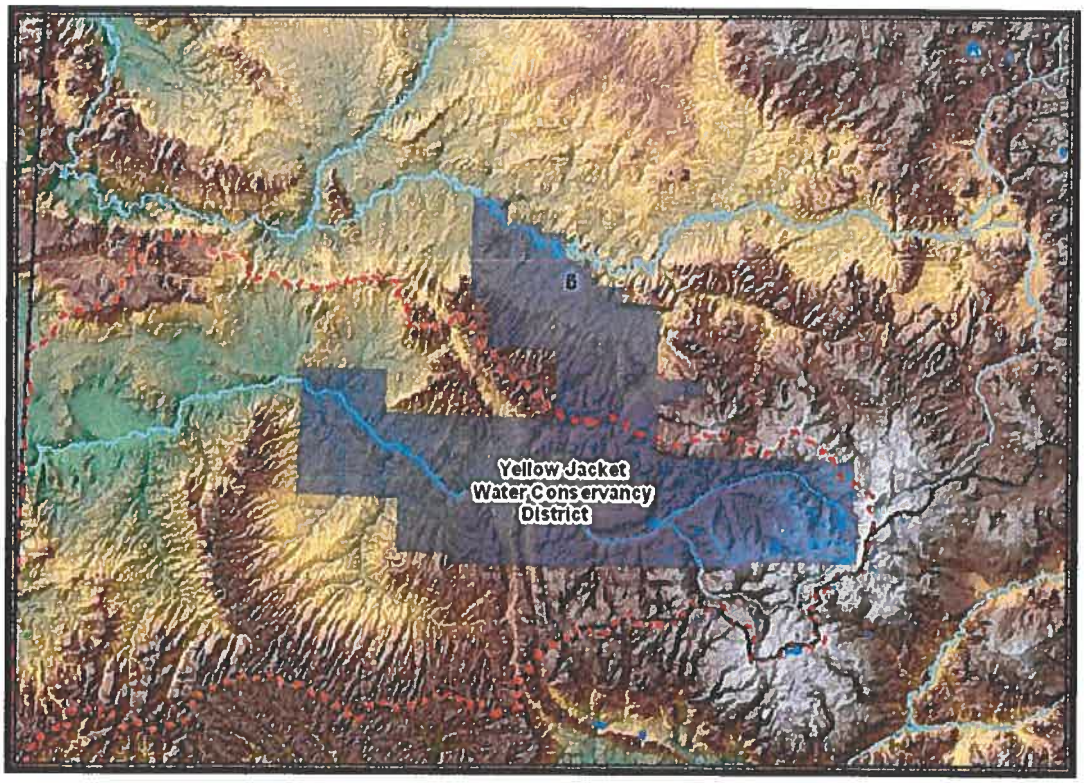
Yellow Jacket Water Conservancy District

Water Storage Feasibility –2016



November, 2016

AG File No. 10-118

DRAFT

Prepared for:

Yellow Jacket Water Conservancy District
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CONTENTS

BACKGROUND

In 2013 the Yellow Jacket Water Conservancy District (District) completed a feasibility study that evaluated the ability of the District's conditional water rights portfolio to meet future needs in its service area (the 2013 Report). A follow up study was completed in 2015 and evaluated several off-channel reservoir sites for potential water storage above the town of Meeker. This annual update evaluates several additional on-channel storage sites both above and below the town of Meeker. In addition, this report provides updated information regarding the future potential water needs within the District with a specific focus on existing wells.

REVISED PURPOSE AND NEED

The future water needs within the District as identified in the 2015 report are summarized in the Table below.

TABLE 1 FUTURE WATER NEEDS WITHIN THE DISTRICT

Water Use	Future Low[1] (2050)	Future High[2] (2050)
Oil Gas	111	303
Municipal	324	2,524
Agricultural	2,000	5,500
Non-Consumptive	1,200	8,050
Total	**3,635**	**14,457**

(1) Assumes population growth according to State Demographer projections, minimum amount of water for ISF purposes

(2) Assumes population growth associated with a 500,000 bbl/day oil shale industry and sufficient water to fulfill the ISF water right of 200 cfs at a point below Meeker

EXISTING WELLS

One potential need within the District that has not been included up to this point is the augmentation of existing wells. Many of the wells within the District are limited to domestic indoor use only; however, there are a significant number of wells used for other purposes that could be subject to administration. The District Board determined that a preliminary evaluation of this potential would allow the District to determine if there could be a significant future need that is unaccounted for in the information above. The current lack of administrative calls within the White River Basin and a lack of potential augmentation water has allowed current well users to operate under a free river regime year round. As discussed in the 2013 and 2015 reports, however, the water right for the Taylor Draw power plant is not met for a significant portion of the year. If a call is made by this water right, all well users with a priority junior to the power plant would need to either shut down their pumps or provide a legal augmentation source to continue diversions. Due to the lack of existing augmentation water most of these users would either have to shut down or provide their own augmentation water. A District owned reservoir could serve as a common source for augmentation water in the basin.

In order to determine the annual volume of water consumed from each of the identified permitted non-exempt wells and decreed wells, a two-step process was adopted. First the annual volume pumped from the well was estimated; and second, an assumed consumptive use factor was applied to that pumped volume to estimate what amount would be consumed from the well each year. The volume consumed would equal the augmentation need assuming a year round call in the basin.

For the permitted non-exempt wells, the type of use and yield of the well (in gpm) is typically reported in the dataset. In a few cases, the annual appropriation from the well (in acre-feet) is also reported in the dataset. The annual volume pumped from each well was set equal to the annual appropriation if this value was reported. If not, the annual volume pumped was calculated as the yield multiplied by an assumed number of days of operation per year. The assumed days of operation varied according to type of use as shown in Table 2. For the seven gravel pits that were identified, the individual permits for these wells were evaluated and the annual volume pumped set equal to the annual appropriation amount set forth in the permit. The annual consumed volume was calculated by multiplying the annual pumped volume by the consumptive use factors set forth in Table 2 for each use type.

TABLE 2 PERMITTED WELL USE TYPE ASSUMPTIONS

Use Type	Days of Operation	Consu ptive Use Factor
Commercial	90	10
Industrial	30	10
Irrigation	180	50
Municipal	180	30
Gravel Pit	n/a	100

Table 3 summarizes the estimated annual pumped volume and annual consumptive use for the 83 permitted wells.

TABLE 3 PERMITTED WELL CONSUMPTIVE USE

Use Type	No. of Wells	Flow Rate [gp]	Pu ped Volu e [ac-ft]	Consu ptive Use [ac-ft]
Commercial	33	868	329	33
Industrial	17	17,345	2,740	274
Irrigation	17	887	728	364
Municipal	9	2,839	2,258	677
Gravel Pit	7	-	454	454
Total	83	21,939	6,509	1,803

For the decreed wells, the dataset defines the decreed flow rate (in cfs) for each structure (totaling 48 cfs absolute for all 574 decreed wells), but it does not indicate the intended

appropriation volume (in acre-feet) or the type of use the structure is decreed for. Approximately 5 of the decreed structures, comprising approximately 21 cfs (44 of the total) of the total flowrate, are listed as having contemporary diversion records. This subset of the decreed structures was reviewed for use type and average annual volume pumped from diversion records maintained by the Colorado Division of Water Resources. This information is compiled in Table 4.

TABLE 4 DECREED WELL SUBSET CONSUMPTIVE USE

Use Type	No. of Wells	Flow Rate [cfs]	Pu ped Volu e [ac-ft]	Consu ptive Use Factor	Consu ptive Use [ac-ft]
Domestic	4	1	92	10	9
Irrigation	16	14	1,529	50	765
Municipal	8	6	941	30	282
Total	28	21	2,562	-	1,056

Assuming that the remaining decreed wells without contemporary diversion records (which total a decreed flow rate of approximately 27 cfs absolute) consume water at the same relative rate as the decreed wells in Table 4, the total consumptive use for all 574 decreed wells is be approximately 2,414 acre-feet per year.

