

# Sand Creek Massacre National Historic Site

National Park Service  
U.S. Department of the Interior

Natural Resource Stewardship & Science  
Water Resources Division



## Water Rights Assessment

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*NPS Photo: Jeff Campbell*

### 1.0 Introduction

In response to a request by Sand Creek Massacre National Historic Site (SAND) the NPS Water Resources Division - Water Rights Branch (WRD-WRB) conducted a water rights assessment and determination of future consumptive needs to determine if existing sources are adequate and to assist SAND in obtaining compliance with state rules that require the replacement of depletions from groundwater pumping. As a part of this assessment, the value and risk of the water supply at SAND was also evaluated. Recommendations and associated action items are summarized in Section 4.0 of this report.

### 2.0 Background

SAND is located in the Arkansas River Basin in the grassland plains of southeastern Colorado just northeast of Eads in Kiowa County (*Appendix I – Figure 1*). SAND was authorized by Public Law 106-465 on November 7, 2000 to recognize the national significance of the Sand Creek Massacre in American history and its ongoing significance to the Cheyenne and Arapaho people and massacre descendants. The park opened to the public on June 1, 2007

and currently encompasses 3,025 acres of prairie grassland and offers trails, an overlook onto the massacre grounds, and interpretive rangers. The intermittent Big Sandy Creek<sup>1</sup> bisects SAND and flows infrequently following heavy and prolonged rain events. The watershed drains approximately 1,850 square miles of southeastern Colorado to the Arkansas River.

An initial water rights review was completed by NPS WRD-WRB in February 2000 as part of initial planning efforts prior to SAND becoming a NPS unit (Lord, 2000). The document provides an overview of surface and groundwater rights in Colorado, the Arkansas River Compact, streamflow protection, and federal reserved water rights. This document is more narrowly focused on water rights as they relate to the current and future projected water supply needs at SAND.

In June 2006, NPS-WRD completed a report reviewing the local hydrogeology and potential groundwater sources for potable water supply at SAND (Martin, 2006). This report recommended SAND construct water supply wells in the shallow valley-fill deposits associated with Big Sandy Creek. In 2006 and in 2007 SAND staff submitted permit applications for three water supply wells (**Table 1**) to Division 2 of the Colorado Department of Water Resources (CDWR)<sup>2</sup>. In 2007, three shallow groundwater wells were installed at SAND (*Appendix I - Figures 1 and 2*). In November 2015, SAND acquired a fourth well with the purchase of 640 acres from the Colorado State Board of Land Commissioners.

**Table 1:** Water Supply wells at SAND

| Permit # | Well Type               | Well Installed  | WRB Docket # |
|----------|-------------------------|-----------------|--------------|
| 271899   | Commercial - Exempt     | March, 2007     | SAND 0002    |
| 270566   | Stock - Exempt          | October, 2007   | SAND 0003    |
| 13260    | Irrigation - Non-Exempt | November, 2007  | SAND 0001    |
| 284444   | Stock - Exempt          | September, 2014 | SAND 0004    |

Commercial and stock water supply wells are exempt from water rights administration in Colorado and are not administered under the priority system. The irrigation well is non-exempt and is administered by the CDWR and governed by the priority system. Since this non-exempt irrigation well is within the Arkansas River Basin, replacement (a/k/a augmentation) of its depletions from groundwater pumping is required by CDWR's "Amended Rules and Regulations Governing the Diversion and Use of Tributary Ground Water in the Arkansas River Basin, Colorado" (Rules).

Based on the location of SAND within the Arkansas River Basin, compliance with the Rules can be achieved through membership in the Lower Arkansas Water Management Association (LAWMA). LAWMA was formed as a private "membership" association for the purpose of providing replacement water to the Arkansas River from below John Martin reservoir to the Kansas State line. It is a shares-based organization similar to a mutual ditch company, which is

<sup>1</sup> HUC 8 - 11020011

<sup>2</sup> CDWR administers surface and groundwater rights throughout Colorado.

governed by Articles and By-Laws (one share = one acre foot). LAWMA has two classes of shares – common and preferred. A preferred share allows a participating well to pump a fixed volume of groundwater regardless of general hydrologic conditions, whereas the volume of groundwater that may be pumped pursuant to a common share varies with the yearly allocation set by the Board (<http://www.lawma.net/faq.html>).

SAND's general management plan (GMP) was finalized in 2015 (NPS, 2015). As noted in the GMP, staff located on-site at SAND will increase and a new contact station with visitor bathrooms will be up and running by approximately 2020. It is expected that water use will increase when these new facilities are in place.

Annual visitation at SAND for 2010 through 2015 is shown in **Table 2**. The average visitation of 2010-2105 is roughly 5,000 per year. Visitation spiked in 2014 as a result of the 150<sup>th</sup> commemoration of the massacre. According to the visitation and expenditure forecast contained in the SAND Special Resource Study (NPS, 2000), it was projected that SAND would have 20,000 to 30,000 visitors per year. This estimate was based largely on an examination of historic visitation data for the nearby Bent's Old Fort National Historic Site (BEOL). BEOL has averaged approximately 40,000 visitors per year over the last 50 years, with an average increase of 1% per year. The annual visitation estimate from the Special Resource Study is considerably higher than the actual visitation documented for SAND over the last five years. For the purposes of the future use determination of this assessment, it is assumed that future annual visitation will range between 4,000 and 20,000 visitors per year.

