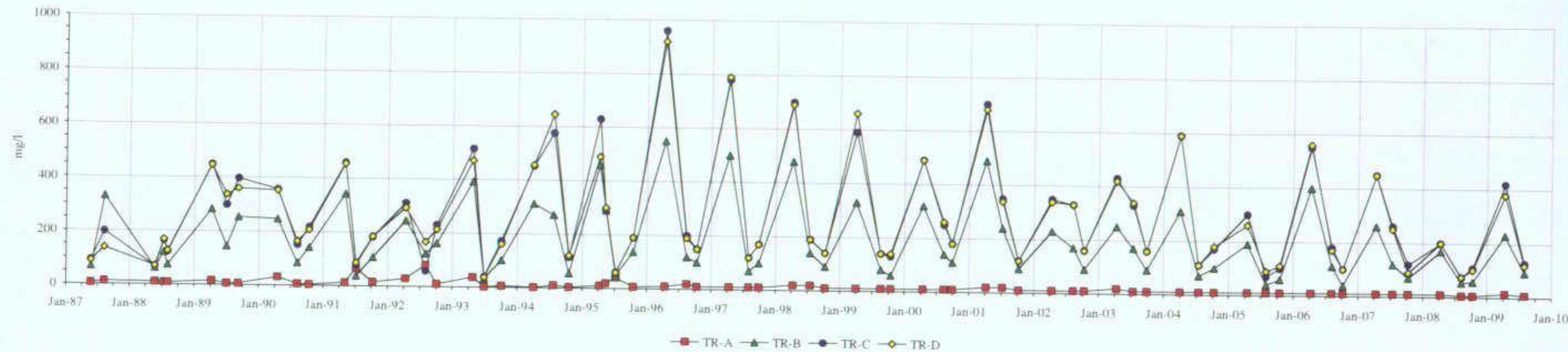
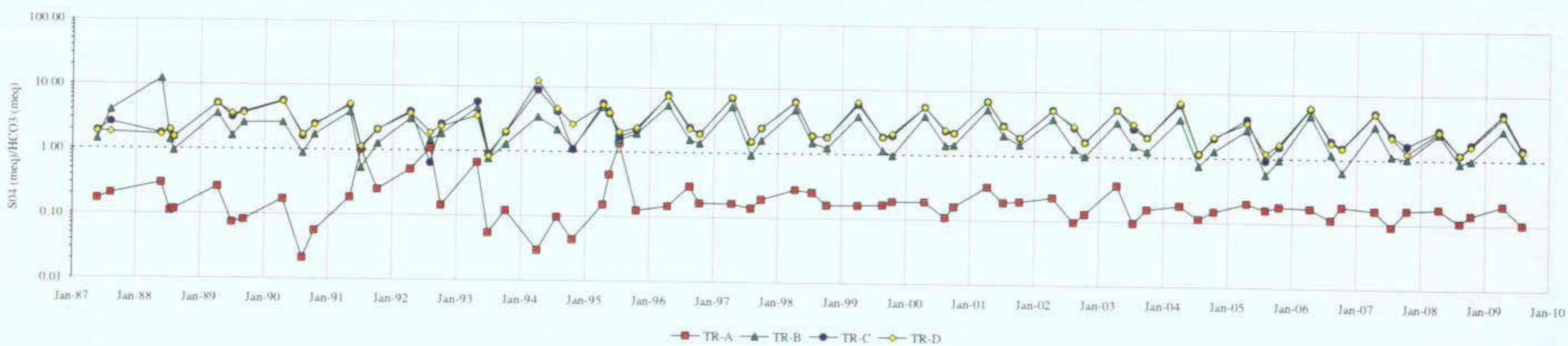


Chart 12. Surface Water Sulfate/Bicarbonate Ratio



(SO_4 = HCO_3 for y = 1.0 (---); SO_4 > HCO_3 for y > 1.0; SO_4 < HCO_3 for y < 1.0)

Chart 13. Surface Water Manganese

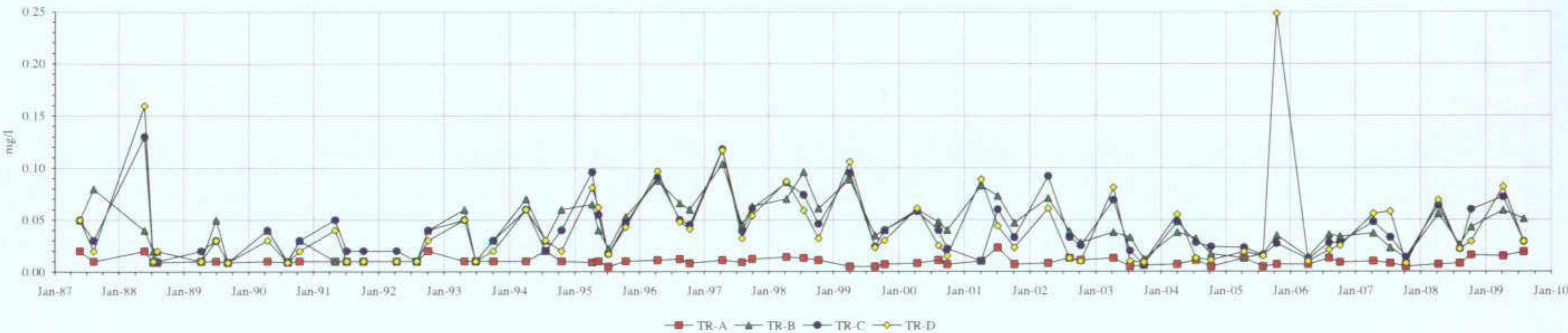


Chart 14. Surface Water Dissolved Aluminum

Chart 15. Surface Water Unionized Ammonia

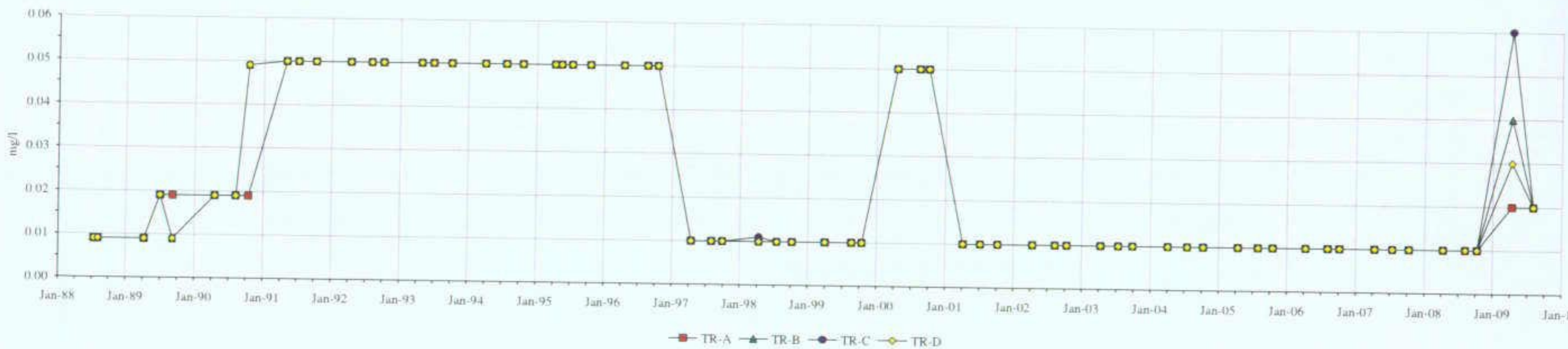


Chart 16. Surface Water Nitrite

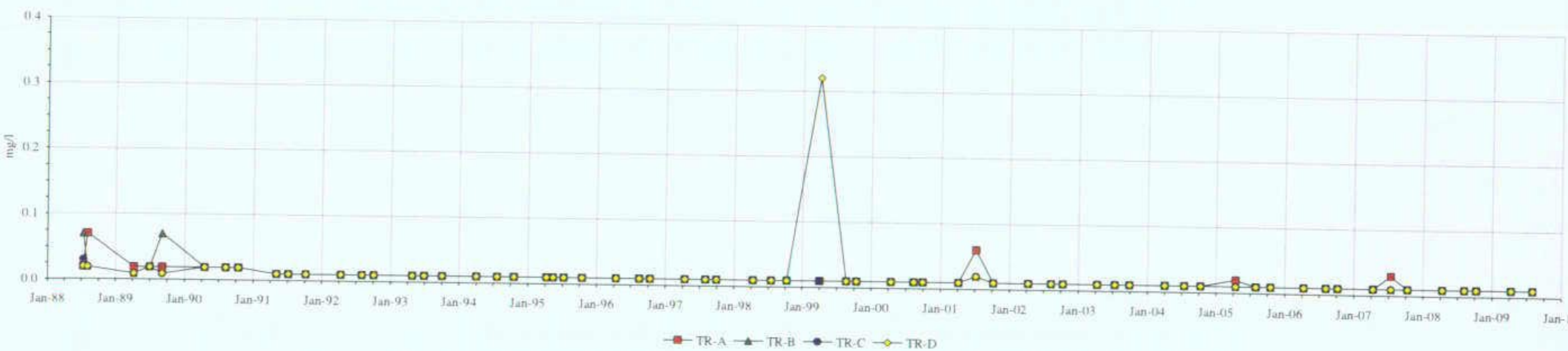


Chart 17. Surface Water Orthophosphate

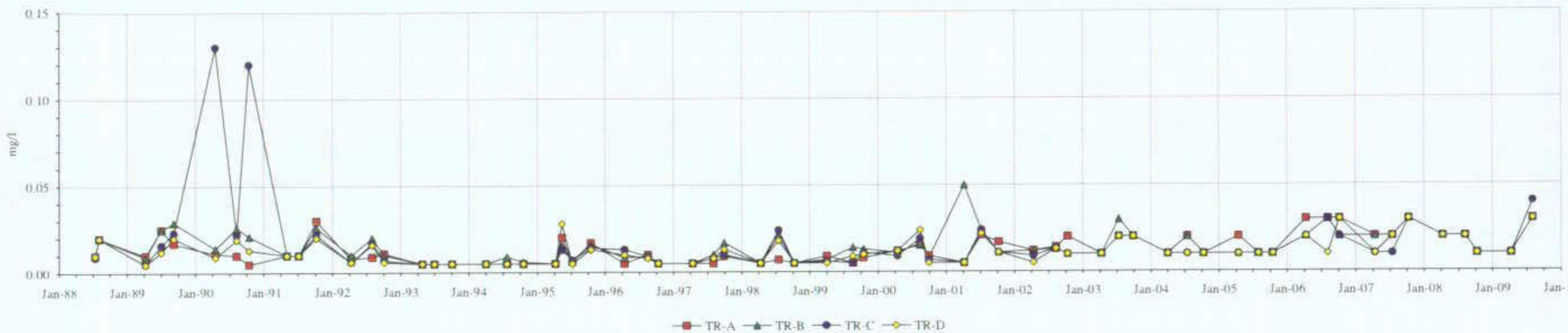


Chart 18. Surface Water Chloride

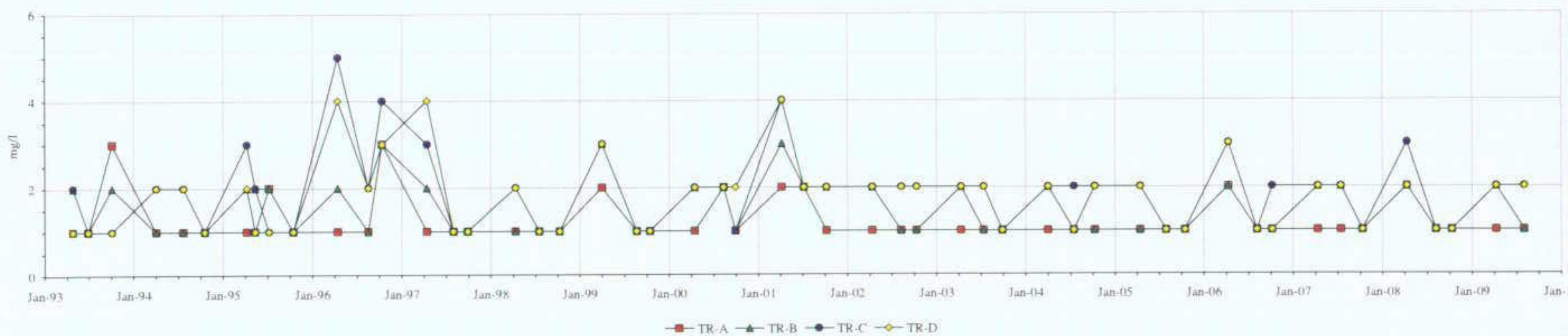


Chart 19. Surface Water Potassium

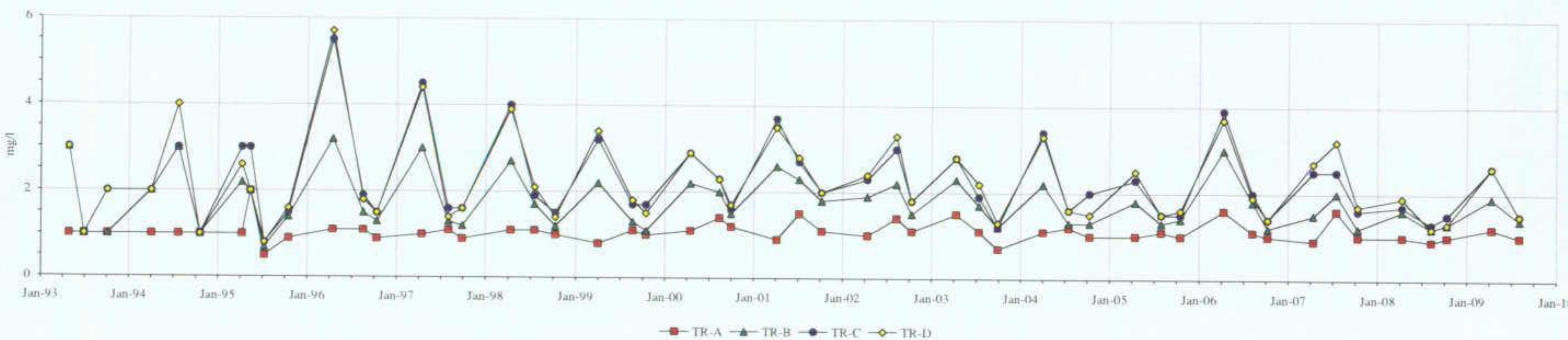


Chart 20. Surface Water Iron

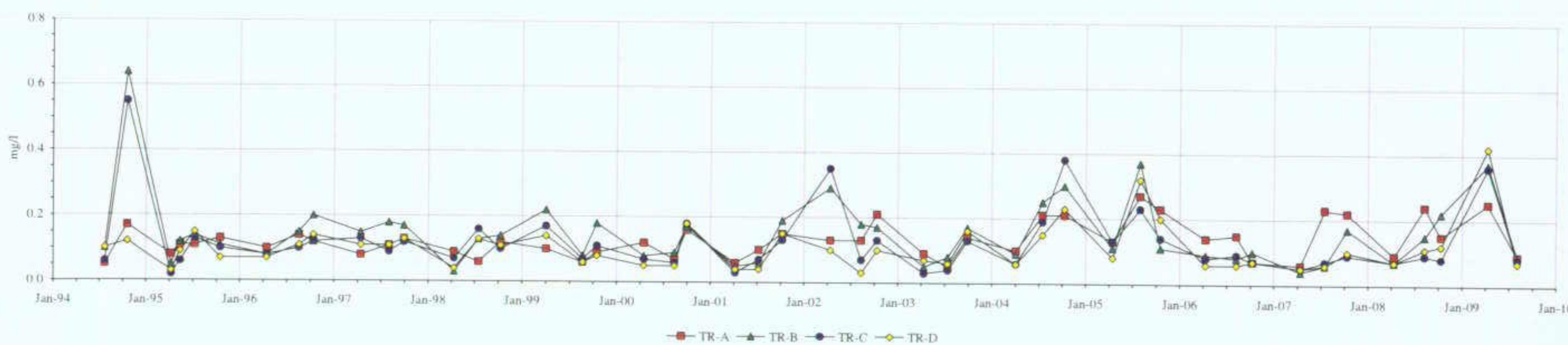


Chart 21. Ground Water Elevation

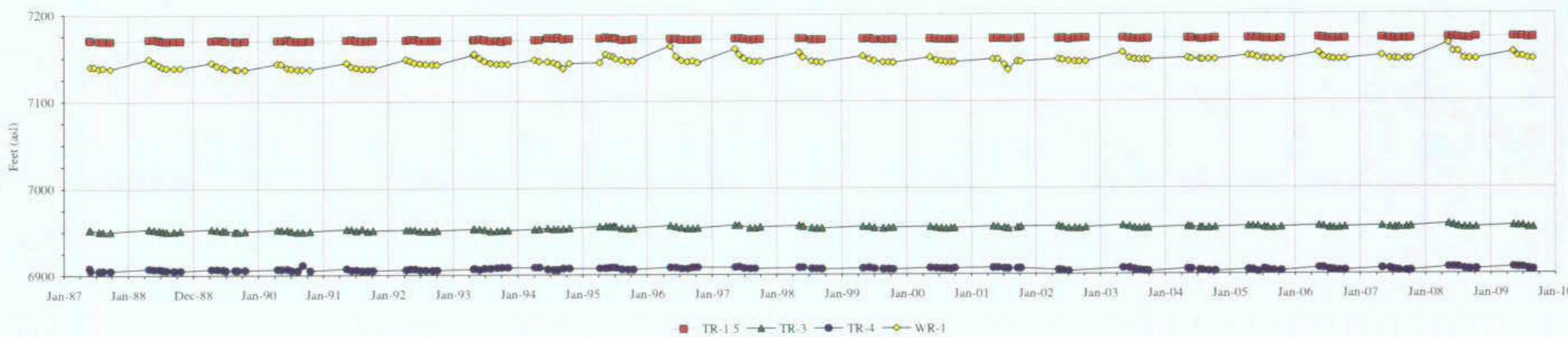


Chart 22. Ground Water Temperature

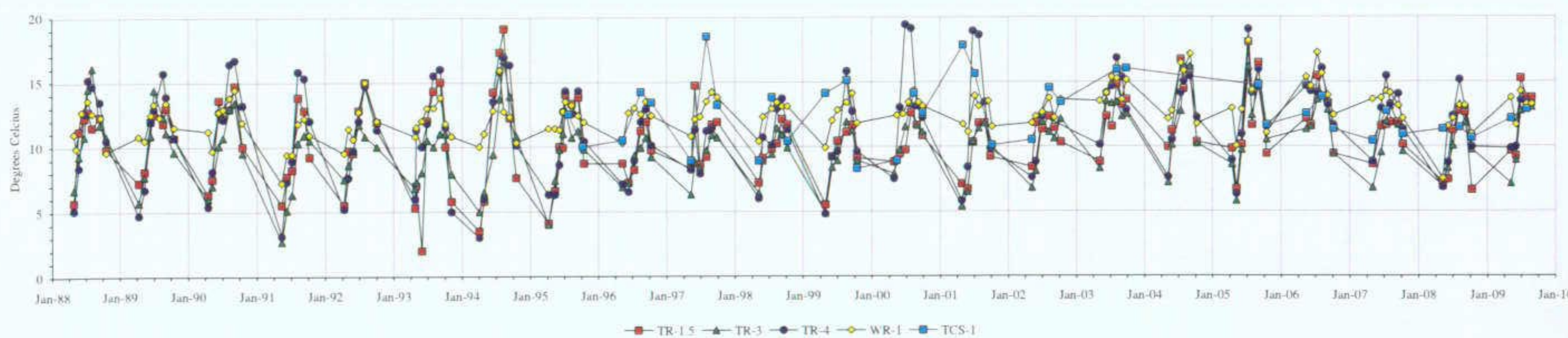


Chart 23. Ground Water pH

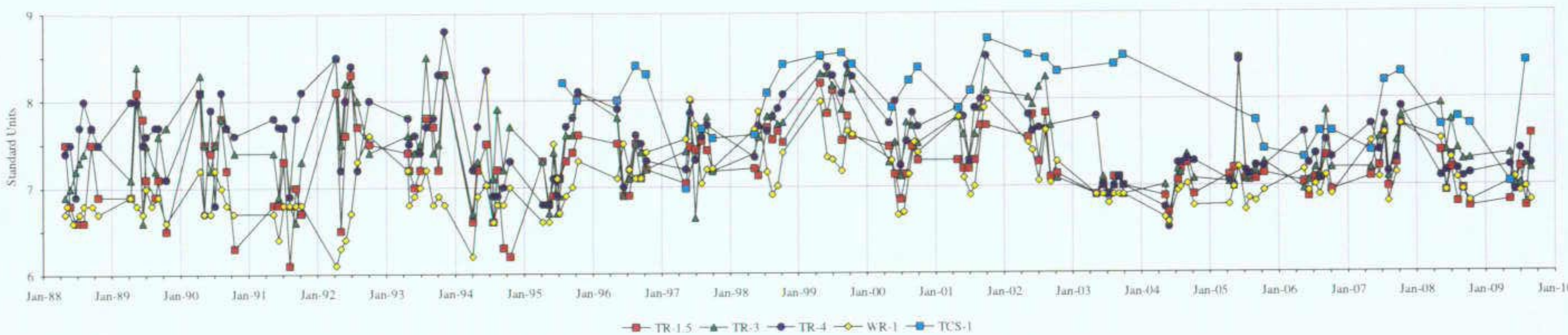


Chart 24. Ground Water Specific Conductivity

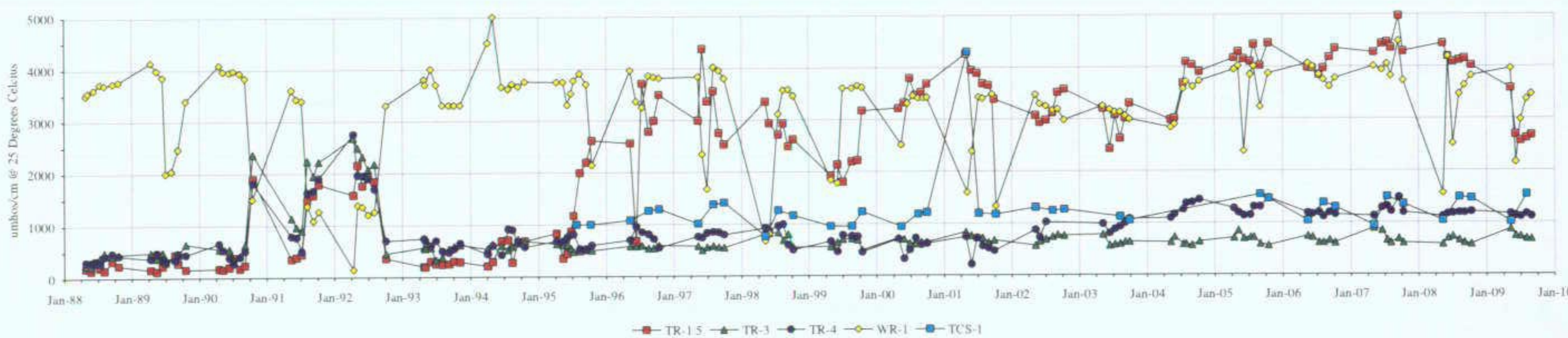


Chart 25. Ground Water Total Dissolved Solids

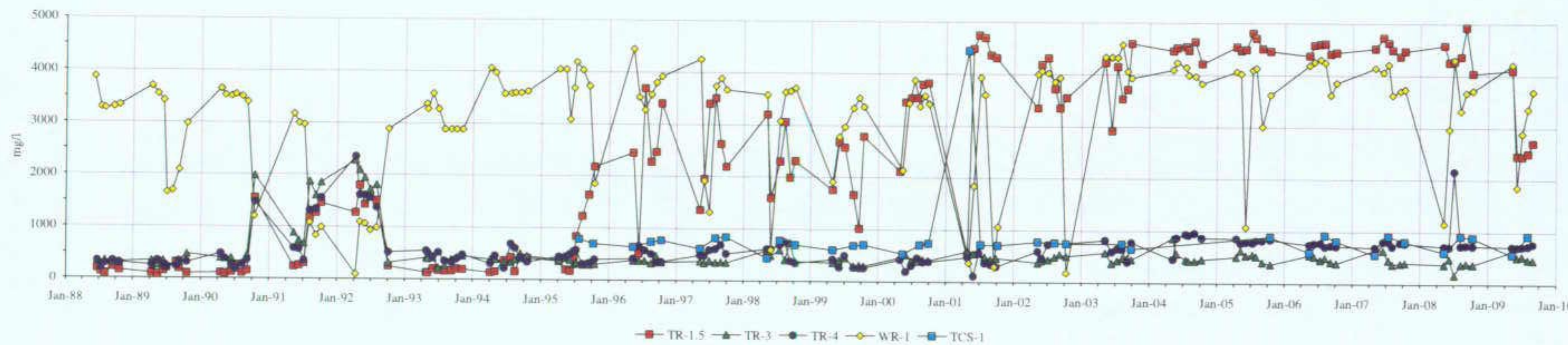


Chart 26. Ground Water Calcium

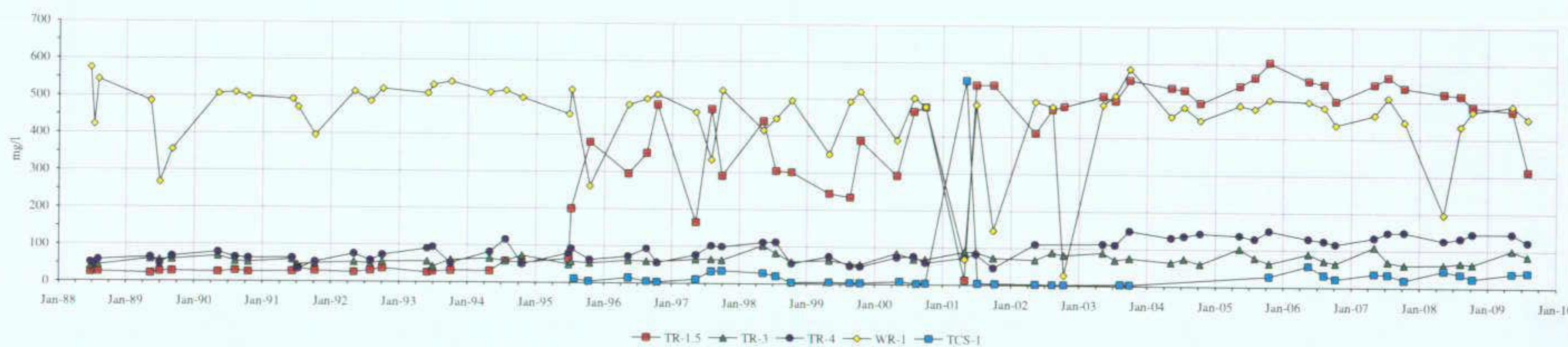


Chart 27. Ground Water Magnesium

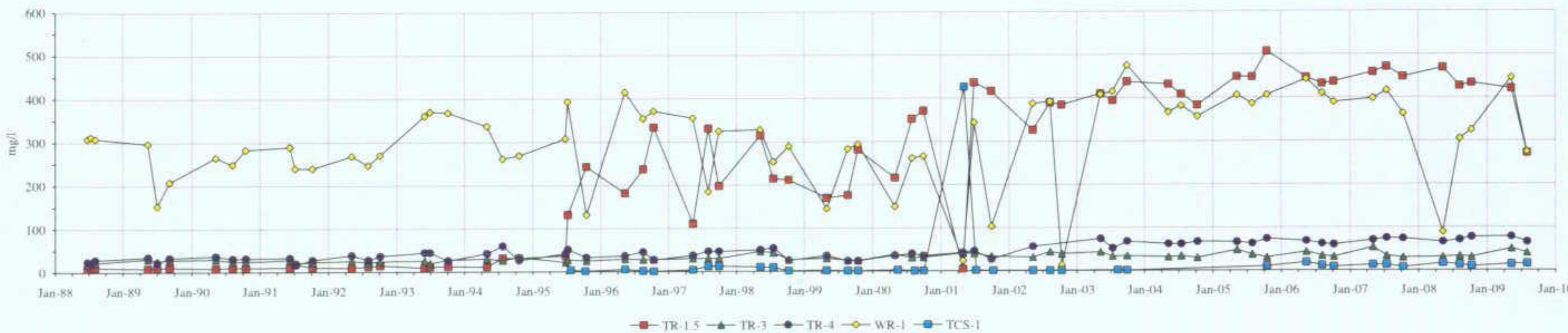


Chart 28. Ground Water Sodium

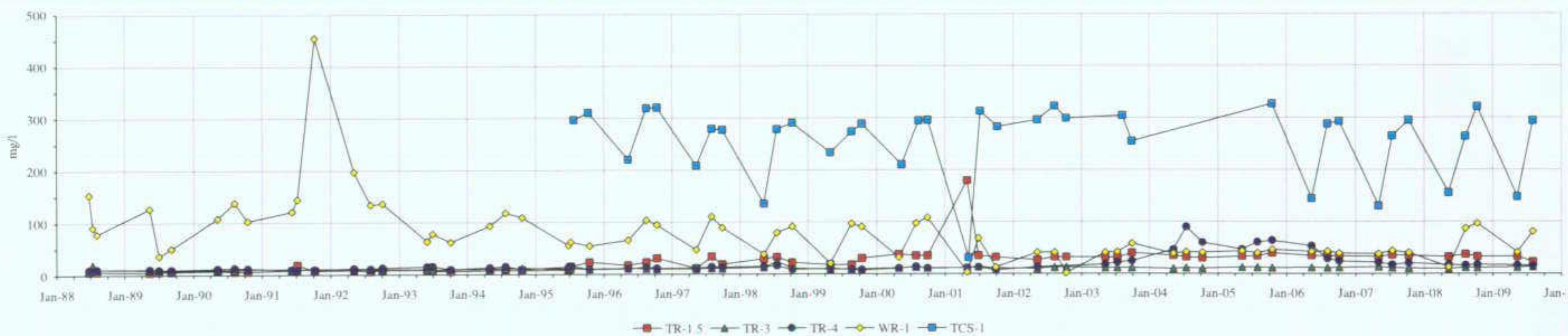


Chart 29. Ground Water Bicarbonate

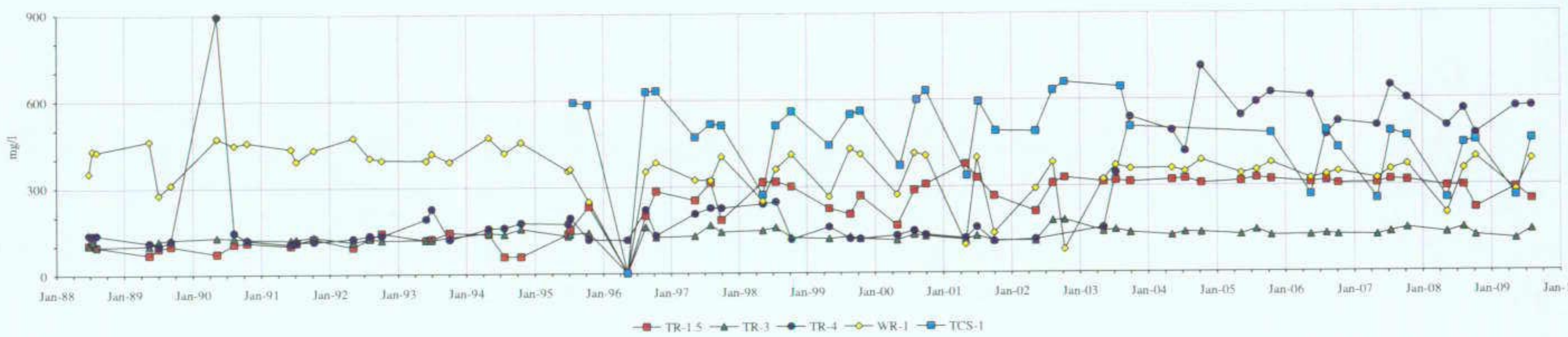


Chart 30. Ground Water Sulfate

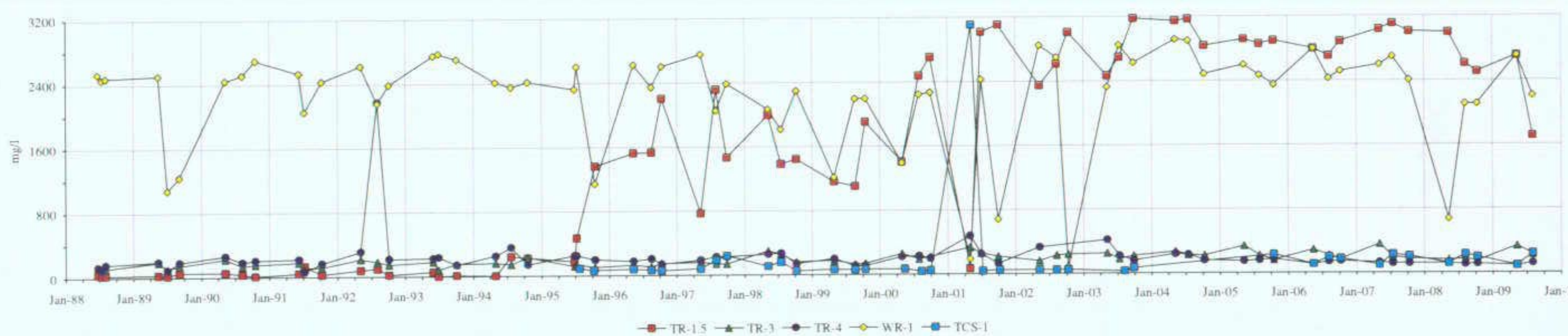


Chart 31. Ground Water Sulfate/Bicarbonate Ratio

(SO4 = HCO3 for y = 1.0 (---); SO4 > HCO3 for y > 1.0; SO4 < HCO3 for y < 1.0)

Chart 32. Ground Water Dissolved Iron

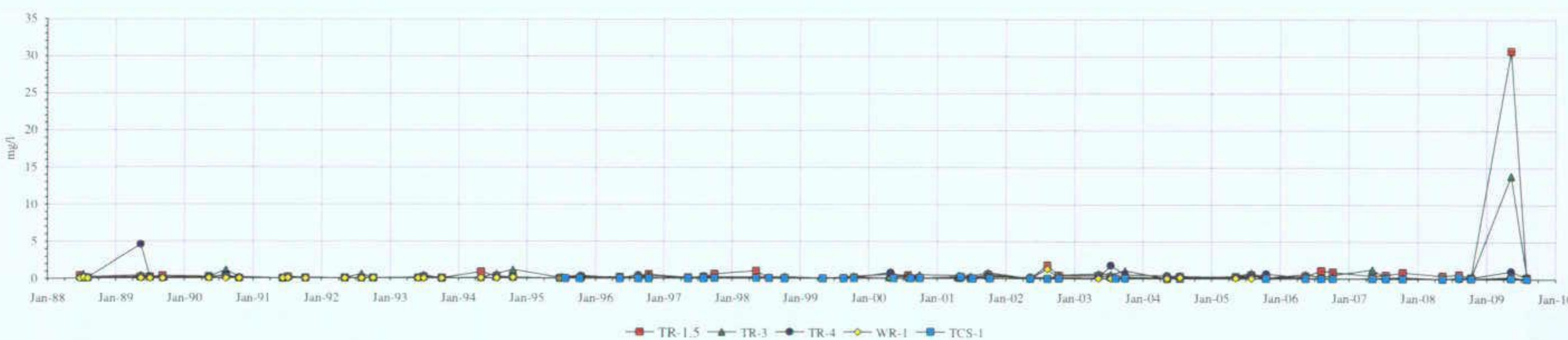


Chart 33. Ground Water Manganese

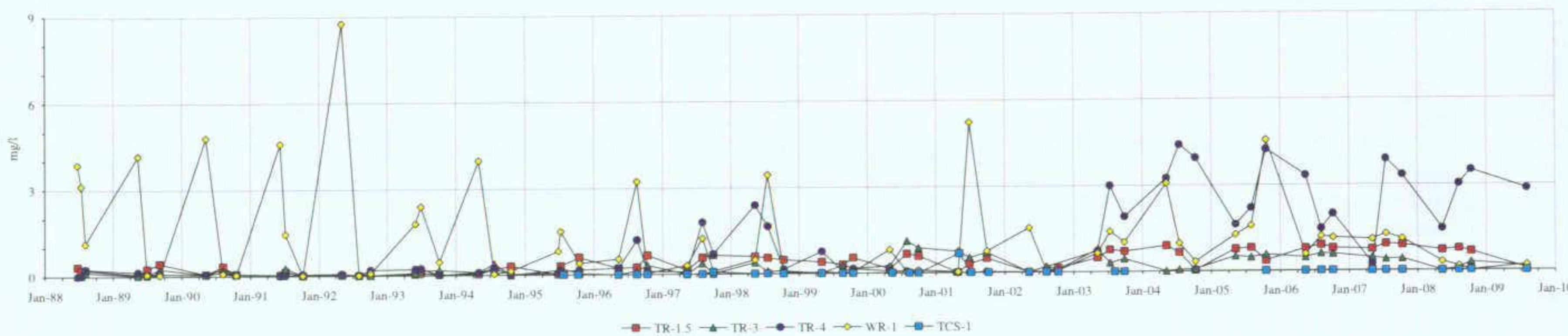


Chart 34. Ground Water Orthophosphate

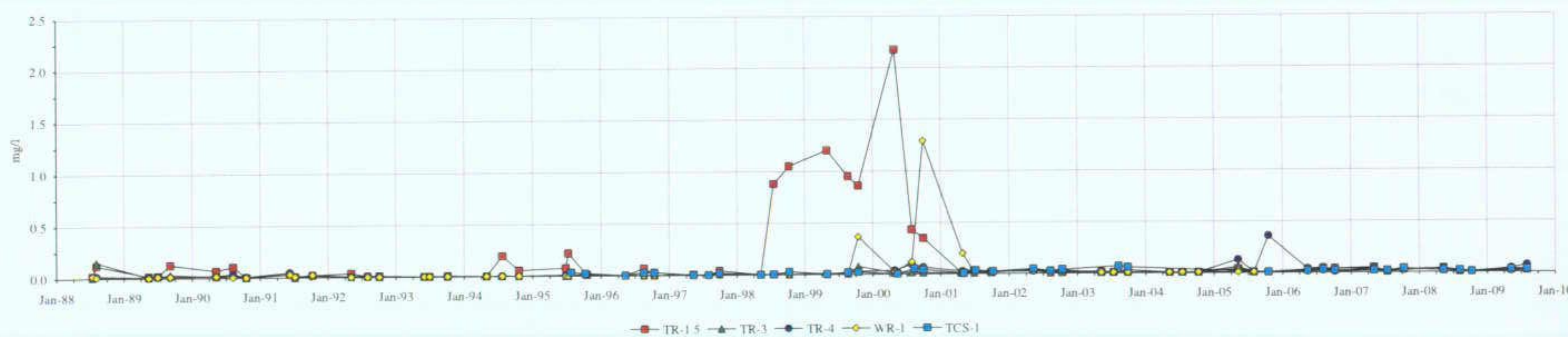


Chart 35. Ground Water Nitrite

Chart 36. Ground Water Chloride

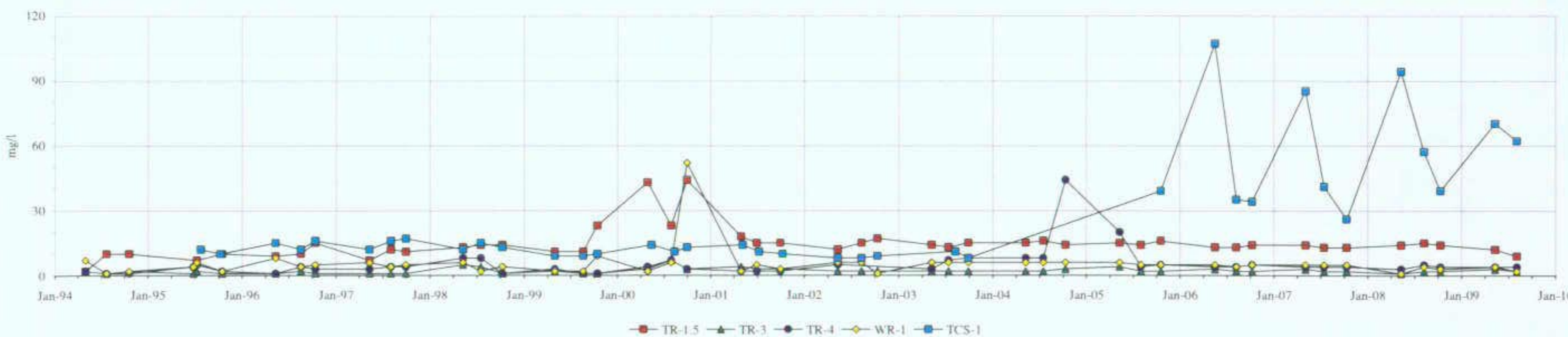
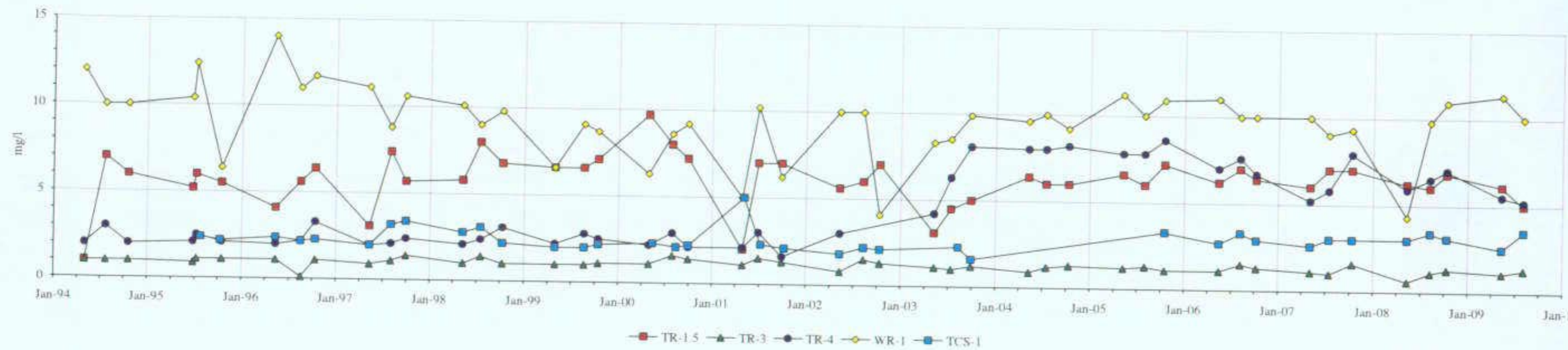


Chart 37. Ground Water Potassium



TABLES

Table 1. Trout Creek Average Streamflow at Site(s) TR-a (a) and/or TR-b (b)

Date	TR-a cfs. (avg)	TR-b cfs. (avg)	TR - A	TR - B	TR - C	TR - D
04/10/89	31.71		a			
04/13/89	24.48			a		
04/14/89	26.95	68.73			ab	ab
05/15/89	58.35	93.60	ab	ab	ab	ab
06/16/89	78.40		a	a		
06/19/89	102.88	93.60			b	b
07/03/89	6.34	19.72	ab	ab	ab	ab
08/03/89	4.03		a			
08/23/89	5.04	10.10		ab	ab	ab
09/07/89	1.79		a			
09/08/89		12.98		b	b	b
04/19/90	21.04	*217.94	ab	ab	ab	ab
05/14/90	58.48	*255.09			ab	ab
06/14/90	101.70	**	a	a	a	a
07/06/90	5.75	**	a	a	a	a
08/10/90	6.20	**				
09/07/90	7.80	25.02	ab	ab	ab	ab
10/16/90	5.88	28.28	ab	ab	ab	ab
05/06/91	21.60	23.57	ab	ab	ab	ab
06/11/91	233.75	**	a	a	a	a
07/09/91	42.29	**	a	a	a	a
08/09/91	24.41	**	a	a	a	a
09/11/91	13.48	**	a	a	a	a
04/13/92	23.35	68.73	ab	ab	ab	ab
05/06/92	81.38	176.20	ab	ab	ab	ab
06/01/92	141.27	148.23	ab	ab	ab	ab
07/01/92	12.09	35.51	ab	ab	ab	ab
08/03/92	18.10	28.15	ab	ab	ab	ab
10/05/92	8.17	33.99	ab	ab	ab	ab
04/28/93		115.23	b	b	b	b
05/04/93	79.49	186.15	ab	ab	ab	ab
06/02/93	198.24	255.09	ab	ab	ab	ab
07/01/93	42.61	78.14	ab	ab	ab	ab
08/04/93	14.46	*142.97	ab	ab	ab	ab
09/09/93	29.00	*257.53	ab	ab	ab	ab
10/06/93	25.49	*351.41	ab	ab	ab	ab
11/08/93	30.99	*295.69	ab	ab	ab	ab
05/03/94	29.83	*186.15	ab	ab	ab	ab
06/20/94	24.86		a	a	a	a
07/25/94	3.08		a	a	a	a
08/16/94	9.42	19.92	ab	ab	ab	ab
09/16/94	7.72	13.14	ab	ab	ab	ab
10/21/94	54.94	20.09	ab	ab	ab	ab

Table 1. Trout Creek Average Streamflow at Site(s) TR-a (a) and/or TR-b (b)

Date	TR-a cfs. (avg)	TR-b cfs. (avg)	TR - A	TR - B	TR - C	TR - D
04/11/95		20.45	b	b	b	b
05/16/95	94.94	76.91	ab	ab	ab	ab
06/08/95	109.17	119.04	ab	ab	ab	ab
07/11/95	177.95	199.82	ab	ab	ab	ab
08/14/95	24.34	29.78	ab	ab	ab	ab
09/18/95	17.83	19.23	ab	ab	ab	ab
10/18/95	20.91	15.95	ab	ab	ab	ab
04/16/96	42.65	71.57	ab	ab	ab	ab
05/13/96	152.68	195.25	ab	ab	ab	ab
06/14/96	110.61	128.08	ab	ab	ab	ab
07/15/96	26.87	13.20	ab	ab	ab	ab
08/19/96	12.10	8.71	ab	ab	ab	ab
09/16/96	9.62	10.12	ab	ab	ab	ab
10/14/96	10.87	16.03	ab	ab	ab	ab
04/16/97	17.78		a	a	a	a
05/13/97	81.30	122.90	ab	ab	ab	ab
06/04/97	162.14	307.07	ab	ab	ab	ab
07/01/97	82.48	65.51	ab	ab	ab	ab
08/04/97	42.18	38.29	ab	ab	ab	ab
09/02/97	34.30	18.14	ab	ab	ab	ab
10/01/97	18.63		a	a	a	a
04/14/98	37.84	42.96	ab	ab	ab	ab
05/12/98	101.80	135.33	ab	ab	ab	ab
06/02/98	167.38	156.95	ab	ab	ab	ab
07/20/98	17.68	17.10	ab	ab	ab	ab
08/17/98	29.07	18.89	ab	ab	ab	ab
09/14/98	27.78	19.06	ab	ab	ab	ab
10/12/98	29.43	15.21	ab	ab	ab	ab
04/01/99	35.06	47.79	ab	ab	ab	ab
05/01/99	82.39	117.22	ab	ab	ab	ab
06/01/99	123.44	153.24	ab	ab	ab	ab
07/01/99	31.19	28.61	ab	ab	ab	ab
08/01/99	25.28	26.53	ab	ab	ab	ab
09/01/99	24.53	*83.15	ab	ab	ab	ab
10/01/99	26.46	35.62	ab	ab	ab	ab
04/01/00	49.57	73.17	ab	ab	ab	ab
05/01/00	34.93	373.84*	ab	ab	ab	ab
06/01/00	23.29	94.76	ab	ab	ab	ab
07/01/00	20.14	8.82	ab	ab	ab	ab
08/01/00	13.15	18.74*	ab	ab	ab	ab
09/01/00	23.53	143.5*	ab	ab	ab	ab
10/01/00	76.87	6.54	ab	ab	ab	ab

Table 1. Trout Creek Average Streamflow at Site(s) TR-a (a) and/or TR-b (b)

Date	TR-a cfs. (avg)	TR-b cfs. (avg)	TR - A	TR - B	TR - C	TR - D
New stage/discharge curve developed in 2001.						
04/01/01	82.00	***	a	a	a	a
05/01/01	90.00	***	a	a	a	a
06/01/01	66.00	34.00	ab	ab	ab	ab
07/01/01	10.00	6.00	ab	ab	ab	ab
08/01/01	8.00	18.00	ab	ab	ab	ab
09/01/01	15.00	***	a	a	a	a
10/01/01	10.00	***	a	a	a	a
04/15/02	10.31	***	a	a	a	a
05/01/02	6.14	***	a	a	a	a
06/01/02	7.76	4.07	ab	ab	ab	ab
07/01/02	0.46	***	a	a	a	a
08/01/02	0.49	5.05	ab	ab	ab	ab
09/01/02	0.42	***	a	a	a	a
10/14/02	1.20	***	a	a	a	a
New digital recorders installed.						
04/16/03	9.77	23.69	ab	ab	ab	ab
05/01/03	13.80	36.68	ab	ab	ab	ab
06/01/03	733.47****	213.34	ab	ab	ab	ab
07/01/03	29.24	18.04	ab	ab	ab	ab
08/01/03	3.48	2.24	ab	ab	ab	ab
09/01/03	3.48	2.24	ab	ab	ab	ab
10/01/03	7.88	3.21	ab	ab	ab	ab
10/26/03	5.20	2.70	ab	ab	ab	ab
04/14/04	21.58	33.67	ab	ab	ab	ab
05/01/04	62.60	62.40	ab	ab	ab	ab
06/01/04	10.45	36.19	ab	ab	ab	ab
07/01/04	4.26	10.56	ab	ab	ab	ab
08/01/04	4.59	5.40	ab	ab	ab	ab
09/01/04	3.18	7.29	ab	ab	ab	ab
10/01/04	9.67	12.77	ab	ab	ab	ab
04/01/05	71.53	66.07	ab	ab	ab	ab
05/01/05	82.67	76.90	ab	ab	ab	ab
06/01/05	12.26	17.26	ab	ab	ab	ab
07/01/05	9.70	12.98	ab	ab	ab	ab
08/01/05	7.00	9.33	ab	ab	ab	ab
09/01/05	10.36	13.23	ab	ab	ab	ab
10/01/05	12.08	13.58	ab	ab	ab	ab
04/01/06	45.61	70.87	ab	ab	ab	ab
05/01/06	138.35	115.19	ab	ab	ab	ab
06/01/06	95.06	70.95	ab	ab	ab	ab
07/01/06	6.73	10.02	ab	ab	ab	ab
08/01/06	15.39	11.93	ab	ab	ab	ab
09/01/06	*****	9.92	b	b	b	b
10/01/06	*****	13.47	b	b	b	b

Table 1. Trout Creek Average Streamflow at Site(s) TR-a (a) and/or TR-b (b)

Date	TR-a cfs. (avg)	TR-b cfs. (avg)	TR - A	TR - B	TR - C	TR - D
04/01/07	31.88	28.29	ab	ab	ab	ab
05/01/07	81.57	58.74	ab	ab	ab	ab
06/01/07	37.32	34.95	ab	ab	ab	ab
07/01/07	2.78	4.10	ab	ab	ab	ab
08/01/07	9.84	5.61	ab	ab	ab	ab
09/01/07	11.11	6.28	ab	ab	ab	ab
10/01/07	15.39	9.42	ab	ab	ab	ab
04/01/08	35.23	94.37	ab	ab	ab	ab
05/01/08	87.35	139.68	ab	ab	ab	ab
06/01/08	200.24	196.29	ab	ab	ab	ab
07/01/08	47.71	63.95	ab	ab	ab	ab
08/01/08	27.11	31.76	ab	ab	ab	ab
09/01/08	17.47	21.02	ab	ab	ab	ab
10/01/08	15.70	17.79	ab	ab	ab	ab
04/01/09	45.46	86.98	ab	ab	ab	ab
05/01/09	136.88	181.01	ab	ab	ab	ab
06/01/09	102.13	138.54	ab	ab	ab	ab
07/01/09	21.59	42.59	ab	ab	ab	ab
08/01/09	15.57	27.72	ab	ab	ab	ab
09/01/09	27.53	32.30	ab	ab	ab	ab
10/01/09	47.45	37.81	ab	ab	ab	ab

*Water flow below Station B blocked by beaver dam
**Water level staff gauge destroyed by high flows
***Continuous reading meter down for repairs
**** Debris upstream of bridge forced water to backup to TR-a resulting in false high readings.
*****Battery failed on digital recorder. Data for TR-a unattainable.

Table 2. Irrigation Ditch Flow Observations at Site TR-A

Date	Flow Observation (Flowing/Not Flowing)	Approximate Flow (cfs)
04/18/00	Not Flowing	0.00
07/18/00	Flowing	1.69
08/15/00	Flowing	0.69
09/11/00	Flowing	0.23
04/09/01	Flowing	0.02
07/10/01	Flowing	8.63
08/01/01	Flowing	0.88
09/21/01	Flowing	0.88
10/10/01	Not Flowing	0.00
05/13/02	Flowing	9.23
06/03/02	Flowing	9.23
07/01/02	Flowing	2.59
07/30/02	Flowing	1.22
09/09/02	Not Flowing	0.00
04/14/03	Flowing	0.07
05/12/03	Flowing	0.02
06/17/03	Flowing	8.34
07/16/03	Flowing	4.63
08/12/03	Flowing	3.72
09/08/03	Flowing	1.01
10/01/03	Not Flowing	0.00
10/27/03	Not Flowing	0.00
04/05/04	Not Flowing	0.00
06/01/04	Flowing	2.49
07/01/04	Not Flowing	0.00
04/18/05	Flowing	1.69
05/12/05	Flowing	2.40
06/09/05	Flowing	9.38
07/15/05	Flowing	15.05
08/03/05	Flowing	0.02
10/20/05	Not Flowing	0.00
04/14/06	Not Flowing	0.00
05/19/06	Flowing	0.53
06/13/06	Flowing	1.10
07/18/06	Flowing	9.69
08/10/06	Not Flowing	0.00
10/11/06	Not Flowing	0.00
04/16/07	Not Flowing	0.00
05/08/07	Not Flowing	0.00
06/22/07	Flowing	9.54
07/01/07	Flowing	11.27
08/09/07	Not Flowing	0.00
09/21/07	Not Flowing	0.00
10/15/07	Not Flowing	0.00

Table 2. Irrigation Ditch Flow Observations at Site TR-A

Date	Flow Observation (Flowing/Not Flowing)	Approximate Flow (cfs)
04/14/08	Not Flowing	0.00
05/14/08	Not Flowing	0.00
06/11/08	Flowing	11.93
07/07/08	Not Flowing	0.00
08/11/08	Not Flowing	0.00
09/08/08	Not Flowing	0.00
10/14/08	Not Flowing	0.00
04/14/09	Not Flowing	0.00
05/14/09	Not Flowing	0.00
06/09/09	Flowing	13.98
07/06/09	Not Flowing	0.00
08/06/09	Not Flowing	0.00
09/02/09	Not Flowing	0.00

Table 3. Surface Water Quality at Site TR-A

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/15/88	7.70	7.0	269		4														
05/25/88	7.90	8.1	216	90	12				53	10	0.3	16.0	6.0	3.0		0.020			
06/24/88	7.80	18.3	152		12														
07/14/88	8.10	13.5	270	152	14	0.010	0.02	0.01	114	8	0.1	32.0	11.0	4.0	0.05	0.009			
08/05/88	8.20	13.7	284	126	8	0.020	0.07	0.01	108	8	0.1	26.0	10.0	3.0	0.05	0.009			
09/21/88	8.20	12.5	201		2														
10/21/88	8.00	8.5	347		2														
04/10/89	7.90	2.8	331	132	38	0.010	0.02	0.01	96	16	0.3	25.0	10.0	3.0	0.09	0.010			
05/15/89	7.60	6.1	78		4														
06/16/89	7.20	16.2	98		18														
07/03/89	8.10	13.9	203	158	2	0.025	0.02	0.02	128	6	0.1	40.0	14.0	4.0	0.05	0.010			
08/03/89	8.10	17.7	223		2														
09/07/89	7.80	18.7	189	148	2	0.017	0.02	0.02	116	6	0.1	32.0	13.0	4.0	0.05	0.009			
10/13/89	7.90	11.1	181		6														
04/19/90	7.10	10.7	149	118	2	0.011	0.02	0.02	286	31	0.2	23.0	10.0	5.0	0.08	0.010			
05/11/90	8.00	8.3	66		6														
06/14/90	7.60	16.0	84		20														
07/06/90	7.50	23.4	211		10														
08/10/90	6.90	14.0	172	146	6	0.010	0.02	0.02	446	6	0.0	33.0	12.0	3.0	0.05	0.009			
09/07/90	6.90	17.9	169		4														
10/16/90	7.90	7.1	1920	132	2	0.005	0.02	0.02	112	4	0.1	26.0	10.0	4.0	0.05	0.010			
05/06/91	8.00	3.0	347	142	4	< 0.010	< 0.01	< 0.05	102	12	0.2	27.0	11.0	5.0	< 0.05	< 0.010			
06/11/91	7.00	5.6	135		30														
07/09/91	7.40	10.3	266	136	28	< 0.010	< 0.01	< 0.05	102	66	1.0	31.0	12.0	12.0	< 0.05	< 0.010			
08/09/91	7.70	9.8	196		8														
09/11/91	7.50	12.2	1200		4														
10/10/91	7.00	9.2	1232	130	< 2	0.030	< 0.01	< 0.05	102	16	0.2	25.0	10.0	4.0	< 0.05	< 0.010			
04/13/92	8.80	5.2	1671	122	< 2	0.008	< 0.01	< 0.05	90	29	0.5	23.0	9.0	3.0	< 0.05	< 0.010			
05/06/92	9.20	12.8	996		< 2														
06/01/92	8.30	6.5	1600		8														
07/01/92	9.00	14.5	1515		4														
08/03/92	8.10	17.9	1430	134	8	0.009	< 0.01	< 0.05	116	80	1.1	31.0	11.0	4.0	< 0.05	< 0.010			
09/08/92	8.40	13.0	180	153	< 2														
10/05/92	6.60	9.3	120	134	< 2	0.011	< 0.01	0.05	110	< 10	0.1	27.0	10.0	4.0	< 0.05	0.020			

Table 3. Surface Water Quality at Site TR-A

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/28/93	8.90	6.0	175	108	< 2	< 0.005	< 0.01	< 0.05	88	37	0.7	25.0	10.0	4.0	< 0.05	0.010	1.0	< 1	
05/04/93	8.50	6.0	170		4														
06/02/93	8.40	8.5	74																
07/01/93	8.50	10.0	100	62	12	< 0.005	< 0.01	< 0.05	58	< 2	0.1	14.0	5.0	2.0	< 0.05	< 0.010	< 1.0	< 1	
08/04/93	8.80	15.3	270		6														
09/09/93	8.80	10.0	170		2														
10/06/93	8.40	6.5	170	132	8	< 0.005	< 0.01	< 0.05	78	6	0.1	26.0	10.0	3.0	< 0.05	< 0.010	1.0	3	
11/08/93	8.60	0.8	200		< 2														
04/05/94	8.60	1.0	200	96	< 2	< 0.005	< 0.01	< 0.05	106	< 2	0.0	23.0	9.0	3.0	< 0.05	< 0.010	< 1.0	< 1	
05/03/94	8.30	4.0	165	104															
06/20/94	7.80	13.1	370	134															
07/25/94	7.80	19.4	335	166	< 2	< 0.005	< 0.01	< 0.05	162	10	0.1	42.0	16.0	5.0	< 0.05	0.020	1.0	< 1	0.05
08/16/94	7.10	17.4	253	146															
09/16/94	7.40	9.1	352	172															
10/21/94	7.60	3.8	248	106	< 5	< 0.005	< 0.01	< 0.05	144	< 4	0.0	21.0	8.0	3.0	< 0.05	0.010	< 1.0	< 1	0.17
04/11/95	7.60	3.2	270	120	6	< 0.005	< 0.01	< 0.05	103	10	0.2	26.6	10.6	4.2	< 0.05	< 0.009	1.0	< 1	0.08
05/16/95	6.90	5.6	250	130	48	0.020	< 0.01	< 0.05	71	20	0.4	19.3	7.3	10.0	< 0.20	0.010	< 2.0	< 1	0.11
06/08/95	7.10	9.1	140	70															
07/11/95	8.00	11.3	101	70	24	0.060	< 0.01	< 0.05	46	40	1.4	11.4	4.0	1.5	0.05	< 0.005	0.5	2	0.11
08/14/95	8.20	17.3	240	100															
09/18/95	8.30	13.4	200	220															
10/18/95	8.50	3.4	240	100	6	0.017	< 0.01	< 0.05	88	7	0.1	20.6	7.9	3.0	< 0.05	< 0.010	0.9	< 1	0.13
04/16/96	8.10	3.8	280	108	< 5	< 0.005	< 0.01	< 0.05	106	< 10	0.1	27.7	10.8	4.0	< 0.03	0.011	1.1	1	0.10
05/13/96	8.70	7.2	200	14															
06/14/96	8.10	11.7	170	80															
07/15/96	7.70	11.9	230	120															
08/19/96	8.70	15.2	240	120	12	0.010	< 0.01	< 0.05	105	20	0.3	26.8	10.0	3.5	< 0.03	0.012	1.1	1	0.14
09/16/96	7.80	7.9	210	100															
10/14/96	8.50	11.3	250	120	6	< 0.005	< 0.01	< 0.05	95	< 10	0.2	22.9	8.3	3.2	< 0.03	0.008	0.9	3	0.12
04/16/97	8.46	10.9	230	130	< 5	< 0.005	< 0.01	0.01	96	10	0.2	132.0	10.4	3.9	< 0.03	0.011	1.0	< 1	0.08
05/13/97	6.96	6.2	230	130															
06/04/97	8.40	8.4	140	70															
07/01/97	8.37	14.1	210	110															
08/04/97	8.49	15.5	220	15	8	< 0.005	< 0.01	< 0.01	112	< 10	0.1	27.6	10.0	3.4	< 0.03	0.009	1.1	< 1	0.11
09/02/97	8.42	15.6	240	180															
10/01/97	8.33	14.7	220	90	< 5	0.009	< 0.01	< 0.01	82	< 10	0.2	19.7	7.3	2.9	< 0.03	0.012	0.9	< 1	0.13

Table 3. Surface Water Quality at Site TR-A

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/98	8.40	3.5	280	150	10	< 0.005	< 0.01	< 0.01	114	20	0.3	30.6	12.1	4.2	< 0.03	0.014	1.1	< 1	0.09
05/12/98	8.38	6.7	280	160															
06/02/98	8.25	10.7	130	70															
07/20/98	8.53	16.6	270	130	< 5	0.007	< 0.01	0.01	125	20	0.3	32.5	11.7	3.9	< 0.03	0.013	1.1	< 1	0.06
08/17/98	8.61	17.9	210	100															
09/14/98	8.35	9.8	220	120															
10/12/98	8.26	4.1	260	120	< 5	< 0.005	< 0.01	< 0.01	98	< 10	0.2	23.9	8.8	3.9	< 0.03	0.011	1.0	< 1	0.12
04/05/99	7.98	5.8	300	112	< 5	0.009	< 0.01	< 0.01	98	10	0.2	26.2	10.2	3.9	< 0.03	< 0.005	0.8	2	0.1
05/03/99	8.86	6.1	310	110															
06/01/99	8.39	8.2	180	50															
07/06/99	8.61	21.0	250	110															
08/24/99	8.43	12.9	390	130	< 5	< 0.005	< 0.01	< 0.01	95	< 10	0.2	23.7	8.8	3.4	< 0.03	< 0.005	1.1	< 1	0.06
09/23/99	8.71	14.5	210	110															
10/18/99	8.67	2.1	210	80	< 5	0.008	< 0.01	< 0.01	84	< 10	0.2	20.8	7.8	3.3	< 0.03	0.007	1.0	< 1	0.09
04/18/00	8.30	3.0	210	120	< 5	0.012	< 0.01	< 0.05	84	< 10	0.2	21.5	8.1	3.4	0.04	0.008	1.1	1	0.12
05/16/00	7.98	6.3	140	90															
06/19/00	7.63	11.1	180	110															
07/18/00	7.23	13.6	280	140															
08/15/00	7.80	16.0	310	170	< 5	0.015	< 0.01	< 0.05	145	10	0.1	39.1	13.5	4.3	< 0.03	0.011	1.4	2	0.07
09/11/00	8.63	14.8	230	120															
10/02/00	8.40	11.0	220	140	8	0.009	< 0.01	< 0.05	99	< 10	0.2	25.5	9.6	3.7	< 0.03	0.007	1.2	1	0.16
04/09/01	7.50	6.8	240	140	< 5	< 0.005	< 0.01	< 0.01	97	20	0.3	26.7	10.1	3.8	< 0.03	0.010	0.9	2	0.06
05/08/01	8.40	9.9	200	110															
06/04/01	7.40	7.3	160	60															
07/10/01	7.50	15.7	380	210	< 5	0.021	0.06	< 0.01	167	20	0.2	45.9	15.7	5.1	< 0.03	0.023	1.5	2	0.10
08/01/01	7.90	15.3	260	150															
09/21/01	8.40	8.2	230	150															
10/10/01	8.60	3.0	250	110	< 5	0.017	< 0.01	< 0.01	81	10	0.2	21.7	7.9	3.0	< 0.03	0.007	1.1	1	0.15
04/15/02	8.16	7.6	200	110	< 5	0.012	< 0.01	< 0.01	69	10	0.2	21.7	8.2	3.3	0.05	0.008	1.0	1	0.13
05/13/02	8.17	15.2	170	120															
06/03/02	8.47	13.6	210	200															
07/08/02	8.34	19.7	340	90															
08/13/02	8.49	16.4	300	180	8	0.014	< 0.01	< 0.01	164	10	0.1	38.0	14.4	4.6	< 0.03	0.013	1.4	< 1	0.13
09/09/02	8.02	15.8	250	160															
10/14/02	8.24	5.5	270	150	6	0.020	< 0.01	< 0.01	123	< 10	0.1	27.9	10.5	3.9	< 0.03	0.011	1.1	1	0.21

Table 3. Surface Water Quality at Site TR-A

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/03	7.70	2.8	200	120	14	< 0.010	< 0.01	< 0.01	88	20	0.4	23.4	9.0	4.5	< 0.03	0.013	1.5	1	0.09
05/12/03	8.60	12.8	240	160															
06/17/03	7.80	13.4	110	80															
07/16/03	8.40	21.9	310	180	10	0.020	< 0.01	< 0.01	165	< 10	0.1	39.2	13.7	4.1	< 0.03	0.005	1.1	1	0.05
08/12/03	8.30	16.5	250	140															
09/08/03	8.30	11.4	220	140															
10/01/03	8.30	11.2	210	120	< 5	0.020	< 0.01	< 0.01	101	< 10	0.2	19.1	7.0	3.2	< 0.03	0.006	0.7	< 1	0.14
04/05/04	8.13	10.1	200	120	6	< 0.010	< 0.01	< 0.01	88	< 10	0.2	23.0	8.8	3.8	0.04	0.007	1.1	1	0.10
05/12/04	7.44	9.5	90	70															
06/01/04	7.81	14.0	140	90															
07/19/04	8.62	20.3	230	160	12	0.020	< 0.01	< 0.01	139	< 10	0.1	29.9	10.6	3.6	< 0.03	0.011	1.2	1	0.21
08/03/04	8.71	24.1	250	170															
09/08/04	8.38	14.0	230	170															
10/13/04	7.93	10.0	160	120	< 5	< 0.010	< 0.01	< 0.01	106	10	0.1	24.1	9.0	3.4	< 0.03	0.005	1.0	1	0.21
04/18/05	8.10	7.9	150	90	12	0.020	0.02	< 0.01	79	10	0.2	19.4	7.3	3.1	0.04	0.013	1.0	< 1	0.13
05/12/05	8.24	6.7	120	110															
06/09/05	8.75	9.0	80	110															
07/15/05	8.36	19.7	190	140															
08/03/05	8.17	15.6	270	130	< 5	< 0.010	< 0.01	< 0.01	99	< 10	0.2	25.4	9.2	3.1	< 0.03	< 0.005	1.1	1	0.27
09/06/05	8.19	13.0	220	120															
10/20/05	7.80	10.3	130	100	10	0.010	< 0.01	< 0.01	88	< 10	0.2	23.3	8.5	3.4	0.06	0.007	1.0	1	0.23
04/14/06	7.79	7.7	160	120	6	0.030	< 0.01	< 0.01	92	< 10	0.2	23.8	9.3	4.0	< 0.03	0.007	1.6	2	0.14
05/19/06	8.28	10.3	70	70															
06/13/06	8.08	14.6	100	70															
07/18/06	8.37	15.5	290	160															
08/10/06	8.34	15.2	270	190	8	0.030	< 0.01	< 0.01	137	< 10	0.1	36.4	12.9	3.7	< 0.03	0.013	1.1	< 1	0.15
09/11/06	8.67	14.8	170	120															
10/11/06	8.54	8.1	180	110	< 5	0.030	< 0.01	< 0.01	86	< 10	0.2	21.9	8.2	3.4	< 0.03	0.009	1.0	1	0.07
04/16/07	8.36	6.0	180	130	< 5	0.020	< 0.01	< 0.01	97	< 10	0.2	24.4	9.5	4.1	< 0.03	0.010	0.9	1	0.06
05/08/07	8.15	3.9	150	100															
06/22/07	8.10	20.0	180	110															
07/19/07	8.30	17.1	300	200	< 5	0.020	0.03	< 0.01	172	< 10	0.1	43.1	14.8	4.5	< 0.03	0.008	1.6	1	0.23
08/09/07	8.20	15.8	220	120															
09/21/07	8.40	12.6	220	140															
10/15/07	8.00	6.4	190	120	< 5	0.030	< 0.01	< 0.01	96	< 10	0.2	19.1	6.9	3.0	< 0.03	< 0.005	1.0	1	0.22

Table 3. Surface Water Quality at Site TR-A

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/08	8.46	7.1	220	120	6	0.020	< 0.01	< 0.01	90	< 10	0.2	24.3	8.7	3.7	< 0.03	0.007	1.0	2	0.09
05/14/08	7.76	5.2	250	160															
06/11/08	7.87	5.5	90	70															
07/07/08	8.32	12.3	130	90															
08/11/08	7.83	11.3	170	110	8	0.020	< 0.01	< 0.01	88	6	0.1	24.3	8.2	3.1	< 0.03	0.008	0.9	1	0.24
09/08/08	7.55	8.9	180	110															
10/14/08	7.94	1.2	150	110	5	< 0.010	< 0.01	< 0.01	67	6	0.1	21.5	8.0	3.3	< 0.03	0.016	1.0	< 1	0.15
04/14/09	8.14	4.8	240	130	< 5	< 0.010	< 0.01	< 0.02	105	14	0.2	26.5	10.0	4.4	< 0.03	0.015	1.2	< 1	0.25
05/14/09	7.78	7.2	110	90															
06/09/09	8.16	10.4	100	80															
07/06/09	7.16	16.9	150	100															
08/06/09	8.65	15.6	260	130	< 5	0.030	< 0.01	< 0.02	122	8	0.1	29.8	10.7	3.4	< 0.03	0.019	1.0	< 1	0.09
09/02/09	8.42	11.8	220	140															

Note: Monitoring site TR-A was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48.