This analysis identified 83 permitted wells and 574 decreed wells within the YJWCD boundaries that could potentially be impacted by a call from the Taylor Draw Power Conduit. The estimated annual consumptive use from these wells totals approximately 4,200 acre-feet. Should a call from the Taylor Draw Power Conduit occur year-round, this would equal the augmentation requirement for the identified wells in the YJWCD boundaries. Several factors that would likely reduce the annual volume of water actually contracted could include:

- Well owners may choose to shut down their wells when a call is in effect
- Others may provide their own source of augmentation water rather than purchase augmentation water from the District

This analysis, however, highlights a significant need that could materialize in the future if the mainstem of the White River comes under administration.

STORAGE SITE IDENTIFICATION

The 2015 Study primarily searched for an off channel reservoir site above Meeker and identified a preferred site on a dry drainage south of Little Beaver Creek. Typically off channel reservoir sites will have fewer environmental constraints and smaller spillways than those located on a live stream. After reviewing the 2015 study, Colorado Parks and Wildlife (CPW) commented that the last active Greater Sage Grouse Lek in the area was located within the inundation area of the preferred reservoir site. This study evaluated a reduced reservoir size that would keep the inundation area 100 feet from the existing Lek and found that doing so would reduce the storage volume by half. CPW further mentioned that 100 feet would not likely be sufficient to avoid

impacting the Lek and a significantly greater offset would likely be required. If this site was chosen for further study, impacts to the Lek would be unavoidable and could impact the ability to construct a reservoir at this site.

This study expanded the criteria to include on channel structures to determine if there were sites on small drainages above Meeker that would be suitable as a storage site. A summary of the pros and cons of the identified sites above Meeker is shown in Table 5 below. Maps depicting each option are located in Appendix B.

TABLE 5 STORAGE SITES ABOVE MEEKER

Site	Pros	Cons
Off-Channel -	Small Drainage Basin – Lower Spillway Cost No existing structures Topographically efficient Dry Drainage – No obvious wetlands Potential to provide pressurized irrigation service to irrigated lands below	8-9 Landowners Impacted Sage Grouse Impacts unavoidable All water must be pumped from Oak Ridge Park Ditch On-site materials likely limited to clay soils
Little Beaver Ck	2 Landowners impacted No impacted structures High topographic efficiency Native water available may be available in average to wet years Fills by gravity from Oak Ridge Park Ditch Clay and sands and gravels potentially available onsite Potential to provide pressurized irrigation service to irrigated lands below	Large drainage basin Natural drainage, wetland impacts likely
Dickerville Ck	Moderate basin size	Natural drainage, wetland

	4-5 Landowners impacted No impacted structures Clay and sands and gravels potentially available onsite Potential to provide pressurized irrigation service to irrigated lands below	impacts likely Lower topographic efficiency Most water would require pumping from Oak Ridge Park Ditch
Lower Coal Creek	4-5 Landowners Impacted No impacted structures Native water available in average to wet years Clay and sands and gravels potentially available onsite Potential to provide pressurized irrigation service to irrigated lands below	Large drainage basin Low topographic efficiency Natural drainage, wetland impacts likely Most water would require pumping from Oak Ridge Park Ditch
Upper Coal Creek	Moderate drainage basin 2 Landowners High topographic efficiency Clay and sands and gravels potentially available onsite	Federal lands impacted – BLM Inundates 1 home site Water supply limited to native inflows, estimated firm yield = 1,000 ac-ft

This study also expanded the search criteria to include on channel dams and sites below Meeker that could store the remaining YJWCD water rights. As discussed in the 2015 Study, a total of 22,500 acre-feet of storage rights remain. Assuming that 5,000 acre-feet was stored above Meeker would result in 17,500 acre-feet that could be stored at a location below Meeker. A location below Meeker would still be able to provide augmentation water during a Taylor Draw scenario but would not be able to augment water rights against a potential in-stream flow call above Meeker. This analysis reveals that some of the sites below Meeker are significantly more efficient storage sites. A summary of the pros and cons of the sites below Meeker is shown in Table 6 and maps of the sites are located in Appendix B.

TABLE 6 STORAGE SITES BELOW MEEKER

Site	Pros	Cons
Kellog Gulch	Small drainage basin – Lower spillway cost 2 Landowners No existing structures High topographic efficiency Dry drainage – No obvious wetlands Clay and sands and gravels potentially available onsite	Federal lands impacted - BLM All water must be pumped from White River
Tom Little Gulch	Small drainage basin – Lower spillway cost 2 Landowners All existing gas wells are listed as abandoned Very high topographic efficiency Dry drainage – No obvious wetlands Clay and sands and gravels potentially available onsite	Federal lands impacted - BLM All water must be pumped from White River
Crooked Wash	2 Landowners No existing structures High topographic efficiency Native supply could range from 400-4,000 ac-ft, with an average of 1,100 ac-ft Clay and sands and gravels potentially available onsite	Very large drainage basin Federal lands impacted - BLM Some water must be pumped from the White River in order to maximize site potential Natural drainage, wetland impacts likely

Another option for the remaining YJWCD water rights would be to cooperate with the Rio Blanco Water Conservancy District on the Wolf Creek Reservoir project currently in the planning stages. Larger storage projects typically have higher cost efficiencies associated with them and it may be possible that storing YJWCD water rights in Wolf Creek Reservoir would be the most cost effective solution. At the time of this report, however, cost estimates for this project are not available and therefore cannot be compared to the options discussed in this report. A summary of the physical characteristics of each reservoir is shown below.

TABLE 7 RESERVOIR SITE SUMMARY

Site No.	Description	Res Vol	Dam Volume	Dam Height	Freeboard	Surface Area	res vol/ emb vol	Basin Area
1	Off Channel	5,327	405,396	65	5	223	21.2	2
2	Off Channel - Reduced	2,702	212,460	50	5	139	20.5	2
3	Little Beaver	4,960	460,841	60	10	220	17.4	40.2
4	Dickerville Ck	4,988	611,166	90	5	166	13.2	12.0
5	Lower Coal Creek	6,875	1,232,014	130	10	175	9.0	35.5
6	Upper Coal Creek	3,178(1)	321,419	105	5	87	16.0	12.3
7	Kellog Gulch	17,687	1,551,954	155	5	313	18.4	3.0
8	Tom Little Gulch	16,345	775,896	143	5	401	34.0	5.0
9	Crooked Wash	17,510	1,090,861	122	10	390	25.9	162.0

(1) Firm Annual Yield is potentially 1/3 of reservoir volume

CONCEPTUAL LEVEL COSTS

Conceptual level costs for each option discussed above were formulated. These costs are based on very limited data and may change significantly in the future as more detailed designs are investigated. A range of pumping costs are shown in order to reflect the difference between pumping when the reservoir is empty versus pumping the last few acre feet when the reservoir is full. The annual pumping costs shown assume that each reservoir is filled from empty in a single year. The actual pumping costs will vary depending on the size of pump selected. Pumping rates used in this analysis would allow the reservoirs to be filled in 30-90 days and ranged from 50 cfs to 200 cfs. Larger pumps often cost more to operate due to the way the electrical rates are structured. Some of this cost may be recoverable if a hydropower turbine was added to the outlet and used to net meter some of the electricity used to pump the water up to the reservoir. Using the head pressure in this manner would, however, reduce the amount of acreage that could be served with pressurized irrigation service.

TABLE 8 COST SUMMARY

Site	Total Cost (millions)	Storage Volume	Cost $/acre foot	Pumping Cost $/ac-ft	Annual Pumping Cost
Off-Channel -Full Size	$15.9	5,327	$2,979	$3-$17	$50,000
Off-Channel	$10.8	2,702	$3,987	$3-$14	$20,000

-Reduced Size					
Little Beaver Ck	$22.1	4,960	$4,439	*n/a*	*n/a*
Dickerville Ck	$22.7	4,988	$4,488	$3-$23	$65,000
Lower Coal Ck	$37.4	6,875	$5,415	$1-$20	$84,000
Upper Coal Ck	$14.1	1,000 (1)	$12,687	*n/a*	*n/a*
Kellog Gulch	$38.8	17,687	$2,187	$2-$24	$260,000
Tom Little Gulch	$25.0	16,345	$1,525	$2-$23	$230,000
Crooked Wash	$65.0	17,510	$3,700	$2-$18	$195,000

(1) Estimated Annual Firm Yield was used in lieu of actual storage volume

RECOMMENDATIONS FOR FURTHER STUDY

PURPOSE AND NEED

A more in depth analysis of potential well augmentation needs within the district would refine the amount of augmentation water needed and identify the type of use. This analysis could also be performed to determine the amount of augmentation water required for junior wells during an instream flow water right call scenario on the White River above Meeker. In past dry years releases were made out of Lake Avery in the amounts shown in Table 9 to provide water for instream flow purposes.

