BOULDER-ELKHORN TMDL PLANNING AREA TEMPERATURE AND INSTANTANEOUS FLOW MONITORING FOR THE BOULDER RIVER

Sampling and Analysis Plan

Document # M07-TMDL-01-SAP-02

Prepared by:

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Approvals

Kyle Flynn, P.H. (Hydrologist)	Date
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Rosie Sada (WQ Monitoring and Assessment Section Supervisor)	Date
Mindy McCarthy (QA Officer)	Date
Jim Bond (TMDL Project Manager)	Date

This document constitutes the Sampling and Analysis Plan (SAP) for the completion of a temperature source assessment/loading estimate for the establishment of reference conditions in the Boulder-Elkhorn TMDL planning area (TPA).

1.0 Introduction and Background

The Boulder-Elkhorn (B-E) TMDL planning area encompasses approximately 760 square miles (487,142 acres) in southwestern Montana. Draining southerly to the Jefferson River, the B-E TPA is bordered by the continental divide to the west and the Elkhorn Mountains to the northwest. Major towns within the TPA include Boulder, Basin, and Elkhorn.

Under Montana law, an impaired water body is defined as a water body for which sufficient and credible data indicates non-compliance with applicable water quality standards (MCA 75-5-103). Section 303 of the Federal Clean Water Act requires states to submit a list of impaired water bodies or stream segments to the U.S. Environmental Protection Agency (EPA) every two years. This list is referred to as the "303(d) list", and is included within the biannual "Integrated Report", the last of which was in 2008. The Montana Water Quality Act further directs states to develop TMDLs for all water bodies appearing on the 303(d) list as impaired or threatened by "pollutants" (MCA 75-5-703).

Three stream segments in the Boulder-Elkhorn TPA appeared on Montana's 2008 Clean Water Act Section 303(d) list for temperature impairment. They are: High Ore Creek (MT41E002_040), and two downstream segments of the Boulder River (MT41E001_022, MT41E001_030) beginning at the town of Boulder and extending to the confluence with the Jefferson River. This project will focus only on the Boulder River. Temperature data loggers will be deployed throughout the listed segments, and shade and flow measurements will be collected to characterize those factors which may be affecting temperature.

Possible temperature influences in the basin may be the result of riparian degradation from timber harvest, agriculture, and stream-side road development; decreases in flow during portions of the summer from significant irrigation withdrawl and/or natural infiltration into the ground; and irrigation return flows.

2.0 Objectives and Design

The main objective of this sampling plan is to collect temperature, riparian cover, and flow data that will be used to identify gaining/losing areas for temperature and to locate areas where the implementation of best management practices may decrease stream temperatures. This information will be incorporated into a modeling effort that will represent existing conditions, as well as simulate various management options that may affect temperature. The results of this study will be the basis for the development of the temperature TMDL and allocations for the Boulder River.

Study Design

Sampling Sites

Approximately twenty data logger sites will be located along the two listed stream segments of the Boulder River (Table 2.1; Figures 1- 15). In addition to the data logger deployment, flow will be measured at all of the designated temperature sampling sites, as well as a few additional locations (see Table 2.1 for details). Sampling sites were identified by assessment of aerial images to capture areas where stream temperature could be influenced by changes in land cover/land use and flow (via irrigation ditches and tributaries).

**All sites are subject to change based on access availability and flow conditions.*

Temperature loggers will be deployed at the end of June, and will collect information every 30 minutes until they are retrieved in late September or early October. Specific deployment and retrieval dates are dependent upon weather conditions, access permission, and availability of the Water Quality Monitoring and Assessment (WQMAS) staff schedules..

Table 2.1 – Boulder-Elkhorn TPA Temperature Proposed Sampling Locations

Stream	Site ID	Temp	Flow	Latitude	Longitude
Ditch	BLDR-F01	No	Yes	-112.05720853600	46.18444836210
Ditch	BLDR-F02	No	Yes	-112.02999588600	46.17597822610
Boulder River	BLDR-T01	Yes	Yes	-112.13309786100	46.23150210290
Boulder River	BLDR-T02	Yes	Yes	-112.11094072200	46.22553280020
Boulder River	BLDR-T03	Yes	Yes	-112.10298800000	46.22347708180
Muskrat Creek	BLDR-T04	Yes	Yes	-112.08754024700	46.21286261470
Boulder River	BLDR-T05	Yes	Yes	-112.09171962800	46.21024958940
Little Boulder River	BLDR-T06	Yes	Yes	-112.08677989400	46.19743365230
Boulder River	BLDR-T07	Yes	Yes	-112.07991246700	46.19614233280
Boulder River	BLDR-T08	Yes	Yes	-112.07062948200	46.19063216950
Boulder River	BLDR-T09	Yes	Yes	-112.05841604200	46.18596648040
Boulder River	BLDR-T10	Yes	Yes	-112.03271207500	46.17761970280
Boulder River	BLDR-T11	Yes	Yes	-112.00585244700	46.16098153150
Elkhorn Creek	BLDR-T12	Yes	Yes	-111.99069206500	46.16566346540
Boulder River	BLDR-T13	Yes	Yes	-111.99563780300	46.15644593120
Boulder River	BLDR-T14	Yes	Yes	-111.98355371600	46.14173805440
Boulder River	BLDR-T15	Yes	Yes	-111.93921526100	46.12889115060
Boulder River	BLDR-T16	Yes	Yes	-111.90818663500	46.09153450060
Boulder River	BLDR-T17	Yes	Yes	-111.88064162600	46.06183388150
Boulder River	BLDR-T18	Yes	Yes	-111.87862796600	46.06125515010
Boulder River	BLDR-T19	Yes	Yes	-111.87090007200	46.03308165450

Boulder River	BLDR-T20	Yes	Yes	-111.87565624900	46.01662029280
Boulder River	BLDR-T21	Yes	Yes	-111.88885152600	45.97582906300
Boulder River	BLDR-T22	Yes	Yes	-111.90357031200	45.94915191660
Boulder River	BLDR-T23	Yes	Yes	-111.92812009000	45.91516252450
Boulder River	BLDR-T24	Yes	Yes	-111.94190104100	45.86932046960

Shade

A Solar Pathfinder will be used to get information on current shade conditions in the study reach. This information will be used in conjunction with the temperature data to compare available shade at sites and determine shade potential for simple modeling procedures. Information will be collected at several sites per stream, representing 5 differing categories: forested, dense riparian (deciduous), low/moderate riparian (deciduous), urban, and open/pasture. At a minimum, three sites of each category will be sampled. Sites should also represent varying geographic aspects relative to the path of the sun. These sites have not yet been identified, but will be determined via aerial analysis and accessibility in the field.

QUAL2K Model

Data collected through this field effort will be used to develop a QUAL2K model of the study reach. The tool will be useful in understanding the interrelationship between climate, shade, irrigation, river morphology, and all other variables other influencing in-stream water temperature. QUAL2K has the ability to simulate the diurnal heat budget based on meteorological forcings and associated point and nonpoint source heat and mass loadings. It will provide a much more specific account of changes in temperature and influencing factors to determine impairment status and associated restoration strategies.

3.0 Field Sampling Methods

3.1 Discharge Measurements

Manual stream discharge measurements will be collected at all sites using a *Marsh McBirney Flo-Mate 2000*™ current velocity meter or the float method in accordance with MDEQ's Field Procedures Manual (DEQ, 2005 a) available at: (http://deq.mt.gov/wqinfo/QAProgram/PDF/SOP%20WQPBWQM-020.pdf). Flow measurements will be performed during installation and retrieval, and possibly in mid-summer.

3.2 Temperature Data

Temperature data loggers will be deployed and retrieved according to the requirements indicated in the Temperature Data Logger Standard Operating procedure (DEQ 2005 b) available at: http://www.deq.state.mt.us/wqinfo/qaprogram/PDF/SOP%20WQPBWQM-006.pdf. The WQMAS Section staff will check in mid-summer the temperature data loggers to ensure they are submerged during low water, and the logger conditions will be noted on the data sheets.

3.3 Shade Measurements

Solar Pathfinder data will be collected by PBS&J according to standard methods and procedures provided with the Solar Pathfinder. Sites for shade measurements will be selected to represent the various vegetation communities and stream directions. Site selection and Solar Pathfinder data collection will occur in August, 2010.