Table 4. Surface Water Quality at Site TR-B

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/28/88	7.90	8.2	378		4														
05/25/88	8.00	9.0	258	186	18				8	62	12.2	31.0	15.0	6.0		0.040			
06/24/88	7.90	18.8	187		4					.									
07/15/88	8.20	19.7	295	336	14	0.010	0.07	0.01	139	121	1.4	56.0	27.0	20.0	0.05	0.020			
08/05/88	8.00	22.4	228	242	4	0.020	0.02	0.01	124	74	0.9	41.0	19.0	6.0	0.05	0.020			
09/21/88	8.40	13.0	365		2														
10/21/88	7.30	10.5	397		2														
04/13/89	7.90	7.0	695	510	8	0.009	0.01	0.01	125	282	3.6	76.0	43.0	12.0	0.05	0.010			
05/15/89	8.00	7.2	243		6														
06/16/89	8.00	17.4	144		18														
07/03/89	7.50	15.9	375	358	6	0.025	0.02	0.02	140	144	1.6	70.0	31.0	10.0	0.05	0.050			
08/23/89	7.60	13.1	362		6														
09/08/89	7.20	14.5	606	544	6	0.029	0.07	0.01	156	253	2.6	77.0	40.0	12.0	0.05	0.009			
10/13/89	7.10	13.7	399		4														
04/19/90	7.90	11.3	536	456	2	0.014	0.02	0.02	148	247	2.6	64.0	35.0	13.0	0.05	0.040			
05/11/90	7.30	10.1	259		2														
06/14/90	6.70	16.2	124		14														
07/06/90	8.00	23.4	284		6														
08/10/90	8.10	16.2	316	270	4	0.026	0.02	0.02	150	84	0.9	50.0	21.0	6.0	0.05	0.010			
09/07/90	7.00	13.8	290		6														
10/16/90	8.30	7.1	2680	326	6	0.021	0.02	0.05	130	142	1.7	54.0	27.0	10.0	0.05	0.030			
05/06/91	8.10	3.8	1182	620	4	< 0.010	< 0.01	< 0.05	140	342	3.8	91.0	54.0	15.0	< 0.05	< 0.010			
06/11/91	7.60	4.8	1843		22														
07/09/91	7.90	11.4	396	238	20	< 0.010	< 0.01	< 0.05	110	37	0.5	36.0	16.0	5.0	< 0.05	0.010			
08/09/91	7.90	10.9	406		12														
09/11/91	8.30	13.1	1890		4														
10/10/91	7.90	6.7	2521	280	< 2	0.026	< 0.01	< 0.05	134	107	1.3	46.0	24.0	8.0	< 0.05	< 0.010			
04/13/92	7.00	8.4	2448	450	6	0.010	< 0.01	< 0.05	126	245	3.1	68.0	38.0	10.0	< 0.05	0.010			
05/06/92	8.00	14.2	1650		4														
06/01/92	7.80	8.0	1674		2														
07/01/92	9.00	16.6	1621		10														
08/03/92	7.10	20.1	1887	244	8	0.020	< 0.01	< 0.05	132	123	1.5	49.0	21.0	7.0	< 0.05	0.010			
09/08/92	8.50	15.2	470	312	< 2														
10/05/92	8.60	12.5	460	356	< 2	0.010	< 0.01	< 0.05	140	161	1.8	58.0	30.0	9.0	< 0.05	0.040			

Table 4. Surface Water Quality at Site TR-B

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/28/93	8.70	8.8	500	656	2	< 0.005	< 0.01	< 0.05	132	393	4.7	101.0	66.0	14.0	< 0.05	0.060	3.0	2	
05/04/93	8.40	8.3	1000		8														
06/02/93	8.40	8.5	74																
07/01/93	8.70	10.4	200	128	16	< 0.005	< 0.01	< 0.05	68	33	0.8	22.0	10.0	3.0	< 0.05	< 0.010	< 1.0	< 1	
08/04/93	8.90	18.9	620		< 2														
09/09/93	8.60	12.0	370		2														
10/06/93	8.60	7.1	450	274	6	< 0.005	< 0.01	< 0.05	124	101	1.3	46.0	23.0	7.0	< 0.05	0.030	1.0	2	
11/08/93	8.30	0.8	500		< 2														
04/05/94	8.60	2.0	600	594	< 2	< 0.005	< 0.01	< 0.05	144	313	3.4	82.0	49.0	13.0	< 0.05	0.070	2.0	1	
05/03/94	8.30	5.8	590	382															
06/20/94	7.70	16.6	430	246															
07/25/94	7.90	21.6	855	564	2	0.009	< 0.01	< 0.05	196	272	2.2	95.0	50.0	14.0	< 0.05	0.030	3.0	1	0.10
08/16/94	6.90	18.1	584	324															
09/16/94	7.80	12.3	410	236															
10/21/94	7.80	9.4	407	194	< 5	0.006	< 0.01	< 0.05	76	54	1.1	35.0	17.0	5.0	< 0.05	0.060	1.0	< 1	0.64
04/11/95	7.60	4.3	1080	760	< 5	< 0.005	< 0.01	< 0.05	147	460	4.9	112.0	70.2	12.8	< 0.05	0.065	2.2	2	0.05
05/16/95	7.00	7.9	580	570	24	0.015	< 0.01	< 0.05	102	290	4.5	53.5	28.9	13.0	< 0.20	0.040	2.0	2	0.12
06/08/95	7.60	10.7	370	190															
07/11/95	7.90	15.0	200	110	22	0.007	< 0.01	< 0.05	51	50	1.5	17.2	8.1	2.2	0.05	0.022	0.7	2	0.14
08/14/95	8.10	17.3	380	240															
09/18/95	8.10	16.5	380	340															
10/18/95	8.40	6.3	550	330	26	0.016	< 0.01	< 0.05	112	137	1.9	50.4	28.7	6.3	< 0.05	0.053	1.4	1	0.11
04/16/96	8.10	2.9	1320	897	< 5	0.008	< 0.01	< 0.05	163	550	5.3	133.0	93.5	16.4	< 0.03	0.088	3.2	2	0.08
05/13/96	8.50	10.2	530	350															
06/14/96	7.60	9.6	230	140															
07/15/96	7.90	13.8	410	260															
08/19/96	8.40	16.4	480	290	10	0.009	< 0.01	< 0.05	120	120	1.6	50.7	27.8	6.3	< 0.03	0.066	1.5	1	0.15
09/16/96	8.30	13.1	490	250															
10/14/96	8.10	10.2	430	270	8	< 0.005	< 0.01	< 0.05	113	100	1.4	44.7	23.5	5.7	0.03	0.060	1.3	3	0.20
04/16/97	8.22	10.5	1210	880	< 5	< 0.005	< 0.01	< 0.01	152	500	5.2	173.0	92.2	14.9	< 0.03	0.104	3.0	2	0.15
05/13/97	7.89	10.1	590	340															
06/04/97	8.81	12.1	280	170															
07/01/97	8.07	11.7	380	240															
08/04/97	8.61	19.1	410	230	10	0.010	< 0.01	< 0.01	119	70	0.9	42.7	20.5	4.9	< 0.03	0.045	1.3	< 1	0.18
09/02/97	8.44	19.2	380	240															
10/01/97	8.26	10.5	440	260	< 5	0.017	< 0.01	< 0.01	100	100	1.6	44.8	24.5	4.9	< 0.03	0.063	1.2	< 1	0.17

Table 4. Surface Water Quality at Site TR-B

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/98	8.20	4.5	1160	850	< 5	< 0.005	< 0.01	< 0.01	160	480	4.7	112.0	80.9	12.4	< 0.03	0.070	2.7	< 1	0.03
05/12/98	8.20	8.9	640	400															
06/02/98	8.35	13.1	230	130															
07/20/98	8.29	17.4	530	370	6	0.021	< 0.01	0.01	149	140	1.5	58.0	30.6	7.5	< 0.03	0.096	1.7	< 1	0.13
08/17/98	8.40	17.2	450	270															
09/14/98	8.45	13.8	380	220															
10/12/98	8.31	5.4	460	250	< 5	< 0.005	< 0.01	< 0.01	115	90	1.2	42.5	21.5	5.3	< 0.03	0.061	1.2	< 1	0.14
04/05/99	8.09	6.3	870	610	< 5	0.007	< 0.01	< 0.01	136	330	3.8	95.0	60.0	11.0	< 0.03	0.089	2.2	3	0.22
05/03/99	8.67	6.3	680	420															
06/01/99	8.43	9.1	280	130															
07/06/99	8.67	21.5	430	330															
08/24/99	8.48	17.7	440	280	< 5	0.014	< 0.01	< 0.01	111	80	1.1	40.8	21.7	5.0	< 0.03	0.035	1.3	< 1	0.08
09/23/99	8.64	12.4	400	200															
10/18/99	8.69	3.5	330	170	< 5	0.013	< 0.01	< 0.01	98	60	1.0	32.2	17.2	4.5	< 0.03	0.040	1.1	< 1	0.18
04/18/00	8.20	7.0	930	580	< 5	0.011	< 0.01	< 0.05	127	320	4.0	85.5	55.7	8.9	< 0.03	0.060	2.2	2	0.08
05/16/00	8.35	11.5	310	190															
06/19/00	8.34	12.7	330	210															
07/18/00	7.71	17.4	490	290															
08/15/00	8.20	21.0	560	410	< 5	0.016	< 0.01	< 0.05	156	140	1.4	71.7	34.3	6.8	< 0.03	0.048	2.0	2	0.09
09/11/00	8.46	14.9	470	290															
10/02/00	8.40	13.0	460	280	8	0.008	< 0.01	< 0.05	121	110	1.4	46.3	24.3	6.1	< 0.03	0.040	1.5	1	0.17
04/09/01	8.00	5.3	1160	850	< 5	< 0.050	< 0.01	< 0.01	151	490	5.1	117.0	78.3	11.7	< 0.03	0.083	2.6	3	0.05
05/08/01	8.40	8.9	540	340															
06/04/01	8.10	9.1	240	130															
07/10/01	7.90	20.2	780	600	< 5	0.024	0.02	< 0.01	184	240	2.1	87.5	47.1	10.7	< 0.03	0.073	2.3	2	0.06
08/01/01	8.20	20.0	410	270															
09/21/01	8.40	13.0	430	280															
10/10/01	8.60	6.5	400	230	6	0.011	< 0.01	< 0.01	96	90	1.5	38.5	20.3	6.1	< 0.03	0.047	1.8	2	0.19
04/15/02	7.82	7.8	700	440	6	0.012	< 0.01	< 0.01	97	230	3.7	65.2	42.1	8.3	< 0.03	0.071	1.9	2	0.29
05/13/02	8.54	12.0	510	310															
06/03/02	8.43	13.0	320	800															
07/08/02	8.08	16.8	1030	170															
08/13/02	8.57	22.1	590	420	6	0.013	< 0.01	< 0.01	207	170	1.3	67.2	36.9	11.1	< 0.03	0.039	2.2	1	0.18
09/09/02	8.05	15.0	400	260															
10/14/02	8.23	10.3	430	260	< 5	0.010	< 0.01	< 0.01	141	90	1.0	50.4	25.3	6.3	< 0.03	0.028	1.5	1	0.17

Table 4. Surface Water Quality at Site TR-B

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/03	7.90	7.3	700	500	20	< 0.010	< 0.01	< 0.01	117	250	3.4	74.3	40.1	8.9	< 0.03	0.038	2.3	2	0.05
05/12/03	8.10	9.0	820	600															
06/17/03	8.00	16.1	220	140															
07/16/03	8.20	19.4	610	450	6	0.030	< 0.01	< 0.01	181	170	1.5	70.2	37.8	9.0	< 0.03	0.033	1.7	1	0.08
08/12/03	8.40	21.8	480	370															
09/08/03	8.30	15.3	370	250															
10/01/03	8.20	13.5	380	240	< 5	0.020	< 0.01	< 0.01	116	90	1.2	44.1	22.5	5.9	0.04	0.012	1.2	1	0.17
04/05/04	7.80	9.9	740	560	10	< 0.010	< 0.01	< 0.01	126	310	3.9	80.4	52.4	9.3	< 0.03	0.038	2.2	2	0.09
05/12/04	7.75	7.6	250	140															
06/01/04	7.64	12.8	230	160															
07/19/04	8.48	20.1	340	250	8	0.020	< 0.01	< 0.01	147	70	0.7	46.0	20.7	5.6	0.04	0.032	1.3	1	0.25
08/03/04	8.55	21.4	360	240															
09/08/04	8.41	17.8	580	430															
10/13/04	8.07	9.9	370	250	< 5	< 0.010	< 0.01	< 0.01	124	100	1.3	41.4	21.9	5.7	< 0.03	0.017	1.3	1	0.30
04/18/05	8.21	9.3	520	360	12	0.010	< 0.01	< 0.01	109	190	2.7	57.3	34.0	7.5	< 0.03	0.013	1.8	1	0.11
05/12/05	8.39	5.6	470	280															
06/09/05	9.24	10.3	190	150															
07/15/05	8.45	22.3	400	270															
08/03/05	8.34	16.1	300	200	< 5	0.010	< 0.01	< 0.01	113	40	0.6	35.2	16.3	4.2	0.04	0.017	1.3	1	0.37
09/06/05	8.46	17.3	380	230															
10/20/05	8.31	8.4	290	200	8	< 0.010	< 0.01	< 0.01	99	60	1.0	38.7	19.3	5.1	< 0.03	0.035	1.4	1	0.11
04/14/06	8.24	8.8	900	690	< 5	0.020	< 0.01	< 0.01	135	400	4.7	97.1	70.5	10.6	< 0.03	0.014	3.0	2	0.09
05/19/06	8.04	14.0	210	140															
06/13/06	8.09	12.6	180	130															
07/18/06	8.64	21.9	640	430															
08/10/06	8.47	20.5	480	370	< 5	0.030	< 0.01	< 0.01	146	110	1.2	54.2	27.5	6.3	< 0.03	0.036	1.8	1	0.08
09/11/06	8.83	14.1	360	210															
10/11/06	8.46	8.1	300	200	6	0.020	< 0.01	< 0.01	100	40	0.6	31.8	16.8	4.7	< 0.03	0.034	1.2	1	0.10
04/16/07	8.39	9.6	720	500	< 5	0.020	< 0.01	< 0.01	125	260	3.3	72.8	46.8	8.3	< 0.03	0.037	1.5	2	0.04
05/08/07	8.32	6.9	420	280															
06/22/07	8.40	18.5	300	200															
07/19/07	8.50	23.1	550	390	< 5	0.020	< 0.01	< 0.01	167	120	1.1	66.5	33.3	10.1	< 0.03	0.023	2.0	2	0.06
08/09/07	8.30	17.6	320	200															
09/21/07	8.50	13.1	410	240															
10/15/07	8.30	9.4	330	220	< 5	0.030	< 0.01	< 0.01	107	70	1.0	29.5	14.8	4.5	< 0.03	0.013	1.2	1	0.17

Table 4. Surface Water Quality at Site TR-B

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/08	8.49	6.5	610	360	< 5	0.020	< 0.01	< 0.01	106	170	2.5	54.5	33.4	8.9	< 0.03	0.056	1.6	2	0.07
05/14/08	8.41	6.4	910	630															
06/11/08	8.25	6.6	200	140															
07/07/08	8.43	15.2	280	180															
08/11/08	8.30	16.0	350	190	7	0.020	< 0.01	< 0.01	95	54	0.9	35.2	16.9	4.0	< 0.03	0.026	1.2	1	0.15
09/08/08	7.20	13.2	340	220															
10/14/08	8.42	3.6	300	190	< 5	< 0.010	< 0.01	< 0.01	92	58	1.0	34.2	17.9	4.6	< 0.03	0.043	1.3	1	0.22
04/14/09	7.26	6.0	740	490	5	0.010	< 0.01	0.04	125	230	2.9	71.0	43.8	9.6	< 0.03	0.059	1.9	2	0.37
05/14/09	8.39	9.4	320	210															
06/09/09	8.20	9.6	250	150															
07/06/09	8.07	14.4	240	160															
08/06/09	8.51	16.3	430	270	6	0.030	< 0.01	< 0.02	131	92	1.1	49.5	25.0	5.8	< 0.03	0.051	1.4	1	0.09
09/02/09	8.37	12.4	400	260															

Note: Monitoring site TR-B was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48.

Table 5. Surface Water Quality at Site TR-C

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/29/88	8.10	6.0	679		4														
05/17/88	7.70	5.2	331	190	90				62	68	1.7	29.0	14.0	4.0		0.130			
06/25/88	7.90	15.5	255		6														
07/14/88	8.20	23.3	354	396	8	0.009	0.03	0.01	135	165	1.9	64.0	34.0	8.0	0.05	0.010			
08/05/88	8.00	20.7	320	298	8	0.020	0.02	0.01	129	123	1.5	49.0	26.0	8.0	0.05	0.010			
09/21/88	8.30	13.9	415		4														
10/21/88	8.00	9.8	451		2														
04/14/89	8.10	8.2	1005	754	6	0.005	0.01	0.01	140	449	5.0	99.0	76.0	18.0	0.05	0.020			
05/15/89	8.50	8.3	333		6														
06/19/89	7.80	17.4	232		10														
07/03/89	7.80	20.1	643	578	2	0.016	0.02	0.02	150	298	3.1	98.0	54.0	17.0	0.05	0.030			
08/23/89	7.60	13.3	487		4														
09/08/89	7.00	14.4	842	740	10	0.023	0.01	0.01	166	397	3.8	104.0	74.0	16.0	0.05	0.009			
10/13/89	7.90	15.0	51		2														
04/19/90	7.90	12.0	712	604	2	0.130	0.02	0.02	100	358	5.6	78.0	48.0	16.0	0.05	0.040			
05/14/90	7.50	7.2	335		12														
06/14/90	7.20	16.2	162		20														
07/06/90	7.70	21.3	371		14														
08/10/90	8.00	21.8	420	354	4	0.022	0.02	0.02	150	152	1.6	62.0	31.0	9.0	0.05	0.009			
09/07/90	8.00	20.2	477		4														
10/16/90	8.60	8.8	2280	422	2	0.120	0.02	0.05	138	218	2.5	64.0	36.0	12.0	0.05	0.030			
05/06/91	8.30	6.7	1272	780	2	< 0.010	< 0.01	< 0.05	147	459	4.9	109.0	69.0	21.0	< 0.05	0.050			
06/11/91	7.70	5.8	275		26														
07/09/91	8.00	13.5	482	304	10	< 0.010	< 0.01	< 0.05	115	78	1.1	43.0	22.0	7.0	< 0.05	0.020			
08/09/91	8.50	14.4	1743		8														
09/11/91	8.30	13.4	1819		< 2														
10/10/91	7.90	10.9	2042	376	< 2	0.022	< 0.01	< 0.05	140	183	2.1	57.0	33.0	11.0	< 0.05	0.020			
04/13/92	8.80	8.8	2282	566	< 2	0.006	< 0.01	< 0.05	122	311	4.0	80.0	48.0	14.0	< 0.05	0.020			
05/06/92	9.20	14.3	1748		6														
06/01/92	8.40	8.2	1972		8														
07/01/92	8.40	11.7	1599		2														
08/03/92	8.00	14.0	1769	356	8	0.017	< 0.01	< 0.05	142	58	0.6	62.0	31.0	10.0	< 0.05	0.010			
09/08/92	8.60	17.0	615	409	2														
10/05/92	8.70	6.9	640	426	4	0.007	< 0.01	< 0.05	140	230	2.6	68.0	38.0	13.0	< 0.05	0.040			

Table 5. Surface Water Quality at Site TR-C

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/28/93	8.90	11.0	900	824	2	< 0.005	< 0.01	< 0.05	140	515	5.8	118.0	81.0	20.0	< 0.05	0.050	3.0	2	
05/04/93	8.80	11.8	600		8														
06/02/93	8.50	9.0	220																
07/01/93	8.60	15.0	205	114	14	< 0.005	< 0.01	< 0.05	68	39	0.9	24.0	11.0	4.0	< 0.05	0.010	< 1.0	< 1	
08/04/93	8.90	20.0	700		14														
09/09/93	8.90	16.0	520		4														
10/06/93	9.00	11.3	590	366	< 2	< 0.005	< 0.01	< 0.05	140	173	1.9	56.0	31.0	10.0	< 0.05	0.030	2.0	< 1	
11/08/93	9.00	1.0	680		< 2														
04/05/94	8.80	6.8	1000	780	< 2	< 0.005	< 0.01	< 0.05	80	453	8.9	99.0	65.0	19.0	< 0.05	0.060	2.0	2	
05/03/94	8.60	7.2	600	444															
06/20/94	8.19	17.9	640	416															
07/25/94	7.90	16.1	1328	990	< 2	< 0.005	< 0.01	< 0.05	220	576	4.1	139.0	87.0	26.0	0.06	0.020	3.0	2	0.06
08/16/94	7.90	16.7	970	626															
09/16/94	8.40	11.5	595	384															
10/21/94	6.90	6.9	486	276	< 5	< 0.005	< 0.01	< 0.05	168	115	1.1	45.0	25.0	8.0	< 0.05	0.040	1.0	< 1	0.55
04/11/95	7.40	2.8	1480	1040	< 5	< 0.005	< 0.01	< 0.05	174	630	5.7	127.0	93.5	25.8	< 0.05	0.096	3.0	3	0.02
05/16/95	7.70	8.5	830	500	68	0.013	< 0.01	< 0.05	117	290	3.9	69.7	42.5	14.0	< 0.20	0.055	3.0	2	0.06
06/08/95	7.40	11.0	410	260															
07/11/95	8.10	15.3	260	130	28	0.007	< 0.01	< 0.05	54	60	1.7	19.7	9.4	2.9	0.04	0.017	0.8	1	0.13
08/14/95	8.00	12.2	510	340															
09/18/95	7.90	15.1	570	340															
10/18/95	8.50	6.6	610	390	8	0.014	< 0.01	< 0.05	137	189	2.2	57.7	34.5	8.6	< 0.03	0.047	1.5	1	0.10
04/16/96	8.20	4.1	1890	1470	10	0.013	< 0.01	< 0.05	194	960	7.8	191.0	152.0	43.4	< 0.03	0.091	5.5	5	0.08
05/13/96	8.50	11.1	630	420															
06/14/96	6.80	9.1	290	160															
07/15/96	8.20	16.4	530	330															
08/19/96	8.30	16.1	620	410	< 5	0.009	< 0.01	< 0.05	129	200	2.4	65.8	40.5	10.0	< 0.03	0.050	1.9	2	0.10
09/16/96	8.40	13.0	620	380															
10/14/96	8.00	8.9	530	350	6	< 0.005	< 0.01	< 0.05	120	150	2.0	53.1	30.7	8.2	0.03	0.045	1.5	4	0.12
04/16/97	8.17	9.9	1660	1270	6	< 0.005	< 0.01	< 0.01	172	780	7.1	172.0	137.0	28.6	0.03	0.118	4.5	3	0.13
05/13/97	7.62	9.0	660	440															
06/04/97	8.87	9.9	250	160															
07/01/97	7.77	11.1	430	260															
08/04/97	8.45	19.6	480	350	< 5	0.008	< 0.01	< 0.01	127	120	1.5	51.0	28.2	6.7	< 0.03	0.039	1.6	< 1	0.09
09/02/97	8.39	19.1	530	410															
10/01/97	8.24	9.1	580	330	< 5	0.010	< 0.01	< 0.01	110	170	2.4	56.3	33.4	7.8	< 0.03	0.061	1.6	< 1	0.12

Table 5. Surface Water Quality at Site TR-C

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/98	8.20	4.6	1420	1160	< 5	< 0.005	< 0.01	< 0.01	174	700	6.3	162.0	114.0	23.8	< 0.03	0.086	4.0	2	0.07
05/12/98	8.16	8.1	650	420															
06/02/98	8.22	11.4	240	140															
07/20/98	8.01	15.1	630	460	< 5	0.024	< 0.01	< 0.01	159	190	1.9	68.8	39.4	10.0	< 0.03	0.074	1.9	< 1	0.16
08/17/98	8.11	18.6	540	360															
09/14/98	8.31	11.9	490	310															
10/12/98	7.80	5.7	520	330	< 5	< 0.005	< 0.01	< 0.01	122	140	1.8	51.3	29.3	7.5	< 0.03	0.046	1.5	< 1	0.1
04/05/99	8.01	9.1	1110	980	< 5	0.006	< 0.01	< 0.01	158	590	5.9	150.0	99.7	18.7	< 0.03	0.095	3.2	3	0.17
05/03/99	8.60	6.7	740	540															
06/01/99	8.35	9.4	250	140															
07/06/99	8.53	22.9	490	320															
08/24/99	8.41	19.4	470	370	< 5	< 0.005	< 0.01	< 0.01	119	140	1.9	50.4	30.3	7.6	< 0.03	0.024	1.7	< 1	0.07
09/23/99	8.62	12.1	420	260															
10/18/99	8.55	3.7	480	250	< 5	0.011	< 0.01	< 0.01	106	130	1.9	43.8	27.0	7.2	< 0.03	0.040	1.7	< 1	0.11
04/18/00	8.20	8.0	1120	830	< 5	0.009	< 0.01	< 0.05	140	490	5.5	114.0	79.4	15.6	< 0.03	0.058	2.9	2	0.07
05/16/00	8.23	10.8	390	260															
06/19/00	7.51	13.9	430	280															
07/18/00	7.81	19.4	520	340															
08/15/00	8.20	20.0	740	560	6	0.019	< 0.01	< 0.05	168	250	2.3	88.5	54.6	10.6	< 0.03	0.040	2.3	2	0.06
09/11/00	8.47	13.6	650	430															
10/02/00	8.10	10.0	560	360	< 5	0.007	< 0.01	< 0.05	129	180	2.2	56.4	33.2	8.0	< 0.03	0.022	1.6	1	0.18
04/09/01	8.00	4.4	1450	1130	< 5	< 0.005	< 0.01	< 0.01	160	700	6.9	151.0	110.0	21.7	< 0.03	0.010	3.7	4	0.03
05/08/01	8.20	6.7	690	470															
06/04/01	8.10	8.2	200	120															
07/10/01	7.50	18.4	920	750	< 5	0.024	< 0.02	< 0.01	189	350	2.9	99.8	58.8	14.5	< 0.03	0.060	2.7	2	0.07
08/01/01	8.00	18.1	540	380															
09/21/01	8.10	10.9	450	270															
10/10/01	8.40	6.2	470	270	< 5	0.011	< 0.01	< 0.01	100	120	1.9	43.9	24.7	7.0	< 0.03	0.033	2.0	2	0.13
04/15/02	7.33	8.0	850	610	< 5	0.009	< 0.01	< 0.01	106	350	5.2	84.4	59.0	12.9	0.79	0.092	2.3	2	0.35
05/13/02	8.17	10.1	570	390															
06/03/02	8.18	14.0	360	950															
07/08/02	8.14	20.5	1170	220															
08/13/02	8.55	20.7	850	680	8	0.013	< 0.01	< 0.01	188	330	2.8	101.0	67.3	17.1	< 0.03	0.033	3.0	2	0.07
09/09/02	8.10	14.4	550	380															
10/14/02	8.17	8.1	580	370	< 5	< 0.010	< 0.01	< 0.01	152	160	1.7	63.8	35.9	9.8	< 0.03	0.025	1.8	2	0.13

Table 5. Surface Water Quality at Site TR-C

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/03	7.80	5.4	910	720	22	< 0.010	< 0.01	< 0.01	127	430	5.3	96.2	64.4	14.0	< 0.03	0.069	2.8	2	0.03
05/12/03	8.10	11.0	1050	850															
06/17/03	7.90	14.3	260	180															
07/16/03	8.10	16.3	800	670	< 5	0.020	< 0.01	< 0.01	191	330	2.7	95.8	60.7	14.0	< 0.03	0.020	1.9	2	0.04
08/12/03	8.30	19.6	660	550															
09/08/03	8.20	13.9	460	320															
10/01/03	8.10	10.4	500	350	< 5	0.020	< 0.01	< 0.01	125	160	2.0	60.7	35.6	9.0	< 0.03	0.007	1.2	1	0.13
04/05/04	8.27	10.3	1110	980	10	< 0.010	< 0.01	< 0.01	142	590	6.5	121.0	93.1	19.9	< 0.03	0.048	3.4	2	0.06
05/12/04	7.40	6.5	240	170															
06/01/04	7.42	10.8	320	210															
07/19/04	8.43	18.2	440	310	6	0.010	< 0.01	< 0.01	150	110	1.2	48.5	25.3	6.9	0.07	0.028	1.6	2	0.19
08/03/04	8.57	17.1	470	320															
09/08/04	8.48	13.5	760	580															
10/13/04	7.74	9.0	510	360	< 5	< 0.010	< 0.01	< 0.01	133	170	2.0	55.8	33.0	9.2	< 0.03	0.024	2.0	2	0.38
04/18/05	8.08	8.7	730	500	22	0.010	< 0.01	< 0.01	118	300	4.0	75.2	50.7	12.0	0.06	0.023	2.3	2	0.13
05/12/05	8.16	6.8	610	440															
06/09/05	8.56	10.2	230	170															
07/15/05	8.57	20.7	540	350															
08/03/05	8.36	15.4	410	460	< 5	0.010	< 0.01	< 0.01	119	70	0.9	43.2	23.0	5.7	0.03	0.016	1.5	1	0.23
09/06/05	8.44	14.3	580	380															
10/20/05	7.94	9.3	400	250	< 5	< 0.010	< 0.01	< 0.01	104	100	1.5	47.4	27.1	7.1	< 0.03	0.027	1.5	1	0.14
04/14/06	8.26	9.0	1180	950	14	0.020	< 0.01	< 0.01	144	550	6.0	126.0	97.6	20.6	< 0.03	0.012	3.9	3	0.08
05/19/06	8.09	14.1	260	180															
06/13/06	8.25	12.1	230	150															
07/18/06	8.65	15.6	920	640															
08/10/06	8.57	21.2	640	480	< 5	0.030	< 0.01	< 0.01	149	180	1.9	70.1	40.9	9.7	< 0.03	0.028	2.0	1	0.09
09/11/06	8.73	11.9	500	320															
10/11/06	8.58	6.7	410	280	8	0.020	< 0.01	< 0.01	105	100	1.5	41.7	24.8	6.9	< 0.03	0.028	1.4	2	0.07
04/16/07	8.27	9.6	1050	780	< 5	0.010	< 0.01	< 0.01	135	450	5.2	103.0	76.4	15.4	< 0.03	0.048	2.5	2	0.05
05/08/07	8.16	8.1	560	380															
06/22/07	8.30	20.3	360	230															
07/19/07	8.40	21.8	790	600	< 5	0.010	< 0.01	< 0.01	174	260	2.4	89.3	54.8	15.0	0.04	0.033	2.5	2	0.07
08/09/07	8.10	18.3	420	260															
09/21/07	8.40	12.5	440	330															
10/15/07	8.70	6.5	450	290	< 5	0.030	< 0.01	< 0.01	114	120	1.7	43.0	24.8	7.1	< 0.03	0.014	1.6	1	0.09

Table 5. Surface Water Quality at Site TR-C

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/08	7.87	6.9	740	420	< 5	0.020	< 0.01	< 0.01	109	200	2.9	61.6	38.6	11.1	< 0.03	0.064	1.7	3	0.07
05/14/08	7.98	6.6	1140	860															
06/11/08	7.55	7.2	250	170															
07/07/08	8.36	14.4	280	460															
08/11/08	7.57	15.7	360	230	6	0.020	< 0.01	< 0.01	97	74	1.2	38.6	20.6	5.2	< 0.03	0.022	1.3	1	0.09
09/08/08	7.36	13.7	510	340															
10/14/08	7.41	4.5	430	270	< 5	< 0.010	< 0.01	< 0.01	97	108	1.8	44.5	26.5	6.7	< 0.03	0.060	1.5	1	0.08
04/14/09	7.24	5.9	1010	740	8	0.010	< 0.01	0.06	127	420	5.2	99.5	70.5	15.6	< 0.03	0.072	2.6	2	0.36
05/14/09	7.54	8.9	410	280															
06/09/09	7.51	9.0	270	180															
07/06/09	7.55	14.0	280	180															
08/06/09	7.98	17.0	540	340	< 5	0.040	< 0.01	< 0.02	134	127	1.5	57.8	32.6	7.1	< 0.03	0.029	1.5	2	0.08
09/02/09	7.79	12.9	550	380															

Note: Monitoring site TR-C was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48.

Table 6. Surface Water Quality at Site TR-D

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/29/88	8.30	6.5	727		2														
05/17/88	7.80	5.8	369	192	106				66	70	1.7	29.0	15.0	5.0		0.160			
06/25/88	7.80	15.2	273		12														
07/14/88	8.40	22.7	358	100	8	0.010	0.02	0.01	135	169	2.0	64.0	34.0	9.0	0.05	0.010			
08/05/88	8.30	21.3	302	306	4	0.020	0.02	0.01	131	126	1.5	49.0	26.0	8.0	0.05	0.020			
09/21/88	8.30	14.2	457		8														
10/21/88	8.00	9.6	558		2														
04/14/89	8.30	8.4	785	756	2	0.005	0.01	0.01	140	447	5.0	113.0	76.0	20.0	0.18	0.010			
05/15/89	8.50	8.3	429		6														
06/19/89	8.20	17.0	231		12														
07/03/89	7.90	21.0	687	632	6	0.012	0.02	0.02	150	338	3.5	103.0	57.0	18.0	0.05	0.030			
08/23/89	7.90	14.4	467		2														
09/08/89	7.60	14.7	755	692	10	0.020	0.01	0.01	158	360	3.6	88.0	68.0	16.0	0.05	0.009			
10/13/89	7.90	15.0	51		2														
04/19/90	8.20	12.6	685	596	2	0.009	0.02	0.02	102	354	5.5	80.0	50.0	18.0	0.06	0.030			
05/14/90	7.50	7.2	336		10														
06/14/90	7.70	16.3	158		28														
07/06/90	7.70	21.3	368		2														
08/10/90	8.20	20.7	432	382	4	0.019	0.02	0.02	152	165	1.7	63.0	31.0	10.0	0.05	0.009			
09/07/90	8.10	20.4	367		12														
10/16/90	8.60	9.2	2140	418	2	0.013	0.02	0.05	137	208	2.4	63.0	35.0	12.0	0.05	0.020			
05/06/91	8.50	7.2	1145	782	4	< 0.010	< 0.01	< 0.05	140	455	5.1	106.0	68.0	21.0	< 0.05	0.040			
06/11/91	7.70	5.1	245		20														
07/09/91	8.00	12.6	579	326	28	< 0.010	< 0.01	< 0.05	120	86	1.1	43.0	22.0	7.0	< 0.05	< 0.010			
08/09/91	8.50	14.6	1686		10														
09/11/91	8.90	15.5	1629		< 2														
10/10/91	8.70	12.3	1851	358	< 2	0.020	< 0.01	< 0.05	140	185	2.1	37.0	33.0	11.0	< 0.05	< 0.010			
04/13/92	9.00	8.5	2209	566	< 2	0.006	< 0.01	< 0.05	124	294	3.7	81.0	49.0	14.0	< 0.05	< 0.010			
05/06/92	9.00	15.2	1648		12														
06/01/92	8.30	8.7	1824		4														
07/01/92	8.50	16.7	1558		4														
08/03/92	7.90	13.7	1748	362	2	0.016	< 0.01	< 0.05	140	167	1.9	60.0	30.0	10.0	< 0.05	0.010			
09/08/92	8.70	17.0	615	409	4														
10/05/92	8.60	6.0	610	406	2	0.006	< 0.01	< 0.05	142	214	2.4	69.0	37.0	12.0	< 0.05	0.030			

Table 6. Surface Water Quality at Site TR-D

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/28/93	8.90	11.8	800	808	6	< 0.005	< 0.01	< 0.05	212	471	3.5	116.0	78.0	19.0	< 0.05	0.050	3.0	< 1	
05/04/93	8.90	12.0	600		< 2														
06/02/93	8.50	9.0	180																
07/01/93	8.50	17.0	200	114	12	< 0.005	< 0.01	< 0.05	70	37	0.8	22.0	10.0	4.0	< 0.05	0.010	< 1.0	< 1	
08/04/93	8.80	19.5	700		6														
09/09/93	8.90	17.8	510		< 2														
10/06/93	9.00	11.9	500	356	< 2	< 0.005	< 0.01	< 0.05	126	161	2.0	56.0	31.0	10.0	< 0.05	0.020	2.0	< 1	
11/08/93	9.00	1.0	690		< 2														
04/05/94	8.40	6.1	1000	562	< 2	< 0.005	< 0.01	< 0.05	58	457	12.4	97.0	63.0	18.0	< 0.05	0.060	2.0	2	
05/03/94	8.60	7.8	600	428															
06/20/94	8.24	22.7	680	470															
07/25/94	8.20	18.0	1346	1076	< 2	< 0.005	< 0.01	< 0.05	222	646	4.6	157.0	99.0	29.0	< 0.05	0.030	4.0	2	0.10
08/16/94	8.10	16.5	970	684															
09/16/94	8.20	13.2	561	384															
10/21/94	8.40	8.2	468	290	12	< 0.005	< 0.01	< 0.05	72	121	2.6	45.0	25.0	8.0	< 0.05	0.020	1.0	< 1	0.12
04/11/95	6.80	2.6	1140	810	< 5	< 0.005	< 0.01	< 0.05	144	490	5.4	105.0	73.5	20.1	< 0.05	0.081	2.6	2	0.03
05/16/95	7.60	8.8	770	510	28	0.028	< 0.01	< 0.05	117	300	4.0	70.8	42.8	14.0	< 0.20	0.062	2.0	1	0.09
06/08/95	7.10	11.8	390	300															
07/11/95	8.00	16.8	190	130	28	0.005	< 0.01	< 0.05	46	60	2.1	19.1	9.4	2.8	0.05	0.017	0.8	1	0.15
08/14/95	8.10	16.8	520	350															
09/18/95	8.00	15.9	530	220															
10/18/95	8.50	6.5	610	380	8	0.013	< 0.01	< 0.05	126	190	2.4	58.2	34.7	8.7	< 0.05	0.043	1.6	1	0.07
04/16/96	8.20	3.8	1840	1440	10	0.010	< 0.01	< 0.05	193	920	7.5	194.0	157.0	45.6	< 0.03	0.097	5.7	4	0.07
05/13/96	8.40	12.4	570	400															
06/14/96	7.10	9.1	250	160															
07/15/96	8.30	17.9	510	340															
08/19/96	8.40	17.0	620	400	10	0.008	< 0.01	< 0.05	128	190	2.3	65.1	39.3	9.7	< 0.03	0.048	1.8	2	0.11
09/16/96	8.40	12.6	610	370															
10/14/96	8.10	8.5	540	340	8	< 0.005	< 0.01	< 0.05	122	150	1.9	53.7	31.1	8.3	0.03	0.041	1.5	3	0.14
04/16/97	8.20	9.8	1670	1290	< 5	< 0.005	< 0.01	< 0.01	171	790	7.3	27.1	138.0	27.1	< 0.03	0.117	4.4	4	0.11
05/13/97	7.56	8.9	660	440															
06/04/97	8.75	10.4	250	160															
07/01/97	7.63	11.5	380	250															
08/04/97	8.47	18.6	490	370	8	0.008	< 0.01	< 0.01	125	120	1.5	51.9	28.7	6.8	< 0.03	0.032	1.4	< 1	0.11
09/02/97	8.51	20.2	520	350															
10/01/97	8.32	10.0	570	340	< 5	0.013	< 0.01	< 0.01	110	170	2.4	56.7	34.3	7.9	< 0.03	0.054	1.6	< 1	0.13

Table 6. Surface Water Quality at Site TR-D

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/98	8.30	4.8	1450	1150	8	< 0.005	< 0.01	< 0.01	174	690	6.2	162.0	111.0	23.6	< 0.03	0.087	3.9	2	0.04
05/12/98	8.13	7.2	660	400															
06/02/98	8.28	11.3	250	150															
07/20/98	8.16	15.8	630	460	< 5	0.018	< 0.01	< 0.01	159	190	1.9	69.1	39.6	10.0	< 0.03	0.059	2.1	< 1	0.13
08/17/98	8.45	19.1	540	390															
09/14/98	8.31	12.3	480	300															
10/12/98	8.48	6.0	510	330	< 5	< 0.005	< 0.01	< 0.01	123	140	1.8	51.4	29.4	7.5	< 0.03	0.032	1.4	< 1	0.11
04/05/99	7.94	9.4	1190	1090	< 5	< 0.005	0.32	< 0.01	164	660	6.3	145.0	109.0	21.0	< 0.03	0.106	3.4	3	0.14
05/03/99	8.64	7.1	770	540															
06/01/99	8.31	9.9	250	150															
07/06/99	8.53	23.7	510	240															
08/24/99	8.53	20.1	480	370	< 5	0.009	< 0.01	< 0.01	120	140	1.8	52.0	31.4	7.6	< 0.03	0.023	1.8	< 1	0.06
09/23/99	8.51	11.8	440	260															
10/18/99	8.64	3.7	500	290	< 5	0.010	< 0.01	< 0.01	106	140	2.1	44.9	27.9	7.3	< 0.03	0.030	1.5	< 1	0.08
04/18/00	8.30	8.0	1130	820	< 5	0.012	< 0.01	< 0.05	141	490	5.5	109.0	79.5	16.4	< 0.03	0.061	2.9	2	0.05
05/16/00	8.24	10.1	410	260															
06/19/00	8.28	15.6	430	280															
07/18/00	7.81	19.3	520	340															
08/15/00	8.20	20.0	750	580	< 5	0.024	< 0.01	< 0.05	168	260	2.4	94.0	56.5	11.2	< 0.03	0.025	2.3	2	0.05
09/11/00	8.20	13.3	620	390															
10/02/00	7.90	9.0	640	380	< 5	< 0.005	< 0.01	< 0.05	130	180	2.2	58.9	35.0	8.5	< 0.03	0.015	1.7	2	0.18
04/09/01	7.70	4.3	1430	1110	8	< 0.005	< 0.01	< 0.01	156	680	6.9	143.0	104.0	20.9	< 0.03	0.089	3.5	4	0.04
05/08/01	7.90	6.6	740	470															
06/04/01	7.80	8.2	210	110															
07/10/01	7.60	18.4	900	740	< 5	0.022	< 0.02	< 0.01	186	340	2.9	98.7	57.5	14.4	< 0.03	0.044	2.8	2	0.04
08/01/01	7.90	18.6	560	360															
09/21/01	8.00	10.4	460	310															
10/10/01	8.50	6.1	470	270	< 5	0.011	< 0.01	< 0.01	99	120	1.9	43.7	24.8	7.5	< 0.03	0.023	2.0	2	0.15
04/15/02	7.25	8.6	860	620	< 5	< 0.005	< 0.01	< 0.01	106	340	5.0	84.1	57.8	13.1	0.04	0.061	2.4	2	0.10
05/13/02	8.01	10.5	580	390															
06/03/02	7.69	13.8	440	860															
07/08/02	7.77	21.0	1060	230															
08/13/02	8.63	22.1	840	680	8	0.013	< 0.01	< 0.01	178	330	2.9	100.0	67.6	16.7	< 0.03	0.013	3.3	2	0.03
09/09/02	8.11	15.3	550	380															
10/14/02	8.32	10.9	590	380	6	< 0.010	< 0.01	< 0.01	153	160	1.6	63.4	36.5	9.1	< 0.03	0.010	1.8	2	0.10

Table 6. Surface Water Quality at Site TR-D

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/03	7.90	5.2	890	710	68	< 0.010	< 0.01	< 0.01	125	420	5.3	92.0	60.5	13.5	< 0.03	0.081	2.8	2	0.07
05/12/03	8.30	10.8	1040	840															
06/17/03	8.00	15.8	260	190															
07/16/03	8.00	17.9	860	690	8	0.020	< 0.01	< 0.01	167	340	3.2	97.6	61.3	14.1	< 0.03	< 0.010	2.2	2	0.06
08/12/03	8.50	20.4	720	580															
09/08/03	8.40	14.5	460	330															
10/01/03	8.30	10.6	510	350	6	0.020	< 0.01	< 0.01	126	160	2.0	49.6	28.6	7.5	< 0.03	0.009	1.3	1	0.16
04/05/04	8.41	10.5	1130	950	12	< 0.010	< 0.01	< 0.01	132	590	7.0	123.0	95.3	20.8	< 0.03	0.055	3.3	2	0.06
05/12/04	7.45	8.9	300	170															
06/01/04	7.66	12.0	310	210															
07/19/04	8.54	18.6	440	300	18	0.010	< 0.01	< 0.01	150	110	1.2	49.0	25.2	6.8	< 0.03	0.013	1.6	1	0.15
08/03/04	8.65	19.8	480	330															
09/08/04	8.64	15.6	720	550															
10/13/04	8.39	10.2	510	370	6	< 0.010	< 0.01	< 0.01	134	180	2.1	55.0	32.8	8.7	< 0.03	0.011	1.5	2	0.23
04/18/05	8.13	10.2	650	520	26	0.010	< 0.01	< 0.01	117	260	3.5	71.7	47.9	11.7	< 0.03	0.019	2.5	2	0.08
05/12/05	8.15	9	580	450															
06/09/05	9.02	13.6	240	170															
07/15/05	8.59	25.1	520	370															
08/03/05	8.46	16.7	410	270	8	0.010	< 0.01	< 0.01	118	90	1.2	42.2	22.4	5.7	0.05	0.015	1.5	1	0.32
09/06/05	8.49	16.8	550	370															
10/20/05	8.16	9.0	400	250	6	< 0.010	< 0.01	< 0.01	104	110	1.7	47.7	29.0	8.1	0.07	0.248	1.6	1	0.20
04/14/06	8.16	9.0	1160	940	22	0.020	< 0.01	< 0.01	143	560	6.2	120.0	92.3	20.0	< 0.03	0.010	3.7	3	0.06
05/19/06	8.22	16.4	260	190															
06/13/06	8.31	12.6	230	160															
07/18/06	8.64	16.7	900	690															
08/10/06	8.49	22.4	590	480	< 5	< 0.010	< 0.01	< 0.01	150	170	1.8	66.3	38.5	9.3	< 0.03	0.021	1.9	1	0.06
09/11/06	8.83	11.9	500	330															
10/11/06	8.51	6.9	420	260	< 5	0.030	< 0.01	< 0.01	107	100	1.5	43.5	25.4	7.0	< 0.03	0.025	1.4	1	0.07
04/16/07	8.08	10.4	1070	770	8	0.010	< 0.01	< 0.01	139	450	5.1	104.0	76.9	15.7	< 0.03	0.056	2.7	2	0.05
05/08/07	8.18	7.9	550	370															
06/22/07	8.40	21.2	360	250															
07/19/07	8.40	23.5	800	610	< 5	0.020	< 0.01	< 0.01	178	250	2.2	85.7	52.1	14.0	0.06	0.058	3.2	2	0.06
08/09/07	8.10	18.1	430	270															
09/21/07	8.40	12.8	580	330															
10/15/07	8.20	6.4	460	270	< 5	0.030	< 0.01	< 0.01	113	90	1.3	36.8	21.3	6.6	< 0.03	0.008	1.7	< 1	0.10

Table 6. Surface Water Quality at Site TR-D

Date	pH (s.u.)	Temp (C)	S.C. (umhos/cm)	TDS (mg/l)	TSS (mg/l)	O-P (mg/l)	NO2 (mg/l)	NH3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Al (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)	Fe (mg/l)
04/14/08	7.71	7.2	890	410	8	0.020	< 0.01	< 0.01	115	200	2.7	63.9	41.2	11.6	< 0.03	0.069	1.9	2	0.07
05/14/08	7.97	6.5	1140	840															
06/11/08	8.12	7.1	260	170															
07/07/08	8.34	14.1	280	720															
08/11/08	7.97	15.4	390	230	8	0.020	< 0.01	< 0.01	97	75	1.2	37.5	20.1	4.8	< 0.03	0.022	1.2	< 1	0.11
09/08/08	7.61	13.0	520	360															
10/14/08	7.80	4.2	430	260	< 5	< 0.010	< 0.01	< 0.01	98	101	1.6	42.9	25.2	6.5	< 0.03	0.029	1.3	1	0.12
04/14/09	7.05	6.2	1000	710	11	< 0.010	< 0.01	0.03	126	380	4.7	99.7	69.6	15.7	0.04	0.082	2.6	2	0.42
05/14/09	7.66	8.8	410	270															
06/09/09	7.35	9.4	270	180															
07/06/09	7.54	16.1	300	190															
08/06/09	7.91	16.6	500	320	5	0.030	< 0.01	< 0.02	132	118	1.4	54.3	30.2	6.7	< 0.03	0.029	1.5	2	0.07
09/02/09	7.76	12.8	480	380															

Note: Monitoring site TR-D was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48.

Table 7. Monitoring Well Static Water Level Elevations

Date	TR-1.5 (asl)	TR-3 (asl)	TR-4 (asl)	WR-1 (asl)
May-87	7170.92	6952.55	6908.50	
Jun-87	7170.45	6952.75	6905.50	7140.38
Jul-87	7169.90	6950.80	6904.90	7138.38
Aug-87	7169.85	6950.65	6905.35	7139.18
Sep-87	7169.60	6950.65	6905.30	7138.18
Apr-88	7171.55	6953.65	6907.60	7149.28
May-88	7171.75	6952.95	6907.00	7145.48
Jun-88	7170.70	6952.10	6907.10	7142.38
Jul-88	7169.90	6951.31	6906.13	7139.93
Aug-88	7169.69	6950.70	6905.52	7139.08
Sep-88	7169.90	6950.95	6905.30	7138.78
Oct-88	7170.05	6951.40	6905.35	7138.98
Apr-89	7170.65	6953.50	6907.05	7145.18
May-89	7171.25	6952.65	6907.10	7141.48
Jun-89	7170.75	6952.05	6906.50	7139.68
Jul-89	7169.90	6951.40	6905.55	7138.43
Aug-89	7169.90	6950.75	6906.00	7137.78
Sep-89	7169.45	6950.25	6905.75	7137.28
Oct-89	7169.90	6951.15	6906.00	7136.88
Apr-90	7170.50	6952.90	6907.10	7143.88
May-90	7170.57	6952.65	6906.90	7143.55
Jun-90	7171.65	6952.70	6907.30	7138.88
Jul-90	7170.00	6951.25	6905.55	7138.18
Aug-90	7169.65	6950.30	6905.15	7137.53
Sep-90	7169.60	6950.35	6911.70	7137.28
Oct-90	7169.95	6951.15	6905.20	7137.03
May-91	7170.90	6953.05	6907.50	7144.68
Jun-91	7171.35	6953.35	6905.60	7140.38
Jul-91	7170.15	6951.60	6906.10	7138.88
Aug-91	7169.75	6953.55	6904.80	7137.98
Sep-91	7170.05	6950.85	6905.45	7137.68
Oct-91	7170.40	6951.37	6905.37	7137.96
Apr-92	7170.57	6952.62	6906.12	7148.48
May-92	7171.37	6952.62	6906.93	7146.96
Jun-92	7171.45	6952.49	6907.03	7144.69
Jul-92	7169.98	6951.24	6905.57	7143.82
Aug-92	7170.15	6951.03	6905.62	7143.15
Sep-92	7170.07	6951.03	6905.37	7142.82
Oct-92	7170.32	6951.37	6905.62	7142.65

Table 7. Monitoring Well Static Water Level Elevations

Date	TR-1.5 (asl)	TR-3 (asl)	TR-4 (asl)	WR-1 (asl)
Apr-93	7171.23	6953.28	6907.03	7153.98
May-93	7171.15	6953.12	6907.66	7154.90
Jun-93	7171.86	6953.53	6905.91	7150.15
Jul-93	7170.69	6952.53	6907.41	7146.48
Aug-93	7169.48	6950.95	6907.32	7144.27
Sep-93	7169.90	6951.20	6908.24	7143.32
Oct-93	7169.15	6951.70	6908.70	7143.32
Nov-93	7170.36	6952.03	6908.53	7143.02
Apr-94	7170.69	6952.91	6908.62	7148.19
May-94	7170.98	6952.99	6908.77	7146.36
Jun-94	7172.89	6954.24	6906.46	7145.77
Jul-94	7172.82	6953.18	6905.71	7144.63
Aug-94	7173.52	6953.21	6905.77	7142.72
Sep-94	7171.84	6953.53	6907.36	7137.87
Oct-94	7172.16	6954.12	6907.66	7143.84
Apr-95	7172.51	6956.02	6907.59	7144.96
May-95	7173.49	6956.51	6907.72	7154.13
Jun-95	7173.01	6956.36	6908.18	7152.14
Jun-95	7173.01	6956.36	6908.53	7151.39
Jul-95	7172.13	6955.61	6908.14	7148.98
Aug-95	7170.84	6954.01	6906.47	7147.62
Sep-95	7171.02	6953.53	6906.03	7145.28
Oct-95	7171.53	6954.08	6906.24	7146.39
May-96	7172.26	6957.16	6908.39	7163.76
Jun-96	7172.06	6955.88	6908.28	7151.60
Jul-96	7171.13	6954.47	6907.03	7147.12
Aug-96	7170.70	6953.52	6906.94	7145.23
Sep-96	7170.97	6953.57	6908.43	7146.37
Oct-96	7171.24	6954.03	6908.69	7144.43
May-97	7172.16	6957.32	6908.54	7160.27
Jun-97	7172.54	6957.39	6909.29	7153.64
Jul-97	7171.49		6907.50	7149.31
Aug-97	7170.70	6954.26	6906.98	7146.37
Sep-97	7171.12	6954.34	6906.96	7145.53
Oct-97	7171.37	6955.37		7146.09

Table 7. Monitoring Well Static Water Level Elevations

Date	TR-1.5 (asl)	TR-3 (asl)	TR-4 (asl)	WR-1 (asl)
May-98	7172.13	6956.93	6908.09	7156.07
Jun-98	7172.14	6955.91	6908.28	7150.67
Jul-98	7170.74	6954.04	6906.72	7146.04
Aug-98	7170.84	6953.76	6906.53	7145.19
Sep-98	7171.02	6953.74	6906.41	7144.69
May-99	7171.69	6955.84	6907.26	7151.84
Jun-99	7171.93	6955.46	6907.81	7148.36
Jul-99	7170.97	6954.29	6906.67	7146.51
Aug-99	7170.84	6953.64	6906.14	7144.79
Sep-99	7171.06	6954.19	6906.12	7144.47
Oct-99	7171.11	6954.49	6906.09	7144.31
May-00	7171.86	6955.44	6907.36	7150.39
Jun-00	7171.19	6954.38	6906.96	7146.96
Jul-00	7171.02	6953.59	6906.69	7145.69
Aug-00	7170.74	6953.04	6906.36	7144.94
Sep-00	7170.84	6953.40	6906.28	7144.79
Oct-00	7171.02	6953.94	6906.98	7144.79
May-01	7171.79	6955.52	6907.31	7148.19
Jun-01	7171.68	6955.10	6907.54	7148.14
Jul-01	7171.53	6954.04	6906.51	7141.86
Aug-01	7171.39	6953.28	6906.49	7135.77
Sep-01	7171.80	6954.36	6906.68	7145.31
Oct-01	7172.11	6955.06	6906.74	7145.13
May-02	7171.77	6955.69	6904.87	7148.17
Jun-02	7171.94	6954.94	6904.39	7147.04
Jul-02	7170.84	6953.42	6903.46	7145.87
Aug-02	7171.67	6953.44		7145.14
Sep-02	7171.87	6953.33		7144.91
Oct-02	7172.08	6954.16		7145.11
May-03	7172.19	6956.46	6906.99	7155.28
Jun-03	7171.44	6955.51	6906.87	7149.01
Jul-03	7170.88	6953.67	6905.28	7147.48
Aug-03	7170.84	6953.22	6904.24	7147.08
Sep-03	7171.22	6953.39	6903.69	7146.96
Oct-03	7171.27	6953.72	6903.12	7146.86

Table 7. Monitoring Well Static Water Level Elevations

Date	TR-1.5 (asl)	TR-3 (asl)	TR-4 (asl)	WR-1 (asl)
May-04	7171.75	6955.21	6905.82	7148.97
Jun-04	7171.42	6954.97	6905.53	7147.83
Jul-04	7170.63	6953.61	6904.28	7147.24
Aug-04	7170.46	6953.39	6904.09	7147.18
Sep-04	7170.87	6953.60	6903.17	7147.36
Oct-04	7171.50	6954.20	6903.28	7147.32
Apr-05	7171.82	6955.49	6904.92	7151.51
May-05	7171.73	6955.54	6904.69	7151.34
Jun-05	7171.57	6955.51	6902.59	7149.14
Jul-05	7170.81	6954.01	6905.57	7147.94
Aug-05	7170.83	6953.58	6904.59	7147.51
Sep-05	7170.33	6953.44	6903.88	7147.21
Oct-05	7170.93	6954.27	6903.56	7146.86
May-06	7172.13	6955.61	6906.98	7154.36
Jun-06	7171.46	6955.13	6906.77	7149.61
Jul-06	7170.62	6953.61	6905.09	7147.67
Aug-06	7170.41	6953.30	6904.29	7147.08
Sep-06	7170.49	6953.53	6903.77	7147.13
Oct-06	7170.84	6954.03	6903.99	7147.14
May-07	7171.62	6955.41	6906.38	7151.22
Jun-07	7170.73	6954.23	6905.78	7147.64
Jul-07	7170.12	6953.76	6904.21	7147.36
Aug-07	7170.32	6954.04	6903.53	7147.21
Sep-07	7170.29	6954.23	6903.27	7147.12
Oct-07	7170.79	6954.93	6903.67	7147.29
May-08	7172.06	6957.59	6907.53	7165.44
Jun-08	7172.16	6956.34	6907.58	7155.71
Jul-08	7171.57	6954.64	6907.31	7155.49
Aug-08	7171.00	6953.88	6905.67	7147.48
Sep-08	7170.61	6953.44	6904.86	7147.16
Oct-08	7172.08	6953.88	6905.14	7147.01
May-09	7172.49	6955.96	6907.59	7155.01
Jun-09	7172.37	6955.52	6907.19	7149.91
Jul-09	7172.19	6955.56	6906.98	7149.48
Aug-09	7171.34	6953.67	6905.44	7147.38
Sep-09	7171.69	6953.44	6904.64	7147.2

Note: Monitoring wells TR-1.5, TR-3, TR-4 and WR-1 were removed from the Monitoring Program on September 2, 2009 in accordance with TR-48. Monitoring wells TR-1.5 and WR-1 were plugged and abandoned September 8, 2009. Monitoring wells TR-3 and TR-4 were transferred to the current land owner September 15, 2009.

Table 8. Ground Water Quality at Monitoring Well TR-1.5

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/88	7.50	5.7	179													
05/25/88	6.80	11.2	141													
06/24/88	6.60	12.2	322	194			104	39	0.6	25.0	9.0	6.0	0.38	0.330		
07/14/88	6.60	12.7	198	128	0.020	0.02	118	23	0.3	31.0	12.0	8.0	0.07	0.230		
08/05/88	6.60	11.5	148	93	0.120	0.08	98	25	0.4	26.0	11.0	6.0	0.08	0.220		
09/16/88	7.50	12.3	324	221												
10/21/88	6.90	9.8	235	155												
04/14/89	6.90	7.2	160	101												
05/15/89	8.10	8.1	123	76	0.016	0.74	70	29	0.7	22.0	9.0	5.0	0.18	0.060		
06/16/89	7.80	12.0	222	145												
07/03/89	7.10	12.5	301	203	0.020	0.08	92	21	0.4	27.0	10.0	6.0	0.18	0.260		
08/23/89	6.90	11.8	444	313												
09/07/89	7.10	13.0	278	186	0.124	0.01	100	56	0.9	28.0	11.0	6.0	0.35	0.440		
10/19/89	6.50	10.7	160	101												
04/19/90	8.10	6.3	174	111												
05/11/90	7.50	7.5	155	98	0.069	0.02	73	58	1.3	26.0	9.0	8.0	0.23	0.070		
06/14/90	7.40	13.6	200	129												
07/06/90	7.50	12.2	380	263												
08/10/90	7.80	12.9	174	111	0.105	0.02	106	35	0.5	30.0	11.0	6.0	0.29	0.340		
09/07/90	7.20	14.7	234	154												
10/19/90	6.30	10.0	1890	1555	0.005	0.02	110	12	0.2	26.0	10.0	6.0	0.03	0.070		
05/15/91	6.80	5.5	348	239												
06/11/91	6.80	7.7	379	262	0.030	< 0.01	100	43	0.7	28.0	11.0	9.0	< 0.02	0.040		
07/09/91	7.30	8.2	437	307	< 0.010	0.01	110	132	1.9	37.0	18.0	19.0	0.21	0.150		
08/09/91	6.10	13.8	1480	1186												
09/11/91	7.00	12.8	1573	1269												
10/10/91	6.70	9.2	1786	1460	0.022	< 0.01	124	29	0.4	29.0	11.0	8.0	0.04	0.020		
04/13/92	8.10	5.5	1582	1277												
05/06/92	6.50	9.7	2155	1798	0.038	0.01	94	80	1.3	26.0	10.0	9.0	0.08	0.030		
06/01/92	7.60	9.5	1754	1432												
07/01/92	8.30	12.8	1923	1585												
08/03/92	7.70	15.0	1840	1509	0.008	< 0.01	124	97	1.2	31.0	13.0	6.0	0.02	< 0.010		
10/05/92	7.50	11.9	360	248	0.011	< 0.01	142	23	0.3	37.0	15.0	9.0	0.04	0.020		

Table 8. Ground Water Quality at Monitoring Well TR-1.5

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/93	7.40	5.3	200	129												
05/04/93	7.20	7.0	190	122												
06/02/93	7.00	2.0	300	203	< 0.005	< 0.01	118	58	0.8	26.0	10.0	9.0	0.07	0.050		
07/01/93	7.20	12.0	255	169	< 0.005	< 0.01	122	2	0.0	29.0	12.0	7.0	0.19	0.090		
08/04/93	7.80	14.3	240	158												
09/09/93	7.70	15.0	250	166												
10/06/93	7.20	10.0	300	203	0.008	< 0.01	144	12	0.1	32.0	13.0	6.0	0.05	0.030		
11/08/93	8.30	5.8	290	195												
04/07/94	6.60	3.5	210	137												
05/03/94	7.20	5.8	290	154	< 0.005	< 0.01	138	6	0.1	31.0	12.0	8.0	0.89	0.040	< 1.0	2
06/20/94	7.50	14.2	690	370												
07/25/94	6.60	17.3	707	434	0.197	0.87	60	243	6.4	58.0	32.0	8.0	0.29	0.210	7.0	10
08/16/94	7.20	19.1	275	156												
09/16/94	6.30	12.2	667	412												
10/21/94	6.20	7.6	686	418	0.056	0.03	60	224	5.9	53.0	32.0	8.0	0.16	0.310	6.0	10
04/11/95	7.30	4.1	830	360												
05/16/95	6.80	6.6	350	200												
06/08/95	6.90	10.0	440	170												
06/28/95	7.10	9.9	870	430	0.080	0.02	138	180	2.1	65.4	37.0	8.5	0.03	0.021	5.2	
07/11/95	7.10	14.0	1170	840	0.220	0.09	153	470	4.8	200.0	132.0	15.4	0.08	0.315	6.0	7
08/14/95	7.30	13.3	1990	1230												
09/18/95	7.40	13.8	2190	1640												
10/18/95	7.60	8.7	2610	2180	0.013	0.19	233	1360	9.2	379.0	243.0	23.3	0.18	0.610	5.5	10
05/13/96	7.50	8.7	2560	2450	< 0.005	< 0.01	< 2	1520	1196.4	295.0	182.0	17.5	0.18	0.220	4.1	9
06/14/96	6.90	7.2	680	520												
07/15/96	6.90	8.2	3710	3690												
08/19/96	7.50	11.2	2780	2280	0.072	0.08	201	1530	12.0	350.0	237.0	23.4	< 0.02	0.260	5.6	10
09/16/96	7.10	11.9	2990	2470												
10/14/96	7.20	9.7	3490	3400	< 0.005	< 0.01	285	2200	12.2	481.0	334.0	30.7	0.57	0.670	6.4	15
05/13/97	7.04	8.3	2990	1360	0.009	0.02	254	770	4.8	165.0	111.0	11.2	0.14	0.150	3.1	7
06/04/97	7.46	14.7	4370	1960												
07/01/97	7.43	8.6	3360	3400												
08/04/97	7.53	9.2	3560	3510	< 0.005	< 0.01	316	2310	11.5	470.0	331.0	33.6	0.18	0.586	7.4	12
09/02/97	7.42	11.7	2750	2630												
10/01/97	7.18	11.9	2530	2190	0.044	< 0.01	185	1460	12.4	290.0	198.0	18.9	0.64	0.660	5.7	11

Table 8. Ground Water Quality at Monitoring Well TR-1.5

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/98	7.21	7.2	3350	3200	< 0.005	< 0.01	316	1990	9.9	438.0	315.0	29.9	1.02	0.614	5.8	13
06/02/98	7.13	9.1	2930	1600												
07/20/98	7.68	9.8	2710	2300	0.879	< 0.01	317	1380	6.9	304.0	215.0	33.0	< 0.05	0.560	8.0	14
08/17/98	7.54	10.2	2930	3060												
09/14/98	7.64	12.1	2480	1990												
10/12/98	7.51	11.7	2620	2310	1.050	0.26	300	1440	7.6	301.0	212.0	22.4	0.06	0.490	6.8	14
05/03/99	8.19	5.5	1920	1760	1.200	1.72	224	1160	8.2	244.0	170.0	18.2	0.03	0.407	6.6	11
06/07/99	7.84	9.2	2130	2680												
07/06/99	8.11	10.4	1800	2580												
08/24/99	7.53	11.1	2190	1670	0.950	0.18	204	1100	8.5	234.0	176.0	17.9	0.05	0.310	6.6	11
09/23/99	7.81	11.6	2210	1020												
10/18/99	7.58	9.1	3170	2790	0.859	0.10	268	1900	11.2	387.0	281.0	30.0	0.11	0.550	7.1	23
05/16/00	7.46	8.8	3210	2120	2.170	0.03	165	1400	13.4	293.0	216.0	37.9	0.09	0.149	9.7	43
06/19/00	7.14	9.4	3320	3450												
07/18/00	6.85	9.7	3790	3530												
08/15/00	7.14	12.6	3460	3530	0.432	0.01	287	2470	13.5	466.0	352.0	35.0	0.42	0.670	8.0	23
09/11/00	7.46	11.6	3520	3790												
10/02/00	7.30	10.8	3680	3820	0.350	< 0.01	307	2700	13.8	478.0	371.0	35.2	0.09	0.590	7.2	44
05/08/01	7.30	7.1	4250	530	0.005	1.24	377	70	0.3	12.9	4.7	179.0	0.06	0.016	2.0	18
06/04/01	7.20	6.7	3940	4480												
07/10/01	7.20	10.3	3880	4740	0.033	0.20	329	3010	14.4	538.0	436.0	35.0	< 0.05	0.310	7.0	15
08/01/01	7.30	11.8	3680	4690												
09/21/01	7.70	11.8	3650	4360												
10/10/01	7.70	9.2	3380	4310	0.013	< 0.01	266	3100	18.3	538.0	416.0	32.0	0.53	0.500	7.0	15
05/13/02	7.56	8.4	3070	3350	0.039	0.01	212	2340	17.4	410.0	326.0	26.5	< 0.02	< 0.010	5.6	12
06/03/02	7.82	11.8	2930	4180												
07/08/02	7.28	11.3	2980	4310												
08/13/02	7.84	12.3	3120	3720	0.028	< 0.01	309	2610	13.3	474.0	389.0	32.0	1.82	< 0.030	6.0	15
09/09/02	7.10	11.4	3510	3350												
10/14/02	7.14	10.3	3570	3550	< 0.010	< 0.01	328	3000	14.4	482.0	384.0	32.0	0.44	0.140	7.0	17
05/12/03	6.90	8.8	3200	4230	0.010	< 0.01	314	2460	12.3	510.0	410.0	32.0	0.44	0.490	3.1	14
06/17/03	7.00	12.3	2420	2920												
07/16/03	6.90	11.5	3080	4150	< 0.010	< 0.01	318	2690	13.3	498.0	394.0	31.0	0.25	0.770	4.5	13
08/12/03	7.10	14.8	2620	3530												
09/08/03	7.10	13.2	3010	3710												
10/01/03	7.00	13.6	3300	4590	0.010	< 0.01	313	3170	15.9	554.0	437.0	40.0	0.25	0.710	5.0	15

Table 8. Ground Water Quality at Monitoring Well TR-1.5

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/04	6.88	9.9	2980	4450	< 0.010	< 0.01	320	3140	15.4	534.0	431.0	35.2	0.14	0.900	6.4	15
06/01/04	6.69	11.2	3010	4510												
07/19/04	7.06	16.7	3680	4530	< 0.010	< 0.01	324	3160	15.4	528.0	408.0	32.0	0.29	0.660	6.0	16
08/03/04	7.19	14.4	4090	4460												
09/08/04	7.26	15.9	4030	4630												
10/13/04	6.90	10.3	3900	4210	< 0.010	< 0.01	308	2830	14.5	493.0	383.0	30.0		0.040	6.0	14
04/18/05	7.12	9.8	4160	4530												
05/12/05	7.20	6.7	4280	4460	0.040	0.02	315	2910	14.5	540.0	448.0	33.9	0.27	0.774	6.6	15
06/09/05	8.46	10.1	4140	4480												
07/15/05	7.08	18.0	4090	4800												
08/03/05	7.06	11.6	4420	4700	< 0.010	< 0.01	326	2850	13.8	563.0	447.0	34.0	0.50	0.820	6.0	14
09/06/05	7.07	16.4	4010	4500												
10/20/05	7.14	9.4	4440	4450	< 0.010	< 0.01	320	2890	14.2	603.0	506.0	39.8	< 0.02	0.364	7.2	16
05/19/06	7.04	12.1	3970	4370	0.030	0.04	309	2790	14.2	554.0	446.0	34.7	0.37	0.800	6.2	13
06/13/06	6.87	11.6	3960	4570												
07/18/06	7.09	15.4	3830	4590												
08/10/06	7.08	13.8	3960	4600	0.040	< 0.01	316	2700	13.5	545.0	432.0	34.0	1.10	0.910	7.0	13
09/11/06	7.34	13.3	4170	4400												
10/11/06	6.94	9.4	4340	4430	0.040	< 0.01	305	2880	14.9	500.0	436.0	34.0	0.92	0.795	6.4	14
05/08/07	7.10	8.6	4260	4510	0.050	0.01	306	3030	15.6	545.0	458.0	33.0	0.40	0.760	6.0	14
06/22/07	7.22	11.5	4430	4720												
07/19/07	7.60	11.6	4460	4620	< 0.010	0.01	318	3100	15.3	565.0	470.0	36.0	0.50	0.940	7.0	13
08/09/07	6.98	11.8	4350	4480												
09/21/07	7.25	11.8	4960	4360												
10/15/07	7.70	10.1	4280	4460	0.030	< 0.01	315	3000	15.0	536.0	447.0	35.0	0.90	0.900	7.0	13
05/14/08	7.39	7.2	4430	4570	0.040	0.01	294	2990	16.0	520.0	468.0	32.3	0.45	0.716	6.2	14
06/11/08	6.93	7.4	4180	4250												
07/07/08	7.19	11.2	4080	4270												
08/11/08	6.80	12.7	4110	4360	0.010	< 0.01	296	2600	13.8	515.0	426.0	37.0	0.60	0.770	6.0	15
09/08/08	6.95	12.6	4140	4920												
10/14/08	6.75	6.6	4010	4040	< 0.010	< 0.01	219	2500	18.0	485.0	433.0	33.2	0.22	0.670	6.8	14
05/14/09	6.82	9.6	3570	4100	0.020	0.02	289	2700	14.7	474.0	420.0	32.7	30.70		6.1	12
06/09/09	6.98	9.2	2680	2460												
07/06/09	7.20	15.2	2560	2450												
08/06/09	6.75	13.7	2610	2510	0.020	< 0.01	248	1700	10.8	312.0	271.0	22.8	0.21	0.071	5.0	9
09/02/09	7.58	13.7	2670	2710												

Note: Monitoring well TR-1.5 was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48. Monitoring well TR-1.5 was plugged and abandoned September 8, 2009.