TABLE 9 LAKE AVERY HISTORIC RELEASES

Year	Released Volume (acre feet)
2002	Approx. 1,200
2012	1,225
2013	293

These rereleases are currently made under a temporary agreement and can only occur 3 out of 10 years. A more permanent solution to providing this water will likely be needed in the future.

RESERVOIR SITES

ABOVE MEEKER

The two most promising locations above Meeker are the Off-Channel and Little Beaver sites. The smaller off-channel site is still cost effective, but in order to adequately address CPW concerns with the Sage Grouse LEK the storage volume could be significantly less than stated in this report. There are no predetermined setbacks required from the LEK and further discussions with the CPW would be the next step to determining if this site is feasible. The Little Beaver site is attractive as it can fill entirely by gravity and thereby eliminate the significant annual pumping costs associated with the other options. If the District decides to pursue either option further we would recommend meeting with the impacted landowners to determine their willingness to work with the District on such a project. These meetings may indicate that one site is preferable over the other.

Lake Avery remains a viable option for 1,200 to 2,600 acre feet of storage; however, the feasibility of this site will depend on the willingness of the landowner to allow inundation of their lands during large flood events. Existing stipulations require that water will not be stored on their

property. As discussed in the 2015 Study the smaller raise could potentially be accomplished through raising the spillway crest but not the dam and would be the most cost effective option evaluated but it only generates 1,200 acre-feet of storage. To attain 2,600 acre-feet of storage would require raising the actual dam which could likely increase the cost to a level that exceeds the cost of constructing the off-channel or Little Beaver structures. The Colorado Dam Safety department has stated that they feel that Avery could be a good candidate as well; however, particular attention will need to be paid to the foundation of the dam and the existing drainage infrastructure.

Below Meeker

The most promising site in this study for a 17,000 acre foot reservoir is Tom Little Gulch. The estimated cost per acre foot is low due to the overall efficiency of the site. Prior to performing any further investigation of this site we would recommend waiting until the next phase of the Rio Blanco study is completed in order to allow the two sites to be compared on a cost efficiency basis. The Tom Little site was eliminated from Rio Blanco's Phase 1 Study due to the size of the reservoir not meeting the minimum size specified in that study. This study, however, indicates that this site could be a reasonably efficient storage site.

PROJECT FUNDING

Identify potential project partners and other funding sources that could be used to fund a project including:

- Loans
- Grants
- Endangered species recovery program
- Fees collected from providing augmentation water sales
- Recreational fees

Several conceptual funding plans could be formulated to determine how much income from potential sources would be need to pay back any loans and cover the annual operation and maintenance costs.

Appendix A – Well Analysis

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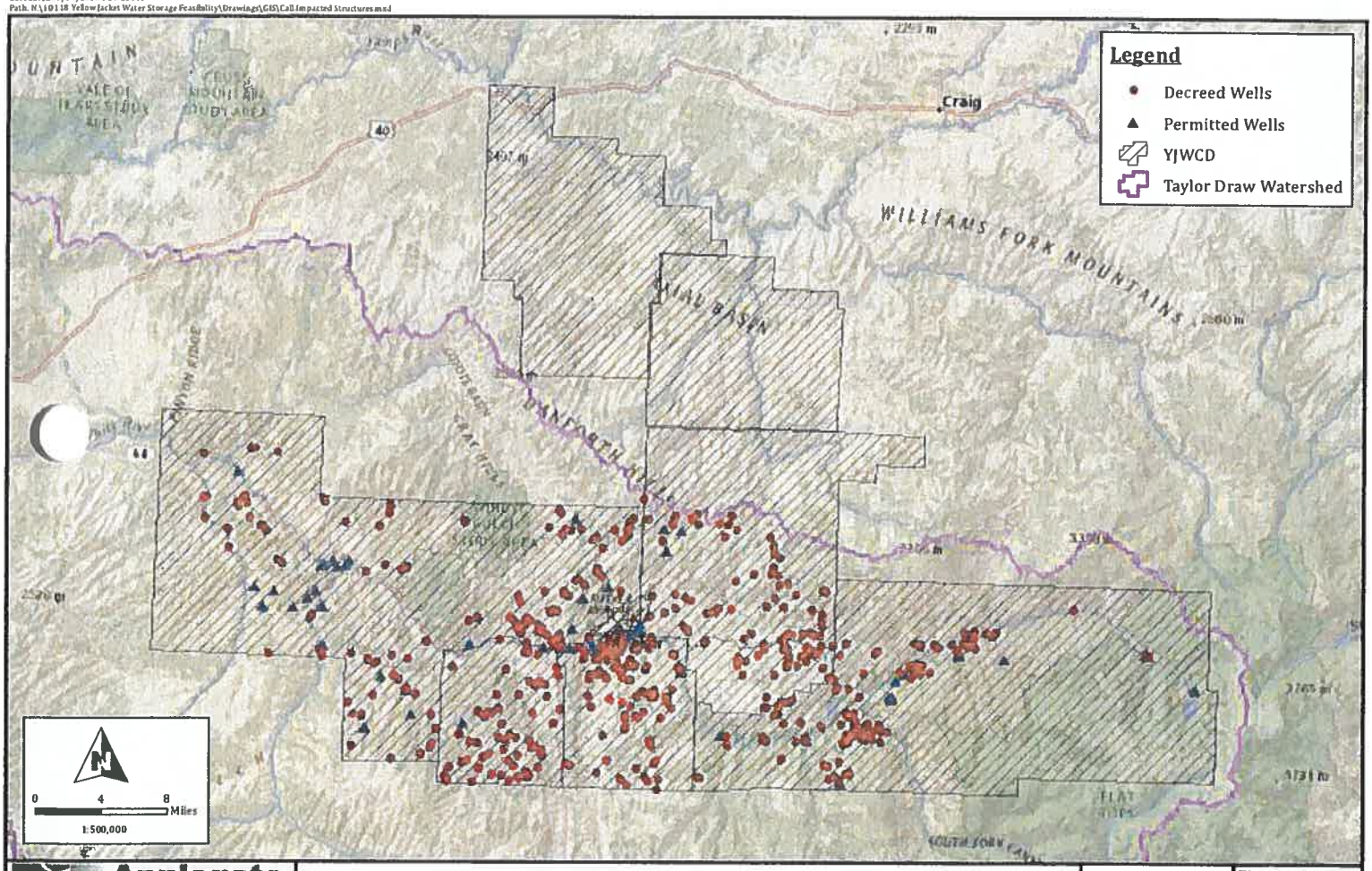