3.4 Digital Photographs

Digital photographs will be taken at each site where the temperature data loggers were deployed and the flow measurements were taken. Digital photographs will also be taken at Solar Pathfinder locations.

4.0 Quality Assurance and Quality Control Requirements

This project will follow the WQPB "internal process". All QA/QC requirements followed by MT DEQ will be instituted for this project. The QA/QC requirements are described in MT DEQ (2005c).

4.1 Instrument Calibration

Temperature Data Loggers

All temperature data loggers will be checked for accuracy prior to deployment and again post retrieval. Pre and post accuracy check is necessary to control and understand any bias that may be present in the data. Instructions for accuracy check and allowable limits of divergence can be found in the MDEQ Temperature Data Logger Protocols Standard Operating Procedure (2005).

To measure precision over the course of a study, two loggers can be placed at a site creating replicate measures of the sampling point. Replicates measures will be performed at a 10% frequency (2 sites). The values obtained from a replicate deployment should not vary more than +/- 0.5 degrees C for readings taken at the same time. Effective precision for the continuous temperature data loggers is +/- .2°C.

McBirney Flo-Mate 2000™

Instrument is checked pre-field season to ensure is measuring correctly according to the instrument manual.

5.0 Data Analysis, Record Keeping, and Reporting Requirements

This project will follow the WQPB "internal process". Site Visit/Chain of Custody forms, field forms and digital photos will be processed by WQPB staff following QA/QC procedures as indicated in section 4.0.

6.0 Schedule for Completion

Tentative:
June 28-29: Deployment
August: Solar Pathfinder data collection; Temperature data logger check and flow measurement
Late September: Retrieval
October 2010 – December 2010: Temperature Modeling and Scenarios

7.0 Project Team and Responsibilities

Project Team:
DEQ:
Jim Bond – Senior TMDL Planner; Project design and data analysis
Kyle Flynn – Hydrologist; Project design review and data analysis
Steve Cook – TMDL Planner, Field Personnel
Zach Stetzner – WQMAS, temperature data logger (TDL) set up and calibration, TDL installation and retrieval; flow measurements during installation, mid-summer (?), and retrieval; instrument data retrieval, flow calculations.
Steven Reistroffer - WQMAS, temperature data loggers installation and retrieval; flow measurements during installation, mid-summer (?), and retrieval; instrument data retrieval, flow calculations.
PBS&J:
Jeff Dunn – Solar Pathfinder site selection and data collection; data analysis and temperature modeling

8.0 References

DEQ 2005a. Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring. Montana Dept. of Environmental Quality, WQPBWQM-020, revision 2. April 21, 2005. *Available at* http://deq.mt.gov/wqinfo/QAProgram/PDF/SOP%20WQPBWQM-020.pdf

DEQ 2005b. Temperature Data Logger Protocols Standard Operating Procedure. Montana Dept. of Environmental Quality, WQPBWQM-006, revision 1. December 4, 2005.
Available at http://deq.mt.gov/wqinfo/QAProgram/PDF/SOP%20WQPBWQM-006.pdf

DEQ. 2005c. Quality Assurance Project Plan (QAPP) Sampling and Water Quality Assessment of Streams and Rivers in Montana, 2005. *Available at* http://deq.mt.gov/wqinfo/QAProgram/PDF/WQPBQAP-02.pdf