Table 9. Ground Water Quality at Monitoring Well TR-3

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/88	6.90	6.7	242													
05/17/88	7.00	9.3	240													
06/25/88	7.20	10.8	298	332			104	138	2.1	41.0	19.0	8.0	0.22	0.030		
07/14/88	7.30	14.5	397	277	0.009	0.05	118	117	1.6	48.0	23.0	20.0	0.59	0.050		
08/05/88	7.40	16.1	490	349	0.150	0.00	98	113	1.8	44.0	22.0	11.0	0.18	0.140		
09/21/88	7.70	11.7	433	304												
10/21/88	7.50	10.8	453	320												
04/14/89	7.10	5.7	485	345												
05/15/89	8.40	7.7	376	260	0.010	0.52	102	189	2.9	61.0	31.0	10.0	0.45	0.030		
06/19/89	6.60	10.9	486	346												
07/03/89	7.50	14.4	376	260	0.016	0.19	118	107	1.4	59.0	26.0	10.0	0.18	0.040		
08/23/89	7.20	12.3	369	255												
09/08/89	7.60	11.1	447	315	0.032	0.25	122	144	1.9	60.0	28.0	8.0	0.11	0.260		
10/19/89	7.70	9.6	643	471												
04/19/90	8.30	6.0	551	397												
05/11/90	7.50	7.0	535	385	0.015	0.07	129	222	2.7	69.0	30.0	10.0	0.19	0.060		
06/17/90	7.20	10.1	549	396												
07/06/90	7.50	10.7	365	252												
08/10/90	7.80	13.0	420	294	0.031	0.02	127	138	1.7	55.0	24.0	9.0	1.14	0.260		
09/07/90	7.70	13.4	630	461												
10/16/90	7.40	9.5	2360	1988	0.005	0.02	123	154	2.0	53.0	24.0	11.0	0.18	0.060		
05/15/91	7.40	2.7	1137	886												
06/11/91	6.90	5.1	966	740	0.050	< 0.01	120	179	2.3	60.0	28.0	11.0	< 0.02	0.030		
07/09/91	7.70	6.3	901	685	<0.010	0.01	123	111	1.4	46.0	21.0	10.0	0.23	0.270		
08/09/91	6.80	10.3	2238	1875												
09/11/91	6.60	10.9	1948	1608												
10/10/91	7.30	10.5	2223	1860	0.022	< 0.01	130	117	1.4	50.0	23.0	11.0	0.09	0.020		
04/13/92	8.50	7.5	2675	2284												
05/06/92	7.50	8.6	2485	2105	0.006	< 0.01	112	218	3.1	54.0	26.0	11.0	0.06	0.040		
06/01/92	8.20	9.7	2321	1952												
07/01/92	8.20	11.7	2076	1725												
08/03/92	8.00	10.8	2177	1818	0.020	0.01	124	187	2.4	50.0	22.0	10.0	0.62	0.030		
10/05/92	7.40	10.0	450	318	0.005	< 0.01	118	150	2.0	55.0	25.0	10.0	0.08	0.010		

Table 9. Ground Water Quality at Monitoring Well TR-3

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/93	7.60	6.8	570	412												
05/04/93	7.20	7.3	550	397												
06/02/93	7.40	8.0	570	412	< 0.005	< 0.01	120	183	2.4	56.0	26.0	10.0	0.15	0.090		
07/01/93	7.50	10.5	330	225	< 0.005	< 0.01	118	84	1.1	42.0	20.0	9.0	0.44	0.170		
08/04/93	8.50	10.0	380	263												
09/09/93	7.40	11.0	540	389												
10/06/93	7.50	11.0	590	429	< 0.005	< 0.01	128	154	1.9	61.0	28.0	10.0	< 0.01	0.190		
11/08/93	8.30	7.9	620	453												
04/07/94	6.70	5.0	540	389												
05/03/94	7.30	6.5	630	392	< 0.005	< 0.01	142	161	1.8	65.0	31.0	11.0	0.13	0.100	1.0	2
06/20/94	7.04	9.4	600	346												
07/25/94	7.10	13.7	523	340	< 0.005	< 0.01	138	146	1.7	58.0	27.0	11.0	0.60	0.400	1.0	< 1
08/16/94	7.90	16.7	583	390												
09/16/94	7.20	13.9	719	502												
10/21/94	7.70	10.8	683	460	< 0.005	< 0.01	156	230	2.3	73.0	34.0	12.0	1.17	0.005	1.0	2
04/11/95	7.30	4.0	630	390												
05/16/95	6.70	7.4	610	420												
06/08/95	7.40	9.8	620	390												
06/28/95	6.70	11.0	540	310	< 0.005	< 0.01	131	120	1.4	49.5	22.6	10.3	0.12	0.167	.9	< 1
07/11/95	6.90	12.8	480	340	< 0.005	< 0.01	138	140	1.6	57.7	27.9	10.9	0.22	0.235	1.1	2
08/14/95	7.60	10.7	490	300												
09/18/95	7.60	11.2	510	300												
10/18/95	8.10	9.8	500	310	0.014	< 0.01	142	106	1.2	53.6	25.4	10.2	0.42	0.040	1.1	1
05/13/96	7.80	6.9	580	380	< 0.005	< 0.01	< 2	130	102.3	61.4	29.1	11.5	0.02	< 0.005	1.1	< 1
06/14/96	6.90	7.2	580	380												
07/15/96	7.10	9.3	590	380												
08/19/96	7.50	9.9	540	330	< 0.005	< 0.01	162	110	1.1	59.7	28.2	11.0	0.49	0.133	.1	2
09/16/96	7.40	10.7	540	480												
10/14/96	7.20	9.2	590	350	< 0.005	< 0.01	126	150	1.9	59.0	27.9	10.2	0.45	0.319	1.1	< 1
05/13/97	7.41	6.3	580	370	< 0.005	< 0.01	130	160	1.9	65.2	30.4	10.6	0.02	< 0.005	.9	1
06/04/97	8.01	8.8	500	340												
07/01/97	6.64	8.4	560	380												
08/04/97	7.67	9.7	580	350	< 0.005	< 0.01	168	140	1.3	65.6	30.5	11.2	0.17	0.377	1.1	< 1
09/02/97	7.81	10.9	560	360												
10/01/97	7.18	10.7	550	350	0.012	< 0.01	144	140	1.5	63.8	30.6	11.0	0.20	0.015	1.4	< 1

Table 9. Ground Water Quality at Monitoring Well TR-3

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/98	7.38	6.4	800	590	< 0.005	< 0.01	148	300	3.2	103.0	47.1	13.2	0.22	0.404	1.0	5
06/02/98	7.57	8.9	820	490												
07/20/98	7.81	9.4	830	600	0.006	< 0.01	159	260	2.6	83.3	43.2	24.3	0.16	0.095	1.4	4
08/17/98	7.83	11.4	680	410												
09/14/98	7.72	10.9	800	740												
10/12/98	7.74	9.9	550	380	< 0.005	< 0.01	123	160	2.0	59.9	27.4	11.5	0.24	0.102	1.0	< 1
05/03/99	8.30	4.9	560	358	< 0.005	< 0.01	119	180	2.4	63.9	29.7	9.3	0.05	0.015	1.0	2
06/07/99	8.30	8.4	640	410												
07/06/99	8.16	8.9	700	460												
08/24/99	7.89	11.9	710	299	0.008	< 0.01	126	130	1.6	54.9	25.5	9.9	0.17	0.294	1.0	1
09/23/99	8.31	11.2	690	320												
10/18/99	8.12	8.9	490	304	0.081	0.01	120	140	1.8	53.7	25.0	10.1	0.30	0.180	1.1	1
05/16/00	7.28	7.9	720	468	0.014	0.01	114	260	3.6	84.2	39.1	11.5	0.55	0.248	1.1	3
06/19/00	7.51	9.7	700	520												
07/18/00	7.12	11.5	620	410												
08/15/00	7.74	13.3	610	394	0.016	0.04	133	190	2.2	69.0	31.1	13.3	0.44	1.110	1.6	7
09/11/00	7.70	11.6	640	430												
10/02/00	7.50	11.1	640	414	0.015	< 0.01	127	220	2.7	68.1	32.1	11.6	0.49	0.873	1.4	3
05/08/01	7.80	5.4	830	590	0.007	0.10	115	330	4.5	89.3	41.5	11.4	0.45	0.748	1.1	4
06/04/01	7.60	6.5	760	550												
07/10/01	7.30	10.4	720	560	0.009	0.32	128	260	3.2	87.8	41.0	13.8	0.31	0.531	1.5	3
08/01/01	7.60	11.4	720	490												
09/21/01	7.90	11.8	630	440												
10/10/01	8.10	10.1	670	470	0.013	< 0.01	111	220	3.1	73.5	34.2	10.9	0.79	0.703	1.3	3
05/13/02	8.02	6.8	570	380	0.036	< 0.01	110	160	2.3	68.9	32.1	10.0	< 0.01	< 0.005	.8	2
06/03/02	7.94	8.1	650	420												
07/08/02	8.14	11.9	690	440												
08/13/02	8.26	11.1	740	491	0.007	0.06	180	230	2.0	89.3	44.0	12.5	< 0.01	0.203	1.5	2
09/09/02	7.70	10.6	780	550												
10/14/02	7.09	12.1	760	510	< 0.010	< 0.01	182	240	2.1	82.5	39.3	12.2	0.52	0.102	1.3	2
05/12/03	6.90	8.3	780	580	< 0.010	0.02	142	250	2.8	89.9	43.6	11.8	0.69	0.784	1.1	2
06/17/03	7.10	13.5	570	380												
07/16/03	6.90	13.3	590	430	< 0.010	< 0.01	148	180	1.9	70.6	33.5	11.4	0.58	0.313	1.0	2
08/12/03	7.00	13.4	600	480												
09/08/03	7.10	12.3	640	480												
10/01/03	6.90	12.5	640	450	0.010	< 0.01	137	220	2.5	75.7	34.4	11.6	1.10	0.448	1.2	2

Table 9. Ground Water Quality at Monitoring Well TR-3

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/04	7.01	7.2	630	860	< 0.010	< 0.01	128	270	3.3	65.1	32.0	10.1	0.01	0.020	.9	2
06/01/04	6.64	10.1	730	570												
07/19/04	7.19	12.7	590	450	< 0.010	< 0.01	139	230	2.6	75.0	33.9	11.4	0.08	0.061	1.2	2
08/03/04	7.15	16.2	590	430												
09/08/04	7.36	16.1	570	430												
10/13/04	7.08	10.2	640	460	< 0.010	< 0.01	137	220	2.5	61.2	29.6	10.2		0.081	1.3	3
04/18/05	7.04	8.6	710	510												
05/12/05	6.99	5.8	850	630	0.060	0.04	130	340	4.1	103.0	47.9	12.6	0.36	0.523	1.2	4
06/09/05	8.48	9.7	700	540												
07/15/05	7.07	16.1	720	560												
08/03/05	7.10	12.4	720	520	< 0.010	0.03	146	220	2.4	78.4	37.5	12.2	0.81	0.488	1.3	2
09/06/05	7.17	14.6	590	410												
10/20/05	7.27	10.5	560	370	0.010	< 0.01	126	160	2.0	64.0	30.5	11.7	0.14	0.570	1.1	2
05/19/06	6.96	11.3	740	550	0.030	0.05	127	290	3.6	89.7	43.4	12.0	0.62	0.481	1.1	3
06/13/06	7.06	11.5	720	520												
07/18/06	7.20	13.6	620	460												
08/10/06	7.12	13.9	620	500	0.040	0.03	132	220	2.6	71.4	34.5	11.8	0.24	0.613	1.5	2
09/11/06	7.86	12.8	660	420												
10/11/06	7.20	9.4	610	400	0.040	< 0.01	128	170	2.1	65.1	32.2	11.9	0.49	0.595	1.3	2
05/08/07	7.20	6.8	892	650	0.040	0.01	126	360	4.5	109.0	53.6	13.4	1.24	0.468	1.1	3
06/22/07	7.55	9.5	850	640												
07/19/07	7.70	11.9	665	460	< 0.010	0.03	137	200	2.3	69.7	33.7	11.7	0.17	0.411	1.0	2
08/09/07	7.10	13.1	610	380												
09/21/07	7.51	11.6	690	400												
10/15/07	7.80	9.6	608	410	0.030	< 0.01	150	180	1.9	61.4	29.5	10.8	0.24	0.423	1.6	2
05/14/08	7.94	6.9	580	380	0.020	< 0.01	134	160	1.9	62.3	31.1	9.5	< 0.02	< 0.005	.6	1
06/11/08	7.40	8.3	700	490												
07/07/08	7.75	10.0	730	180												
08/11/08	7.42	13.2	660	381	< 0.010	< 0.01	151	174	1.8	67.4	32.8	12.0	0.19	0.098	1.1	2
09/08/08	7.29	11.8	610	400												
10/14/08	7.30	9.7	580	380	< 0.010	< 0.01	123	148	1.9	63.3	31.1	11.6	0.15	0.292	1.3	2
05/14/09	7.36	7.1	870	630	0.030	0.03	111	330	4.7	101.0	50.5	12.2	13.90		1.1	3
06/09/09	7.01	8.9	740	520												
07/06/09	7.01	12.7	730	540												
08/06/09	7.24	13.1	690	480	0.030	0.01	144	230	2.5	85.2	40.8	13.2	0.43	0.153	1.3	2
09/02/09	7.19	13.0	680	470												

Note: Monitoring well TR-3 was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48. Monitoring well TR-3 was transferred to the current land owner September 15, 2009.

Table 10. Ground Water Quality at Monitoring Well TR-4

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/29/88	7.40	5.1	304													
05/17/88	7.50	8.4	295													
06/25/88	6.90	12.6	309	338			139	134	1.5	51.0	24.0	10.0	0.06	0.009		
07/14/88	7.70	15.2	296	200	0.010	0.02	137	97	1.1	46.0	22.0	9.0	0.06	0.030		
08/05/88	8.00	14.7	410	286	0.020	0.05	139	161	1.8	58.0	29.0	11.0	0.15	0.260		
09/21/88	7.70	13.5	475	337												
10/21/88	7.50	10.5	426	299												
04/14/89	8.00	4.7	368	254												
05/15/89	8.00	6.7	480	341	0.008	0.57	112	196	2.8	65.0	35.0	11.0	4.61	0.150		
06/19/89	7.50	12.0	364	251												
07/03/89	7.60	12.9	321	218	0.022	0.02	100	93	1.5	48.0	22.0	10.0	0.12	0.070		
08/23/89	7.70	15.7	339	232												
09/08/89	7.70	13.9	468	332	0.012	0.01	118	185	2.5	68.0	33.0	10.0	0.02	0.090		
10/19/89	7.10	10.7	440	310												
04/19/90	8.10	5.4	655	481												
05/14/90	6.70	8.1	532	382	0.023	0.11	895	261	0.5	79.0	37.0	12.0	0.12	0.050		
06/14/90	7.90	12.7	384	266												
07/06/90	6.80	12.1	269	180												
08/10/90	8.10	16.4	395	275	0.036	0.02	146	185	2.0	66.0	31.0	13.0	0.43	0.140		
09/07/90	7.70	16.7	507	362												
10/16/90	7.60	13.2	1810	1482	0.010	0.02	120	206	2.7	63.0	32.0	12.0	0.08	0.080		
05/15/91	7.80	3.1	788	590												
06/11/91	7.70	7.3	768	573	0.050	0.02	106	220	3.3	64.0	33.0	10.0	<0.02	0.010		
07/09/91	7.70	8.9	499	356	<0.010	< 0.01	113	66	0.9	34.0	17.0	10.0	0.02	0.020		
08/09/91	6.90	15.8	1623	1314												
09/11/91	7.80	15.3	1660	1346												
10/10/91	8.10	12.0	1899	1563	0.018	< 0.01	114	167	2.3	54.0	28.0	10.0	0.09	0.050		
04/13/92	8.50	5.2	2749	2354												
05/06/92	7.20	7.6	1960	1619	0.008	< 0.01	124	311	3.9	76.0	39.0	12.0	0.04	0.070		
06/01/92	8.00	9.7	1952	1611												
07/01/92	8.40	12.0	1899	1563												
08/03/92	7.20	14.7	1698	1381	0.014	< 0.01	134	2165	25.4	58.0	28.0	11.0	0.08	0.014		
10/05/92	8.00	11.3	700	518	< 0.005	< 0.01	134	218	2.6	73.0	37.0	13.0	0.06	0.200		

Table 10. Ground Water Quality at Monitoring Well TR-4

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/93	7.80	6.0	740	551												
05/04/93	7.50	11.3	700	518												
06/02/93	7.60	10.0	600	437	< 0.005	< 0.01	192	228	1.9	91.0	45.0	15.0	0.04	0.220		
07/01/93	7.40	11.8	700	518	0.007	< 0.01	226	239	1.7	95.0	45.0	16.0	0.23	0.240		
08/04/93	7.70	15.5	500	357												
09/09/93	7.80	16.0	470	333												
10/06/93	8.30	11.5	540	389	< 0.005	< 0.01	120	142	1.9	52.0	26.0	10.0	< 0.01	0.020		
11/08/93	8.80	5.0	650	477												
04/07/94	7.20	3.0	440	310												
05/03/94	7.70	6.0	600	458	< 0.005	< 0.01	158	251	2.5	82.0	43.0	13.0	0.06	0.100	2.0	2
06/20/94	8.35	13.5	420	216												
07/25/94	6.90	15.8	917	690	0.006	< 0.01	160	356	3.5	116.0	60.0	15.0	0.06	0.240	3.0	1
08/16/94	6.90	16.9	900	608												
09/16/94	7.00	16.3	643	422												
10/21/94	7.30	10.1	570	340	< 0.005	< 0.01	176	140	1.3	50.0	27.0	10.0	0.11	0.030	2.0	< 1
04/11/95	6.80	6.3	680	450												
05/16/95	6.80	6.3	680	450												
06/08/95	7.10	8.6	760	500												
06/28/95	6.90	12.7	800	560	0.012	< 0.01	173	250	2.3	80.0	42.0	14.0	0.02	0.068	2.1	4
07/11/95	7.10	14.3	810	580	< 0.005	< 0.01	194	250	2.0	92.0	51.9	15.6	0.02	0.118	2.5	5
08/14/95	7.70	12.5	530	310												
09/18/95	7.80	14.3	530	330												
10/18/95	8.10	10.4	600	400	0.020	< 0.01	118	198	2.6	62.8	33.2	9.7	0.34	0.167	2.1	2
05/13/96	7.90	7.1	700	420	< 0.005	< 0.01	117	180	2.4	72.6	36.9	10.6	0.07	0.220	2.0	1
06/14/96	7.00	6.5	960	660												
07/15/96	7.20	8.9	850	580												
08/19/96	7.60	11.9	810	510	< 0.005	< 0.01	222	210	1.5	93.8	45.6	13.7	0.44	1.210	2.2	4
09/16/96	7.50	12.9	720	340												
10/14/96	7.30	10.1	550	360	< 0.005	< 0.01	132	140	1.7	55.9	27.5	11.4	0.09	0.112	3.3	3
05/13/97	7.20	8.2	760	490	< 0.005	< 0.01	207	190	1.4	76.6	37.7	11.7	0.03	0.097	2.0	3
06/04/97	7.85	11.3	740	480												
07/01/97	7.31	7.9	830	590												
08/04/97	7.58	11.2	850	610	< 0.005	< 0.01	227	230	1.6	102.0	47.5	13.9	0.31	1.810	2.1	4
09/02/97	7.71	11.4	840	690												
10/01/97			797	520	< 0.005	< 0.01	226	230	1.6	99.6	46.8	13.6	0.12	0.702	2.4	4

Table 10. Ground Water Quality at Monitoring Well TR-4

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/98	7.34	6.0	920	620	< 0.005	< 0.01	240	260	1.7	112.0	50.4	14.6	0.20	2.400	2.1	8
06/02/98	7.70	10.7	870	620												
07/20/98	7.64	10.1	960	700	< 0.005	< 0.01	248	270	1.7	113.0	54.0	16.0	0.10	1.660	2.4	8
08/17/98	7.80	12.9	990	750												
09/14/98	7.90	13.7	590	390												
10/12/98	8.06	11.3	500	350	< 0.005	< 0.01	117	140	1.9	54.7	25.6	9.0	0.11	0.154	3.1	< 1
05/03/99	8.50	4.8	660	424	0.006	< 0.01	160	200	2.0	74.5	36.1	11.0	0.05	0.770	2.2	3
06/07/99	8.38	9.2	460	270												
07/06/99	8.28	9.6	780	500												
08/24/99	8.07	15.8	760	266	0.022	< 0.01	119	110	1.5	49.1	23.9	8.9	0.07	0.073	2.8	< 1
09/23/99	8.40	12.7	750	260												
10/18/99	8.27	9.6	450	264	0.031	< 0.01	118	110	1.5	47.6	23.9	7.9	0.12	0.160	2.5	1
05/16/00	7.73	7.5	700	427	0.039	0.03	130	220	2.7	73.1	36.1	10.9	0.80	0.079	2.2	4
06/19/00	7.98	13.0	320	200												
07/18/00	7.24	19.4	490	310												
08/15/00	7.52	19.1	720	459	0.095	< 0.01	146	230	2.5	75.8	40.5	14.0	0.04	0.058	2.9	7
09/11/00	7.85	13.1	590	380												
10/02/00	7.69	12.2	610	390	0.069	< 0.01	132	200	2.4	58.9	35.5	10.9	0.07	0.014	2.1	3
05/08/01	7.90	5.8	740	480	0.029	0.20	120	475	6.2	73.1	42.6	11.8	0.09	0.010	2.1	2
06/04/01	7.80	8.4	210	120												
07/10/01	7.30	18.9	720	570	0.037	0.08	158	250	2.5	83.2	46.6	12.7	< 0.01	< 0.005	3.0	2
08/01/01	7.90	18.6	560	370												
09/21/01	8.00	13.4	520	340												
10/10/01	8.50	9.8	470	300	0.023	< 0.01	108	130	1.9	45.7	27.1	7.5	0.25	0.029	1.6	2
05/13/02	7.82	7.6	870	600	0.024	0.06	115	330	4.5	111.0	56.4	13.1	0.21	0.012	3.0	5
06/03/02	7.63	8.8	730	470												
07/08/02	7.67	12.3	1020	730												
08/13/02																
09/09/02																
10/14/02																
05/12/03	7.80	10.1	980	820	0.020	< 0.01	155	420	4.3	113.0	74.2	18.1	0.13	0.727	4.2	3
06/17/03	7.00	14.1	800	600												
07/16/03	6.90	14.6	880	650	< 0.010	< 0.01	345	220	1.0	111.0	52.2	22.2	1.80	3.000	6.3	7
08/12/03	7.00	16.8	930	640												
09/08/03	7.10	15.3	1000	400												
10/01/03	7.00	12.8	1080	780	0.030	0.02	537	160	0.5	149.0	68.1	24.5	0.54	1.920	8.1	8

Table 10. Ground Water Quality at Monitoring Well TR-4

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/04	6.75	7.6	1090	460	< 0.010	0.02	491	240	0.8	131.0	62.2	46.4	0.45	3.250	8.0	8
06/01/04	6.52	10.5	1160	870												
07/19/04	7.26	14.1	1250	940	0.010	0.02	419	230	0.9	135.0	61.6	89.8	0.37	4.410	8.0	8
08/03/04	7.26	15.0	1370	920												
09/08/04	7.31	15.4	1390	960												
10/13/04	7.28	12.2	1440	870	< 0.010	0.02	713	160	0.4	143.0	66.9	59.9		3.950	8.2	44
04/18/05	7.06	8.9	1270	860												
05/12/05	7.00	6.3	1190	770	0.130	0.02	542	150	0.4	138.0	66.5	46.7	0.20	1.630	7.8	20
06/09/05	8.44	10.9	1130	790												
07/15/05	7.17	19.0	1140	780												
08/03/05	7.13	14.1	1300	820	0.010	0.02	588	160	0.4	129.0	63.1	60.8	0.25	2.210	7.8	4
09/06/05	7.23	15.9	1300	820												
10/20/05	7.22	11.5	1470	840	0.360	0.02	621	170	0.4	151.0	73.8	63.7	0.67	4.240	8.6	5
05/19/06	7.61	14.6	1180	750	0.040	0.02	610	110	0.3	130.0	68.4	53.2	0.14	3.330	7.0	4
06/13/06	7.25	14.2	1160	770												
07/18/06	7.36	14.1	1190	780												
08/10/06	7.07	16.0	1110	710	0.050	0.02	474	140	0.5	124.0	62.0	28.7	0.06	1.480	7.6	4
09/11/06	7.52	13.2	1190	730												
10/11/06	7.32	11.6	1150	720	0.010	< 0.01	520	150	0.5	116.0	60.3	24.3	0.08	1.990	6.7	5
05/08/07	7.70	8.8	1120	700	0.040	< 0.01	505	130	0.4	134.0	70.7	21.7	0.03	0.249	5.2	4
06/22/07	7.40	12.9	1280	810												
07/19/07	7.80	15.4	1310	810	< 0.010	0.04	644	120	0.3	148.0	75.0	17.3	0.22	3.890	5.8	4
08/09/07	7.15	13.2	1210	720												
09/21/07	7.31	14.0	1480	790												
10/15/07	7.90	11.3	1190	780	0.030	< 0.01	599	120	0.3	149.0	73.6	20.5	0.13	3.340	7.9	4
05/14/08	7.10	6.8	1110	720	0.040	0.01	503	120	0.4	127.0	66.2	17.2	0.04	1.470	5.9	3
06/11/08	7.16	8.7	1160	710												
07/07/08	7.34	12.3	1170	2160												
08/11/08	7.18	15.1	1180	730	0.020	0.05	561	106	0.3	133.0	70.9	16.5	0.13	3.030	6.5	5
09/08/08	7.09	13.0	1180	740												
10/14/08	7.13	9.9	1200	730	< 0.010	0.01	475	110	0.4	145.0	77.6	17.3	0.22	3.500	7.0	4
05/14/09	7.22	9.8	1160	720	0.040	0.02	569	92	0.3	145.0	78.2	16.4	1.08		5.5	4
06/09/09	6.93	9.9	1120	710												
07/06/09	7.41	13.5	1100	720												
08/06/09	7.31	13.4	1160	730	0.070	0.13	571	121	0.3	123.0	65.6	14.9	0.18	2.860	5.2	4
09/02/09	7.24	13.2	1110	770												

Note: Monitoring well TR-4 was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48. Monitoring well TR-4 was transferred to the current land owner September 15, 2009.

Table 11. Ground Water Quality at Monitoring Well WR-1

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/88	6.70	11.0	3499													
05/09/88	6.80	9.9	3549													
06/09/88	6.60	12.7	3605	3874			353	2527	11.3	574.0	309.0	153.0	0.03	3.880		
07/14/88	6.70	13.6	3720	3290	0.020	4.64	431	2457	9.0	422.0	313.0	91.0	0.12	3.140		
08/05/88	6.80	12.6	3698	3269	0.010	4.04	427	2472	9.1	543.0	309.0	78.0	0.03	1.140		
09/21/88	6.80	12.3	3729	3299												
10/21/88	6.70	9.6	3764	3334												
04/13/89	6.90	10.8	4129	3693												
05/15/89	6.80	10.5	3982	3548	0.005	1.73	464	2503	8.5	485.0	297.0	127.0	0.04	4.180		
06/16/89	6.70	12.5	3850	3418												
07/03/89	7.00	13.3	2000	1655	0.013	0.56	278	1076	6.1	267.0	153.0	36.0	0.03	0.060		
08/03/89	6.80	12.3	2040	1692												
09/07/89	6.90	13.4	2465	2086	0.014	0.55	312	1239	6.3	355.0	208.0	50.0	0.02	0.040		
10/19/89	6.60	11.5	3399	2978												
04/19/90	7.20	11.2	4083	3648												
05/11/90	6.70	9.7	3959	3525	0.017	0.56	472	2441	8.1	506.0	265.0	108.0	0.06	4.800		
06/14/90	6.70	12.7	3942	3509												
07/06/90	7.20	12.9	3974	3540												
08/10/90	7.00	13.8	3930	3497	0.007	0.44	448	2507	8.8	509.0	249.0	138.0	0.02	0.090		
09/07/90	6.80	14.4	3830	3398												
10/16/90	6.70	11.9	1500	1204	0.005	0.26	458	2690	9.2	498.0	283.0	103.0	0.02	0.040		
05/15/91	6.70	7.2	3602	3175												
06/11/91	6.40	9.4	3422	3000	0.030	< 0.01	436	2529	9.1	491.0	289.0	121.0	< 0.02	4.590		
07/09/91	6.80	9.4	3392	2971	< 0.010	0.32	392	2046	8.2	469.0	240.0	144.0	0.04	1.450		
08/09/91	6.80	11.8	1370	1089												
09/11/91	6.80	12.2	1084	840												
10/10/91	6.80	10.9	1265	997	0.027	< 0.01	432	2428	8.8	395.0	240.0	454.0	< 0.02	< 0.010		
04/13/92	6.10	9.5	147	92												
05/06/92	6.30	11.4	1385	1102	< 0.005	0.01	474	2618	8.7	513.0	268.0	197.0	< 0.02	8.760		
06/01/92	6.40	10.6	1350	1071												
07/01/92	6.70	12.7	1203	943												
08/03/92	7.30	15.0	1257	990	< 0.005	< 0.01	404	2151	8.4	486.0	247.0	134.0	< 0.02	0.010		
10/05/92	7.60	12.0	3300	2882	0.005	< 0.01	396	2379	9.5	520.0	270.0	136.0	0.08	0.080		

Table 11. Ground Water Quality at Monitoring Well WR-1

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
04/28/93	7.20	10.8	3800	3369												
05/04/93	6.80	11.5	3700	3271												
06/02/93	6.90	12.0	4000	3566	< 0.005	0.02	394	2741	11.0	508.0	361.0	64.0	< 0.02	1.800		
07/01/93	7.00	13.0	3700	3271	< 0.005	< 0.01	418	2766	10.4	531.0	370.0	78.0	< 0.02	2.400		
08/04/93	7.20	13.0	3300	2882												
09/09/93	6.80	13.8	3300	2882												
10/06/93	6.90	11.8	3300	2882	< 0.005	< 0.01	390	2696	10.9	540.0	368.0	62.0	< 0.02	0.470		
11/08/93	6.80	10.8	3300	2882												
04/07/94	6.20	10.0	4500	4062												
05/03/94	6.90	11.0	5000	3974	< 0.005	< 0.01	474	2408	8.0	512.0	337.0	93.0	0.09	3.980	12.0	7
06/20/94	7.03	12.8	3650	3572												
07/25/94	6.60	15.9	3610	3578	< 0.005	< 0.01	420	2346	8.8	516.0	262.0	118.0	0.06	0.040	10.0	1
08/16/94	6.80	12.7	3710	3586												
09/16/94	6.80	12.3	3660	3592												
10/21/94	7.00	10.3	3750	3620	< 0.005	< 0.01	456	2410	8.3	498.0	269.0	109.0	0.12	0.140	10.0	2
04/11/95	6.60	11.4	3740	4050												
05/16/95	6.60	11.4	3740	4050												
06/08/95	7.50	11.3	3300	3090												
06/28/95	7.10	12.7	3520	3690	< 0.005	< 0.01	357	2320	10.2	454.0	308.0	55.5	< 0.01	0.826	10.4	4
07/11/95	6.70	13.5	3770	4190	< 0.005	< 0.01	362	2600	11.3	520.0	393.0	62.3	< 0.01	1.510	12.4	6
08/14/95	6.90	13.2	3900	4040												
09/18/95	7.00	12.4	3700	3730												
10/18/95	7.30	11.9	2140	1860	0.011	< 0.01	251	1140	7.2	261.0	132.0	54.6	< 0.01	0.400	6.4	2
05/13/96	7.10	10.3	3960	4440	< 0.005	< 0.01	< 2	2620	2062.3	480.0	415.0	66.0	< 0.05	0.540	14.0	8
06/14/96	7.50	12.6	3360	3520												
07/15/96	7.20	13.0	3250	3280												
08/19/96	7.10	12.5	3860	3570	< 0.005	< 0.01	354	2340	10.4	496.0	354.0	104.0	< 0.05	3.240	11.0	4
09/16/96	7.10	13.5	3830	3800												
10/14/96	7.40	12.4	3810	3920	< 0.005	< 0.01	385	2600	10.6	508.0	371.0	95.0	0.04	0.040	11.7	5
05/13/97	7.55	10.8	3830	4250	< 0.005	< 0.01	324	2750	13.4	461.0	355.0	47.0	0.03	0.310	11.1	6
06/04/97	8.01	12.1	2340	1920												
07/01/97	7.72	12.3	1670	1320												
08/04/97	7.04	13.5	4020	3740	0.006	< 0.01	322	2050	10.0	333.0	185.0	111.0	< 0.01	1.250	8.8	4
09/02/97	7.20	14.2	3950	3890												
10/01/97	7.21	13.8	3800	3670	< 0.005	< 0.01	405	2380	9.3	520.0	325.0	89.3	0.03	0.100	10.6	5

Table 11. Ground Water Quality at Monitoring Well WR-1

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/98	7.66	10.4	670	3580	< 0.005	0.01	251	2060	12.9	413.0	328.0	38.0	0.04	0.498	10.1	6
06/02/98	7.87	12.3	810	600												
07/20/98	7.17	12.9	3110	3080	0.008	< 0.01	361	1810	7.9	445.0	254.0	80.0	< 0.05	3.450	9.0	2
08/17/98	6.91	13.4	3570	3630												
09/14/98	7.01	13.1	3580	3650												
10/12/98	7.39	13.1	3460	3710	< 0.005	< 0.01	412	2290	8.8	494.0	289.0	91.7	< 0.02	0.040	9.8	4
05/03/99	7.98	9.9	1840	1910	0.011	< 0.01	265	1210	7.2	350.0	145.0	20.7	< 0.01	0.045	6.6	2
06/07/99	7.34	12.0	1780	2780												
07/06/99	7.31	12.8	3600	2970												
08/24/99	7.18	13.4	3600	3330	0.011	< 0.01	431	2190	8.0	492.0	283.0	96.5	0.02	0.030	9.1	2
09/23/99	7.64	14.1	3650	3530												
10/18/99	7.60	11.8	3620	3360	0.366	< 0.01	412	2190	8.4	519.0	294.0	91.0	0.04	0.040	8.7	9
05/16/00	7.30	12.4	2510	2140	0.025	< 0.01	272	1390	8.0	388.0	150.0	31.9	0.02	0.811	6.3	2
06/19/00	6.67	12.5	3310	3430												
07/18/00	6.70	13.4	3450	3870												
08/15/00	7.14	14.3	3410	3370	0.120	< 0.01	415	2240	8.5	502.0	262.0	97.1	0.06	0.040	8.6	6
09/11/00	7.51	13.4	3410	3570												
10/02/00	7.39	13.1	3420	3420	1.290	< 0.01	407	2260	8.7	479.0	266.0	108.0	0.08	0.100	9.2	52
05/08/01	7.80	11.7	1590	370	0.200	0.87	98	190	3.1	69.6	24.2	3.8	0.03	0.039	5.0	2
06/04/01	7.10	11.1	2380	1850												
07/10/01	6.90	13.9	3420	3930	0.018	< 0.02	399	2420	9.5	485.0	344.0	68.1	0.03	5.240	10.2	5
08/01/01	7.00	13.1	3400	3600												
09/21/01	7.90	13.5	3480	300												
10/10/01	8.00	11.5	1330	1070	0.025	< 0.01	138	680	7.8	147.0	103.0	12.7	< 0.01	0.755	6.2	3
05/13/02	7.50	11.8	3470	4000	0.027	< 0.01	291	2840	15.4	494.0	387.0	41.0	< 0.05	1.550	10.0	6
06/03/02	7.41	12.3	3290	4060												
07/08/02	7.06	12.6	3250	4020												
08/13/02	7.64	13.7	3170	3850	0.007	< 0.01	382	2690	11.1	481.0	392.0	41.0	1.31	< 0.030	10.0	6
09/09/02	7.04	12.2	3190	3930												
10/14/02	7.28	13.6	2980	190	0.030	< 0.01	80	80	1.6	28.2	13.7	1.8	0.04	0.060	4.1	< 1
05/12/03	6.90	13.5	3250	4330	0.010	0.02	322	2320	11.3	487.0	408.0	41.0	< 0.05	0.650	8.3	6
06/17/03	6.90	14.1	3180	4330												
07/16/03	6.80	15.3	3130	4320	< 0.010	< 0.01	370	2840	12.1	512.0	415.0	42.0	< 0.05	1.410	8.5	6
08/12/03	6.90	15.2	3130	4570												
09/08/03	6.90	13.6	3060	4060												
10/01/03	6.90	15.1	2990	3930	< 0.010	< 0.01	359	2620	11.5	584.0	475.0	58.1	< 0.02	1.030	9.9	6

Table 11. Ground Water Quality at Monitoring Well WR-1

Date	pH (s.u.)	Temp (C)	S.C (umhos/cm)	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 (Ratio)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss. Fe (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Cl (mg/l)
05/12/04	6.63	12.1	2830	4090	< 0.010	< 0.01	360	2910	12.7	456.0	367.0	39.1	0.06	3.080	9.6	6
06/01/04	6.58	12.7	2890	4230												
07/19/04	6.94	16.4	3570	4140	< 0.010	< 0.01	349	2890	13.0	482.0	382.0	42.0	0.16	0.980	10.0	6
08/03/04	6.98	15.8	3710	3990												
09/08/04	7.02	17.1	3610	3970												
10/13/04	6.77	11.7	3720	3830	< 0.010	< 0.01	388	2480	10.1	447.0	357.0	40.9		0.340	9.2	6
04/18/05	6.78	12.9	3940	4060												
05/12/05	6.98	10.0	4010	4020	< 0.010	< 0.01	341	2590	12.0	487.0	406.0	43.7	0.01	1.280	11.2	6
06/09/05	7.21	12.8	2370	1080												
07/15/05	6.72	18.1	3840	4090												
08/03/05	6.85	14.3	4000	4130	< 0.010	< 0.01	353	2460	11.0	478.0	386.0	40.0	0.10	1.590	10.0	5
09/06/05	6.82	14.8	3220	3010												
10/20/05	6.94	11.0	3860	3620	< 0.010	< 0.01	378	2340	9.7	503.0	406.0	46.5	0.05	4.560	10.9	5
05/19/06	7.18	15.3	4050	4190	< 0.010	0.04	323	2790	13.6	498.0	442.0	42.5	0.08	0.590	11.0	5
06/13/06	6.93	14.6	3990	4250												
07/18/06	7.01	17.2	3840	4300												
08/10/06	6.89	15.6	3740	4240	0.020	< 0.01	337	2420	11.3	483.0	410.0	43.0	< 0.10	1.210	10.0	4
09/11/06	7.11	13.9	3610	3620												
10/11/06	6.90	12.4	3770	3850	< 0.010	< 0.01	346	2510	11.4	436.0	389.0	39.6	0.03	1.170	10.0	5
05/08/07	7.50	13.6	4000	4140	0.020	< 0.01	322	2590	12.7	463.0	398.0	38.0	0.10	1.100	10.0	5
06/22/07	7.09	13.7	3930	4060												
07/19/07	7.60	14.2	4040	4210	< 0.010	< 0.01	353	2690	12.0	509.0	416.0	44.0	< 0.10	1.290	9.0	5
08/09/07	6.81	14.1	3810	3620												
09/21/07	7.14	13.1	4480	3700												
10/15/07	7.70	12.1	3720	3730	0.020	< 0.01	370	2400	10.2	445.0	363.0	40.3	< 0.04	1.120	9.3	5
05/14/08	7.53	7.5	1560	1160	0.040	< 0.01	201	670	5.2	196.0	89.2	12.2	< 0.02	0.312	4.3	< 1
06/11/08	6.93	11.5	4180	2970												
07/07/08	7.31	12.1	2510	4300												
08/11/08	7.08	13.1	3460	3320	< 0.010	< 0.01	355	2100	9.3	433.0	305.0	86.8	0.04	0.160	9.8	4
09/08/08	6.94	13.1	3630	3670												
10/14/08	6.81	10.9	3810	3710	< 0.010	< 0.01	396	2100	8.3	473.0	325.0	96.3	< 0.04	0.020	10.9	3
05/14/09	7.03	13.7	3950	4210	0.010	0.02	281	2700	15.1	488.0	445.0	40.9	0.33		11.3	4
06/09/09	7.08	11.6	2150	1860												
07/06/09	6.92	14.2	2970	2890												
08/06/09	6.97	13.2	3360	3360	0.020	< 0.01	388	2200	8.9	453.0	274.0	80.9	0.02	0.187	10.0	2
09/02/09	6.82	13.2	3460	3690												

Note: Monitoring well WR-1 was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48. Monitoring well WR-1 was plugged and abandoned September 8, 2009.

Table 12. Ground Water Quality at Monitoring Well TCS-1

Date	pH (s.u.)	Temp Cel.	S.C umhos/cm	TDS mg/l	O-P (mg/l)	NO2 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	SO4:HCO3 Ratio	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	Diss.Fe (mg/l)	Diss.Mn (mg/l)	K (mg/l)	Cl (mg/l)
7/27/1995	8.20	12.5	1000	790	0.036	0.03	594	90	0.2	11.9	4.6	296.0	0.01	0.0080	2.4	12
10/12/1995	8.00	10.0	1000	700	0.025	< 0.01	586	68	0.2	5.0	1.7	310.0	< 0.01	< 0.0090	2.2	10
5/13/1996	8.00	10.5	1080	640	< 0.005	0.09	< 2	80	63.0	15.0	5.7	220.0	0.01	< 0.0050	2.4	15
8/19/1996	8.40	14.2	1260	740	0.031	< 0.01	630	70	0.2	5.5	1.9	319.0	< 0.01	0.0060	2.2	12
10/14/1996	8.30	13.4	1290	770	0.030	< 0.01	633	60	0.1	4.2	1.4	320.0	0.01	0.0050	2.3	16
5/13/1997	6.98	8.9	1010	620	< 0.005	< 0.01	472	80	0.3	11.9	4.4	208.0	< 0.01	0.0050	2.0	12
8/4/1997	7.67	18.5	1380	820	< 0.005	0.14	518	190	0.6	33.1	12.7	279.0	0.01	0.0140	3.2	16
10/1/1997	7.56	13.2	1410	840	0.020	< 0.01	513	240	0.7	34.4	12.9	277.0	0.03	0.0770	3.4	17
5/12/1998	7.60	8.9	760	440	< 0.005	0.01	272	110	0.6	29.1	10.4	135.0	0.06	0.0110	2.8	12
7/20/1998	8.08	13.8	1260	780	0.007	0.05	512	160	0.5	21.1	9.5	278.0	< 0.05	0.0190	3.1	15
10/12/1998	8.41	10.4	1160	700	0.030	< 0.01	560	50	0.1	4.3	1.5	290.0	< 0.01	0.0050	2.2	13
5/3/1999	8.51	14.1	950	606	0.006	0.13	443	70	0.2	5.6	2.2	233.0	< 0.01	0.0110	2.0	9
8/24/1999	8.54	15.1	950	692	0.021	< 0.01	550	60	0.2	4.1	1.4	273.0	< 0.01	0.0070	2.0	9
10/18/1999	8.41	8.3	1230	712	0.024	< 0.01	561	70	0.2	3.8	1.3	288.0	0.02	0.0060	2.2	10
5/16/2000	7.91	8.9	940	535	< 0.005	< 0.01	372	70	0.3	8.3	3.0	210.0	0.03	0.0100	2.3	14
8/15/2000	8.22	14.1	1180	711	0.055	< 0.01	600	40	0.1	3.1	.9	294.0	0.02	< 0.0050	2.1	11
10/2/2000	8.37	12.6	1210	742	0.043	< 0.01	631	50	0.1	4.0	1.2	295.0	0.04	0.0050	2.2	13
5/8/2001	7.90	17.8	4290	4440	0.008	0.03	337	3100	14.5	550.0	426.0	31.0	0.23	0.6800	5.0	14
7/10/2001	8.10	15.6	1190	720	0.036	< 0.02	593	40	0.1	4.9	1.7	312.0	0.01	0.0060	2.3	11
10/10/2001	8.70	10.1	1170	710	0.025	< 0.01	491	50	0.2	3.6	1.1	282.0	0.02	0.0060	2.1	10
5/13/2002	8.51	10.5	1300	780	0.047	< 0.01	489	50	0.2	3.1	1.0	295.0	0.02	< 0.0050	1.8	8
8/13/2002	8.47	14.5	1240	765	0.029	< 0.01	631	50	0.1	3.0	1.0	322.0	< 0.01	< 0.0050	2.2	8
10/14/2002	8.32	13.4	1260	750	0.040	< 0.01	658	50	0.1	2.8	.9	298.0	0.04	0.0050	2.1	9
8/12/2003	8.40	15.9	1120	750	0.070	< 0.01	642	30	0.1	4.8	1.6	303.0	0.08	< 0.0050	2.3	11
10/1/2003	8.50	16.0	1050	650	0.060	< 0.01	504	70	0.2	4.0	1.4	254.0	0.06	0.0080	1.6	8
9/6/2005	7.75	14.7	1540													
10/20/2005	7.42	11.6	1460	900	< 0.010	0.30	480	230	0.8	28.5	10.2	326.0	0.05	0.0140	3.3	39
5/19/2006	7.32	12.5	1030	600	0.020	< 0.01	267	110	0.6	57.5	18.7	144.0	0.05	0.0130	2.7	107
8/10/2006	7.62	13.8	1380	930	0.030	< 0.01	489	200	0.6	33.2	12.1	287.0	0.02	0.0170	3.3	35
10/11/2006	7.62	11.3	1290	820	0.020	< 0.01	429	180	0.7	23.0	8.7	292.0	< 0.02	0.0190	2.9	34
5/8/2007	7.40	10.4	945	560	0.020	< 0.01	252	100	0.6	37.4	13.2	130.0	0.03	0.0150	2.6	85
7/19/2007	8.20	12.7	1490	920	0.020	< 0.01	485	230	0.7	35.7	13.3	264.0	0.05	0.0150	3.0	41
10/15/2007	8.30	10.9	1350	810	0.040	< 0.01	468	210	0.7	20.8	7.5	294.0	< 0.02	0.0150	3.0	26
5/14/2008	7.69	11.3	1030	610	0.020	< 0.01	254	120	0.7	45.9	16.5	155.0	< 0.02	0.0060	3.0	94
8/11/2008	7.78	11.4	1480	920	0.020	< 0.01	444	230	0.8	36.5	13.3	263.0	0.21	0.0170	3.4	57
10/14/2008	7.70	10.6	1460	890	< 0.010	< 0.01	453	196	0.7	24.9	9.8	320.0	0.07	0.0190	3.1	39
5/14/2009	7.03	12.1	1010	570	0.030	< 0.01	261	91	0.5	39.0	14.4	147.0	0.12		2.5	70
8/6/2009	8.42	12.8	1530	930	0.030	< 0.01	458	240	0.8	41.3	15.8	293.0	0.03	0.0150	3.5	62

Note: Monitoring well TCS-1 was removed from the Monitoring Program on September 2, 2009 in accordance with TR-48.

Table 13. Spring and Seep Survey

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Spring [a]																	
SPR 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPR 2	X		X	X	X	X			X								
SPR 3	X		X	X	X	X			X	X	X	X	X	X	X	X	X
SPR 4	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
SPR 5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPR 6	X	X	X	X	X	X	X	X								X	X
SPR 7	X		X	X	X	X	X	X						X	X	X	X
SPR 10	X		X	X	X							X	X	X	X	X	X
SPR 11	X	X	X	X	X					X	X	X	X	X	X	X	X
SPR 12	X	X	X	X	X				X	X	X		X	X	X	X	X
SPR 13	X		X	X	X									X	X	X	X
SPR 14	X		X	X	X	X				X	X	X	X				
SPR 15			X	X	X	X			X			X					
SPR 16			X	X	X	X	X	X	X	X	X	X	X			X	X
SPR 17			X	X	X	X	X	X	X		X		X			X	X
Seep [a]																	
SE 1	X	X	X	X													
SE 2[b]	X	X	X	X	X	X	X	X	X								
SE 10	X	X	X	X	X	X											
SE 11	X	X	X	X	X	X											
SE 12	X	X	X	X	X	X											
SE 13	X	X	X	X	X	X			X	X	X		X		X	X	X
SE 14	X	X	X	X													
SE 15	X	X	X	X	X												
SE 16	X	X	X	X	X	X				X			X	X	X	X	X
SE 17	X	X	X	X	X	X						X					
SE 18	X	X	X	X	X	X											
SE 19	X	X	X	X	X	X											
SE 20	X	X	X	X	X	X			X	X	X	X	X	X	X	X	
SE 21	X	X	X	X													
SE 22	X	X	X	X													
SE 23	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SE 26	X		X	X	X												
SE 27	X		X	X	X									X	X	X	X
SE 28			X	X	X	X	X	X									
SE 29			X	X	X	X	X	X	X								
SE 30					X						X		X		X	X	X

[a] Springs 8 and 9, and Seeps 24 and 25 have been deleted from the survey. These areas actually represented surface expressions of ground water within the alluvial valley floor.

[b] Individual seeps 2, 3, 4, 5, 6 and 7 have been combined into one seep area (SE 2) to more accurately depict the seep area located adjacent to SPR 1.

Table 14. Spring and Seep Flow and Field Water Quality

Spring No.	Date	Level	Flow (gpm)	pH (s.u.)	Temp (°C)	SC (μmhos/cm)	TDS* (mg/l)
SPR 1	05/05/09	0.73	1012.51	6.68	11.2	3920	3920
SPR 2	05/06/09	0.00	0.00				
SPR 3	05/06/09	0.40	73.28	6.87	11.6	1880	1540
SPR 4	05/06/09	0.05	1.15	6.91	11.8	1870	
SPR 5	05/06/09	0.39	69.66	7.11	10.9	2630	2480
SPR 6	05/06/09	0.03	0.41	7.16	11.4	2710	
SPR 7	05/06/09	0.02	0.18	7.06	11.1	2740	
SPR 10	05/05/09	0.04	0.73	7.03	12.1	4210	
SPR 11	05/05/09	0.43	351.31	7.04	12.2	4350	4510
SPR 12	05/05/09	0.03	0.41	7.01	12.4	4360	
SPR 13	05/05/09	0.01	0.05	7.09	12.7	4290	
SPR 14	05/05/09	0.00	0.00				
SPR 15	05/06/09	0.00	0.00				
SPR 16	05/05/09	0.02	0.18	7.03	12.5	4400	
SPR 17	05/05/09	0.03	0.41	7.07	12.3	4380	

Seep No.	Date	Level	Flow (gpm)	pH (s.u.)	Temp (°C)	SC (μmhos/cm)	TDS (mg/l)
SE 1	05/06/09	0.00	0.00				
SE 2	05/05/09	0.00	0.00				
SE 8	05/06/09	0.00	0.00				
SE 12	05/06/09	0.00	0.00				
SE 13	05/06/09	0.01	0.05	7.58	12.1	1490	
SE 14	05/06/09	0.00	0.00				
SE 15	05/06/09	0.00	0.00				
SE 16	05/06/09	0.06	1.65	6.98	10.8	2690	
SE 17	05/06/09	0.00	0.00				
SE 18	05/06/09	0.00	0.00				
SE 19	05/06/09	0.00	0.00				
SE 21	05/05/09	0.00	0.00				
SE 22	05/05/09	0.00	0.00				
SE 23	05/05/09	0.44	367.84	6.84	10.6	2590	2270
SE 26	05/05/09	0.00	0.00				
SE 27	05/05/09	0.02	0.18	7.07	12.5	4340	
SE 28	05/05/09	0.00	0.00				
SE 29	05/05/09	0.00	0.00				
SE 30	05/05/09	0.01	0.05	7.02	12.6	4190	

* Measurements were analytically derived; all other measurements were derived with a field test meter.

Table 15. Spring and Seep Laboratory Water Quality

Spring/Seep	Date	Diss. Al (mg/l)	Ca (mg/l)	Fe (mg/l)	Mg (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	NH_3 (mg/l)	Cl (mg/l)	NO_2 (mg/l)	Ortho-P (mg/l)	SO_4 (mg/l)
SPR 1	May-98	< 0.2	522	< 0.05	406	0.950	12.0	48.0	360	< 0.01	7	< 0.01	< 0.005	2730
SPR 3	May-98	< 0.06	264	0.02	113	< 0.005	2.8	9.2	297	< 0.01	5	0.01	< 0.005	900
SPR 5 - 7	May-98	< 0.06	434	< 0.02	198	< 0.005	4.8	12.7	256	< 0.01	3	< 0.01	< 0.005	1590
SPR 16 & 17	May-98	< 0.2	515	< 0.05	490	0.170	16.0	63.0	532	< 0.01	11	< 0.01	< 0.005	3050
SE 23	May-98	< 0.06	313	< 0.02	183	0.010	6.7	15.0	364	< 0.01	5	< 0.01	< 0.005	1240
SPR 1; SE 2	May-99	< 0.06	540	< 0.02	418	1.240	11.3	45.2	375	< 0.01	6	< 0.01	< 0.005	2460
SPR 4	May-99	< 0.03	348	0.04	157	< 0.005	2.8	10.1	335	< 0.01	4	< 0.01	< 0.005	1030
SPR 5-7	May-99	< 0.06	426	< 0.02	191	< 0.005	3.9	11.9	256	< 0.01	3	< 0.01	< 0.005	1520
SPR 16-17; SE 28-29	May-99	< 0.2	543	< 0.05	504	0.120	17.0	72.0	432	< 0.01	12	< 0.01	< 0.005	2820
SE 23	May-99	< 0.06	331	0.06	190	0.020	7.0	14.8	376	< 0.01	4	< 0.01	< 0.005	1120
SPR 1	May-00	< 0.2	506	0.13	394	1.070	11.0	44.0	368	< 0.05	7	< 0.01	0.007	2630
SPR 5 - 7	May-00	< 0.06	392	0.03	181	< 0.010	4.4	11.6	242	< 0.05	3	< 0.01	0.019	1470
SPR 16-17; SE 28-29	May-00	< 0.2	503	< 0.05	480	0.050	15.0	69.0	414	< 0.05	12	< 0.01	0.007	2990
SPR 23	May-00	< 0.06	331	< 0.02	186	< 0.005	6.0	13.1	383	< 0.05	4	< 0.01	< 0.005	1280
SPR 1	May-01	< 0.2	509	< 0.05	403	1.120	11.0	45.0	364	< 0.05	6	< 0.01	0.009	2710
SPR 3	May-01	< 0.2	331	0.03	151	< 0.005	2.6	10.4	328	< 0.05	30	< 0.01	0.007	1160
SPR 5 - 7	May-01	< 0.2	383	0.06	178	< 0.010	3.8	11.2	254	< 0.05	3	< 0.01	0.021	1580
SPR 16 & 17	May-01	< 0.2	502	< 0.05	465	0.070	15.0	67.0	411	< 0.05	11	< 0.01	0.007	3050
SE 23	May-01	< 0.2	341	< 0.02	188	< 0.010	6.0	14.1	401	< 0.05	4	< 0.01	0.009	1380
SPR 1	May-02	< 0.06	486	< 0.02	385	1.240	10.2	41.8	286	< 0.01	6	< 0.01	0.022	2730
SPR 3	May-02	< 0.06	416	< 0.02	180	< 0.010	2.6	9.6	278	< 0.01	3	< 0.01	0.031	1450
SPR 5 - 7	May-02	< 0.06	433	< 0.02	189	< 0.010	4.4	11.0	208	< 0.01	3	< 0.01	0.032	1720
SPR 12	May-02	< 0.02	522	< 0.01	478	0.073	14.0	73.0	284	< 0.01	12	< 0.01	0.035	3150
SPR 1	May-03	< 0.06	491	< 0.02	389	0.700	6.2	42.0	337	< 0.01	6	< 0.01	< 0.01	2680
SPR 3	May-03	< 0.03	287	< 0.02	131	< 0.010	2.7	10.1	272	< 0.01	4	< 0.01	0.02	900
SPR 5 - 7	May-03	< 0.03	238	< 0.02	204	< 0.010	4.5	11.2	236	< 0.01	2	< 0.01	0.02	1410
SPR 14	May-03	< 0.06	486	< 0.02	479	0.020	6.7	64.0	407	< 0.01	11	< 0.01	0.01	3070
SE 23	May-03	< 0.03	183	< 0.02	211	< 0.010	6.3	13.7	363	< 0.01	4	< 0.01	< 0.01	1140

Table 15. Spring and Seep Laboratory Water Quality

Spring/Seep	Date	Diss. Al (mg/l)	Ca (mg/l)	Fe (mg/l)	Mg (mg/l)	Diss. Mn (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	NH_3 (mg/l)	Cl (mg/l)	NO_2 (mg/l)	Ortho-P (mg/l)	SO_4 (mg/l)
SPR 1	May-04	< 0.03	501	< 0.01	385	1.090	9.2	36.2	339	< 0.01	6	< 0.01	0.01	2870
SPR 5-7	May-04	0.04	405	0.03	184	< 0.005	3.9	10.9	269	< 0.01	2	< 0.01	0.03	1570
SPR 1	May-05	< 0.03	485	< 0.01	401	1.240	10.6	43.8	354	0.20	6	< 0.01	< 0.01	2510
SPR 3	May-05	< 0.03	200	0.03	84.3	0.084	3	8.1	219	< 0.05	3	0.01	0.02	590
SPR 5-7	May-05	< 0.03	409	< 0.01	197	< 0.005	4.6	11.7	260	< 0.05	3	< 0.01	0.01	1590
SPR 11	May-05	< 0.03	489	< 0.01	498	0.033	15.9	74.5	395	0.08	13	< 0.01	< 0.01	2080
SPR 1	May-06	< 0.06	505	< 0.04	432	0.810	10.9	43.8	330	< 0.05	5	< 0.01	< 0.01	2630
SPR 3	May-06	< 0.03	317	< 0.02	146	< 0.005	2.6	10.7	333	< 0.01	4	0.01	0.01	1050
SPR 5	May-06	< 0.06	426	< 0.04	206	< 0.010	4.7	12.1	272	< 0.01	3	0.01	0.01	1600
SPR 11	May-06	< 0.2	494	< 0.10	503	< 0.030	15	71.0	401	< 0.01	13	0.01	< 0.01	2930
SPR 1	May-07	< 0.2	465	< 0.1	386	0.950	10	37	331	< 0.05	5	< 0.01	0.01	2610
SPR 3	May-07	< 0.03	311	< 0.02	147	< 0.005	2.3	9.9	316	< 0.05	3	< 0.01	0.02	1060
SPR 5	May-07	< 0.06	401	< 0.04	195	< 0.010	4.1	11.2	269	< 0.05	2	< 0.01	0.02	1540
SPR 11	May-07	< 0.2	471	< 0.1	469	0.070	14	68	371	< 0.05	12	< 0.01	0.01	2870
SE 23	May-07	< 0.06	341	< 0.04	213	< 0.010	5.5	15.8	435	< 0.05	5	< 0.01	< 0.01	1430
SPR 1	May-08	0.09	518	< 0.04	461	0.730	11.6	47.7	292	< 0.01	4	< 0.01	0.01	2400
SPR 3	May-08	0.06	244	< 0.02	112	< 0.005	3.7	8.9	254	< 0.01	3	< 0.01	0.02	720
SPR 5	May-08	0.03	395	< 0.02	207	< 0.005	5.3	11.6	223	< 0.01	2	< 0.01	0.03	1370
SPR 11	May-08	< 0.06	502	< 0.04	540	< 0.010	15.6	64.8	368	< 0.01	8	< 0.01	0.01	2800
SE 23	May-08	0.03	342	< 0.02	224	< 0.005	7	15.3	318	< 0.01	3	< 0.01	0.01	1250
SPR 1	May-09	< 0.03	452	< 0.02	416	0.496	9.6	40.2	311	< 0.05	4	< 0.01	< 0.01	2300
SPR 3	May-09	0.07	261	0.19	121	0.007	2.1	9.3	262	< 0.01	3	< 0.01	0.02	770
SPR 5	May-09	< 0.03	389	< 0.02	200	< 0.005	4.2	11.8	217	< 0.01	2	< 0.01	0.02	1400
SPR 11	May-09	< 0.03	443	< 0.02	499	< 0.005	13.9	64.4	362	< 0.01	9	< 0.01	0.01	2800
SE 23	May-09	0.04	308	< 0.02	210	< 0.005	5.9	14.8	337	< 0.01	3	0.10	< 0.01	1200

Springs and Seeps with Flow Greater than 20 gpm

Table 16. Moffat Stability Monument Survey

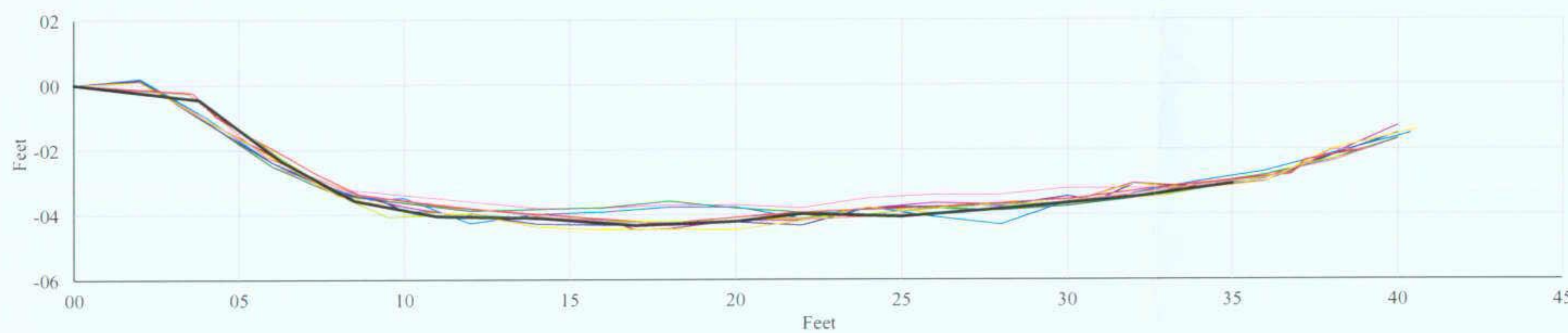
	Date	Surveyed Coordinates			Δ from Initial Survey		
		Northing (feet)	Easting (feet)	Elevation (feet)	Northing (feet)	Easting (feet)	Elevation (feet)
SM-1	11/05/97	372660.78	1590514.65	7189.03	-	-	-
	03/13/98	372660.78	1590514.65	7188.99	0.00	0.00	-0.04
	06/26/98	372660.72	1590514.59	7188.49	0.06	0.06	-0.54
	09/28/98	372660.75	1590514.58	7188.40	0.03	0.07	-0.63
	10/13/99	372660.79	1590514.62	7187.92	-0.01	0.03	-1.11
	09/25/00	372660.78	1590514.70	7187.64	0.00	-0.05	-1.39
	09/21/01	372660.79	1590514.68	7187.64	0.00	-0.03	-1.39
	09/16/02	372660.83	1590514.58	7187.63	-0.05	0.07	-1.40
	09/12/03			7187.58	-	-	-1.45
	09/17/04	372660.91	1590514.54	7187.53	-0.13	0.11	-1.50
	09/20/05	372660.90	1590514.56	7187.74	-0.12	0.09	-1.29
	09/06/06	372660.92	1590514.55	7187.54	-0.14	0.10	-1.49
	08/24/07	372660.85	1590514.57	7187.53	-0.14	0.08	-1.50
	09/22/08	372660.92	1590514.50	7187.62	-0.14	0.15	-1.41
	08/12/09	372660.89	1590514.45	7187.64	-0.14	0.20	-1.39
SM-2	11/05/97	372458.06	1590451.58	7208.34	-	-	-
	03/13/98	372458.05	1590451.61	7208.38	0.01	-0.03	0.04
	06/26/98	372458.03	1590451.58	7208.33	0.03	0.00	-0.01
	09/28/98	372458.04	1590451.57	7208.30	0.02	0.01	-0.04
	10/13/99	372457.99	1590451.49	7208.22	0.07	0.09	-0.12
	09/25/00	372457.96	1590451.61	7207.82	0.10	-0.03	-0.52
	09/21/01	372457.98	1590451.54	7207.72	0.09	0.04	-0.62
	09/16/02	372458.01	1590451.46	7207.65	0.05	0.12	-0.69
	09/12/03			7207.48	-	-	-0.86
	09/17/04	372457.98	1590451.41	7207.22	0.08	0.17	-1.12
	09/20/05	372458.03	1590451.35	7207.38	0.03	0.23	-0.96
	09/06/06	372457.99	1590451.33	7207.08	0.08	0.25	-1.26
	08/24/07	372457.97	1590451.32	7206.96	0.09	0.26	-1.38
	09/22/08	372458.00	1590451.23	7207.06	0.06	0.35	-1.28
	08/12/09	372457.94	1590451.19	7207.01	0.12	0.39	-1.33
SM-3	11/05/97	372597.33	1591009.48	7258.66	-	-	-
	03/13/98	372597.35	1591009.46	7258.60	-0.02	0.02	-0.06
	06/26/98	372597.42	1591009.38	7257.89	-0.09	0.10	-0.77
	09/28/98	372597.46	1591009.38	7257.81	-0.13	0.10	-0.85
	10/13/99	372597.47	1591009.43	7257.60	-0.14	0.05	-1.06
	09/25/00	372597.45	1591009.56	7257.42	-0.12	-0.08	-1.24
	09/21/01	372597.54	1591009.56	7257.42	-0.20	-0.08	-1.24
	09/16/02	372597.58	1591009.49	7257.41	-0.25	-0.01	-1.25
	09/12/03			7257.39	-	-	-1.27
	09/17/04	372597.65	1591009.45	7257.30	-0.32	0.03	-1.36
	09/20/05	372597.66	1591009.47	7257.49	-0.33	0.01	-1.17
	09/06/06	372597.66	1591009.45	7257.27	-0.33	0.03	-1.39
	08/24/07	372597.65	1591009.48	7257.25	-0.32	0.00	-1.41
	09/22/08	372597.69	1591009.44	7257.41	-0.36	0.04	-1.25
	08/12/09	372597.64	1591009.43	7257.27	-0.31	0.05	-1.39

Table 16. Moffat Stability Monument Survey

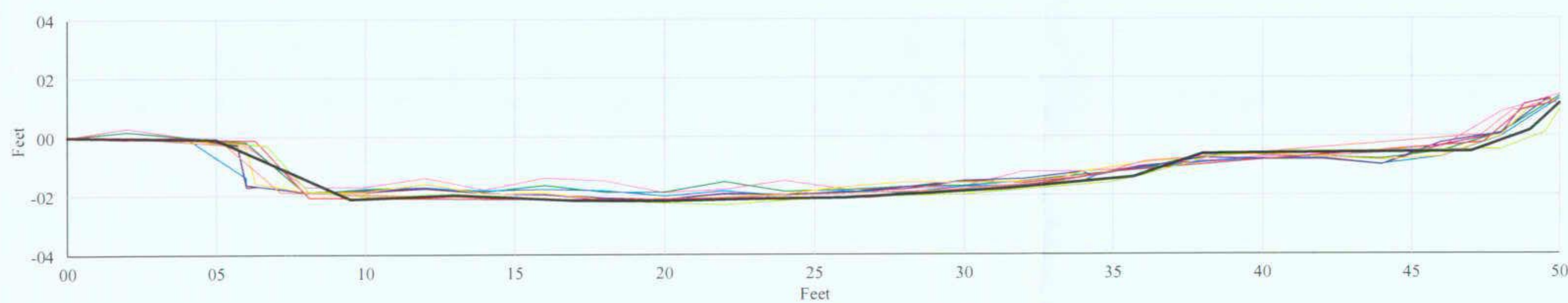
	Date	Surveyed Coordinates			Δ from Initial Survey		
		Northing (feet)	Easting (feet)	Elevation (feet)	Northing (feet)	Easting (feet)	Elevation (feet)
SM-4	11/05/97	372388.45	1590956.14	7276.78	-	-	-
	03/13/98	372388.44	1590956.12	7276.75	0.01	0.02	-0.03
	06/26/98	372388.38	1590956.07	7276.45	0.07	0.07	-0.33
	09/28/98	372388.37	1590956.04	7276.36	0.08	0.10	-0.42
	10/13/99	372388.25	1590955.99	7276.13	0.20	0.15	-0.65
	09/25/00	372388.23	1590956.02	7275.71	0.22	0.12	-1.07
	09/21/01	372388.24	1590955.93	7275.62	0.21	0.21	-1.16
	09/16/02	372388.26	1590955.82	7275.54	0.19	0.32	-1.24
	09/12/03			7275.49	-	-	-1.29
	09/17/04	372388.28	1590955.70	7275.27	0.17	0.44	-1.51
	09/20/05	372388.26	1590955.62	7275.40	0.19	0.52	-1.38
	09/06/06	372388.28	1590955.61	7275.17	0.17	0.53	-1.61
	08/24/07	372388.28	1590955.55	7275.11	0.17	0.59	-1.67
	09/22/08	372388.30	1590955.52	7275.24	0.15	0.62	-1.54
	08/12/09	372388.24	1590955.45	7275.16	0.21	0.69	-1.62
SM-5	11/05/97	372451.43	1591657.64	7348.69	-	-	-
	03/13/98	372451.50	1591657.57	7348.69	-0.07	0.07	0.00
	06/26/98	372451.51	1591657.55	7348.51	-0.08	0.09	-0.18
	09/28/98	372451.53	1591657.55	7348.45	-0.10	0.09	-0.24
	10/13/99	372451.50	1591657.47	7348.29	-0.07	0.17	-0.40
	09/25/00	372451.41	1591657.49	7348.23	0.02	0.15	-0.46
	09/21/01	372451.43	1591657.52	7348.23	0.00	0.12	-0.46
	09/16/02	372451.51	1591657.52	7348.20	-0.08	0.12	-0.49
	09/12/03			7348.19	-	-	-0.50
	09/17/04	372451.54	1591657.41	7348.08	-0.11	0.23	-0.61
	09/20/05	372451.49	1591657.43	7348.22	-0.06	0.21	-0.47
	09/06/06	372451.50	1591657.44	7348.05	-0.07	0.20	-0.64
	08/24/07	372451.51	1591657.42	7347.96	-0.08	0.22	-0.73
	09/22/08	372451.50	1591657.42	7348.15	-0.07	0.22	-0.54
	08/12/09	372451.48	1591657.38	7348.12	-0.05	0.26	-0.57
SM-6	11/05/97	372257.93	1591585.79	7359.12	-	-	-
	03/13/98	372257.92	1591585.78	7359.12	0.01	0.01	0.00
	06/26/98	372257.97	1591585.71	7358.88	-0.04	0.08	-0.24
	09/28/98	372257.99	1591585.67	7358.81	-0.06	0.12	-0.31
	10/13/99	372257.92	1591585.60	7358.63	0.01	0.19	-0.49
	09/25/00	372257.98	1591585.61	7358.27	-0.05	0.18	-0.85
	09/21/01	372257.98	1591585.49	7358.19	-0.05	0.30	-0.93
	09/16/02	372258.03	1591585.37	7358.09	-0.10	0.42	-1.03
	09/12/03			7358.03	-	-	-1.09
	09/17/04	372258.04	1591585.22	7357.73	-0.11	0.57	-1.39
	09/20/05	372258.08	1591585.19	7357.83	-0.15	0.60	-1.29
	09/06/06	372258.05	1591585.16	7357.58	-0.12	0.63	-1.54
	08/24/07	372258.08	1591585.12	7357.52	-0.15	0.67	-1.60
	09/22/08	372258.07	1591585.05	7357.70	-0.14	0.74	-1.42
	08/12/09	372258.03	1591585.04	7357.59	-0.10	0.75	-1.53

Note: Survey coordinates are based upon a Local coordinate system.

FIGURES



CROSS-SECTION TR-a



CROSS-SECTION TR-b

LEGEND

- 2009 PROFILE
- 2008 PROFILE
- 2007 PROFILE
- 2006 PROFILE
- 2005 PROFILE
- 2004 PROFILE
- 2003 PROFILE
- 2002 PROFILE
- 2001 PROFILE
- 2000 PROFILE
- 1999 PROFILE

0 5'
SCALE

NO.	REVISIONS	DATE

WWC ENGINEERING

CHANNEL CROSS-SECTIONS

EDNA MINE
CHEVRON MINING INC

DESIGNED BY: TNS
DRAWN BY: TNS
CHECKED BY: TNS
DATE: 02/10

FIGURE 1

SHEET 1 OF 1

PLATES

Civil/Water Resource Engineering

- Pumps and pipelines
- Surface and groundwater modeling
- FEMA floodplain assessments
- Hydraulic and hydrologic analysis and design
- Dam design and rehabilitation
- Water supply, treatment and distribution
- Wastewater treatment and disposal
- Irrigation systems
- GPS and conventional surveying
- Civil engineering design, plans and specifications
- Construction engineering
- Water rights
- Computer-aided design and drafting (CADD)
- GIS mapping
- Stormwater management
- Geotechnical sampling
- 404 permits

Transportation Services

- Reconnaissance reports
- Surveys (right of way, ground control, construction)
- Bridge hydraulics, scour analysis, structure selection
- Design of urban streets, rural roadways and interstate reconstruction
- Streetscape enhancements
- Utility replacement
- Drainage design
- Bicycle/pedestrian pathways
- Parking facilities
- Construction administration

Mine Services

- NEPA compliance documents
- Baseline studies (climatology, geology, hydrology, wetlands and AVF assessments)
- GPS and conventional surveying
- Drilling and monitoring services
- Mining and reclamation design and permitting
- Hydrologic control plans
- Reservoir and dam design
- Haulroads and stream crossings
- Annual reports and bond calculations
- Blast monitoring and reporting
- Assessment of probable hydrologic consequences
- Mine simulation modeling
- Postmine topography design
- Reclaimed stream channels, AVF reclamation and wetland mitigation design
- Abandoned mine land reclamation

Environmental Services

- Environmental compliance and best management practices
- Environmental impact analysis and regulatory permitting
- Environmental site assessments
- Geomorphologic investigations
- Hydrocarbon product recovery system design
- Hydrologic and water quality monitoring
- Hazardous and non-hazardous waste management planning
- Site remediation planning and design
- Soil and groundwater cleanup plans
- Underground storage tanks investigation and removal plans
- NEPA compliance documents
- Environmental audits
- Wetland delineation and mitigation

Other offices:

1849 Terra Ave.	6000 East 2nd Street, Suite 1004	1275 Maple Street, Suite F
Sheridan, Wyoming 82801	Casper, Wyoming 82609	Helena, Montana 59601
(307) 672-0761	(307) 473-2707	(406) 443-3962
Fax: (307) 674-4265	Fax: (307) 237-0828	Fax: (406) 449-0056

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EXHIBIT D

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Trout Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	confluence with an unnamed tributary at UTM North: 4457645.23 UTM East: 323578.92
LOWER TERMINUS:	Koll Ditch headgate UTM North: 4464276.41 UTM East: 329133.88
WATER DIVISION:	6
WATER DISTRICT:	57
COUNTY:	Routt
WATERSHED:	Upper Yampa
EXISTING ISF:	77W1338, 5 cfs (01/01 - 12/31)
CWCB ID:	19/6/A-009
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	6.64 miles
FLOW RECOMMENDATION:	2.0 cfs (11/01 - 03/31) 8.0 cfs (04/01 - 07/31) 7.0 cfs (08/01 - 10/31)

Trout Creek

Introduction

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3), C.R.S.). The statute vests the Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights (NLL). Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

The BLM recommended that the CWCB appropriate an increase to the existing ISF water right on a reach of Trout Creek. Trout Creek is located within Routt County and originates in the Flat Tops Mountains at an elevation of approximately 11,250 ft. The stream flows north 43 miles to the confluence with the Yampa River at an elevation of approximately 6,500 ft (See Vicinity Map). The proposed reach extends from the confluence with an unnamed tributary downstream to the Koll Ditch headgate. The BLM manages 11 percent of the land on the 6.64 mile proposed reach, and 89 percent is privately owned (See Land Ownership Map). The current ISF water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning. The proposed increase in flow rates during winter is warranted to make much of the physical habitat in the stream channel less susceptible to freezing.

The information contained in this report and the associated supporting data and analyses (located at http://cwcb.state.co.us/environment/instream-flow-program/Pages/2019ProposedISFRecommendations.aspx) form the basis for staff's ISF recommendation to be considered by the Board. This report provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury.

Natural Environment

CWCB staff relies on the recommending entity to provide information about the natural environment. In addition, staff reviews information and conducts site visits for each recommended ISF appropriation. This information is used to provide the Board with a basis for determining that a natural environment exists.