**Table 2:** Annual visitation at SAND

| CY   | Number of Visitors |
|------|--------------------|
| 2010 | 4,063              |
| 2011 | 3,935              |
| 2012 | 4,384              |
| 2013 | 4,795              |
| 2014 | 7,402              |
| 2015 | 5,887              |

### 3.0 Water Rights Assessment:

NPS-WRB reviewed existing records for the four groundwater wells at SAND in order to determine whether existing water supplies are adequate to meet future needs and if current and projected use are aligned with permit conditions. All records for these wells were obtained from the CDWR website (<http://www.dwr.state.co.us/WellPermitSearch/default.aspx>). Water use data was obtained from Park staff. Water rights dockets were created as a part of this report (Docket SAND 0001, SAND 0002, SAND 0003, and SAND 0004) and are available on IRMA (<https://irma.nps.gov/DataStore/SavedSearch/Profile/2180>). A summary of recommendations and action items are listed in **Section 4.0**. Since the wells at SAND have different administrative requirements, future use was evaluated for each well separately.

### 3.1. Commercial Exempt Well Permit #271899 (WRB Docket# SAND 0002):

In September 2006, the NPS acquired land from the Cheyenne and Arapaho Tribes of Oklahoma where the point of diversion (POD) for the commercial-exempt well is located (*Appendix I - Figures 1 and 2*). This is also where the temporary administrative / visitors contact station is located and where the future visitors contact station will be located. In December 2006, Park staff filed a water well permit application for a commercial-exempt well for bathrooms and drinking water for the contact station at the Park<sup>3</sup>. As a part of the application, a construction variance was requested because the proposed shallow alluvial well would have less than 20 feet of watertight steel casing. The variance was approved and the Permit was issued by CDWR on December 13, 2006 (permit# 271899).

On March 11, 2007, the well was completed in alluvium to a total depth of 36 feet. The well is screened from 16 to 36 feet and has a static water level of approximately eight feet below land surface (bls). Conditions of the initial well permit #271899 required abandonment of unregistered wells within the 40 acre parcel and abandonment of permitted well #13260R (**Section 3.3**). As a result of a phone conversation between Park staff and CDWR<sup>4</sup> the Park requested a modification to the permit so that Permit 13260R be made inactive, but not abandoned. Three unregistered wells within the parcel were plugged and abandoned on March 12, 2007. The original permit for the commercial-exempt well (permit# 271899) was modified on August 22, 2007, noting that the well under Permit 13260R was not abandoned and remains valid.

According to permit #271899, water cannot be used for any purpose outside of the building structure, pumping cannot exceed 15 gallons per minute (gpm), and annual use cannot exceed 108,600 gallons. The Park must maintain permanent records of all pumping (recorded at least annually) and submit to the CDWR Division Engineer upon request. Monthly meter readings have been noted since August 2009 (**Table 3**).

**Table 3:** Annual water use and visitation for Permit# 271899

| CY   | Total Gallons | Visitors | Gallons per Visitor |
|------|---------------|----------|---------------------|
| 2010 | 29,000        | 4,063    | 7.14                |
| 2011 | 39,260        | 3,935    | 9.98                |
| 2012 | 39,820        | 4,384    | 9.08                |
| 2013 | 43,940        | 4,795    | 9.16                |
| 2014 | 48,470        | 7,402    | 6.55                |

Since SAND opened to the public in 2007, water use from this well has included drinking water, sanitation, a staff bathroom (with shower), and a kitchen (sink, dishwasher, and laundry). The well is treated to meet drinking water standards. Current visitor restrooms are vault toilets

<sup>3</sup> Note: the range was incorrectly noted R46W on the application, this was corrected on the permit as R45W

<sup>4</sup> Dan DiRezza (CDWR Division 2 Groundwater Enforcement Technician) informed Park Staff that a water right is associated with Permit #13260.

with no potable water. According to the GMP, new visitor restrooms will be installed, thereby increasing water use starting in approximately 2020. Water use may also increase if the number of on-site staff increases. If average water use per visitor is assumed to be five to ten gallons (**Table 3**), the permitted water use for the commercial-exempt well should be sufficient to meet the needs of between 10,000 and 22,000 visitors.

In the event that water use increases and approaches the 108,600 gpy limit, WRB recommends that SAND consider using the non-exempt well (**Section 3.3**) to supplement water from the exempt well. WRB recommends that new facilities incorporate water conserving technology, such as low-flush toilets with signage encouraging smart water use by visitors. WRB recommends the Park continue to record meter readings monthly. The meter reading and the date of the reading should be noted and kept on file in the permanent records of the Park.

### **3.2. Stock Well – Exempt – Permit #270566-A (WRB Docket# SAND 0003):**

In 2002, the NPS purchased the parcel containing the POD for the exempt stock well from the Conservation Fund, who had acquired the property from the Mace Trust Fund. The Mace family had leased the property to a landowner who had used the well for watering livestock. In June 2006, Park staff filed a water well permit application to register the existing exempt well (*Appendix I - Figure 1*) for livestock and fire suppression purposes. A permit (#270566) was issued in September 2006. In July 2007, Park staff determined that the well needed to be re-drilled and filed a permit application to replace the existing well. A new permit (#270566-A) was granted on July 25, 2007, with the condition that the existing well be plugged. On October 2, 2007, the new well was completed in alluvium to a total depth of 40 feet, screened from 20 to 40 feet with a static water level of approximately 22 feet bls. The old well was plugged and abandoned on the same day.

Currently, a solar panel is used to power a pump that fills a stock tank adjacent to the well, which is triggered by float device. Although the current pumping rate is known to be 4.5 gpm (allowable is 15 gpm), this well is not metered and, therefore, no annual volume of withdrawals can be determined. No annual pumping limit has been established by CDWR for exempt stock wells. Current and future uses of this well are for wildlife and emergency fire suppression.