Figure 1 – Boulder-Elkhorn TPA and Temperature Sampling Locations

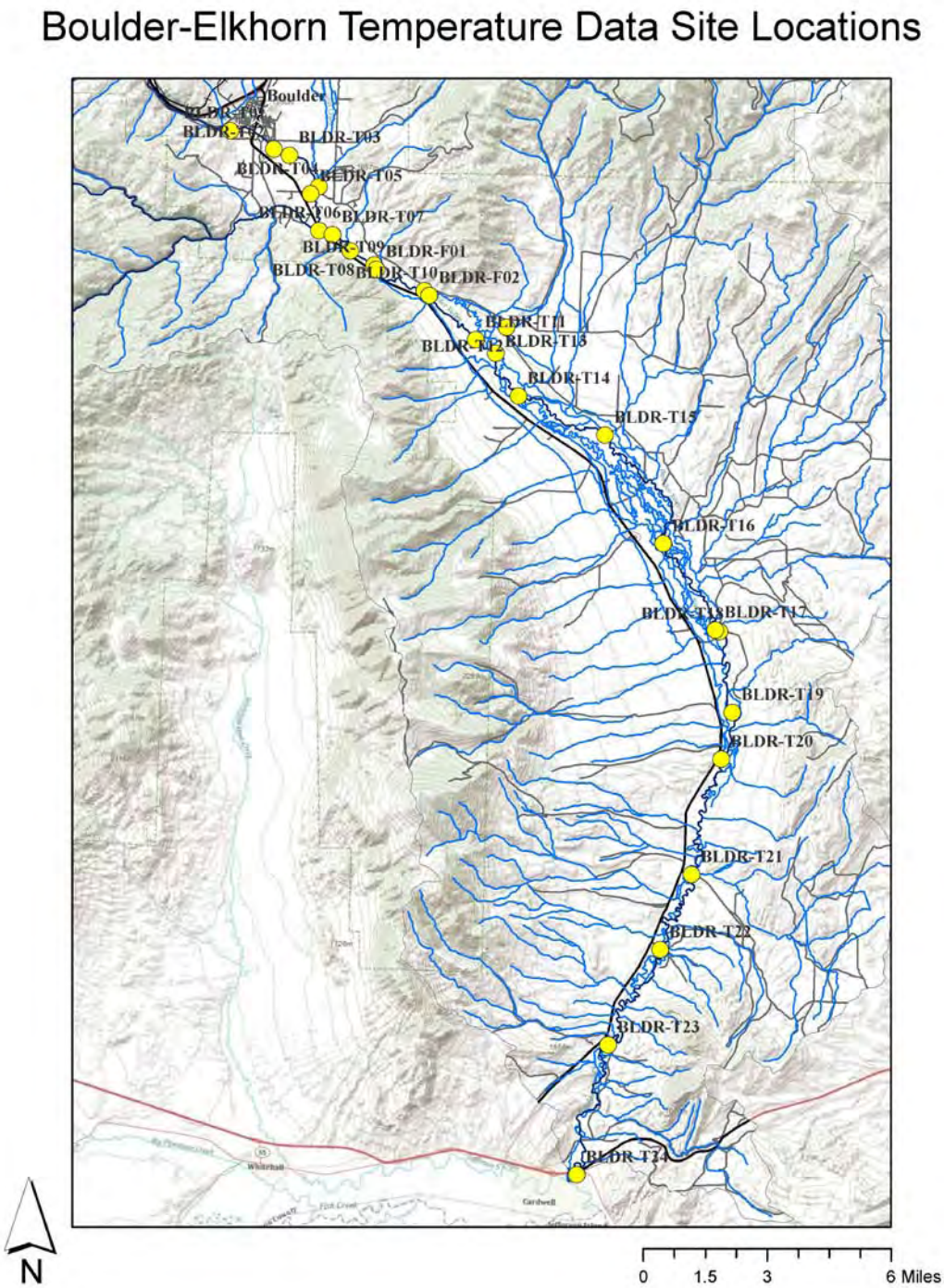

Figure 2 – Boulder River Sampling Locations - Detail

Figure 3 – Boulder River Sampling Locations - Detail

