Idaho Water Resource Board

Mountain Home Air Force Base

Snake River Surface Water Supply

Water Supply Planning Report

Contract No. 01110

May 2016

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WATER SUPPLY PLANNING REPORT

Mountain Home Air Force Base
Snake River Water Supply

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Executive Summary

Mountain Home Air Force Base (MHAFB) relies on ground water from several wells on base to meet water demands of the base. MHAFB is located in the Mountain Home Groundwater Management Area which has a documented declining aquifer.

The Idaho Water Resource Board (IWRB) is evaluating a potential new water supply for MHAFB that would utilize surface water from C.J. Strike Reservoir on the Snake River. IWRB has obtained water rights that would be used for this proposed source of supply. IWRB intends to enter into a long-term Water Utility Supply Agreement with MHAFB to deliver treated water meeting drinking water standards to the MHAFB distribution system.

This report presents the findings of a water supply planning study to evaluate the proposed water supply project. The study analyzes historical water demands and provides recommendations for system capacity. Water right issues are investigated and a recommended water right strategy is presented. Snake River water quality is evaluated for suitability as a source of drinking water. Three potential intake locations and two pipeline alignments are evaluated. Conceptual design criteria for the intake pump station, pipeline, and water treatment facility are developed, and cost estimates are presented for the water supply system including construction costs and annual operations and maintenance costs.

A preliminary project schedule is presented that includes planning, permitting, design, construction, and start-up phases over a 4-year period. The major tasks for each phase are identified and described with projected schedules for each. Project delivery methods including Design/Bid/Build and Turnkey approaches are described with discussion of their advantages and disadvantages.

Finally, recommendations are provided for next steps to continue the planning and permitting phases of the project.

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1. BACKGROUND

Mountain Home Air Force Base (MHAFB) relies on ground water from several wells to meet water demands of the base. MHAFB is located in the Mountain Home Groundwater Management Area which has a documented declining aquifer.

The Idaho Water Resource Board (IWRB) is evaluating a potential new water supply for MHAFB that would utilize surface water from C.J. Strike Reservoir on the Snake River. IWRB has obtained water rights that would be used for this proposed source of supply. The IWRB intends to enter into a long-term Water Utility Supply Agreement with MHAFB in 2017 to deliver treated water meeting drinking water standards to the MHAFB distribution system starting in 2021.

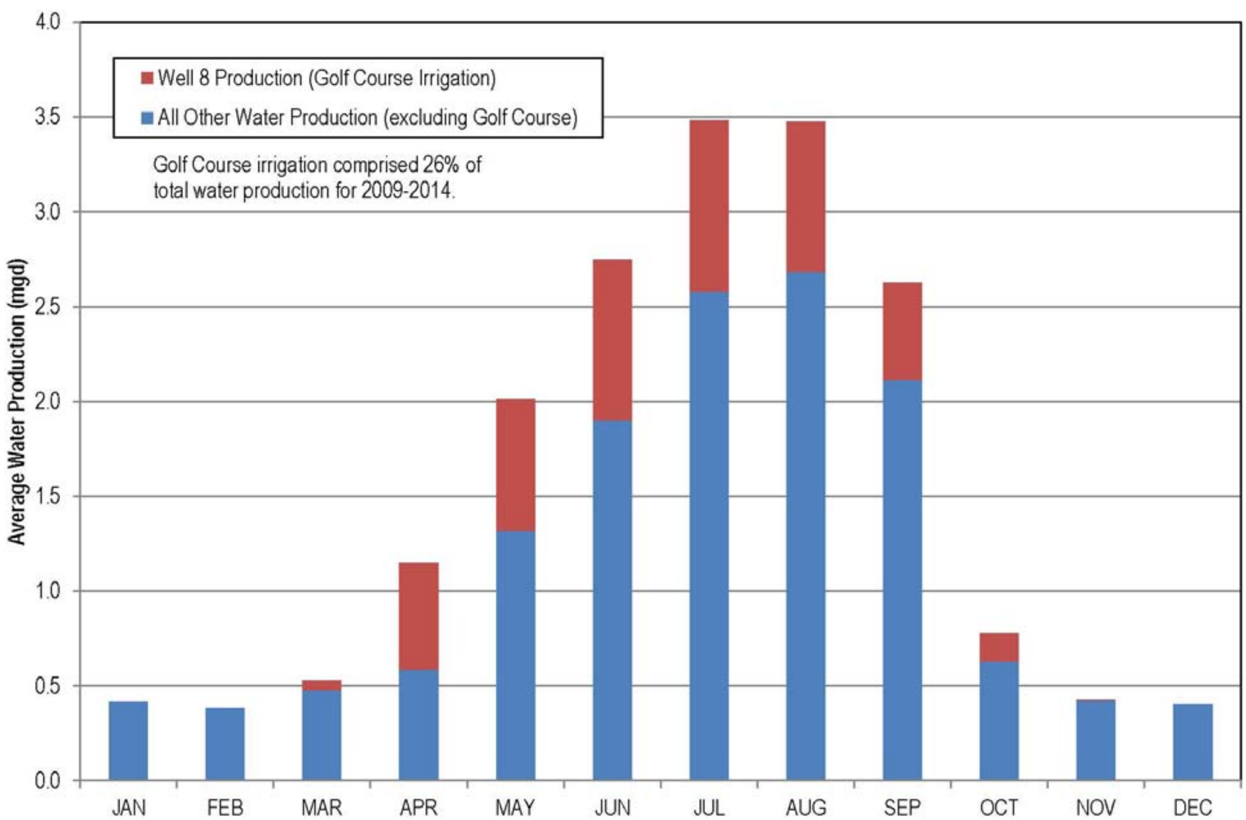
This Water Supply Planning Report has been developed to advance the project by further developing and documenting project requirements including facilities, costs, permitting, schedule, and project delivery methods. The new water system will include an intake pump station at C.J. Strike Reservoir, a Raw Water Pipeline to convey water to the base, and a Water Treatment Plant to process the water to drinking water standards.

2. WATER SYSTEM CAPACITY EVALUATION

Water production data for the 6-year period from January 2009 through December 2014 were provided by MHAFB for this analysis and are included in Appendix A. Data include water production in gallons per month for Wells 2, 4, 6, 8, 11, 12, and 13. Well 8 supplies non-potable water for irrigation at the golf course and produced 26% of total water production from 2009 through 2014. All other wells provide potable water for use in the potable water distribution system serving the Base. This analysis does not include data from Well 9 which supplies a small amount of non-potable water for use at the Air Traffic Control Tower.

Figure 1 presents historical water production for the 6-year period from 2009 through 2014.

Figure 1
Historical Water Production (2009-2014)



Water demand is highest in the summer and lowest during the winter due primarily to irrigation demands. The average day demand (ADD) for the 6-year period was 1.55 million gallons per day (mgd). ADD for the months of July and August was 3.5 mgd, and the average baseload demand during the months of November through March was 0.4 mgd.

Excluding production from Well 8 which supplies non-potable water for irrigation at the golf course, the ADD was 1.13 mgd, and the ADD for the months of July and August was 2.7 mgd.

2.1 ESTIMATING MAXIMUM DAY DEMAND (MDD)

Daily water production data were not available, so maximum day demand was estimated by using a peaking factor (ratio of MDD to ADD for a given year). The peaking factor for MHAFB was reported to range from 2.5 to 3.1, with an average of 2.9, for the period from 2006 through 2011 (AECOM, 2012). A typical peaking factor for a small city in the western United States is 2.0 to 3.5. For comparison, the peaking factor for Suez Water, the municipal water provider for the city of Boise, was 2.02 for 2014. The peaking factor is highly dependent upon the amount of water used for irrigation in comparison to the amount used for other purposes (e.g., domestic, commercial, municipal, and industrial).

A peaking factor of 3.1 is used in this analysis to represent the high end of the observed range reported and provide a conservative estimate of MDD. Estimated MDDs range from 4.4 to 5.1 mgd for the years 2009 through 2014. See Table 1 for a tabulation of annual ADD and MDD data.

Table 1

Annual ADD(1) and MDD(2) With and Without Golf Course Irrigation (2009-2014)

YEAR	TOTAL PRODUCTION		EXCLUDING GOLF COURSE (3)	
	ADD (mgd) (4)	MDD(5) (mgd)	ADD (mgd)	MDD(5) (mgd)
2009	1.60	4.94	1.22	3.80
2010	1.58	4.91	1.21	3.76
2011	1.42	4.39	1.13	3.50
2012	1.53	4.76	1.07	3.31
2013	1.49	4.62	1.10	3.41
2014	1.65	5.13	1.15	3.58
AVERAGE	*1.55*	*4.79*	*1.16*	*3.56*
Ave Annual Volume	*1,730 AFA(6)*		*1,300 AFA*	

(1) ADD = Average Day Demand
(2) MDD = Maximum Day Demand
(3) Excludes Well 8 production which provides irrigation water to the Golf Course.
(4) mgd = million gallons per day
(5) MDD estimated using a peaking factor of 3.1. Peaking factor is the ratio of MDD to ADD for a given year.
(6) Average Annual Volume presented in acre-feet annually (AFA).

2.2 MAXIMUM DAY DEMAND EXCLUDING GOLF COURSE IRRIGATION

Excluding Well 8 which provides water for irrigating the golf course, the average ADD was 1.13 mgd, and the highest annual MDD was 3.80 mgd (see Table 1). If the proposed surface water system is not used to supply irrigation water to the golf course, the MDD would be reduced from 5.13 mgd to 3.80 mgd.

2.3 WATER DEMAND PRIOR TO 2005

The MHAFB population decreased substantially in 2004 as a result of a change in the mission of the base, and water use declined as a result. The population was 8,894 in 2000, and was 3,238 in 2010 according to the U.S. Census Bureau. For the 6-year period from 1999 through 2004, ADD was 2.2 mgd and the average of annual MDDs was 5.7 mgd (AECOM, 2012). The ADD for 1999 through 2004 was 42% higher than the ADD for 2009 through 2014. The highest MDD for 1999-2004 was 6.65 mgd and occurred in 2003. This was 30% higher than the highest MDD for 2009-2014 which was 5.13 mgd and occurred in 2009. If the MHAFB population were to increase in the future, then ADD and MDD would be expected to increase as well.