### **3.3. Irrigation Non-Exempt Well #13260-R-R (WRB Docket# SAND 0001):**

The initial registration for this well (Permit# 13260) was completed in 1960 by Lloyd Philpy, with first use indicated as May of 1956. In 1963, J.W. Dawson purchased the parcel from Philpy and in 1972 filed an application to CDWR Division 2 Water Court for underground water rights for well permit #13260<sup>5</sup> (also known as Dawson Well No. 1) in addition to 13 other wells. In 1974, by ruling of Case #W-3235, an underground water right was granted for Well #13260 with a priority date of May 31, 1956. On December 19<sup>th</sup>, 2003, the Cheyenne and Arapaho Tribes of

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<sup>5</sup> It should be noted that in some historical documentation associated with this well, the well permit number has been incorrectly noted as #13280.

Oklahoma purchased the parcel associated with Permit #13260 from Dawson. In September 2006, the NPS acquired the parcel from the Cheyenne and Arapaho Tribes of Oklahoma (*Appendix I - Figures 1 and 2*). In June 2007, Park staff filed a water well permit application<sup>6</sup> for replacement of the existing non-exempt well for irrigation.

On August 22, 2007 Permit #13260-R-R was issued to the NPS to drill a new well. As a part of the application, a construction variance was required since the shallow alluvial well would have less than 20 feet of watertight steel casing. On November 2007, the replacement well was completed in alluvium to a total depth of 30 feet. The well is screened from 10 to 30 feet and has a static water level of approximately 7 feet bls. Conditions of the well permit #13260-R-R required the abandonment of the existing well (permit# 13260-R), which was plugged and abandoned on December 20, 2007.

Permit# 13260-R-R states that water use is restricted to irrigation of 20 acres of native grass with pumping not to exceed 300 gpm and annual pumping not to exceed 100 acre feet per year (afy). The groundwater withdrawn from the well is not being treated and therefore, is only used for non-potable purposes. A 45 gpm pump was installed in 2008. The collection of monthly meter readings for this well did not begin until March 2015. According to Park staff, the water use from this well was greatest in 2013 when newly-planted cottonwood trees were irrigated via a drip irrigation system. Although meter records were not recorded, Park staff estimated that 30,000 gallons of water was used from the well that year.

Park staff indicated that future use would not be much greater than pumping during 2013 and estimated that 50,000 gallons per year (gpy) would be a reasonable estimate for future use. Current and future uses for the groundwater withdrawn from this well will be drip irrigation of new plantings, dust abatement, native vegetation restoration, emergency fire suppression, cleaning of park structures and equipment, and other miscellaneous outside projects. It is also possible that this well may be used in the future to provide a supplemental source of potable water if the pumping limits on the commercial-exempt well are reached.

Replacement of depletions from groundwater pumping for this non-exempt well is required by the Rules. Prior to August 2015, Park staff leased shares from a LAWMA shareholder on a temporary basis while searching for an opportunity to purchase shares. On August 7, 2015, SAND purchased one common share of LAWMA stock as recommended by NPS-WRB. A copy of the share certificate is attached to this report (*Appendix I - Figure 3*). According to Don Higbee and Randy Hendrix of LAWMA, in the last 18 years the annual allocation for a common share ranged from a low of 20% in 2003/2004 to a high of 110% in 1998 through 2002 (*Appendix I – Table 4*). This equates to an allowable pumping at SAND ranging between 5 and 27.5 afy (or 1,629,500 to 8,962,250 gpy). **Figure 4** (*Appendix I*) illustrates how the annual allowable pumping is calculated.

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<sup>6</sup> Note that the POD was incorrectly noted as R46W in the application which was corrected to 45W in the permit.

Using **Equation 2** (*Appendix I - Figure 4*), the range in allowable pumping based on annual allocation in afy and in gpy was calculated in 10-percent increments (**Table 5**). Considering a year with only a 10% allocation, over 800,000 gpy of pumping would be allowed from the non-exempt well and with a 100% allocation over 8 million gpy of pumping would be allowed.

**Table 5:** Allowable pumping scenarios depending on annual allocation (Figure 4 - Equation 2)

| <b>Annual Allocation (percent)</b> | <b>Allowable pumping (afy)</b> | <b>Allowable pumping (gpy)</b> |
|------------------------------------|--------------------------------|--------------------------------|
| 10                                 | 2.50                           | 814,750                        |
| 20                                 | 5.00                           | 1,629,500                      |
| 30                                 | 7.50                           | 2,444,250                      |
| 40                                 | 10.00                          | 3,259,000                      |
| 50                                 | 12.50                          | 4,073,750                      |
| 60                                 | 15.00                          | 4,888,500                      |
| 70                                 | 17.50                          | 5,703,250                      |
| 80                                 | 20.00                          | 6,518,000                      |
| 90                                 | 22.50                          | 7,332,750                      |
| 100                                | 25.00                          | 8,147,500                      |

SAND will receive a notice every year by April 1<sup>st</sup> from LAWMA indicating the annual allowable pumping from the non-exempt well. These notices should be kept on file at SAND and any concerns regarding the annual allocation should be discussed with NPS-WRB prior to contacting LAWMA. Based on SAND staff's future use estimates, WRB believes that the annual allocation for allowable pumping with one common share of LAWMA stock for the non-exempt well will be sufficient to satisfy the current and future water supply requirements of the Park.