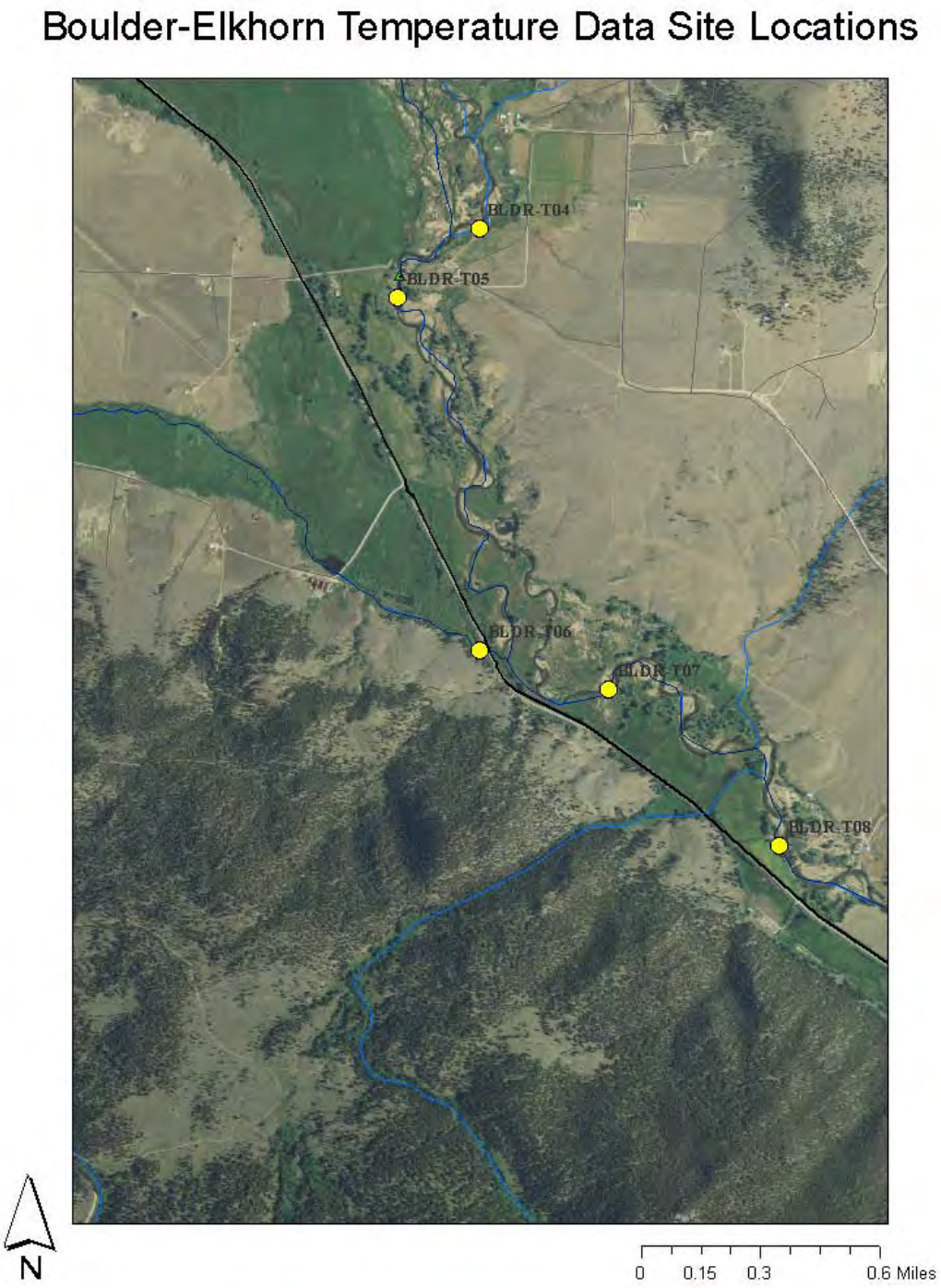

Figure 4 – Boulder River Sampling Locations - Detail

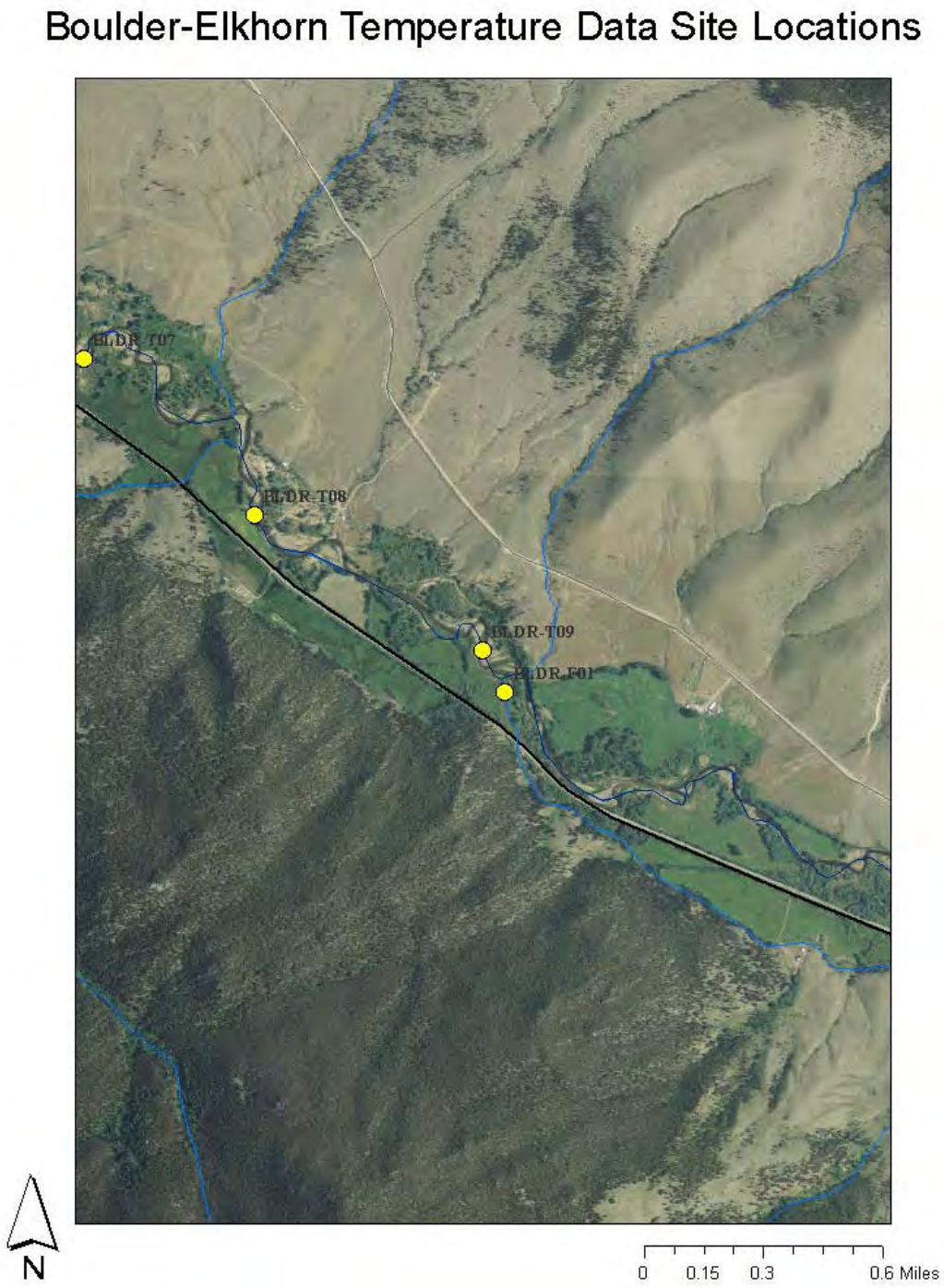

Figure 5 – Boulder River Sampling Locations – Detail

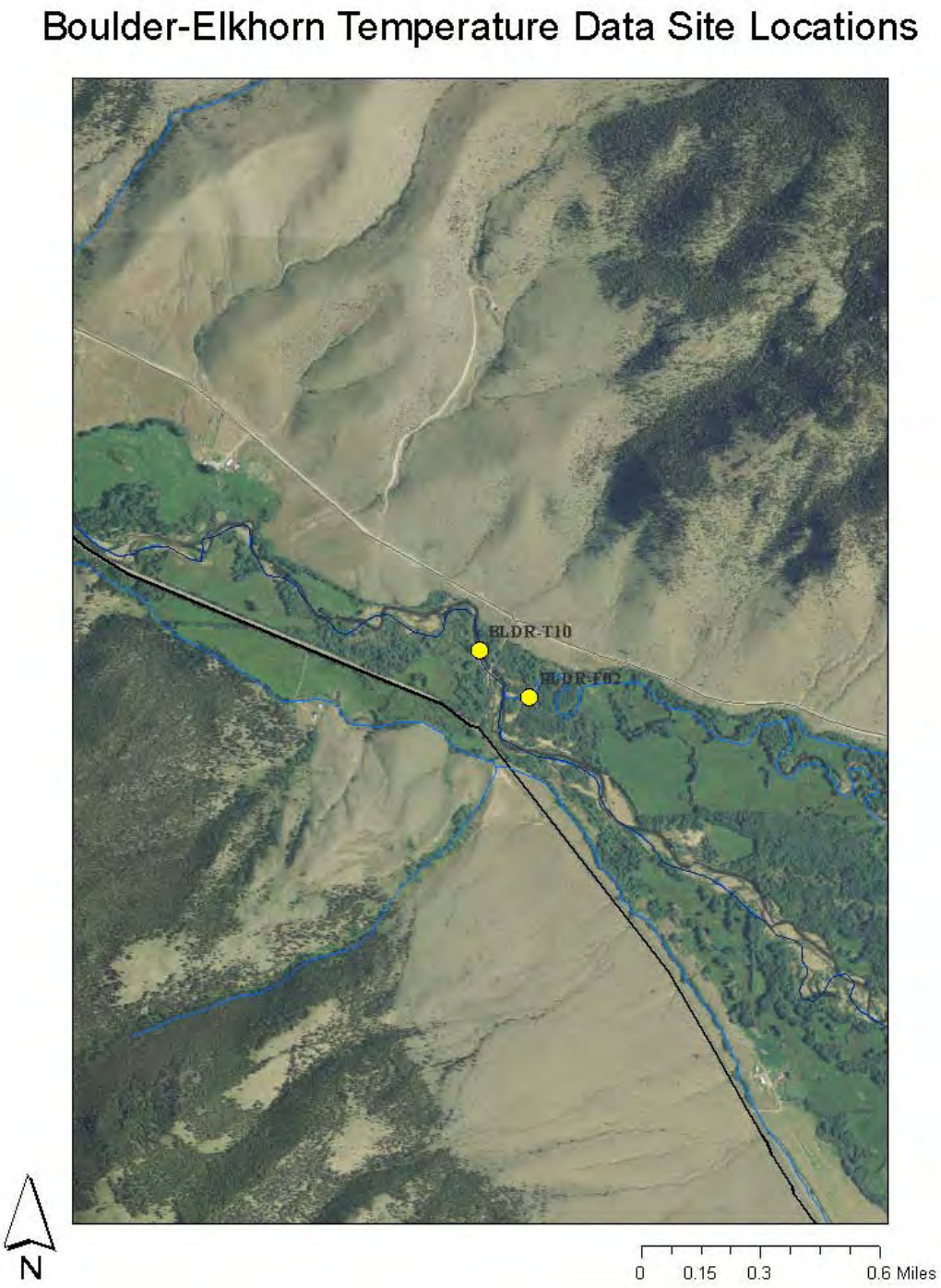