2.4 FUTURE DEMAND PROJECTIONS

Future water demand at MHAFB is dependent upon the base mission as determined by Congress, which can change abruptly and is difficult to predict with accuracy. For water systems at facilities with populations less than 5,000, the Department of Defense Handbook for Water Supply Systems (MIL-HNBK-1005/7A) recommends designing water facilities for a future water demand increase of 50%. The population was 3,273 in 2013 according to the U.S. Census Bureau.

Following these guidelines, the proposed water facilities should be designed for a 50% increase in water demand over current MDD. Additionally, given that the Base population historically was much higher than current population, we recommend that the proposed facilities be designed to accommodate future expansion to an ultimate capacity twice the current MDD. This recommendation is provided because the raw water pipeline from the intake pump station to the water treatment plant is not readily expandable in the future; thus it should be designed for the ultimate capacity. Historical water demands, projected water demands, and recommended capacities for the intake pump station, transmission pipeline, and water treatment plant are presented in Table 2.

Table 2
Water Demands and Recommended Facility Capacities

	TOTAL PRODUCTION	EXCLUDING GOLF COURSE (1)
HISTORICAL WATER DEMAND (2009-2014)		
AVERAGE DAY DEMAND	1.6 mgd (2)	1.2 mgd
MAXIMUM DAY DEMAND(3)	5.1 mgd	3.8 mgd
AVERAGE ANNUAL VOLUME	1,730 afa (4)	1,300 afa
DESIGN CAPACITY FOR 50% GROWTH		
MAXIMUM DAY DEMAND	7.7 mgd	5.7 mgd
AVERAGE ANNUAL VOLUME	2,600 afa	1,950 afa
ULTIMATE CAPACITY FOR 100% GROWTH		
MAXIMUM DAY DEMAND	10.3 mgd	7.6 mgd
AVERAGE ANNUAL VOLUME	3,460 afa	2,600 afa
RECOMMENDED CAPACITIES		
INTAKE PUMP STATION	8 mgd (expandable to 10 mgd)	6 mgd (expandable to 8 mgd)
RAW WATER PIPELINE	10 mgd	8 mgd
WATER TREATMENT PLANT	8 mgd (expandable to 10 mgd)	6 mgd (expandable to 8 mgd)

(1) Excludes Well 8 production which provides irrigation water to the golf course.
(2) mgd = million gallons per day.
(3) The highest MDD was estimated to be 5.1 mgd and occurred in 2014. The highest MDD excluding golf course irrigation was estimated to be 3.8 mgd and occurred in 2009. See Section 2.2 for discussion of MDD calculation.
(4) afa = acre-feet annually.
(5) Design capacities are based on 50% increase over highest MDD as recommended by MIL-HNBK-1005/7A.

2.5 RECOMMENDED SYSTEM CAPACITY

The recommended design capacity for the water system is 6 mgd, with an ultimate capacity of 8 mgd. The capacity recommendation is based on continuing to use ground water to irrigate the golf course to avoid the cost of treating golf course irrigation water to drinking water standards. The recommended design capacity is 50% higher than current MDD, and the recommended ultimate capacity is 100% higher than current MDD.

3. WATER RIGHTS EVALUATION

This section evaluates existing Snake River water rights owned by IWRB for the proposed use at MHAFB and provides recommendations for how best to make use of the water rights. Recommendations are also made for securing additional water rights from the Snake River for use at MHAFB. The evaluation is based on existing and projected water demands as outlined in Section 2 of this report.

3.1 BACKGROUND

The MHAFB is located in the Mountain Home Groundwater Management Area (GWMA) which was established in 1982 pursuant to Idaho Code § 42-233b.[1] The 437,000-acre GWMA was established in response to declining groundwater levels in the area surrounding the Cinder Cone Butte Critical Groundwater Area (established in 1981 pursuant to Idaho Code § 42-233a) and in other areas of the Mountain Home Plateau. Groundwater levels in the GWMA continue to be of concern to local area water users.

The Idaho Water Resource Board (IWRB, or the Board) is evaluating a proposed new water supply system that would deliver surface water from C.J. Strike Reservoir on the Snake River to MHAFB and replace the existing groundwater supply. To this end, the IWRB purchased Snake River water rights from J.R. Simplot Company in 2014. This memo provides an evaluation of the water rights acquired by the Board from Simplot for potential use at MHAFB, including the transferability of the rights. This memo also provides recommendations for developing additional Snake River water rights to meet future demands at MHAFB.

3.2 EVALUATION OF EXISTING WATER RIGHTS

The IWRB acquired three Snake River water rights from J.R. Simplot Company in 2014 (Table 1). The Simplot rights authorize irrigation use on a total of 625 acres. The authorized diversion rate from the Snake River is a total of 12.50 cfs (approximately 5,600 gpm) for the three water rights. Total annual volume for the rights is 2,500 ac-ft (approximately 815 million gallons). The season of use for the three water rights is limited to April 1 to October 31.

The Simplot rights were confirmed in the Snake River Basin Adjudication (SRBA), which is now final. Partial decrees for water rights 2-10300A and 2-10300B were issued on July 31, 2012. Water right 2-10506 is a portion of its parent right 2-10337, and a partial decree for 2-10337 was issued on April 8, 2008. The partial decrees became final on August 25, 2014

[1] *Order Establishing Ground Water Management Area.* Idaho Department of Water Resources (November 9, 1982)

with issuance of the Final Unified Decree in the SRBA. All three water rights are leased to the Board's Idaho Water Supply Bank (IWSB) and are currently unused. The IWSB leases are set to expire on December 31, 2019.

Table 3
Existing Water Rights

Water Right No.	Priority Date	Water Use	Season	Authorized Diversion Rate (cfs)	Authorized Annual Vol. (ac-ft)	Combined Volume (ac-ft)	Authorized Area (ac)
2-10300A	2/25/1963	irrigation	4/1 to 10/31	8.00	1,339.0	1,600.0	400.0
2-10300B	5/10/1965	irrigation	4/1 to 10/31	8.00	not specified		
2-10506	2/25/1963	irrigation	4/1 to 10/31	4.50	900.0	900.0	225.0
			TOTAL	12.50		2,500.0	625.0

3.3 SUMMARY OF CURRENT AND FUTURE DEMANDS

Current and projected future water demands were evaluated in Section 2. For water right purposes, it is useful to further separate water demands into irrigation and non-irrigation season demands. Seasonal demands are provided in Table 4 below.

For the remaining analysis and discussion, it is assumed that the current annual irrigation season demand is 1,530 ac-ft (golf course plus non-golf course demands), and current annual non-irrigation season demand is 200 ac-ft. These demands can be met by maximum-day diversion rates of 7.9 cfs and 1.9 cfs, respectively. Assuming 50% growth, future irrigation season demand could be 2,300 ac-ft (11.9 cfs maximum day), and future non-irrigation season demand could be 300 ac-ft (2.9 cfs maximum day). Assuming 100% growth, future irrigation season demand could be 3,060 ac-ft (15.9 cfs maximum day), and future non-irrigation season demand could be 400 ac-ft (3.8 cfs maximum day).

Table 4
Current and Future Water Demands

Water Demands	Units	Irrigation Season (4/1-10/31)	Non-Irrigation Season (11/1-3/31)	Total
HISTORICAL (2009-2014 ave)				
NON GOLF COURSE	AF	1,100	200	1,300
GOLF COURSE	AF	430	-	430
TOTAL	AF	1,530	200	1,730
MAXIMUM DAY DEMAND	MGD	5.1	1.2	
	CFS	7.9	1.9	
50% GROWTH				
NON GOLF COURSE	AF	1,650	300	1,950
GOLF COURSE	AF	650	-	650
TOTAL	AF	2,300	300	2,600
MAXIMUM DAY DEMAND	MGD	7.7	1.9	
	CFS	11.9	2.9	
100% GROWTH				
NON GOLF COURSE	AF	2,200	400	2,600
GOLF COURSE	AF	860	-	860
TOTAL	AF	3,060	400	3,460
MAXIMUM DAY DEMAND	MGD	10.3	2.5	
	CFS	15.9	3.8	

3.4 TRANSFERABILITY OF EXISTING WATER RIGHTS

It is contemplated that the Simplot water rights will be used for municipal water supply at MHAFB. Due to the season-of-use limitation of the Simplot water rights, a separate water right authorization is needed during the non-irrigation season.

An IDWR-approved administrative transfer, to change the authorized place of use and (potentially) the authorized nature of use, is required before the Simplot water rights can be used as a water supply for MHAFB. There are essentially three options:

1. The full water rights (minus any deductions discussed below) can be transferred for "municipal purposes" as defined by Idaho Code § 42-202B. Municipal purposes include use for "residential, commercial, industrial, irrigation of parks and open space, and related purposes…" A new water right for non-irrigation season municipal use would be required. <u>OR</u>

2. A portion of the rights can be transferred directly for irrigation use, which could reduce the annual volume deducted from the rights during processing of the transfer. The balance of the rights could be transferred to municipal use (including domestic potable supply, and any other use). A new water right for non-irrigation season municipal use would be required. <u>OR</u>

3. A new water right for year-round municipal use could be developed and the Simplot rights transferred to meet irrigation demands, only.

   The three water right options are discussed in greater detail below:

3.4.1 OPTION 1: TRANSFER TO MUNICIPAL USE ONLY

IDWR's current policy concerning the processing of administrative transfers is detailed in Administrator's Memorandum No. 24. A water right transfer that includes a change in the nature of use (in this case from irrigation to municipal use) is subject to a review of historical beneficial use and the calculation of a volume of consumptive use that can be transferred. IDWR's policy requires a review of available data and information concerning crop types, crop production, water diversion records, delivery system efficiency, and any other information to determine the historical consumptive use volume. An approved transfer from irrigation to municipal use would likely authorize only historical consumptive use volume for transfer to the new municipal use.