LAWMA will send out an annual fees letter out after January 1<sup>st</sup> of each year with payment in full due by no later than the following February 10<sup>th</sup>. In 2015, annual LAWMA "per structure" fees were \$375 with a share "assessment" fee of \$38.00 per common share per year. The "per structure" rate is set each year by the Board and the "assessment" fee is set by the stockholders based on the recommendation of the Board (<http://www.lawma.net/faq.html>). LAWMA requires that a monthly well usage report be filled out by the Park staff and returned. LAWMA forwards this information on to the CDWR.

Because SAND is now a LAWMA shareholder and member, LAWMA will submit an application to Division 2 Water Court to have SAND well #13260-R-R added to their decreed augmentation plan. NPS-WRB has requested that the application include the actual current and future uses and the correct decreed well location for W-3235<sup>7</sup>.

#### **3.4. Stock Well – Exempt – Permit #284444-A (WRB Docket# SAND 0004):**

In October 2015, the NPS acquired a 640 acre parcel (S36 T17S R46W) from the Colorado State Board of Land Commissioners (Land Board). The new parcel is encumbered by a grazing

<sup>7</sup> The correct well location should be NW1/4 SW1/4 of S30 T17S R45W (not SW1/4 SW1/4 of S30 T17S R45W)

lease (Agricultural Lease No. 46519) that expires in 2022. The Park, as landowner, will become the lessor. The lessee is Art Fox of Chivington, CO.

Prior to NPS acquisition, the Land Board filed an application for an existing exempt stock well (also known as Dawson Well #4) and reported that water from the well was first beneficially used by the original owner in 1956 for livestock (*Appendix I - Figure 1*). Permit# 284444 was granted in November 2010. In June 2014, the Land Board on behalf of the lessee filed an application to replace the existing well with a new well. In July, 2014 permit# 284444-A was granted, with the condition that the existing well be plugged. On September 14, 2014, the new well was completed in alluvium to a total depth of 40 feet, screened from 25 to 40 feet with a static water level of 21.5 feet bls. The old well was plugged and abandoned on December 16, 2014.

A windmill pump was abandoned onsite and replaced with a solar pump that fills a stock tank adjacent to the well. Currently there is no float device connected to the pump therefore, the pump runs continuously when it is in operation and forms an artificial pond adjacent to the stock tank. WRB recommends the Park work with the lessee to install a float device that triggers the pump to shut off when the stock tank is full. The Park should request that the lessee turn off the pump during non-grazing periods.

The current pumping rate is eight gpm (allowable is 15 gpm), the well is not metered. No annual pumping limit has been established by CDWR for exempt stock wells. Current and future uses of this well are for livestock grazing for the duration of the lease. WRB recommends that the Park decide whether or not to continue leasing this parcel after 2022 so that decisions regarding future use (or abandonment) can be made. A meeting should be scheduled with the lessee to clarify ownership of the well and associated improvements and responsibilities for maintenance and operation should be documented.

#### **4.0 Water Rights Assessment Summary, Recommendations, and Action Items:**

In summary, NPS-WRB reviewed existing records for the four groundwater wells at SAND, evaluated future use to ensure existing sources are adequate to meet future needs, and examined whether current uses are aligned with permit conditions. Based on the expected amount of augmentation water associated with the newly-acquired LAWMA common share, WRB believes that allowable pumping from the commercial-exempt well combined with a range of allowable pumping (based on the annual allocation percentage) from the non-exempt irrigation well will be more than sufficient to meet future projected water needs at SAND. The following are NPS-WRB recommendations and associated action items (responsible party noted for each item).

1. Keep permanent records of monthly water use from the non-exempt well and the commercial-exempt well. Record actual meter readings and date and time. (SAND staff)
2. Finalize Water Rights Dockets SAND 0001, SAND 0002, SAND 0003, and SAND 0004 and upload to IRMA. (WRB)

3. Request that when LAWMA submits an application to Division 2 Water Court to add well #13260-R-R to their decreed augmentation plan they note the actual uses and the correct well location for W-3235. Dockets will be updated accordingly. (WRB)
4. Submit an annual payment to LAWMA before February 10th to cover the structure fee and share assessment. (SAND staff)
5. Take particular notice of the annual allocation for allowable pumping for the non-exempt well from the notice sent by LAWMA. The Park should receive this by April 1<sup>st</sup> of each year. Keep permanent copies of these notices on file at the Park. Notify WRB with any concerns prior to contacting LAWMA. (SAND staff)
6. Complete the well usage report for the non-exempt irrigation well on the form provided by LAWMA by the 6<sup>th</sup> of each month. Provide actual meter readings only. Keep copies on permanent record at the Park. (SAND)
7. Evaluate the feasibility of using the non-exempt well to supplement potable water use from the exempt well during construction of the new facilities in approximately 2020. Annual visitation is projected to reach 20,000 -30,000 and it is estimated the annual pumping limit of the commercial well will be reached when visitation approaches between 10,000 and 22,000 visitors per year. (SAND with WRB oversight if needed)
8. Adopt water conserving technology for new facilities such as low-flush toilets and have signage encouraging smart water use by visitors. (SAND staff)
9. Determine if grazing lease No. 46519 will be renewed or expire once the lease term has ended so the future of stock well #28444 can be determined. Contact WRB to discuss options for future use and associated administrative requirements for this well. A meeting with the grazing lessee should be scheduled to clarify ownership of improvements and operation and maintenance responsibilities associated with this well. The outcome of this meeting should be documented in writing. The pump on this well should be set up with automatic shutoff and turned off completely during non-grazing periods. (SAND with WRB oversight if needed).