Figure 6 - Boulder River Sampling Locations – Detail

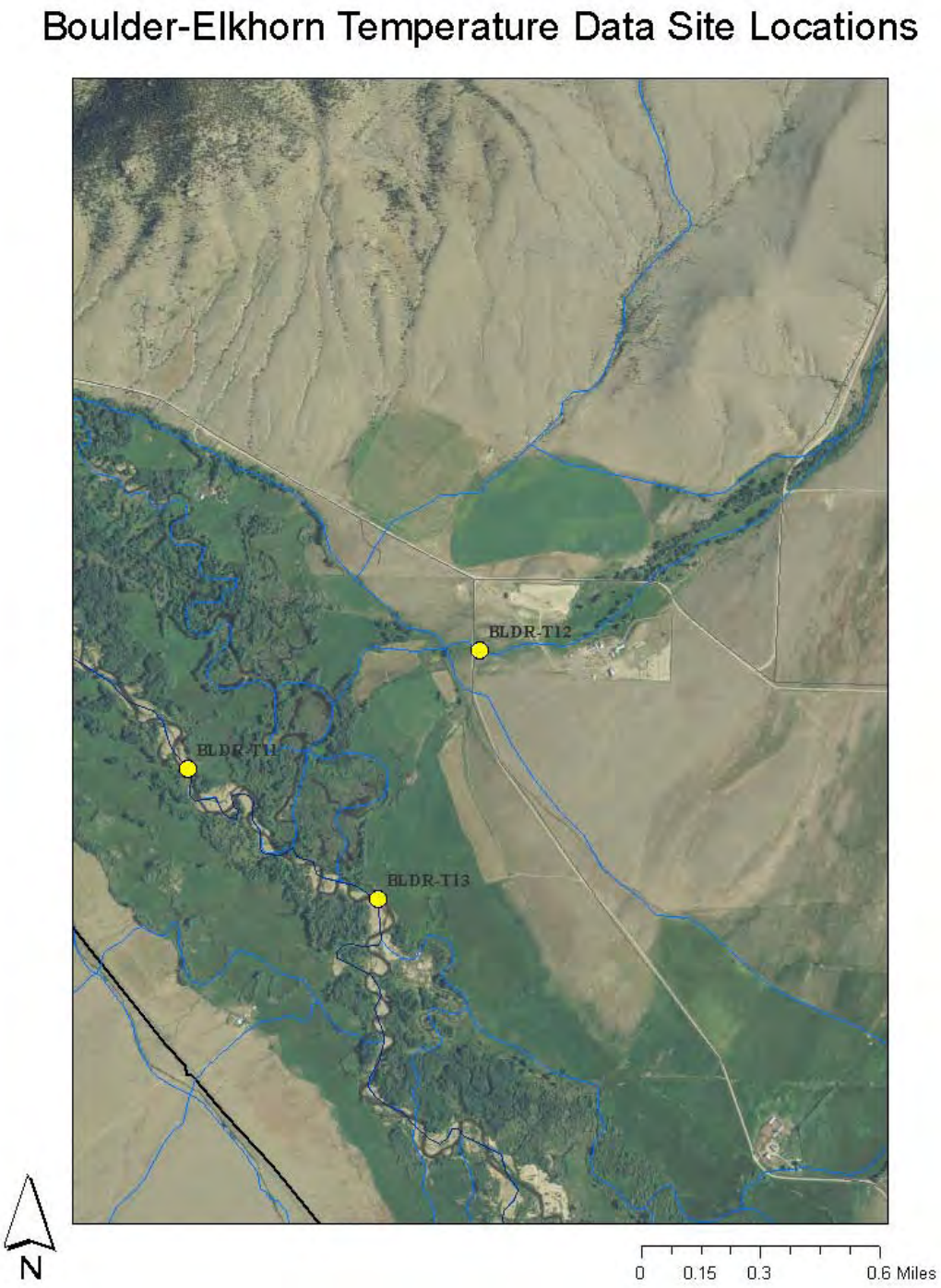

Figure 7 - Boulder River Sampling Locations – Detail

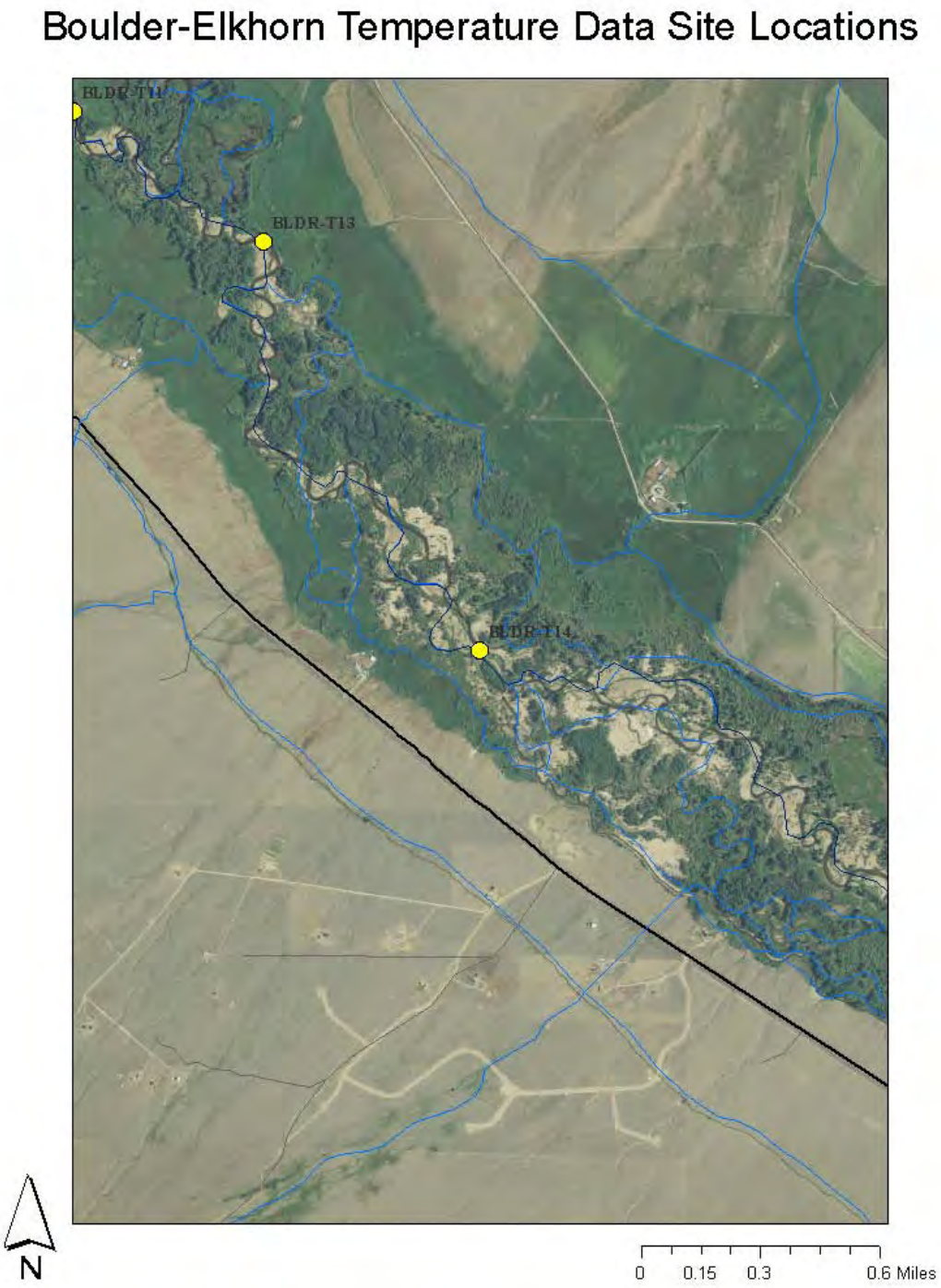

Figure 8 - Boulder River Sampling Locations – Detail