Trout Creek is a cold water, moderate gradient stream. The reach that is the subject of this recommendation flows through a valley that ranges from 1/8 to 1/2 mile in width. The upper part of the reach flows through agricultural lands used for livestock grazing, while the lower part of the reach flows through a confined canyon that is largely in natural condition. Substrate is generally from medium to large size, ranging from 4-inch cobbles to small boulders. Water quality is good for supporting salmonid fish species, but during July and August, temperatures can approach the maximum temperatures that trout can tolerate.

Fish surveys indicate a diverse and self-sustaining fish community. Trout Creek provides habitat for brook trout, brown trout, Colorado River cutthroat trout, mottled sculpin, speckled dace, and mountain sucker. Spot surveys have indicated abundant populations of stonefly and caddisfly.

Table 1. List of species identified in Trout Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
brown trout	*Salmo trutta*	None
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State - Species of Special Concern Federal - Sensitive Species
mottled sculpin	*Cottus bairdii*	None
mountain sucker	*Catostomus platyrhynchus*	State - Species of Special Concern Federal - Sensitive Species
speckled dace	*Rhinichthys osculus*	None

ISF Quantification

CWCB staff relies upon the biological expertise of the recommending entity to quantify the amount of water required to preserve the natural environment to a reasonable degree. CWCB staff performs a thorough review of the quantification analyses completed by the recommending entity to ensure consistency with accepted standards.

Methodology

BLM staff used the R2Cross methodology to develop the initial ISF recommendation. The R2Cross method is based on a hydraulic model and uses field data collected in a stream riffle (Espegren, 1996). Riffles are most easily visualized as the stream habitat types that would dry up first should streamflow cease. The field data collected consists of streamflow measurements and surveys of channel geometry at a transect and of the longitudinal slope of the water surface.

The field data is used to model three hydraulic parameters: average depth, average velocity, and percent wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types also will maintain aquatic habitat in pools and runs for most life stages of fish and aquatic macro-invertebrates (Nehring, 1979). BLM staff interprets the model results to develop an initial recommendation for summer and winter flows. The summer flow recommendation is based on meeting 3 of 3 hydraulic criteria. The winter flow recommendation is based on meeting 2 of 3 hydraulic criteria. The model's suggested accuracy range is 40% to 250% of the streamflow measured in the field. Recommendations that fall outside of the accuracy range may not give an accurate estimate of the hydraulic parameters necessary to determine an ISF rate.

The R2Cross methodology provides the biological quantification of the amount of water needed for summer and winter periods based on empirical studies of fish species preferences. The recommending entity uses the R2Cross results and its biological expertise to develop an initial ISF recommendation. CWCB staff then evaluates water availability for the reach typically based on median hydrology (see the Water Availability section below for more details). The water availability analysis may indicate less water is available than the initial recommendation. In that case, the recommending entity either modifies the magnitude and/or duration of the recommended ISF rates if the available flows will preserve the natural environment to a reasonable degree, or withdraws the recommendation.

Data Analysis

R2Cross data was collected at two transects for this proposed ISF reach (Table 2). Results obtained at more than one transect are averaged to determine the R2Cross flow rate for the reach of stream. The R2Cross model results in a winter flow of 7.53 cfs, which meets 2 of 3 criteria and is within the accuracy range of the R2Cross model. The R2Cross model results in a summer flow of 13.04 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model.

Table 2. Summary of R2Cross transect measurements and results for Trout Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	08/12/2017 #1	9.43	3.77 - 23.58	9.27	13.28
BLM	08/12/2017 #2	8.58	3.43 - 21.45	5.79	12.80
			Mean	7.53	13.04

ISF Recommendation

The BLM recommends the following flows based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

8.0 cubic feet per second increase is recommended during the snowmelt runoff period and early summer, from April 1 to July 31. This recommendation is driven by the average depth criteria. In many locations, the Trout Creek channel is wide with large substrate, so meeting the depth criteria is important for passage between rocks and between pools. Implementing this recommendation would increase the instream flow rate during this time period to a total of 13.0 cubic feet per second.

7.0 cubic feet per second increase is recommended during late summer and early fall, from August 1 to October 31. This recommendation is driven by limited water availability. This flow rate will maintain sufficient physical habitat in the creek for the fish population to complete important parts of their life cycle before cold temperatures reduce fish activity for the winter. Implementing this recommendation would increase the instream flow rate during this time period to a total of 12.0 cubic feet per second.

2.0 cubic feet per second increase is recommended during the cold temperature portion of the year, from November 1 through March 31. This recommendation is driven by limited water availability but comes very close to meeting the wetted perimeter criteria and the velocity criteria. This flow rate should prevent complete icing of the numerous pools in this reach, allowing the fish population to overwinter. Implementing this recommendation would increase the instream flow rate during this time period to a total of 7.0 cubic feet per second.

The BLM believes an instream flow increase for Trout Creek is warranted because of physical habitat characteristics. The R2Cross data summarized above clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing, and spawning. When the existing instream flow rights are applied to the cross-sections that were collected, the stream would exhibit 40 percent to 66 percent wetted perimeter. However, this habitat is not highly usable by the fish population, because 5.0 cfs constrains the habitat to an average depth of 0.22 to 0.26 feet. An average habitat depth of 0.22 to 0.26 feet is not sufficient in a stream that averages 35 to 40 feet in top width. During the warm weather season, the fish populations need to have access to as much of the stream channel as possible for feeding, resting, and spawning if they are to survive the pronounced cold winters in this canyon. The increase in flow rates during winter is warranted because the average depths associated with 7.0 cfs make much of the physical habitat in the stream channel less susceptible to freezing.

Water Availability
CWCB staff conducts hydrologic analyses for each recommended ISF appropriation to provide the Board with a basis for making the determination that water is available.

Methodology
Each recommended ISF reach has a unique flow regime that depends on variables such as the timing, magnitude, and location of water inputs (such as rain, snow, and snowmelt) and water losses (such as diversions, reservoirs, evaporation and transpiration, groundwater recharge, etc). Although extensive and time-consuming investigations of all variables may be possible, staff takes a pragmatic and cost-effective approach to analyzing water availability. This approach focuses on streamflows and the influence of flow alterations, such as diversions, to understand how much water is physically available in the recommended reach.

Staff's hydrologic analysis is data-driven, meaning that staff gathers and evaluates the best available data and uses the best available analysis method for that data. Whenever possible, long-term stream gage data (period of record 20 or more years) will be used to evaluate streamflow. Other streamflow information such as short-term gages, temporary gages, spot streamflow measurements, diversion records, and StreamStats will be used when long-term gage data is not available. StreamStats, a statistical hydrologic program, uses regression equations developed by the USGS (Capesius and Stephens, 2009) to estimate mean flows for each month based on drainage basin area and average drainage basin precipitation. Diversion records will also be used to evaluate the effect of surface water diversions when necessary. Interviews with water commissioners, landowners, and ditch or reservoir operators can provide additional information. A range of analytical techniques may be employed to extend gage records, estimate streamflow in ungaged locations, and estimate the effects of diversions. The goal is to obtain the most detailed and reliable estimate of hydrology using the most efficient analysis technique.

The final product of the hydrologic analysis used to determine water availability is a hydrograph, which shows streamflow and the proposed ISF rate over the course of one year. The hydrograph will show median daily values when daily data is available; otherwise, it will present mean-monthly streamflow values. Staff will calculate 95% confidence intervals for the median streamflow if there is sufficient data. Statistically, there is 95% confidence that the true value of the median streamflow is located within the confidence interval.

Basin Characteristics
The drainage basin of the proposed ISF on Trout Creek is 32.2 square miles, with an average elevation of 9,477 ft and average annual precipitation of 33.55 inches (See the Vicinity Map). There are a number of known surface water diversions in the drainage basin tributary to the proposed ISF on Trout Creek. These structures potentially divert approximately 105.5 cfs and include the Sheriff Reservoir (986 AF) and an additional 61 AF in other storage. The Alex Ditch (1.28 cfs, appropriation

dates 1912 and 1948) is the only diversion structure located within the proposed reach. This water right is relatively small and has sporadic diversion records.

Available Data

There is not a current or historic daily streamflow gage on Trout Creek. However, the Edna Mine measured streamflow at a location near the proposed lower terminus from 1989 to 2009 (Edna Mine site identifier TR-a). These measurements were reported to the Department of Reclamation, Mining and Safety on an approximately monthly basis for April through October (Edna Mine, 2010).

The Koll Ditch (WDID 5700635, 13.22 cfs, appropriation dates 1894, 1903, and 1949) is the proposed lower terminus. This structure has diversion records between 1938 and 2017.

CWCB staff made two streamflow measurements on the proposed reach of Trout Creek as summarized in Table 3.

Table 3. Summary of Streamflow Measurement Visits and Results for Trout Creek.

Visit Date	Flow (cfs)	Collector
05/07/2018	64.58	CWCB
10/09/2018	9.59	CWCB

Data Analysis

The Edna Mine made 144 streamflow measurements between 1989 and 2009. These measurements were made at various times throughout the month, but typically on the first of the month from 1999 to 2009. All measurements for a given month were used to determine the median measured streamflow for that month.

The Koll Ditch is located near the proposed lower terminus, but does not sweep the stream (personal communication, Brian Romig, November 2018). Therefore, the diversion record is not a good proxy for the total amount of water available at that location. The diversions also typically start in late May and end by early September which limit information during runoff, late fall, and winter. Because of these limitations, the Koll Ditch was not used as a primary source of information about water availability.

Water Availability Summary

The hydrographs (See Complete and Detailed Hydrographs) show the median of monthly measured streamflow values from the Edna Mine data and mean-monthly streamflow from StreamStats. There is good agreement between the mean of the measured values and StreamStats values between April and October. However, StreamStats is generally higher, which is not unexpected given that StreamStats does not explicitly account for water diversions. During the winter, there is little water use in the Trout Creek basin and StreamStats provides an estimate of streamflow conditions. The proposed ISF rate is below the median monthly streamflow measurements from April through October and below the StreamStats mean-monthly flow from November through March. Staff concludes that water is available for appropriation on Trout Creek.

Material Injury

Because the proposed ISF on Trout Creek is a new junior water right, the ISF can exist without material injury to other water rights. Under the provisions of section 37-92-102(3)(b), C.R.S. (2018), the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

Citations

Capesius, J.P. and V.C. Stephens, 2009, Regional regression equations for estimation of natural streamflow statistics in Colorado, Scientific Investigations Report 2009-5136.

Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

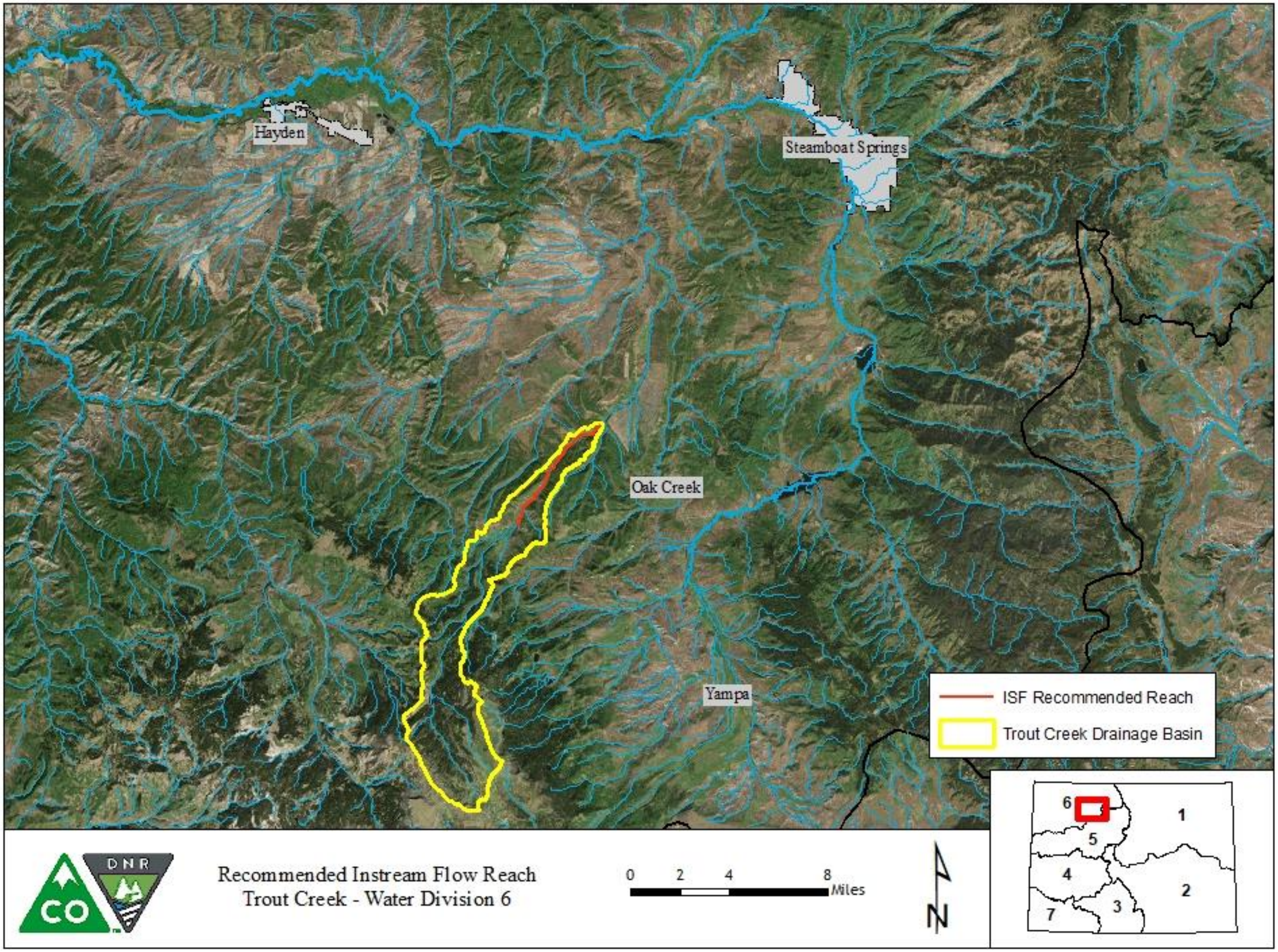
WWC Engineering, 2010, 2009 Annual Hydrology Report - Edna Mine. Available at DMRS laserfiche: http://10.14.11.214/drmsimaging/0/doc/904586/Page1.aspx?searchid=faed753d-29fc-4589-95ea-c127f0e3c102.

Metadata Descriptions

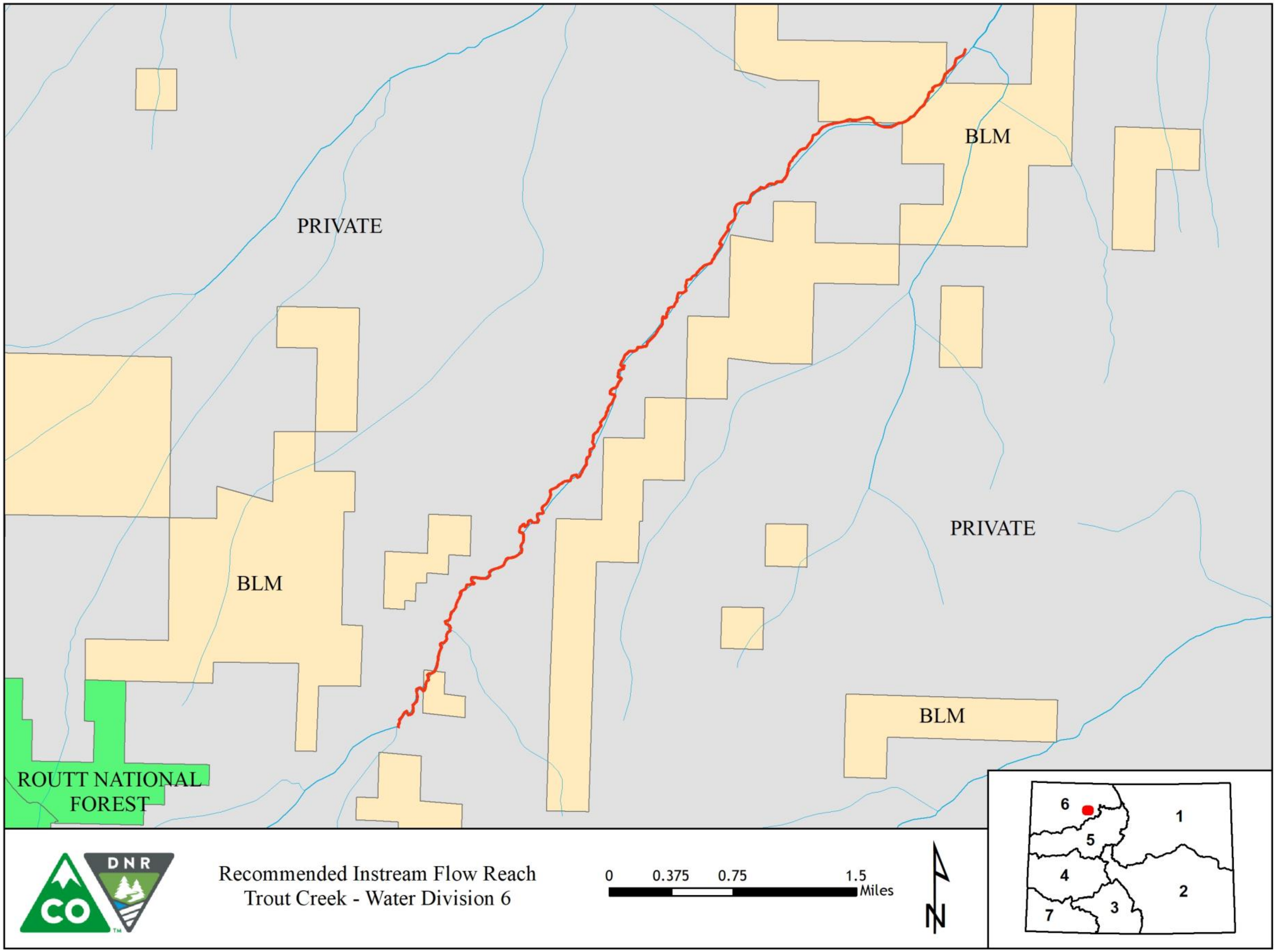
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

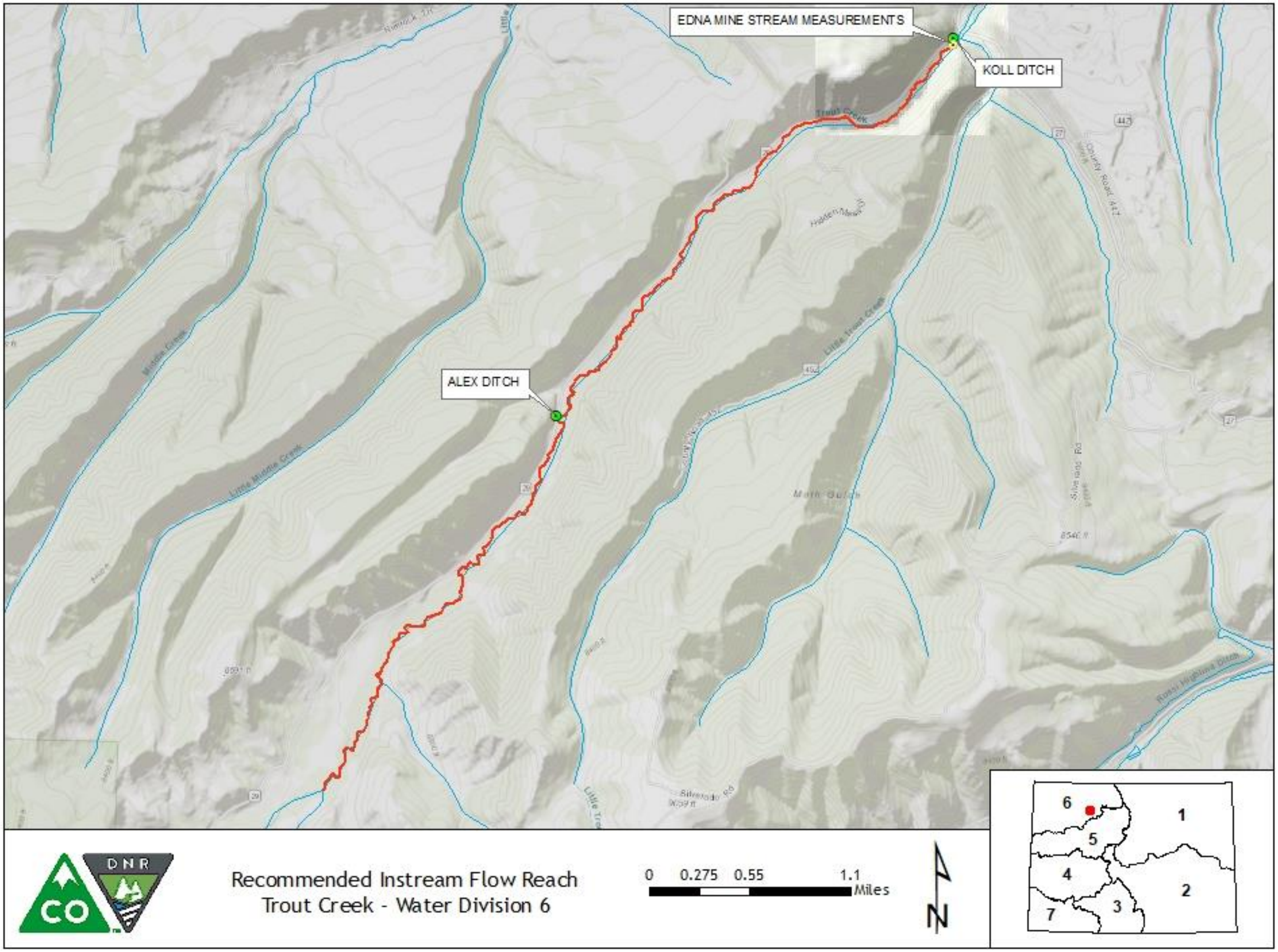
VICINITY MAP



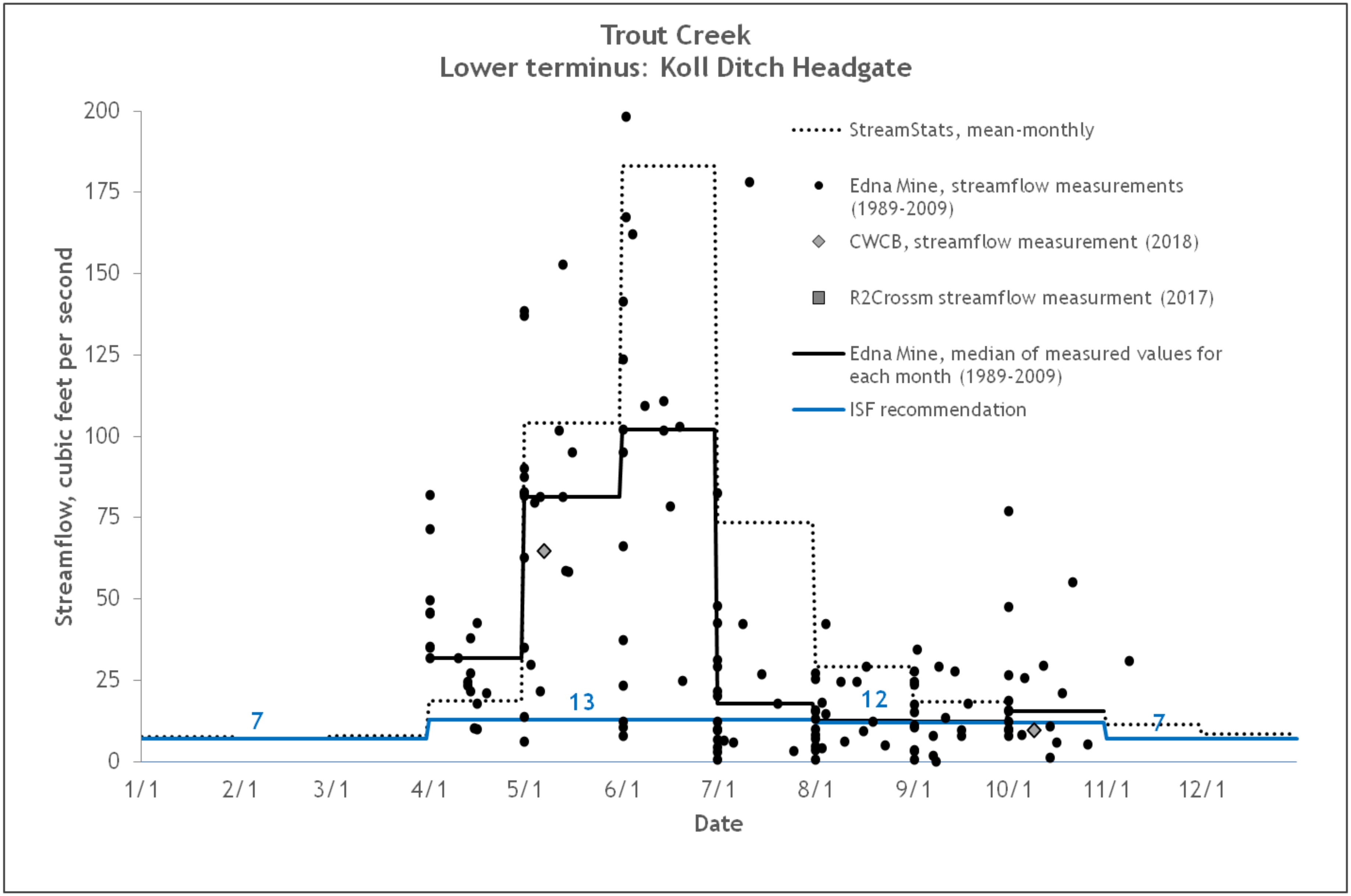
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH

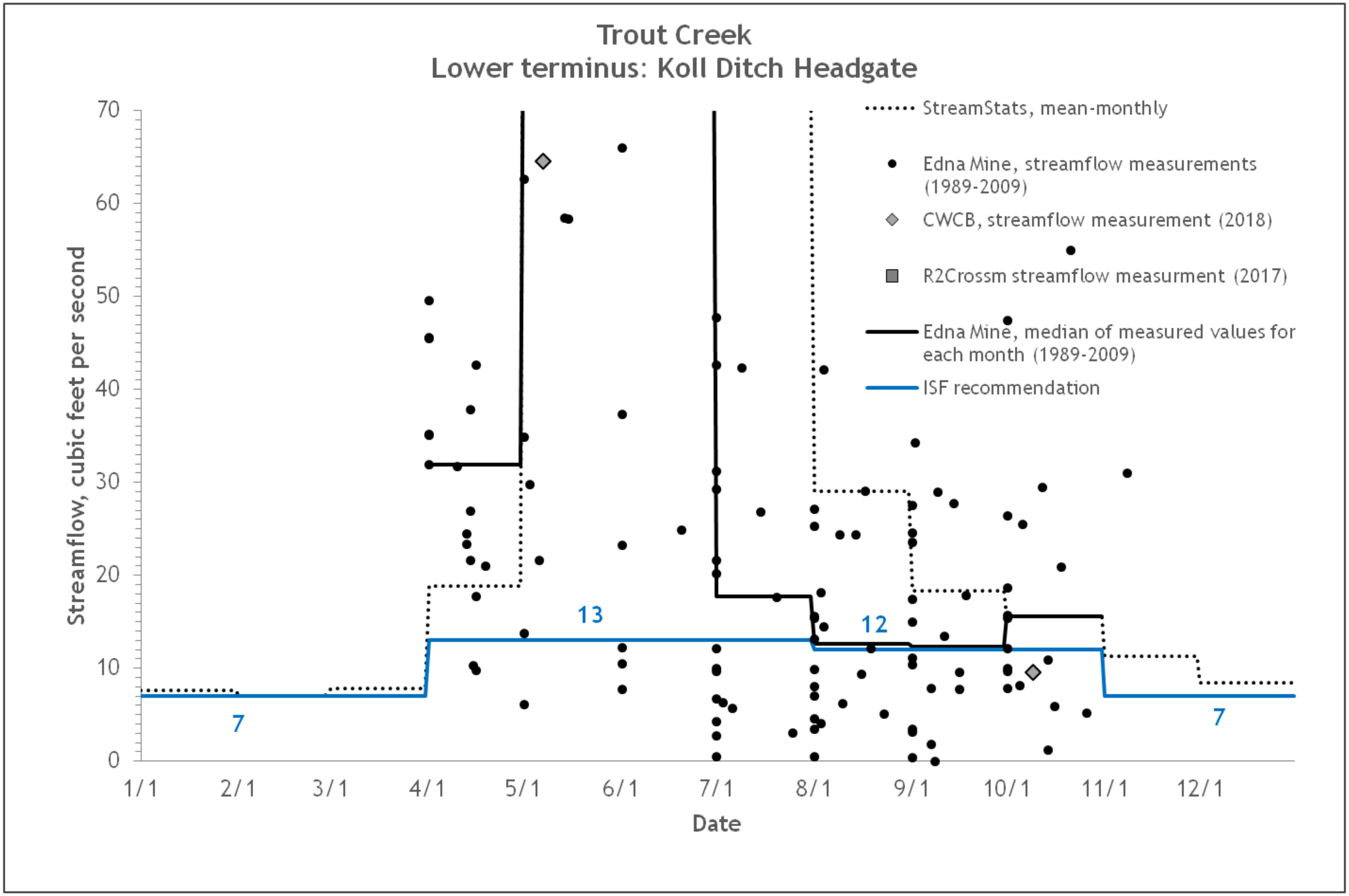


EXHIBIT E

Quantum Water & Environment
1746 Cole Boulevard, Suite 340
Lakewood, Colorado 80401
(720) 524-4294

September 3, 2019

Alyson Meyer Gould, Esq.
Holsinger Law LLC
1800 Glenarm Place, Suite 500
Denver, Colorado 80202-3829

RE: Quantum Review of U.S. Bureau of Land Management's In-Stream Flow Calculations for 7-Mile Reach of Trout Creek, Routt County, Colorado

Dear Ms. Gould:

In accordance with your request, Quantum Water & Environment LLC (Quantum) has reviewed in-stream flow calculations completed by the U.S. Bureau of Land Management (BLM), which were delivered to the Colorado Water Conservation Board (CWCB) with a letter, date-stamped December 19, 2018. The letter explained that, based on the results of BLM's assessment of in-stream flow conditions in a reach of Trout Creek, the magnitude of the in-stream flow water right assigned to that reach should be increased, in order to maintain stream habitat conditions adequate to support native aquatic species.

The in-stream flow calculations on which this assertion was based were completed using streamflow and other measurements collected by BLM staff on August 2, 2017, on a reach of Trout Creek – a tributary of the Yampa River – located primarily in Township 4 North, Range 86 West, in Routt County, Colorado (Figure 1, attached). The headwaters of Trout Creek lie in the Flattops Wilderness area, approximately 22 miles south of the confluence of Trout Creek with the Yampa River (Figure 1). Just below its headwaters, Trout Creek flows into Sheriff Reservoir, a man-made impoundment used primarily for storage of irrigation water. The Town of Oak Creek, Colorado holds water rights and storage rights in Sheriff Reservoir; and the United States government holds junior rights to water in Trout Creek, with a decreed beneficial use of habitat maintenance (among other decreed uses). BLM's assertion of a right to an in-stream flow increase applies to that reach of Trout Creek beginning at the confluence of Trout Creek with an un-named tributary, in the southwest ¼ of the northwest ¼ of Section 8 (SWNW 8), Township 3 North, Range 86 West, and extending to the headgate of the Koll Ditch (contrasting shaded reach of Trout Creek depicted on Figure 1). The subject reach of Trout Creek is approximately 7 miles in length; BLM manages approximately 0.8 miles of the subject reach, with the remaining 6.2 miles of the reach traversing private land.

The calculations supporting BLM's assertion of a right to an in-stream flow increase on the subject reach of Trout Creek were completed by BLM using the R2CROSS software tool, developed and maintained by the CWCB for the specific purpose of assessing the requirements for in-stream flows capable of supporting habitat for aquatic species in Colorado. Hardcopy results of the BLM's calculations and supporting information (referenced subsequently as "data package") were provided by the BLM as an attachment to the letter; during our review, Quantum relied primarily on the BLM data package, supplemented, as necessary, with materials from other sources. These sources are referenced, as appropriate, in the subsequent discussion.

BLM DATA PACKAGE

In reviewing the documentation developed by CWCB and provided with the R2CROSS[1] software tool, Quantum notes that, as described in the program documentation, the tool is intended to be used to calculate seasonal in-stream flows necessary to preserve the natural environment to a reasonable degree, using site-specific hydraulic and biological data collected from a representative riffle stream habitat-type on the subject stream reach. Application of the R2CROSS method requires collection of certain site-specific physical and hydraulic data, including information about channel geometry, measured flow velocity, and measured water depth at several measuring points along an orthogonal transect which traverses the riffle site selected to represent stream-channel characteristics[2]. (After the necessary field measurements have been collected and compiled, these are used to calculate average flow velocity and average water depth across the transect, and total water discharge through the transect.) Examination of the hardcopy results of BLM's calculations indicates that the information necessary to the calculations apparently was collected by BLM staff; and elements of the supporting field documentation were included in BLM's data package.

BLM's data package comprised the following materials:

1. Undated letter (4 p.) from Mr. Brian St. George (Deputy State Director, BLM) to Ms. Linda Bassi (CWCB), date-stamped December 19, 2018. In the letter, BLM recommends to CWCB that, based on the results of BLM's assessment of in-stream flow conditions in a reach of Trout Creek (stream reach depicted in Figure 1), the magnitude of the in-stream flow water right on that reach should be increased. The letter describes the location and land status of the subject stream reach; notes the current in-stream flow water rights appropriated to the subject reach (5.0 cubic feet per second [cfs] year-round); summarizes current biological conditions in the subject stream reach; briefly describes the results of BLM's in-stream flow calculations, completed using the R2CROSS software tool, and provides recommendations for seasonal increases to protect in-stream flows, purportedly derived from the results of R2CROSS calculations; provides rationale for the proposed increases to in-stream flows; provides a listing of existing water rights on the subject stream reach and in upstream reaches; and relates the proposed increases to in-stream flows to BLM's long-term management plan for the subject stream reach.
2. Computer print-out (17 p.) of results of two fish surveys, completed on September 8, 1993

[1] Espergren, Gregory D. 1996. *Development of Instream Flow Recommendations in Colorado Using R2CROSS*. Colorado Water Conservation Board. Denver, Colorado. January. 34 p.

[2] Parker, Gene W., Armstrong, David S., and Todd A. Richards. 2004. *Comparison of Methods for Determining Streamflow Requirements for Aquatic Habitat Protection at Selected Sites on the Assabet and Charles Rivers, Eastern Massachusetts, 2000-02*. U.S. Geological Survey Scientific Investigations Report SIR 2004-5092. 44 p.

and July 19, 2007. The stream reach(es) in which the fish surveys were completed are not clearly identified in the computer print-out.

3. Computer print-out (12 p.) of results of R2CROSS calculations of in-stream flows on the subject reach for a transect (*Transect 1*, or *XS NUMBER 1* in the print-out, hereinafter referenced as *BLM Transect 1*), using measurements reportedly collected on August 2, 2017. The computer print-out is in standard R2CROSS format (version of October 31, 2008).

4. Field notes for *BLM Transect 1* were not included in the BLM's data package. Consequently, the actual location of *BLM Transect 1* cannot be verified using the available information.

5. Computer print-out (12 p.) of results of R2CROSS calculations of in-stream flows on the subject reach for a transect (*Transect 2*, or *XS NUMBER 2* in the print-out, hereinafter referenced as *BLM Transect 2*), using measurements collected on August 2, 2017. The computer print-out is in standard R2CROSS format (version of October 31, 2008).

6. Field notes (4 p.) itemizing location and hydraulic measurements collected by BLM staff along a transect across the subject reach, identified in the notes as *Cross Section No. 2* (hereinafter referenced as *BLM Transect 2*). The transect data were collected on August 2, 2017, at a location identified as Universal Transverse Mercator (UTM) Zone 13N, 4463647N, 328647E (corresponding to 40.305775°N latitude, 107.016375°W longitude; Figure 1, and Figure 2, attached). Channel bed material size range is described in the field notes as ***4** (-inch)* ***cobble to 18*** *(-inch)* **boulders**. A notation on the field notes indicates that a water sample(s) was/were collected for analysis of stream water chemistry; however, no indication of the disposition of the sample(s) or results of analyses is provided in the data package. The field notes also indicate that three (3) photographs were taken to document the transect location; the notes are accompanied by 16 color photographs. Although not annotated, these photographs apparently depict features of the transect (Transect 2) and of the transect location on the subject stream reach.

7. Computer print-out (6 p.) of transcribed field notes itemizing location and measurements collected along a transect across the subject reach, identified in the notes as *Trout Creek – D6, Measurement Number 507* (hereinafter referenced as *CWCB Transect 1*). (It also seems possible that the "transcription" of field notes actually represents information that was entered directly into a handheld electronic device – e.g., notebook computer or tablet – in the field, and subsequently downloaded from that device.) The transect data were collected by CWCB personnel on May 7, 2018, at a location identified as UTM Zone 13N, 4463623N, 328640E (corresponding to 40.305558°N latitude, 107.016453°W longitude; Figures 1 and 2). The cross-section is described in the field notes as ***run, cobble substrate, confined by valley wall to south*****; flow is** ***turbulent***; and comments include (l)***ots of beaver ponds and old dams in area, this xsec one of few good spots for measurement***. Field notes are accompanied by instrument calibration information and graphic presentation of field data, including water depth at each measurement point; velocity of streamflow at each measurement point; and incremental stream discharge calculated for each segment of the transect. The temperature of water in the stream apparently also was measured during collection of hydraulic information along *CWCB Transect 1*; the measured water temperature (52.252°F) is reported in the transcribed notes.

The location of *CWCB Transect 1*, established and measured on May 7, 2018, is on the main stem of Trout Creek (Figure 2), approximately 83 feet (ft) southwest of the location of *BLM Transect 2* (established and measured on August 2, 2017). The R2CROSS software tool apparently was not applied to field data and other information collected at the *CWCB Transect 1* – results of R2CROSS calculations incorporating data from this location were not included in the BLM data package.

8. Computer print-out (2 p.) of transcribed field notes itemizing location and measurements collected along a transect across the subject reach, identified in the notes as *Trout Creek and Beaver Ponds, Measurement Number 2* (hereinafter referenced as *CWCB Transect 2*). (It also seems possible that this "transcription" of field notes actually represents information that was entered directly into a handheld electronic device – e.g., notebook computer or tablet – in the field, and subsequently downloaded from that device.) The transect data were collected by CWCB and other personnel on October 9, 2018 or October 10, 2018 (the field notes are internally contradictory), at a location identified as UTM Zone 13N, 4463735N, 328736E (corresponding to 40.306586°N latitude, 107.015354°W longitude; Figure 1). Streamflow at the cross-section is described in the field notes as ***slightly turbulent***; and location description comments include ***above LT beaver ponds***. Field notes are accompanied by an apparently-erroneous graphic representation of the channel cross-sectional profile derived from field transect measurements.

   The location of *CWCB Transect 2*, established and measured on October 9/10, 2018, is on the main stem of Trout Creek (Figure 1), approximately 400 ft northeast of the location of *BLM Transect 2* (established and measured on August 2, 2017). The R2CROSS software tool apparently was not applied to field data and other information collected at the *CWCB Transect 2* location – results of R2CROSS calculations incorporating data from this location were not included in the BLM data package.

9. Annual Hydrology Report for the Edna Mine[3], calendar year 2009, submitted on February 18, 2010 by Mr. Troy Summers of WWC Engineering (engineering consultant to Chevron Corporation, the mine owner) to Mr. Jason Musick of the Colorado Division of Reclamation, Mining, and Safety (DRMS). The Edna Mine is a reclaimed surface coal-mining property, located along the east bank of Trout Creek (Figure 2), approximately 3,750 ft northeast of (downstream from) the location of *BLM Transect 2*. Examination of the Annual Hydrology Report for the Edna Mine indicates that the flow of water ("*discharge*") moving in Trout Creek in the vicinity of the reclaimed mine routinely has been gaged through the period extending from 1988 into 2010; discharges from seeps and springs also have been gaged periodically. Information presented in the Annual Hydrology Report suggests that the volume of water moving through Trout Creek in the vicinity of the Edna Mine may be somewhat greater than the volume of water moving through *BLM Transect 2*, which is upstream from the reclaimed mine. The increase in Trout Creek discharge in the vicinity of the Edna Mine may be a consequence of the discharge of seeps and springs from the vicinity of the reclaimed mine into Trout Creek – instantaneous discharges measured during a gaging

[3] WWC Engineering. 2010. *2009 Annual Hydrology Report, Edna Mine, Permit CO-80-001, Rout County, Colorado*. WWC Engineering and Chevron Mining, Inc. Laramie, Wyoming. February. 19 p., 3 pl.

event in May 2009 indicate that the total discharge measured from seeps and springs at the reclaimed mine contributed water to nearby Trout Creek at a rate of nearly 2,000 gallons per minute (gpm; approximately 4 cfs), downstream from the *BLM Transect 2* location. Samples of water also have been collected from Trout Creek, from on-site groundwater monitoring wells, and from certain seeps and springs, and have been analyzed for various water-quality constituents/parameters. Results of water-quality analyses also are included in the annual report[4].

MANNING'S EQUATION AND ITS IMPLEMENTATION IN R2CROSS SOFTWARE TOOL

As described in the documentation[5] for the R2CROSS software tool, several mathematical models have been developed to predict the hydraulic behavior of water moving through stream channels. Manning's equation (so-called) is one such model; it was developed in the late 19th century as a mathematical description of the movement of water in an open channel under steady-state (non-varying) conditions[6]:

$$V = 1.49 \times \frac{R_h^{2/3} \times S^{1/2}}{n}$$

where

- V = the average instantaneous velocity of water moving through a cross-section transverse to the axis of the channel (feet per second [*ft/sec*]);
- R_h = hydraulic radius of the channel (*ft*);
- S = hydraulic gradient of channel reach (*ft/ft* – dimensionless), and
- n = roughness coefficient ($sec/ft^{1/3}$).

In practice, an actual stream channel is assumed to be a reasonable approximation to an idealized open channel. Under these conditions, the average instantaneous velocity of water moving through the channel at a particular location (V) is calculated by measuring the velocity of water at several points (to determine different flow velocities along the channel width) along a transect perpendicular to the channel axis, using a current meter. The hydraulic radius of an open channel is the ratio of the channel cross-sectional area to the channel wetted perimeter; in a wide rectangular channel containing water of shallow depth, the hydraulic radius is approximately equal to the width of the channel. The hydraulic gradient of an open channel is approximately equal to the slope of the channel bed. These channel properties, and the velocity of water moving through the channel under (assumed) steady-state conditions, can be measured in the field.

[4] WWC Engineering (2010), Tables 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, and 15.

[5] Espergren, Gregory D. (1996), p. 3.

[6] Daugherty, Robert L., and Joseph B. Franzini. 1977. *Fluid Mechanics with Engineering Applications*. McGraw-Hill Book Company. New York, New York. 4th ed. 564 p.

Channel and streamflow characteristics which are measured in the field during an assessment of channel hydraulics include[7]:

- Width of active channel (bankfull width at current water surface) along transect transverse to channel axis at measurement location;
- Width of active channel at normal annual bankfull high-flow conditions (estimated from characteristics of vegetation bordering the channel at measurement location);
- Depth of active channel (distance from current water surface to channel base) at several locations along transect;
- Depth of active channel at normal annual high-flow conditions (estimated from elevation at which vegetation bordering the channel occurs at measurement location); and
- Velocity of streamflow through transect, at several locations along transect.

A transect is established across the channel at the location to be measured using a level line (string, cable). Geometric characteristics of the channel (width; water depth at a particular location) can be measured along the transect using a tape. Velocity of streamflow through the transect at a particular location is measured using a current meter. The channel hydraulic gradient at the transect location (slope of the channel bed) is estimated by inspection of topographic elevations depicted on a map containing the channel reach and transect location, and surrounding area.

Hydraulic computations involving flow in open channels require an evaluation of the roughness characteristics of the channel (which influence the friction between the water moving through the channel, and the sides and base of the channel). The "*roughness coefficient*" (or *Manning's n*) is an empirically-derived number describing channel roughness characteristics. The roughness coefficient of a channel can be estimated by visual inspection of the channel, and the characteristics of streamflow moving through the channel (laminar vs turbulent flow); by consulting compilations of roughness coefficients for typical channels; or by computation[8]. As stated by the U.S. Geological Survey,

> *"At the present state of knowledge, the selection of roughness coefficients for natural channels remains chiefly an art."*[9]

The average stream velocity and geometry of the stream channel are derived from measurements collected in the field; and the roughness coefficient of the channel at that location can be estimated by calculation (using Manning's equation). If this approach is followed, the value of roughness coefficient so obtained should be compared with published values of roughness coefficients for similar channels[8], to assess whether the calculated roughness coefficient is reasonable, given the physical characteristics and flow regime of that particular channel.

[7] Espergren, Gregory D. (1996), p. 2.

[8] Barnes, Harry H., Jr. 1967. *Roughness Characteristics of Natural Channels*. U.S. Geological Survey Water-Supply Paper 1849. 4th ed. 213 p.

[9] Barnes (1967), p. 2.

The R2CROSS software tool[1] applies Manning's equation, using geometric and hydraulic measurements collected along a stream-channel traverse at a particular location, to calculate a roughness coefficient for the channel at that location, under the hydraulic regime (width of water surface across the channel, water depth, average flow velocity) in effect at the time of measurement. The R2CROSS software tool then uses the calculated roughness coefficient, together with other channel geometric features, to calculate a range of water depths and associated streamflow velocities (hence, total stream discharge through the transect) for several different flow regimes (low-flow, high-flow, and intermediate-flow conditions). The results of calculations completed by the software tool are presented (in program output) as a "staging table", which can be used to make decisions regarding the quality of stream habitat in that channel reach. *The channel roughness coefficient used in these calculations is assumed to remain constant through all flow regimes, from low-flow to high-flow conditions* ("*constant Manning's n*" output). In particular circumstances, it also is possible to adjust Manning's roughness coefficient to account for some of the changes in flow regime[10], from low-flow to high-flow conditions ("*Jarrett variable Manning's n correction*" output).

Documentation developed by CWCB and provided with the R2CROSS software tool states[11] that hydraulic conditions in a stream riffle reach are used as indicators of aquatic habitat conditions at that location, and that application of three principal hydraulic criteria – average stream depth, average streamflow velocity, and percent of wetted perimeter – is sufficient for assessing stream habitat quality. Acceptable values for these three hydraulic criteria, at several ranges of bankfull channel width, are presented in the R2CROSS documentation[12]. Current practice requires that two of three criteria should be satisfied for hydraulic conditions to be considered adequate to support stream habitat of good quality under a low-flow ("winter") hydrologic regime; and that three of three criteria should be satisfied for hydraulic conditions to be considered adequate to support stream habitat of good quality under a high-flow ("summer") hydrologic regime[13].

According to BLM's letter, staging tables were developed for the subject stream reach using the results of R2CROSS calculations completed using measurements collected at *BLM Transect 1* and *BLM Transect 2*, on August 2, 2017. Values of the three "critical" hydraulic parameters calculated for the two transects under a variety of flow regimes then were compared with "acceptable" values of the three criteria[12] to develop the recommendations for in-stream flows presented in BLM's letter.

REVIEW OF BLM DATA PACKAGE

Quantum began our review of the BLM data package by examining the field notes collected during measurement of streamflow velocities and channel characteristics along stream transects in the subject reach of Trout Creek:

- Field notes containing information collected along *BLM Transect 1* on August 2, 2017 were

[10] Jarrett, Robert D. 1985. *Determination of Roughness Coefficients for Streams in Colorado*. U.S. Geological Survey Water Resources Investigations Report WRI 85-4004. 54 p.

[11] Espergren, Gregory D. (1996), p. 2ff; and p. 18ff.

[12] Espergren, Gregory D. (1996), p. 19, and Table 2.

[13] Espergren, Gregory D. (1996), p. 18.

not provided in the BLM data package.

- Field notes containing information collected along *BLM Transect 2* on August 2, 2017 were reviewed for consistency and completeness. Information provided in the field forms completed for *BLM Transect 2* indicated that field procedures for site selection and field data collection appeared to meet the requirements for data collection established in R2CROSS documentation[14]. Coordinates of *BLM Transect 2* were provided in the field notes; these were used to identify the location of *BLM Transect 2* on a GoogleEarth map. To the extent that relevant site details were presented in field notes or could be discerned from topography, the characteristics of the transect location (riffle stream reach; no identifiable hydraulic controls – e.g., dams or other structures – located immediately upstream or downstream from the transect) appeared to meet the requirements for field data site selection established in R2CROSS documentation[11]. However, inspection of aerial images of the transect location (on the GoogleEarth depiction) indicates that numerous beaver dams are present along the stream at locations upstream of and downstream from the transect location (Figure 2). Although not in the immediate vicinity of the transect, it is possible that nearby beaver dams could affect the hydrology of the subject stream reach.
- The transcription of field notes containing information collected along *CWCB Transect 1* on May 7, 2018 were reviewed for consistency and completeness. Information provided in the field notes completed for *CWCB Transect 1* indicated that field procedures for site selection and field data collection may not have met the requirements for data collection established in R2CROSS documentation[11] – review of field notes indicated that beaver ponds (which could represent hydraulic controls on streamflow) were present nearby. Coordinates of *CWCB Transect 1* were provided in the field notes; these were used to identify the location of the transect on a GoogleEarth map. To the extent that relevant site details could be discerned on the GoogleEarth depiction, the characteristics of the transect location (possible beaver ponds in the vicinity of the transect) appeared to confirm the description provided in the field notes. If nearby beaver dams represent a hydraulic control on flow in Trout Creek at or near the location of *CWCB Transect 1*, this condition would violate the requirements for field data site selection established in R2CROSS documentation[11].
- The transcription of field notes containing information collected along *CWCB Transect 2* on October 9/10, 2018 were reviewed for consistency and completeness. Review of information provided in the field notes completed for *CWCB Transect 2* indicated that field procedures for site selection and field data collection may not have met the requirements for data collection established in R2CROSS documentation[11] – the location description indicates that beaver ponds (which could represent hydraulic controls on streamflow) were present in the area. Coordinates of *CWCB Transect 2* were provided in the field notes; these were used to identify the location of the transect on a GoogleEarth map. To the extent that relevant site details could be discerned on the GoogleEarth depiction, the characteristics of the transect location (possible beaver ponds in the vicinity of the transect) appeared to confirm the description provided in the field notes. If nearby beaver dams represent a hydraulic control on flow in Trout Creek at or near the location of *CWCB*

[14] Espergren, Gregory D. (1996), p. 2ff.

Transect 2, this condition would violate the requirements for field data site selection established in R2CROSS documentation[11].

After the information necessary for executing the necessary calculations has been compiled from field data and entered into the R2CROSS software tool, the software tool generates an exact listing of the data (as they were entered into the program) as a part of program output. Examination of this data listing is useful in assessing whether correct information has been supplied to the software tool, and in identifying possible data-entry errors. After Quantum had completed our review of field notes, we next compared channel measurements and streamflow data collected in the field (as presented in those field notes that were available for each transect) with pertinent data that were supplied to the R2CROSS software tool, by comparing field notes with the program data listing for each of the transects:

- Field notes containing information collected along *BLM Transect 1* on August 2, 2017 were not provided in the BLM data package; consequently, channel measurements and streamflow data collected along *BLM Transect 1* could not be compared with the data listing included as part of the R2CROSS output for *BLM Transect 1*.

- Field notes containing information collected along *BLM Transect 2* on August 2, 2017 were compared with the data listing included as part of the R2CROSS output for *BLM Transect 2*. No data entry errors or omissions were identified during comparison of *BLM Transect 2* field notes with the R2CROSS data listing for *BLM Transect 2*.

- The value of hydraulic slope of the subject stream reach used by BLM in calculations (presented as "*Channel Profile Data – Slope*" in the data listing section of R2CROSS output for *BLM Transect 1* and *BLM Transect 2*) was 0.013 ft/ft (dimensionless). Quantum estimated the hydraulic slope of the stream reach by noting (in GoogleEarth) the change in elevation of the channel bed (24 ft) along a length of stream thalweg (1,786 ft) that includes all of the transect locations. Quantum's estimate of the hydraulic slope of the subject stream reach (0.0134 ft/ft [dimensionless]) is in reasonable agreement with the value of hydraulic slope used by BLM in hydraulic calculations.

- The transcription of field notes containing information collected along *CWCB Transect 1* on May 7, 2018 was assumed to accurately represent field notes for that transect. However, information collected along *CWCB Transect 1* on May 7, 2018 apparently was not used by BLM to complete R2CROSS staging-table calculations for that transect (computer print-out of results of R2CROSS calculations for *CWCB Transect 1* was not provided in the BLM data package). Consequently, the transcription of field notes for *CWCB Transect 1* could not be compared with a data listing of R2CROSS output for that transect.

- The transcription of field notes containing information collected along *CWCB Transect 2* on October 9/10, 2018 was assumed to accurately represent field notes for that transect. However, information collected along *CWCB Transect 2* on October 9/10, 2018 apparently was not used by BLM to complete R2CROSS staging-table calculations for that transect (computer print-out of results of R2CROSS calculations for *CWCB Transect 2* was not provided in the BLM data package). Consequently, the transcription of field notes for *CWCB Transect 2* could not be compared with a data listing of R2CROSS output for that transect.

After completing our comparison of transect data recorded in the field with program data listings, Quantum next entered the appropriate data for *BLM Transect 1* and *BLM Transect 2* into the R2CROSS software tool, using the spreadsheet-based user interface supplied as part of the tool. Quantum then instructed the R2CROSS tool to execute the program calculations, and provide program output for the two transects:

- Output generated by the R2CROSS software tool for hydraulic data collected at *BLM Transect 1*, and supplied to the program by Quantum, replicated the output generated for *BLM Transect 1* by the R2CROSS tool, that was provided in the BLM data package.
- Output generated by the R2CROSS software tool for hydraulic data collected at *BLM Transect 2*, and supplied to the program by Quantum, replicated the output generated for *BLM Transect 2* by the R2CROSS tool, that was provided in the BLM data package.

Quantum's replication of results for both transects indicates that data were entered correctly into the software tool; and that the version of the software tool used by Quantum apparently is the same version of the tool used by BLM to generate the calculation results presented in the BLM data package.

REVIEW OF CALCULATION RESULTS PROVIDED IN BLM DATA PACKAGE

After Quantum verified the field data used in R2CROSS calculations, and verified that it could replicate program results using field data for *BLM Transect 1* and *BLM Transect 2*, Quantum then examined the results of calculations generated by the R2CROSS software tool for both transects, to ensure that the results of calculations were hydraulically reasonable, and that the recommendations for in-stream flow conditions generated for the subject reach of Trout Creek were in accordance with in-stream flow criteria established by CWCB (as presented in R2CROSS documentation[9]).

- Application of the R2CROSS software tool using field data collected at *BLM Transect 1* on August 2, 2017 generated the following calculation results for the flow regime at the *BLM Transect 1* location, at the time of measurement:

  Stream Top Width (at bankfull discharge): 39.5 ft
  Maximum Measured Depth: 0.70 ft
  Mean Velocity: 1.39 feet per second (ft/sec)
  Measured Flow (i.e., total discharge through the transect): 9.43 cfs
  Calculated Manning's Roughness Coefficient (n): 0.059 sec/ft$^{1/3}$

- Application of the R2CROSS software tool using field data collected at *BLM Transect 2* on August 2, 2017 generated the following calculation results for the flow regime at the *BLM Transect 2* location, at the time of measurement:

  Stream Top Width (at bankfull discharge): 35.2 ft
  Maximum Measured Depth: 0.55 ft
  Mean Velocity: 1.16 feet per second (ft/sec)
  Measured Flow (i.e., total discharge through the transect): 8.58 cfs
  Calculated Manning's Roughness Coefficient (n): 0.064 sec/ft$^{1/3}$

- As part of program output, the R2CROSS software tool generates a hydraulic cross-section of the stream channel along the transect from which data were collected for use in executing the hydraulic calculations (calculating Manning's roughness coefficient and generating the staging table) for the transect. The cross-section generated by the tool depicts the channel configuration oriented along the transect (i.e., perpendicular to the channel axis), and includes the geometry of the sides and base of the channel, and the water-surface profile along the transect. The hydraulic cross-section is developed using the water-surface elevation and depth to the base of the channel, measured in the field at several points along the transect. The cross-sections generated by the R2CROSS software tool for *BLM Transect 1* and *BLM Transect 2* were compared visually, and were judged to be dissimilar. This indicates that the locations of *BLM Transect 1* and *BLM Transect 2* did not coincide – if *BLM Transect 1* and *BLM Transect 2* had been co-located, the hydraulic cross-sections for the two transects should have been similar. Furthermore, comparison of the flow regime (Stream Top Width, Measured Depth, Mean Velocity, Measured Flow, and Manning's Roughness Coefficient) at *BLM Transect 1* with the flow regime at *BLM Transect 2* (values presented above) also indicates that the two transects were not co-located. Located transects at the same place on the stream allows for quality control checks for accuracy of data collection.

- CWCB has established values for three "critical" criteria[12] used to assess whether in-stream flow is adequate to maintain stream habitat across a range of stream "top widths" (i.e., stream width measured along the free water surface): *Average Depth*, *Percent Wetted Perimeter*, and *Average Flow Velocity*. The R2CROSS software tool uses values of specific types of information collected at a field transect to calculate values of the three "critical" criteria for a range of flow regimes, ranging from low-flow, through intermediate discharges, to high-flow regimes, which are assumed to be representative of the range of annual flow regimes experienced by the stream reach. The values of the three criteria calculated for the transect through the range of flow regimes is presented (in program output) in the form of a "staging table". Values of each criterion presented in the staging table are compared with the "critical" values[12] to identify those calculated values of streamflow that will meet (or exceed) "critical" values. The minimum streamflow calculated for a transect that meets (or exceeds) two of three criteria is considered to represent an adequate condition for winter streamflow; and the minimum streamflow calculated for a transect that meets (or exceeds) three of three criteria is considered to represent an adequate condition for summer streamflow[12].

- The "critical" values established for the three criteria for a stream having a top width ranging from 21 ft to 40 ft (the range within which the stream top widths measured at *BLM Transect 1* and *BLM Transect 2* fall) are: *Average Depth*: **0.2 ft – 0.4 ft**; *Percent Wetted Perimeter*: **50%**; and *Average Flow Velocity*: **1.0 ft/sec**. Using the results of R2CROSS calculations presented in the staging table for *BLM Transect 1* (Table displaying "*Jarrett Variable Manning's n Correction Applied*" in the BLM data package, confirmed by Quantum calculations), Trout Creek at *BLM Transect 1* will satisfy two of three criteria (winter conditions) in a flow regime having a cross-sectional discharge area of 3.37 square feet (ft^2), and a stream discharge (flow through the transect) of 3.50 cfs. Under this flow regime, the values of the three criteria are: *Average Depth*: **0.24 ft**; *Percent Wetted Perimeter*: **35.6%**;

and *Average Flow Velocity*: **1.04 ft/sec**.

- Trout Creek at *BLM Transect 1* will satisfy three of three criteria (summer conditions) in a flow regime having a cross-sectional discharge area of 6.79 ft^2, and a stream discharge (flow through the transect) of 9.43 cfs. Under this flow regime, the values of the three criteria are: *Average Depth*: **0.34 ft**; *Percent Wetted Perimeter*: **50.3%**; and *Average Flow Velocity*: **1.39 ft/sec**. Quantum notes that the total discharge measured at *BLM Transect 1* on August 2, 2017 (9.43 cfs) equaled the stream discharge calculated to occur through this transect in a flow regime that just satisfies the three criteria for summer conditions (based on examination of the staging table calculated for *BLM Transect 1* by the R2CROSS software tool).
- In the undated letter from Mr. Brian St. George (Deputy State Director, BLM) to Ms. Linda Bassi (CWCB), included in the BLM data package, BLM recommends to CWCB that, based on the results of calculations completed for *BLM Transect 1* using the R2CROSS software tool, winter discharge in Trout Creek at the location of *BLM Transect 1* should be 9.27 cfs; and summer discharge in Trout Creek at the location of *BLM Transect 1* should be 13.28 cfs. The basis for these recommendations is not clear, as the recommended discharges do not appear to correspond with discharges at levels satisfying the three critical criteria, presented in the staging table (Table displaying "*Jarrett Variable Manning's n Correction Applied*" in the BLM data package) calculated for *BLM Transect 1*.
- Using the results of R2CROSS calculations presented in the staging table for *BLM Transect 2* (Table displaying "*Jarrett Variable Manning's n Correction Applied*" in the BLM data package, confirmed by Quantum calculations), Trout Creek at *BLM Transect 2* will satisfy two of three criteria (winter conditions) in a flow regime having a cross-sectional discharge area of 4.97 ft^2, and a stream discharge (flow through the transect) of 4.33 cfs. Under this flow regime, the values of the three criteria are: *Average Depth*: **0.21 ft**; *Percent Wetted Perimeter*: **65.2%**; and *Average Flow Velocity*: **0.87 ft/sec**.
- Trout Creek at *BLM Transect 2* will satisfy three of three criteria (summer conditions) in a flow regime having a cross-sectional discharge area of 6.17 ft^2, and a stream discharge (flow through the transect) of 6.25 cfs. Under this flow regime, the values of the three criteria are: *Average Depth*: **0.25 ft**; *Percent Wetted Perimeter*: **67.7%**; and *Average Flow Velocity*: **1.01 ft/sec**. Quantum notes that the total discharge measured at *BLM Transect 2* on August 2, 2017 (8.58 cfs) exceeded the stream discharge calculated to occur through this transect (6.25 cfs) in a flow regime that just satisfies the three criteria for summer conditions (based on examination of the staging table calculated for *BLM Transect 2* by the R2CROSS software tool).
- In the undated letter from Mr. Brian St. George (Deputy State Director, BLM) to Ms. Linda Bassi (CWCB), included in the BLM data package, BLM recommends to CWCB that, based on the results of calculations completed for *BLM Transect 2* using the R2CROSS software tool, winter discharge in Trout Creek at the location of *BLM Transect 2* should be 5.79 cfs; and summer discharge in Trout Creek at the location of *BLM Transect 2* should be 12.80 cfs. The basis for these recommendations is not clear, as the recommended discharges do not appear to correspond with discharges at levels satisfying the three critical criteria, presented in the staging table (Table displaying "*Jarrett Variable Manning's n Correction*

Applied" in the BLM data package) calculated for *BLM Transect 2*.

DEFICIENCIES IDENTIFIED DURING REVIEW OF BLM DATA PACKAGE

Quantum's review of information provided in the BLM data package (as described above) included:

- Review of field procedures that were followed by BLM and CWCB personnel during site selection, data collection, and documentation (as assessed from field notes);
- Review of BLM's application of the R2CROSS software tool to calculate in-stream flow requirements for habitat maintenance for aquatic species, using site-specific field data; and
- Review of calculation results and interpretation of results of calculations.

During our review, Quantum identified the following possible deficiencies in field procedures, application of the R2CROSS software tool, and BLM's interpretation of results of calculations:

- R2CROSS documentation[15] recommends that a biological survey of the subject stream reach should be conducted in conjunction with a survey of hydraulic conditions in the same reach. Biologic data typically consist of a fish sample, and an aquatic invertebrate sample. It is not clear from the documentation provided in the BLM data package that the biological survey and the hydraulic survey were completed in the same stream reach. Some information regarding the fish-sampling surveys (two surveys) was provided in the BLM data package; however, no information was provided regarding an aquatic invertebrate sampling survey. Furthermore, the fish-sampling surveys apparently were completed in 1993 and 2007. It is not clear that biological surveys completed 24 years (in 1993) and 10 years (in 2007) prior to the hydraulic survey of the subject stream reach (in 2017) are representative of current biologic conditions in the stream. In addition, data regarding water temperatures in the subject stream reach apparently were not collected at the time that hydraulic data were collected at *BLM Transect 1* and *BLM Transect 2*. It seems possible that information regarding water temperature could be useful in assessing the quality of stream habitat for various aquatic species.
- The location of *BLM Transect 1*, at which physical and hydraulic data reportedly were collected on August 2, 2017, was not provided in the BLM data package.
- Field notes describing data collection at *BLM Transect 1* were not provided in the BLM data package; consequently, data entry for *BLM Transect 1* in the R2CROSS software tool could not be verified.
- Field notes containing the location of *BLM Transect 2* and other information collected along the transect on August 2, 2017 were provided in the BLM data package. Review of field notes, and examination of the location of *BLM Transect 2* on a GoogleEarth map, appear to indicate that field procedures for site selection and field data collection met the requirements for data collection established in R2CROSS documentation.

  Review of field notes compiled for two other transects in the area (*CWCB Transect 1* and *CWCB Transect 2*, occupied and measured on May 7, 2018 and October 9/10, 2018,

[15] Espergren, Gregory D. (1996), p. 5.

respectively), together with examination of these two transect locations on a GoogleEarth map, indicate that numerous beaver ponds (which could exert hydraulic controls on streamflow) are present along the Trout Creek channel through the subject reach. (The presence of beaver dams which impound water changes the longitudinal water-surface profile along the affected reach of stream channel, thereby ***reducing*** the local hydraulic slope in the reach of stream channel affected by the impoundment. According to Manning's equation [above], a reduction in hydraulic slope will cause a reduction in the velocity of flow in the stream channel, potentially also reducing the rate of discharge in the channel *at that location, and at nearby locations, upstream of, or downstream from the impoundment*. In certain circumstances, the reductions in flow velocity and rate of discharge resulting from impoundments may be mis-interpreted as resulting from greater-than-actual values of Manning's roughness coefficient.)

Hydraulic conditions at *CWCB Transect 1* and *CWCB Transect 2* clearly were affected by the presence of beaver ponds/dams; consequently, data collected at these two transects were judged by Quantum to be unsuitable for use in evaluating in-stream flow conditions at these locations. It also is possible that streamflows measured at *BLM Transect 1* and *BLM Transect 2* were affected hydraulically by the presence of beaver dams at locations upstream of (or downstream from) the transects. (Inspection of aerial images of the *BLM Transect 2* location indicates that numerous beaver dams are present along the stream at locations upstream of and downstream from *BLM Transect 2*. Although not in the immediate vicinity of the transect, it is possible that nearby beaver dams could affect the hydrology of the subject stream reach.) In this situation, the locations of *BLM Transect 1* and/or *BLM Transect 2* also would not meet the requirements for field data site selection established in R2CROSS documentation.

- According to the U.S. Geological Survey[16], in applying the R2CROSS software tool,

  "*Cross-section data, and measurements of water depths in a riffle **for a range of discharges** are used to develop and calibrate a step-backwater flow model of a riffle habitat.*" (emphasis added)

  Furthermore,

  "***Use of multiple cross-sections and the HEC-RAS model*** *provides improved simulations of the hydraulic conditions expected in riffles, in comparison to conditions simulated by modeling an individual cross section.*"[17] (emphasis added)

  In natural streams, the value of Manning's roughness coefficient can vary greatly along a particular stream reach, and will even vary in a given reach of channel with changing flow regime (i.e., with changing stream stage)[18]. Collection of physical and hydraulic data for the subject stream reach through a range of discharge conditions, and at several transect

[16] Parker *et al*. (2004), p. 2.

[17] Parker *et al*. (2004), p. 8.

[18] Hardy, Thomas, Panja, Palavi, and Dean Mathias. 2005. WinXSPRO, *A Channel Cross Section Analyzer – User's Manual, Version 3.0*. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Fort Collins, Colorado. Gen. Tech. Rep. RMRS-GTR-147. 94 p.

locations, can assist in reducing bias that may be introduced into calculations as a consequence of using a limited data set to develop the step-backwater flow model.

Physical and hydraulic data were collected from the subject reach of Trout Creek during a single measurement event (August 2, 2017), representative of flow-regime conditions in the stream during late summer (intermediate flow to low-flow) conditions. It is not clear that physical and hydraulic data representing a single flow regime are adequate to assess stream conditions across a broad range of discharges.

- The values of Manning's roughness coefficient calculated using physical and hydraulic measurements collected at *BLM Transect 1* and *BLM Transect 2* (0.059 sec/ft$^{1/3}$ and 0.064 sec/ft$^{1/3}$, respectively) appear to be high[19]. The values of Manning's roughness coefficient calculated for the Trout Creek flow regime at these two transect locations may reflect downstream (or upstream) hydraulic controls, possibly related to the presence of beaver ponds/dams. In this circumstance, field data collected at these transects should not be used to calculate stream staging tables or in-stream flow requirements for habitat maintenance for aquatic species, using the R2CROSS software tool.

- In the undated letter from Mr. Brian St. George (Deputy State Director, BLM) to Ms. Linda Bassi (CWCB), included in the BLM data package, BLM recommends to CWCB that, based on the results of calculations completed for *BLM Transect 1* and *BLM Transect 2* using the R2CROSS software tool, winter discharge in Trout Creek at the location of *BLM Transect 1* should be 9.27 cfs; and summer discharge in Trout Creek at the location of *BLM Transect 1* should be 13.28 cfs. Winter discharge in Trout Creek at the location of *BLM Transect 2* should be 5.79 cfs; and summer discharge in Trout Creek at the location of *BLM Transect 2* should be 12.80 cfs. The basis for these recommendations is not clear, as the recommended discharges do not appear to correspond with discharges at levels satisfying the three critical criteria for R2CROSS streamflows, presented in the staging tables (Tables displaying "*Jarrett Variable Manning's n Correction Applied*" in the BLM data package) calculated for *BLM Transect 1* and *BLM Transect 2*.

  It seems possible that the presence of hydraulic controls within the subject stream reach may have influenced physical and hydraulic data collection at *BLM Transect 1* and/or *BLM Transect 2*. In turn, these physical and hydraulic data would have influenced calculation of the staging tables from which in-stream flow requirements for the subject stream reach were derived. In light of uncertainties associated with the locations of transects along the subject reach of Trout Creek at which physical and hydraulic data were collected, and the possible effects of hydraulic controls on streamflow along the subject reach, it is not clear to Quantum that staging tables developed using data collected at *BLM Transect 1* and *BLM Transect 2* on August 2, 2017, are representative of the range of flow conditions that may occur in the reach.

[19] refer to Barnes (1967), p. 150. The value of Manning's roughness coefficient (0.050) presented for a reach of Clear Creek, near Golden, Colorado, in which the stream channel is occupied by numerous clasts ranging in size from cobbles to boulders, may be representative of roughness coefficients determined by the U.S. Geological Survey for gravel-bottomed streams in Colorado.

- Documentation for the R2CROSS software tool requires[20] that

  "*Once an initial biologic instream flow recommendation has been developed, the CWCD staff must determine whether water is physically available to satisfy the biologic recommendation.*"

  The subject reach of Trout Creek is ungaged, so that historic measurements of seasonal discharges through the subject stream reach are not available. In the undated letter from Mr. Brian St. George (Deputy State Director, BLM) to Ms. Linda Bassi (CWCB), included in the BLM data package, BLM notes that historic data collected at two nearby gages (USGS Gage No. 092380000, on Oak Creek near the community of Oak Creek; and USGS Gage No. 09248500, on the East Fork of Williams Fork, near Willow Creek) could be used to assess historic stream discharge conditions on the subject reach of Trout Creek. However, no attempt has been made to extend the historic gaging information available on nearby streams to the subject reach of Trout Creek. Furthermore, although BLM provides a summary listing of existing water rights on the subject reach, and on Trout Creek upstream from the subject reach, no call analysis or firm-yield analysis (which can be used to assess the potential seasonal availability of water in the stream under varying discharge conditions) is provided.

PROFESSIONAL OPINIONS REGARDING HYDROLOGIC CONDITIONS IN THE SUBJECT STREAM REACH

After consideration of information contained in the BLM data package, documentation for the R2CROSS software tool and the results of calculations completed using the R2CROSS software tool, and other information, Quantum has developed the following professional opinions regarding BLM's assertion of a right to an in-stream flow increase in the subject reach of Trout Creek. Information supporting each opinion is included in the preceding discussion.

Opinion No. 1 – Streamflows measured at *BLM Transect 2* have been affected hydraulically by the presence of beaver dams at locations upstream of (or downstream from) the transect. In this situation, the location of *BLM Transect 2* does not meet the requirements for field data site selection established in R2CROSS documentation; and hydraulic data collected at the transect are not representative of "natural" riffle conditions. In order to develop an understanding of hydraulic conditions in a stream riffle habitat unaffected by upstream (or downstream) hydraulic controls, it is necessary to collect supplemental hydraulic data along a transect located on a stream reach having features which correspond to the requirements of the R2CROSS approach.