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YELLOW JACKET WATER CONSERVANCY DISTRICT

Wells Impacted by a Talyor Draw Power Conduit Call

Date: 22 Nov 2016
Job #: 10-118
Drawn By: JMD

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Of: 1

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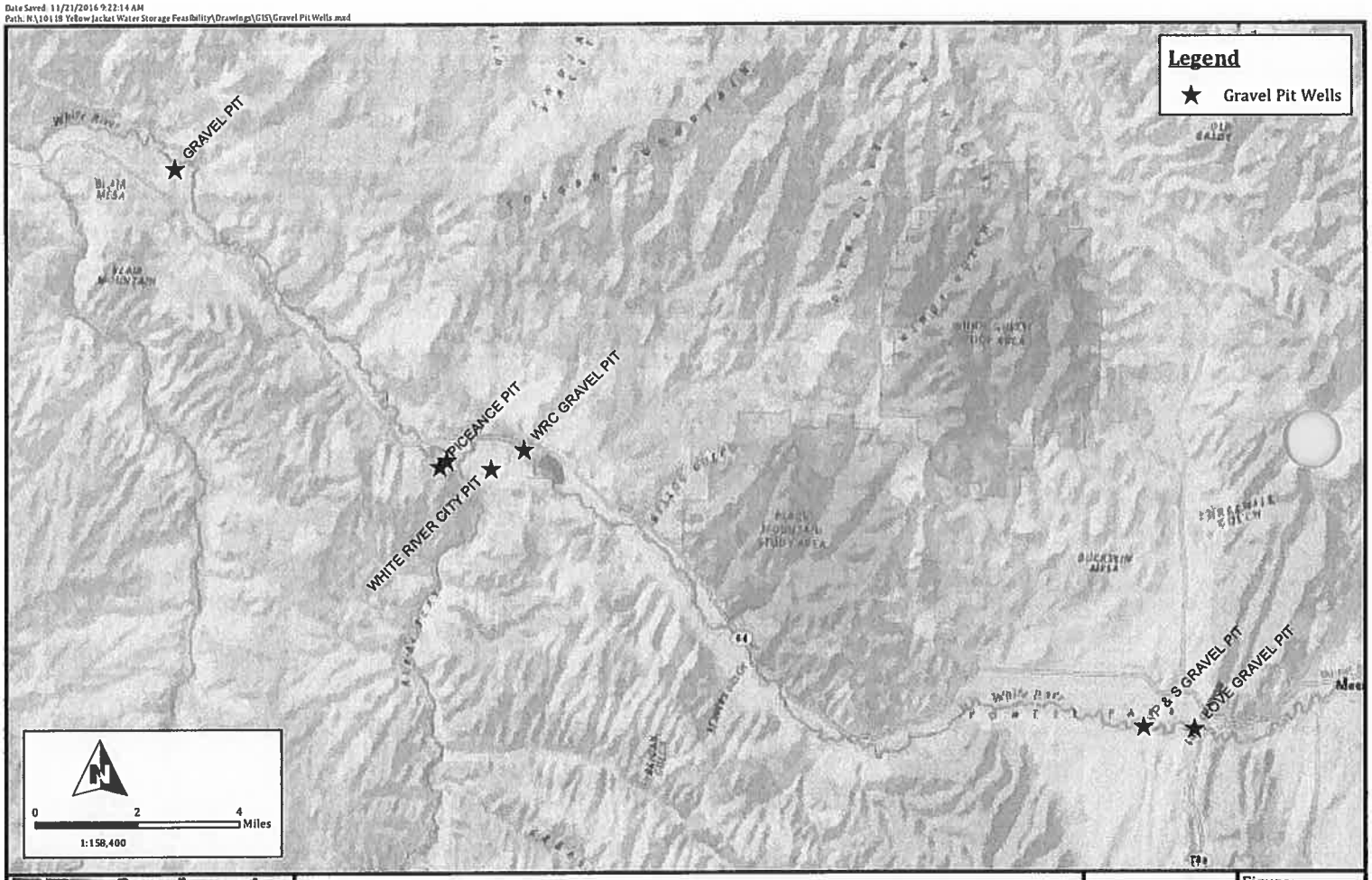

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YELLOW JACKET WATER CONSERVANCY DISTRICT

Gravel Pit Wells Impacted by a
Talyor Draw Power Conduit Call

Date: 21 Nov 2016
Job #: 10-118
Drawn By: JMD

Figure: 1
Of: 1

Appendix B – Reservoir Site Figures

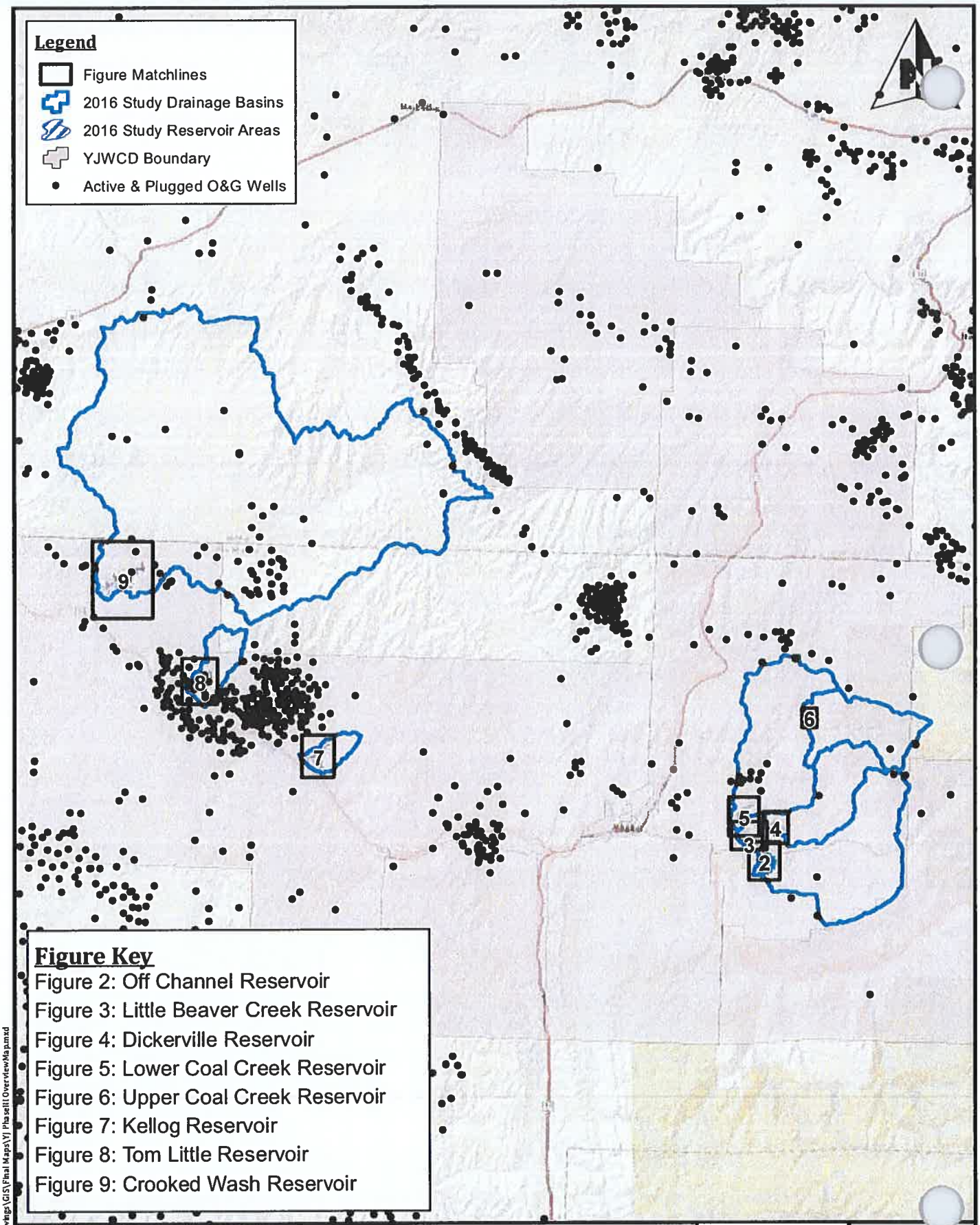

Figure Key

Figure 2: Off Channel Reservoir
Figure 3: Little Beaver Creek Reservoir
Figure 4: Dickerville Reservoir
Figure 5: Lower Coal Creek Reservoir
Figure 6: Upper Coal Creek Reservoir
Figure 7: Kellog Reservoir
Figure 8: Tom Little Reservoir
Figure 9: Crooked Wash Reservoir