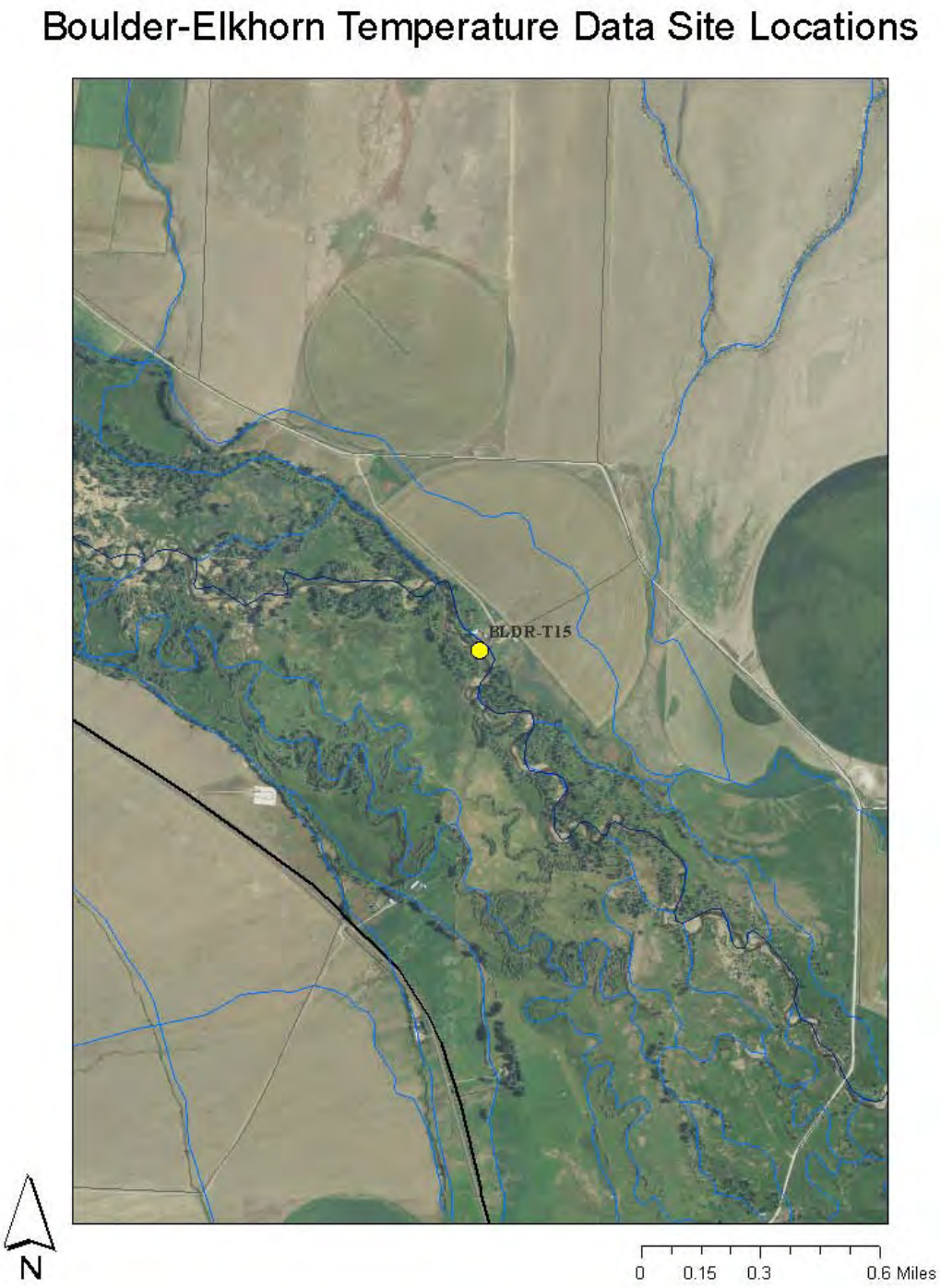

Figure 9 - Boulder River Sampling Locations – Detail

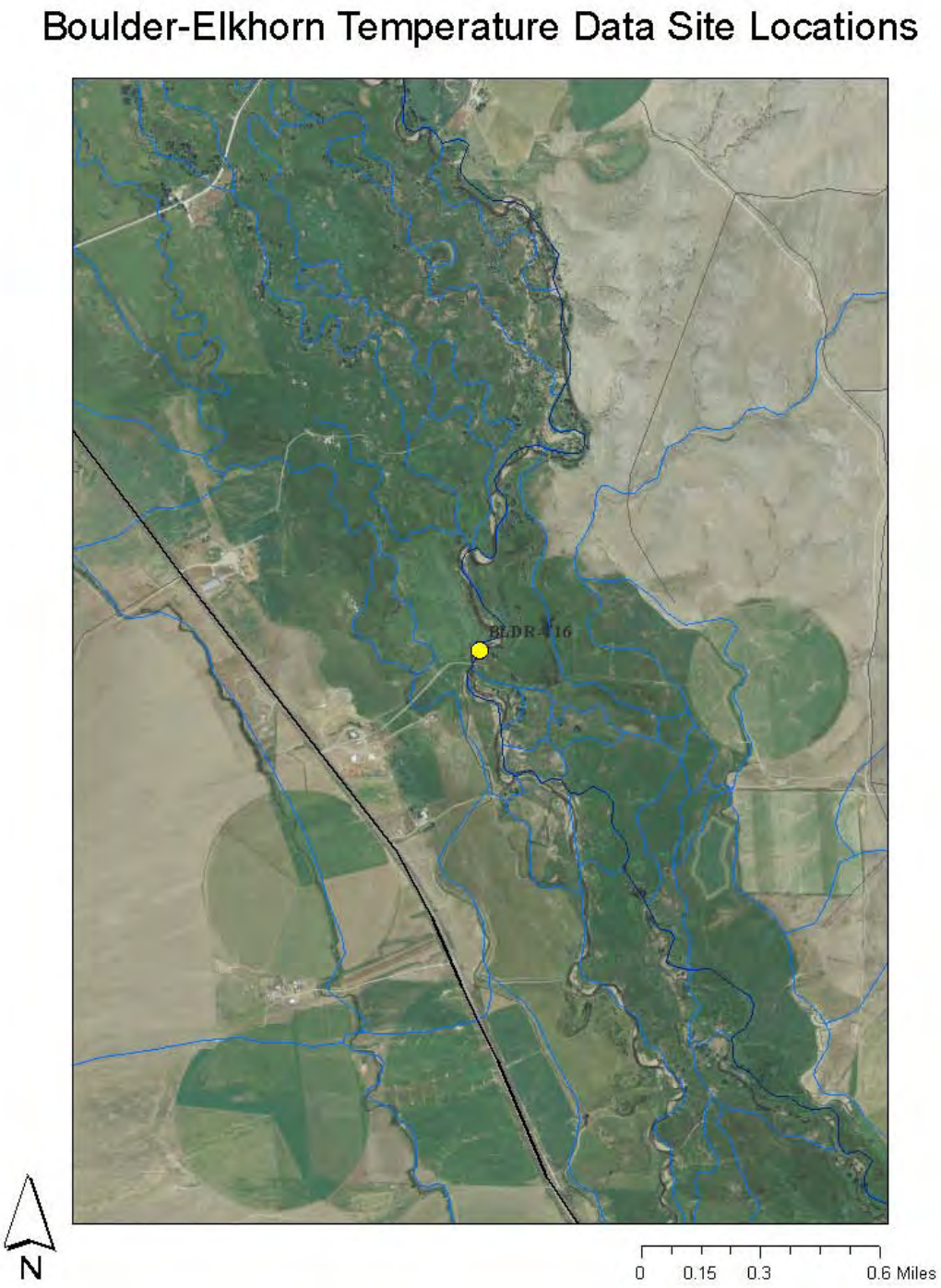

Figure 10 – Boulder River Sampling Locations – Detail

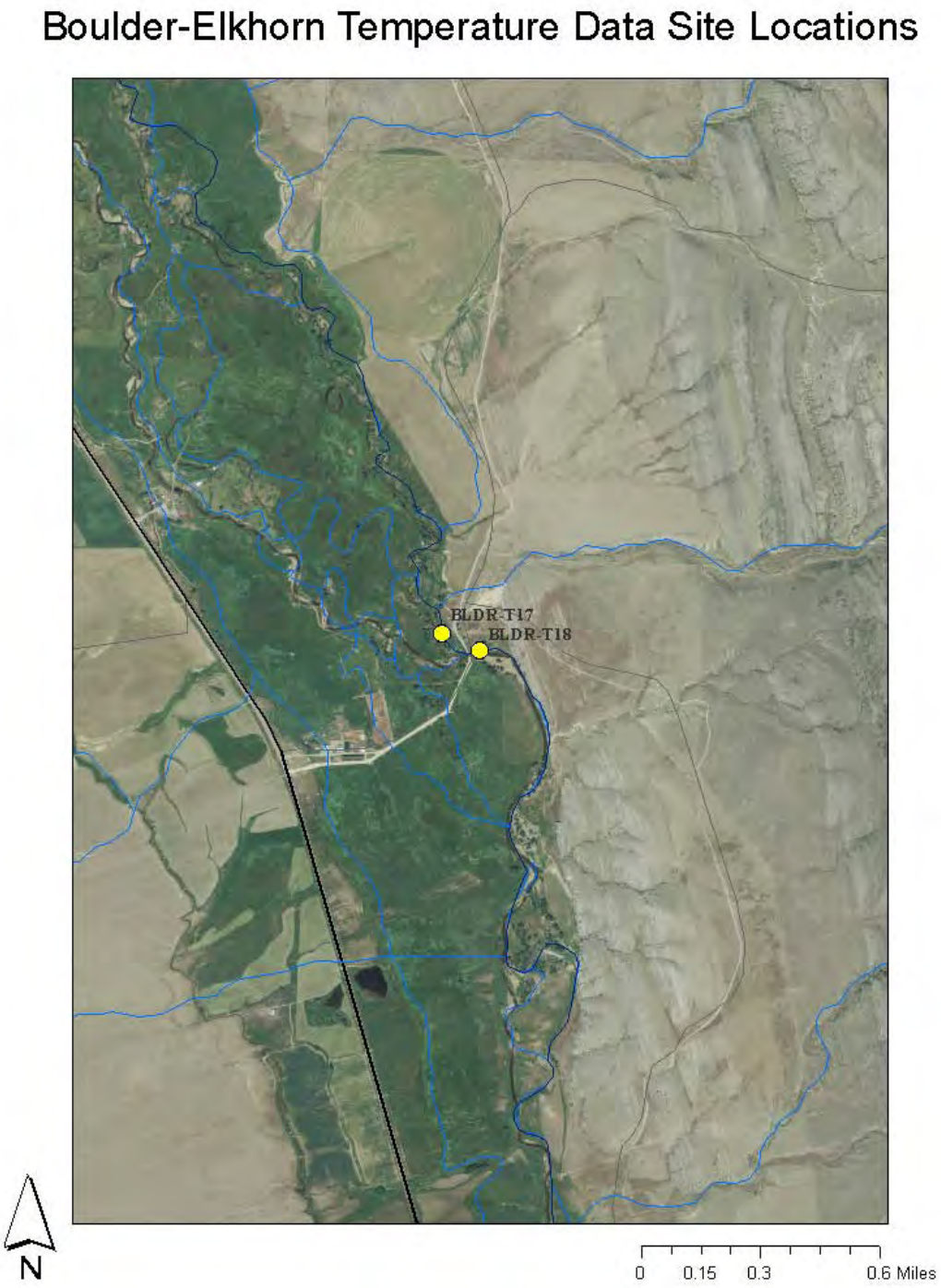