Opinion No. 2 – The data were collected correctly at *BLM Transect 2*, located on the subject reach of Trout Creek, with the exception of the choice of the transect location (August 2, 2017). The location of *BLM Transect 2* does not meet the requirements for field data site selection established in R2CROSS documentation; and hydraulic data collected at the transect are not representative of "natural" riffle conditions. (Refer to Opinion No. 1, above.). As judged by comparison of the values of three "critical" criteria (*Average Depth*, *Percent Wetted Perimeter*, and *Average Flow Velocity*) derived from field measurements collected at *BLM Transect 2* with values for

[20] Espergren, Gregory D. (1996), p. 19.

three "critical" criteria established by the CWCB[12], hydraulic conditions measured at *BLM Transect 2* at that time (during seasonal low-flow conditions) were adequate to maintain stream habitat conditions that will support native aquatic species. If hydraulic conditions at *BLM Transect 2* were representative of "natural" riffle conditions, then according to the results of R2CROSS calculations completed for *BLM Transect 2*, a "threshold" stream discharge of 6.25 cfs would satisfy the three criteria for summer conditions in Trout Creek at the location of *BLM Transect 2*. The actual discharge measured in Trout Creek at *BLM Transect 2* (8.58 cfs) on August 2, 2017 – summer – exceeded the threshold stream discharge (6.25 cfs). Similarly, if hydraulic conditions at *BLM Transect 2* were representative of "natural" riffle conditions, then a "threshold" stream discharge of 4.33 cfs will satisfy two of three criteria for winter conditions in Trout Creek at the location of *BLM Transect 2*.

Opinion No. 3 – Physical and hydraulic data were collected from the subject reach of Trout Creek during a single measurement event (August 2, 2017). Appropriate application of the R2CROSS approach requires that information that is collected is sufficient to assess stream conditions under the broad range of flow regimes (i.e., low, intermediate and high flow) in the stream at the measured location. Collection of physical and hydraulic data from the subject reach of Trout Creek under conditions representing a single (low-flow) regime does not meet this requirement. Supplemental physical and hydraulic data are necessary to be collected from transects at two (or more) distinct locations in the subject reach of Trout Creek, during two (or more) separate measurement events representing different flow-regime conditions, in order to develop an understanding of hydraulic conditions in the subject reach of Trout Creek.

Opinion No. 4 – Documentation for the R2CROSS software tool[14] recommends that a biological survey of the subject stream reach be conducted in conjunction with a survey of hydraulic conditions *in the same reach*, to ensure that the hydraulic and biologic surveys are representative of conditions in the subject stream reach at the time of the surveys. Biological information provided in the BLM data package is not representative of biological conditions in the subject stream reach at the time the hydraulic survey was completed. At such time as supplemental hydraulic data are collected on Trout Creek, a biological survey, to include a fish sample and an aquatic invertebrate sample, are required be completed concurrently with the supplemental hydraulic survey, on the same reach of Trout Creek.

Opinion No. 5 – A determination of injury to decreed Water Rights was not provided as part of BLM's analysis, which is required under C.R.S. § 37-92-102(3)(c). Without a determination of injury to vested water rights, the application for a new junior water right is incomplete.

An assessment of physical water availability is required by the R2CROSS methodology[20], to assist in determining injury to vested water rights. The discussion of water availability provided in the BLM data package is inadequate. At a minimum, the assessment of water availability should include:

- A description of seasonal stream-discharge conditions in the subject reach of Trout Creek, derived from consideration of the historic record of gages in nearby streams in similar hydrologic regimes.
- A summary listing of existing vested water rights (both absolute and conditional) along the

full length of Trout Creek, from its headwaters through the subject stream reach, including water rights along tributaries to Trout Creek, and rights in Sheriff Reservoir. The summary listing should include priority dates for each water right, together with the timing and amount of water, points of diversion, beneficial use(s), and any restrictions placed on diversion or use.

- A call analysis of existing water rights along Trout Creek and its tributaries, and in Sheriff Reservoir.
- A firm-yield analysis of water availability along Trout Creek, from Sheriff Reservoir through the subject reach of Trout Creek.

CLOSING

Professional judgments and conclusions used to support the opinions in this Engineering Report are based on a review and analysis of the data provided for review.
Should additional information become available, we reserve the right to make modifications accordingly.

Sincerely,
QUANTUM WATER & ENVIRONMENT

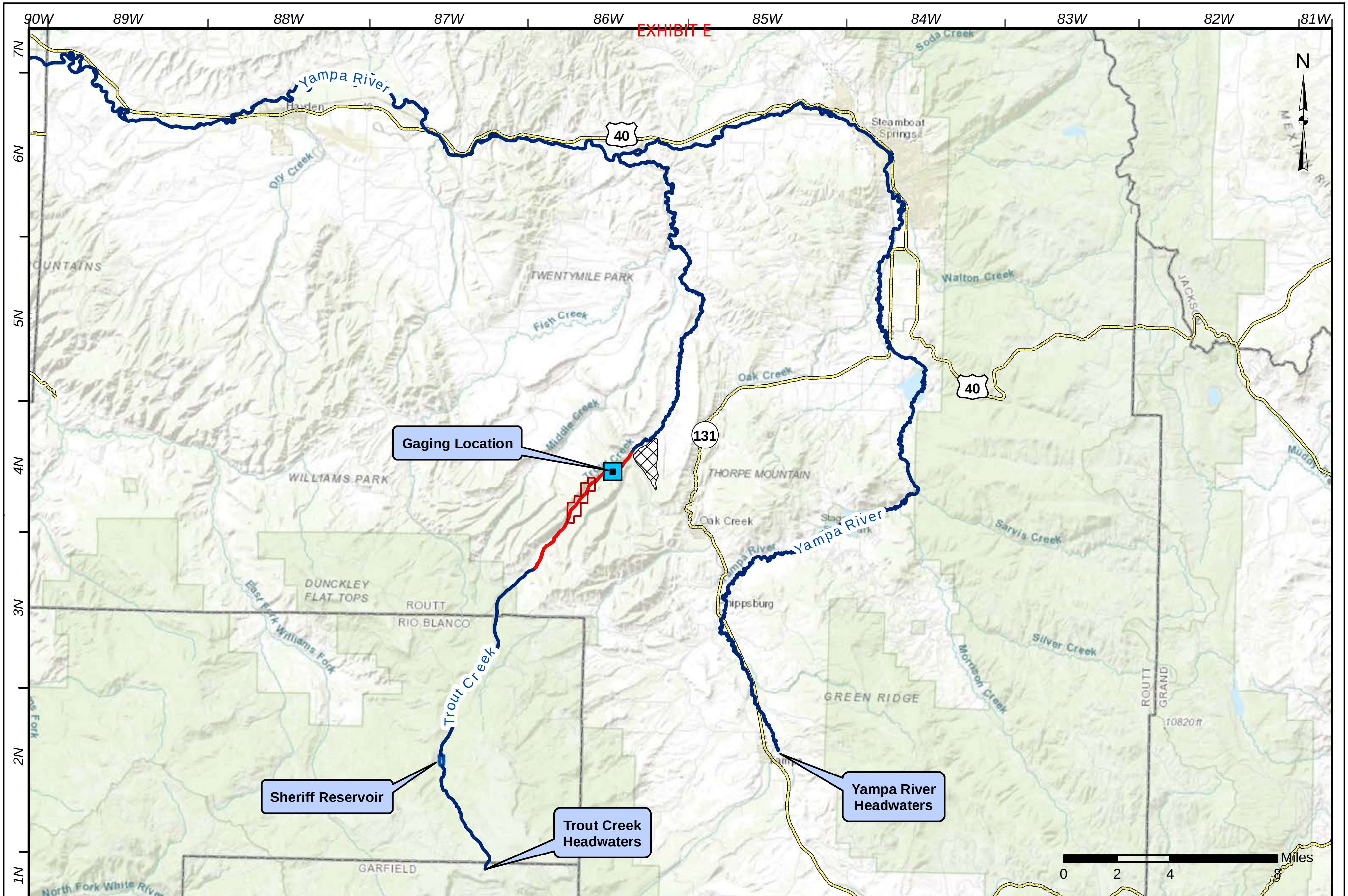
Theresa Jehn-Dellaport. P.G.
President

Rochelle Ann Hoover, P.E.
Senior Engineer

John Anthony, R.G., C.E.G., C.P.H.
Senior Consultant

Attachments: Figure 1 – Regional Setting of Trout Creek Basin
Figure 2 – Transect Locations Along Trout Creek

EXHIBIT E



Regional Setting of Trout Creek Basin

Routt County, Colorado

LEGEND

- Trout Creek - BLM Reach
- Trout Creek
- Approximate Extent of Former Edna Mine (Reclaimed)
- Knott Property Boundary

Figure 1

Sources: NHD
Colorado DOT
ESRI World Topography

Note: Not a survey map

Job Number: 285-19
Prepared By: CVW
Checked By: TJD
Date: August 19, 2019

Projection: UTM Zone 13N
Datum: NAD 1983

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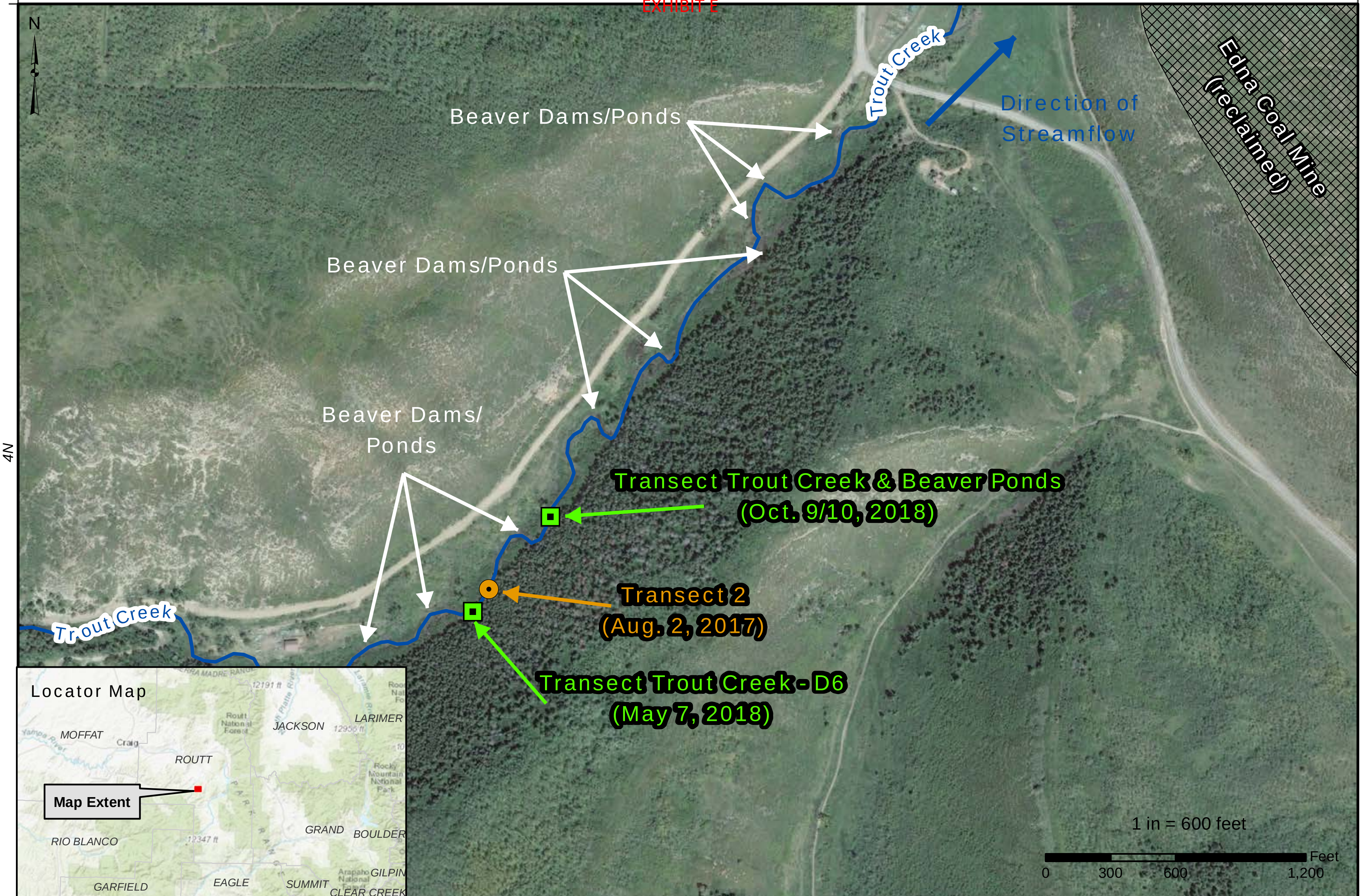
EXHIBIT E



Transect Locations Along Trout Creek

Routt County, Colorado

Figure 2

Sources:
Google Earth Imagery (061814)
ESRI World Topography

Note: Not a survey map

Job Number: 285-19
Prepared By: CVW
Checked By: JWA
Date: August 13, 2019

Projection: UTM Zone 13N
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EXHIBIT F

Pub 64

Development of Instream Flow Recommendations In Colorado Using

R2CROSS

Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman Street, Room 721
Denver, Colorado 80203

Water Rights Investigations Section

January 1996

EXHIBIT F

Development of Instream Flow Recommendations In Colorado Using

R2CROSS

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Water Rights Investigations Section

January 1996

EXHIBIT F

Abstract

In 1973, the Colorado State Legislature vested the Colorado Water Conservation Board with the authority to appropriate instream flow water rights in the State of Colorado. Today, the Board holds 1,326 instream flow water rights covering approximately 7,982 miles of Colorado streams. Standardized field and office procedures help to ensure that instream flow recommendations reflect the amount of water required to "preserve the natural environment to a reasonable degree", as prescribed by state statute. R2CROSS is one of the standard techniques employed by state and federal agencies to model instream hydraulic parameters. R2CROSS was chosen because it is time and labor efficient and produces comparable results to more costly techniques, i.e., the Instream Flow Incremental Methodology. This manuscript provides an overview of Colorado's Instream Flow Program and documentation for the Board's R2CROSS Lotus macro. The R2CROSS macro runs efficiently on an IBM-compatible 80486 personal computer equipped with a hard disk drive, and DOS 6.O, Windows 3.1, and Lotus 1-2-3 Release 4 for Windows software.

EXHIBIT F

Acknowledgments

The Colorado Water Conservation Board would like to thank everyone involved in the development of the Board's R2CROSS Lotus macro. In addition, the author wishes to acknowledge the persons involved in the review and testing of the R2CROSS macro including R. Barry Nehring and Jay Skinner of the Colorado Division of Wildlife, Dr. Eric P. Bergersen, Dr. Kurt Fausch, and Charles Gowan of Colorado State University, Dennis Murphy of the Bureau of Land Management, Dave Gerhardt of the United States Forest Service, Dan Merriman, Anne Janicki, and Margaret Langdon of the Colorado Water Conservation Board, and Steven O. Sims of the State Attorney General's Office. The Board is very grateful to all of those who participated in the development of the R2CROSS macro and this document.

Disclaimer

The R2CROSS macro is in the public domain, and the recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Colorado State Government-produced program. R2CROSS is provided "as-is" without warranty of any kind, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The user assumes all responsibility for the accuracy and suitability of this program for a specific application. In no event will the Colorado Water Conservation Board or the Colorado Division of Wildlife be liable for any damages, including lost profits, lost savings, or other incidental or consequential damages arising from the use of or the inability to use this program.

The CWCB staff verified the calculations preformed in its R2CROSS program with hand-held calculators and by comparison with other Manning's equation-based hydraulic streamflow models. Based upon this verification process, the staff believes that the instream hydraulic parameters summarized in the R2CROSS staging table are accurate calculations of Manning's equation. However, the CWCB does not suggest that the predicted hydraulic parameters will necessarily be realized at any particular stream discharge.

On November 10, 1993, the Colorado Water Conservation Board adopted Rules and Regulations that codified the procedures the Board follows in appropriating instream flow water rights. This document is intended to conform to the procedures presented in the Rules and Regulations.

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Introduction

Colorado's Instream Flow Program originated in 1973 with the passage of Senate Bill 97 (SB 97). Under SB 97, the Colorado Water Conservation Board (CWCB) was vested with the authority to appropriate instream flow water rights in the State of Colorado (§ 37-92-102(3), C.R.S. (1990)). Instream flow water rights are held by the CWCB on behalf of the people of the State of Colorado to "preserve the natural environment to a reasonable degree." Today, the CWCB holds 1,326 instream flow water rights covering approximately 7,982 miles of Colorado streams.

Determining the quantity of water required to preserve the natural environment to a reasonable degree can be a difficult task. The CWCB, in cooperation with the Colorado Division of Wildlife (DOW), has developed standard field and office procedures to ensure that each instream flow appropriation is necessary and reasonable and that the amount of water recommended is available for appropriation.

The R2CROSS methodology described in this document is a valuable tool in developing these instream flow recommendations. The CWCB uses R2CROSS because it is time and labor efficient and produces results which are comparable to more data intensive techniques (Nehring 1979).

This manuscript is divided into two sections. The first section describes Colorado's Instream Flow Program, including some of the statutory guidelines that have shaped the program. It also describes the standard field techniques and office procedures that are used by the CWCB staff in the development of R2CROSS-based instream flow recommendations. This section is intended to provide an understanding of the procedural and technical aspects of Colorado's Instream Flow Program.

The second section of the manuscript is a users' manual for the CWCB's R2CROSS macro. The CWCB has received many requests for its R2CROSS macro from both the public and private sectors but has been hesitant to release the program without proper documentation. The second section of the manuscript is intended to provide that documentation.

Colorado's Instream Flow Program

Instream Flow Legislation

The CWCB was created in 1937 to serve as the State's chief water planning agency (§ 37-60-101 through 123, C.R.S. (1990)). Today, the CWCB is responsible for the administration of the State's Instream Flow Program, protection of endangered aquatic species, identification of flood plains, funding of new water development and water conservation projects, and negotiation of inter- and intra-state water planning issues.

The CWCB is a fourteen-member board. The board consists of one Governor-appointee from each of the eight major river drainages in the State and one from the City and County of Denver. Each Governor-appointee must also be confirmed by the Colorado State Senate. Ex-officio members of the board include the

Executive Director of the Department of Natural Resources, the Directors of the CWCB and DOW, the State Attorney General, and the State Engineer. The diverse backgrounds of its board members provides the CWCB with an excellent representation of Colorado's various water interests.

Colorado's Instream Flow Program was created in 1973 when the Colorado State Legislature recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" through the passage of SB 97. Within SB 97, the definition of beneficial use was changed to include minimum stream flows and the CWCB was vested with the authority to appropriate "waters of natural streams and lakes ... as may be required ... to preserve the natural environment to a reasonable degree." SB 97 was amended by Senate Bill 414 in 1981, Senate Bill 91 in 1986, Senate Bill 212 in 1987, and Senate Bill 54 in 1994. These changes and amendments are consolidated within § 37-92-102(3), C.R.S. (1990), the Instream Flow statute.

The Instream Flow statute sets forth the guidelines for the administration of Colorado's Instream Flow Program. The statute vests the CWCB with the exclusive authority to appropriate and acquire instream flow and natural lake level water rights. In order to encourage other entities to participate in Colorado's Instream Flow Program, the statute directs the CWCB to request instream flow recommendations from other state and federal agencies prior to initiating an instream flow appropriation. The CWCB routinely requests instream flow recommendations from the DOW, Colorado Division of Parks and Outdoor Recreation, United States Department of Agriculture, and United States Department of Interior (the "cooperating agencies").

Prior to appropriating an instream flow water right, the statute requires the CWCB to: (1) "determine that the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made; (2) determine that there is a natural environment that can be preserved to a reasonable degree with the CWCB's water right, if granted; and (3) determine that such environment can exist without material injury to water rights" (§ 37-92-102(3c), C.R.S. (1990)). The CWCB makes these determinations based upon a review of the supporting technical data and a final instream flow recommendation prepared by the CWCB staff.

Standardized field and office procedures have been developed to help ensure that final instream flow recommendations meet statutory guidelines and are consistent. The standard field procedures that were established concern selection of transect sites and collection of hydraulic and biologic data. Standard office procedures have been established for determining biological instream flow recommendations using output from R2CROSS and for analyzing water availability.

Field Procedures

Instream flow recommendations are typically based on hydraulic and biologic data collected during a single field visit. Hydraulic data collection consists of setting up a transect, surveying stream channel geometry, and measuring stream discharge. Biologic data is gathered to document the existence of a natural environment. The biologic data usually consists of a fish sample, collected by electrofishing, and an aquatic invertebrate sample.

<u>Field Data Site Selection</u>

The R2CROSS method requires that stream discharge and channel profile data be collected in a riffle stream habitat-type. A riffle is a stream segment that is controlled by channel geometry rather than a downstream flow control. Riffles are most easily visualized as the stream reaches which would dry up most quickly should streamflow cease.

Biologically, riffles are essential to the production of benthic invertebrates and the passage, spawning, egg incubation, feeding, and protective cover of fish. Riffles are also the stream habitat-type most sensitive to changes in hydraulic parameters with variation in discharge (Nehring 1979). Riffles are critical to a healthy aquatic environment because small reductions in streamflow may result in large reductions in water depth and the amount of wetted perimeter available for aquatic habitat. Maintaining adequate streamflow in riffles also preserves the natural environment in other important stream habitat-types such as pools and runs (Nehring 1979).

Hydraulic engineers have developed several mathematical models and equations to predict instream hydraulic parameters (Chow 1959). Manning's equation is one such model that is well-suited to the riffle stream habitat-type (Grant et al. 1992). In order to maximize the reliability of Manning's equation, transects are placed within a riffle so that streamflow is uniform across the transect (Grant et al. 1992). The transect represents the average stream width, depth, and cross-sectional area within the riffle being characterized. Transects should be located in areas that exhibit natural banks or grasslines and concentrated water flow, free from braiding. They should not be located on eroded or undercut streambanks.

<u>Hydraulic Data Collection</u>

Stream discharge is measured using standardized procedures established by the United States Geological Survey (USGS) (Buchanan and Somers 1969). On streams less than 50 feet in width, channel geometry is typically measured using sag-tape methodology (Silvey 1976; Ray and Megahan 1979). Larger streams typically require the use of a land survey level and stadia rod (Benson and Dalrymple 1967). A list of required field equipment for making streamflow measurements is provided in Table 1.

The sag-tape methodology consists of suspending a steel tape from bank to bank across the stream channel, perpendicular to the streamflow (Figure A). Metal cross section stakes are driven into the ground above the grassline. The steel tape is suspended by attaching the zero-end of the tape to one of the metal stakes, stretching the tape across the stream, and then attaching the other end to a tape clamp and spring scale fastened to the metal stake on the opposite streambank. A minimum of 15 pounds of tension is applied to the tape, as the tape is drawn up and clamped. A survey level and stadia rod are used to adjust the ends of the tape up or down until they are level, thereby producing a consistent datum from which vertical distance measurements can be read.

The R2CROSS program uses the standard weight of a one-foot section of the steel tape, tape tension, and the length of tape in suspension to correct horizontal distance and vertical depth measurements made from the sagging tape. The program adjusts the coordinates at each cross section vertical so that the corrected measurements correspond to a level datum from stake to stake and not the curved datum created by the sagging tape (Figure A).

On larger streams, vertical measurements between the suspended tape and the stream channel may be replaced with readings using a survey level and stadia rod. The suspended tape is then used to measure only the horizontal location of each cell vertical. There is no need to precisely level the ends of the suspended tape or to record the tape tension as no sag corrections are required.

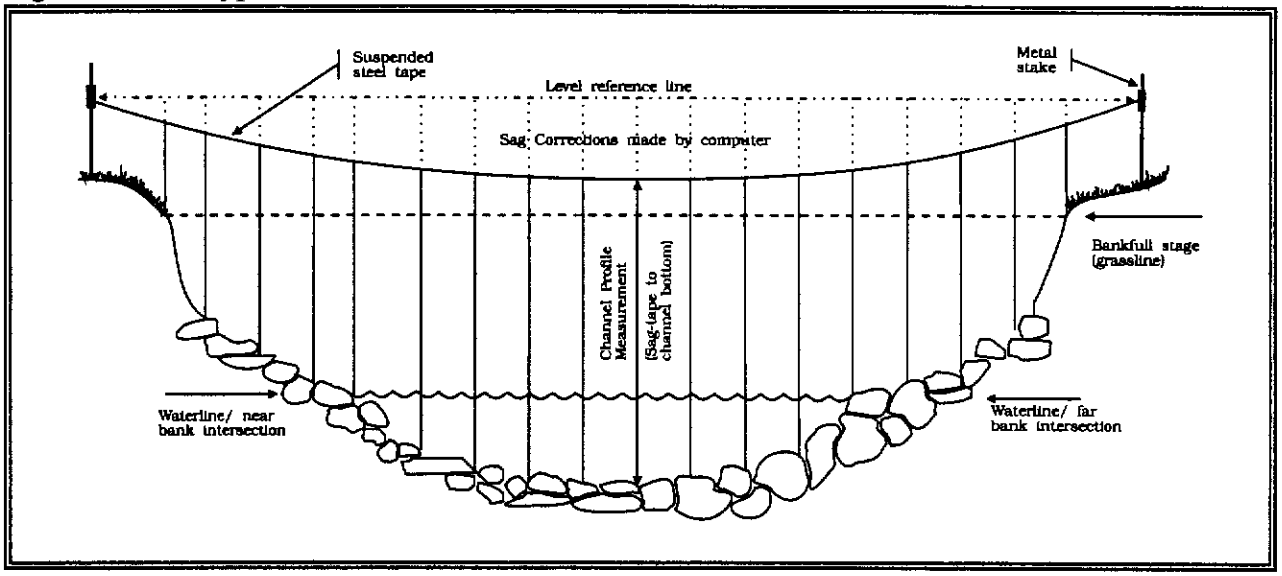
EXHIBIT F

Table 1. Field equipment list for making streamflow measurements

Equipment	Description
100' Steel Survey tape	Stretched between cross section stakes. (Obtain standard weight of a 1.0 foot section of tape from manufacturer)
Spring Tension Scale	Used to measure pounds of tension on steel tape when stretched between stakes.
Tape Clamp Handle	Holds tape in tension.
Cross Section Stakes	Two 24"-36" metal stakes used to maintain tape tension and to level steel tape. Must be strong enough to be driven into rocky stream bank.
Discharge Wading Rod (or Stadia Rod)	Used to measure vertical depths from suspended tape to stream channel.
Level, Tripod, and Stadia Rod	Used to level ends of suspended tape and to measure slope.
Current Meter	Pygmy, Price AA, Marsh-McBirney or similar devise used to measure stream velocity.
Hand Sledge Hammer	Used to drive cross section stakes into streambank.
Staging Pin	Used to detect changes in discharge during the streamflow measurement.
100' Fiberglass Tape	Used to measure horizontal distance from suspended tape to water-slope stadia rod readings.
Field Forms and Clipboard	Standardized form to ensure complete set of field data.
Miscellaneous Items	Camera, film, maps, waders, stopwatch and calculator.

EXHIBIT F

Figure A. Typical stream cross section



Biologic Data Collection

Biologic sampling is conducted to document the existence of a natural environment. Coldwater fish species, particularly salmonids, have been used to indicate the existence of such a natural environment in the majority of the CWCB's instream flow appropriations to date. Warmwater fish species and other aquatic life forms may be used to document the existence of a natural environment in more downstream, low-elevation stream segments. In addition to salmonids, the CWCB has used amphibians, such as frogs and salamanders, and warmwater fish species, including the endangered fishes of the Colorado River basin, as the biologic basis for instream flow appropriations.

Biologic data typically consists of a fish sample, collected by electrofishing, and an aquatic invertebrate sample. Captured fish are identified and measured and a length-frequency distribution is constructed for each species. The sample is not tied directly to the R2CROSS hydraulic modeling but it may be used to refine the biologic instream flow recommendation to meet the specific habitat requirements of unique populations.

The Field Form

The CWCB and DOW use a standardized field form to record all field data. The use of this form helps to ensure that all instream flow recommendations are based upon a uniform set of field data. The front page of the form provides space for cross section "Location Information", "Supplemental Data", "Channel Profile Data", an "Aquatic Sampling Summary", and "Comments" (Figure B). The back page is dedicated to "Discharge/Cross Section Notes" (Figure C).

The "Location Information" section of the field form is used to describe the location of the cross section as well as the date and names of the members of the field crew. Geographic information can be obtained from either USGS or United States Forest Service (USFS) maps. Water divisions and DOW water codes can be obtained from the State Engineers' Office, the CWCB, or the DOW.

The "Supplemental Data" section is used to provide supporting documentation of the field data collection effort. Most importantly, this section is used to record the tape manufacturer's standard weight (lbs/ft) and tape tension (lbs). The R2CROSS program uses this information, together with the length of tape in suspension, to adjust vertical distances measured from the sagging tape to a level reference datum.

The "Channel Profile Data" section of the form is used to establish the relationship between the sag-tape cross section and the stream. Stadia rod readings are taken at each end of the suspended tape and at the water surface on the right and left streambanks. These readings are recorded within the "Rod Reading (ft)" column. They are used to assure that the ends of the tape are level and to quantify the vertical distance between the suspended tape and the water surface. Water surface readings and horizontal distances are also recorded upstream and downstream of the suspended tape. These observations are used to establish the water surface slope for input into Manning's equation.

The right side of the "Channel Profile Data" section is used to graphically depict the relative locations of the suspended tape and survey level, the direction of streamflow, and any photographic documentation of the field data collection effort. Photographs of the suspended tape are taken looking up, down, and across the stream.

Biologic sampling is summarized in the "Aquatic Sampling Summary" portion of the field form. Biologic data typically consists of a fish sample, collected by electrofishing, and an aquatic invertebrate sample. Captured fish are identified by species and measured to the nearest inch. A species-specific length-frequency distribution is created by placing a hashmark in the appropriate cell of the table as each fish is measured. Aquatic invertebrate sampling is summarized within the space provided at the bottom of this section.

All other pertinent field data is recorded in the "Comments" section of the field form. This section is often used to record weather conditions, water turbidity, or species-specific biomass estimates. This additional information helps characterize the field data when it is being analyzed in the office.

The "Discharge/Cross Section Notes" portion of the field form is used to record all of the hydraulic measurements associated with the discharge measurement (Figure C). A heading is provided to record the stream name, cross section number, date, edge of water looking downstream, the staging pin reading, and time at the beginning of the stream discharge measurement. The table below the heading is used to record "Features", "Distance From Initial Point", "Width", "Total Vertical Depth From Tape/Inst(rument)", and "Water Depth" channel geometry parameters at each cell vertical. Stream velocity measurements are recorded under the columns labeled "Depth of Observation", "Revolutions", "Time", and "Velocity" for each wet cell. All discharge measurement procedures are as outlined by Buchanan and Somers (1969).

The first and last channel geometry measurements are always taken at the cross section stakes. Channel geometry measurements should also be taken at the grassline-streambank and streambank-waterline intersections and at all distinguishable slope breaks between these two intersection points. The horizontal locations of the grassline-streambank and streambank-waterline intersections are also documented by placing a "G" and a "W" in the appropriate row of the "Features" column of the field form. Grassline is identified at the normal high water line, not flood stage, and is generally located below sedges and other plants that may survive submerged under high flows. The "Features" column is also used to document the horizontal locations of the two cross section stakes ("S") and any rocks ("R") or other features that may have an impact on the discharge measurement.

In streams with uniform bottom profiles (i.e., sand, cobble, etc.), channel geometry and discharge measurements are taken at fixed intervals within the wetted portion of the channel. The interval is varied in streams with boulder substrates to more accurately reflect changes in the velocity distribution with changes in channel bottom profile. The stream discharge measurement is divided into a minimum of 20 to 30 discharge cells, depending upon wetted stream width, with a minimum cell width of 0.3 feet. Sufficient measurements are taken to ensure that no more than 10% of the total streamflow occurs within a single discharge cell. Horizontal and vertical distances are taken from the suspended tape and recorded to the nearest tenth of a foot. Stream velocity (ft/sec) within each cell is averaged and recorded.

The bottom of the "Discharge/Cross Section Notes" section is used to summarize the discharge measurement. Space is also provided to record the names of the persons responsible for the field data calculations, the staging pin reading, and time at the end of the stream discharge measurement.

EXHIBIT F

Figure B. Field data input sheet (Front Page)

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME:					CROSS-SECTION NO.:
CROSS-SECTION LOCATION					
DATE	OBSERVERS				
LEGAL DESCRIPTION	¼ SECTION:	SECTION	TOWNSHIP N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED	WATER DIVISION:	DOW WATER CODE:		
MAP(S)	USGS:				
	USFS:				

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE:			
METER NUMBER:	DATE RATED:	CALIB/SPIN _____ sec	TAPE WEIGHT _____ lbs/foot	TAPE TENSION _____ lbs
CHANNEL BED MATERIAL SIZE RANGE	PHOTOGRAPHS TAKEN YES/NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	
⊗ Tape @ Stake RB	0.0	
① WS @ Tape LB/RB	0.0	
② WS Upstream		
③ WS Downstream		
SLOPE		

SKETCH

TAPE

LEGEND: Stake ⊗ Station ① Photo

Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED YES/NO	DISTANCE ELECTROFISHED _____ ft	FISH CAUGHT YES/NO	WATER CHEMISTRY SAMPLED YES/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME

COMMENTS

FORM #ISF FD 1-85

EXHIBIT F

Figure C. Field data input sheet (Back Page)

DISCHARGE/CROSS SECTION NOTES

STREAM NAME	CROSS-SECTION NO	DATE	SHEET ___ OF ___
BEGINNING OF MEASUREMENT — EDGE OF WATER LOOKING DOWNSTREAM (0.0 AT STAKE) LEFT / RIGHT	Gage Reading ______ ft	TIME	

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft²)	Discharge (cfs)
TOTALS											

End of Measurement	Time:	Gage Reading ______ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

Office Procedures

The CWCB uses a Lotus 1-2-3 macro, called R2CROSS, to process the field data and model instream hydraulic parameters at streamflows above and below the field-measured discharge. The CWCB relies upon the biologic expertise of the cooperating agencies to interpret the output from R2CROSS and develop an initial, biologic instream flow recommendation. This initial recommendation is designed to address the unique biologic requirements of each stream without regard to water availability. After receiving the cooperating agencies' biologic recommendation, the CWCB staff evaluates stream hydrology to determine whether water is physically available for an instream flow appropriation.

Background on the R2CROSS Methodology

Three instream hydraulic parameters, average depth ($\bar{x}_d$), average velocity ($\bar{x}_v$), and percent wetted perimeter (*%WP*), are used to develop biologic instream flow recommendations in Colorado. The DOW has determined that by maintaining these three hydraulic parameters at adequate levels across riffle habitat-types, aquatic habitat in pools and runs will also be maintained for most life stages of fish and aquatic invertebrates (Nehring 1979).

The R2CROSS methodology uses Manning's equation to predict $\bar{x}_d$, $\bar{x}_v$, *%WP*, and other instream hydraulic parameters, at discharges both above and below the field-measured stream discharge. The methodology is both time and labor efficient, requires data from only a single stream transect, and has been found to produce similar results to more data intensive techniques (Nehring 1979) such as the Instream Flow Incremental Methodology (IFIM) developed by the U.S. Fish and Wildlife Service (Bovee 1982).

In 1973, the CWCB staff performed all Manning's equation calculations with a hand-held calculator. In 1981, the USFS released "*Program Documentation for R2-CROSS-81*" (Weatherred et al. 1981). This Fortran-based, mainframe computer program automated the repetitive task of manipulating and recalculating Manning's equation by hand. The CWCB used the USFS version of R2CROSS on the Colorado State University mainframe computer until 1985.

In 1986, the CWCB staff began development of a personal computer version of R2CROSS using the macro capabilities of Lotus 1-2-3. The CWCB found the R2CROSS macro to be advantageous because it ran on a personal computer and it could be customized to the specific needs of the CWCB. The most recent version of R2CROSS is menu-driven (Figure D) and requires very little experience with Lotus 1-2-3. The macro formats the R2CROSS worksheet, initiates data entry, and performs all calculations and printing automatically.

Figures E through K provide an example of R2CROSS output from a typical Colorado stream. Figure E is a "Proof Sheet" that is printed and inspected for data entry errors prior to performing final R2CROSS calculations. Final output consists of a five page printout (Figures F through J). Page one summarizes most of the stream location information, supplemental data, and channel profile data from the field form (Figure F). Page two summarizes the channel geometry/discharge field data set and values computed from the raw field data, including an estimate of Manning's "n" (Figure G). Page three consists of a water line comparison table which the program uses to interpolate the single water surface elevation that results in a calculated cross-sectional area equal to the field-measured cross-sectional area (Figure H). Page four is the staging table that is used by the cooperating agency to develop an initial, biologic instream flow recommendation

(Figure I). The staging table provides estimates of modeled instream hydraulic parameters at stages above and below the measured discharge. Page five summarizes measured and calculated flows, waterlines, and depths (Figure J). It also presents estimates of mean velocity, Manning's "n", water slope, and upper and lower streamflow limits within which the instream flow recommendation should fall. In general, hydraulic models based upon Manning's equation are most accurate when predicted flows fall within a range of 0.4 to 2.5 times measured flow (Bovee and Milhous 1978; Bovee 1982). Space is also provided for a narrative describing the basis for the initial instream flow recommendation and for the signatures of the personnel involved in making the recommendation. The macro can also be used to generate a plot of the stream cross section (Figure K).

Figure D. The R2CROSS Menu

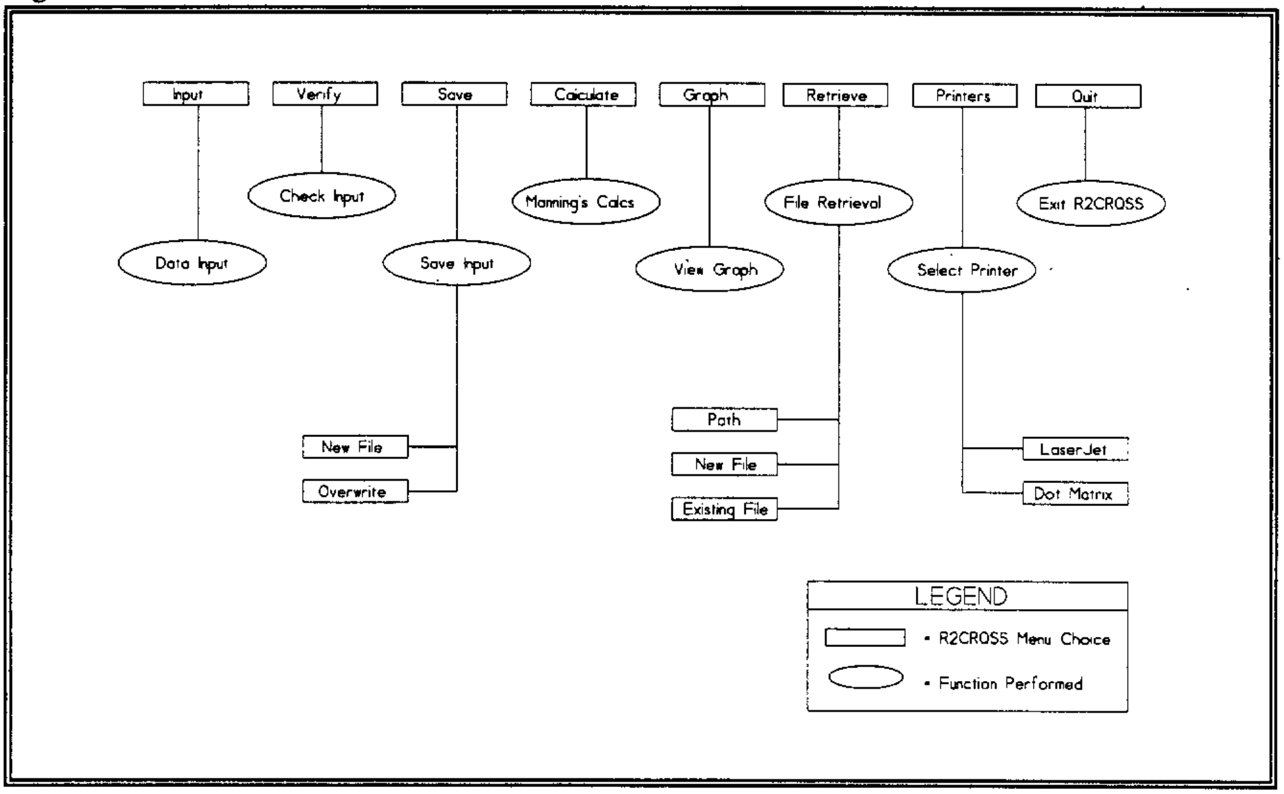


EXHIBIT F

Figure E. R2CROSS proof sheet

PROOF SHEET
===========

LOCATION INFORMATION
====================

STREAM NAME: IRON CREEK
XS LOCATION: 100 YDS U/S DWB DIVERSION
XS NUMBER: 1

DATE: 10/17/86
OBSERVERS: SEAHOLM, PUTTMAN

1/4 SEC:
SECTION: 20
TWP: 2S
RANGE: 76W
PM: 6TH

COUNTY: GRAND
WATERSHED: FRASER
DIVISION: 5
DOW CODE: 25482

USGS MAP: BYERS PEAK
USFS MAP: ARAPAHOE

SUPPLEMENTAL DATA
=================

TAPE WT: 0.0106
TENSION: 28

CHANNEL PROFILE DATA
====================

SLOPE: 0.0055

INPUT DATA # DATA POINTS= 34

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	A	Q	TAPE TO WATER
	S	0.00	1.10	0.00	0.00	0.00	0.00	0.00
		0.50	1.30	0.00	0.00	0.00	0.00	0.00
1	G	1.00	1.40	0.00	0.00	0.00	0.00	0.00
		2.00	1.80	0.00	0.00	0.00	0.00	0.00
		2.50	1.95	0.00	0.00	0.00	0.00	0.00
		3.00	2.00	0.00	0.00	0.00	0.00	0.00
	R	3.50	1.90	0.00	0.00	0.00	0.00	0.00
		4.00	2.45	0.00	0.00	0.00	0.00	0.00
		4.50	2.45	0.00	0.00	0.00	0.00	0.00
	W	5.00	2.60	0.00	0.00	0.00	0.00	0.00
		5.70	3.00	0.40	0.80	0.20	0.16	2.61
		6.00	3.10	0.45	0.45	0.13	0.06	2.66
		6.30	3.00	0.40	1.10	0.12	0.13	2.61
		6.60	3.00	0.40	0.95	0.12	0.11	2.61
		6.90	2.95	0.35	0.95	0.11	0.10	2.61
		7.20	2.85	0.25	0.70	0.07	0.05	2.61
		7.50	3.10	0.50	0.75	0.15	0.11	2.61
		7.80	3.10	0.50	0.65	0.15	0.10	2.61
		8.10	3.10	0.50	0.85	0.15	0.13	2.61
		8.40	3.20	0.60	0.95	0.18	0.17	2.61
		8.70	3.20	0.60	1.10	0.18	0.20	2.61
		9.00	3.20	0.60	1.35	0.18	0.24	2.61
		9.30	3.15	0.55	1.40	0.16	0.23	2.61
		9.60	3.25	0.65	1.50	0.19	0.29	2.61
		9.90	3.30	0.70	1.55	0.21	0.33	2.61
		10.20	3.30	0.70	1.60	0.21	0.34	2.61
		10.50	3.30	0.70	1.25	0.12	0.15	2.61
	W	10.55	2.60	0.00	0.00	0.00	0.00	0.00
1	G	11.00	1.30	0.00	0.00	0.00	0.00	0.00
		11.50	0.85	0.00	0.00	0.00	0.00	0.00
		12.00	0.60	0.00	0.00	0.00	0.00	0.00
		12.50	0.55	0.00	0.00	0.00	0.00	0.00
		13.00	0.55	0.00	0.00	0.00	0.00	0.00
	S	13.50	0.50	0.00	0.00	0.00	0.00	0.00
					TOTALS	2.65	2.91	

EXHIBIT F

Figure F. Final output from R2CROSS (Page 1)

```
*******************************************************
*          COLORADO WATER CONSERVATION BOARD          *
*      INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM     *
*       STREAM CROSS-SECTION AND FLOW ANALYSIS        *
*******************************************************

LOCATION INFORMATION
====================

STREAM NAME:   IRON CREEK
XS LOCATION:   100 YDS U/S DWB DIVERSION
XS NUMBER:     1

DATE:          10/17/86
OBSERVERS:     SEAHOLM, PUTTMAN

1/4 SEC:
SECTION:       20
TWP:           2S
RANGE:         76W
PM:            6TH

COUNTY:        GRAND
WATERSHED:     FRASER
DIVISION:      5
DOW CODE:      25482

USGS MAP:      BYERS PEAK
USFS MAP:      ARAPAHOE

SUPPLEMENTAL DATA             *** NOTE ***
=================        Leave TAPE WT and TENSION
                       at defaults for data collected
TAPE WT:       0.0106   with a survey level and rod
TENSION:           28

CHANNEL PROFILE DATA
====================
SLOPE:         0.0055



INPUT DATA CHECKED BY: .....................................DATE...................

ASSIGNED TO: ...............................................DATE...................
```

EXHIBIT F

Figure G. Final output from R2CROSS (Page 2)

STREAM NAME: IRON CREEK
XS LOCATION: 100 YDS U/S DWB DIVERSION
XS NUMBER: 1

INPUT DATA # DATA POINTS= 34 | VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
S	0.00	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	0.50	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
1 G	1.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	2.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	2.50	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
R	3.50	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	4.00	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	4.50	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
W	5.00	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	5.70	3.00	0.40	0.80	0.81	0.40	0.20	0.16	5.5%
	6.00	3.10	0.45	0.45	0.32	0.45	0.13	0.06	2.1%
	6.30	3.00	0.40	1.10	0.32	0.40	0.12	0.13	4.5%
	6.60	3.00	0.40	0.95	0.30	0.40	0.12	0.11	3.9%
	6.90	2.95	0.35	0.95	0.30	0.35	0.11	0.10	3.4%
	7.20	2.85	0.25	0.70	0.32	0.25	0.07	0.05	1.8%
	7.50	3.10	0.50	0.75	0.39	0.50	0.15	0.11	3.9%
	7.80	3.10	0.50	0.65	0.30	0.50	0.15	0.10	3.4%
	8.10	3.10	0.50	0.85	0.30	0.50	0.15	0.13	4.4%
	8.40	3.20	0.60	0.95	0.32	0.60	0.18	0.17	5.9%
	8.70	3.20	0.60	1.10	0.30	0.60	0.18	0.20	6.8%
	9.00	3.20	0.60	1.35	0.30	0.60	0.18	0.24	8.4%
	9.30	3.15	0.55	1.40	0.30	0.55	0.16	0.23	7.9%
	9.60	3.25	0.65	1.50	0.32	0.65	0.19	0.29	10.1%
	9.90	3.30	0.70	1.55	0.30	0.70	0.21	0.33	11.2%
	10.20	3.30	0.70	1.60	0.30	0.70	0.21	0.34	11.6%
	10.50	3.30	0.70	1.25	0.30	0.70	0.12	0.15	5.3%
W	10.55	2.60	0.00	0.00	0.70	0.00	0.00	0.00	0.0%
1 G	11.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	11.50	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	12.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	12.50	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
	13.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
S	13.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
TOTALS	----------				6.49	0.7 (Max.)	2.65	2.91	100.0%

Manning's n = 0.0552

EXHIBIT F

Figure H. Final output from R2CROSS (Page 3)

STREAM NAME: IRON CREEK
XS LOCATION: 100 YDS U/S DWB DIVERSION
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
2.36	2.65	4.21	59.0%
2.38	2.65	4.07	53.9%
2.40	2.65	3.94	48.8%
2.42	2.65	3.81	43.8%
2.44	2.65	3.67	38.8%
2.46	2.65	3.54	33.8%
2.48	2.65	3.42	29.2%
2.50	2.65	3.30	24.7%
2.52	2.65	3.18	20.2%
2.54	2.65	3.07	15.8%
2.56	2.65	2.95	11.4%
2.57	2.65	2.89	9.3%
2.58	2.65	2.84	7.1%
2.59	2.65	2.78	5.0%
2.60	2.65	2.72	2.9%
2.61	2.65	2.67	0.8%
2.62	2.65	2.61	-1.3%
2.63	2.65	2.56	-3.4%
2.64	2.65	2.50	-5.5%
2.65	2.65	2.45	-7.6%
2.66	2.65	2.39	-9.6%
2.68	2.65	2.28	-13.7%
2.70	2.65	2.18	-17.8%
2.72	2.65	2.07	-21.9%
2.74	2.65	1.96	-25.9%
2.76	2.65	1.86	-29.9%
2.78	2.65	1.75	-33.9%
2.80	2.65	1.65	-37.8%
2.82	2.65	1.54	-41.8%
2.84	2.65	1.44	-45.6%
2.86	2.65	1.34	-49.5%

WATERLINE AT ZERO
AREA ERROR = 2.611

EXHIBIT F

Figure I. Final output from R2CROSS (Page 4)

```
STREAM NAME:        IRON CREEK
XS LOCATION:        100 YDS U/S DWB DIVERSION
XS NUMBER:          1

                    *GL* = lowest Grassline elevation corrected for sag
STAGING TABLE       *WL* = Waterline corrected for variations in field measured water surface elevations and sag
```

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PER (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	1.40	**<u>9.97</u>**	1.21	1.90	12.09	12.14	100.0%	1.00	24.07	1.99
	1.61	9.38	1.07	1.70	10.08	11.37	93.6%	0.89	18.57	1.84
	1.66	9.23	1.04	1.65	9.61	11.18	92.0%	0.86	17.36	1.81
	1.71	9.09	1.01	1.60	9.15	10.99	90.5%	0.83	16.18	1.77
	1.76	8.95	0.97	1.55	8.70	10.80	89.0%	0.81	15.04	1.73
	1.81	8.80	0.94	1.50	8.26	10.61	87.4%	0.78	13.95	1.69
	1.86	8.62	0.91	1.45	7.82	10.39	85.5%	0.75	12.93	1.65
	1.91	8.41	0.88	1.40	7.40	10.13	83.5%	0.73	11.97	1.62
	1.96	7.90	0.88	1.35	6.99	9.55	78.6%	0.73	11.33	1.62
	2.01	7.16	0.92	1.30	6.61	8.75	72.0%	0.76	10.96	1.66
	2.06	7.10	0.88	1.25	6.26	8.63	71.0%	0.73	10.08	1.61
	2.11	7.04	0.84	1.20	5.90	8.51	70.0%	0.69	9.24	1.57
	2.16	6.97	0.80	1.15	5.55	8.39	69.1%	0.66	8.42	1.52
	2.21	6.91	0.75	1.10	5.21	8.27	68 1%	0.63	7.64	1.47
	2.26	6.85	0.71	1.05	4.86	8.15	67.1%	0.60	6.88	1.42
	2.31	6.79	0.67	1.00	4.52	8.02	66.1%	0.56	6.16	1.36
	2.36	6.72	0.62	0.95	4.18	7.90	65.1%	0.53	5.47	1.31
	2.41	6.66	0.58	0.90	3.85	7.78	64.1%	0.49	4.81	1.25
	2.46	6.09	0.58	0.85	3.52	7.16	58.9%	0.49	4.38	1.24
	2.51	5.91	0.55	0.80	3.22	6.93	57.1%	0.46	3.86	1.20
	2.56	5.72	0.51	0.75	2.93	6.70	55.2%	0.44	3.37	1.15
WL	2.61	5.55	0.48	0.70	2.65	6.48	53.4%	0.41	2.91	1.10
	2.66	5.45	0.43	0.65	2.37	6.33	52.1%	0.37	**<u>2.46</u>**	**<u>1.04</u>**
	2.71	5.36	0.39	0.60	2.10	6.18	**<u>50.9%</u>**	0.34	**<u>2.04</u>**	**<u>0.97</u>**
	2.76	5.27	0.35	0.55	1.84	6.03	**<u>49.7%</u>**	0.30	**<u>1.66</u>**	0.90
	2.81	5.18	0.30	0.50	1.57	5.88	48.4%	0.27	1.31	0.83
	2.86	5.08	0.26	0.45	1.32	5.72	47.1%	0.23	0.99	0.75
	2.91	4.78	**<u>0.22</u>**	0.40	1.07	5.33	43.9%	0.20	**<u>0.73</u>**	0.68
	2.96	4.47	**<u>0.19</u>**	0.35	0.84	4.94	40.7%	0.17	**<u>0.51</u>**	0.61
	3.01	3.73	0.17	0.30	0.63	4.11	33.8%	0.15	0.36	0.57
	3.06	3.36	0.13	0.25	0.45	3.66	30.2%	0.12	0.22	0.49
	3.11	2.41	0.12	0.20	0.29	2.63	21.6%	0.11	0.14	0.46
	3.16	2.22	0.08	0.15	0.18	2.39	19.7%	0.07	0.06	0.35
	3.21	1.05	0.08	0.10	0.08	1.15	9.4%	0.07	0.03	0.34
	3.26	0.88	0.04	0.05	0.03	0.93	7.6%	0.04	0.01	0.22

** NOTE**: Bold and underlined text within the Iron Creek staging table was added to facilitate explanation of the procedure for developing biologic instream flow recommendations (see Pages 18-19). Standard R2CROSS staging table printouts will not contain these enhancements.

EXHIBIT F

Figure J. Final output from R2CROSS (Page 5)

STREAM NAME: IRON CREEK
XS LOCATION: 100 YDS U/S DWB DIVERSION
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.91 cfs	RECOMMENDED INSTREAM FLOW:	
CALCULATED FLOW (Qc)=	2.91 cfs	==========================	
(Qm-Qc)/Qm * 100 =	-0.1 %		
		FLOW (CFS)	PERIOD
MEASURED WATERLINE (WLm)=	2.61 ft	==========	======
CALCULATED WATERLINE (WLc)=	2.61 ft		
(WLm-WLc)/WLm * 100 =	-0.1 %	________	________
MAX MEASURED DEPTH (Dm)=	0.70 ft	________	________
MAX CALCULATED DEPTH (Dc)=	0.70 ft		
(Dm-Dc)/Dm * 100	0.6 %	________	________
MEAN VELOCITY=	1.10 ft/sec	________	________
MANNING'S n=	0.055		
SLOPE=	0.0055 ft/ft		
.4 * Qm =	1.2 cfs		
2.5 * Qm=	7.3 cfs		

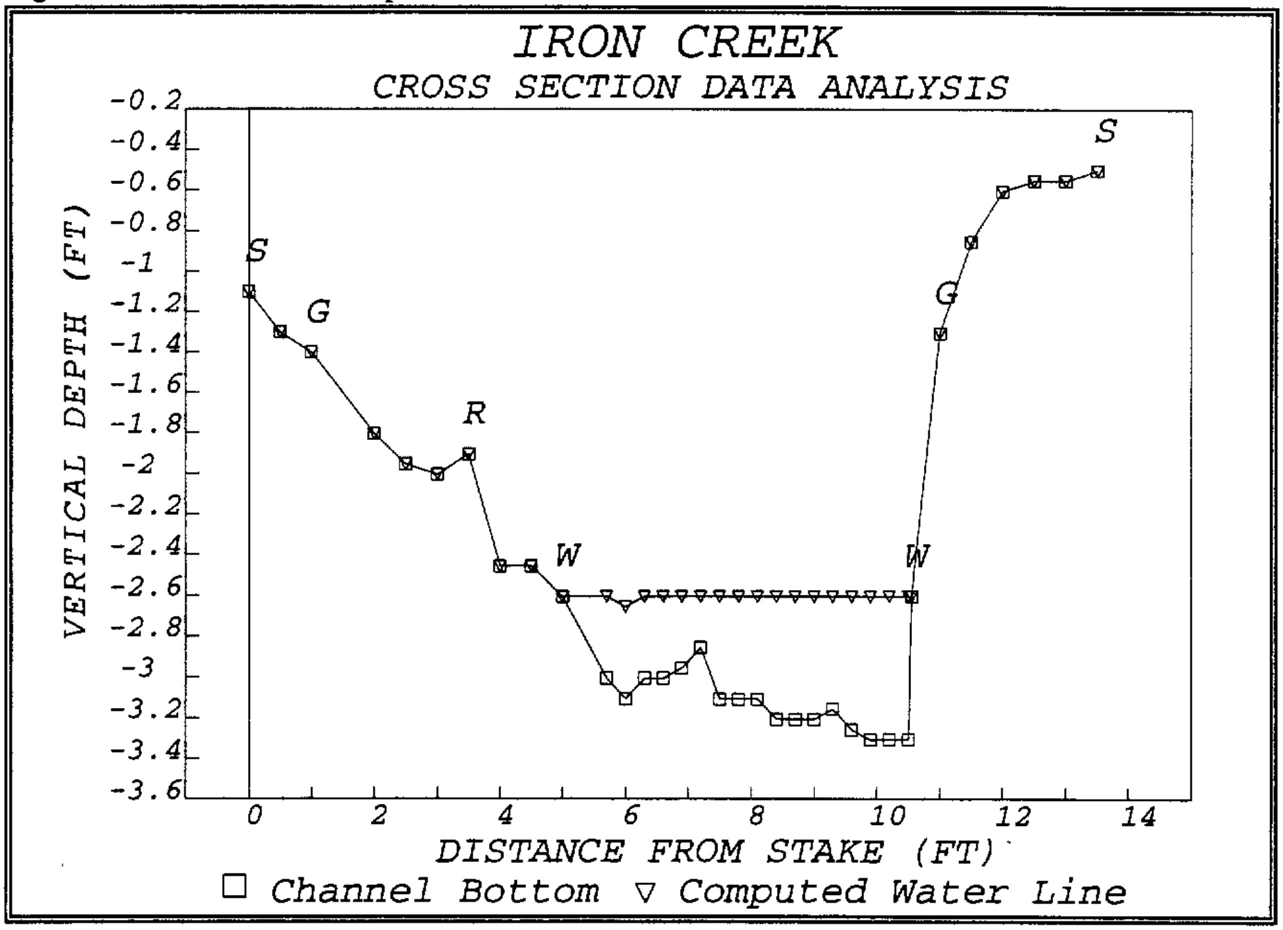
RATIONALE FOR RECOMMENDATION:
=============================

RECOMMENDATION BY: .... AGENCY................ DATE:................

CWCB REVIEW BY: .... DATE:................

EXHIBIT F

Figure K. Cross section plot from R2CROSS



<u>Biologic Instream Flow Recommendations</u>

When using R2CROSS, biologic instream flow recommendations are based on maintaining three principal hydraulic criteria, $\bar{x}_d$, $\bar{x}_v$, and *%WP*, at adequate levels across the stream transect (Table 2). The $\bar{x}_d$ and *%WP* criteria are functions of stream top width and grassline-to-grassline wetted perimeter, respectively. A constant $\bar{x}_v$ of 1 ft/sec is recommended for all streams. The DOW has determined that these three parameters are good indices of flow-related stream habitat quality and that maintenance of these parameters at adequate levels across riffle habitat-types will also result in maintenance of adequate aquatic habitat in pools and runs for most life stages of fish and aquatic invertebrates (Nehring 1979).

The three critical hydraulic parameters are estimated within the R2CROSS staging table at various levels of discharge (Figure I). Biologic instream flow recommendations are developed by locating the modeled streamflow(s) in the R2CROSS staging table that satisfy the three hydraulic criteria summarized in Table 2. The streamflow that meets two of the three criteria is considered as an initial winter flow recommendation. Initial summer flow recommendations are based upon satisfying all three criteria (Skinner, pers. comm). Aquatic biologists may modify summer and winter flow recommendations

Table 2. Criteria used to determine minimum flow requirements using the R2CROSS single transect method (Nehring 1979)

Stream Top Width (ft)[1]	Average Depth (ft)	Percent Wetted Perimeter (%)[1]	Average Velocity (ft/sec)
1-20	0.2	50	1.0
21-40	0.2-0.4	50	1.0
41-60	0.4-0.6	50-60	1.0
61-100	0.6-1.0	$\geq$ 70	1.0

[1] At bankfull discharge.

based upon biologic considerations such as stream conditions, species composition, and aquatic habitat quality.

These hydraulic criteria can be applied to the R2CROSS staging table from the Iron Creek example (Figure I) to develop an initial biologic instream flow recommendation. In this example, the grassline top width of Iron Creek is 9.97 ft. Therefore, the DOW criteria for an $\bar{x}_d$ of 0.2 feet would be satisfied at a flow of approximately 0.6 cfs. The *%WP* criterion of 50% would be met at a flow of around 1.75 cfs and an $\bar{x}_v$ of 1 ft/sec at a flow of 2.25 cfs. Based upon this analysis, a winter flow recommendation of 1.75 cfs would meet the $\bar{x}_d$ and *%WP* criteria and a summer flow recommendation of 2.25 cfs would satisfy all three criteria. These initial recommendations may be adjusted up or down based upon biologic judgment and expertise.

Water Availability Requirements

Once an initial biologic instream flow recommendation has been developed, the CWCB staff must determine whether water is physically available to satisfy the biologic recommendation. The staff uses stream gaging records to analyze physical water availability whenever possible. In the absence of a gage record, the staff may use standardized hydrologic techniques, such as areal apportionment or synthetic streamflow modeling (Kircher et al. 1985), to estimate physical water availability. The staff may also conduct a review of the State Engineer's water rights tabulation and consult with Division Engineers and District Water Commissioners to determine the effect of senior diversions on a stream reach.

The water availability analyses may lead the CWCB staff to conclude that sufficient water is not available to meet the biologic recommendation. In that situation, the CWCB staff may request that the cooperating agency reconsider its biologic recommendation and determine whether the natural environment can be preserved with the amount of water available. If the natural environment can be preserved with the available water, the instream flow recommendation may be revised to reflect the lower available flow amounts. If the statutory water availability requirement cannot be satisfied, the CWCB must reject the instream flow recommendation.

Appropriating and Protecting an Instream Flow Water Right

On November 10, 1993, the CWCB adopted the "Statement of Basis and Purpose and Rules and Regulations Concerning the Colorado Instream Flow and Natural Lake Level Program." These Rules and Regulations codified existing CWCB procedures for implementing the Instream Flow Program and established procedures for handling acquisition of water, water rights, and interests in water including conditional rights, modification of instream flows, and inundation of instream flow water rights. The CWCB's procedural requirements for appropriating and protecting instream flow water rights are also described in great detail within these Rules and Regulations.

The procedural aspects of appropriating and protecting an instream flow water right are beyond the intended scope of this manuscript. Individuals who are interested in learning more about these procedures are encouraged to obtain a copy of the above-referenced Rules and Regulations from the CWCB.

Summary

In 1973, the Colorado State Legislature vested the CWCB with the authority to appropriate instream flow water rights to preserve the natural environment to a reasonable degree. Since that time, the CWCB has completed instream flow appropriations on approximately 7,982 miles of Colorado streams, and the Instream Flow Program is expanding.

The CWCB has adopted standardized field and office procedures for developing instream flow recommendations. This standardization helps to ensure that each instream flow recommendation is "necessary" and "reasonable", as required by state statute.

R2CROSS is one of the standard methodologies employed by the CWCB to model instream hydraulic parameters. The CWCB has chosen to use the R2CROSS methodology because it is both time and labor efficient, requiring data from only a single stream transect. It has also been found to produce similar results to more data intensive techniques like the IFIM. The R2CROSS macro is also easy to use and requires very little in the way of computer hardware or software.

Biologic instream flow recommendations based upon output from R2CROSS are designed to maintain $\bar{x}_v$, $\bar{x}_d$, and *%WP* at critical levels across riffle habitat-types. It is assumed that by maintaining these critical hydraulic parameters across riffles, aquatic habitat in pools and runs is also preserved. In addition to biologic considerations, water must be physically available for the CWCB to file for an instream flow water right.

An instream flow water right requires a coordinated effort between various state and federal agencies, the public, and the CWCB. The culmination of these efforts is a decreed instream flow water right that is held by the CWCB on behalf of the people of Colorado to "preserve the natural environment to a reasonable degree."

The Colorado State Legislature enacted SB 97 in 1973. By "recognizing the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (§ 37-92-102(3), C.R.S. (1990)), the Legislature sought to balance traditional water development with some reasonable protection of Colorado's natural environment. This is not a simple task in the semi-arid Western United States where water is a scarce, and extremely valuable resource. The ongoing success of Colorado's Instream Flow Program assures that coordination between water development and protection of the natural environment will continue -- both now and into the future.

EXHIBIT F

R2CROSS Program Documentation

Program documentation for the R2CROSS macro is divided into four sections. The "Setup and Installation" section describes the hardware and software requirements of the R2CROSS macro and installation of the R2CROSS program on a hard disk drive. The "Iron Creek Example" provides an opportunity for the new user to learn the most common procedures for entering and analyzing typical R2CROSS data sets and to verify that a newly installed version of R2CROSS is operating properly. "The R2CROSS Menu" provides detailed program documentation for each of the menu choices within R2CROSS (Figure D). Instructions for "Terminating and reactivating the R2CROSS macro" are described in the final section.

Appendix A provides a brief description of the "Program Calculations" that are performed within the R2CROSS macro. Rather than emphasizing the technical aspects of these calculations, this appendix is intended to provide a fundamental understanding of the operations being performed within the macro.

Output from the R2CROSS macro was verified against several simple hand-calculated examples. More complex cross sections were verified by comparison with output from the MANSQ option of IFIM (Bovee 1982). Based on this verification process, it is our belief that the instream hydraulic parameters summarized in the R2CROSS staging table are accurate estimations based upon Manning's equation.

To date, the majority of the CWCB's instream flow water rights have been based upon recommendations from an R2CROSS analysis. The CWCB chose the R2CROSS methodology because it is both time and labor efficient. It has also been shown to produce similar results to more costly techniques for modeling streamflows (Nehring 1979).

The CWCB hopes that the release of the R2CROSS macro will foster a greater understanding of this technical aspect of Colorado's Instream Flow Program. It is intended to be user-friendly. If you have any problems running the macro or questions regarding its operation, please feel free to contact the CWCB staff.

Setup and Installation

The R2CROSS macro runs efficiently on an IBM-compatible 80486 personal computer equipped with a hard disk drive, and DOS 6.O, Windows 3.1, and Lotus 1-2-3 Release 4 for Windows software.

Copying R2CROSS to a Hard Disk Drive

To begin installation of the R2CROSS program, create an R2CROSS subdirectory on your computer's hard drive using the DOS command:

md c:\R2CROSS

and press <ENTER>.

Copy the files from the enclosed diskette into this subdirectory using the DOS command:

copy a:*.* c:\R2CROSS.

Press <ENTER> to execute the command.

EXHIBIT F

Loading Lotus 1-2-3 and Retrieving the R2CROSS Macro

To run the R2CROSS macro, load your copy of Lotus 1-2-3 Version 4 for Windows and open the R2CROSS.WK4 file using the Lotus menu commands “File” and “Open”. The R2CROSS macro begins with an introductory message screen. Press <ENTER> to continue.

The data entry and data editing routines of the R2CROSS macro were intended to be very user-friendly. In R2CROSS, the <ENTER> key is used to complete the entry of all data within the "Location Information", "Supplemental Data", and "Channel Profile Data" sections of the data input screen (see Figure E). After entering the stream "Slope", the macro moves into the "Input Data" table. The arrow keys are used to complete the entry of all data within the "Input Data" table. After using the arrow keys to complete the entry of all data within the "Input Data" table, simultaneously press "<Ctrl> G" to exit the data entry routine.

After initial data entry, the arrow keys are used to correct and edit all data entry errors, including corrections to the "Location Information", "Supplemental Data", and "Channel Profile Data" (which were initially entered using the <ENTER> key). Table 3 is intended to help clarify the proper use of the <ENTER> key and the arrow keys within the R2CROSS data entry and data editing routines.

Table 3. Data entry and data editing using the <ENTER> key and arrow keys

	Initial data entry	Data correction/ editing
Location Information Supplemental Data Channel Profile Data	<ENTER> key	Arrow keys
Input Data Table	Arrow keys	Arrow keys

The "Iron Creek Example" which follows is a useful exercise. It is intended to familiarize new users with the data entry nuances of the R2CROSS macro and to verify that the newly installed copy of the R2CROSS macro is operating properly. We recommend that new users take a couple of minutes to work through the "Iron Creek Example" in order to gain hands-on experience with the R2CROSS macro prior to entering individual data sets.

EXHIBIT F

Iron Creek Example

Figure E depicts an actual set of R2CROSS field data collected on Iron Creek, a tributary to the Fraser River in Grand County, Colorado. Assuming that the R2CROSS macro has been installed and initiated as described above, highlight the "Printers" menu choice and select either the LaserJet or Dot Matrix menu choice. Other printer-types may require a customized setup (consult your Lotus 1-2-3 reference manual).

In order to ensure that all subsequent data files are stored in the R2CROSS subdirectory, select the "Retrieve" menu choice, choose the "Path" suboption, key-in:

c:\ R2CROSS

and press <ENTER>.

To initiate data entry, select the "Input" menu option. R2CROSS then prompts you to enter the number of data points collected in the stream cross section. Count the number of data points (Iron Creek has 34), key-in this number at the prompt, and press <ENTER>.

Enter the remainder of the data within the "Location Information", "Supplemental Data", and "Channel Profile Data" sections of the R2CROSS macro. Use the <ENTER> key to complete each data entry and move the cursor through each of the data input cells in sequential order. The final use of the <ENTER> key occurs after keying-in the stream "Slope".

After entering the stream "Slope", use the arrow keys to enter all of the "Feature", "Dist", "Vert Depth", "Water Depth", and "Vel" data from the Input Data table of Figure E. The grasslines on each streambank represent a very important piece of information in the R2CROSS analysis. In the Iron Creek example, these grasslines occur at distances of 1.00 and 11.00 feet. It is imperative that these grasslines be identified within R2CROSS by placing the number "1" in the appropriate cell of Column A in the R2CROSS worksheet. This designation is so important that the R2CROSS macro will not proceed until the two grasslines have been specified. After entering all of the data within the Input Data table, including the two grasslines, simultaneously press "<Ctrl> G" to terminate the data entry routine and return to the main R2CROSS menu.

Select the "Verify" option to print a "Proof Sheet" for comparison with Figure E. If data entry errors are found, return to the "Input" menu option and correct them. When editing data, use the arrow keys to move around the worksheet and correct mistakes. When all data entry errors have been corrected, exit the editing routine by pressing "<Ctrl> G". The data editing routine can be repeated until all data entry errors have been corrected.

Once all data entry errors have been corrected, use the "Save" menu choice to store the input data file to the R2CROSS directory on the hard disk drive. Select the "New File" menu option, type an appropriate eight letter file name for the data set, and press <ENTER>. The file will automatically be saved with a .WK4 file extension. **Caution: do not name the file "R2CROSS".**

Select the "Calculate" option and press <ENTER> to initiate staging table calculations and print the final output from R2CROSS. Verify that the printed output is identical to Figures F through J.

Select the "Graph" option to view the cross section plot. Press <ENTER> to exit the view and print the cross section plot.

Exit the R2CROSS macro by selecting the "Quit" option. Answer "No" to the Lotus prompt to exit R2CROSS and remain in Lotus 1-2-3.

This general procedure can be followed to enter, edit, and analyze almost all R2CROSS datasets. To begin data entry on your own R2CROSS data set, select "Retrieve" a "New file" from the R2CROSS menu.

EXHIBIT F

The R2CROSS Menu

The R2CROSS menu consists of eight main menu choices arranged from left to right across the top of the computer screen (Figure D). Use the arrow keys to move between menu choices and the <ENTER> key to select a highlighted menu choice.

Input

The "Input" menu choice is used to enter data in a new R2CROSS.WK4 worksheet or to correct/edit data in an existing worksheet. As depicted in Table 3, the <ENTER> key is used for the initial entry of the information contained within the "Location Information", "Supplemental Data", and "Channel Profile Data" sections of the field form. The arrow keys are used for the initial entry of the "Discharge/Cross Section Notes" within the "Input Data" table. The arrow keys are also used for all subsequent editing of data. This procedure ensures that the cursor is always located within the appropriate cell of the worksheet during the initial entry of the "Location Information", "Supplemental data" and "Channel Profile Data" (not always a one cell movement) and also allows the greatest flexibility in the initial entry of the discharge notes and subsequent editing of data.

Entering data in a new file

To enter data in a new file:

1. *Select the "Input" menu choice.*
2. *Count the number of data points (cell verticals) collected across the stream channel. Key-in that number and press <ENTER>. R2CROSS automatically sizes the worksheet to the proper number of discharge cells.*
3. *Once the worksheet has been sized, the macro prompts for the entry of a "Stream Name". Key-in the "Stream Name" and press the <ENTER> key to complete the data entry. Follow this same procedure for all of the information contained within the "Location Information", "Supplemental Data", and "Channel Profile Data" data entry cells. The final use of the <ENTER> key occurs after the entry of a stream "Slope". The cursor then moves to the upper left corner of the "Input Data" table (cell C50).*
4. *Use the arrow keys to enter all channel geometry and stream velocity data within the "Input Data" table. Key-in the horizontal distance from the zero stake to the cell vertical in the "Dist" column, vertical distance from the suspended tape to the channel bottom in the "Vert Depth" column, water depth in the "Water Depth" column, and water velocity in the "Vel" column for each cell in the cross section. Use the "Feature" column (Column B) to indicate the horizontal locations of the cross section stakes (S), grasslines (G), waterlines (W), and other features such as rocks (R), etc. Finally, enter a "1" in the appropriate cell of Column A to indicate the location of the grassline/streambank intersection on each streambank. R2CROSS uses the grassline locations to determine bankfull wetted perimeter and top width. These grassline locations are integral to the development of biologic instream flow recommendations in Colorado. The R2CROSS macro will not proceed until the grassline/streambank intersection on each streambank has been depicted with a "1" in Column A of the worksheet.*

5. *When all of the field data has been entered in the "Input Data" table, simultaneously press "<Ctrl> G" to exit from the "Input" routine and return to the main R2CROSS menu.*

Editing data in the current worksheet

To correct data entry errors in the current worksheet:

1. *Select the "Input" option.*
2. *Use the arrow keys to edit data. Data editing begins at the top of the "Input Data" table in cell C50. Move the cursor up from cell C50 to edit "Location Information", Supplemental Data", or "Channel Profile Data". Move down to edit data within the "Input Data" table.*
3. *After correcting all data entry errors, simultaneously press "<Ctrl> G" to terminate the "Input" routine and return to the main R2CROSS menu.*

Editing data in an "Existing file"

Previously-saved files can be retrieved, edited and re-run. Use the R2CROSS menu to "Retrieve" an "Existing file" and then following the instructions under "Editing data in the current worksheet" to edit previously-saved data files.