Information to support the volume of consumptive use for these rights may be difficult to obtain. Although there is no question as to the validity of the Simplot rights, the rights have not been used for an extended period of time and information about historic water use is likely unavailable. However, a consumptive use volume can be calculated using several assumptions, including:

- crop types are a typical mix known to be under cultivation in the area;
- typical system efficiency, based on local area farming practice;
- consumptive use volume can be calculated using evapotranspiration values provided on the University of Idaho ET_{Idaho} website, using the assumed crop mix.

As an alternative, IDWR may accept the current standard for consumptive use in the area where the water rights were last used (in this case 3 ac-ft per acre). If a transfer application seeks to change the nature of use for these rights entirely from irrigation to municipal use, and the standard value is applied, the 2,500 ac-ft combined volume would be reduced to 1,875 ac-ft (a 25% "shrink"). This transferable volume might be less depending on the assumptions made during a more rigorous analysis of crop types and historical farm practice (which may be in the range of 2 to 3 ac-ft per acre). A transfer of the Simplot water rights that changes the nature of use entirely from irrigation to municipal use at 3 ac-ft per acre would result in a transferrable volume that would support approximately 25% growth at MHAFB in the irrigation season. If the volume were reduced to 2.4 ac-ft per acre, the transferred water right would not allow for any growth. In either case, a new water right would still be required for the non-irrigation season.

SPF does not recommend a full transfer to municipal use because the value of the Simplot water rights would be reduced by the determination of consumptive use volume.

3.4.2 OPTION 2: PARTIAL TRANSFER FOR IRRIGATION USE

Administrator's Memo No. 24 instructs IDWR staff to consider consumptive use volume in the case of a proposed change to the nature of beneficial use, but does not require the same analysis if the transfer merely proposes a change in the location of irrigation use. In other words, where the crop irrigated was historically corn or sugar beets, it will now be turf and landscaping. The nature of use has not changed.

As described in SPF's Capacity Memo, water demand is highest in the summer (due primarily to irrigation demands) and lowest during the winter. As shown in Table 2, current non-irrigation season demand is 200 ac-ft, or approximately 40 ac-ft per month. The 40 ac-ft per month demand is assumed to be typical for non-irrigation municipal purposes year-round. The irrigation season demand is 1,530 ac-ft annually, or an average of 220 ac-ft per month. Assuming that 40 ac-ft per month is used for non-irrigation municipal purposes, the irrigation demand averages 180 ac-ft per month (1260 ac-ft per season).

Current demands could be met by transferring a 1,200 ac-ft (300 acres and 6.0 cfs) portion of the existing Snake River water right portfolio for irrigation and converting a portion (4.0 cfs) of the remaining rights to municipal use (which can include some irrigation). A new non-irrigation season municipal water right would be required.

3.4.3 OPTION 3: TRANSFER FOR IRRIGATION USE ONLY

In this alternative, a new year-round water right would be sought for municipal use and a stepped transfer of the Simplot rights would occur as irrigation demand increased over time. In this scenario, a year-round municipal water right would be developed, as outlined in Section 6, to provide 100% of the current and future demands for non-irrigation uses. Additional portions of the Simplot rights would be transferred to MHAFB as irrigation demands increased over time. This would provide for nearly 100% growth in irrigation demands for MHAFB. Unused portions of the Simplot rights could be stored in the Idaho Water Supply Bank to protect the rights from forfeiture.

3.5 ACQUIRING ADDITIONAL WATER RIGHTS TO MEET FUTURE DEMANDS

The Simplot rights can provide a surface-water supply for MHAFB from April 1 to October 31 (the existing season-of-use for the rights). A new water right appropriation from the Snake River will be needed for use from November 1 to March 31 (or year-round for Option 3). Developing a new water right from the Snake River for use at MHAFB is possible, but complicated by (1) minimum streamflow rights at the Murphy gauge (3,900 cfs from April 1 through October 31, and 5,600 cfs from November 1 through March 31), and Weiser gauge (4,750 cfs year-round); (2) the 1984 Swan Falls Settlement that created the concept of "trust water" made available from the Snake River for future development; and (3) the potential for Idaho Power Company (IPCo) power-generation revenue losses. These complicating factors are not insurmountable and IDWR has recently issued several permits to develop new Snake River water rights.

The complicating factors are considered below, followed by a discussion of the specific process for developing a new water right from the Snake River for MHAFB.

3.5.1 SNAKE RIVER MINIMUM STREAMFLOW AT MURPHY AND WEISER

Idaho's Minimum Stream Flow Program was approved by the Legislature to preserve stream flows and lake elevations for purposes defined by Idaho Code §42-1501. Minimum stream flow water rights are held by the Idaho Water Resource Board in trust for Idaho citizens (Idaho Code, Title 42, Chapter 15). The minimum stream flow is the amount of flow necessary to preserve desired stream values, including fish and wildlife habitat, aquatic life, navigation and transportation, recreation, water quality, and aesthetic beauty. The minimum stream flow water rights at Swan Falls (Murphy gauge) and Weiser could potentially impact appropriation of water from the Snake River for MHAFB. The minimum streamflow rights are summarized in Table 5.

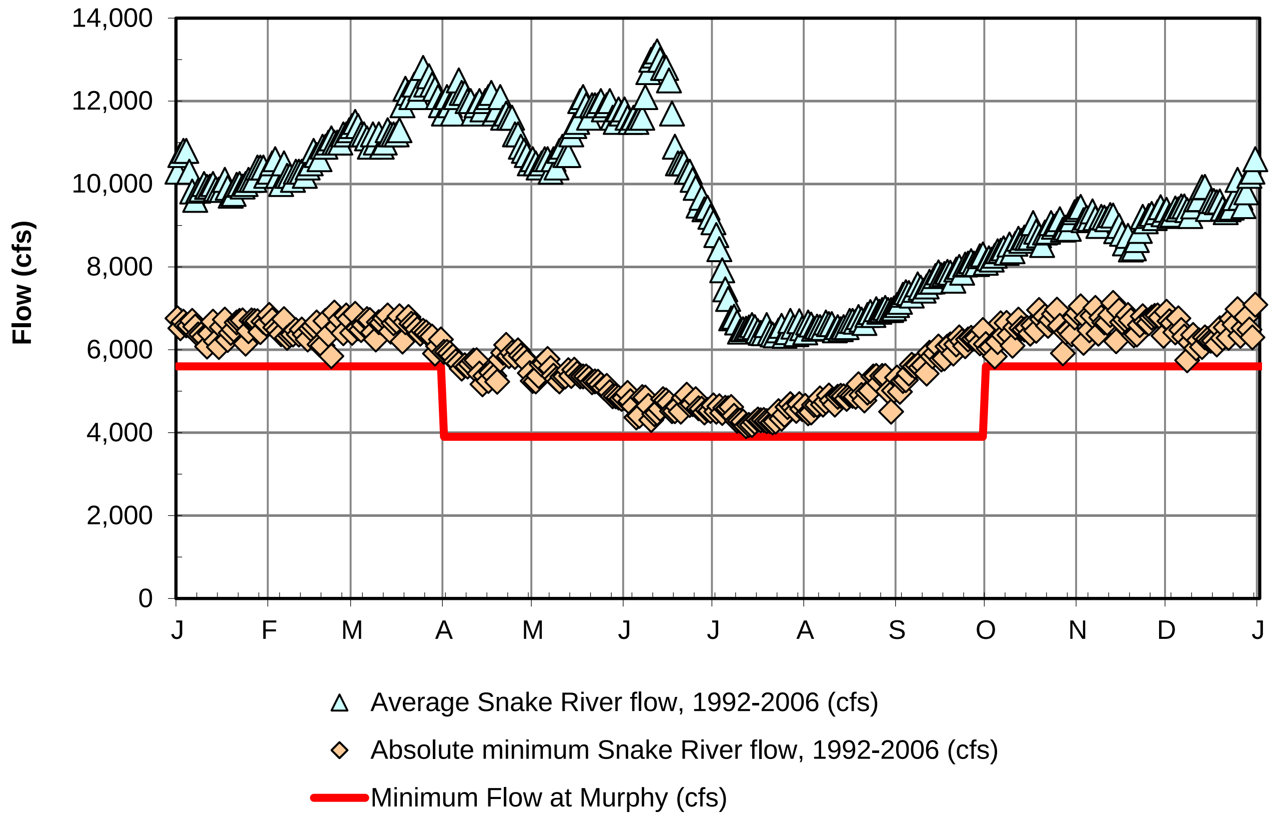
Table 5
Minimum Streamflow Water Rights at Murphy and Weiser Gauges

Gauge	Water Right No.	Priority Date	Quantity (cfs)	Season
Murphy	2-201	December 29, 1976	3,300	Year-round
Murphy	2-223	July 1, 1985	600	Year-round
Murphy	2-224	July 1, 1985	1,700	Non-irrigation
Weiser	3-6	December 29, 1976	4,750	Year-round

Stream flows in the Snake River have approached the minimum streamflow at Murphy (3,900 cfs) each spring for several years; the minimum was violated for the first time on March 31, 2015 (Figure 2), and 98 ac-ft of stored water was released from Palisades Reservoir to compensate for the breach.