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Yellow Jacket 2016 Study

Potential Reservoir Sites

Overview Map **Figure Key**

Date: 25 Aug 2016
Job #: 10-118
Drawn By: TJD

Figure: 1
Of: 9

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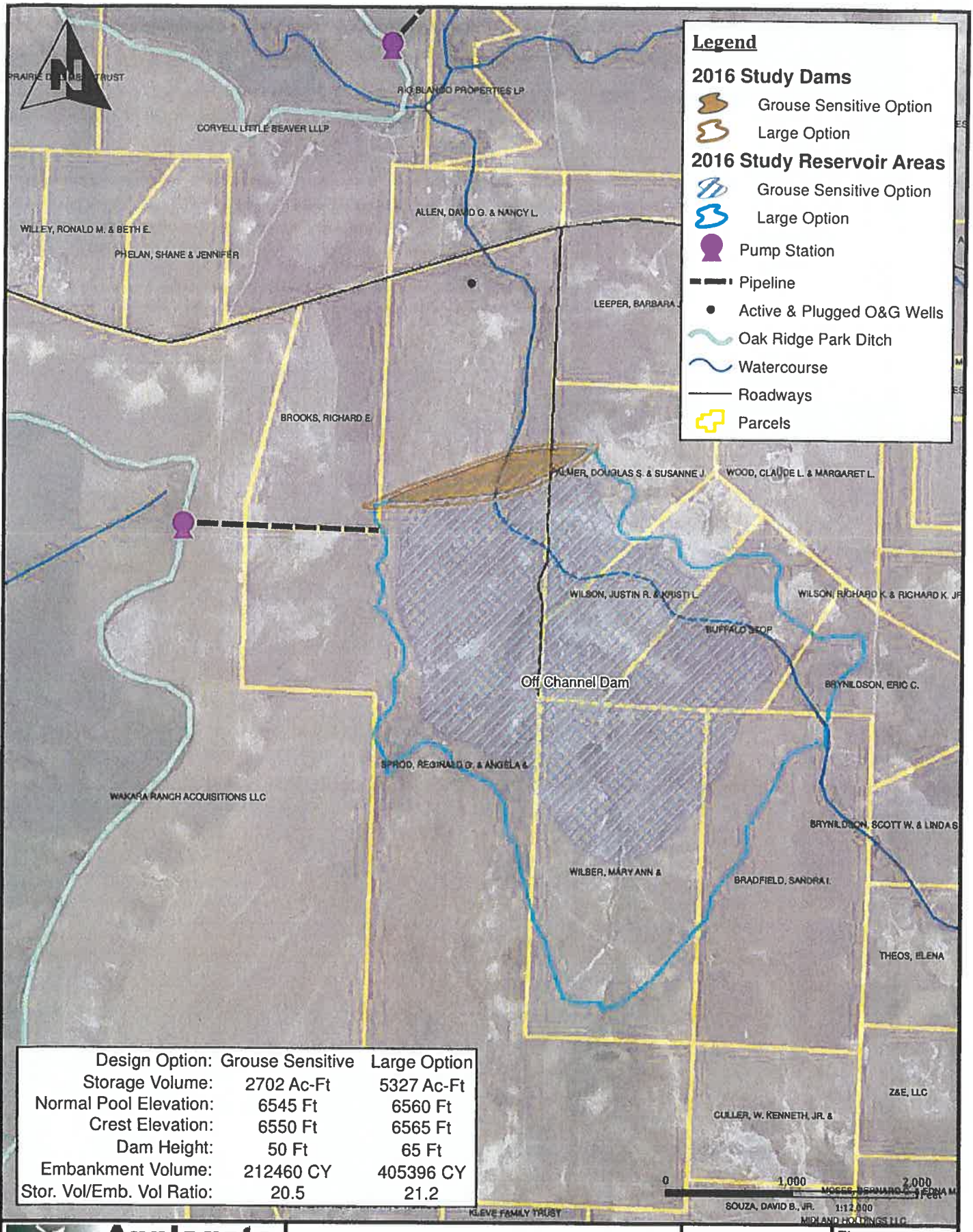

Design Option:	Grouse Sensitive	Large Option
Storage Volume:	2702 Ac-Ft	5327 Ac-Ft
Normal Pool Elevation:	6545 Ft	6560 Ft
Crest Elevation:	6550 Ft	6565 Ft
Dam Height:	50 Ft	65 Ft
Embankment Volume:	212460 CY	405396 CY
Stor. Vol/Emb. Vol Ratio:	20.5	21.2

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Yellow Jacket 2016 Study

Potential Reservoir Sites

Off Channel Reservoir Site

Date: 25 Aug 2016

Job #: 10-118

Drawn By: TJD

Figure: 2

Of: 9

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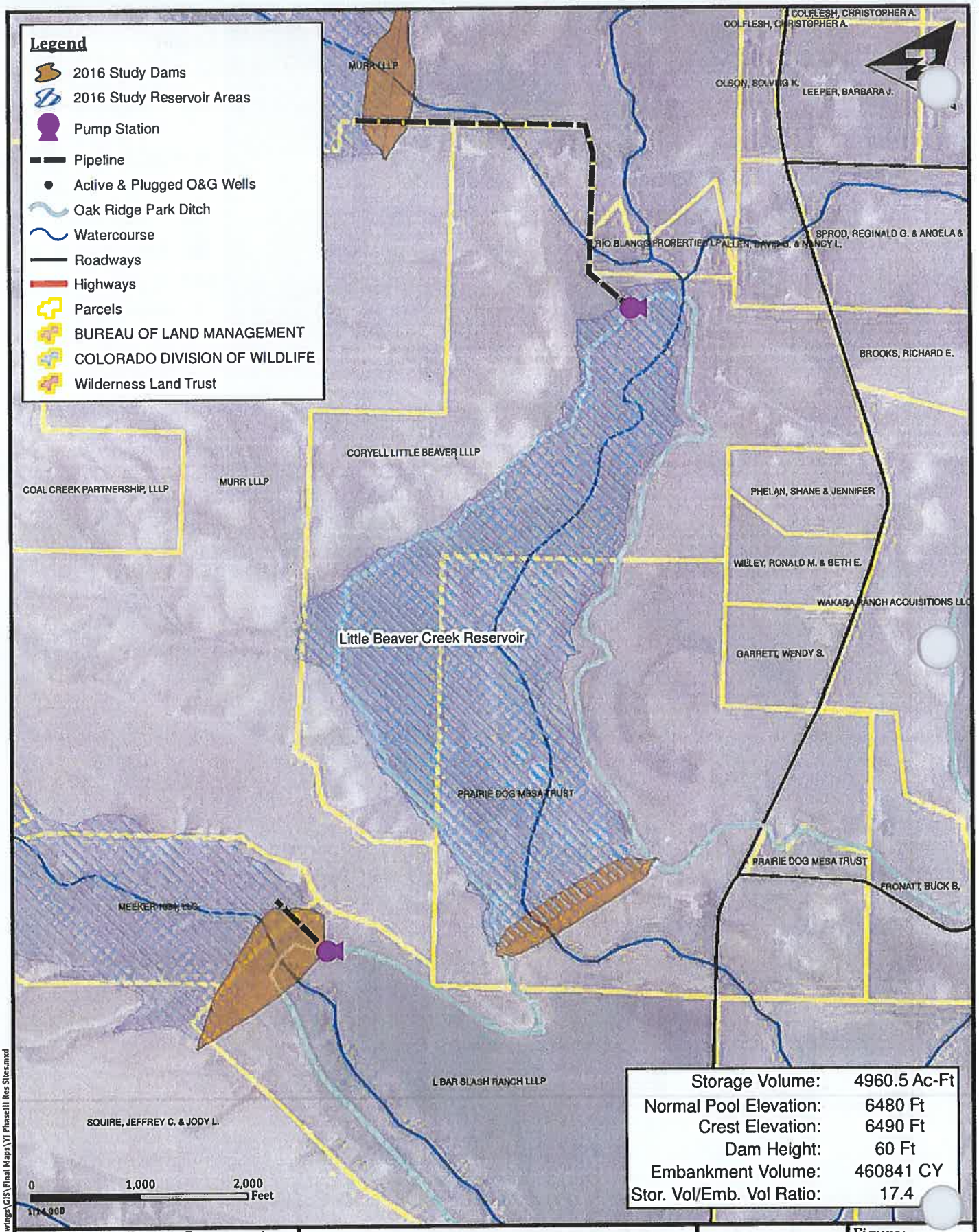

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Yellow Jacket 2016 Study
Potential Reservoir Sites
Little Beaver Creek Reservoir