## **5.0 Assessment of Value and Risk**

It is important to understand the value of each water right and evaluate the risk to these rights in order to protect park resources and support future park visitation and operations. At SAND, the water necessary to support the riparian ecosystem of intermittent Big Sandy Creek and the water supply source for visitors and operations are the same. All four water supply wells at SAND pump from the shallow alluvial aquifer which is recharged by precipitation and surface flows from Big Sandy Creek. As a result, the risk is generally the same for all wells at SAND as it is for the water dependent ecosystem. According to the analysis in *Appendix II*, the value of the water resources at SAND is considered high and the risk to the water supply is considered low to moderately low. It may be of value for SAND to monitor water levels in the shallow alluvium to establish long-term trends. Contact WRD if you would like assistance in establishing a long-term monitoring plan.

## **6.0 Conclusions:**

In conclusion, if the four existing wells and associated water rights are operationally and administratively maintained according to the summary and recommendations in **Section 4.0** the high value / low risk water supply should continue to support the parks riparian ecosystem and future visitation and operations well into the future. This document should provide SAND staff with the information necessary to manage the water supply and water rights at SAND. Contact WRD for any additional water rights or water supply support in the future.

## **References:**

- Coffin 1967     *Geology and ground-water resources the Big Sandy Creek Valley, Lincoln, Cheyenne, and Kiowa Counties, Colorado*, U.S. Geological Survey Water Supply Paper 1843, 49 pp, 1 plate.
- Lord 2000     *Special Resource Study: Sand Creek Massacre Site Water Rights Issues*, National Park Service, Water Resources Division, February 2000. Unpublished.
- Martin 2006     *Potential Groundwater Sources for a Potable Water Supply Sand Creek Massacre Site, Kiowa County, Colorado*, National Park Service, Water Resources Division, June 2006.
- NPS 2000     *Sand Creek Massacre Project, Volume 2: Special Resource Study and Environmental Assessment*, National Park Service, Intermountain Region, 2000. Pg 75
- NPS 2015     *Sand Creek Massacre National Historic Site General Management Plan / Environmental Assessment*, National Park Service, Denver Service Center, June 2015.