Figure 2

Historical Snake River Flows at Murphy Gauge



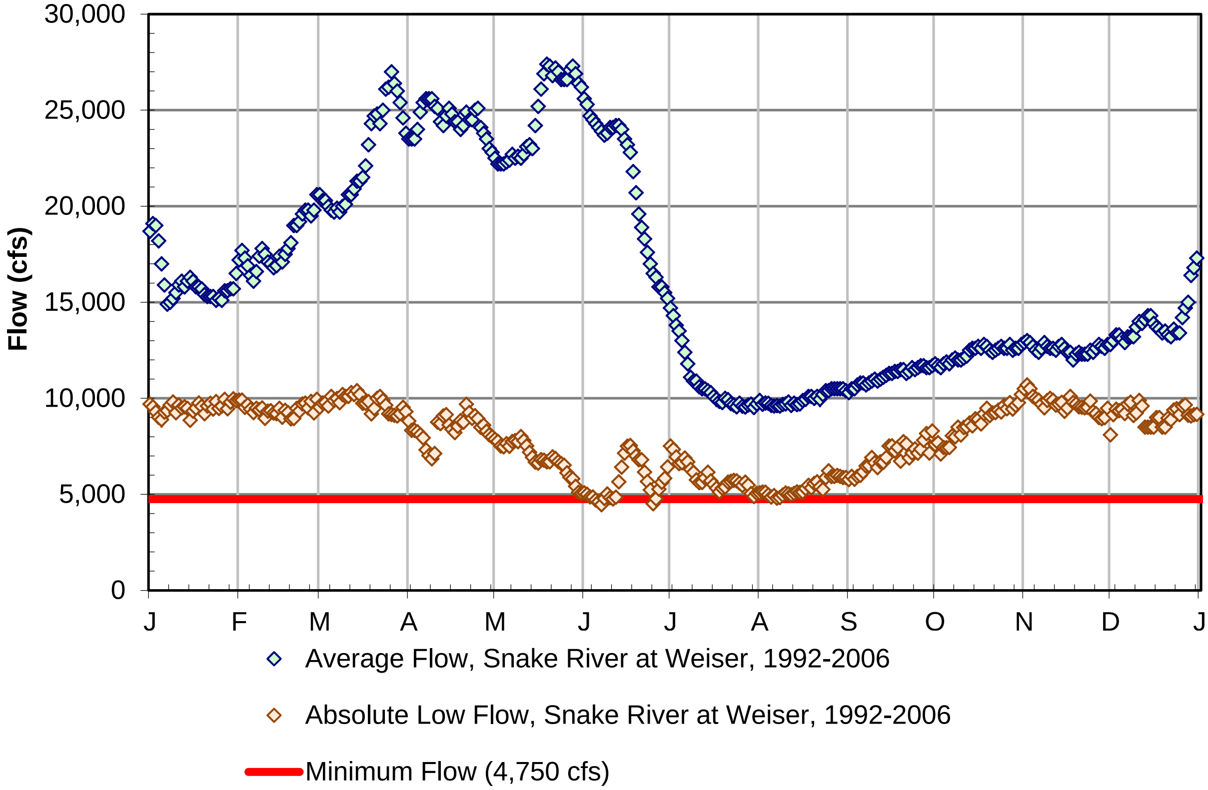
Stream flows in the Snake River have approached the minimum streamflow at Weiser several times during the irrigation season, and violated the minimum in 1977 and 1992 (Figure 2). Stream flows in the Snake River at Murphy and Weiser are currently affected (increased) by the release of augmentation flows from upstream reservoirs to support habitat for anadromous fish.[2] Minimum streamflow water rights at Murphy and Weiser may be violated more regularly if flow augmentation is reduced in the future.

Violations of the minimum streamflow water rights at Murphy and Weiser have occurred historically during periods of drought. The Board's acquisition of the Simplot water rights will

[2] Augmentation flows are provided to the Snake River, Boise River, and Payette River from federal storage reservoirs. Contributions from the Snake River are provided upstream of Murphy gauge. Additional contributions from the Boise River and Payette River are provided upstream of the Weiser gauge.

allow MHAFB to transition to a surface water supply with greater certainty that its municipal supply is secure during the irrigation season.

Figure 3
Historical Snake River Flows at Weiser Gauge



3.5.2 NEW APPROPRIATIONS OF "TRUST WATER"

The Snake River upstream of Swan Falls Dam (at the Murphy gauge) and below Milner Dam is open to appropriation of water under the terms of the Swan Falls Settlement (the Agreement). In the Agreement, IPCo's water rights were subordinated to all water rights with priority dates earlier than October 1, 1984. Consistent with the Agreement, subsequent statutes also subordinated The IPCo water rights to some amount of future water right development, provided the minimum streamflows are met at Murphy gauge. The water available for appropriation defined by these constraints is referred to as "trust water".

Water rights for "trust water" are processed in accordance with Idaho Code § 42-203C and applicable water appropriation rules (IDAPA 37.03.08). Specifically, IDWR is required to determine "whether the proposed use, individually or cumulatively with other existing uses…would significantly reduce the amount of trust water available to the holder of the water right used for power production", and if so, whether the proposed reduction is in the public interest. (Idaho Code 42-203C)." However, the rules also state, "Other provisions of these rules not withstanding (sic), applications or permits…for DCMI[3] purposes are presumed to not cause a significant reduction" (IDAPA 37.03.08.45.02.e). MHAFB would be applying for a municipal right, which is covered by the rule.

3.5.3 POTENTIAL POWER GENERATION REVENUE LOSSES

Idaho Power Company could potentially be a protestant to a water right application made by MHAFB for its municipal use, based on lost power-generation revenues caused by the new diversion of Snake River water. To our knowledge, IPCo has not yet determined a method to calculate potential losses. The possibility that IPCo may have lost revenues based on MHAFB diversions can be addressed at the time a permit application is submitted (or protested by IPCo).

3.5.4 PROCESS FOR NEW WATER RIGHT DEVELOPMENT

Preparation and submittal of a new water right application is straight-forward once MHAFB is able to provide sufficient information about potential future development. We recommend MHAFB submit an application for "reasonably anticipated future needs", known as "RAFN". RAFN are defined by Idaho Code § 42-202B(8) as "future uses of water by a municipal provider for municipal purposes within a service area which, on the basis of population and other planning data, are reasonably expected to be required within the planning horizon…" The "planning horizon" varies by individual applicant and can be 20-50 years, but is generally based on the type of information supplied with the application (e.g. population growth projections for MHAFB).

An application for RAFN will include information to support the requested diversion rate (cfs) and planning horizon. The application will be reviewed by IDWR staff and, if acceptable, public notice will be provided by advertisement in the local newspaper. A fourteen-day protest period follows advertisement. A permit is issued if no protest is submitted, or after protests are resolved.

RAFN applications can be developed over time to meet the needs of the applicant. Importantly, the applicant is not required to fully develop the proposed system capacity in order to obtain a water right license. Under current IDWR policy, a RAFN license will be based on system capacity. The "capacity of the system" is determined by IDWR on a case-by-case basis, but generally the applicant need not have installed all facilities (pipes, pumps, etc) to meet the entire diversion rate requested on the application. A demonstration that plans exist for construction of a facility to meet future needs is generally accepted prior to licensing.

[3] "DCMI" stands for domestic, commercial, municipal, and industrial.

3.6 WATER RIGHTS SUMMARY AND RECOMMENDATIONS

IWRB has acquired a valuable set of Snake River water rights from Simplot. The rights can be used for irrigation of MHAFB (after issuance of an approved transfer), or portions of the rights can be converted to municipal use (which could include irrigation). Unused portions of the water rights could be placed in the Idaho Water Supply Bank while not being used to protect the rights from forfeiture.

The Simplot water rights are valid during the irrigation season only. A new appropriation is needed to authorize diversion from the Snake River during the non-irrigation season. To assure MHAFB can meet its projected future water demands, we recommend MHAFB take the following steps:

Submit an application for transfer of water right to modify the Simplot water rights as follows.

1. Change the place of use to MHAFB for a 6.0 cfs (300-acre and 1,200 ac-ft) portion of the rights. The nature of use would remain as irrigation.
    a. Change the nature of use to municipal and place of use to MHAFB for a 4.0 cfs (200-acre and 600 +/- ac-ft after shrink) portion of the rights.
    b. In combination, the rights would provide 1,800 ac-ft and 10.0 cfs of supply to the base, which provides for approximately 15% increase in total water demand.
2. Retain the 2.5 cfs (125 acres and 500 ac-ft) balance of the Simplot water rights in the Idaho Water Supply Bank for forfeiture protection until needed for future irrigation or municipal use.
3. Submit a permit application based on RAFN (“reasonably anticipated future needs”) for non-irrigation season municipal use. An application can be prepared as soon as MHAFB develops a projected water demand for the application. For 100% growth, the application would seek 3.8 cfs.

4. WATER QUALITY EVALUATION

Water quality samples were collected from C.J. Strike Reservoir and analyzed to evaluate its suitability as a source of drinking water for MHAFB. Four sets of samples were collected at monthly intervals and analyzed for 19 parameters shown in Table 6 below. Samples were collected at the existing Simplot irrigation pump station at a depth of 10 feet below water surface.

Table 6
CJ Strike Reservoir Water Quality

Parameter	Units	Average	Min - Max(1)	MCL(2)
Alkalinity	mg/L as $CaCO_3$	173	165-180	
Aluminum	mg/L	<0.10	<0.10	0.05-0.2(3)
Arsenic	ug/L	5	4-6	10
Bromide	ug/L	68	54-95	
Calcium Hardness	mg/L as $CaCO_3$	114	106-120	
Calcium	mg/L	46	42-48	
Escherichia coli	MPN/100mL	ND	2	10(4)
Fluoride	mg/L	0.55	0.50-0.65	4
Iron	mg/L	<0.05	<0.05	0.3(3)
Magnesium	mg/L	21.3	20.9-21.8	
Manganese	mg/L	<0.05	<0.05	0.05(3)
Mercury	ug/L	<0.2	<0.2	
Nitrate	mg/L	1.55	0.9-2.1	10
Nitrite	mg/L	0.025	0.02-0.03	1
pH	Units	8.1	8.0-8.2	6.5-8.5(3)
Total Hardness	mg/L as $CaCO_3$	199	190-205	
Total Organic Carbon	mg/L	1.3	1.03-1.56	
Turbidity	NTU	2.5	1.5-3.4	
UV Transmittance at 254nm	cm^{-1}	92.7	90.8-94.8	

Notes:
1. Indicates the minimum and maximum results for a specific parameter across all four sample events.
2. MCL is Maximum Contaminant Level for drinking water as defined by the USEPA.
3. Indicates the standard is a secondary maximum contaminant level which is a non-enforceable guideline for aesthetic purposes.
4. *E. Coli* concentrations for proposed surface water sources must be monitored monthly for a duration of 12 months per the LT2 Enhanced Surface Water Treatment Rule. If the average *E. Coli* concentration is greater than 10 CFU/100 mL, then additional sampling and treatment may be required.