Figure 11 - Boulder River Sampling Locations – Detail

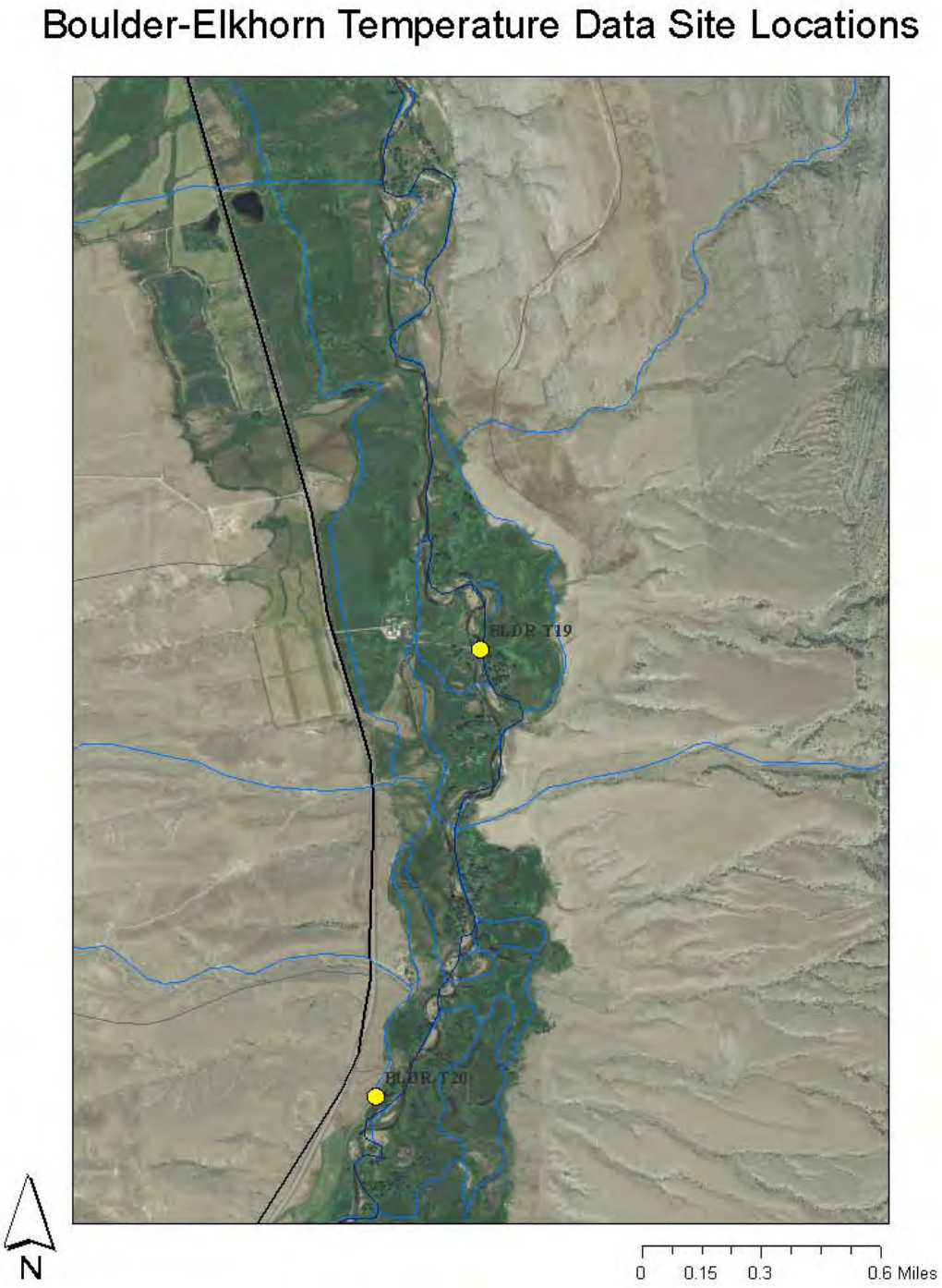

Figure 12 - Boulder River Sampling Locations – Detail

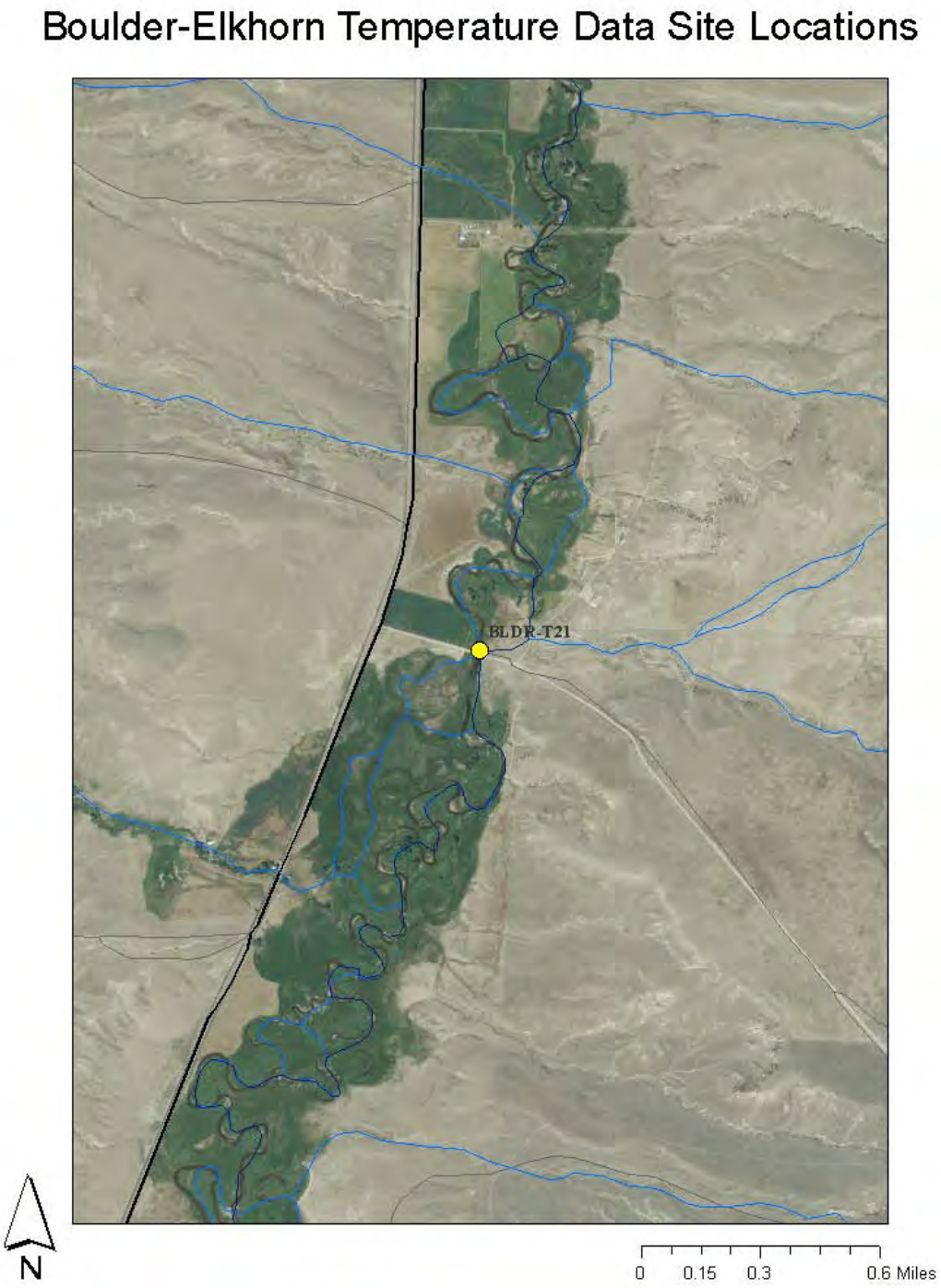

Figure 13 - Boulder River Sampling Locations – Detail