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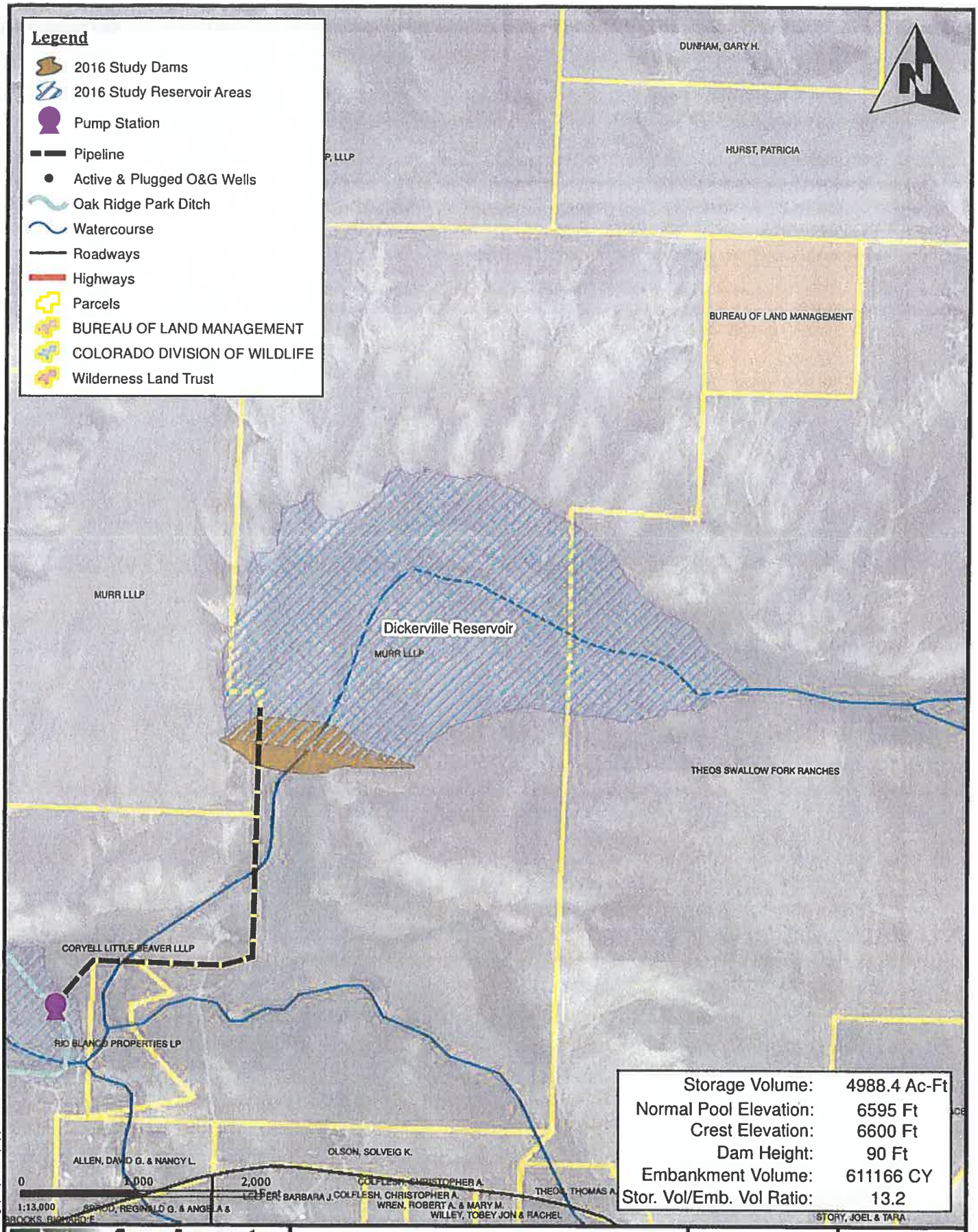
Figure: 3
Of: 9



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Yellow Jacket 2016 Study

Potential Reservoir Sites

Dickerville Reservoir

Date: 25 Aug 2016

Job #: 10-118

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Figure: 4

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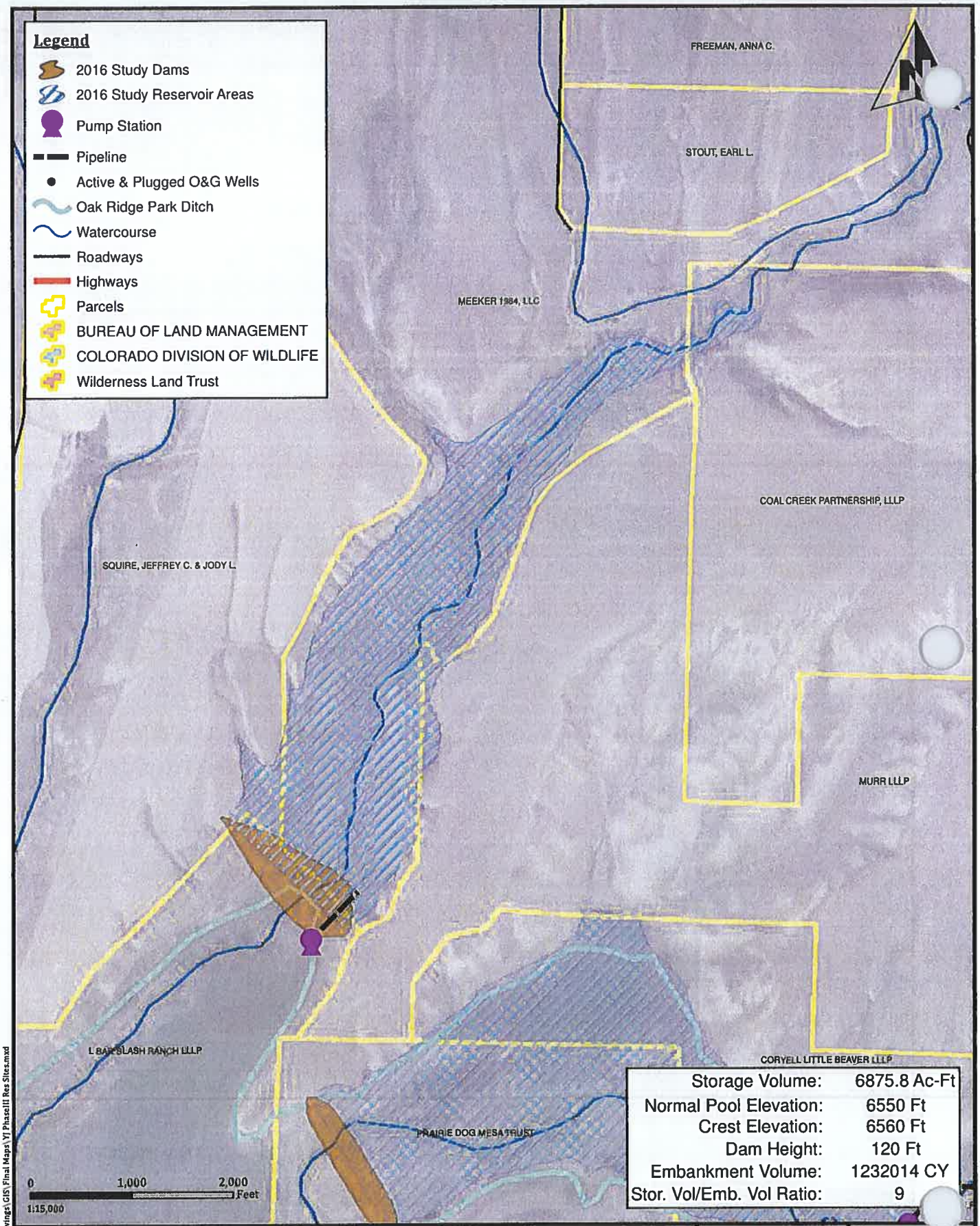