In addition, one set of water samples was analyzed for all 145 federal primary drinking water standards. None of the samples collected were found to violate any primary drinking water standards. Laboratory analysis reports are included in Appendix B.

4.1 WATER QUALITY EVALUATION

In general, Snake River water quality at C.J. Strike Reservoir appears to be well suited for treatment to drinking water standards through either conventional treatment or membrane filtration with pretreatment. The water can be characterized as low in turbidity, moderate to slightly basic pH, with moderate levels of total organic carbon. Total hardness is moderately high and is discussed below. Nitrate, fluoride, and arsenic levels are well below their respective maximum contaminant levels.

4.1.1 Escherichia Coli

Escherichia coli (*E. Coli*) concentrations were low. Three samples were non-detect and one sample had a concentration of 2 MPN (most probable number)/100mL. If *E. Coli* concentrations are above 10 MPN/100mL, based on 12 months of sampling, then additional and expensive *Cryptosporidium* sampling would be required and more advance treatment could ultimately be required. One year of monthly *E. Coli* sampling is required for new water treatment plants using surface water sources, so eight more months of sampling will be necessary which can be conducted during pilot testing.

4.1.2 Nitrate and Nitrite

Nitrate and nitrite concentrations averaged 1.6 mg/L and 0.03 mg/L, which are well below their respective MCLs of 10 and 1 mg/L.

4.1.3 Total Organic Carbon and DBP Precursors

Total Organic Carbon concentrations averaged 1.3 mg/L, which is low. TOC is a general indicator of disinfection byproduct formation potential. If TOC was significantly higher (e.g. greater than 4 or 5 mg/L) then disinfection byproduct formation could be more of a concern.

4.1.4 Fluoride

The fluoride concentration averaged 0.55 mg/L. The MCL is 4 mg/L and the recommended concentration for preventing tooth decay is 0.7 mg/L (per US Dept. of Health and Human Services). With naturally occurring fluoride at 0.55 mg/L, adding fluoride to the water should not be necessary.

4.1.5 Total Hardness

Total hardness concentration averaged 199 mg/L as $CaCO_3$, which is categorized as hard water. Hardness is not a health concern, but rather an aesthetic and maintenance issue. Hardness concentrations for the existing wells at MHAFB range from 39 to 350 mg/L. Wells 2 and 13 are most commonly used on Base and have average hardness levels of 73 and 39 mg/L, respectively. Using the CJ Strike source will generally result in a significant increase in hardness which in turn could lead to some scaling and deposits on piping and plumbing fixtures. Softening treatment (lime softening or membranes) could be considered at the WTP, however this is typically not implemented at hardness levels below 250 to 300 mg/L due to the increased cost. The Base may want to consider water softeners for specific uses in their facilities (they may already have water softeners in some locations). The magnesium concentrations averaged 21 mg/L, so precipitation in water heaters could also be a potential issue.

4.1.6 Turbidity

All turbidity samples were less than 5 NTU, which is low and amenable to removal via conventional water treatment processes. If raw water turbidity is always less than 10 to 15 NTU, then direct filtration is an option which eliminates the sedimentation process and would provide significant savings (Kawamura, 2000). Data from the pilot study will be valuable in evaluating this option. However, if raw water turbidity ever exceeds 15 NTU, then a sedimentation process would be necessary upstream of granular media filters.

4.1.7 UV-254 Transmittance

UV Transmittance at 254 nm averaged 92.7% across the four samples. This is relatively high for raw surface water and indicates that the water would be amenable to UV disinfection, especially after filtration. UV disinfection is not recommended in this study, but it could be implemented at any time to enhance primary disinfection.

4.1.8 Other Snake River Water Purveyors

There are few existing drinking water systems that use this stretch of the Snake River as a water source. The two closest are Glenns Ferry, Idaho and Ontario, Oregon. Water quality data from both cities were evaluated with respect to drinking water standards. Glenns Ferry is located upstream and uses membrane filtration treatment while Ontario is located downstream and uses conventional water treatment with granular media filters. Based on the data reviewed, both conventional treatment and membrane filtration treatment process are expected to meet all existing water quality standards including disinfection by-product regulations for trihalomethanes (THMs) and haloacetic acids (HAAs). For further discussion and conceptual design of proposed conventional treatment and membrane treatment, see Section 6.

4.2 WATER QUALITY SUMMARY

Overall, Snake River water at C.J. Strike Reservoir was found to be well suited as a supply for the proposed potable water system. Four monthly samples were collected and analyzed, and every test meets federal primary drinking water standards. In addition, turbidity was low in all samples collected. Additional data should be collected during the required water treatment pilot study to determine if raw water turbidity is always less than 15 NTU, and whether or not direct filtration can be implemented. Disinfection Byproducts (DBPs) are not anticipated to be an issue due to low raw water TOC concentrations and historical DBP data from Glenns Ferry, Idaho and Ontario, Oregon.

5. INTAKE PUMP STATION

Conceptual design of the intake pump station includes four vertical turbine pumps with space provided for two additional pumps for future expansion to an ultimate capacity of 8 mgd (5,600 gpm) and piping designed to accommodate the ultimate capacity. Intake screens will be provided to screen out solids and protect fish, with final screening requirements such as slot size and approach velocity to be determined during permitting of the new intake facility. Screens will be located roughly 10 feet below the minimum water surface elevation, and intake piping will convey water to the pump suction header. Table 7 presents conceptual design criteria for the intake pump station.

Table 7
Conceptual Design Criteria for Intake Pump Station

PARAMETER	UNIT	VALUE
INITIAL DESIGN CAPACITY (FIRM) [(1)]	MGD	4.0
	GPM	2,800
ULTIMATE CAPACITY	MGD	8.0
	GPM	5,600
NUMBER OF PUMPS	NO.	4
LARGE PUMPS		
NUMBER OF LARGE PUMPS	NO.	2
PUMP TYPE	VERTICAL TURBINE	
DRIVE TYPE	VARIABLE FREQUENCY	
PUMP POWER (EA.)	HP	300
DESIGN FLOWRATE (EA.)	GPM	1,400
TOTAL DYNAMIC HEAD	FT	650
SMALL PUMPS		
NUMBER OF SMALL PUMPS	NO.	2
PUMP TYPE	VERTICAL TURBINE	
DRIVE TYPE	VARIABLE FREQUENCY	
PUMP POWER (EA.)	HP	150
DESIGN FLOWRATE	GPM	700
TOTAL DYNAMIC HEAD	FT	650
FUTURE PUMPS, LARGE (SPACE PROVIDED)	NO.	2

Notes:

1. Firm capacity is the total pump station capacity with the largest pump out of service.

The intake pump station will be located at the shore and will house the pumps and motors, mechanical piping, surge control equipment, and electrical and controls equipment. All equipment and piping will be housed in a new building for security and protection from the elements. A diesel standby generator is included in the conceptual design, but may not be necessary due to reliability provided by the proposed 30 acre-foot (AF) raw water reservoir located at the water treatment plant. This decision can be finalized during preliminary design. Figure 4 shows a potential intake site.

Figure 4. *Potential CJ Strike Reservoir Intake Site*

5.3 ENVIRONMENTAL PERMITTING OF INTAKE AND PIPELINE

An easement from BLM will be required for either pipeline alignment (Alternative 1 or 2) because either pipeline would traverse several miles of BLM land. In addition, the intake for Alternative 1 would be located on BLM land, while the intake for Alternative 2 would be located on privately owned land. In either case, environmental permitting will be required to obtain the BLM easement. At this time, it appears that an Environmental Assessment (EA) will be more likely than the more detailed, costly, and time consuming Environmental Impact Statement (EIS). However, BLM will ultimately determine whether an EA or EIS is required, assuming they are the lead agency in the National Environmental Policy Act (NEPA) permitting process.

Regardless of the alternative selected, the pipeline will cross a Slickspot Peppergrass Management Area, and would be subject to guidelines specific to the management area and the greater range of the species. However, slickspot peppergrass habitat is easily identifiable and therefore avoidable by construction activities.