Verify

The "Verify" option is used to initiate R2CROSS discharge calculations and print a proof sheet (Figure E). Prior to running "Verify", be sure that the proper printer has been initialized (see "Printer" menu option).

Printed output consists of the cross section input data, calculated cross-sectional area, and calculated discharge. The proof sheet should be reviewed to verify accurate entry of all field measurements before continuing to the "Save" option. If data entry errors are discovered, return to the instructions for "Editing data in the current worksheet" and correct the errors. Proceed to "Save" only after all field data has been entered correctly.

Save

Use "Save" to store data input files. Data input files should always be saved prior to running the "Calculate" option because they are generally smaller in size and they can be retrieved, edited, and rerun if necessary. The "Calculate" option can not be run twice on the same file!

Prior to saving data input files, be sure to run the "Retrieve" and "Path" menu options to specify the location of data storage.

There are two suboptions under the "Save" menu choice, "New file" and "Overwrite". Choose your option carefully and do not overwrite the original R2CROSS.WK4 file!

New file

The first suboption, "New file", is used to save a newly created R2CROSS data set. This is accomplished by the following procedure:

1. *Select "Save" and then "New file" from the R2CROSS menu. R2CROSS prompts for the name of a new file.*
2. *Enter a name of up to eight characters and press <ENTER>.*

If a filename is selected that already exists in the default directory, the computer will beep and the file will not be saved. Should this happen, either repeat the above procedure and save under a different file name or go to the "Overwrite" suboption.

Overwrite

The "Overwrite" suboption is designed to overwrite an existing data file. Use the following procedure to perform this task:

1. *Select "Save" and then "Overwrite" from the R2CROSS menu. R2CROSS will list the files in the current directory that you may chose to overwrite.*
2. *Select a file from the list using the arrow keys and overwrite it by pressing <ENTER>. The existing file will be replaced with the current file. Do not select the original R2CROSS.WK4 file!*

Calculate

"Calculate" initiates all staging table calculations and prints a five page data summary (Figures F through Figure J). Be sure that you have saved your input data set and that the proper printer type has been specified prior to running "Calculate". This operation may take several minutes depending upon the speed of your computer. A detailed explanation of the four major calculations performed within R2CROSS can be found in "Appendix A - Program Calculations".

Graph

The "Graph" option allows the user to view and print a cross-section plot of the stream transect (Figure K). The cross section plot is useful for revealing potential problems with the input data set or potential errors in data collection or data entry. Errors, such as misread rod readings on waterlines or ground profiles, are often easily detected on a cross section plot.

Retrieve

The "Retrieve" menu option has three suboptions, "Path", "New file", and "Existing file". These suboptions are used to change the current file storage path and to retrieve data files.

Path

The "Path" suboption changes the current data storage location. A valid storage path may be any drive and/or directory which is in existence on the computer's hard drive. To select a new path, follow these steps:

1. *Select "Retrieve" and then "Path" from the R2CROSS menu.*
2. *Type in the name of an existing directory on your hard drive and press <Enter>.*

Subsequent files will be stored and retrieved within this directory. In the event that a non-existent path is entered, the computer will beep and return to the main menu. The default directory will remain in effect until a valid path has been entered.

The "Path" suboption choice is not frequently used. It may be appropriate if you wish to organize R2CROSS data from different streams into separate subdirectories. However, file organization can also be accomplished by simply using descriptive file names. If you do decide to create separate directories for your R2CROSS output files, you should copy the files from the R2CROSS diskette into each of these subdirectories so that they can be retrieved when you want to create a new data set.

New file

The "New file" suboption is used to initiate data entry on a new cross section. It erases the current worksheet from the screen and replaces it with a blank R2CROSS.WK4 worksheet. Read the introductory message and press <ENTER> to initiate data entry.

EXHIBIT F

Existing file

The final suboption, "Existing file", retrieves a previously-saved R2CROSS data set from storage. Simply select the file to be retrieved. Select the "Input" command on the R2CROSS menu to edit the dataset. Staging table calculations are initiated by selecting the "Calculate" option. Remember, the "Calculate" option cannot be run twice on the same file.

Printers

LaserJet

Dot Matrix

The "Printers" menu option is used to format R2CROSS output for either a LaserJet or Dot Matrix type printer. The proper printer-type should be selected prior to running the "Verify" or "Calculate" menu options. Use the arrow keys to highlight the proper printer and press the <ENTER> key. Experienced Lotus 1-2-3 users can setup additional printers prior to retrieving the R2CROSS.WK4 worksheet if necessary. Consult a Lotus manual for specific instructions on setting up other types of printers.

Quit

Select the "Quit" menu option and answer "No" to the Lotus prompt to de-activate the R2CROSS macro and return to normal Lotus 1-2-3 operations. De-activating the R2CROSS macro allows for the use of standard Lotus 1-2-3 commands on all unprotected cells within the current data file. The R2CROSS menu can be reactivated by simultaneously pressing "<Ctrl> M". Alternatively, a new R2CROSS worksheet can be brought up from within Lotus 1-2-3 by retrieving the original R2CROSS.WK4 file from the computer's hard disk drive (see "Installation" section).

Terminating and Reactivating the R2CROSS Macro

Situations may arise where the macro must be terminated during data entry or calculation routines. To terminate the R2CROSS macro and return to the standard Lotus 1-2-3 menu, press <Ctrl><Break>. Then press the <Esc> key several times to clear the Lotus error message screen.

If the R2CROSS macro was terminated due to a data entry error or a problem with the execution of the macro, the integrity of the worksheet may have been compromised. If so, the current worksheet should be erased and a fresh copy of the R2CROSS.WK4 file retrieved from the computer's hard disk drive. The data should definitely be re-entered if the macro failed during the "Calculate" option of R2CROSS. Trying to rerun a compromised dataset may result in additional problems and unreliable output. It is always safer, albeit more time consuming, to start over.

If you do not believe the data in the current worksheet has been compromised, the R2CROSS macro can be re-activated by simultaneously pressing "<Ctrl> M". Macro operation will begin with the standard R2CROSS menu and data entry or calculations may then resume within the existing file.

EXHIBIT F

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Skinner, J. Instream Flow Coordinator. Colorado Division of Wildlife. Personal communication.

Weatherred, J.D., H.L. Silvey and D.J. Pfankuch. 1981. Program documentation for R2-CROSS-81. Watershed Systems Development Group. United States Department of Agriculture, Forest Service. 3825 East Mulberry Street. Fort Collins, CO 80524.

EXHIBIT F

Appendix A - Program Calculations

Some R2CROSS users may be interested in the operation and layout of the Lotus 1-2-3 macro. Figure L depicts the sequence of operations performed within each R2CROSS menu option. Figure M provides the layout of the R2CROSS macro within the Lotus 1-2-3 worksheet. The four major computations performed within the R2CROSS macro are sag-tape corrections, estimation of Manning's "n", calculation of a water line comparison table, and calculation of a staging table.

Sag-Tape Calculations.

Channel geometry measurements that are taken using the sag-tape methodology must be corrected to a level reference. R2CROSS uses catenary curve formulas to compute these corrections from a sagging tape that has been leveled at each end. The use of the catenary curve solution is based on the assumption that the suspended steel tape is analogous to a suspended cable placed under a unidirectionally distributed load (Laursen 1978).

The derivation of the catenary curve solution is beyond the scope of this manuscript. Basically, R2CROSS uses the length of tape in suspension, the tension applied to the tape, and the standard weight of one foot of tape to apply the necessary vertical distance corrections to each cell vertical within the cross section.

When using a level and stadia rod to survey channel geometry, the tape weight and tension defaults, supplied in the original R2CROSS.WK4 worksheet, will simulate an extremely light tape stretched at very high tension. This results in a sag correction of approximately zero at each cell vertical.

Use of Manning's Equation.

Manning's equation is defined as:

$$Q = \frac{1.486 * A * R^{2/3} * S^{1/2}}{n}$$

where;
Q = discharge (cfs);
A = cross-sectional area (ft^2);
R = hydraulic radius (ft);
S = slope (ft/ft); and
n = Manning's "n", a dimensionless coefficient of roughness.

Manning's equation is used in two separate R2CROSS calculations. It is first used within the "Verify" option to provide an initial estimate of Manning's "n" using the rearranged equation:

$$n = \frac{1.486 * A * R^{2/3} * S^{1/2}}{Q}.$$

The parameters Q, A, R, and S are calculated from the raw field data and used to solve directly for "n" (Figures G and J). Once estimated, Manning's "n" remains constant throughout the remainder of the streamflow modeling.

Manning's equation is also used within the "Calculate" option to solve for Q at each simulated water surface elevation within the staging table (Table 4).

EXHIBIT F

Calculation of the Water Line Comparison Table.

R2CROSS uses two techniques for estimating cross-sectional area. One estimate is obtained by summing the product of "measured" water depth and cell width for all cells in the cross section (A_m). This technique allows independent water surface elevations within each cell and provides the most accurate estimate of cross-sectional area at the time the field measurement was made. However, this technique cannot be used to simulate a single, flat water surface elevation at computer-modeled stream discharges.

The second technique used to estimate cross-sectional area involves projecting a single water surface elevation across the stream channel. Channel bottom elevations are subtracted from this projected water surface elevation to obtain a "computed" water depth at each cell vertical. Cross-sectional area is obtained by summing the product of the "computed" water depth and cell width at each cell vertical (A_c). This technique constrains the water surface to a flat plane and is useful for simulating discharges above and below the field-measured discharge.

The water line comparison table (Figure H) iteratively calculates 31 separate estimates of A_c, using projected waterlines ranging from 0.25 feet above to 0.25 feet below the mean waterline measured in the field. The single water surface elevation that results in A_c equal to A_m is interpolated from the water line comparison table and is used in the staging table as the best estimate of the waterline at the field-measured discharge.

Calculation of the Staging Table.

The final product of the R2CROSS macro is the staging table (Figure I). In addition to the three critical biologic criteria ($\bar{x}_d$, $\%WP$, and $\bar{x}_v$), R2CROSS also calculates incremental estimates of top width (TW), maximum depth (D_{max}), cross-sectional area (A), wetted perimeter (WP), hydraulic radius (R), and flow (Q) at a number of waterline elevations. The upper limit of the model occurs at bankfull discharge which is defined as the lower of the two grassline elevations measured in the field. The lower limit is either 1.75 feet below the waterline calculated in the water line comparison table or stage of zero flow (the lowest field-measured channel profile), whichever is higher in elevation. The formulae for each of the parameters estimated in the staging table are summarized in Table 4.

EXHIBIT F

Figure L. Sequence of operations performed by R2CROSS macro

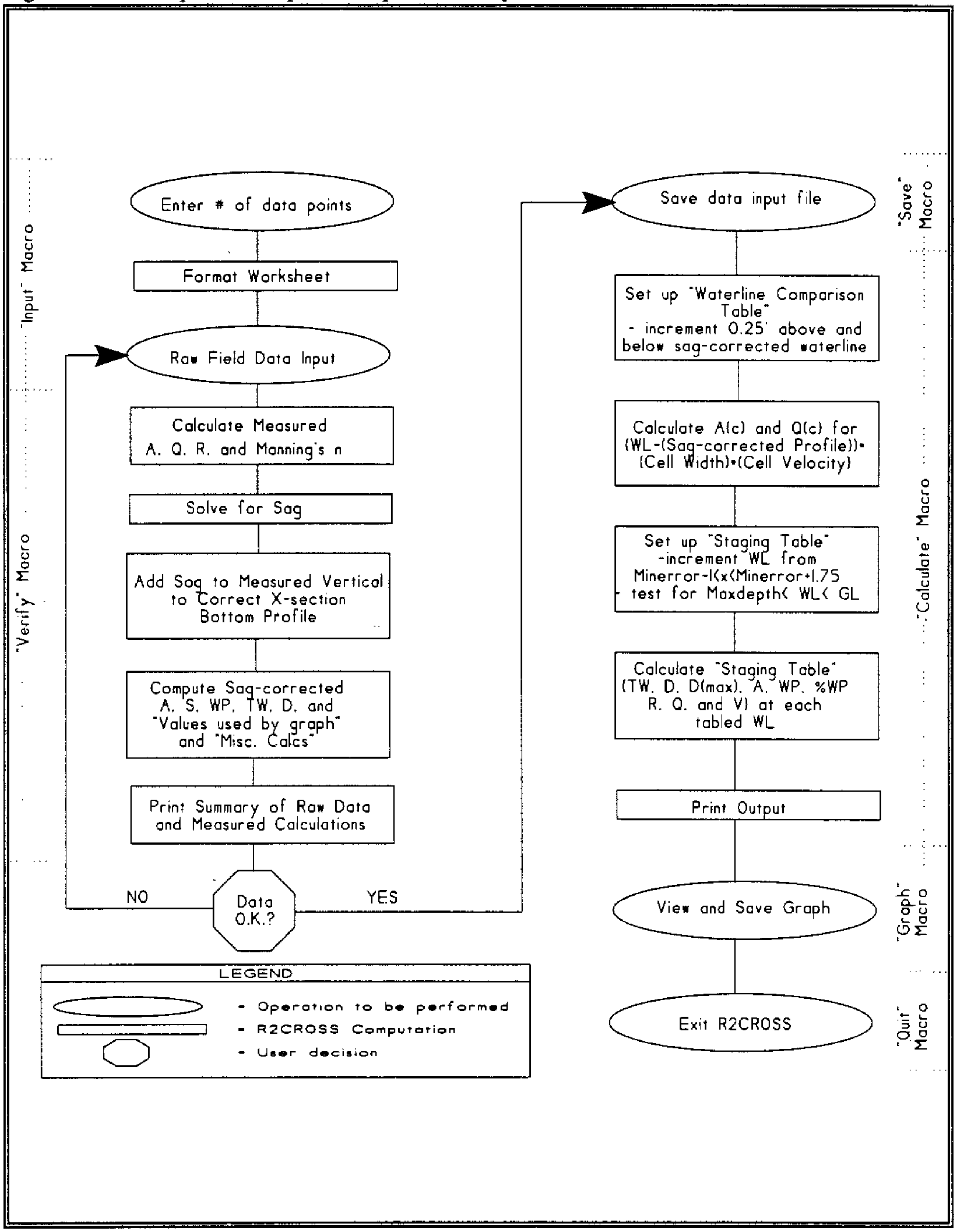


EXHIBIT F

Figure M. Lotus 1-2-3 worksheet layout for R2CROSS macro

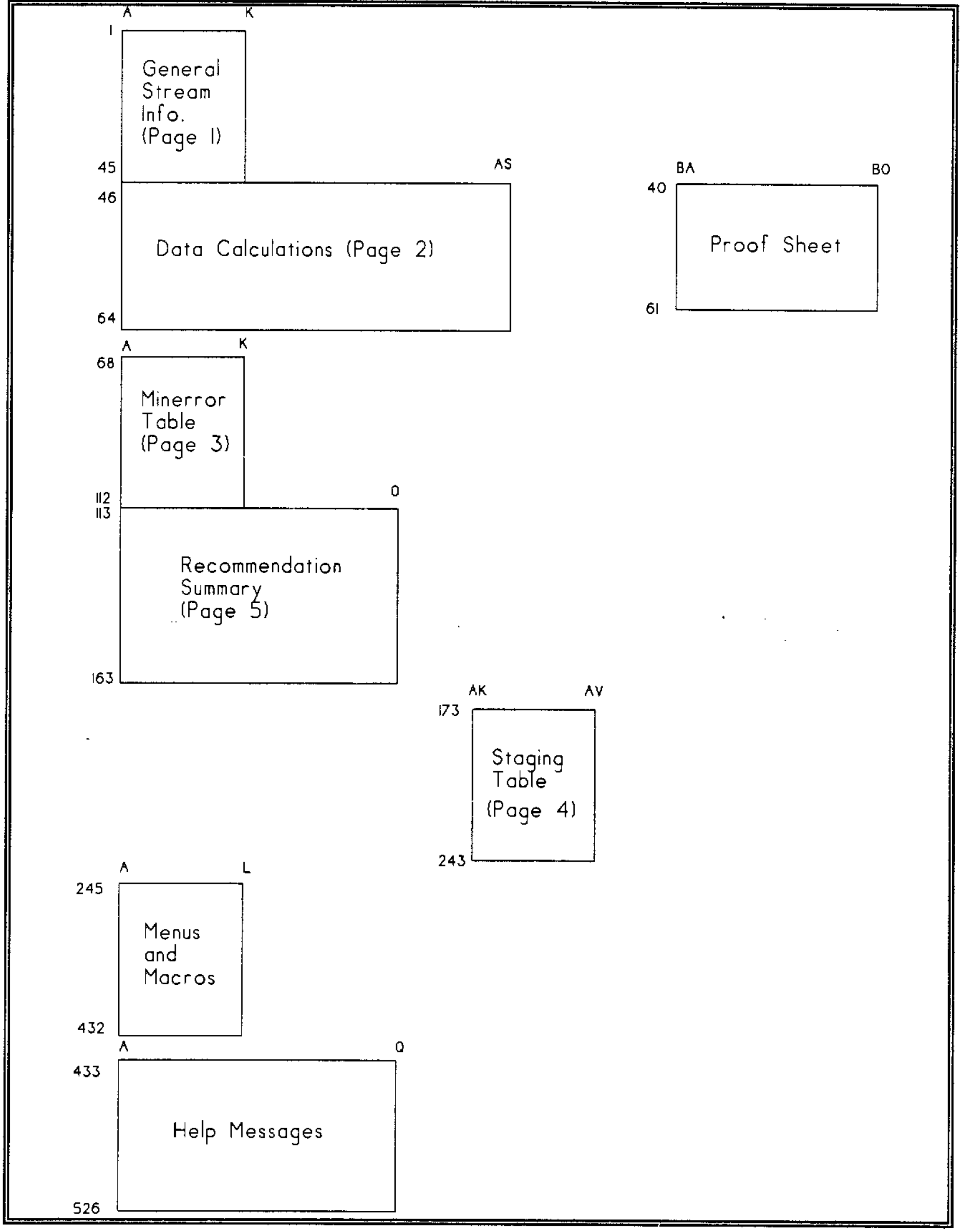


Table 4. Hydraulic Formulas used in R2CROSS staging table

Parameter	Formula
Top Width (TW)	$\sum_{i=1}^{n} TW_i$
Average Depth ($\bar{x}_d$)	$\frac{A}{TW}$
Maximum Depth (D_{max})	$\underset{i=1}{\overset{n}{MAX}}(D_i)$
Area (A)	$\sum_{i=1}^{n} A_i$
Wetted Perimeter (WP)	$\sum_{i=1}^{n} WP_i$
Percent Wetted Perimeter (%WP)	$\frac{WP}{Bankfull\ WP} * 100$
Hydraulic Radius (R)	$\frac{A}{WP}$
Flow (Q)	$\frac{1.486 * A * R^{\frac{2}{3}} * S^{\frac{1}{2}}}{n}$
Average Velocity ($\bar{x}_v$)	$\frac{Q}{A}$

EXHIBIT F

The Board's R2CROSS Lotus Macro is written for Lotus 1-2-3 Release 4.0 for Windows.

To obtain a copy of the Macro on diskette, please contact Greg Espegren at the CWCB. (303) 866-3441


Colorado's Instream Flow and
Natural Lake Level Program
Colorado Water Conservation Board
Stream and Lake Protection Section
Little Cimarron River

CWCB

To promote the protection, conservation, and development of Colorado's water resources for present and future generations

Provides policy direction on water issues

- Finance and Administration
- Interstate & Federal
- Stream and Lake Protection
- Water Supply Planning
- Watershed & Flood Protection

Ex-Officio Members:

Bob Randall, DNR Director *(voting)*

James Eklund, CWCB Director

Cynthia Coffman, AG

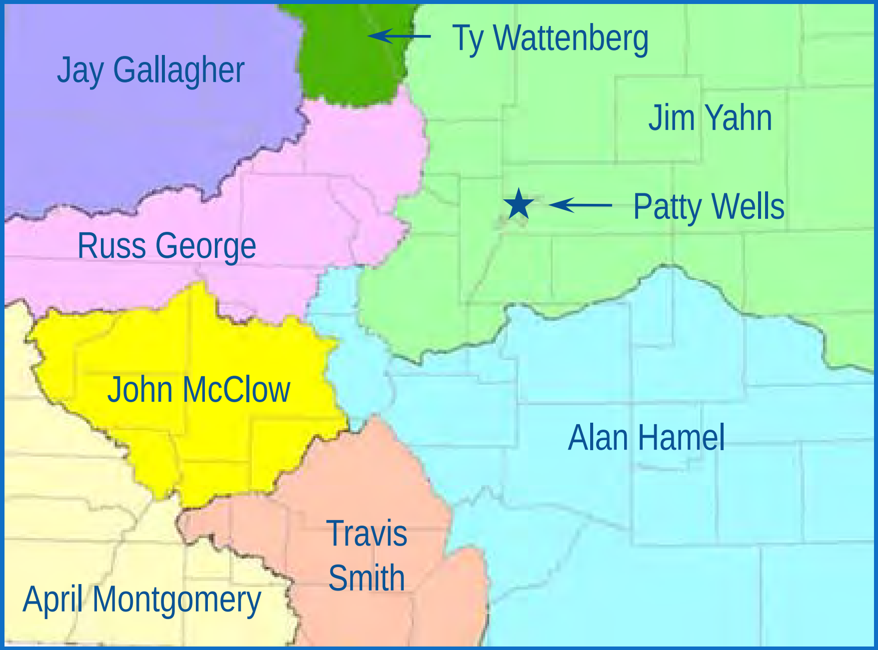
Dick Wolfe, State Engineer

Bob Broscheid, CPW Director

Don Brown, Dept. of Ag Director

John Stulp, Special Policy Advisor to the Governor for water

Board of directors



Stream and Lake Protection Section

New Appropriations

Appropriate and adjudicate a new (junior) ISF water right for the minimum required to preserve the natural environment to a reasonable degree

Water Acquisitions

Acquire existing water rights and change to ISF use in amounts CWCB determines appropriate to preserve or improve the natural environment to a reasonable degree

Monitoring and Request for Administration

Actively monitor conditions at stream gages and initiate administrative calls as necessary to ensure ISF rights are met.

Legal Protection

Initiating legal action through Colorado's water courts when necessary to provide 100% protections of the state's decreed ISF rights.

Inter-Section Issues –
DSS, Wild and Scenic, State Water Plan, River Restoration, Stream Management Plans, and Stream gaging, etc.

Stream and Lake Protection Staff

Linda Bassi
Section Chief
Policy, Program & Staff Management

Jeff Baessler
Deputy Section Chief
Hydrologist
Appropriations, Monitoring & Enforce.,
Section Finances & Planning

Kaylea White
Senior Water Resource Specialist
Acquisitions and Legal Protection

Brandy Logan
Hydrologist
Appropriations &
Physical Protection Analyses

Don West
Engineer
Engineering Analysis,
Acquisition Support

Rob Viehl
Water Resource Specialist
Appropriations &
Legal Protection Analyses

Brian Epstein
Hydrologist \ Hydrographer
Physical Protection & Monitoring

Kim Ricotta
Legal Protection Support

Elkhead Creek

ISF Program History

Pruden Creek – Park County

Environmental Movement

Increasing public concern about the impact that human activity could have on the environment

Toxic Chemicals

1st Earth Day

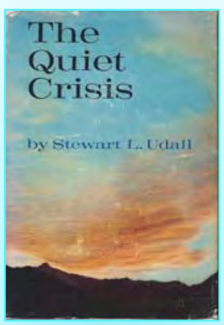
1970 National Environmental Policy Act

1972 Clean Water Act,
Costal Zone Mgt. Act
Marine Mammal Protection Act

1973 Endangered Species Act

1974 Safe Drinking Water Act

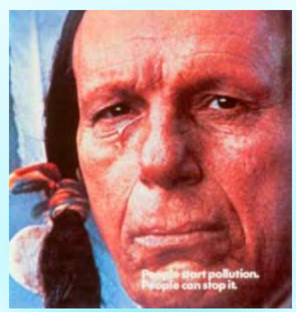
1960's — **1970's**



Abuse of Nation's Natural Resources

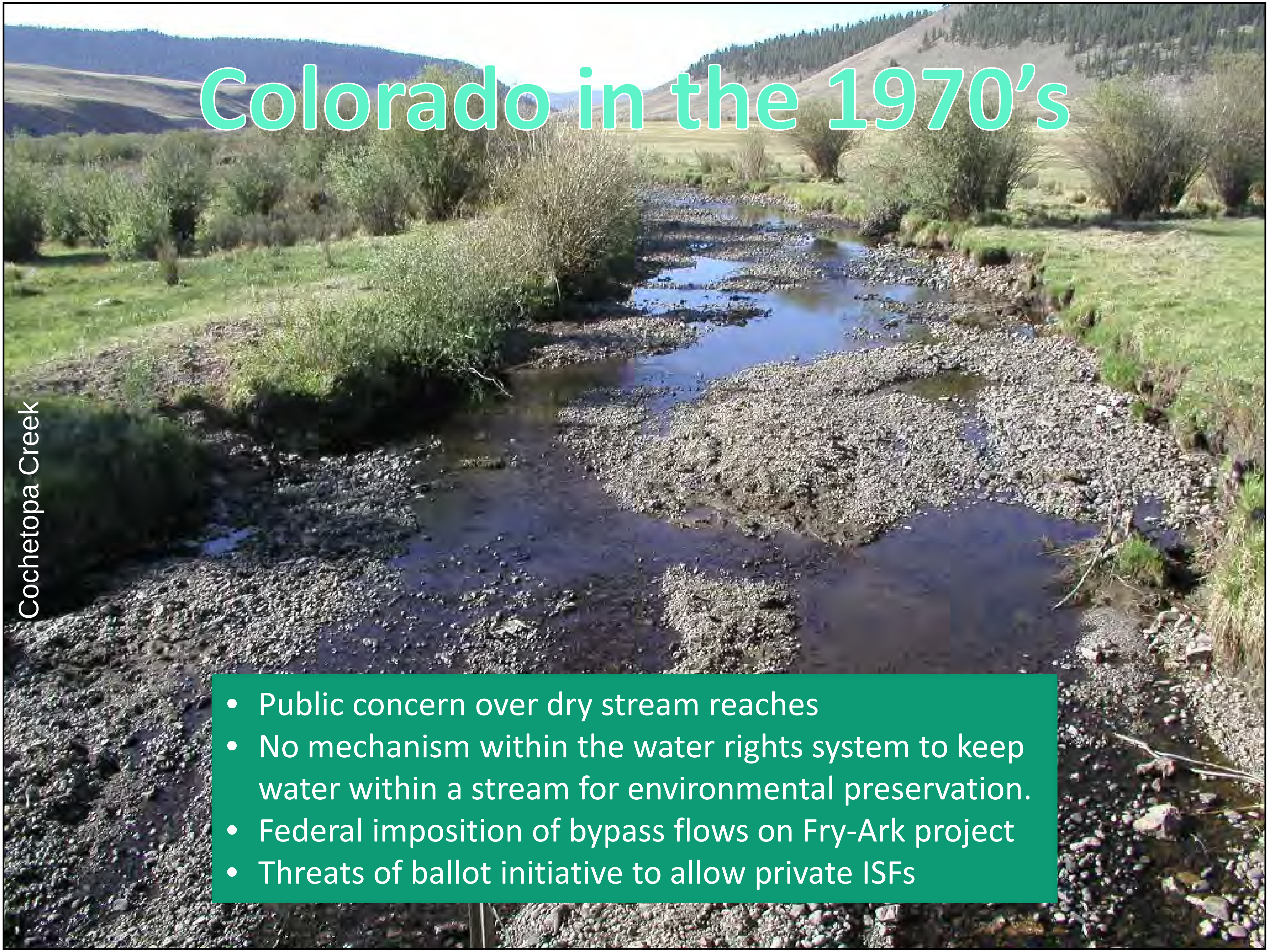
1964
Wilderness Preservation Act

1968
Wild and Scenic Rivers Act



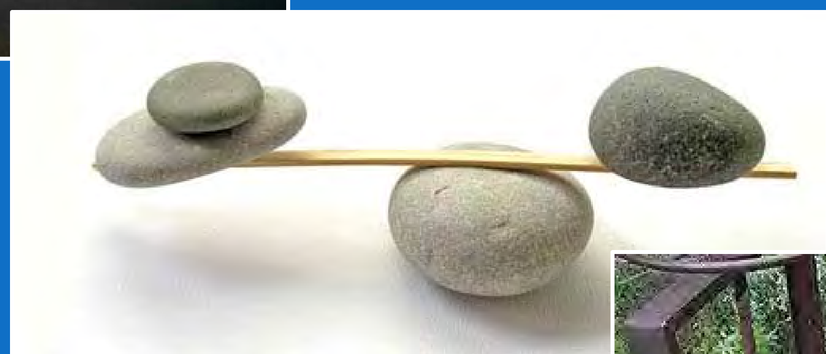
Keep America Beautiful Campaign

Creation of New Federal Agencies

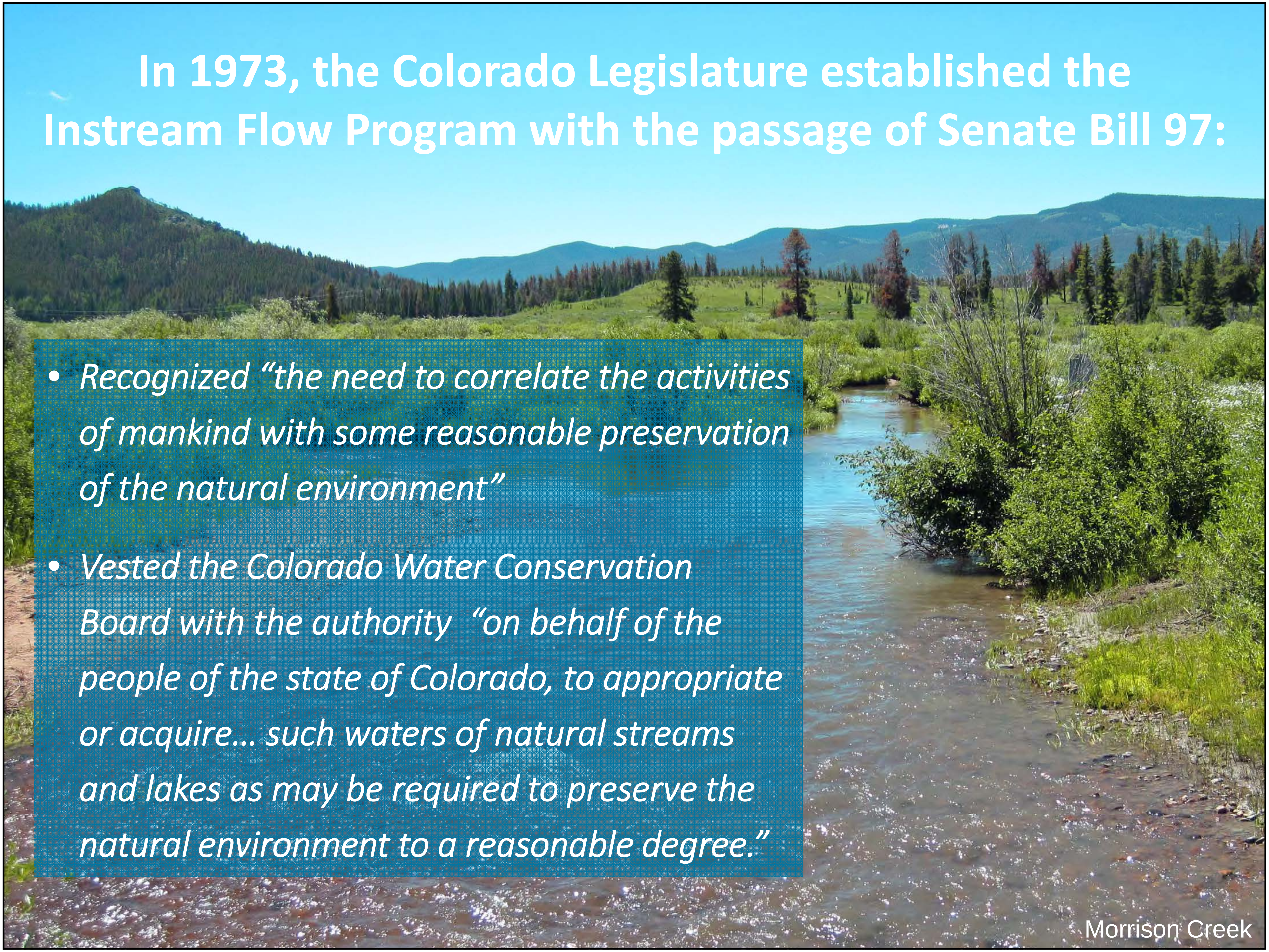

Colorado in the 1970's
Cochetopa Creek
• Public concern over dry stream reaches
• No mechanism within the water rights system to keep water within a stream for environmental preservation.
• Federal imposition of bypass flows on Fry-Ark project
• Threats of ballot initiative to allow private ISFs

Colorado's Legislature Weighs In

Maintain flows in streams to ensure reasonable preservation of the natural environment and achieve a balance with other beneficial uses of water in the state.

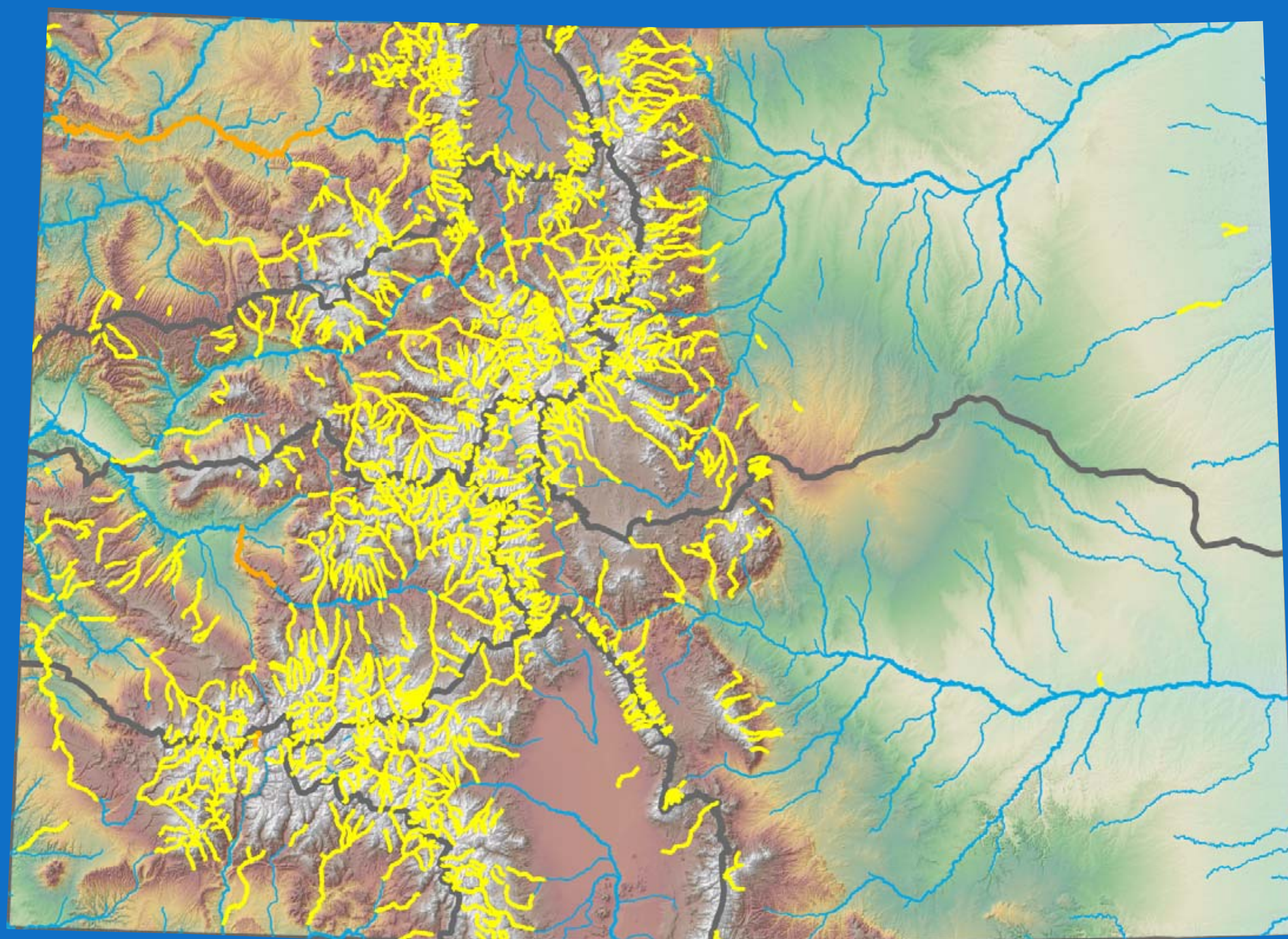


Provide regulatory certainty for water users through continued reliance on the doctrine of prior appropriation.

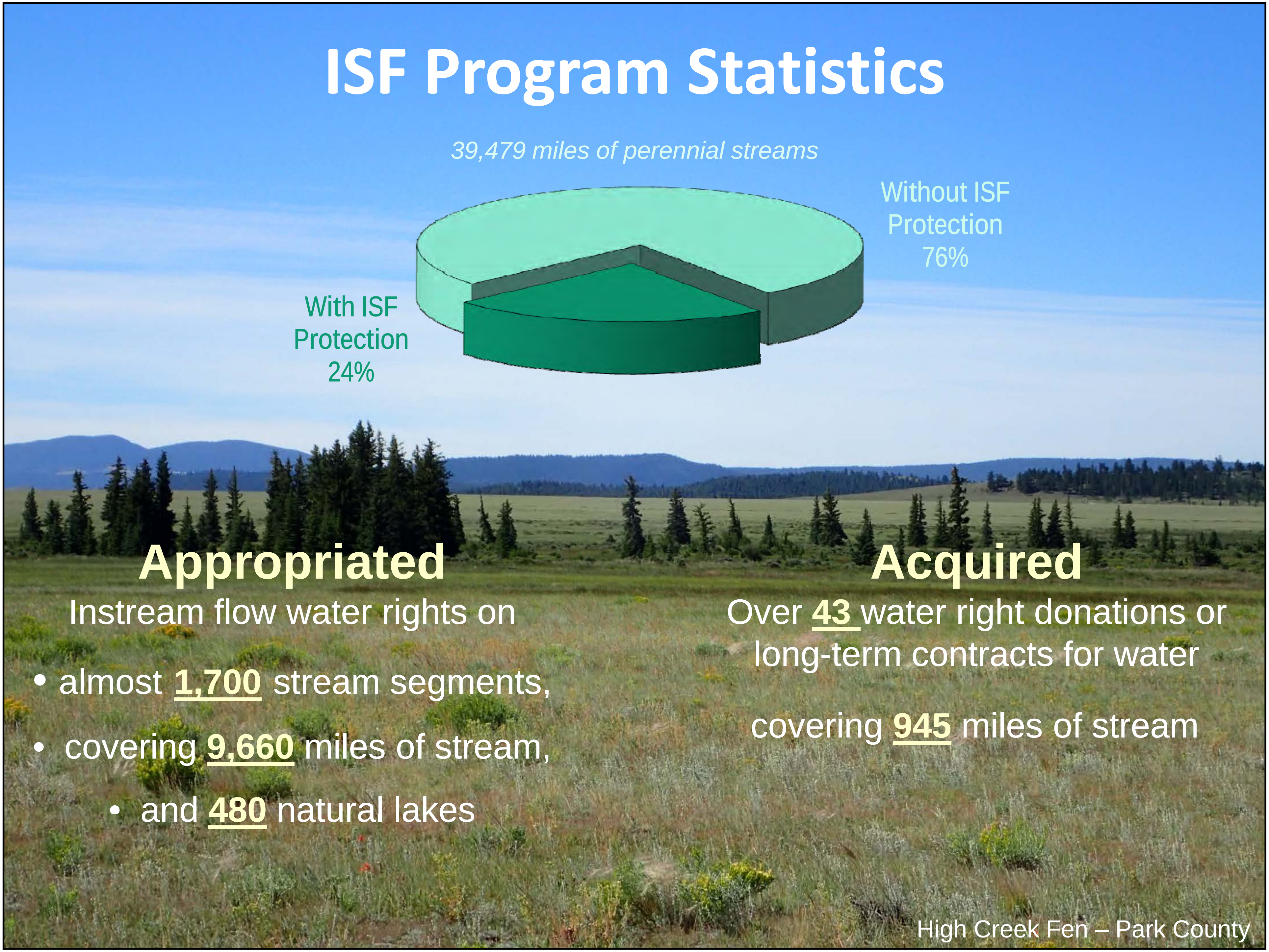

In 1973, the Colorado Legislature established the Instream Flow Program with the passage of Senate Bill 97:
• Recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment"
• Vested the Colorado Water Conservation Board with the authority "on behalf of the people of the state of Colorado, to appropriate or acquire… such waters of natural streams and lakes as may be required to preserve the natural environment to a reasonable degree."
Morrison Creek


What did the ISF legislation establish?
▪ ISF and NLL rights are "in-channel" or "in-lake" appropriations of water and are recognized beneficial uses of water.
▪ Made exclusively by the Colorado Water Conservation Board
▪ To preserve the natural environment to a reasonable degree
▪ For "minimum flows" between specific points on a stream, or "levels" on natural lakes
▪ Administered within the State's water right priority system

Distribution of Existing ISF Water Rights in Colorado



Yellow lines represent streams with decreed ISF rights


ISF Program Statistics
39,479 miles of perennial streams
Without ISF Protection 76%
With ISF Protection 24%
Appropriated
Instream flow water rights on
• almost 1,700 stream segments,
• covering 9,660 miles of stream,
• and 480 natural lakes
Acquired
Over 43 water right donations or long-term contracts for water
covering 945 miles of stream
High Creek Fen – Park County

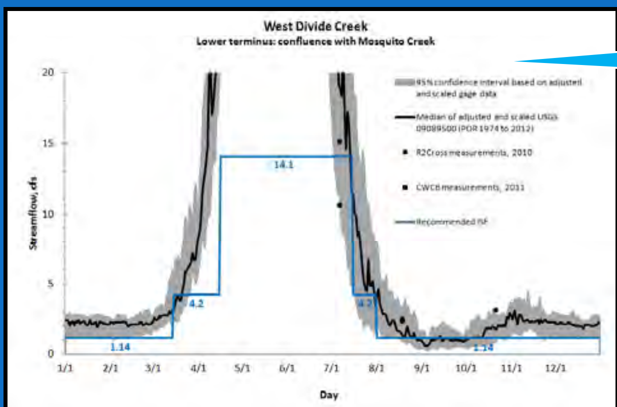

New Appropriations
(ISF Rule 5 Procedure)
Any person or entity may recommend streams or lakes to be considered for appropriation to preserve the natural environment
Kelso Creek

Statutory Requirements

A natural environment exists

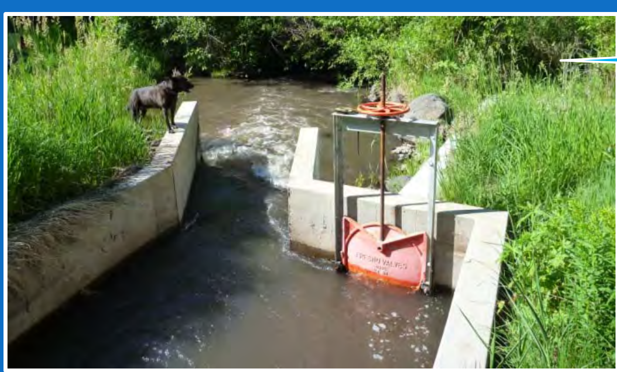
- Typically identified by the presence of a fishery, but other indicators can be used

Note: Quantification of the amount of water needed is provided by the recommending entity.



Natural environment will be preserved by the water available for appropriation

- Determined by water right and hydrologic investigations
- Daily **Median** hydrology when available – general CWCB policy to show water available 50% of time



No material injury to other rights

- New appropriations are junior water rights and have no effect on existing senior appropriations
- 37-92-102(3) b. Recognition of existing undecreed uses and exchanges

Natural Environment

There is a natural environment that can be preserved to a reasonable degree

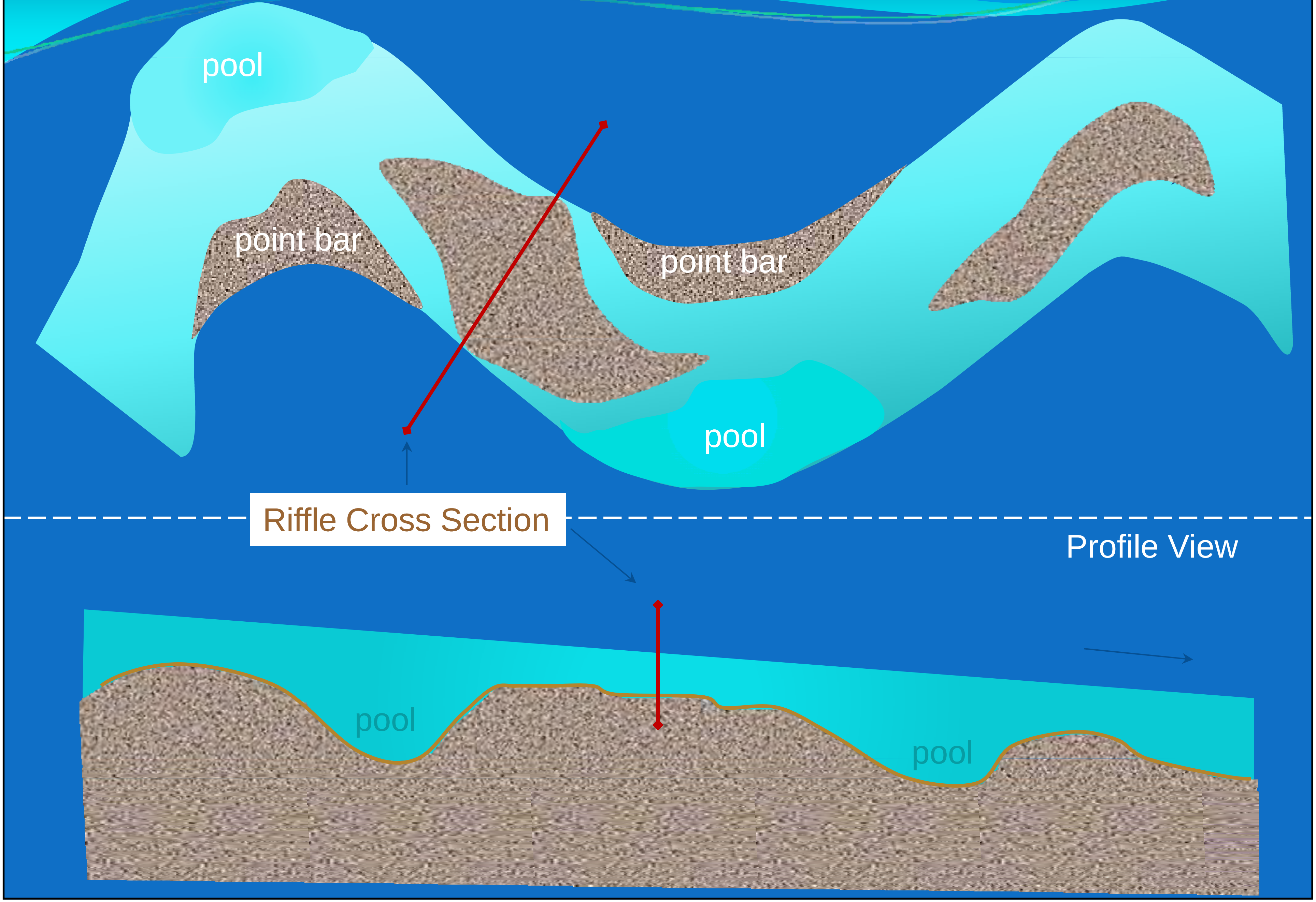
When we try to pick out anything by itself, we find it hitched to everything else in the universe.
John Muir

Central stoneroller Nate Cathcart photo 2010


Flow Quantification Overview


R2Cross
Collect streamflow measurements & channel geometry to model hydraulic parameters of average depth, velocity, and percent wetted perimeter

Site Selection

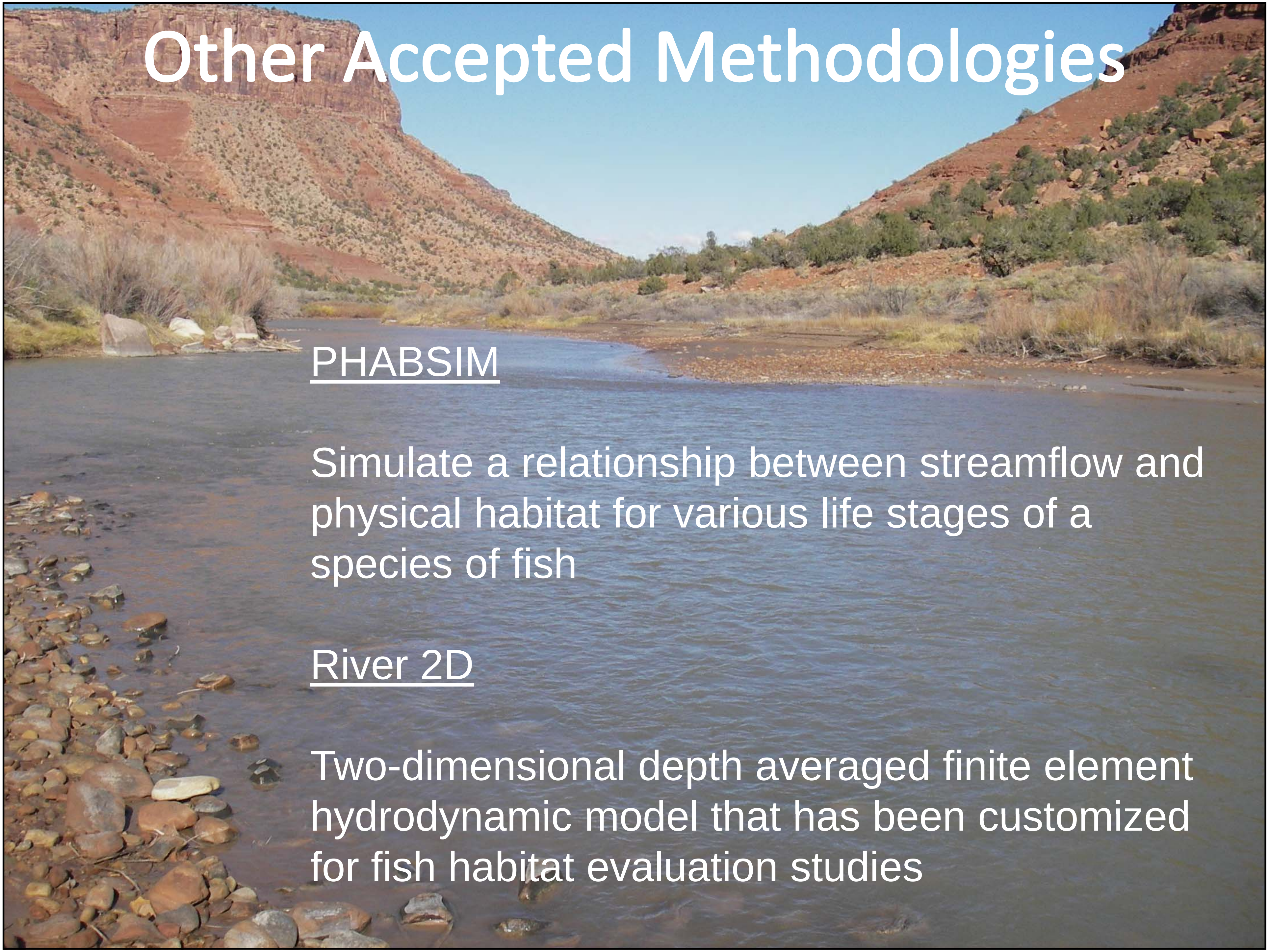


R2CROSS Parameters

- Biological R2CROSS recommendation based on maintaining hydraulic parameters related to stream habitat preferences for fish.
- 3 of 3 required for summer flow; 2 of 3 required for winter flow
- Many original R2Cross recommendations were based solely on 2 of 3

Stream Width (ft)	Average Depth (ft)	Average Velocity (ft/sec)	Wetted Perimeter (%)
1 - 20	0.2	1.0	50
21 - 40	0.21 - 0.40	1.0	50
41 - 60	0.41 - 0.60	1.0	50 - 60
61 - 100	0.61 - 1.00	1.0	70 or greater

Requirements Using R2CROSS Transect Method (Nehring 1979)


Other Accepted Methodologies
PHABSIM
Simulate a relationship between streamflow and physical habitat for various life stages of a species of fish
River 2D
Two-dimensional depth averaged finite element hydrodynamic model that has been customized for fish habitat evaluation studies


Water Availability
The natural environment will be preserved to a reasonable degree
by the water available for the appropriation
FlowTracker

Hydrologic analyses for Water Availability

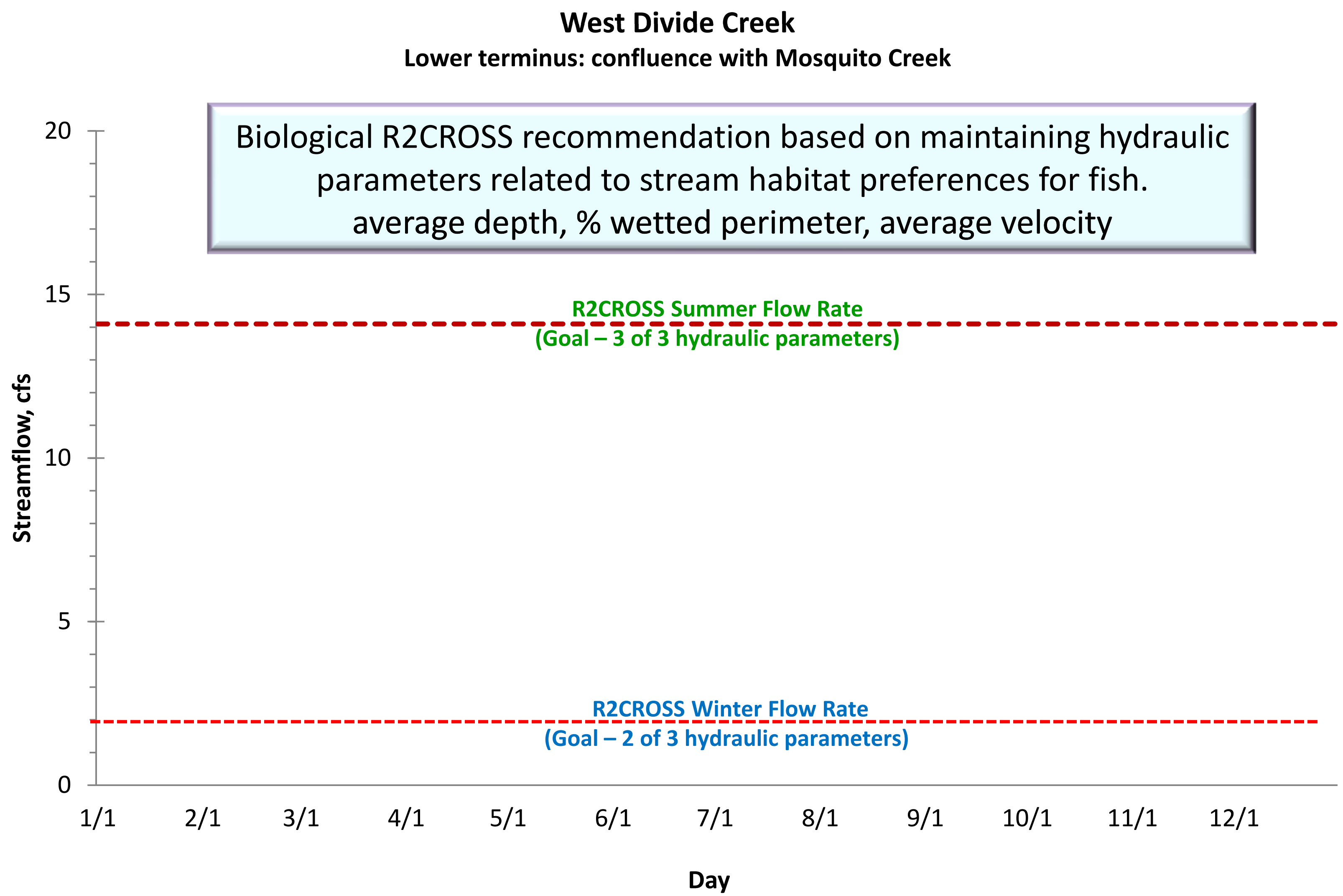
Water Balance approach, driven by best available data

- ✓ Statistical analysis of data to provide *median* daily flow hydrograph when possible.
- ✓ Gage Records +20 years, short term gages, temporary gages, spot flow measurements, diversion records.
- ✓ StreamStats analysis to provide mean monthly hydrograph when data is limited.
- ✓ Detailed CDSS modeling on larger streams.
- ✓ Anecdotal information from water commissioners, land owners, ditch or reservoir operators, resource managers.

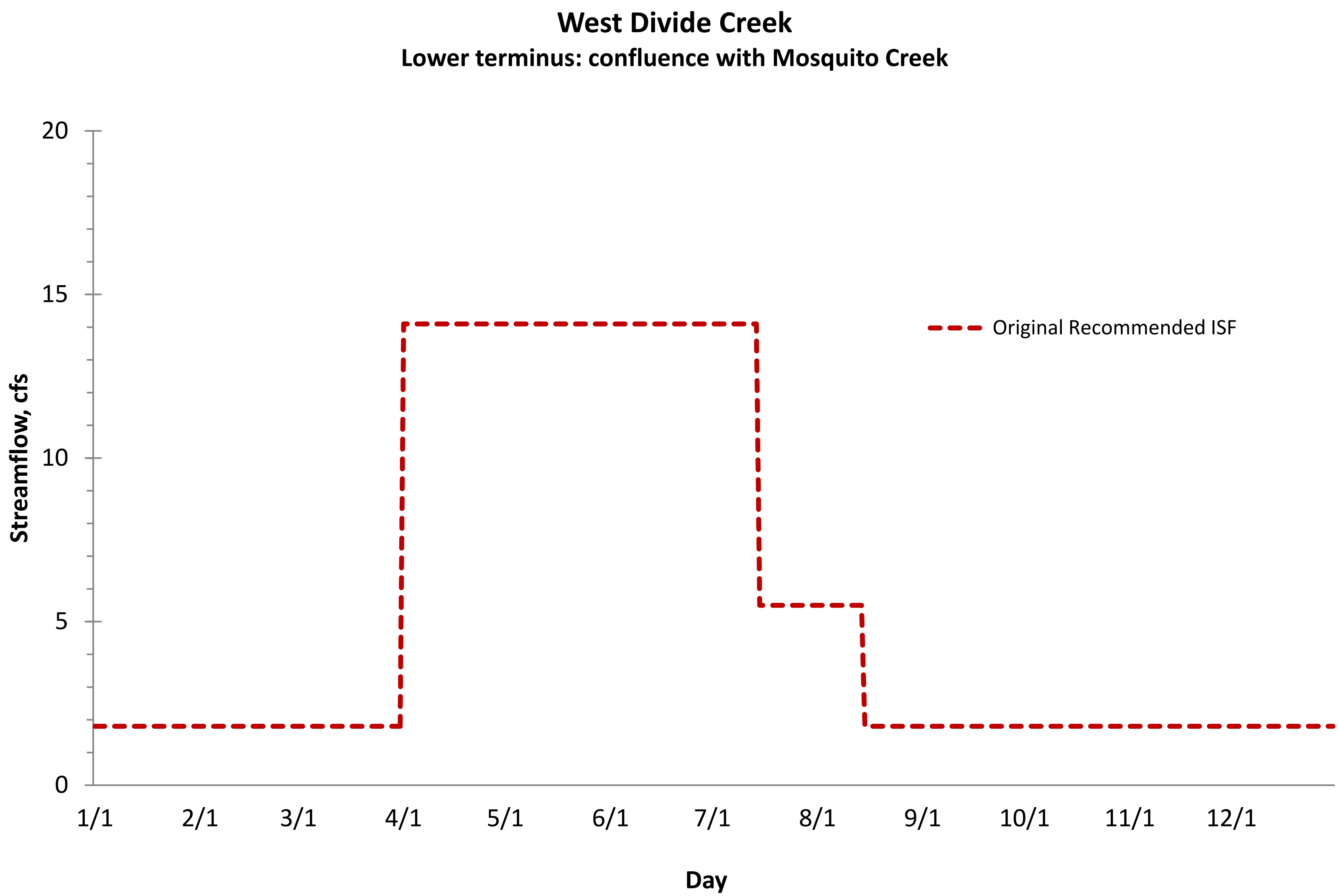
USGS 0930622 (Piceance Creek near White River, Co)
Approximately 47 years of record

Water availability can be viewed as a necessary refinement that may impose limitations on biological quantification model findings.

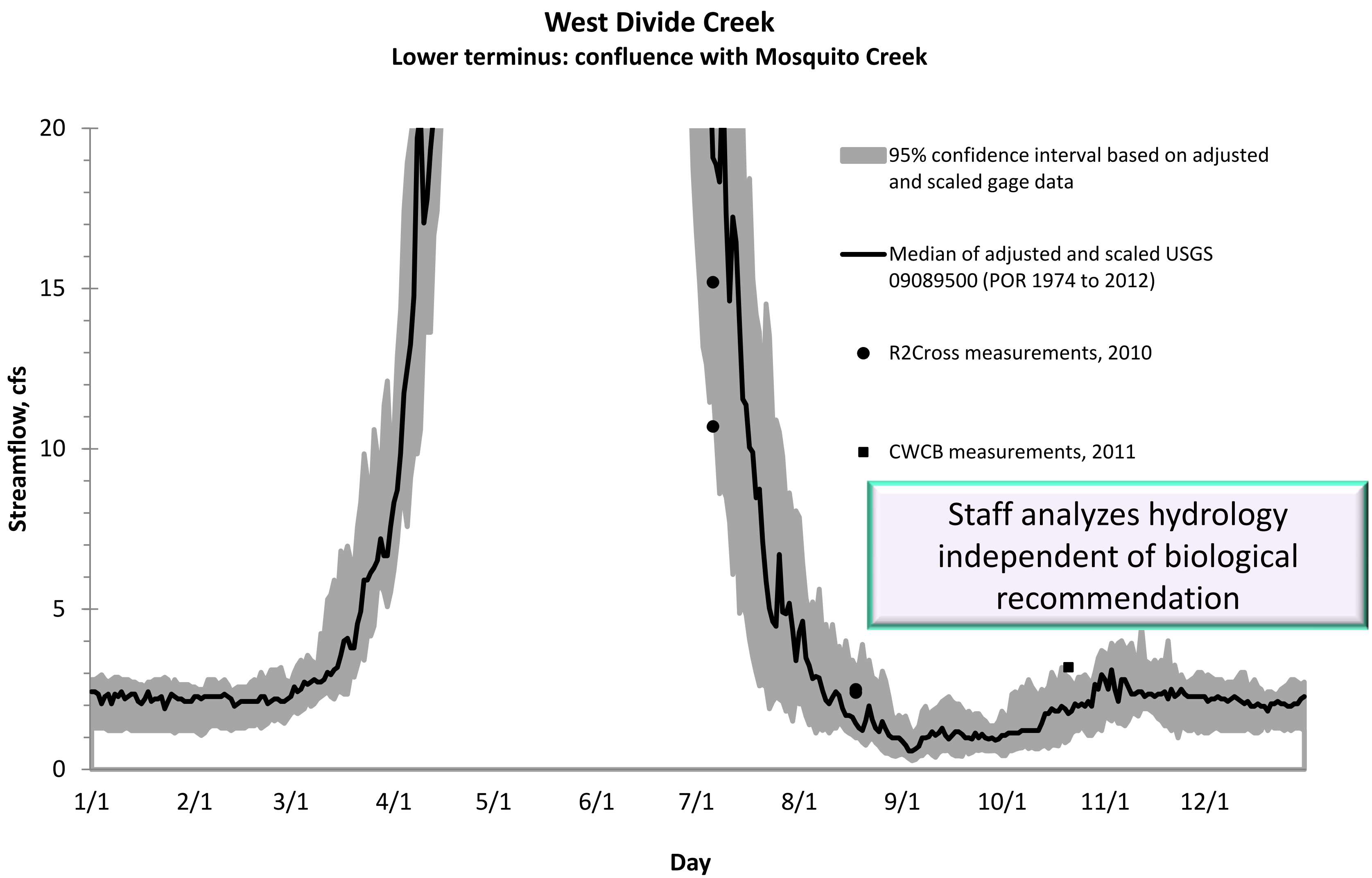
Water Availability



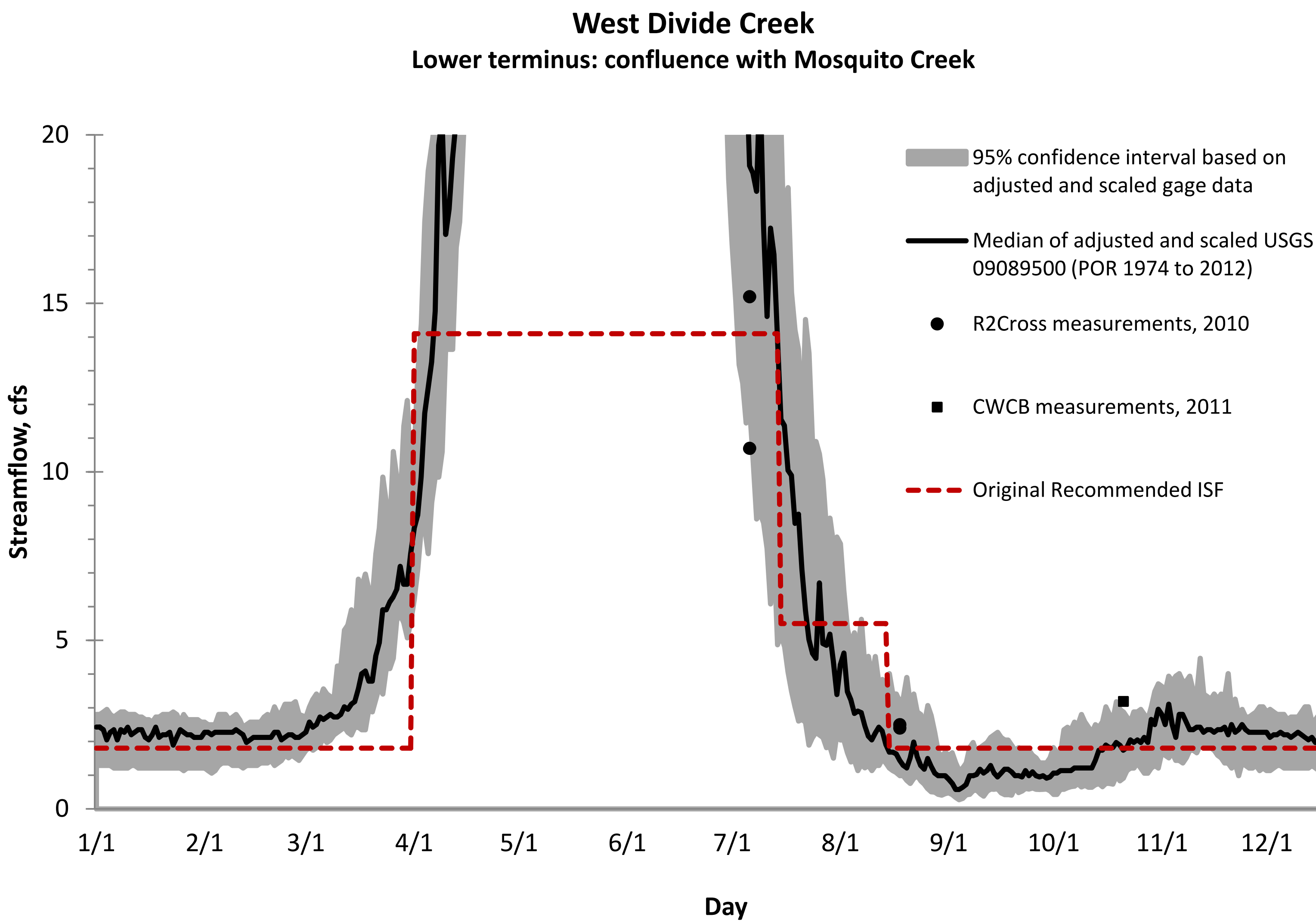
Water Availability



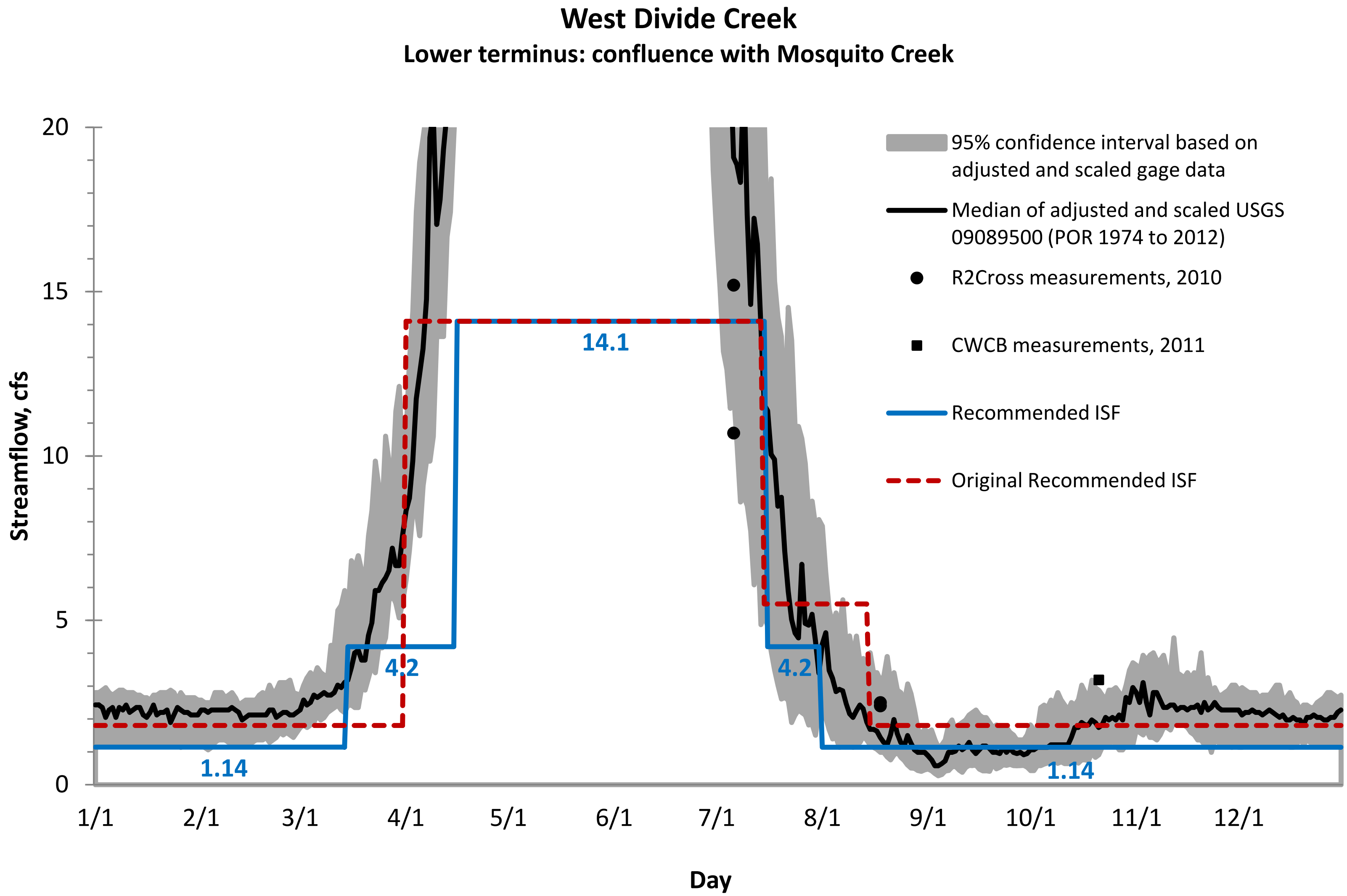
Water Availability



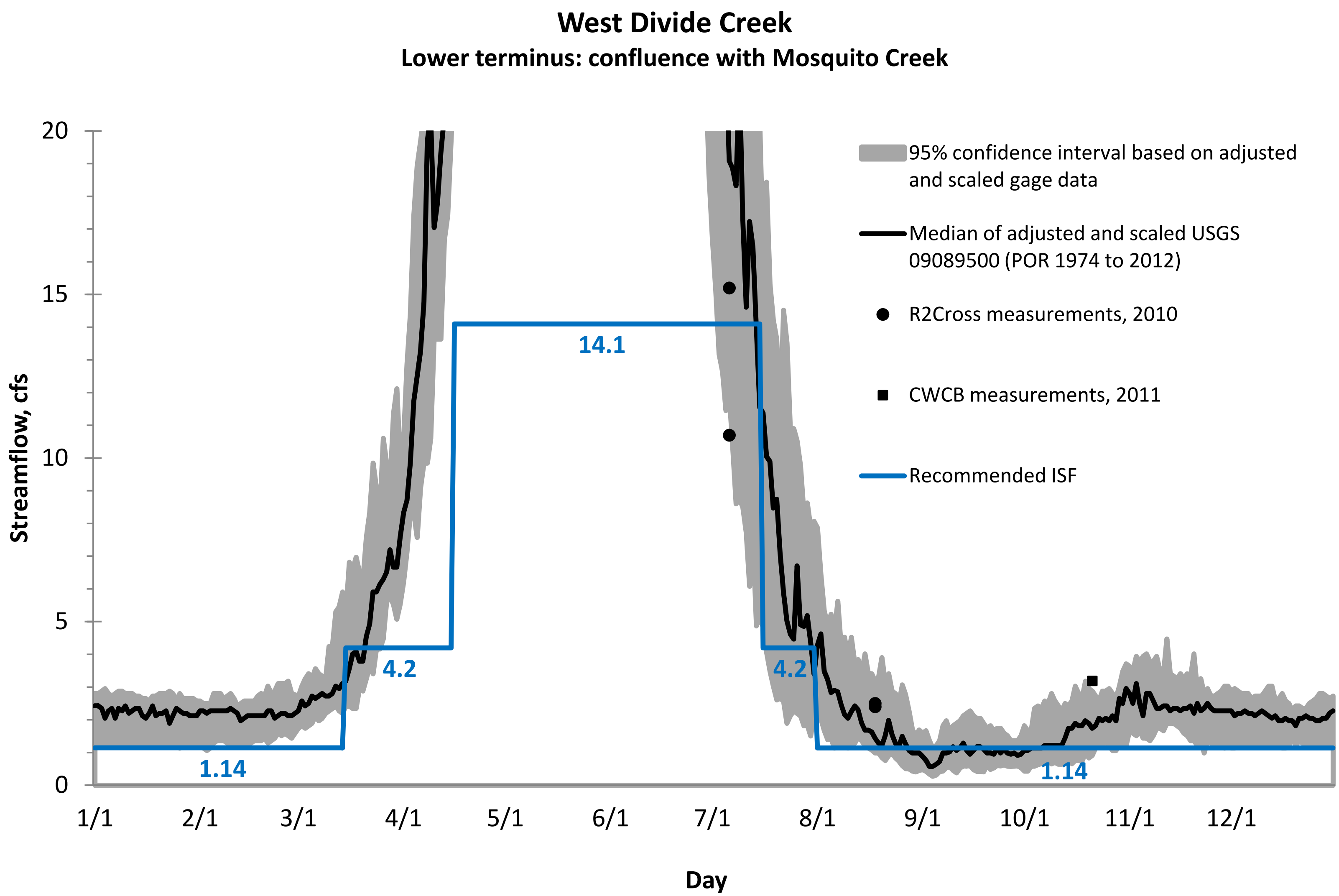
Water Availability



Water Availability



Water Availability




New Appropriation Process
Collect and analyze scientific information related to the required statutory findings and conduct outreach activities with stakeholders so that the Board can declare its intent to appropriate and take final action on the recommendation.