**APPENDIX I:**  
Figures and Tables

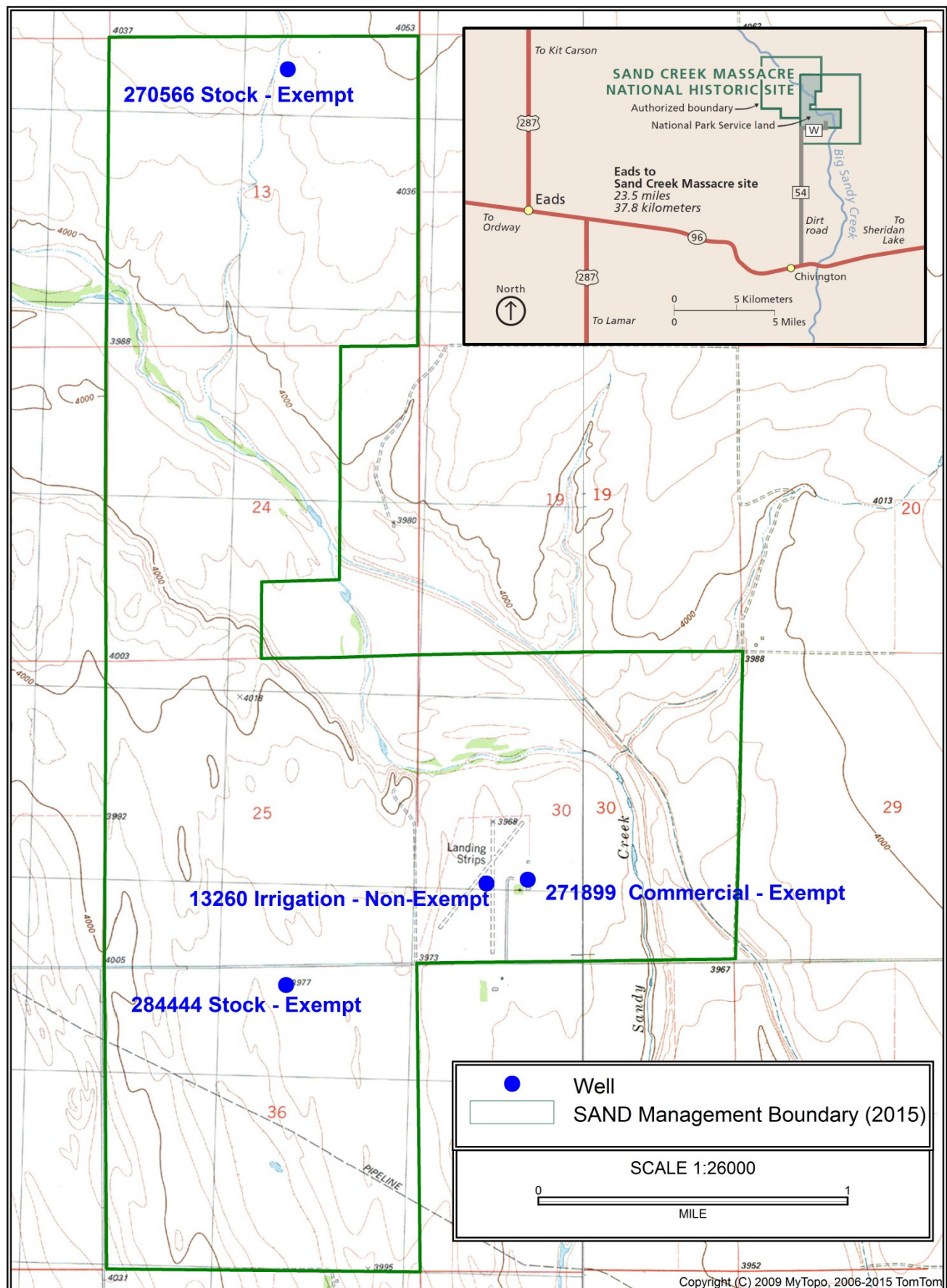


**Figure 1: SAND Well Location Map (shown by well permit numbers)**

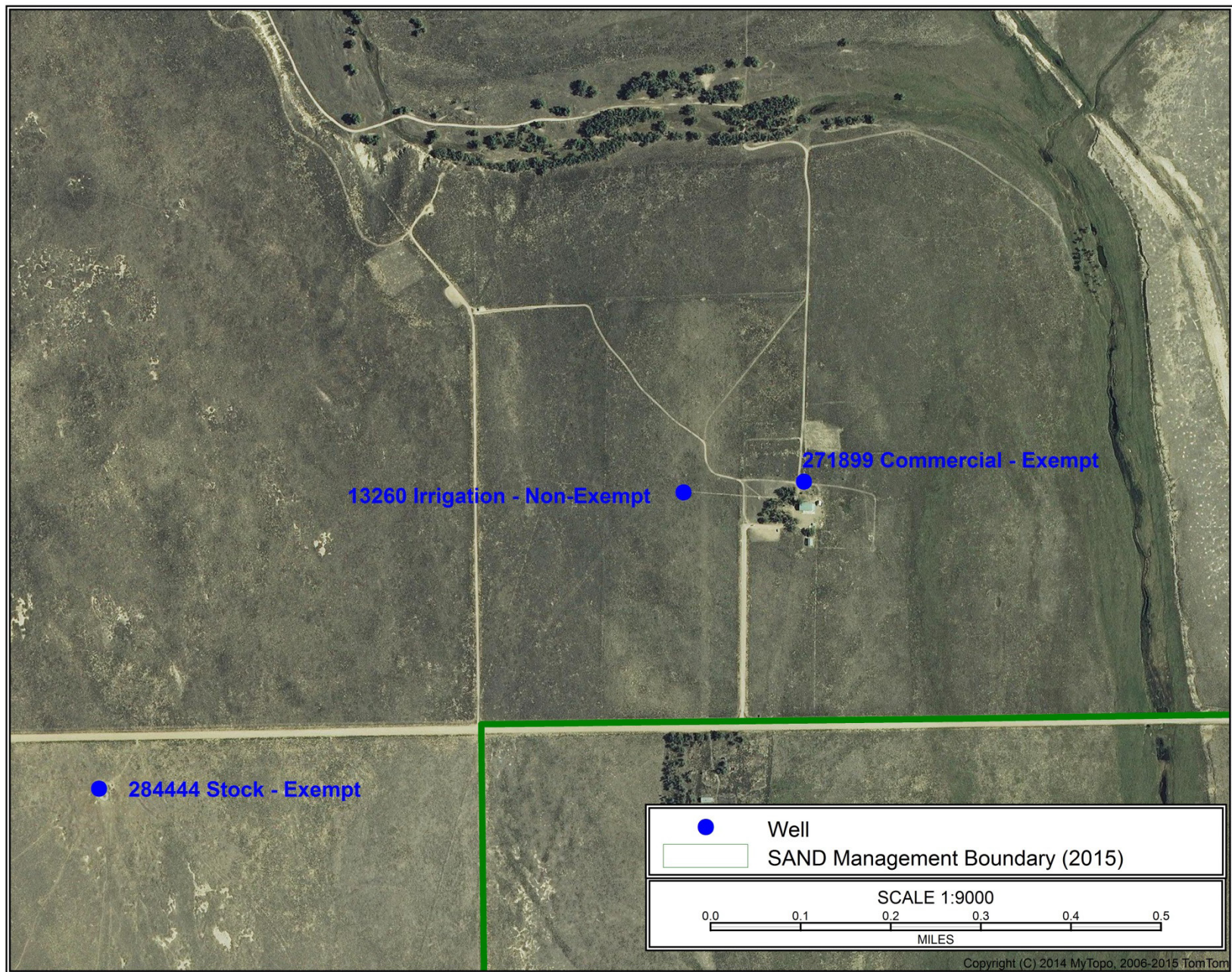


**Figure 2:** SAND Well Location Map (zoom)

Transferred from certificate # 731



**Figure 3:** Scanned copy of Share Certificate

**Table 4:** Copy of Yearly Plan Allocations (Don Higbee and Randy Hendrix, personal communication).

| Year | Initial Allocation (%) | Add Allocation 1 (%) | Add Allocation 2 (%) | Total Allocation (%) | Comment                       | Allowable pumping in acre feet for NPS - Sand Creek (one share) |
|------|------------------------|----------------------|----------------------|----------------------|-------------------------------|-----------------------------------------------------------------|
| 1998 | 110                    |                      |                      | 110                  |                               | 27.5                                                            |
| 1999 | 110                    |                      |                      | 110                  |                               | 27.5                                                            |
| 2000 | 110                    |                      |                      | 110                  |                               | 27.5                                                            |
| 2001 | 110                    |                      |                      | 110                  |                               | 27.5                                                            |
| 2002 | 110                    |                      |                      | 110                  |                               | 27.5                                                            |
| 2003 | 20                     |                      |                      | 20                   | drought, stateline correction | 5.0                                                             |
| 2004 | 20                     |                      |                      | 20                   | drought, stateline correction | 5.0                                                             |
| 2005 | 80                     | 10                   |                      | 90                   |                               | 22.5                                                            |
| 2006 | 70                     |                      |                      | 70                   |                               | 17.5                                                            |
| 2007 | 85                     |                      |                      | 85                   |                               | 21.3                                                            |
| 2008 | 95                     | 5                    |                      | 100                  |                               | 25.0                                                            |
| 2009 | 90                     | 10                   |                      | 100                  |                               | 25.0                                                            |
| 2010 | 100                    |                      |                      | 100                  |                               | 25.0                                                            |
| 2011 | 100                    |                      |                      | 100                  |                               | 25.0                                                            |
| 2012 | 100                    | -15                  |                      | 85                   | drought                       | 21.3                                                            |
| 2013 | 10                     | 25                   |                      | 35                   | drought, Buffalo payback      | 8.8                                                             |
| 2014 | 81                     | 9                    |                      | 90                   |                               | 22.5                                                            |
| 2015 | 75                     | 25                   |                      | 100                  |                               | 25.0                                                            |
|      |                        |                      |                      |                      | <b>Average:</b>               | <b>21.5</b>                                                     |

**Figure 4:** Determination of allowable pumping (Don Higbee and Randy Hendrix, personal communication)

**Equation 1:**

$$\text{Allowable pumping in afy} = \frac{(\text{Yearly allocation} \times \text{number of shares})}{(\text{well depletion factor} \times \text{usability factor} \times \text{well area designation})}$$