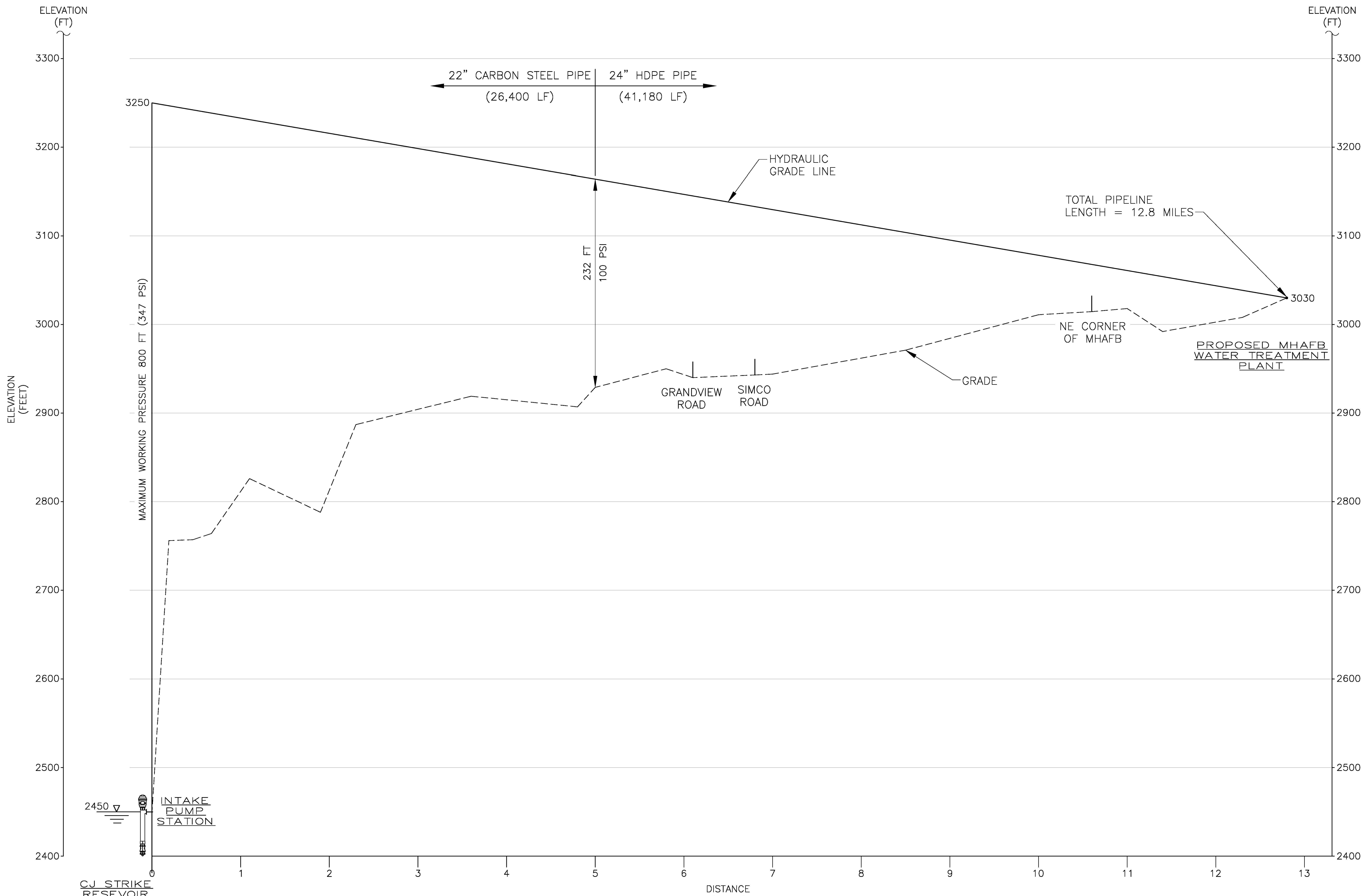
The pipeline will also cross portions of the Birds of Prey National Conservation Area (NCA). The NCA contains the greatest concentration of nesting raptors in North America. The NCA is a unique habitat for birds of prey because the cliffs of the Snake River Canyon provide ideal nesting sites, while the adjacent upland plateau supports unusually large populations of small mammal prey species. Special attention should be given towards avoiding, minimizing, or mitigating environmental impacts at the Snake River, adjacent canyon walls, and raptor foraging areas along the canyon rim.

Potential impacts at the intake facilities include aquatic species such as fish and snails. Fish screens will be included at the intake with technical requirements such as slot size and approach velocity to be determined by the federal agencies during the permitting process. Other issues of concern could include cultural and visual resources near the Snake River Canyon. For Alternative 1 the pipeline would be buried and run parallel to the existing 30" Simplot pipeline through an existing notch in the canyon rim. For Alternative 2 the pipeline could either be exposed at the canyon rim or a borehole could be drilled behind the rim to conceal the pipeline and minimize visual impacts.

The majority of anticipated impacts would occur during the pipeline construction phase, and are considered to be short-term and local in nature. Further, these potential environmental impacts could likely be avoided, minimized, or mitigated through construction best management practices (BMPs), cultural and biological field surveying, and effective pipeline route planning. Further, environmental mitigation measures described in the recently completed West-Wide Energy Corridor (WWEC) Programmatic EIS could potentially be applied to the NEPA process.

From an environmental resources standpoint, neither of the proposed pipeline alternatives is anticipated to impede or preclude the project. However, a final determination of environmental and cumulative effects can only be made by the Federal Government, in this case the BLM, which would be evaluated through the ROW application and NEPA process. The first step in the process is to file a Notice of Intent (NOI) with BLM, then BLM will determine whether an EA or an EIS is required.

PIPELINE ALTERNATIVE 1



NOTE:
THE HYDRAULIC GRADE LINE REPRESENTS THE PRESSURE IN A PIPELINE ALONG IT'S ALIGNMENT.

HYDRAULIC PROFILE AT 8 MILLION GALLONS/DAY (5,600 GPM)

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

IDAHO WATER RESOURCES BOARD
MOUNTIAN HOME AIR FORCE BASE

HYDRAULIC PROFILE – ALTERNATIVE 1

PRELIMINARY DRAFT NOT FOR CONSTRUCTION

REVISIONS

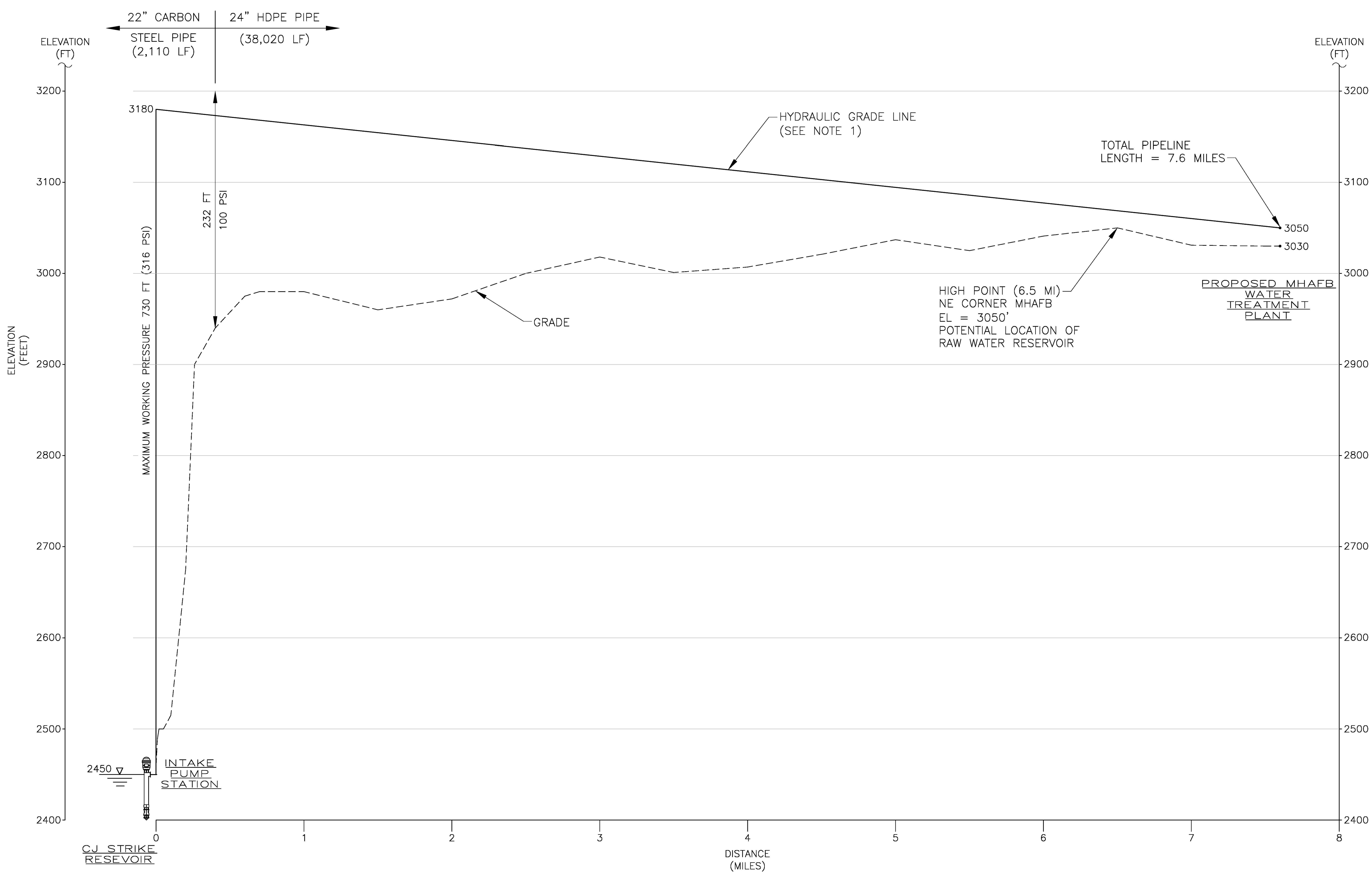
ITEM	DESCRIPTION	DATE
1	WATER SUPPLY PLANNING REPORT	2/22/16

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON ORIGINAL DRAWING. IF NOT ONE-INCH, SCALE ACCORDINGLY.

PROJECT:	780.0030
DESIGNED:	EAL
DRAWN:	SCB
CHECKED:	CGC

FIGURE 5

PIPELINE ALTERNATIVE 2



NOTE:
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MOUNTIAN HOME AIR FORCE BASE

HYDRAULIC PROFILE – ALTERNATIVE 2

PRELIMINARY DRAFT NOT FOR CONSTRUCTION

REVISIONS

ITEM	DESCRIPTION	DATE
1	WATER SUPPLY PLANNING REPORT	2/22/16

VERIFY SCALE
0 1/2 1
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DESIGNED:	EAL
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FIGURE 6

6. WATER TREATMENT PLANT

Snake River water will require treatment at a water treatment plant (WTP) prior to delivery to the MHAFB distribution system. There are many drinking water treatment options, but ultimately treatment process selection should be based on raw water quality and treated water goals. Raw water quality was evaluated during this study and is summarized in Section 4 of this report. The evaluation showed that Snake River water at C.J. Strike Reservoir is a suitable drinking water source and will be expected to meet all federal drinking water standards with conventional water treatment processes or membrane filtration.