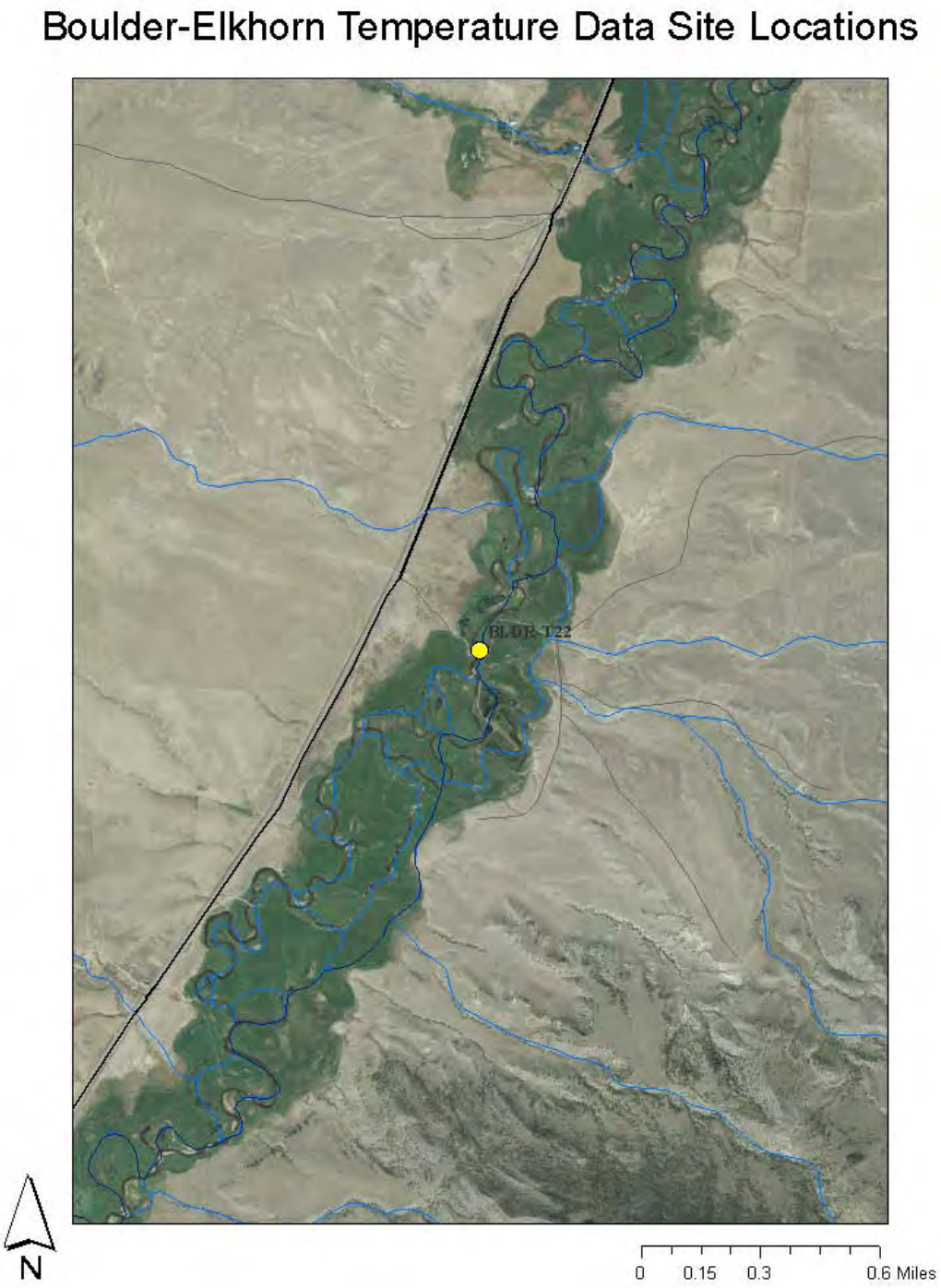

Figure 14 - Boulder River Sampling Locations – Detail

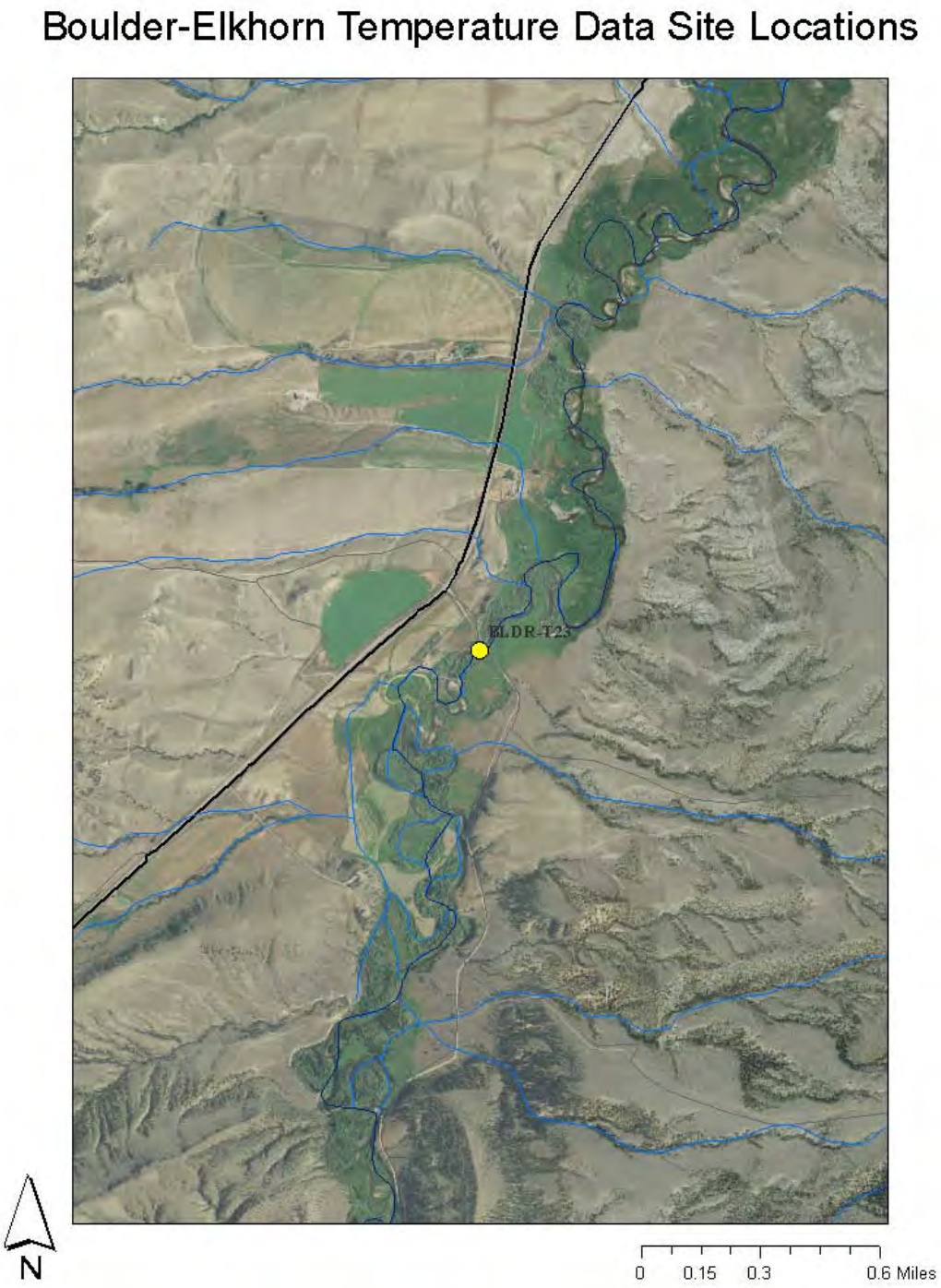
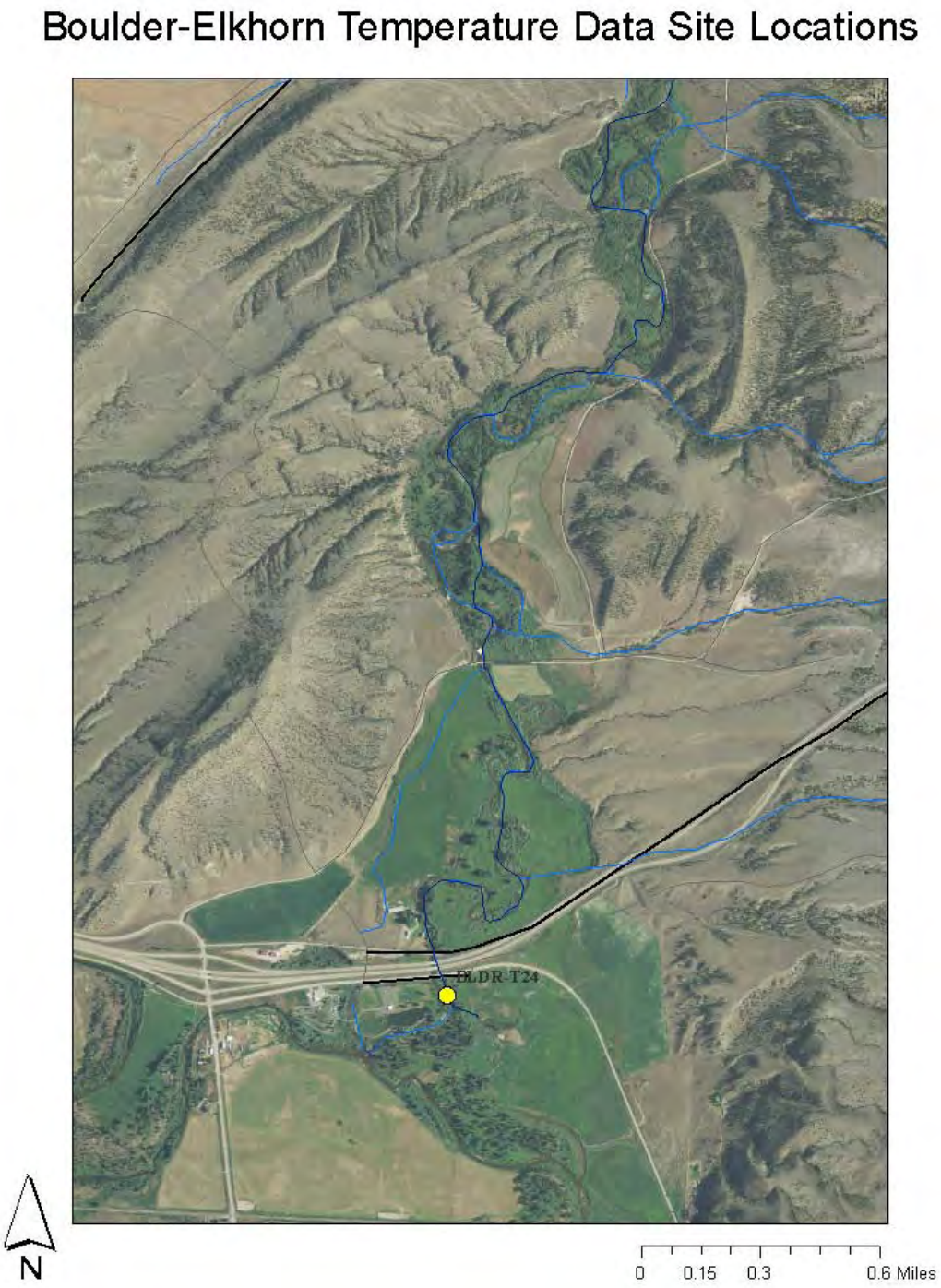
Figure 15 - Boulder River Sampling Locations – Detail