**Where:**

|                               |                                                                                                                                                                                                                                                                                                                       |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Yearly allocation:</i>     | Determined by the LAWMA Board on March 1 <sup>st</sup> . This is determined based on snowpack, NOAA projected river flows on the Arkansas and Purgatoire Rivers, water in storage in John Martin Reservoir, and water already delivered to the State of Kansas in the State Line Credit from the ten-year accounting. |
| <i>Number of shares:</i>      | For SAND this is one (1). Share purchased on August 7, 2015.                                                                                                                                                                                                                                                          |
| <i>Well depletion factor:</i> | The wellhead depletion factor assigned by CDWR is 1.0 for the SAND well. This ranges between 1.0 and 0.75 and varies based on use (example 1.0 is for drip irrigation and 0.75 for sprinklers).                                                                                                                       |
| <i>Usability factor:</i>      | The usability factor for wells in LAWMA's augmentation plan is 1.0.                                                                                                                                                                                                                                                   |
| <i>Well Area Designation:</i> | 0.04 for wells along Sand Creek.                                                                                                                                                                                                                                                                                      |

**So:**

**Equation 2:**

$$\text{Allowable pumping in afy} = \frac{(\text{Yearly allocation} \times 1)}{(1.0 \times 1.0 \times 0.04)}$$

## **APPENDIX II:**

### Assessment of Value and Risk

## Value and Risk Assessment

As a part of the Water Rights Assessment for Sand Creek Massacre National Historic Site (SAND) the value and risk associated with the four water supply wells and the intermittent Big Sandy Creek was evaluated.

### 1.0 Value Assessment

According to SAND enabling legislation the Secretary of the Interior and the National Park Service (NPS) is required to “protect and preserve the site, including: the topographic features, artifacts and other physical remains, and the cultural landscape; interpret the natural and cultural resource values of the site; provide for public understanding of, and preserve for future generations, those values; enhance cultural understanding about the site; and assist in minimizing the chances of similar incidents in the future” (NPS, 2015). Big Sandy Creek and the riparian ecosystem are considered “fundamental resources” as they are “essential or important to achieving the national historic site’s purpose and maintaining its significance” (NPS, 2015). As a result, Big Sandy Creek is considered of “high” value.

Both the commercial and irrigation water supply wells (permit #271899 and #13260) are considered necessary to support daily park operations and therefore, the value associated with these wells is considered “high”. The commercial well provides drinking water to park facilities whereas the irrigation well supports all miscellaneous outside uses since the commercial exempt well cannot be used for any outside uses. As a result, the commercial well is considered higher value than the irrigation well. The irrigation well can therefore be considered moderately high in value. The two stock wells (permit#’s 270566 and 284444) are not needed for daily park operations and therefore value associated with these wells are considered “low” (**Table 1**).

**Table 1:** Water sources at SAND and associated value and risk

| Permit # | Source                        | Value           | Risk                  |
|----------|-------------------------------|-----------------|-----------------------|
| NA       | Big Sandy Creek               | High            | Low to Moderately Low |
| 271899   | Well: Commercial - Exempt     | High            | Low to Moderately Low |
| 270566   | Well: Stock - Exempt          | Low             | Low to Moderately Low |
| 13260    | Well: Irrigation – Non-Exempt | Moderately High | Low to Moderately Low |
| 284444   | Well: Stock - Exempt          | Low             | Low to Moderately Low |

### 2.0 Risk Assessment

At SAND, the water necessary to support the riparian ecosystem of intermittent Big Sandy Creek and the water supply source for visitors and operations are the same. All four water supply wells at SAND pump from the shallow alluvial aquifer which is recharged by precipitation and surface flows from Big Sandy Creek. As a result, the risk is generally the same for all wells at SAND as it is for the water dependent ecosystem (**Table 1**). Many factors affect the assessment of risk for water sources including 1) risk from adjacent development, 2) climate change, 3) aquifer sustainability and 3) priority and enforceability of water rights.