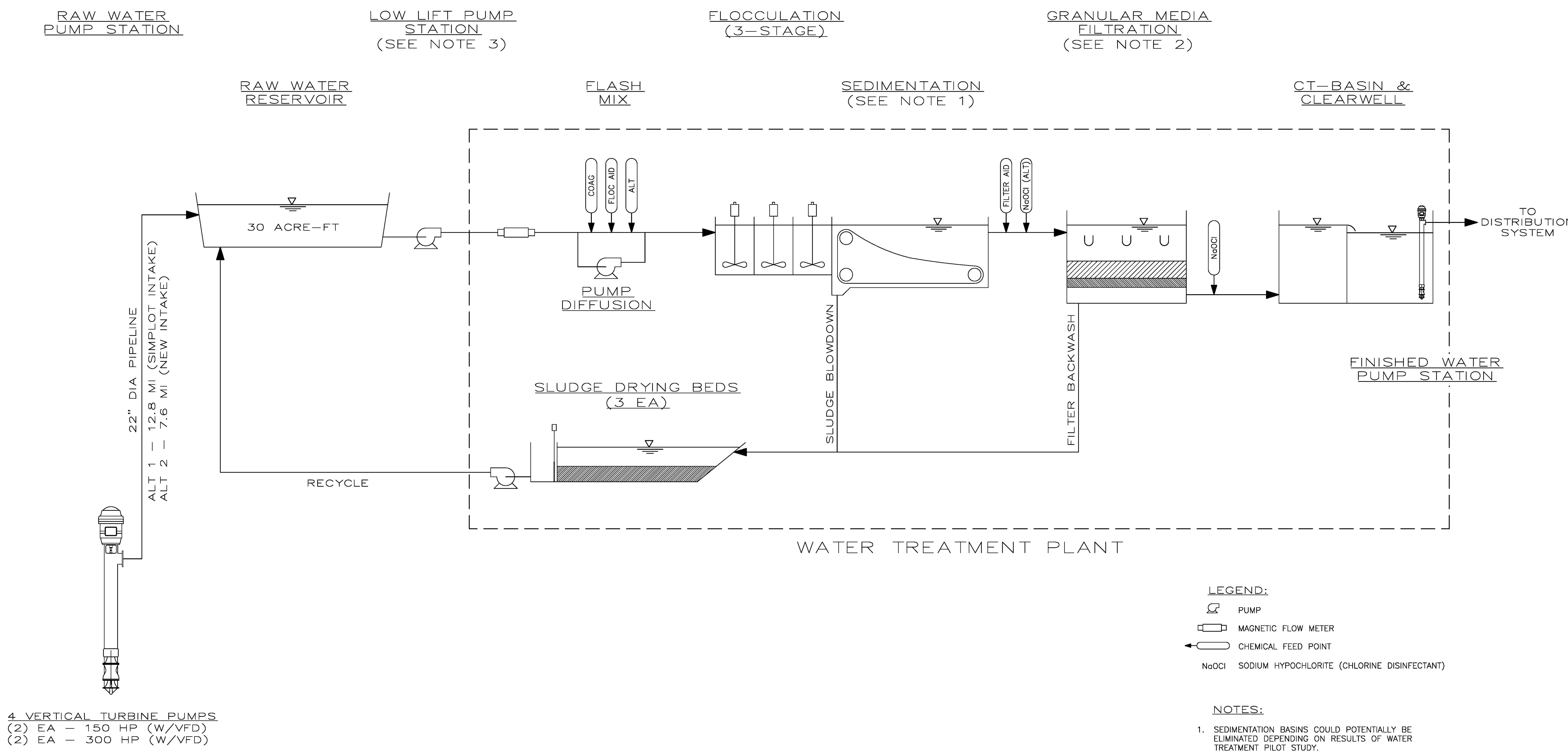
The cost estimates presented in Section 7 show that conventional treatment is the most cost effective approach, as compared to membrane filtration. Therefore conventional treatment is presented as the preferred option, with membrane treatment discussed as a potential treatment alternative. A water treatment Pilot Study will be required by the Idaho Department of Environmental Quality (IDEQ). Conventional water treatment with granular media filters is recommended for the pilot study, but both conventional and membrane treatment could be studied, although at a higher cost.

Conceptual design of the conventional WTP includes a raw water reservoir, coagulation with pump diffusion flash mix, 3-stage tapered flocculation, gravity sedimentation, granular media filtration, and disinfection with sodium hypochlorite generated on-site. A preliminary process flow diagram is shown in Figure 7.

6.1 RAW WATER RESERVOIR

A raw water reservoir is recommended to provide storage of raw water at the WTP site to increase the reliability and flexibility of the water supply system. It is possible that at some point in the future, water supply could be curtailed to meet minimum flow requirements at Swan Falls or Weiser as described in Section 3. Snake River flows frequently approach minimum flows in late-March. If diversion of water was curtailed for several days, then on-site storage of raw water would provide a back-up supply. The raw water reservoir would also provide water in case the intake pump station or pipeline was temporarily out of service for any reason. Further, the raw water reservoir would decouple operations of the intake pump station and the WTP so that each facility could operate at an optimal flow rate without having to ramp up and down in tandem.

Conceptual design includes a raw water reservoir capacity of 30 AF (approximately 10 million gallons), which would provide 24 days of storage at the current winter average demand of 0.4 mgd. If winter demand doubled in the future, then it would provide 12 days of storage. The conceptual design assumes an average depth of 15 feet, surface area of approximately 2 acres, and an earthen liner. A low lift pump station would deliver water from the reservoir to the WTP.



LEGEND:

- PUMP
- MAGNETIC FLOW METER
- CHEMICAL FEED POINT
- NaOCl SODIUM HYPOCHLORITE (CHLORINE DISINFECTANT)

NOTES:

1. SEDIMENTATION BASINS COULD POTENTIALLY BE ELIMINATED DEPENDING ON RESULTS OF WATER TREATMENT PILOT STUDY.
2. MEMBRANE FILTRATION COULD BE SELECTED IN LIEU OF GRANULAR MEDIA FILTRATION AT SOMEWHAT HIGHER COST.
3. FOR INTAKE AND PIPELINE ALTERNATIVE 2, THE LOW LIFT PUMP STATION COULD POTENTIALLY BE ELIMINATED IF THE RAW WATER RESERVOIRS LOCATED AT THE PIPELINE HIGH POINT (NE CORNER OF MHAFB)

PROCESS FLOW DIAGRAM

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
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IDAHO WATER RESOURCES BOARD
MOUNTIAN HOME AIR FORCE BASE

PROCESS FLOW DIAGRAM

PRELIMINARY DRAFT NOT FOR CONSTRUCTION

REVISIONS

ITEM	DESCRIPTION	DATE
1	WATER SUPPLY PLANNING REPORT	2/22/16

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON ORIGINAL DRAWING. IF NOT ONE-INCH, SCALE ACCORDINGLY.

PROJECT:	780.0030
DESIGNED:	EAL
DRAWN:	SCB
CHECKED:	CGC

FIGURE 7

The Raw Water Reservoir could be located adjacent to the WTP, which might have the added benefit of the aesthetics of a large pond near the main entrance to the Base. But technically it could be located anywhere along the pipeline alignment. Potential sites should be evaluated geologically to minimize excavation of rock and for the suitability of soils for an earthen pond liner. Bentonite could be added to the earthen liner if necessary to reduce seepage. The reservoir will likely attract water fowl, and distance from flight paths will need to be considered. For comparison, the surface area of the Raw Water Reservoir will be similar to the combined surface area of the two existing ponds at the MHAFB Golf Course.

For Pipeline Alternative 2, the reservoir could be located at the high-point of the pipeline near the northeast corner of MHAFB. Under this scenario water would be conveyed by gravity from the Reservoir to the WTP, thereby eliminating the capital and operational costs of the proposed low-lift pump station. The runways at the Base run from south-east to north-west, so it appears that this location would avoid the flight path, and it would be further from the runways than the existing ponds at the Golf Course.

6.2 COAGULATION AND FLASH MIX

Pump diffusion flash mix will provide mixing energy of approximately 700 s^{-1} for the coagulation process. Different coagulants should be tested during the pilot study, including metal salts and polymers, to identify the optimal primary coagulant for final design. Provisions for the addition of coagulant aid (anionic polymer) should also be considered and are included in the chemical feed cost estimates. After coagulation, the water will be conveyed directly to the flocculation basins.

6.3 FLOCCULATION AND SEDIMENTATION

Conceptual design includes three flocculation/sedimentation basins with a firm capacity of 6 mgd (with one set of basins out of service). Flocculation will be provided by 3-stage, tapered, horizontal flocculators, with a total hydraulic detention time of 36 minutes. Diffuser walls between flocculation stages and between the final stage of flocculation and the head of the sedimentation basins will reduce short circuiting. The sedimentation basins will be designed with a surface loading rate of 0.75 gpm/ft^2, length to width ratio of 4.8, and will be provided with longitudinal sludge collectors and motorized telescoping sludge valves for sludge blowdown. Future expansion could involve the construction of one additional set of flocculation/sedimentation basins or the addition of plate settlers to the existing basins to achieve a higher surface loading rate.

If the raw water turbidity is always less than 15 Nephelometric Turbidity Units (NTU), then the sedimentation process could be eliminated, and the flocculation duration could be reduced. This would save significant cost and should be evaluated further during the Pilot Study. During the 4 months of water testing conducted as part of this study, raw water turbidity ranged from 1.5 to 3.4 NTU. The average raw water turbidity for the City of Glenns Ferry was 2.8 NTU during the 5-year period between 2010 and 2014. The absolute maximum was 23 NTU, and the 99^{th} percentile was 9.1 NTU. Based on these data, the proposed Raw Water Reservoir could be used as a settling basin possibly with coagulant addition if raw water turbidity ever exceeds 15 NTU. Eliminating the sedimentation basins and reducing the size of the flocculation basins would save approximately $1.0 million in construction cost.