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Yellow Jacket 2016 Study

Potential Reservoir Sites

Lower Coal Creek Reservoir

Date: 25 Aug 2016

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Figure: 5

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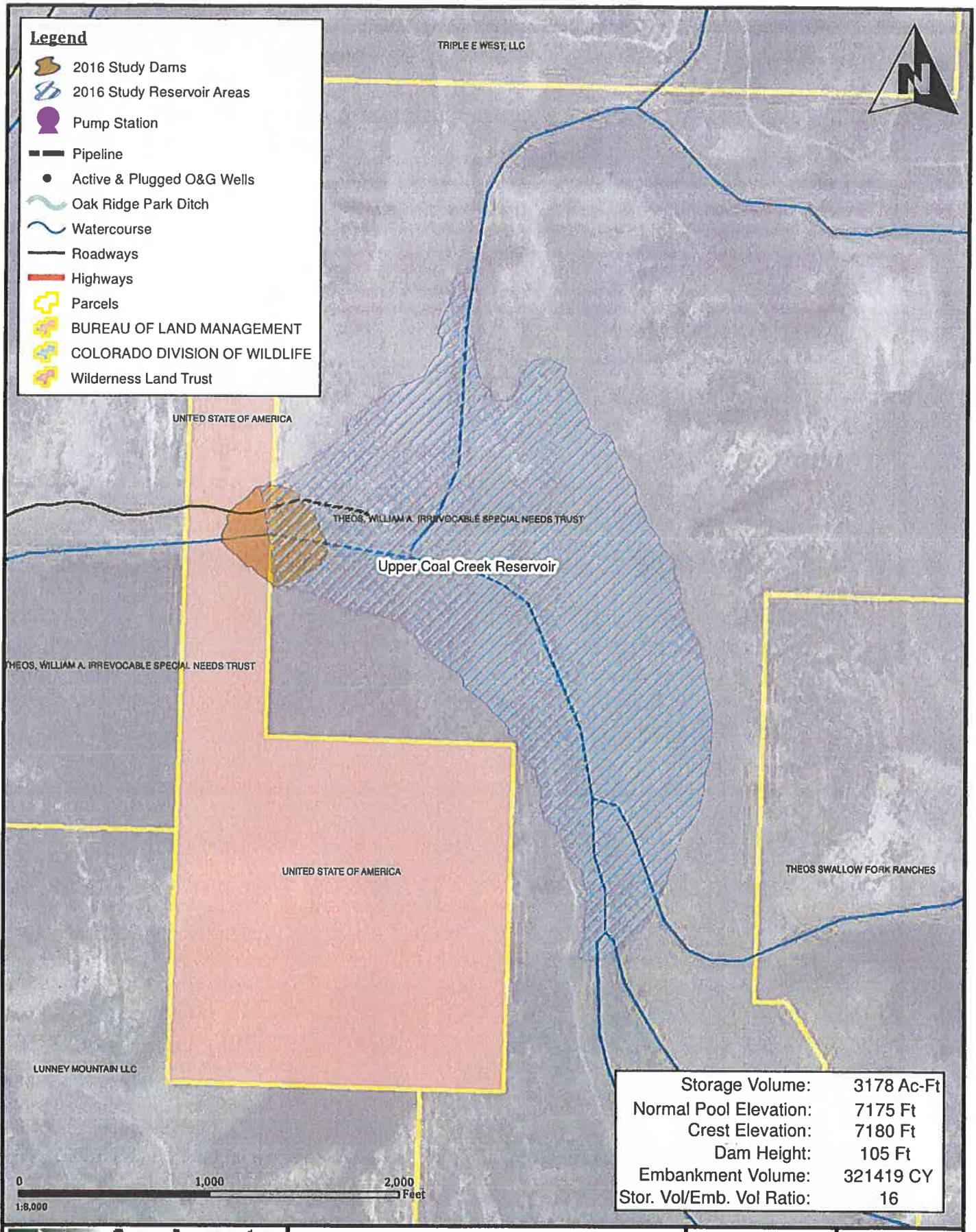

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Yellow Jacket 2016 Study
Potential Reservoir Sites
Upper Coal Creek Reservoir

Date: 25 Aug 2016
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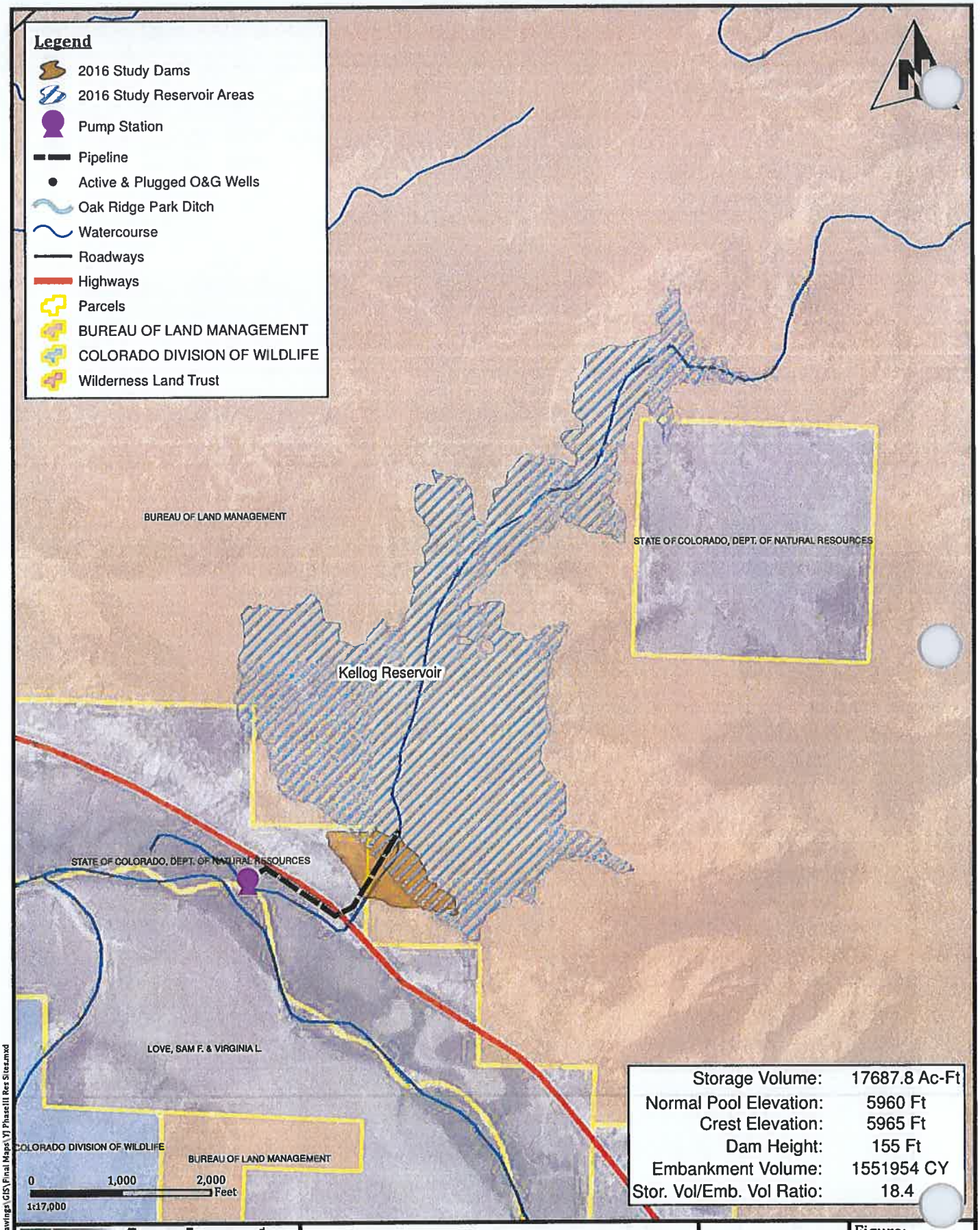

Storage Volume:	17687.8 Ac-Ft
Normal Pool Elevation:	5960 Ft
Crest Elevation:	5965 Ft
Dam Height:	155 Ft
Embankment Volume:	1551954 CY
Stor. Vol/Emb. Vol Ratio:	18.4