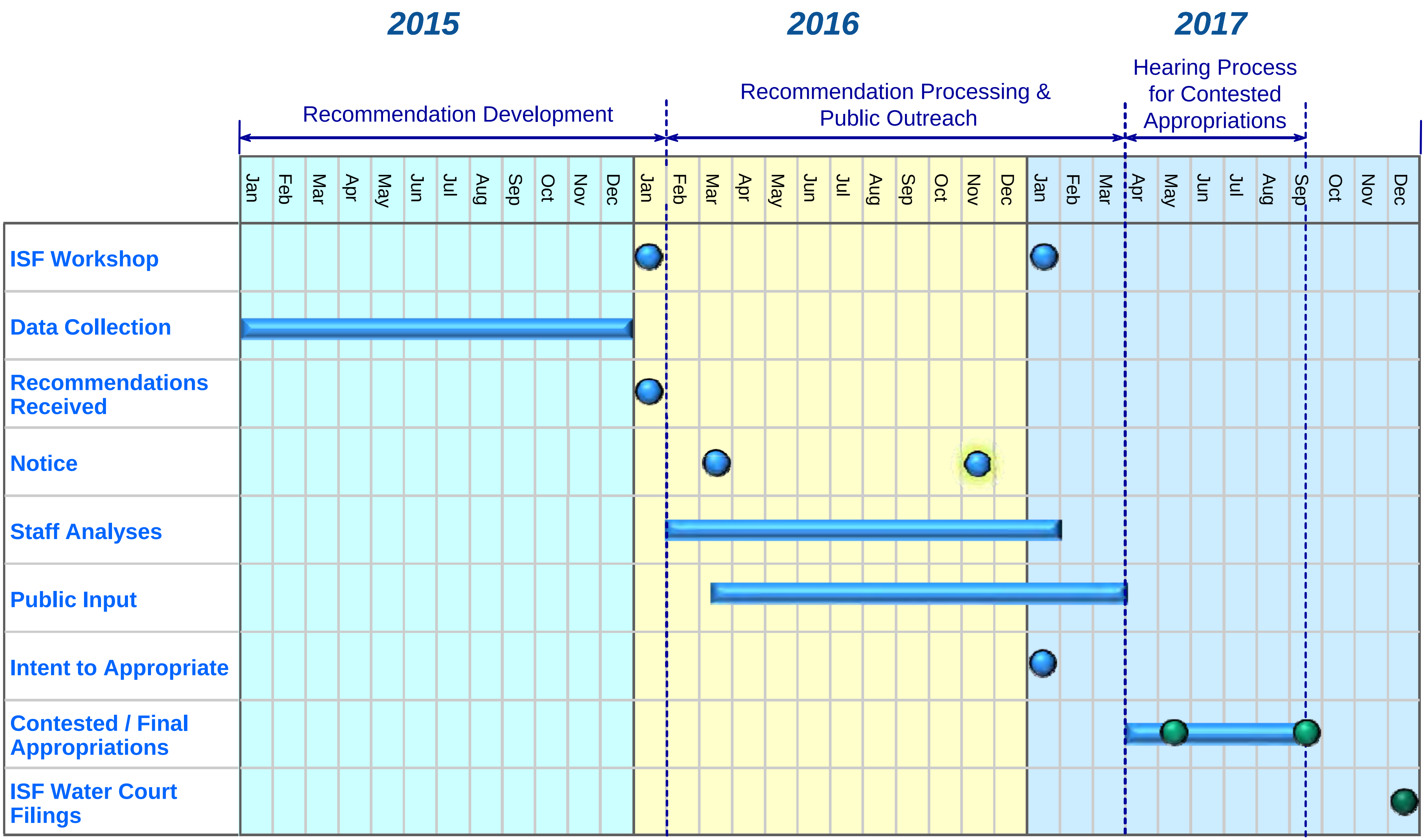
Recommending Entity's Role

- Identify the stream or lake of interest and provide location information and termini for stream reaches (UTM locations, Division, County, etc).
- Identify the aspects of the natural environment that would be preserved with an ISF or NLL water right (Provide any supporting reports, fish surveys, photos).
- Quantify the amount of water needed using standard methodologies: R2Cross, PHABSIM, River2D, etc.
- Prepare a cursory analysis of water availability (ie: Streamstats, water rights review).
- Identify stakeholders and participate in staff outreach efforts.
- Identify any specific stream access issues.
- Testify on natural environment and quantification science at a potential contested hearing.

CWCB Staff's Role

- Review and analyze data provided by the recommending entity.
- Prepare a detailed water availability analysis
- Perform a site investigation on each stream and collect additional data as necessary.
- Provide notice and outreach to stakeholders
- Prepare executive summaries for the Board for each stream that provide sufficient information for the Board to make its statutory findings.
- Move the recommendation through the Board's ISF Rule 5 process from appropriation to filing with the water court. (If contested, staff will work with the recommending entity to support the appropriation).

New Appropriation Processing Timeline



Acquisitions

(ISF Rule 6 Procedure)

Blue River – Boulder Creek Confluence, Peabody Ditch Acquisition

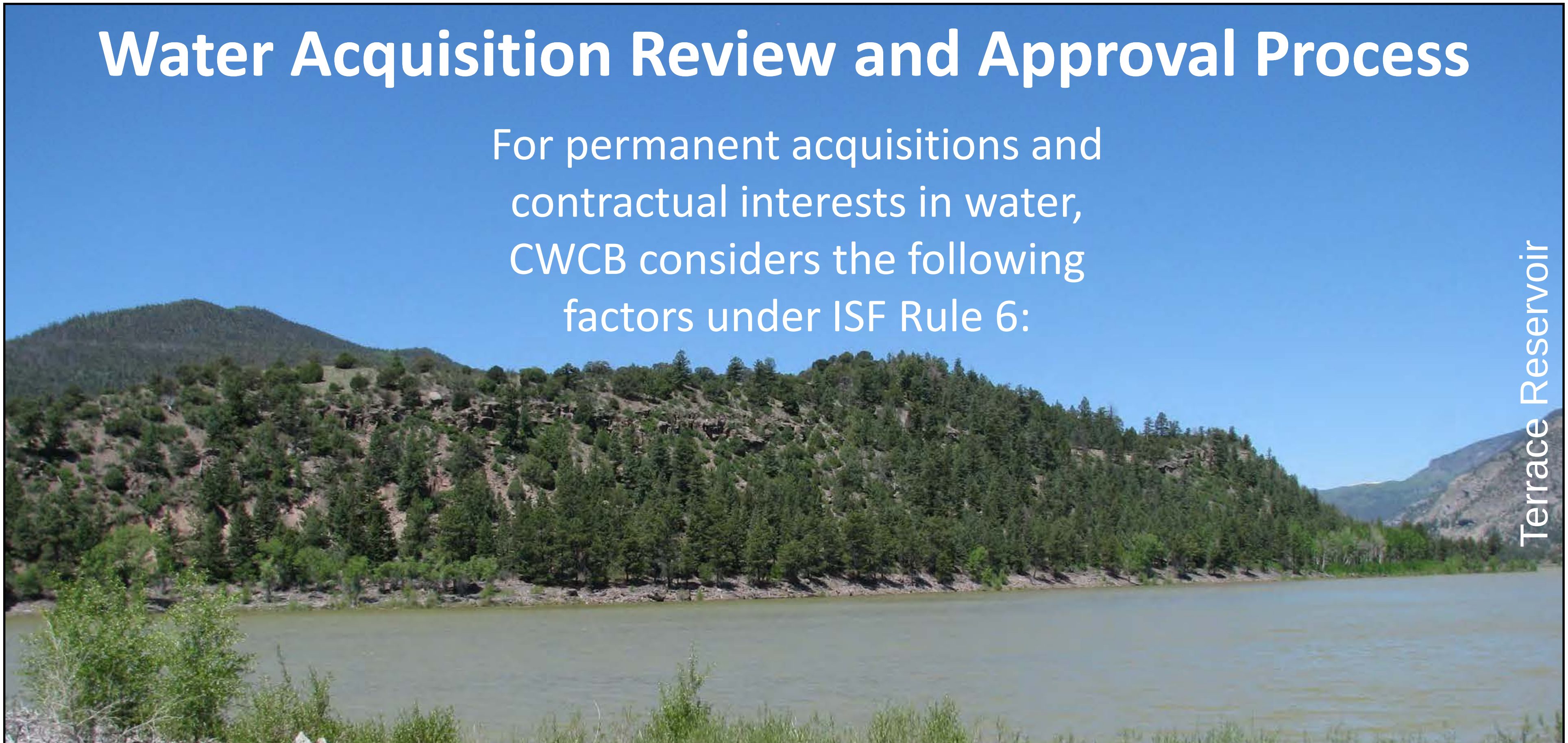
CWCB can acquire water :

- in amounts it determines appropriate to preserve or **improve** the natural environment to a reasonable degree
- by donation, purchase, lease, or other contract
- on a permanent or temporary basis
- from willing water rights owners.

CWCB may use any funds available to it for water acquisitions (Construction Fund, Species Conservation Trust Fund)

Water Acquisition Review and Approval Process

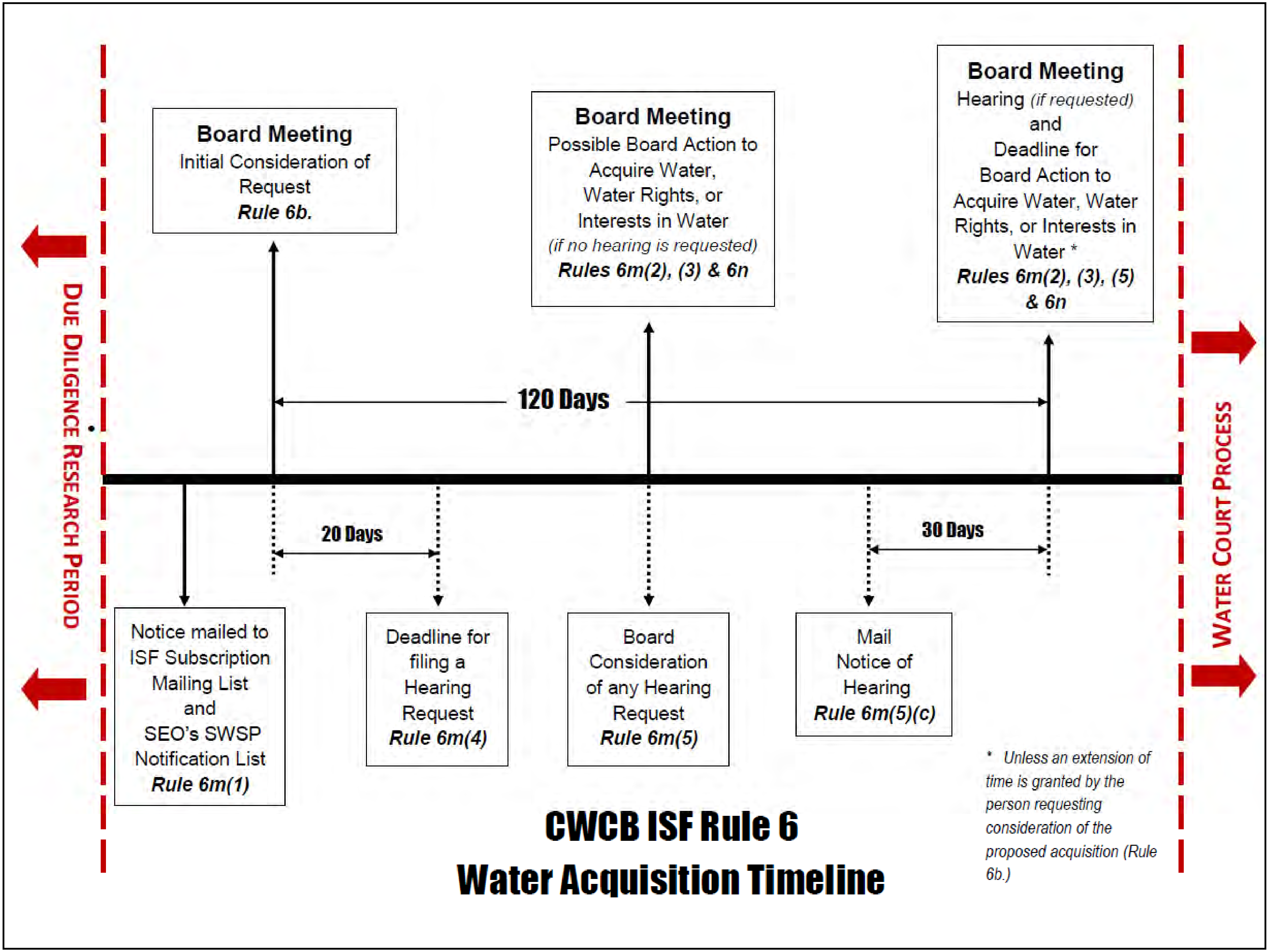
For permanent acquisitions and contractual interests in water, CWCB considers the following factors under ISF Rule 6:

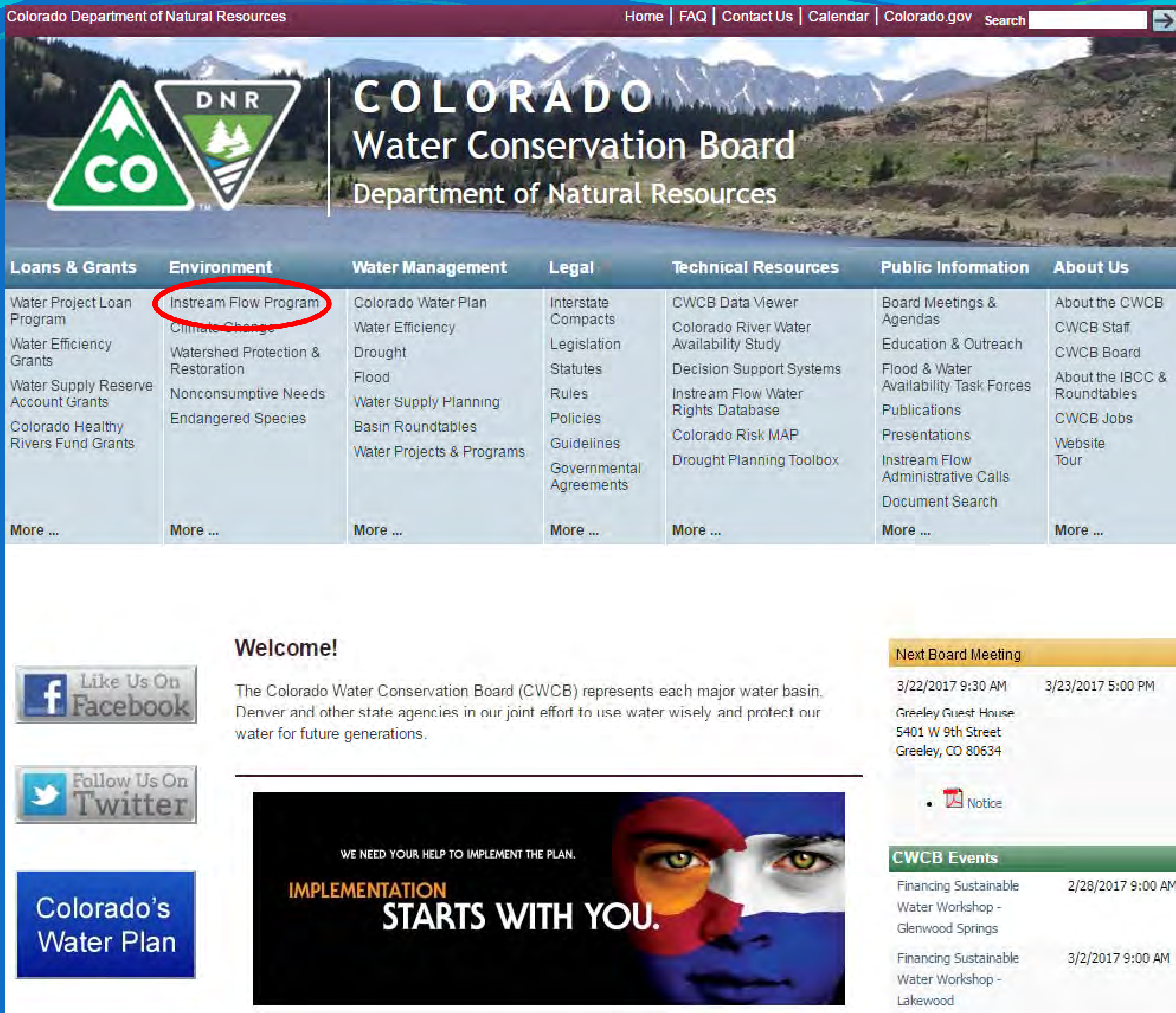


Terrace Reservoir

- Reach of stream where acquired water will be used
- Historical use and return flows
- Location of other water rights on reach
- Potential for material injury to existing decreed water rights

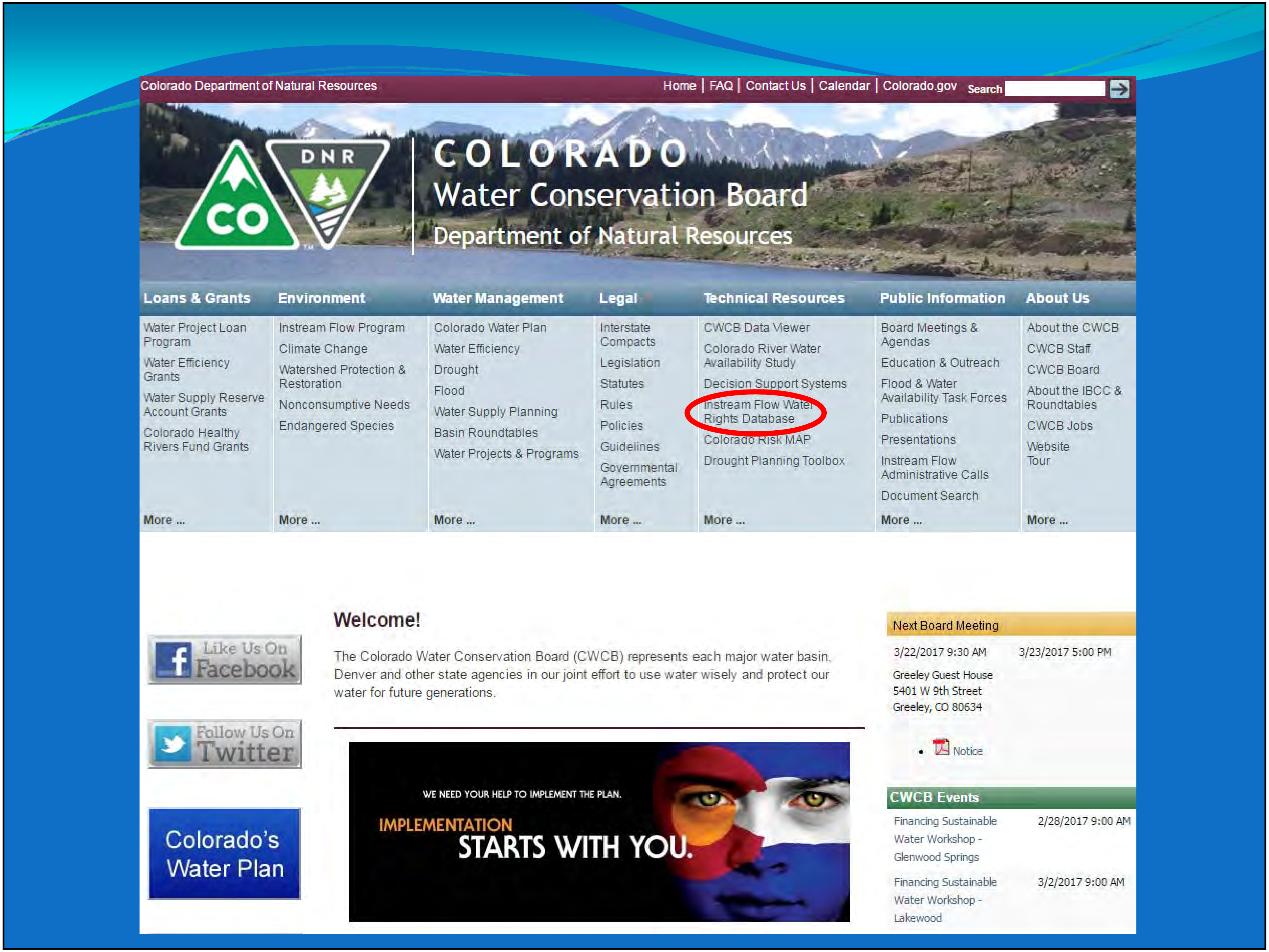
Restored Alamosa River


Due Diligence Research Period
Board Meeting
Initial Consideration of Request
Rule 6b.
Board Meeting
Possible Board Action to Acquire Water, Water Rights, or Interests in Water
(if no hearing is requested)
Rules 6m(2), (3) & 6n
Board Meeting
Hearing (if requested)
and
Deadline for Board Action to Acquire Water, Water Rights, or Interests in Water *
Rules 6m(2), (3), (5) & 6n
120 Days
Water Court Process
20 Days
30 Days
Notice mailed to ISF Subscription Mailing List and SEO's SWSP Notification List
Rule 6m(1)
Deadline for filing a Hearing Request
Rule 6m(4)
Board Consideration of any Hearing Request
Rule 6m(5)
Mail Notice of Hearing
Rule 6m(5)(c)
* Unless an extension of time is granted by the person requesting consideration of the proposed acquisition (Rule 6b.)
CWCB ISF Rule 6
Water Acquisition Timeline


Colorado Department of Natural Resources
Home | FAQ | Contact Us | Calendar | Colorado.gov
Search
DNR
CO
COLORADO
Water Conservation Board
Department of Natural Resources
Loans & Grants
Water Project Loan Program
Water Efficiency Grants
Water Supply Reserve Account Grants
Colorado Healthy Rivers Fund Grants
More ...
Environment
Instream Flow Program
Climate Change
Watershed Protection & Restoration
Nonconsumptive Needs
Endangered Species
More ...
Water Management
Colorado Water Plan
Water Efficiency
Drought
Flood
Water Supply Planning
Basin Roundtables
Water Projects & Programs
More ...
Legal
Interstate Compacts
Legislation
Statutes
Rules
Policies
Guidelines
Governmental Agreements
More ...
Technical Resources
CWCB Data Viewer
Colorado River Water Availability Study
Decision Support Systems
Instream Flow Water Rights Database
Colorado Risk MAP
Drought Planning Toolbox
More ...
Public Information
Board Meetings & Agendas
Education & Outreach
Flood & Water Availability Task Forces
Publications
Presentations
Instream Flow Administrative Calls
Document Search
More ...
About Us
About the CWCB
CWCB Staff
CWCB Board
About the IBCC & Roundtables
CWCB Jobs
Website Tour
More ...
Like Us On Facebook
Follow Us On Twitter
Colorado's Water Plan
Welcome!
The Colorado Water Conservation Board (CWCB) represents each major water basin, Denver and other state agencies in our joint effort to use water wisely and protect our water for future generations.
WE NEED YOUR HELP TO IMPLEMENT THE PLAN.
IMPLEMENTATION
STARTS WITH YOU.
Next Board Meeting
3/22/2017 9:30 AM
3/23/2017 5:00 PM
Greeley Guest House
5401 W 9th Street
Greeley, CO 80634
Notice
CWCB Events
Financing Sustainable Water Workshop - Glenwood Springs
2/28/2017 9:00 AM
Financing Sustainable Water Workshop - Lakewood
3/2/2017 9:00 AM

ISF Web Site

http://cwcb.state.co.us/environment/instream-flow-program/Pages/main.aspx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Colorado's Water Plan
Welcome!
The Colorado Water Conservation Board (CWCB) represents each major water basin, Denver and other state agencies in our joint effort to use water wisely and protect our water for future generations.
WE NEED YOUR HELP TO IMPLEMENT THE PLAN.
IMPLEMENTATION
STARTS WITH YOU.
Next Board Meeting
3/22/2017 9:30 AM
3/23/2017 5:00 PM
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5401 W 9th Street
Greeley, CO 80634
Notice
CWCB Events
Financing Sustainable Water Workshop - Glenwood Springs
2/28/2017 9:00 AM
Financing Sustainable Water Workshop - Lakewood
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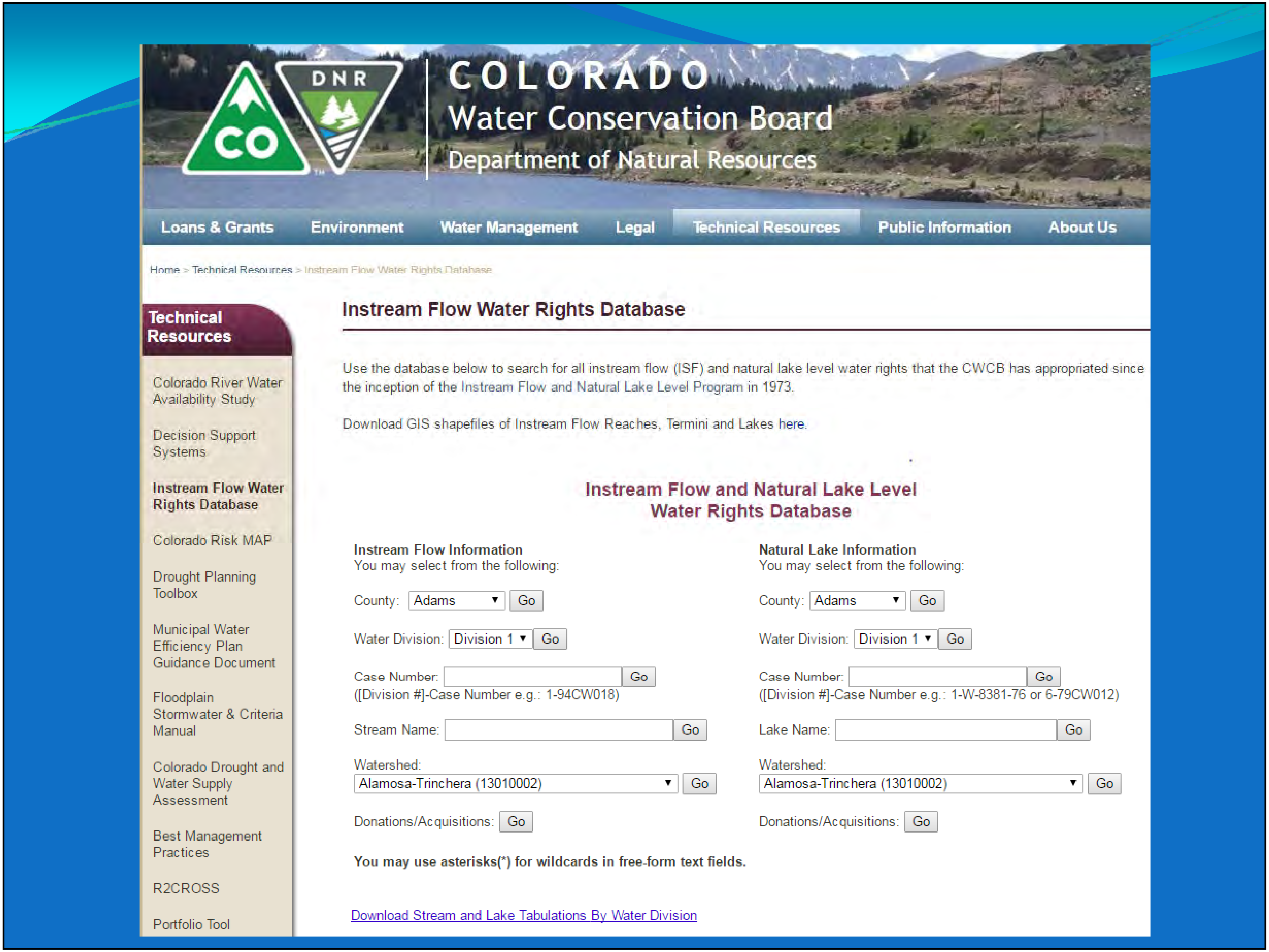
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Colorado Risk MAP
Drought Planning Toolbox
Municipal Water Efficiency Plan Guidance Document
Floodplain Stormwater & Criteria Manual
Colorado Drought and Water Supply Assessment
Best Management Practices
R2CROSS
Portfolio Tool
Instream Flow Water Rights Database
Use the database below to search for all instream flow (ISF) and natural lake level water rights that the CWCB has appropriated since the inception of the Instream Flow and Natural Lake Level Program in 1973.
Download GIS shapefiles of Instream Flow Reaches, Termini and Lakes here.
Instream Flow and Natural Lake Level Water Rights Database
Instream Flow Information
You may select from the following:
County: Adams Go
Water Division: Division 1 Go
Case Number: Go
([Division #]-Case Number e.g.: 1-94CW018)
Stream Name: Go
Watershed:
Alamosa-Trinchera (13010002) Go
Donations/Acquisitions: Go
Natural Lake Information
You may select from the following:
County: Adams Go
Water Division: Division 1 Go
Case Number: Go
([Division #]-Case Number e.g.: 1-W-8381-76 or 6-79CW012)
Lake Name: Go
Watershed:
Alamosa-Trinchera (13010002) Go
Donations/Acquisitions: Go
You may use asterisks(*) for wildcards in free-form text fields.
Download Stream and Lake Tabulations By Water Division

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Colorado's Water Plan

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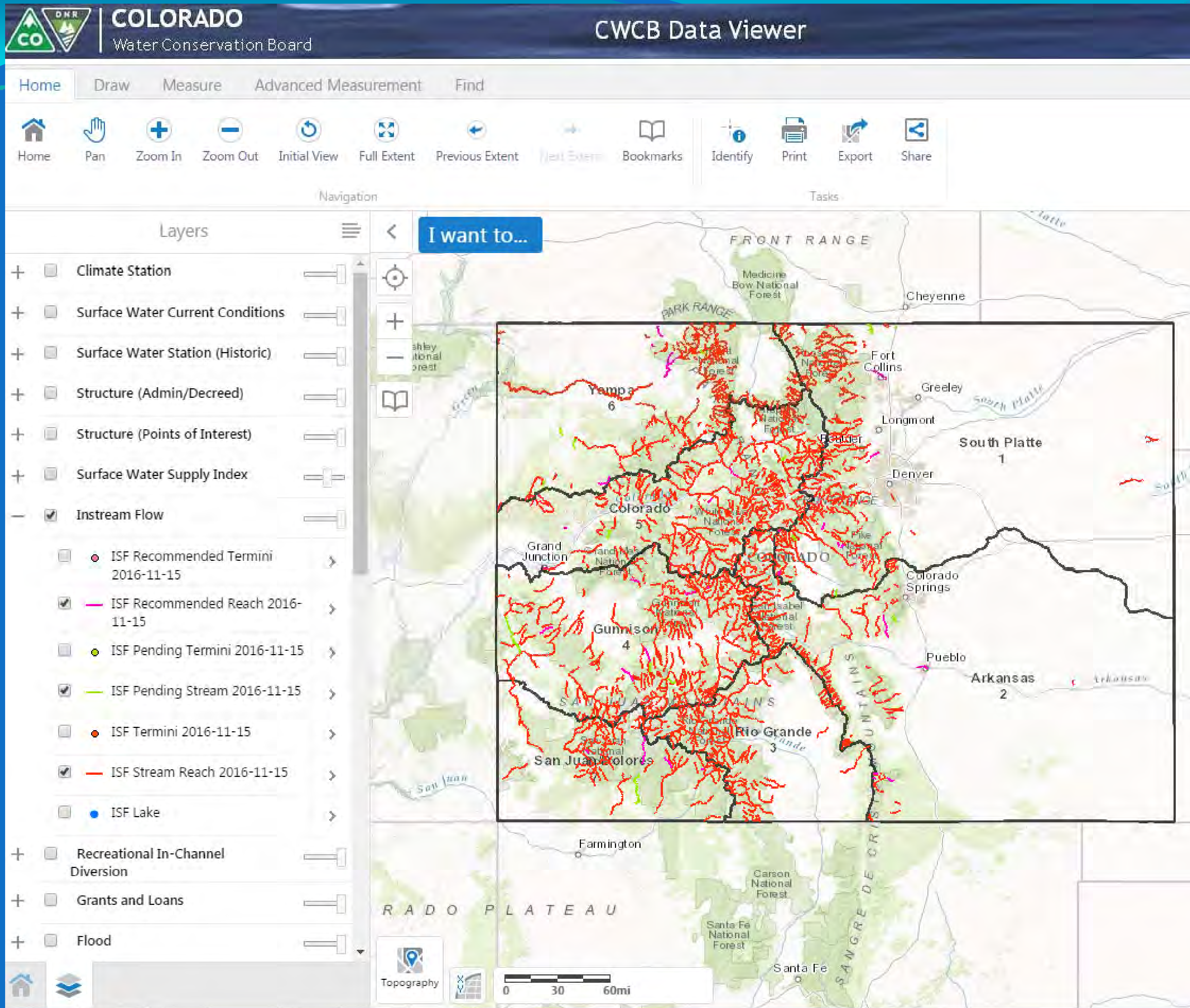
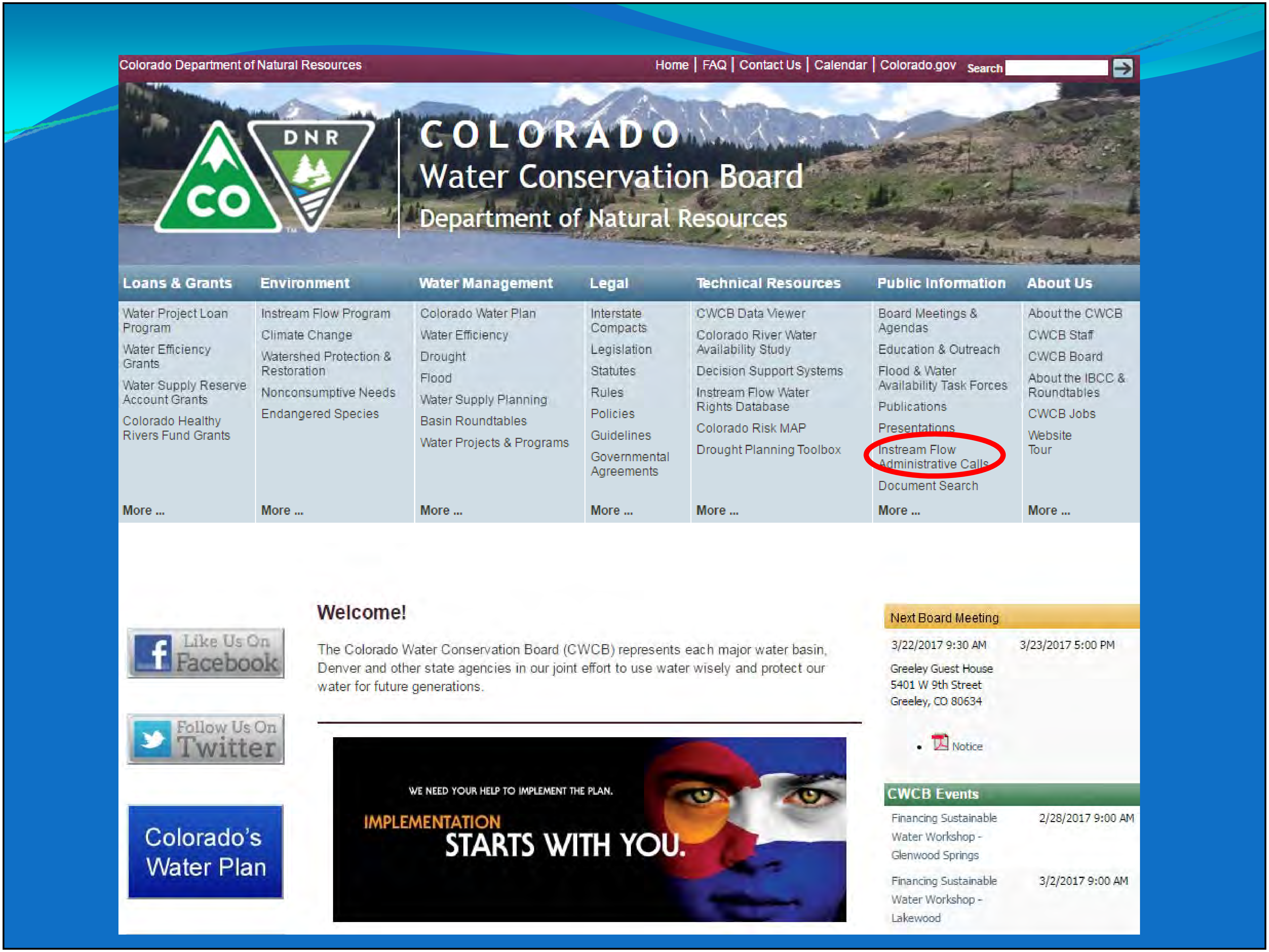
EXHIBIT G Slide 42

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Questions?
Jeff Baessler
303-866-3441 x3202

Instream Flow Administrative Calls

The CWCB monitors streamflow to ensure decreed instream flow (ISF) water rights are protected. If streamflow drops lower than the amount decreed to an ISF water right, and that right is in priority, staff may place an administrative call for water. The following links provide information about specific calls for water.

Recent Calls

STREAM NAME	CASE NUMBER	DATE OF FORMAL WRITTEN CALL
Dolores River	7-75W1346	October 4, 2016
Colorado River	5-80CW0447	October 3, 2016
Slate River	4-80CW0092	September 16, 2016
Eagle River	5-77W3811	September 8, 2016
Crystal River	5-77W2720	August 31, 2016
Elk River	6-77W1279 6-77W1331	August 17, 2016
Roaring Fork River	5-76W2948	March 25, 2016
St. Louis Creek	5-90CW317	November 16, 2015
Colorado River	5-80CW447	November 13, 2015
Slate River	4-80CW092	October 16, 2015
Elk River	6-77W1279 6-77W1331	September 2, 2015
Colorado River	5-80CW447	December 12, 2014
Tenmile Creek	5-86CW209	December 12, 2014
Slate River	4-80CW092	September 4, 2013
Elk River	6-77W1279 6-77W1331	August 21, 2013
Pine Creek	2-77W4674	May 13, 2013
Taylor River	4-87CW264	April 19, 2013

Additional Information

- Instream Flow Program
- Instream Flow Appropriations
- Water Acquisitions
- Monitoring and Enforcement

ISF Acquisition Administrative Calls

Review administrative calls on acquired water from previous water years. Wildcards (*) may be used in the Case Number and Stream Name fields as necessary.

Case Number

Stream Name

Document Type
Administration/Calls

Search

ISF Appropriation Administrative Calls

Review administrative calls on appropriated water from previous water years. Wildcards (*) may be used in the Case Number and Stream Name fields as necessary.


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Structures (Diversions)
Water Rights
Map Viewer
Ground Water (Water Levels)
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Software Products
StateCU
StateDGI
StateDMI
StateMod
StateView
StateWB
TSTool
Third Party Software
Modeling Data
Consumptive Use (StateCU)
Surface Water (StateMod)
Groundwater (MODFLOW)
Water Budget (StateWB)
GIS Data
Division 1 South Platte
Division 2 Arkansas
Division 3 Rio Grande
Division 4 Gunnison
Division 5 Colorado
Division 6 Yampa / White
Division 7 San Juan / Dolores
More ...
Documents
Basin Reports
Meeting Materials
Modeling Briefs
Modeling Dataset Documentation
Peer Review
Publications
Reports
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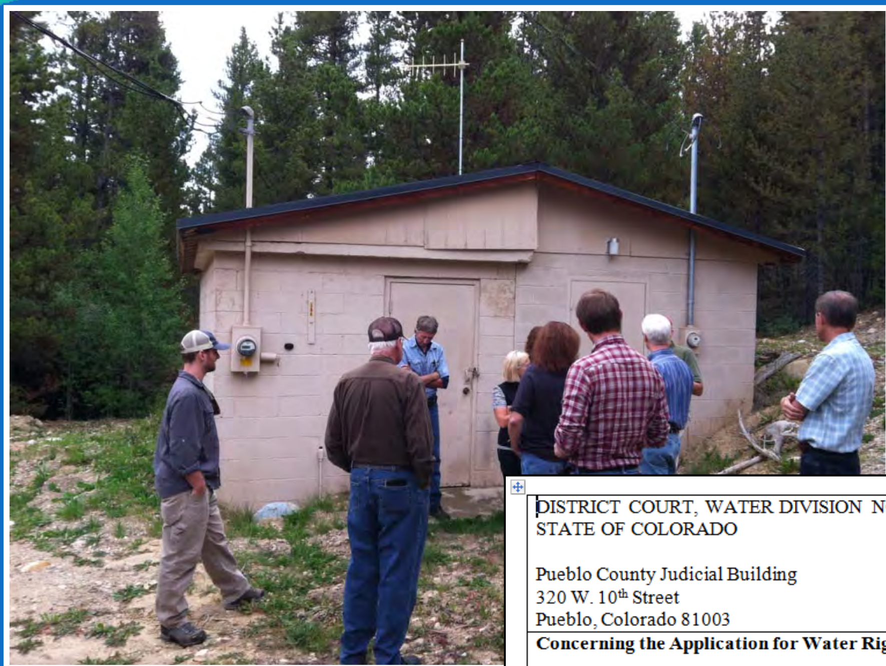
Welcome to Colorado's Decision Support Systems!
Colorado's Decision Support Systems (CDSS) is a water management system developed by the Colorado Water Conservation Board (CWCB) and the Colorado Division of Water Resources (DWR) for each of Colorado's major water basins.

Legal Protection



Parkville Water District

Bailey, Thomas

DISTRICT COURT, WATER DIVISION NO. 2 STATE OF COLORADO Pueblo County Judicial Building 320 W. 10th Street Pueblo, Colorado 81003	
Concerning the Application for Water Rights of: PARKVILLE WATER DISTRICT, IN LAKE COUNTY, COLORADO	▲ COURT USE ONLY ▲
Attorney for Applicants: HENRY D. WORLEY, #14368 Worley Law Firm, LLC 611 North Weber St., Ste. 104 Colorado Springs, CO 80903 Telephone: (719) 634-8330 Facsimile: (719) 471-3814 E-mail: hank.worley@psisys.net Attorney for Opposer: JOHN W. SUTHERS, Attorney General DEREK L. TURNER, #44091* Assistant Attorney General 1525 Sherman Street, 7th Floor Denver, CO 80203 Telephone: (303) 866-3505 e-mail address: derek.turner@state.co.us *Counsel of Record	Case No.: 2009CW149

STIPULATION BETWEEN PARKVILLE WATER DISTRICT AND THE COLORADO WATER CONSERVATION BOARD

Legal Protection

ISF water rights are adjudicated and administered within Colorado's priority system, like all other water rights in the state.

All decreed water rights are entitled to stream conditions as they existed at the time of appropriation.

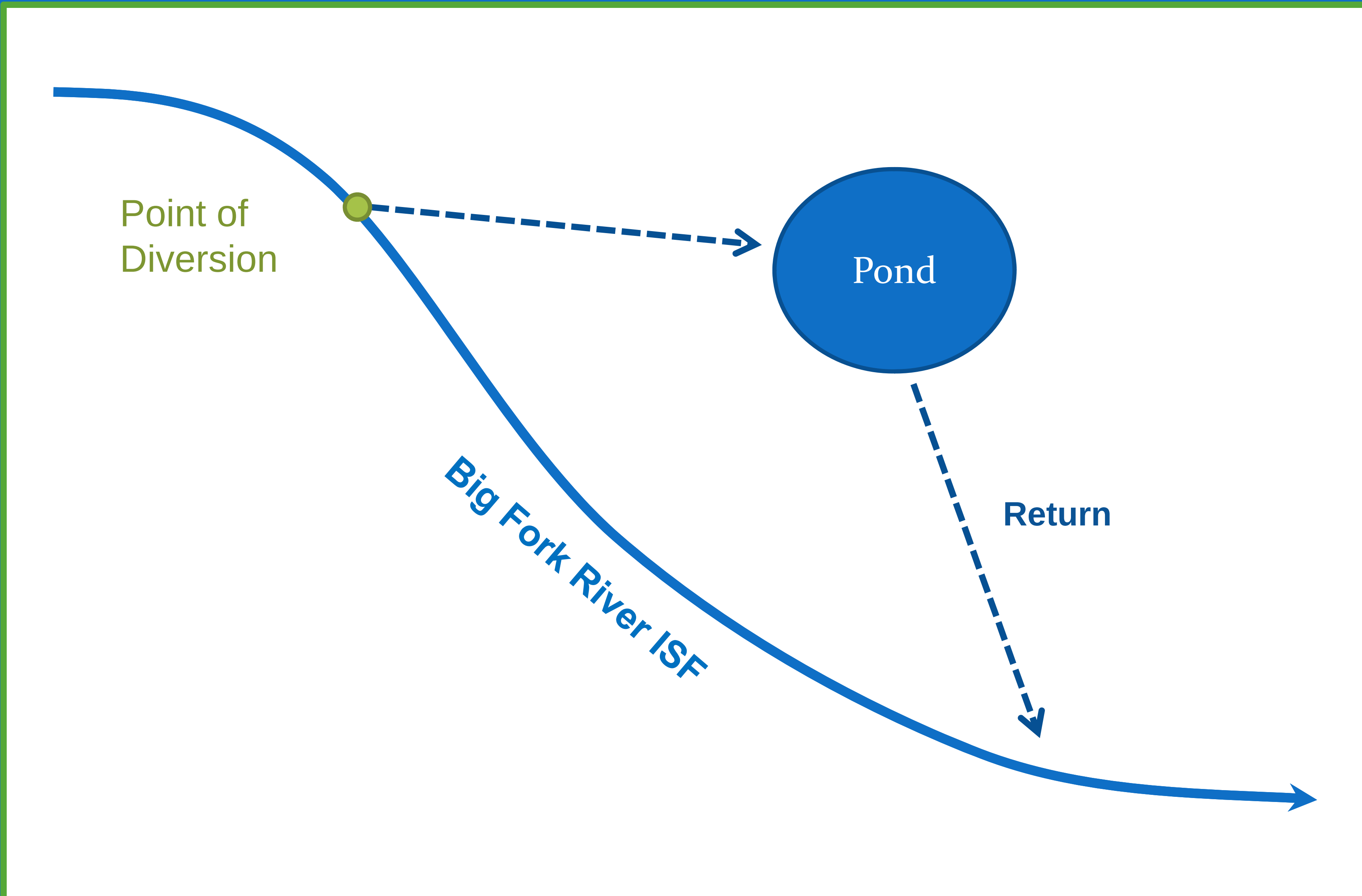
CWCB has standing in Water Court to ensure changes to senior rights do not alter stream conditions in a way that injures decreed ISF water rights.

Eldorado Artesian Springs – South Boulder Creek

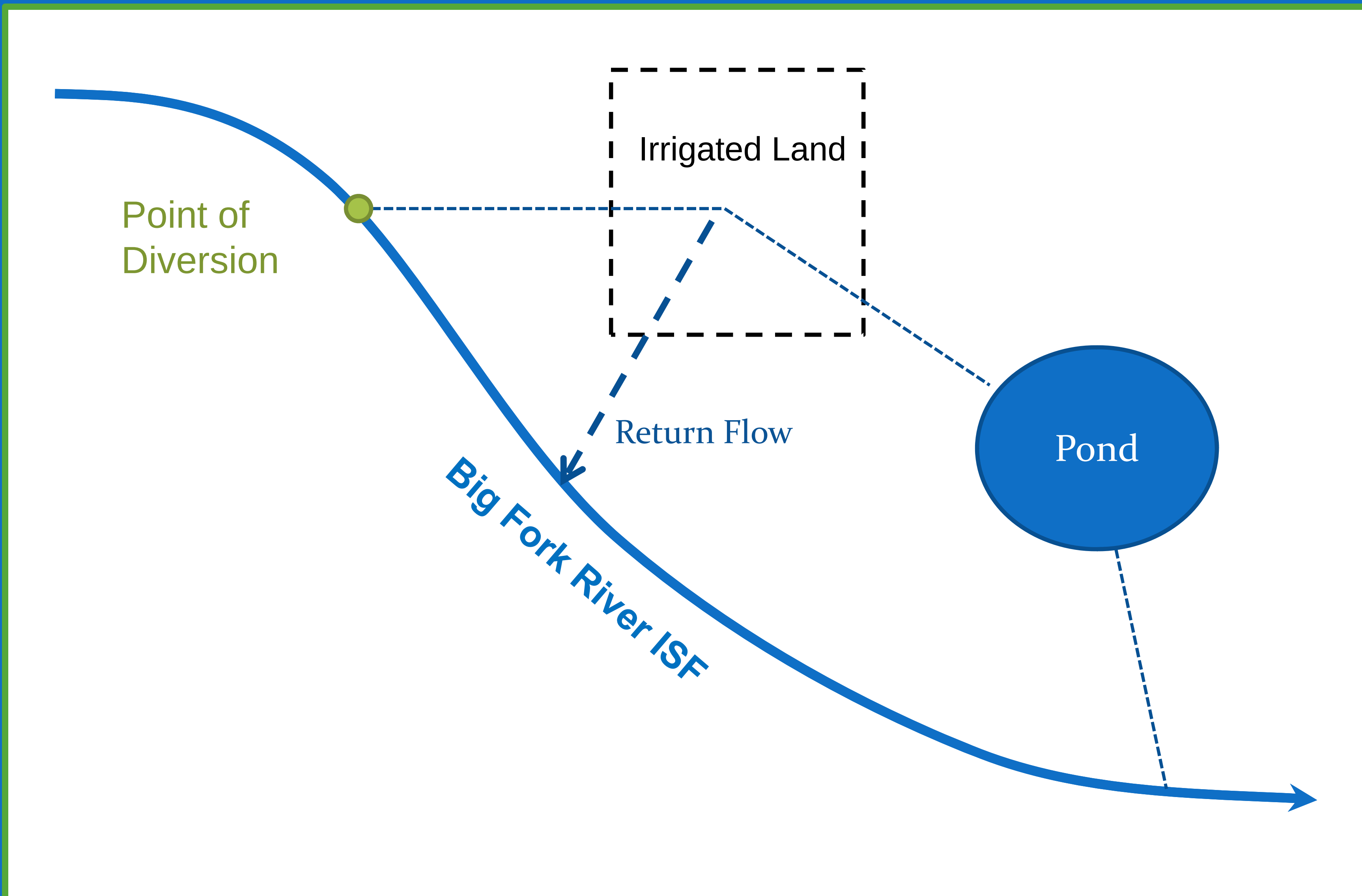
Legal Protection Issues

- Augmentation Plans Based Upon Call Record.
- Exchanges Without Upstream Replacement.
- Flow-through Diversions and Hydropower
- Return Flows and Augmentation Ponds that Release at the Lower End of the Site.

Flow-through Diversions



Augmentation Plan



Monitoring & Administration

Crystal River Satellite Monitoring gage

CWCB installs new stream gages and cooperates with USGS and DWR on existing stream gages.

Real time monitoring by over 125 gages via the DWR / CWCB flow alert system—sends email alerts to staff.

Staff gages and interested stakeholders also alert staff to observed or suspected low flow conditions.

Staff coordinates with the DWR on low flow conditions and places administrative calls for ISFs when warranted.

Questions ?

OVERVIEW OF COLORADO'S INSTREAM FLOW PROGRAM & ANALYSIS TOOLS

GRAD 592 Water Management in Colorado
November 6, 2017

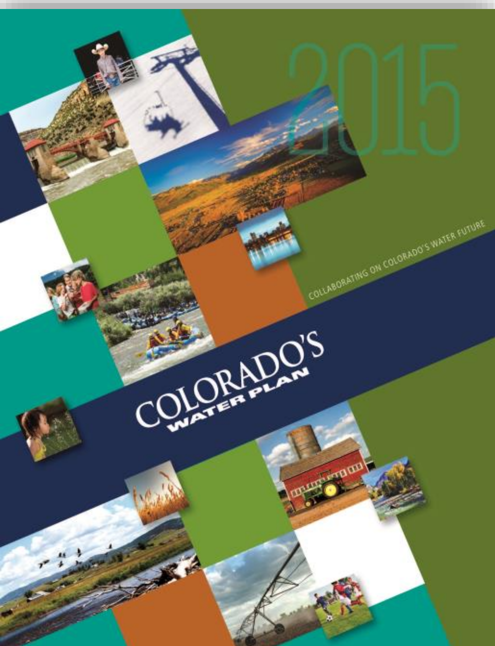
COLORADO
Colorado Water Conservation Board
Department of Natural Resources

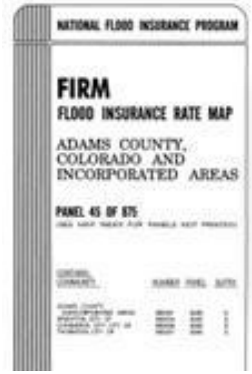
Linda Bassi
Brandy Logan

COLORADO WATER CONSERVATION BOARD

EXHIBIT H

Slide 2




NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

ADAMS COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 45 OF 875

Operations/Programs:

- Water Project Loan Program
- Water Conservation and Drought Planning
- Interstate Compact Protection
- Stream and Lake Protection
- Watershed & Flood Protection
- Decision Support Systems
- Water Supply Planning

ISF PROGRAM HISTORY

EXHIBIT H

Slide 3

1960s and 70s - Increasing public concern about the impact of human activities on the environment

Toxic Chemicals

1st Earth Day

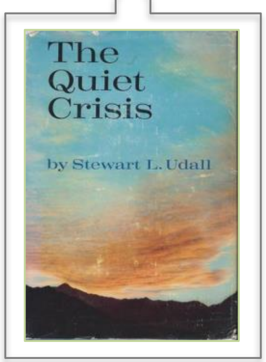
1970 National Environmental Policy Act

1972 Clean Water Act,
Costal Zone Mgt. Act
Marine Mammal Protection Act

1973 Endangered Species Act

1974 Safe Drinking Water Act

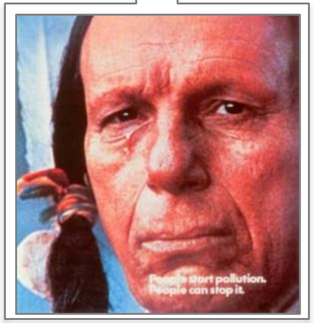
1960's **1970's**



Abuse of Nation's Natural Resources

1964
Wilderness
Preservation Act

1968
Wild and Scenic
Rivers Act



Keep America Beautiful Campaign

Creation of New Federal Agencies

EXHIBIT H

Slide 4

COLORADO IN THE 1970s

- Public concern over dry stream reaches
- No mechanism within the water rights system to keep water within a stream for environmental preservation
- Federal imposition of bypass flows on Fry-Ark project
- Threats of ballot initiative to allow private ISFs

Coal Creek near Crested Butte Colorado

EXHIBIT H

Slide 5

SENATE BILL 73-97

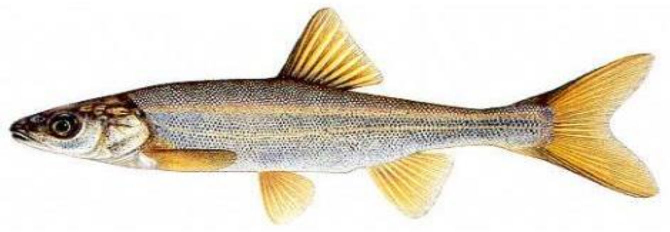
Established Colorado's Instream Flow Program

- Recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment"
- Vested the CWCB with the authority "on behalf of the people of the state of Colorado, to appropriate or acquire… such waters of natural streams and lakes as may be required to preserve the natural environment to a reasonable degree."

SENATE BILL 73-97

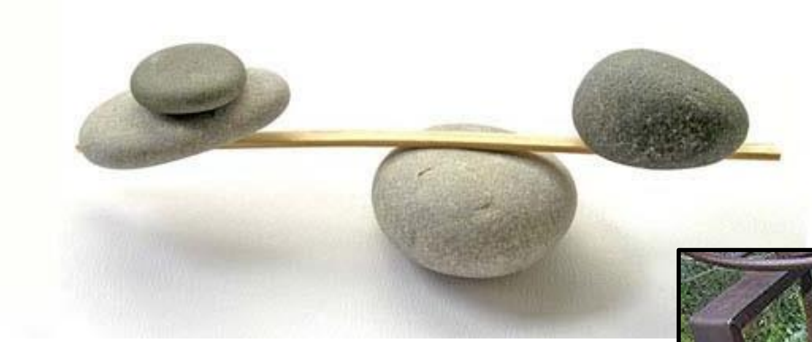
Instream Flow & Natural Lake Level water rights:

- In-channel or in-lake appropriations of water
- For minimum flows between specific points on a stream, or levels on natural lakes
- To preserve the natural environment to a reasonable degree
- Administered within the State's water right priority system
- Entitled to stream conditions existing at time of appropriation
- Made exclusively by CWCB



WHAT DOES THE PROGRAM ACCOMPLISH?

Maintains flows in streams to ensure preservation of the natural environment and achieves a balance with other beneficial uses of water in the state.



Provides regulatory certainty for water users by preserving the doctrine of prior appropriation and operating within the priority system.

TWO WAYS CWCB OBTAINS ISF WATER RIGHTS

New Appropriations

- Appropriate and adjudicate a new (junior) ISF water right for the **minimum required to preserve** the natural environment to a reasonable degree.

Water Acquisitions

- Acquire existing water rights and change to ISF use **in amounts CWCB determines appropriate to preserve or improve** the natural environment to a reasonable degree.

ISF PROGRAM AREAS

New Appropriations

Appropriate and adjudicate a new (junior) ISF water right for the minimum required to preserve the natural environment to a reasonable degree

Water Acquisitions

Acquire existing water rights and change to ISF use in amounts CWCB determines appropriate to preserve or improve the natural environment to a reasonable degree

Monitoring and Request for Administration

Actively monitor conditions at stream gages and initiate administrative calls as necessary to ensure ISF rights are met.

Legal Protection

Initiating legal action through Colorado's water courts when necessary to provide 100% protections of the state's decreed ISF rights.

Inter-Section Issues –
DSS, Wild and Scenic, State Water Plan, River Restoration, Stream Management Plans, etc.

NEW ISF APPROPRIATION PROCESS

- Any ***person*** or ***entity*** may recommend streams or lakes to be considered for appropriation to ***preserve*** the natural environment.

Recommendation Development (Year 1)

- Collect data and quantify flow requirements using standard methodology
- Submit recommendations "in writing and with specificity" at ISF workshop.

Recommendation Processing and Outreach Activities by Staff (Year 2)

- Public Notice in March and November
- Reviews submitted data and performs a detailed water availability analysis
- Perform site visits and collects additional data
- Holds public meetings to get input on recommendations

Board Appropriation Administrative Process (Year 3)

- Staff recommends Board form its intent to appropriate – *typically at the Board's January Meeting.*
- If recommendation contested, staff negotiates settlement or Board holds hearing (ISF Rule 5 notice and comment procedures)
- File application for ISF water right in water court

STATUTORY REQUIREMENTS

The Board must make 3 determinations before applying to water court for an ISF water right:

(1) A natural environment exists

Typically identified by the presence of a coldwater fishery, but other indicators can be used (warm water fishery, riparian vegetation)

(2) Water is available for appropriation

- Determined by water right and hydrologic investigations
- Daily Median hydrology when available –water available 50% of time

(3) No material injury to other water rights will occur

- New appropriations are junior water rights and have no effect on existing senior appropriations
- 37-92-102(3) b. Recognition of existing undecreed uses and exchanges

CWCB'S WATER ACQUISITION PROGRAM

CWCB can acquire water:

- in amounts it determines appropriate to preserve or improve the natural environment to a reasonable degree
- by donation, purchase, lease, or other contract
- on a permanent or temporary basis
- from willing water rights owners.

Maroon Creek

CWCB may use any funds available to it for water acquisitions (Construction Fund, Species Conservation Trust Fund)

TYPES OF ISF ACQUISITIONS

Permanent:

- Donation or purchase
- Water right conveyed to CWCB
- Change water right to ISF use (water court)

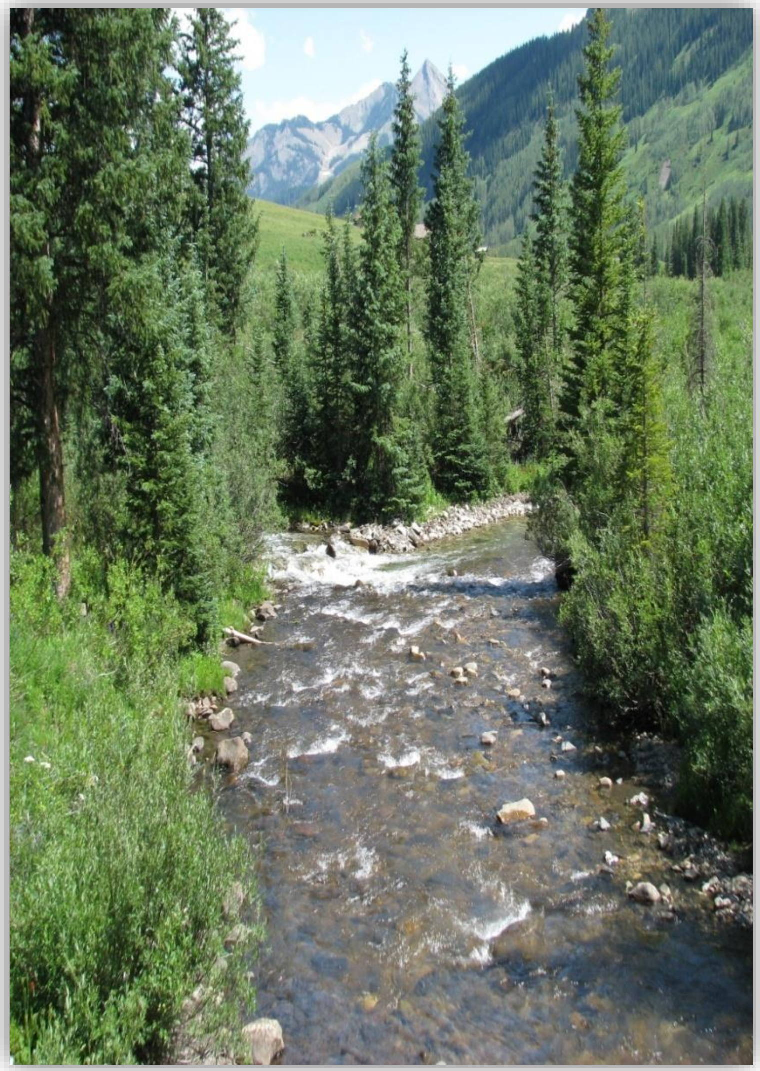
Contractual Interest:

- Can be for any time period
- Can be flexible to meet water right owner's needs
- CWCB must apply to water court to obtain a decreed right to use the water for ISF purposes
  - Add ISF as a decreed use
  - Ensure no injury to other water rights on stream

WATER ACQUISITION REVIEW & APPROVAL PROCESS

Using two-board meeting process, CWCB considers these factors:

- Reach of stream where acquired water will be used
- Historical use and return flows
- Location of other water rights on reach
- Potential for material injury to existing decreed water rights
- Effect of proposed acquisition on
  - Interstate compact issues
  - Maximum utilization of waters of state
- Whether water will be available for subsequent use downstream
- Water administration issues, if any



ACQUISITION AGREEMENTS & WATER COURT ACTION

Every transaction requires a written agreement.

- Developed cooperatively with water right owner.
- Outlines the terms and conditions of the conveyance.
- Can address water court responsibilities, streamflow monitoring, protection and enforcement of the conveyed right, and other issues.
- Enforceable by either party as a water matter in water court.

CWCB must apply to water court to obtain a decreed right to use that water for ISF purposes – usually a change of water right.

NO INJURY TO OTHER WATER RIGHTS!

LEGAL PROTECTION

ISF water rights are adjudicated and administered within Colorado's priority system, like all other water rights in the state.

All decreed water rights are entitled to stream conditions as they existed at the time of appropriation.

CWCB has standing in Water Court to ensure changes to senior rights do not alter stream conditions in a way that injures decreed ISF water rights.

Eldorado Artesian Springs – South Boulder Creek

LEGAL PROTECTION

CWCB staff:

- reviews water court resumes each month for applications that could injure ISF water rights
- files statements of opposition to such applications
- works with the AG's Office to negotiate terms and conditions to include in water court decree that protect the ISF

Injury can result from:

- Plans for augmentation
- Changes of water rights
- Inundation

Aldasoro Ranch Homeowners

MONITORING AND ENFORCEMENT

Crystal River Satellite Monitoring gage

CWCB installs new stream gages and cooperates with USGS and DWR on existing stream gages.

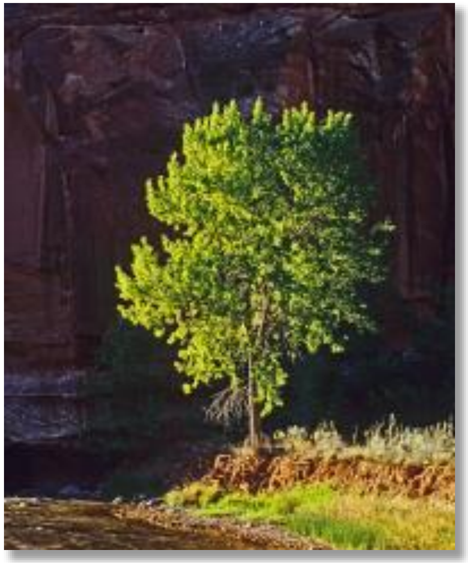
Real time monitoring by over 150 gages via the DWR / CWCB flow alert system—sends email alerts to staff.

Staff gages and interested stakeholders also alert staff to observed or suspected low flow conditions.

Staff coordinates with the DWR on low flow conditions and places administrative calls for ISF water rights when warranted.