### **2.1. Adjacent development:**

SAND is located in rural southeastern Colorado with land use predominately ranching and farming. According to the U.S. Census Bureau the population of Kiowa County, Colorado has steadily decreased over the last 45 years. The population was reported as 2,030 in 1970 and has steadily declined to 1,402 in 2014. The risk to SAND's water supply from adjacent development is considered low.

### **2.2. Climate Change:**

According to the Colorado Climate Change Vulnerability Study (Gordon and Ojima 2015) there is a projected continued warming trend in Colorado whereas future precipitation trends are less certain. No long term trends have been detected in average annual precipitation across Colorado. Precipitation events and surface water flows are the primary recharge mechanisms for the shallow alluvial aquifer that the water supply for SAND relies on and that is crucial to the water dependent ecosystem of Big Sandy Creek. Although no decreasing trends in precipitation are certain, the future warming is projected to increase water use by crops and natural vegetation. As a result the risk to SAND's water supply and water resources from climate change is considered moderately low.

### **2.3. Aquifer Sustainability:**

According to Coffin (1967) the area around SAND is comprised of a thin layer of Quaternary deposits which overlay relatively impermeable Cretaceous bedrock. Precipitation and surface flows infiltrate the permeable valley-fill deposits and create a shallow perched aquifer above the impermeable bedrock. The USGS completed a series of test wells along an east-west transect across SAND in the 1960's (Coffin, 1967). The thickness of the alluvial deposits at SAND averages approximately 40 feet.

According to Martin (2006) nearby USGS Well 17-45-31 was monitored from 1959 – 1986 and showed no signs of decreasing water levels. No current water level monitoring of the shallow alluvial aquifer at SAND is ongoing. It may be of value for SAND to maintain a record of water levels at SAND to monitor long term trends. Contact WRD for assistance in establishing a long-term monitoring plan.

According to a well permit search on CDWR's website<sup>1</sup> there are approximately 105 wells<sup>2</sup> installed in the shallow alluvium within a six mile radius of SAND. Most of these wells (63%) are stock wells or domestic wells which have a pumping limit of 15 gpm. The remaining wells are for either irrigation (28%) or other uses (10%) and have pumping rates ranging from 45 to 2,000 gpm. Only one non-NPS well used for stock was found within a mile of the SAND potable well. Only five non-NPS wells were found within two miles of the SAND potable well,

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<sup>1</sup> <http://www.dwr.state.co.us/WellPermitSearch/default.aspx>

<sup>2</sup> It cannot be determined if all these wells are active. Search was limited on these statuses: permit issued, well constructed, and well replaced. Duplicate permits and monitoring wells were not counted.

all of which are stock wells. The closest irrigation well is approximately 2.5 miles down-gradient of SAND's potable well. It is not known if this well is currently active or what the pumping rate is.

However, Martin (2006) concluded that based on analysis of a drawdown test that "there is plenty of groundwater available in the surficial aquifer". The risk to the water supply and water resources related to aquifer sustainability is considered low.

## **2.4. Priority and Enforceability of Water Rights:**

### **2.4.1. Surface Water**

SAND does not have a surface water right on Big Sandy Creek. Lord (2000) evaluated possible ways in which instream flows could be protected. However, due to the intermittent nature of Big Sandy Creek, it would be difficult to administer any such right. Lord concluded that stream flow at SAND was not vulnerable to future surface water use by third parties<sup>3</sup>.

According to the CDWR's website<sup>4</sup>, only five active surface water rights exist with Big Sandy Creek as a source. Four are over 100 miles upstream near the headwaters west of Limon. The remaining right on Big Sandy Creek is for the Amity Canal, which is approximately 25 miles downstream from SAND. The risk to surface water at SAND due to the priority and enforceability of senior water rights is considered low.

### **2.4.2. Groundwater**

The three exempt wells at SAND (**Table 1**) are not administered under the priority system and therefore, are not subject to calls of downstream users. The non-exempt well at SAND is administered under the priority system but is now managed according to LAWMA's<sup>5</sup> augmentation plan. The augmentation plan allows SAND to use its well as a junior water right user because its depletions are being replaced. The annual pumping limit for the non-exempt well is determined by the annual allocation set by LAWMA. Risk to groundwater rights related to priority and enforceability at SAND are considered low.

## **3.0 Value and Risk Assessment Summary**

In summary, the value of Big Sandy Creek and the shallow alluvial aquifer is considered high. The overall risk to the water supply and water resources at SAND is considered low to moderately low based on the following considerations: 1) the low risk as a result of future development, 2) the moderately low risk due to climate change, 3) the low risk due to aquifer sustainability, and 4) the low risk based on the priority and enforceability of waters rights.

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<sup>3</sup> From Lord, 2000: "it seems clear that most surface users depend on precipitation events, that their diversions have little impact on the flows, and that increased use of surface flows is not likely. These three factors suggest that the instream flows through the proposed site are not now in jeopardy."

<sup>4</sup> <http://cdss.state.co.us/onlineTools/Pages/WaterRights.aspx>

<sup>5</sup> Lower Arkansas Water Management Association

## 4.0 References

- Coffin 1967      *Geology and ground-water resources the Big Sandy Creek Valley, Lincoln, Cheyenne, and Kiowa Counties, Colorado*, U.S. Geological Survey Water Supply Paper 1843, 49 pp, 1 plate.
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- Lukas and Others 2014      *Climate Change in Colorado: A Synthesis to Support Water Resources Management and Adaptation*. A Report for the Colorado Water Conservation Board. Western Water Assessment.
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