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Yellow Jacket 2016 Study

Potential Reservoir Sites

Kellog Reservoir

Date: 25 Aug 2016

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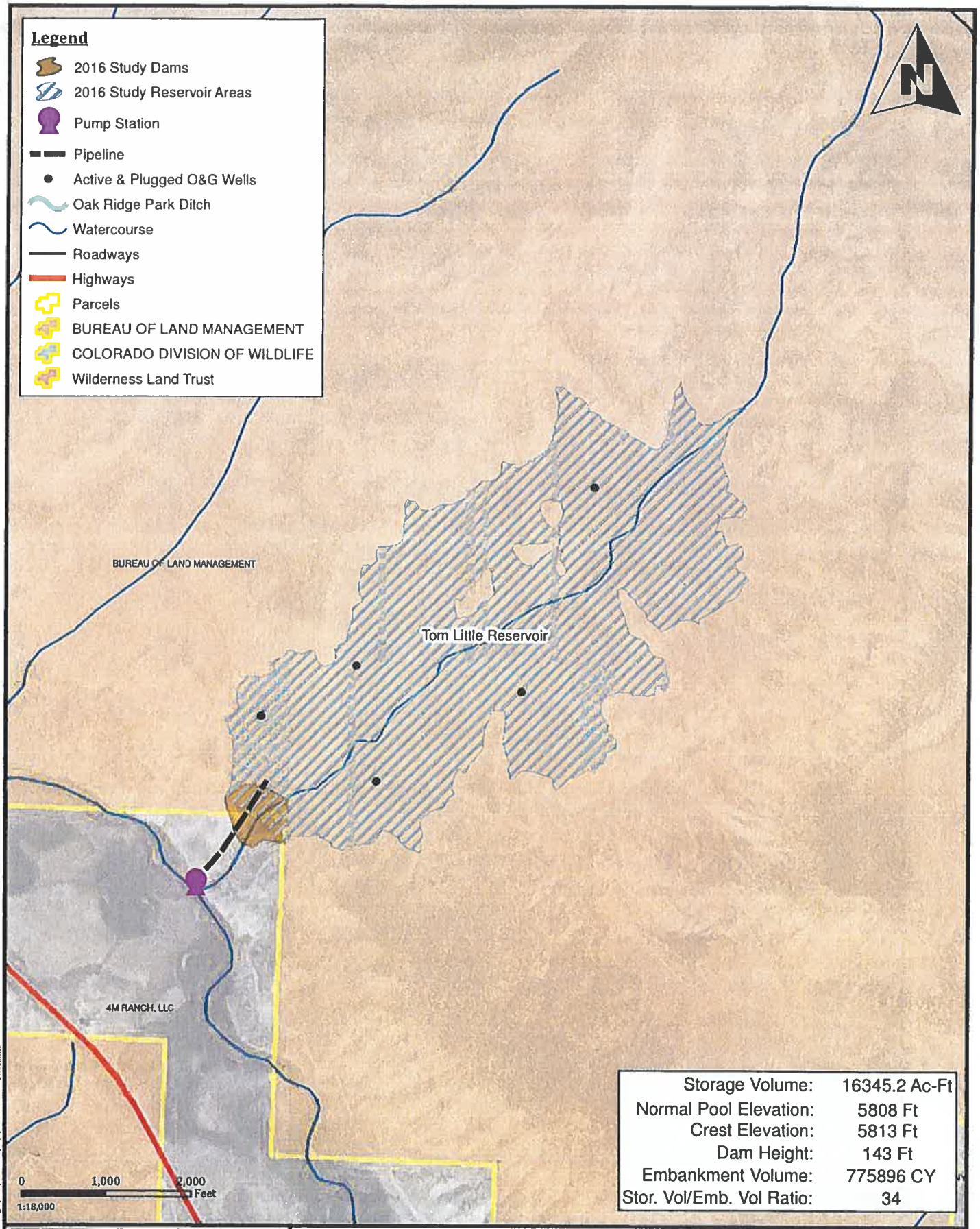

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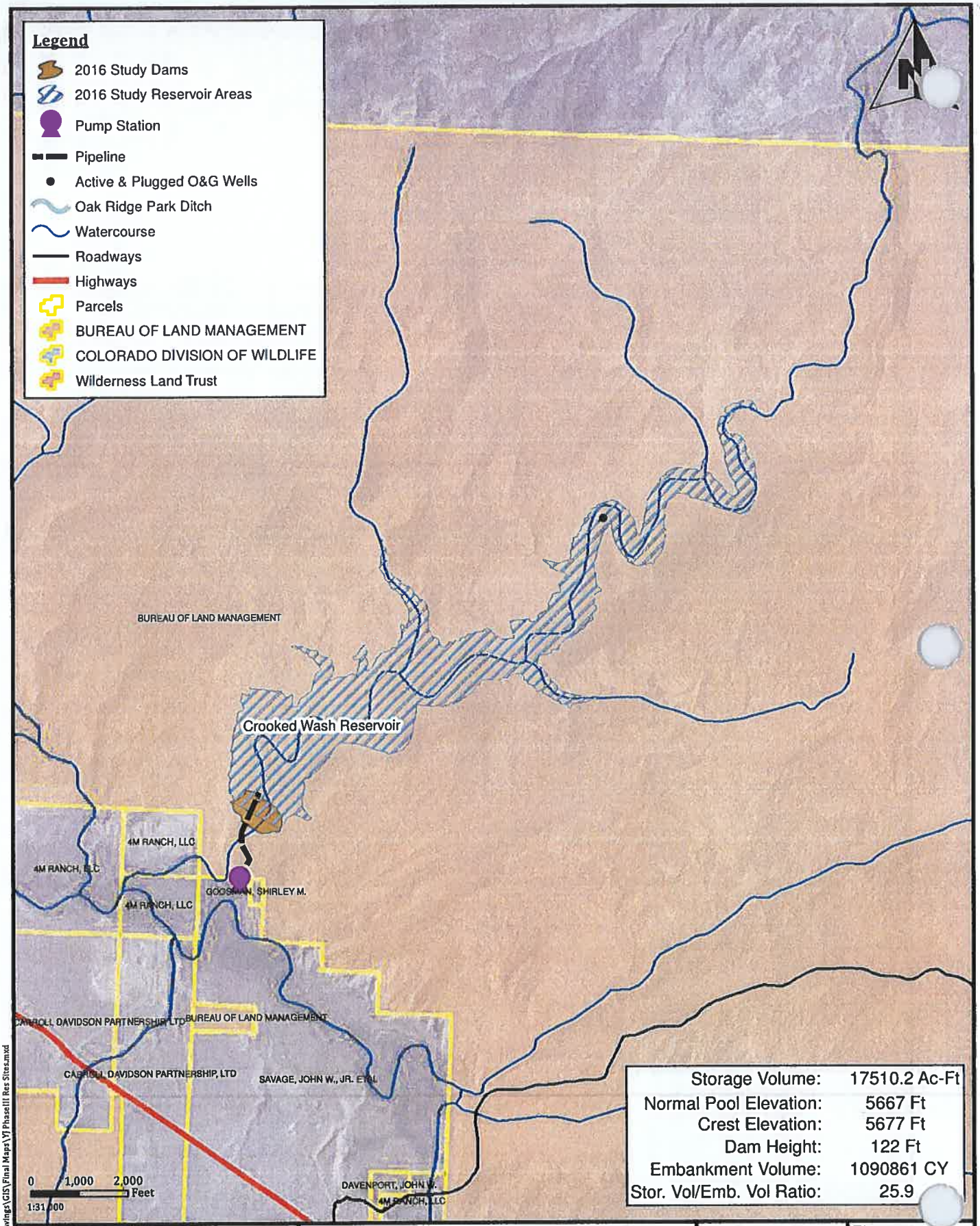
Yellow Jacket 2016 Study
Potential Reservoir Sites
Tom Little Reservoir

Date: 25 Aug 2016
Job #: 10-118
Drawn By: TJD

Figure: 8
Of: 9



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Yellow Jacket 2016 Study
Potential Reservoir Sites
Crooked Wash Reservoir

Date: 25 Aug 2016
Job #: 10-118
Drawn By: TJD

Figure: 9
Of: 9

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