NATURAL ENVIRONMENT

flannelmouth sucker



Colorado cutthroat trout

brook trout

NATURAL ENVIRONMENT

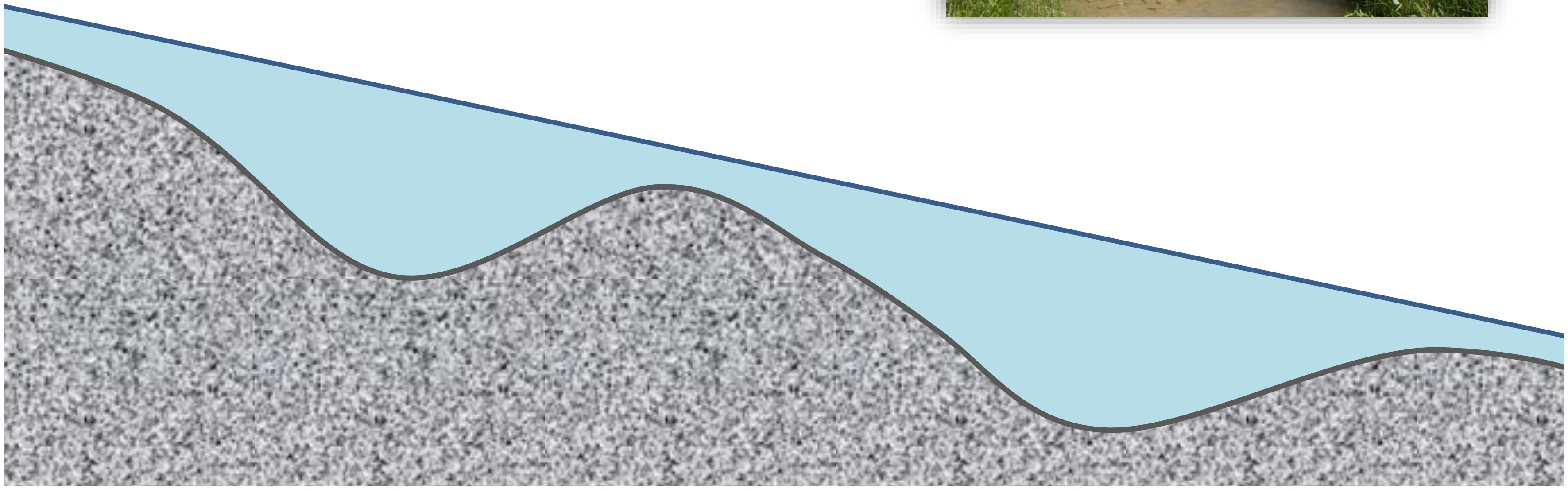
- Fish population surveys
- Botanical investigations
- Field Observations

Little Spring Creek – Data Collection

FLOW QUANTIFICATION

R2Cross

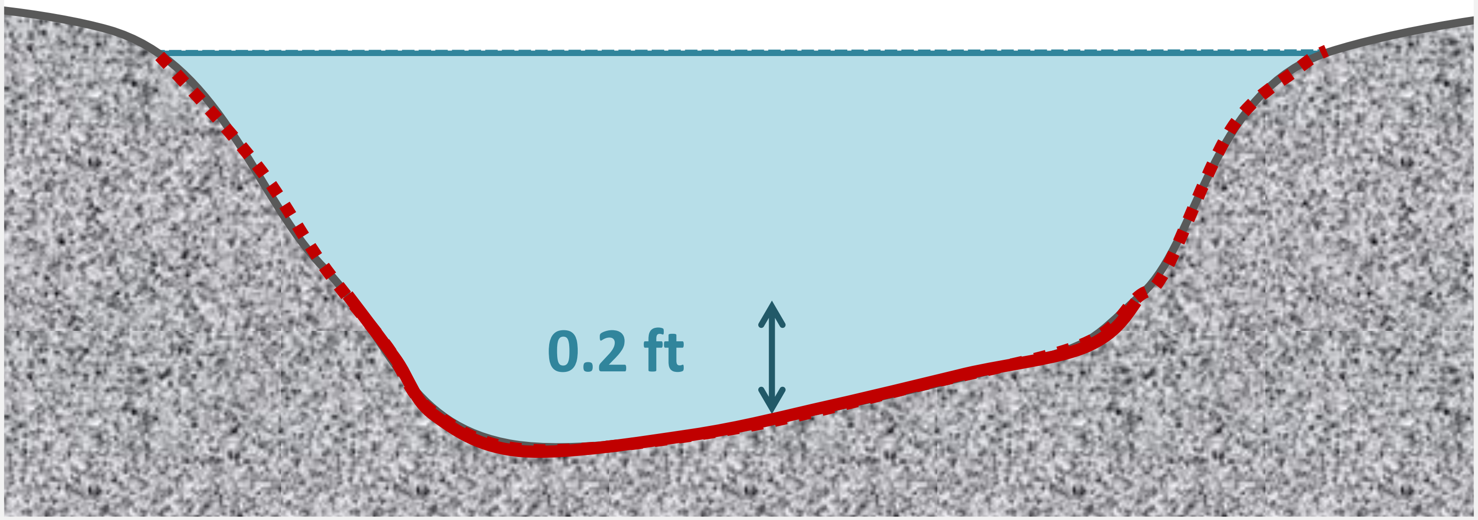
- 1D model determines the streamflow that will maintain hydraulic parameters related to fish habitat



FLOW QUANTIFICATION

Habitat Criteria

- 1 ft/second average flow velocity
- 0.2 ft average depth
- 50% of wetted perimeter



WATER AVAILABILITY

- Water balance approach
  - Median physically available streamflow
- Best available data
  - Streamflow gages
  - Diversion records
  - StreamStats
  - Temporary streamflow gages
  - Spot measurements

LOST CREEK

Natural Environment

Colorado River Cutthroat trout *
Mountain sucker *
Mottled sculpin
Speckled dace
Rainbow trout/hydrids*

Mountain sucker

LOST CREEK

LOST CREEK

Flow Quantification

Winter Rate = 1.1 cfs

Summer Rate = 6.8 cfs

EXHIBIT H

Slide 27

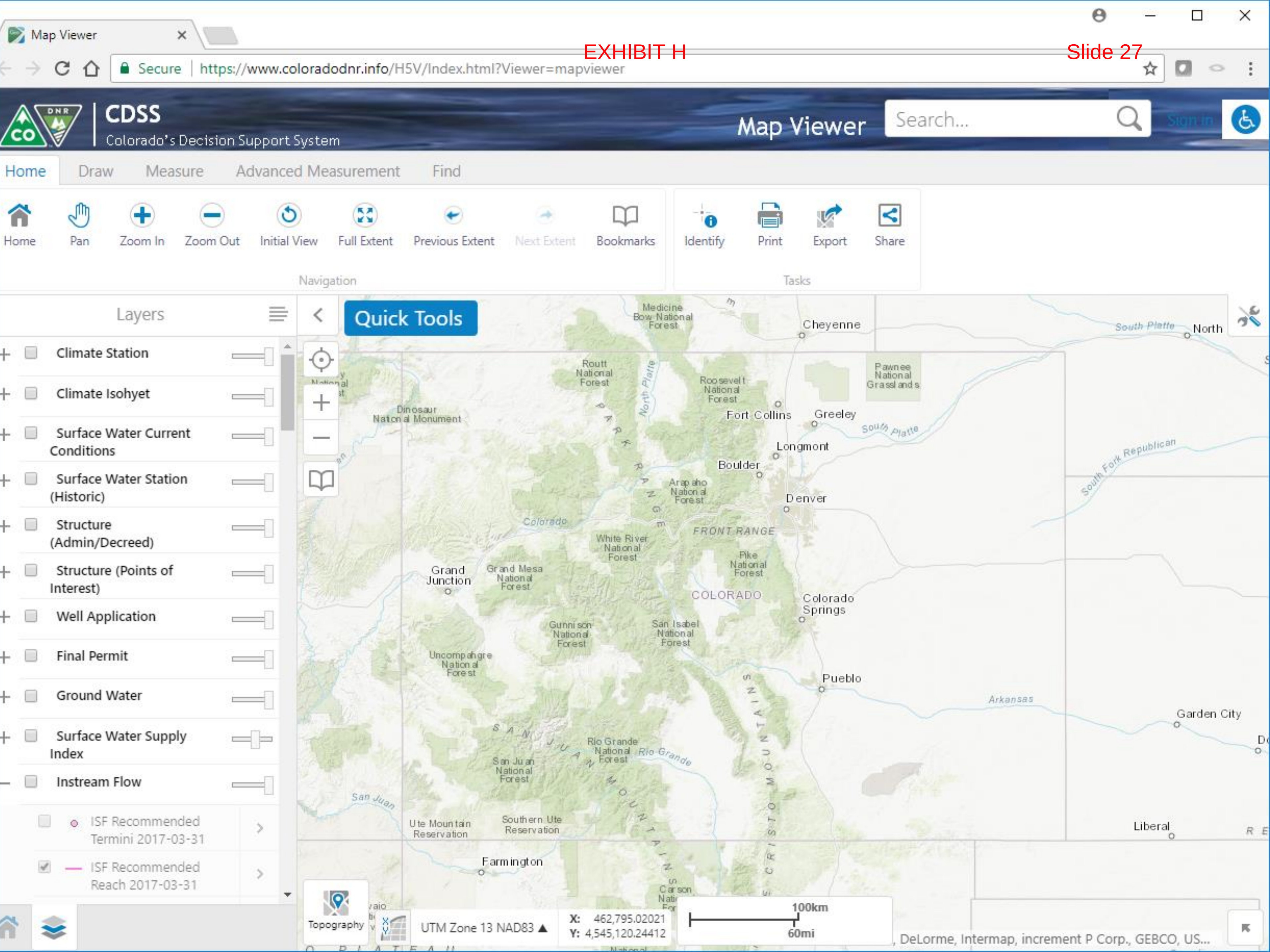


EXHIBIT H

Slide 28

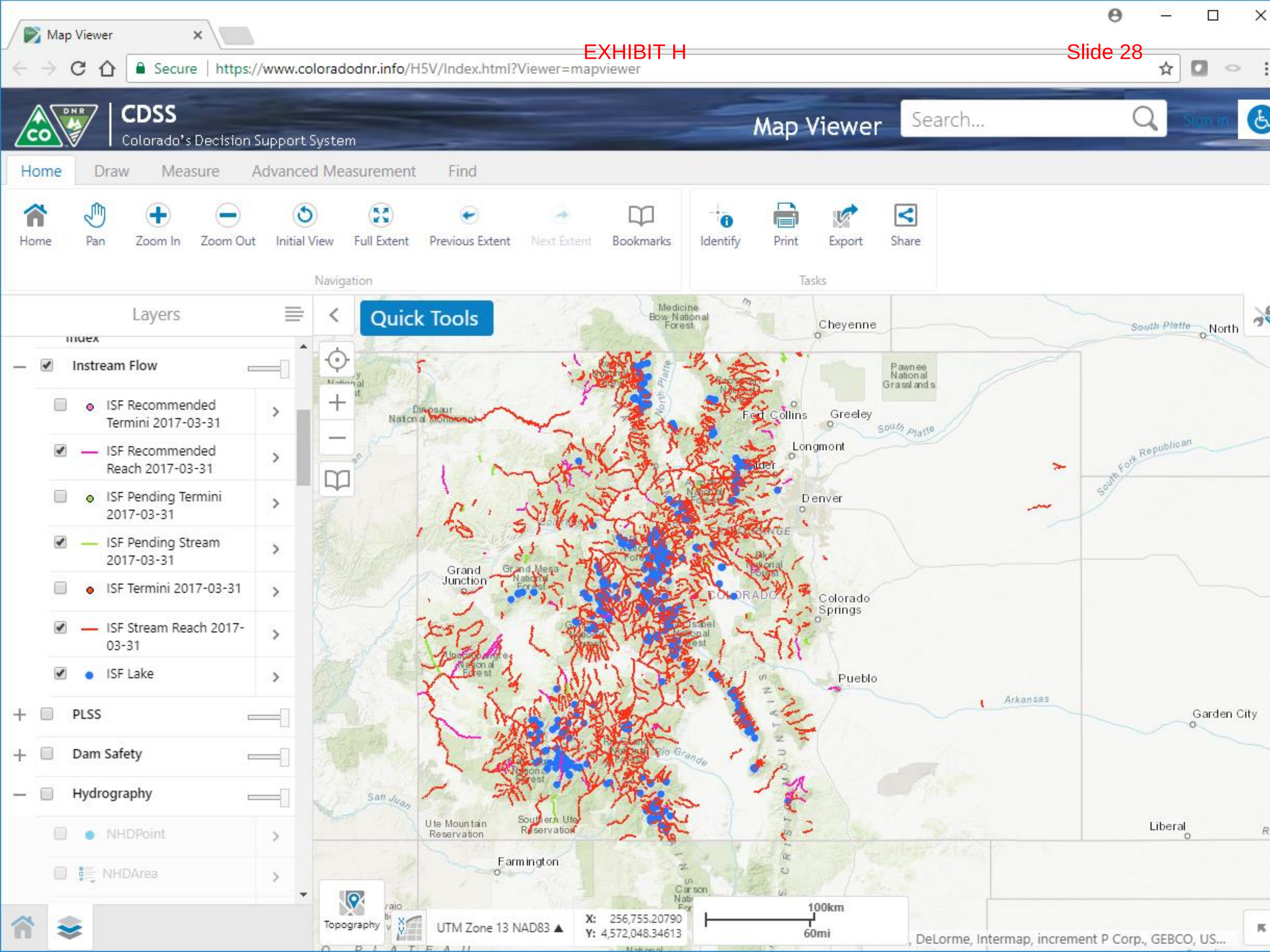


EXHIBIT H

Slide 29

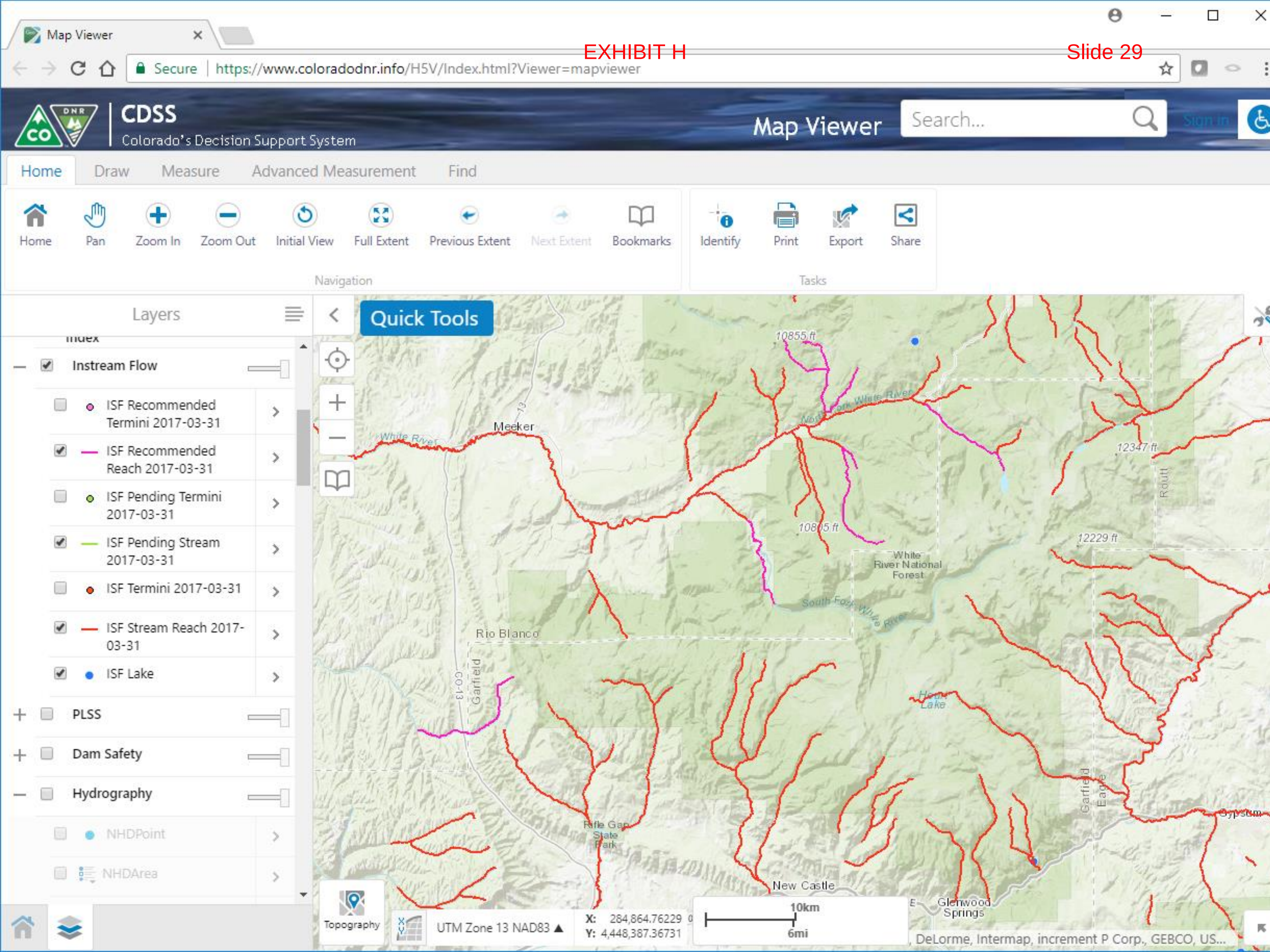


EXHIBIT H

Slide 30

Map Viewer

Secure | https://www.coloradodnr.info/H5V/Index.html?Viewer=mapviewer

CDSS
Colorado's Decision Support System

Map Viewer

Search...

Home | Draw | Measure | Advanced Measurement | Find

Navigation: Home, Pan, Zoom In, Zoom Out, Initial View, Full Extent, Previous Extent, Next Extent, Bookmarks

Tasks: Identify, Print, Export, Share

Identify Results (101)

ISF Stream Reach Lost Creek
Name = Lost Creek
ID = 5-77W3652
Case No = 5-77W3652
ISF Type = Appropriated
Miles = 0.83184338

United States Geological Survey

United States Geological Survey

National Oceanic and Atmospheric Administration

Intermap Technologies

United States Geological Survey

U.S. National Geospatial-Intelligence Agency

Food and Agricultural Organization of the United Nations

United States Geological Survey

Displaying 1 - 50 (Total: 101)

Page 1 of 3

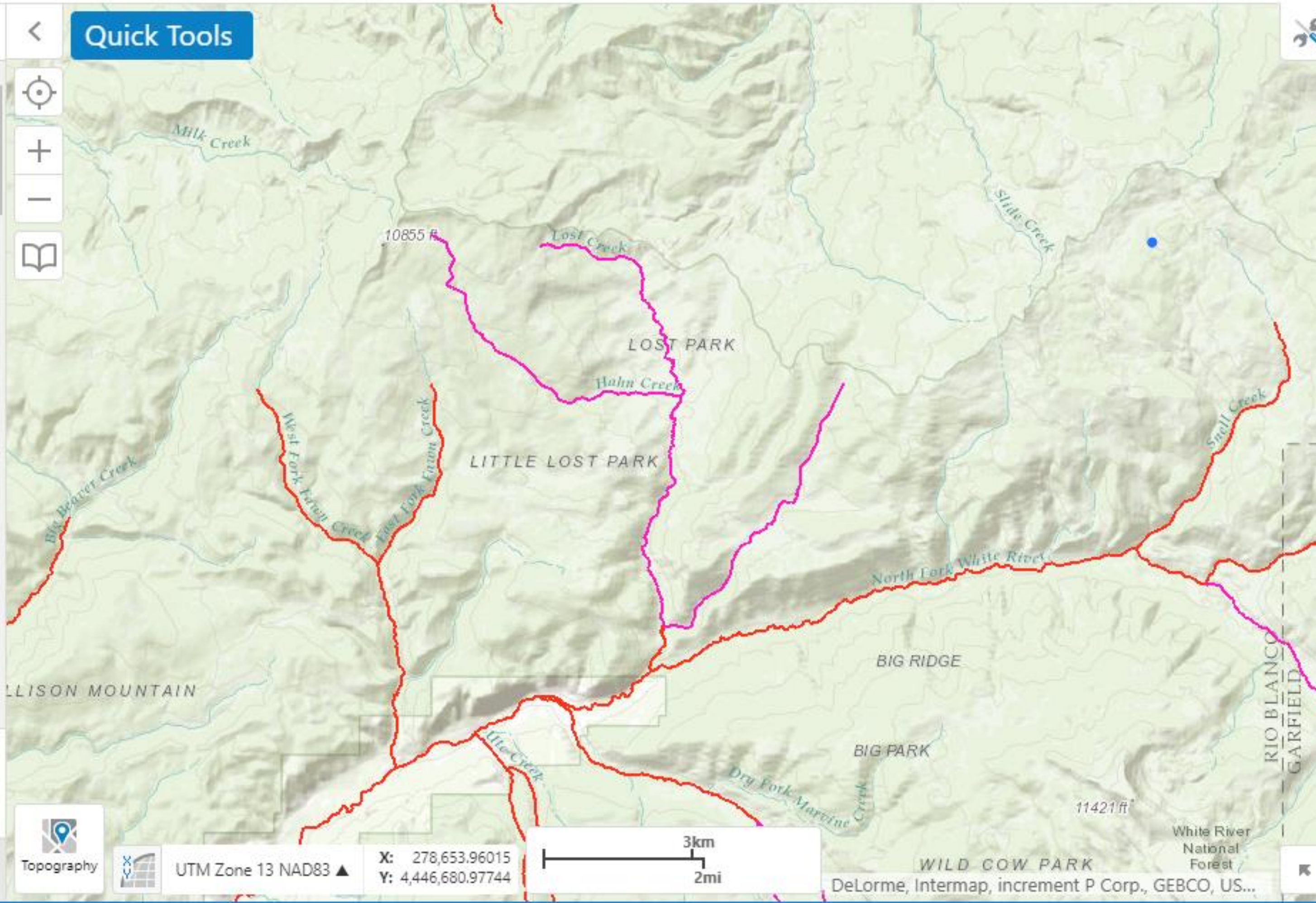


EXHIBIT H

Slide 31

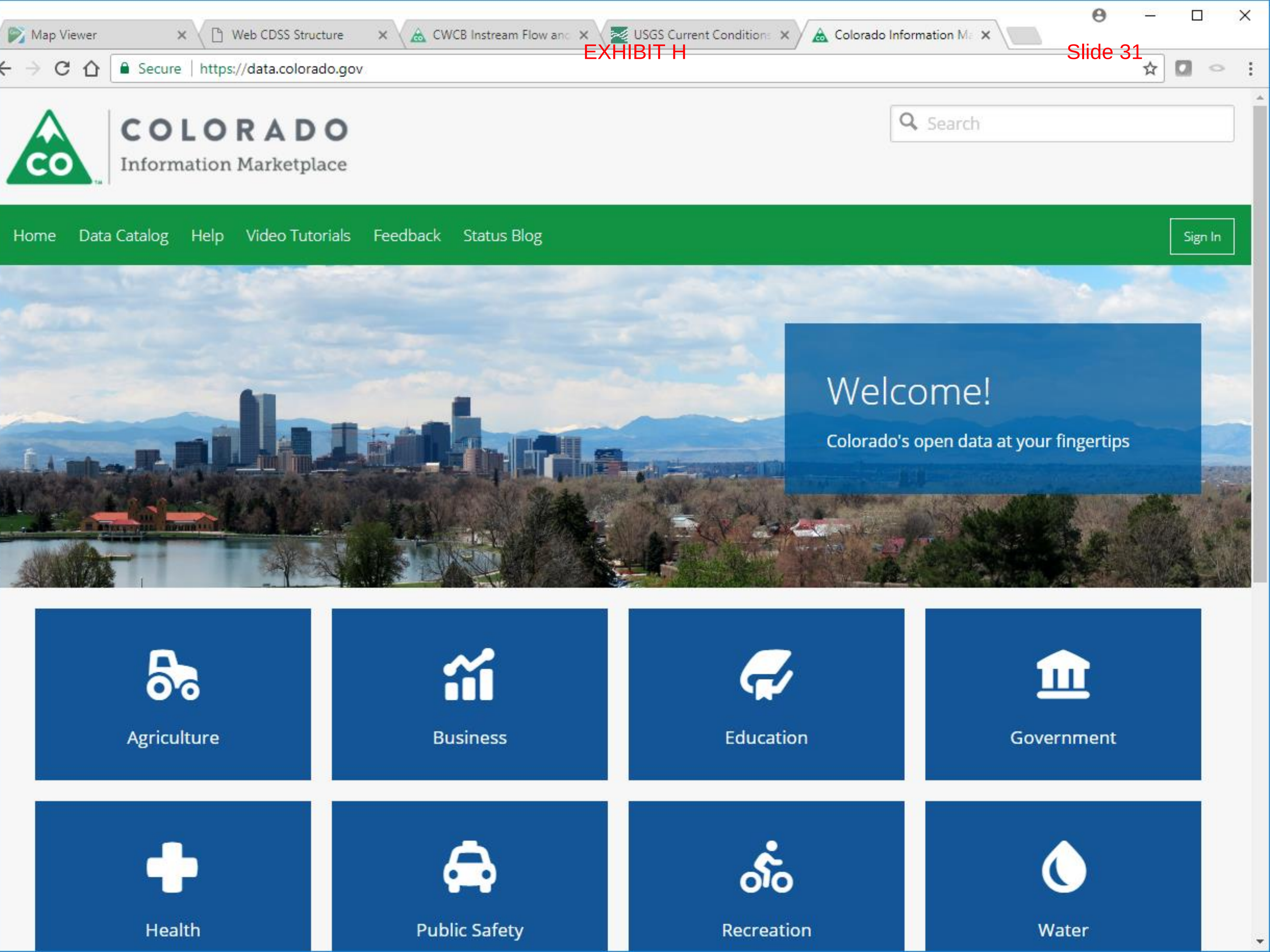


EXHIBIT H

Slide 32

Map Viewer | Web CDSS Structure | CWCB Instream Flow and | USGS Current Conditions | Results for "Instream Flow

Secure | https://data.colorado.gov/browse?category=Water&anonymous=true&q=Instream%20Flow&sortBy=relevance

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Instream Flow

Authority

- Official
- Community

Categories

- Agriculture
- Business
- Demographics
- Economic Growth
- Education
- Water

Show All...

View Types

8 Results filtered by Categories > Water × | Clear All

Sort by Most Relevant

CWCB Instream Flow and Natural Lake Level Data
Water | Dataset

Instream Flow and Natural Lake Level water rights of the Colorado Water Conservation Board

Tags minimum lake levels, minimum flows, appropriations, cwcb, instream, and 1 more | API Docs

Updated October 25, 2017
Views 477

Instream Flow Termini
Water | External Link

Point Dataset Identifying Upper and Lower Termini of Instream Flow Reaches.

Tags instream flow, water right, water, gis

Updated May 13, 2015
Views 66

Instream Flow Reaches
Water | External Link

Identification of Natural Streams in Colorado that have an Instream Flow Water Right.

Tags instream flow, water right, water, gis

Updated May 13, 2015
Views 58

CWCB ISF Acquisitions
COMMUNITY | Water | Map

Map Viewer | CWCB Instream Flow and

EXHIBIT H

Slide 33

Secure | https://data.colorado.gov/Water/CWCB-Instream-Flow-and-Natural-Lake-Level-Data/kzsx-aqy6/data

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Based on CWCB Instream Flow and Natural Lake Level Data

Instream Flow and Natural Lake Level water rights of the Colorado Water Conservation Board

77w3652

Manage | More Views | Filter | Visualize | Export | Discuss | Embed | About

	Case No	Division	Water District	Waterbody Name	Waterbody Type	Appropriation Type	Appropriation Date	Prior Adjudication Date	WDID	Upper Termin
1	77W3652	5	43	Lost Creek	Stream	New Appropriation	11/15/1977		4301846	confl NF White Ri

Appropriation Date	11/15/1977
Prior Adjudication Date	
WDID	4301846
Upper Terminus	confl NF White River in
UT UTM East	289667.03

Location	(40.048633°, -107.469242°)
Length	0.8
Flow Amounts	3 (1/1 - 12/31)
Volume In AF	
County	Rio Blanco
Watershed	Upper White

Viewing row 1 of 1

EXHIBIT H

Slide 34

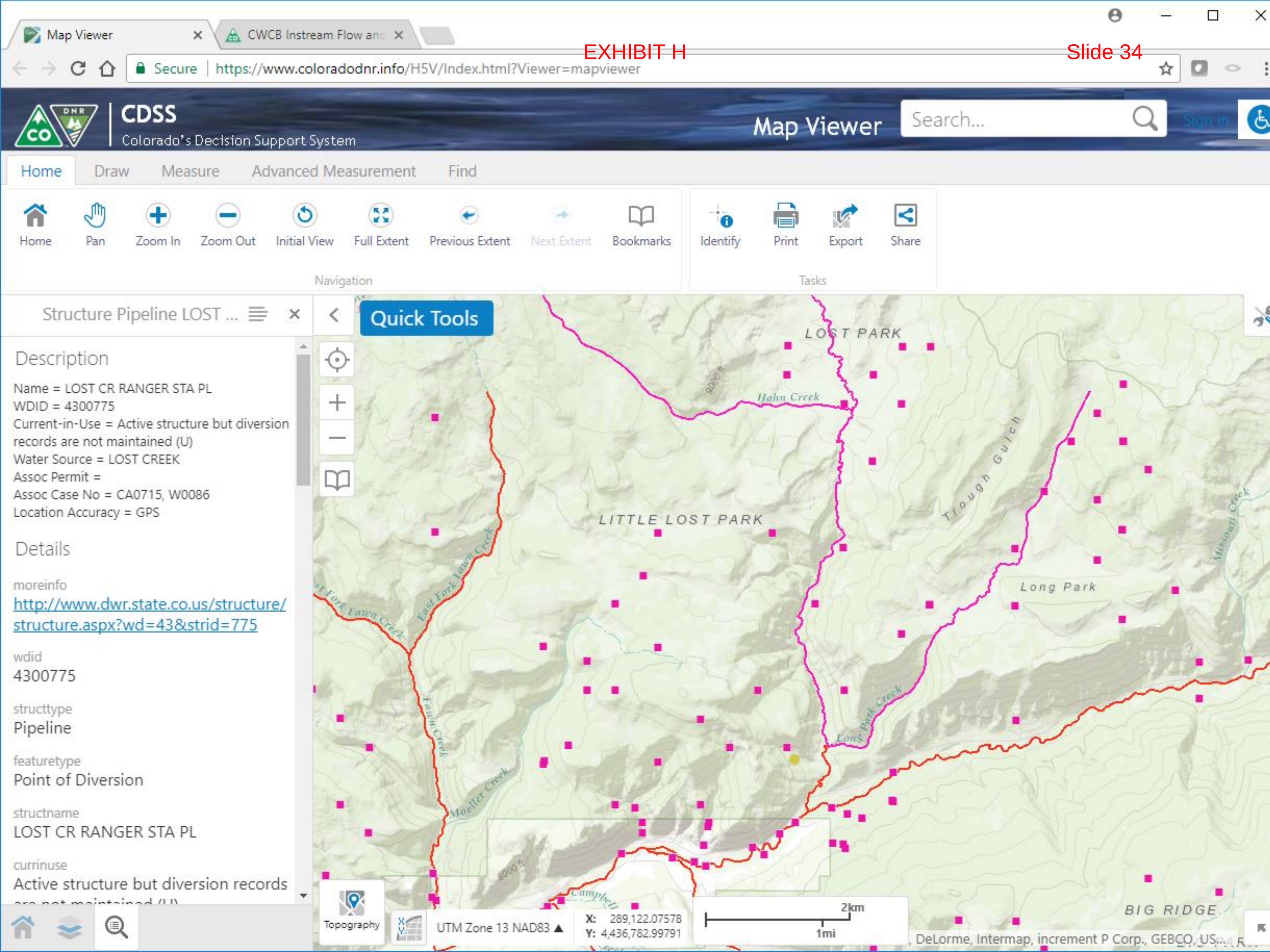


EXHIBIT H

Slide 35

Map Viewer | Web CDSS Structure | CWCB Instream Flow and

www.dwr.state.co.us/structure/structure.aspx?wd=43&strid=775

Water Division/District: ...43 - White River Basin

Structure Type: All Structures

Last Refresh Date

2017-10-16

Structure Name | Structure ID | Source | Legal Location | Decreed Amounts | Owner Name | Case Number

Structure Id: 775 **To**

Submit Request

Select a row from the search results below to activate the reporting features

	Div	WD	Structure ID	Structure Name	Q10	Q40	Q160	Sect	Twshp	Range	PM	Distance From N/S Line	Distance From E/W Line	Water Source	Stream Mile
	6	43	775	LOST CR RANGER STA PL		SW	NE	15	1N	90W	S			Lost Creek	131.2

1 records returned

Results List Report:

Adobe Acrobat (Preferred for Printing)

Generate Report

Structure Reports:

Diversion Records

Structure Summary

Structure Summary Report

State of Colorado HydroBase

Structure Name: LOST CR RANGER STA PL **Water District:** 43 **Structure ID Number:** 775

Source: Lost Creek

Location:	Q10	Q40	Q160	Section	Twnshp	Range	PM
		SW	NE	15	1N	90W	S

Distance From Section Lines: From N/S Line: From E/W Line:

UTM Coordinates (NAD 83): Northing (UTM y): 4436815 Easting (UTM x): 289194 Spotted from PLSS distances from section lines

Latitude/Longitude (decimal degrees): 40.055238 -107.471479

Water Rights Summary:							
Total Decreed Rate(s) (CFS):	Absolute:	0.1000	Conditional:	0.0000	AP/EX:	0.0000
Total Decreed Volume(s) (AF):	Absolute:	0.0000	Conditional:	0.0000	AP/EX:	0.0000

Water Rights -- Transactions

Case Number	Adjudication Date	Appropriation Date	Administration Number	Order Number	Priority Number	Decreed Amount	Adjudication Type	Uses	Action Comment
W0086	1972-12-31	1891-10-16	15264.00000	0		0.0500 C	O	F	
CA0715	1947-09-08	1931-04-30	33748.29704	0	23	0.0500 C	S	1789	

Water Rights -- Net Amounts

Adjudication Date	Appropriation Date	Administration Number	Order Number	Priority/Case Number	Rate (CFS)			Volume (Acre-Feet)		
					Absolute	Conditional	AP/EX	Absolute	Conditional	AP/EX
1972-12-31	1891-10-16	15264.00000	0	W0086	0.0500	0	0			
1947-09-08	1931-04-30	33748.29704	0	23	0.0500	0	0			

Irrigated Acres Summary -- Totals From Various Sources

GIS Total (Acres):		Reported:
Diversion Comments Total (Acres):	0	Reported: 2007
Structure Total (Acres):		Reported:

Irrigated Acres From GIS Data

Year	Land Use	Acres Flood	Acres Furrow	Acres Sprinkler	Acres Drip	Acres Groundwater	Acres Total

No data available for this report

EXHIBIT H

Slide 37

Year	FDU	LDU	DWC	Maxq & Day	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Total
1988	1988-04-08	1988-10-31	207	0 04-08	0	0	0	0	0	2	3	3	3	3	3	3	21
1989	1989-05-02	1989-10-31	183	0 05-02	0	0	0	0	0	0	3	3	3	3	3	3	18
1990	1990-05-09	1990-10-31	176	0 05-09	0	0	0	0	0	0	2	3	3	3	3	3	17
1991	1990-11-01	1991-10-31	365	0 11-01	3	3	3	3	3	3	3	3	3	3	3	3	36
1992	1992-05-01	1992-10-30	183	0 05-01	0	0	0	0	0	0	3	3	3	3	3	3	18
1993	1993-05-01	1993-10-30	183	0 05-01	0	0	0	0	0	0	3	3	3	3	3	3	18
1994	1994-05-01	1994-10-31	184	0 05-01	0	0	0	0	0	0	2	2	2	2	2	2	12
1995	1995-05-12	1995-10-31	173	0 05-12	0	0	0	0	0	0	2	3	3	3	3	3	17
1996	1996-05-08	1996-10-31	177	0 05-08	0	0	0	0	0	0	2	3	3	3	3	3	18
1997	1997-05-05	1997-10-31	180	0 05-05	0	0	0	0	0	0	3	3	3	3	3	3	18
1998	1998-05-14	1998-10-31	171	0 05-14	0	0	0	0	0	0	2	3	3	3	3	3	17
1999	1999-05-04	1999-10-31	181	0 05-04	0	0	0	0	0	0	2	2	2	2	2	2	12
2000	2000-05-15	2000-10-31	170	0 05-15	0	0	0	0	0	0	1	2	2	2	2	2	11
2001	2001-05-03	2001-10-31	182	0 05-03	0	0	0	0	0	0	2	2	2	2	2	2	12
2002	2002-04-20	2002-10-31	195	0 05-27	0	0	0	0	0	1	2	3	3	3	3	3	17
2003			0	0 05-02	0	0	0	0	0	0	0	0	0	0	0	0	0
2004			0	0 04-17	0	0	0	0	0	0	0	0	0	0	0	0	0
2005			0	0 05-26	0	0	0	0	0	0	0	0	0	0	0	0	0
2006 *																	0
2007			0	0 05-12	0	0	0	0	0	0	0	0	0	0	0	0	0
2008			0	0 05-27	0	0	0	0	0	0	0	0	0	0	0	0	0
2009			0	0 05-06	0	0	0	0	0	0	0	0	0	0	0	0	0
2011 *																	0
2012 *																	0
2013 *																	0
			Minimum:	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Maximum:	0	3	3	3	3	3	3	3	3	3	3	3	3	36
			Average:	0	0	0	0	0	0	0	2	2	2	2	2	2	11

25.00 years with diversion records

Notes: The average considers all years with diversion records, even if no water is diverted.
The above summary lists total monthly diversions.
* = Infrequent Diversion Record. All other values are derived from daily records.
Average values include infrequent data if infrequent data are the only data for the year.

Diversion Comments

IYR	NUC Code	Acres Irrigated	Comment
1976	No information available		
1977	No information available		
2002			USFS , 317 E. MARKET ST, MEEKER, COLO, 81641
2003	Structure not usable	0	STATION USES A WELL
2004	Structure not usable	0	STATION USES A WELL
2005	Structure not usable	0	STATION USES A WELL
2006	Structure not usable	0	STATION USES A WELL

EXHIBIT H

Slide 38

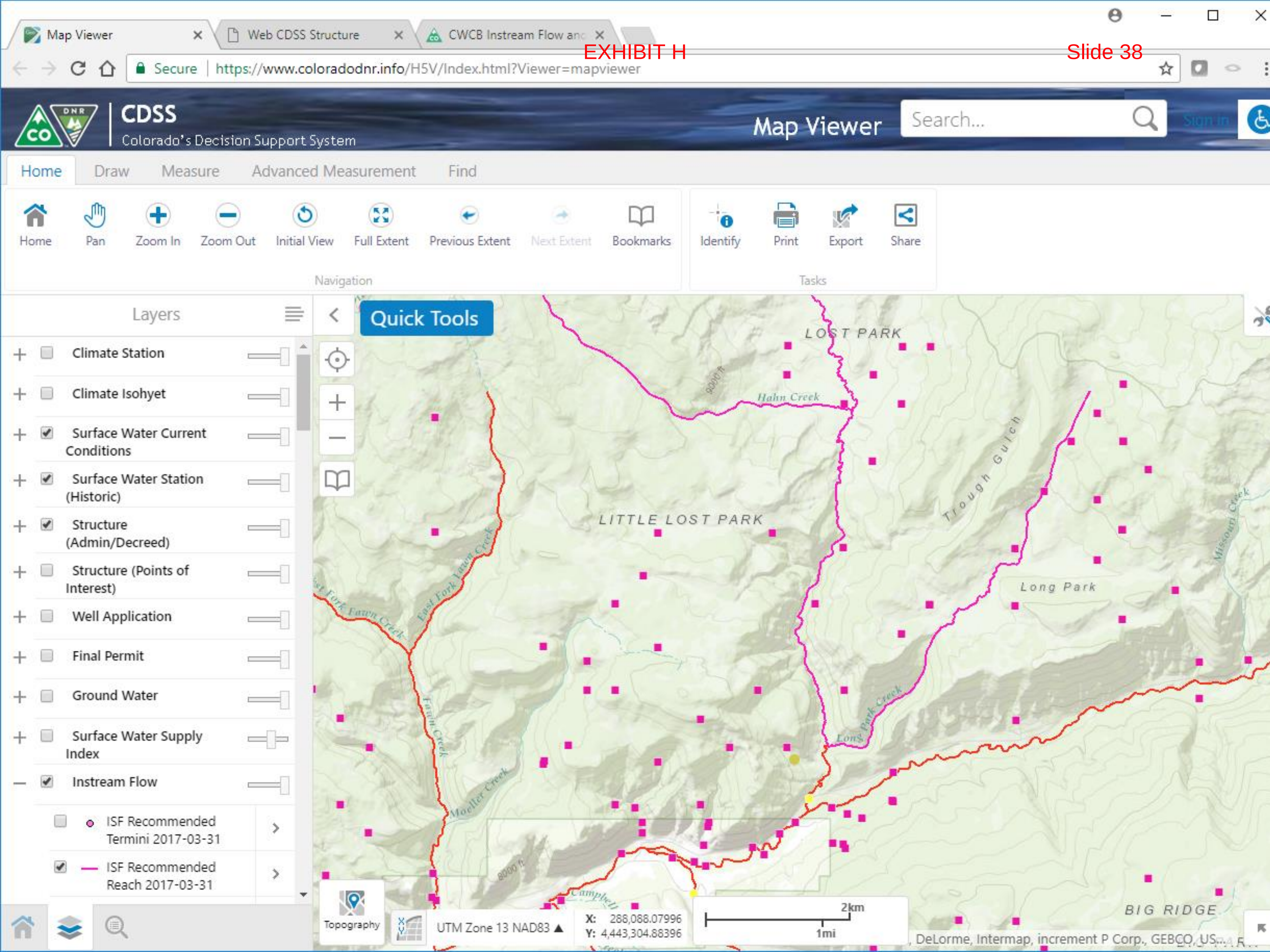
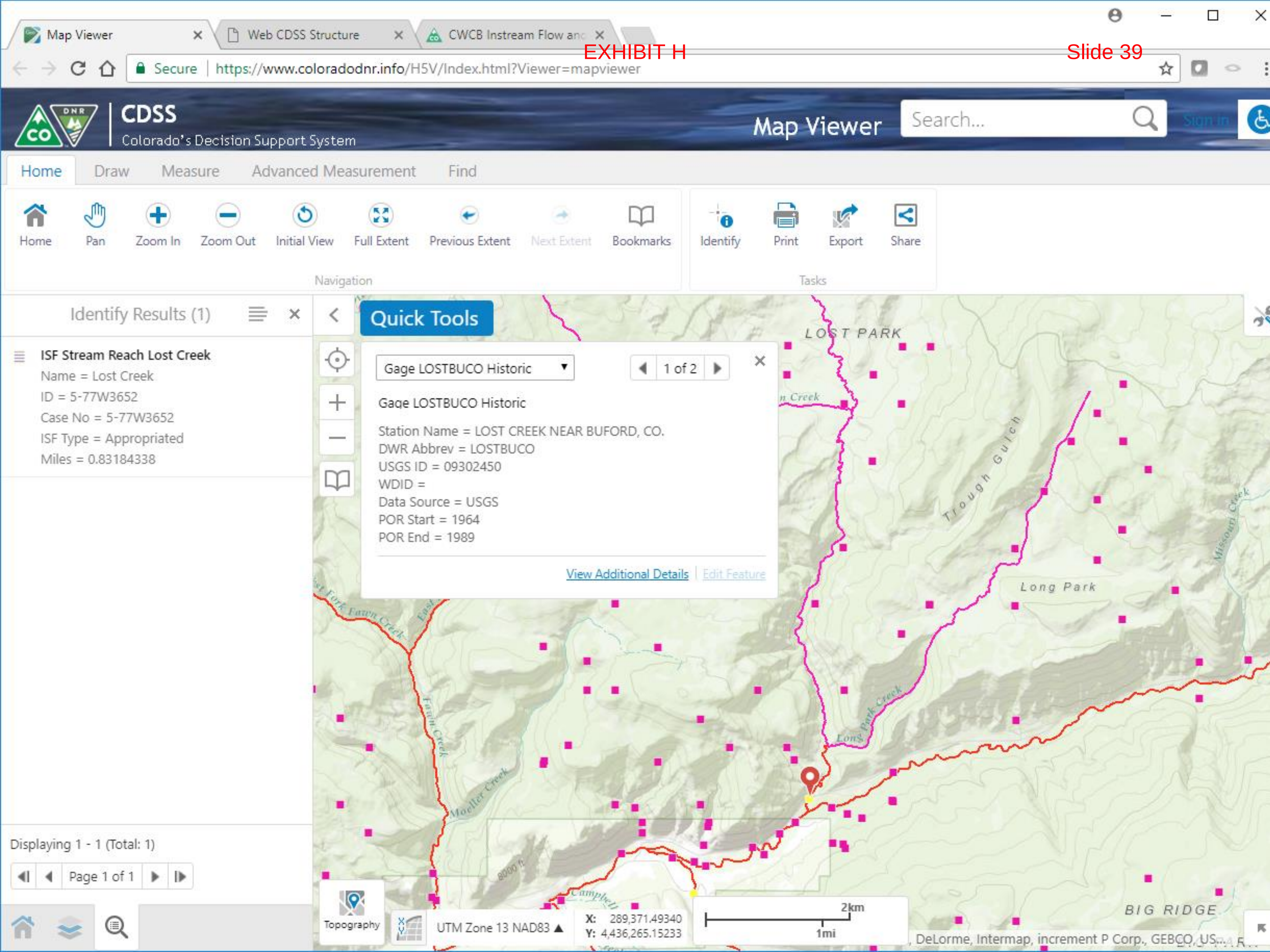


EXHIBIT H

Slide 39



Map Viewer | Web CDSS Structure | CWCB Instream Flow and | USGS Current Conditions

EXHIBIT H

Slide 40

Secure | https://waterdata.usgs.gov/nwis/dv?cb_00060=on&format=gif_default&site_no=09302450&referred_module=sw&period=&begin_date=1964-...

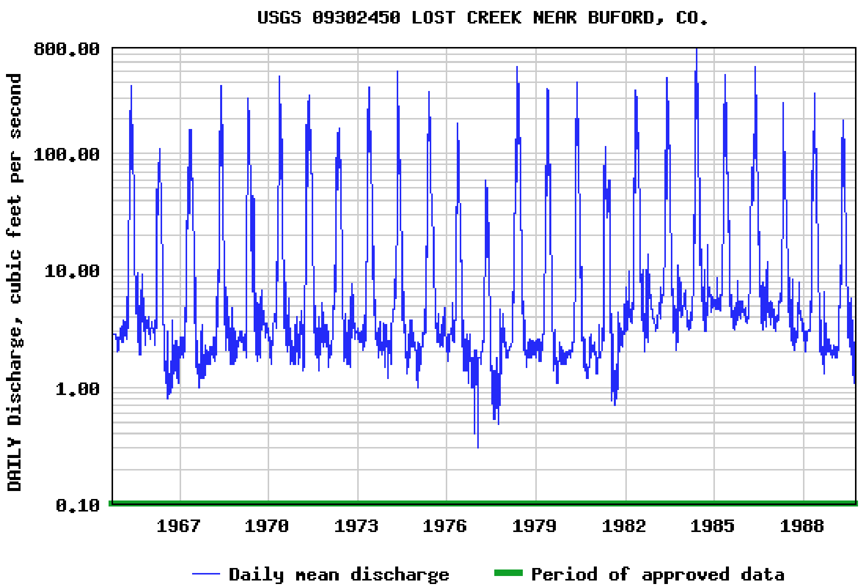
Available Parameters	Period of Record	Output format	Days (9129)
All 1 Available Parameters for this site		Graph	
00060 Discharge(Mean)	1964-10-01 1989-09-29	Graph w/ stats	-- or --
		Graph w/ meas	Begin date 1964-10-01
		Graph w/ (up to 3) parms	
		Table	End date 1989-09-29
		Tab-separated	

GO

Summary of all available data for this site

Instantaneous-data availability statement

Discharge, cubic feet per second



Add up to 2 more sites and replot for "Discharge, cubic feet per second"

Add site numbers Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality graph. P00060 Discharge.ft^3/s.Mean A(00003:0)

Questions about sites/data?
Feedback on this web site
Automated retrievals
Help

Data Tips
Explanation of terms
Subscribe for system changes
News

EXHIBIT H

Slide 41

Map Viewer | Web CDSS Structure | CWCB Instream Flow | USGS Current Condit | Results for "Instream | StreamStats

Secure | https://streamstats.usgs.gov/ss/

USGS StreamStats

Report | About | ? Help

SELECT A STATE / REGION >

Step 1: Use the map or the search tool to identify an area of interest. At zoom level 8 or greater State/Region selection will be enabled.

Search for a place

Help

IDENTIFY A STUDY AREA

SELECT SCENARIOS

BUILD A REPORT

POWERED BY WIM

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FOIA | Privacy | Policy & Notices

EXHIBIT H

Slide 42

Map Viewer | Web CDSS Structure | CWCB Instream Flow | USGS Current Condit | Results for "Instream | StreamStats

Secure | https://streamstats.usgs.gov/ss/

USGS StreamStats

Report | About | Help

SELECT A STATE / REGION

Colorado

IDENTIFY A STUDY AREA

Basin Delineated

Step 5: Your delineation is complete. You can now clear, edit, or download your basin, or choose a state or regional study specific function (if available). Click **continue** when you are ready.

Clear Basin

Edit Basin

State/Region Specific Functions

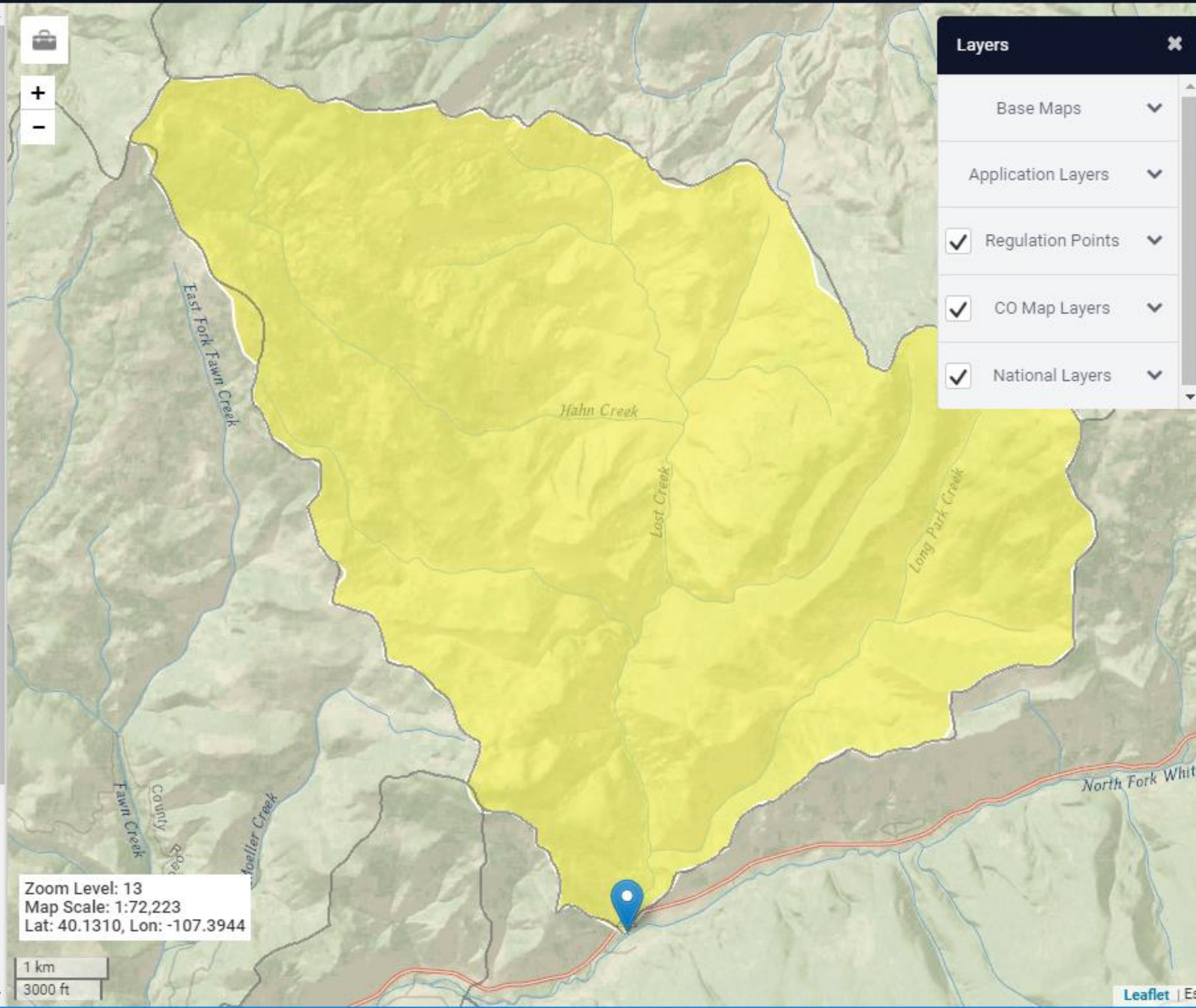
The following additional functions are available for Colorado.

Check For Upstream Regulation

Download Basin

or

Continue



Map Viewer | Web CDSS Structure | CWCB Instream Flow | USGS Current Condi | Results for "Instream | StreamStats

EXHIBIT H

Slide 43

Secure | https://streamstats.usgs.gov/ss/

USGS StreamStats

Report | About | ? Help

IDENTIFY A STUDY AR
Basin Delineated

SELECT SCENARIOS

BUILD A REPORT | Report Built

Step 1: You can modify computed basi characteristics here, then select the types of reports you wish to generate. Then click the "Build Report" button

Show Basin Characteristics

Select available reports to display:

- Basin Characteristics Report
- Scenario Flow Reports

Continue

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FOIA Privacy Policy & Notices

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	21.6	square miles
PRECIP	Mean Annual Precipitation	30.3	inches

Monthly Flow Statistics Parameters [Mountain Region Mean Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	21.6	square miles	1	1060
PRECIP	Mean Annual Precipitation	30.3	inches	18	47

Monthly Flow Statistics Flow Report [Mountain Region Mean Flow]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

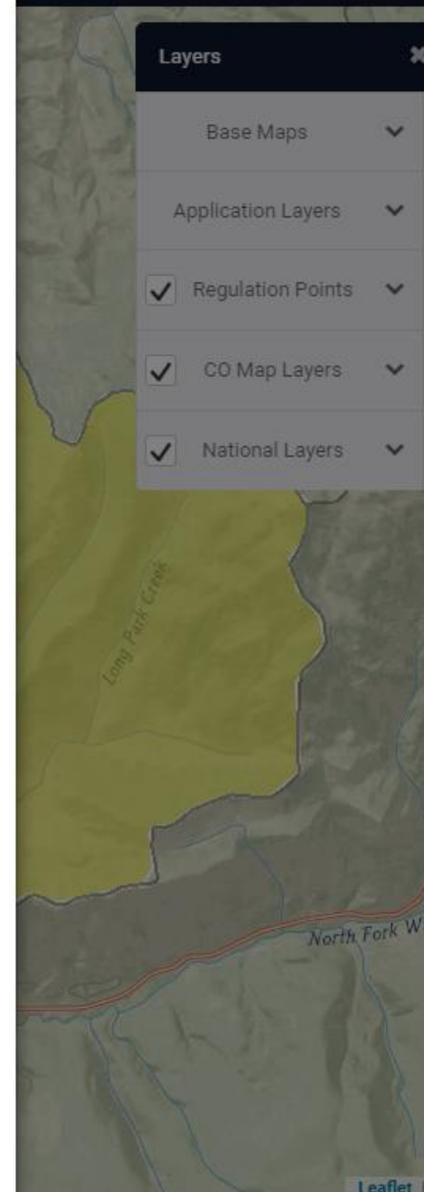
Statistic	Value	Unit	SEp
January Mean Flow	4.34	ft^3/s	50
February Mean Flow	4.02	ft^3/s	51
March Mean Flow	4.45	ft^3/s	49
April Mean Flow	10	ft^3/s	44
May Mean Flow	61.3	ft^3/s	46
June Mean Flow	114	ft^3/s	46
July Mean Flow	42.1	ft^3/s	76
August Mean Flow	17.1	ft^3/s	80
September Mean Flow	10.6	ft^3/s	59
October Mean Flow	8.66	ft^3/s	45
November Mean Flow	6.38	ft^3/s	46
December Mean Flow	4.86	ft^3/s	47

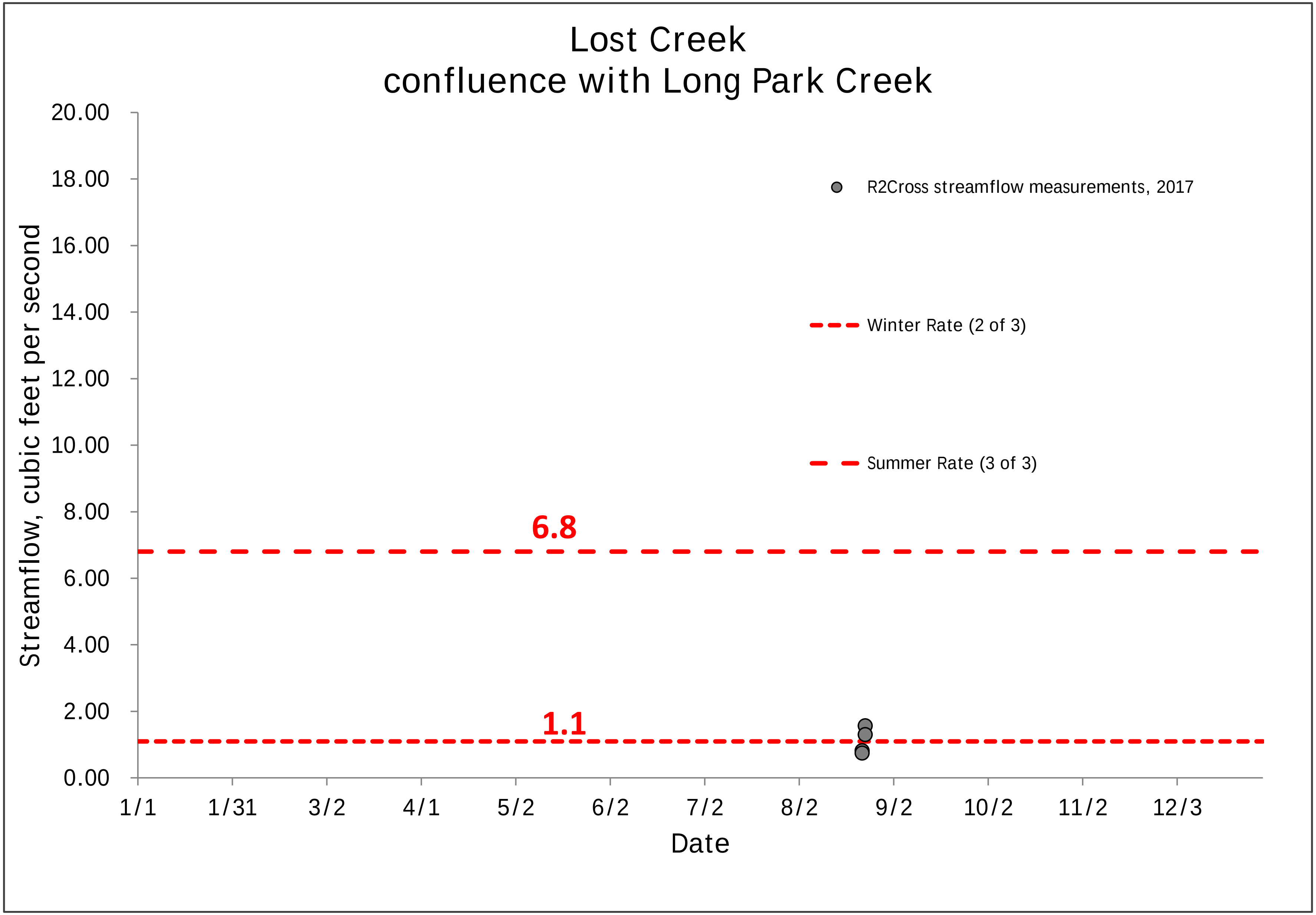
Monthly Flow Statistics Citations

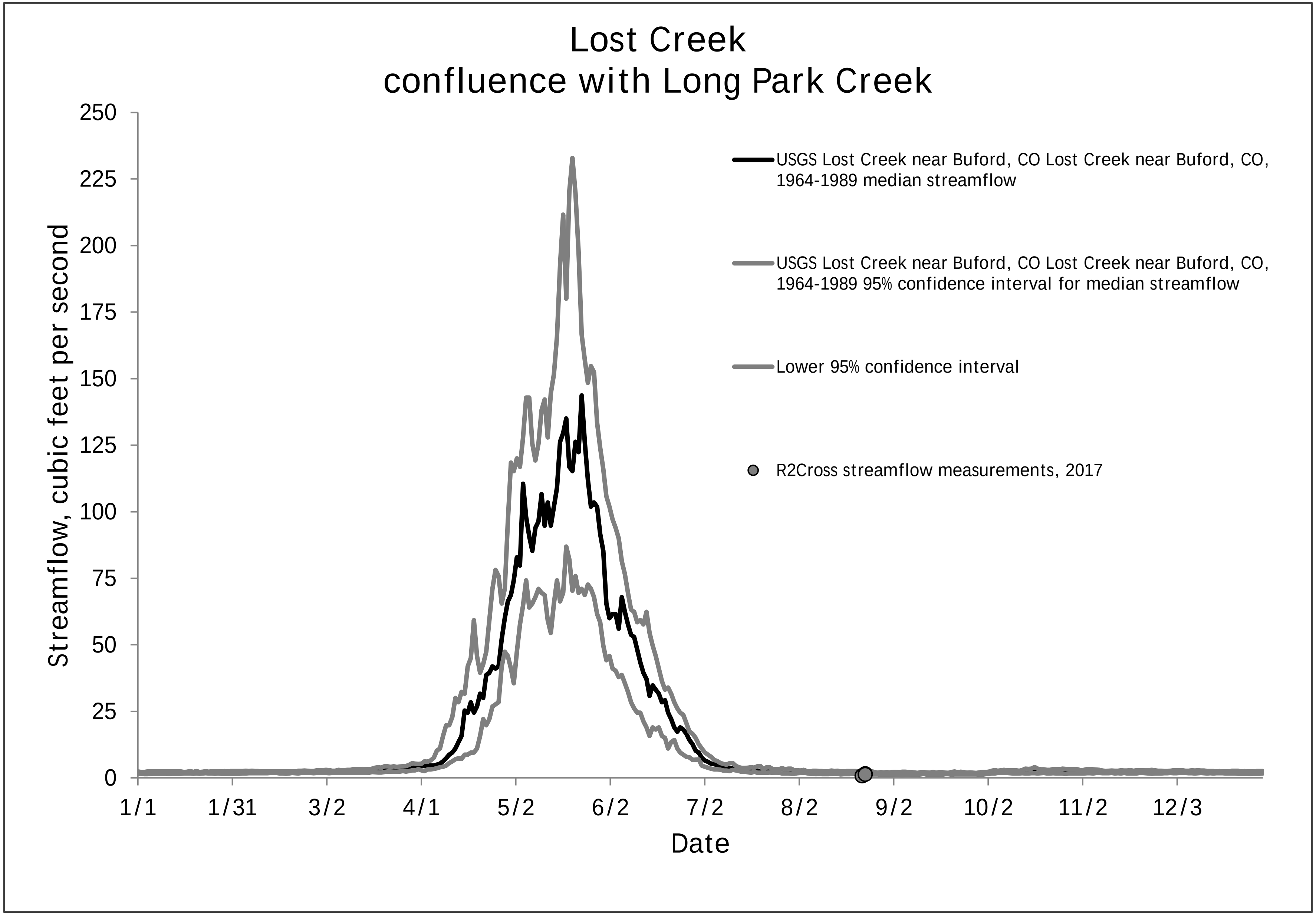
Capesius, J.P., and Stephens, V. C.,2009, Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado: U. S. Geological Survey Scientific Investigations Report 2009-5136, 32 p.

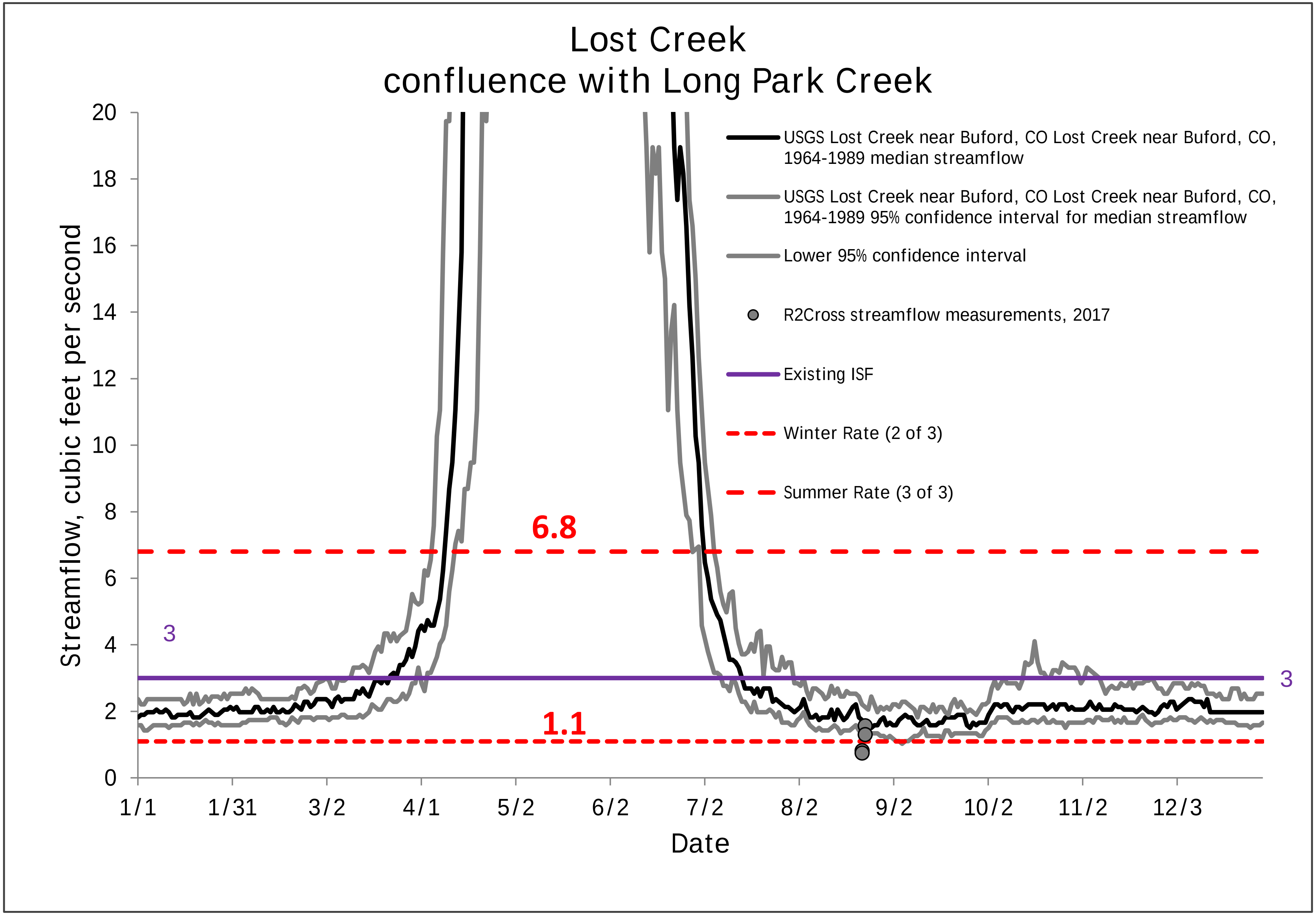
Layers

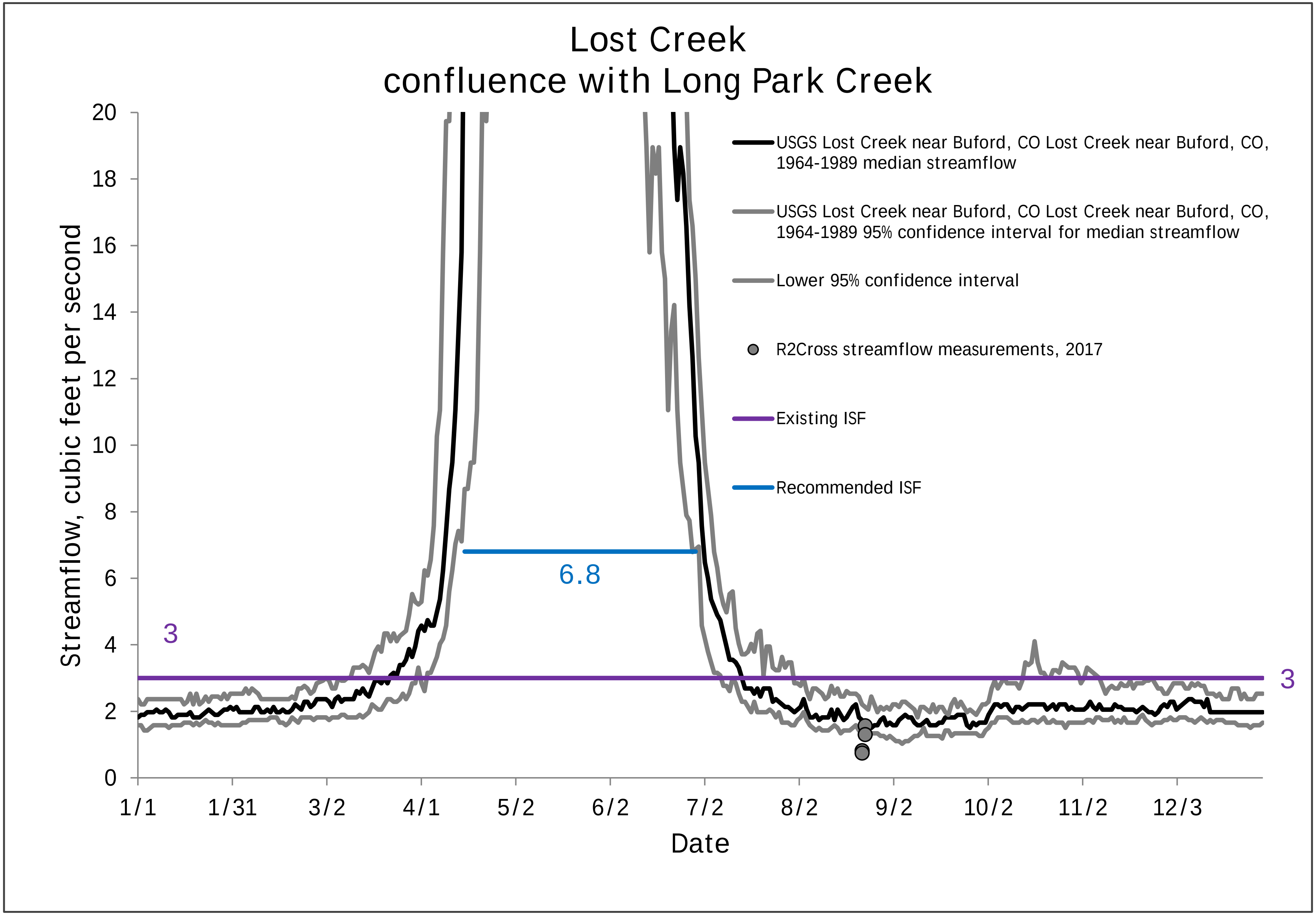
- Base Maps
- Application Layers
- Regulation Points
- CO Map Layers
- National Layers

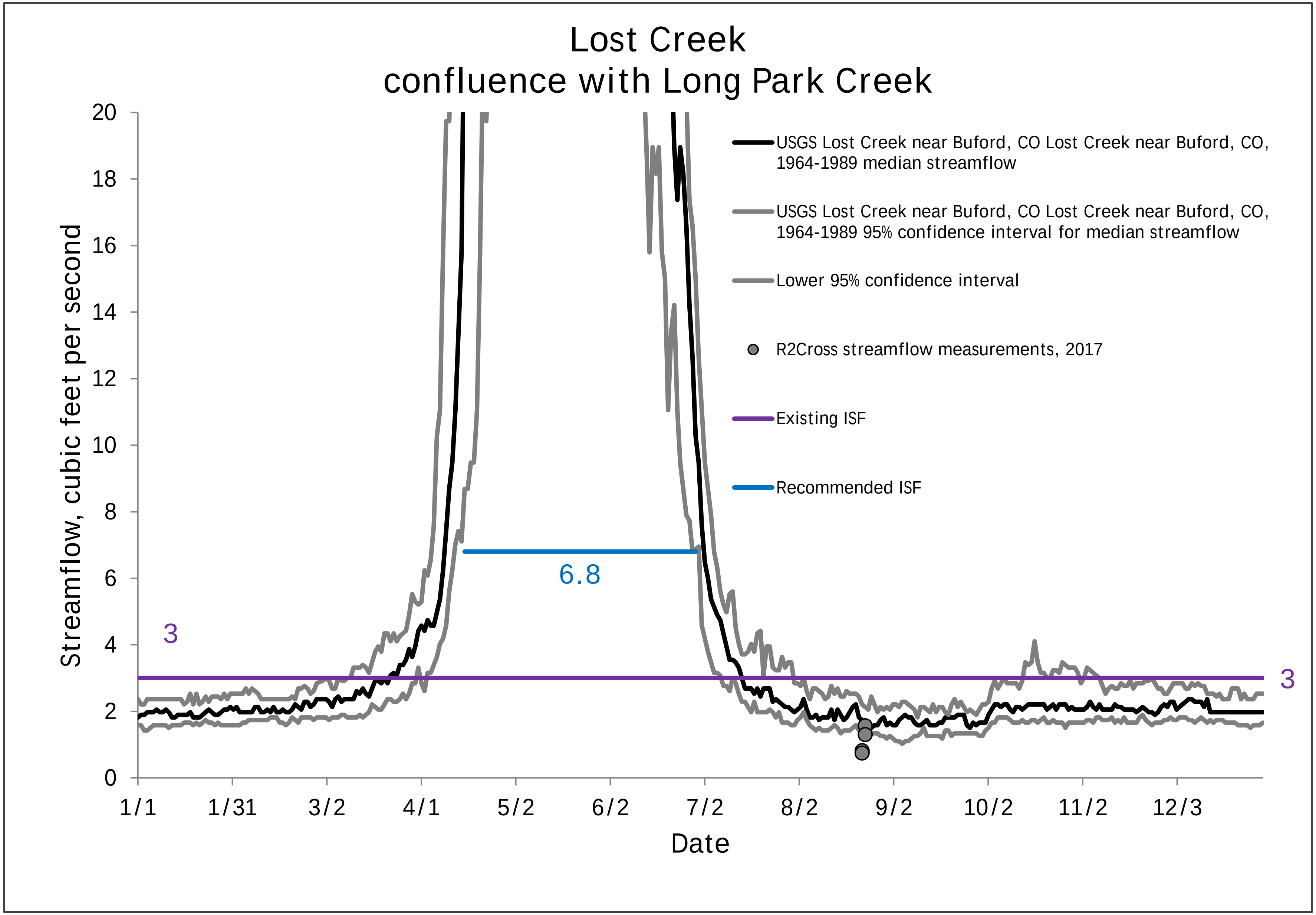



Lost Creek
confluence with Long Park Creek
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Streamflow, cubic feet per second
R2Cross streamflow measurements, 2017
Winter Rate (2 of 3)
Summer Rate (3 of 3)
6.8
1.1
1/1
1/31
3/2
4/1
5/2
6/2
7/2
8/2
9/2
10/2
11/2
12/3
Date


Lost Creek
confluence with Long Park Creek
Streamflow, cubic feet per second
250
225
200
175
150
125
100
75
50
25
0
1/1
1/31
3/2
4/1
5/2
6/2
7/2
8/2
9/2
10/2
11/2
12/3
Date
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 median streamflow
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 95% confidence interval for median streamflow
Lower 95% confidence interval
R2Cross streamflow measurements, 2017


Lost Creek
confluence with Long Park Creek
Streamflow, cubic feet per second
0
2
4
6
8
10
12
14
16
18
20
Date
1/1
1/31
3/2
4/1
5/2
6/2
7/2
8/2
9/2
10/2
11/2
12/3
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 median streamflow
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 95% confidence interval for median streamflow
Lower 95% confidence interval
R2Cross streamflow measurements, 2017
Existing ISF
Winter Rate (2 of 3)
Summer Rate (3 of 3)
6.8
1.1
3
3


Lost Creek
confluence with Long Park Creek
Streamflow, cubic feet per second
20
18
16
14
12
10
8
6
4
2
0
1/1
1/31
3/2
4/1
5/2
6/2
7/2
8/2
9/2
10/2
11/2
12/3
Date
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 median streamflow
USGS Lost Creek near Buford, CO Lost Creek near Buford, CO, 1964-1989 95% confidence interval for median streamflow
Lower 95% confidence interval
R2Cross streamflow measurements, 2017
Existing ISF
Recommended ISF
6.8
3
3



Water availability can be viewed as a necessary refinement that may impose limitations on biological quantification model findings.

DATA ANALYSIS RESOURCES

CDSS Mapviewer

http://cdss.state.co.us/ONLINETOOLS/Pages/MapViewer.aspx

Colorado Information Marketplace

https://data.colorado.gov/

DWR Structure Summaries

http://cdss.state.co.us/onlineTools/Pages/StructuresDiversions.aspx

USGS

https://waterdata.usgs.gov/co/nwis/rt

StreamStats

https://ssdev.cr.usgs.gov/streamstats/


QUESTIONS?
LOST CREEK