6.4 GRANULAR MEDIA FILTRATION

Conceptual design of the filtration process includes 4 filters with a firm capacity of 6 mgd (with one filter out of service). A filtration rate of 6 gpm/ft^2 is used in the cost estimates and would need to be demonstrated during pilot testing. Cost estimates include cast-in-place nozzle underdrain system, air scour, surface wash, and provisions for filter aid storage and feed. A standard mixed media design including 24 inches of anthracite and 12 inches of sand is included. The filters will be located in a building to protect equipment and water quality from the elements.

6.5 MEMBRANE FILTRATION

As an alternative, membrane filtration could be employed instead of granular media filtration. Either microfiltration or ultrafiltration would be used and raw water straining would be provided upstream to protect the membranes. The membrane system would include automated backwash cycle and a clean in place (CIP) system for periodic chemical cleaning. Membrane systems are fully automated and require somewhat less operations and maintenance as compared to conventional treatment.

As compared to conventional treatment, membrane filtration is somewhat more expensive at a capacity of 6 mgd (see Section 7 for cost estimates and discussion). Operations and maintenance is also somewhat more expensive due to higher power, chemical, and equipment maintenance costs (driven by membrane replacement every 5-10 years). Labor costs are estimated to be slightly lower as a result of the fully automated control system. A membrane WTP would be readily expandable, with the addition of more racks of membrane modules.

6.6 DISINFECTION AND CT BASIN

A baffled 350,000 gallon CT Basin will provide disinfection contact time. Sodium hypochlorite will be generated on site at 0.8% concentration and used for primary disinfection. The CT Basin will share common wall construction with the clearwell but will have dedicated volume for achieving disinfection CT. The CT Basin and Clearwell will be constructed of cast-in-place concrete.

6.7 FINISHED WATER PUMP STATION

Finished water will be stored in a 400,000 gallon clearwell and pumped to the distribution system by the finished water pump station. The pump station will include four vertical turbine pumps with a firm pumping capacity of 6 mgd. Space will be provided for additional pumps for future expansion. Total dynamic head will be designed to work with the existing distribution system pressure requirements and is assumed to be 180 feet for conceptual design. Variable frequency drives will be provided to allow for a range of pumping rates.

Table 8 presents conceptual design criteria for the water treatment plant.

Table 8
Conceptual Design Criteria for Water Treatment Plant

PARAMETER	UNIT	VALUE
DESIGN CAPACITY	MGD	6.0
	GPM	4,200
ULTIMATE CAPACITY	MGD	8.0
	GPM	5,600
RAW WATER RESERVOIR		
RESERVOIR CAPACITY	AF	30
AVERAGE RESERVOIR DEPTH	FT	15
SURFACE AREA	ACRE	2
DAYS STORAGE AT CURRENT AVE WINTER DEMAND	DAYS	24
RESERVOIR LINING	EARTHEN	
WATER TREATMENT PLANT		
TREATMENT TYPE	CONVENTIONAL	
FLASH MIX TYPE	PUMP DIFFUSION	
MIXING ENERGY	SEC^{-1}	700
FLOCCULATION:		
STAGES (TAPERED)	NO.	3
MIXING ENERGY (VFD ADJUSTABLE)	SEC^{-1}	60/30/10
FLOCCULATOR ORIENTATION	VERTICAL	
HYDRAULIC DETENTION TIME (TOTAL)	MIN	36
SEDIMENTATION		
SURFACE LOADING RATE	GPM/SF	0.75
NUMBER OF BASINS	NO.	3
SEDIMENTATION BASIN DIMENSIONS (EA.)	FT X FT	24' X 116'
GRANULAR MEDIA FILTRATION		
FILTRATION RATE(2)	GPM/SF	6
NUMBER OF FILTER BASINS	NO.	4
FILTER BASIN DIMENSIONS (EA.)	FT X FT	12' X 20'
FILTER MEDIA	ANTHRACITE/SAND	
TOTAL FILTER MEDIA L/D	-	>1,100
PRIMARY DISINFECTION	SODIUM HYPOCHLORITE	
SODIUM HYPOCHLORITE CONCENTRATION	%WT	0.8%
ON-SITE GENERATION CAPACITY	LBS/DAY	300
CT BASIN/CLEARWELL		
TOTAL CAPACITY	GAL	750,000
DEDICATED CT BASIN VOLUME (FIXED)	GAL	350,000
FINISHED WATER PUMP STATION		
CLEARWELL VOLUME	GAL	400,000
NUMBER OF PUMPS	NO.	4
TOTAL FIRM CAPACITY	GPM	4,200
TOTAL DYNAMIC HEAD	FT	180

Notes:
1. Direct filtration may be possible if raw water turbidity is always less than 15 NTU. This would eliminate sedimentation and reduce the size of the flocculation basins.
2. Filtration rate to be demonstrated during pilot testing.

7. BUDGETARY COST ESTIMATES

Cost estimates were developed at a budgetary level, or Class 3 as defined by the Association for the Advancement of Cost Engineering International (AACEI). The estimates were based on equipment quotes, actual costs of recently completed similar projects, and capacity factored parametric models. Cost estimates at this level have an expected accuracy range of -15% to +20%. The cost estimates were prepared following standard industry practice to provide a defensible basis for project decisions.

The capital cost estimates include permitting, design, and construction. Idaho State Sales Tax of 6% is included in line item estimates for all equipment and materials. Costs for land acquisition, easements, and legal work are not included in the estimates.

Annual operations and maintenance cost estimates include costs for labor, power, equipment maintenance, consumable supplies, and support services. Table 9 summarizes the cost estimates for each alternative.

Table 9
Summary of Construction and O&M Cost Estimates

	Alternative 1 West Intake	Alternative 2 East Intake
ENVIRONMENTAL PERMITTING(3)	$160,000	$160,000
WATER TREATMENT PILOT STUDY(4)	$640,000	$640,000
INTAKE PUMP STATION	$4,051,000	$4,051,000
RAW WATER PIPELINE	$13,251,000	$6,036,000
WATER TREATMENT PLANT(5)	$11,504,000	$11,504,000
DISTRIBUTION AND STORAGE	$5,230,000	$5,230,000
TOTAL PROJECT COST	$34,560,000	$27,210,000
ANNUAL O&M COST	$882,000	$868,000

Notes:

1. Capital costs include permitting, design and construction. Capital costs do not include land acquisition, easements, power supply upgrades, or legal costs.
2. Operations and maintenance costs include labor, power, equipment maintenance, consumable supplies, and support services.
3. Permitting costs assume that an Environmental Assessment (EA) is required. If an Environmental Impact Statement (EIS) is required, costs would likely be higher.
4. Pilot study costs include 12-month conventional treatment pilot study. The pilot study duration could potentially be reduced to reduce cost.
5. Water Treatment Plant Cost is for a conventional treatment process including granular media filters.
6. Costs shown for facilities include engineering and contingency costs as detailed in Tables 10, 11, and 12.

SPF WATER ENGINEERING

TABLE 10
ALTERNATIVE 1 - WEST INTAKE
MHAFB SNAKE RIVER WATER SUPPLY SYSTEM

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	3
CAPACITY:	6 mgd (8 mgd Ultimate)	**DATE :**	2/16/2016
JOB # :	780.0030	**BY :**	EL
LOCATION	Elmore County, ID	**REVIEWED :**	BH

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	150 HP VERTICAL TURBINE PUMP & MOTOR	2	EA	$109,400	$218,800
1.2	300 HP VERTICAL TURBINE PUMP & MOTOR	2	EA	$138,600	$277,200
1.3	MECHANICAL PIPING		LS	$346,500	$346,500
1.4	SURGE CONTROL		LS	$264,600	$264,600
1.5	YARD PIPING		LS	$151,200	$151,200
1.6	INTAKE SCREENS AND PIPING		LS	$453,600	$453,600
1.7	BUILDING STRUCTURE	2,000	SF	$180	$360,000
1.8	SITEWORK		LS	$50,400	$50,400
1.9	1200 kW STANDBY GENERATOR & ATS		LS	$478,800	$478,800
2.0	ELECTRICAL, INSTRUMENTATION & CONTROL		LS	$468,200	$468,200
	SUBTOTAL				**$3,069,000**
2.0	**RAW WATER PIPELINE**				
2.1	22-IN DIA CARBON STEEL PIPE, 0.25 IN WALL	26,400	LF	$160.91	$4,248,000
2.2	24-IN DIA HDPE PIPE, 4710 RESIN, DR17	18,480	LF	$53.28	$984,700
2.3	24-IN DIA HDPE PIPE, 4710 RESIN, DR21	22,704	LF	$44.15	$1,002,400
2.4	TRENCHING - NO ROCK (73%)	49,300	LF	$7.95	$392,000
2.5	TRENCHING - W/ ROCK (27%)	18,200	LF	$31.53	$573,900
2.6	PIPE INSTALL, BED, BACKFILL	66,484	LF	$21.26	$1,413,300
2.7	PIPE INSTALL, BED, BACKFILL (STEEP SLOPE)	1100	LF	$158.52	$174,400
2.8	STEEP SLOPE PREPARATION	1100	LF	$83.67	$92,000
2.9	WELD STEEL PIPE (48 FT LENGTHS+10%)	605	JOINT	$252.68	$152,900
3.0	FUSE HDPE PIPE (50 FT LENGTHS+10%)	906	JOINT	$510.40	$462,500
2.10	CATHODIC PROTECTION	26,400	LF	$5.84	$154,200
2.11	PIPELINE TESTING		LS	$25,200	$25,200
2.12	ISOLATION VALVES, AIR/VAC, AND BLOW OFF	56,900	LF	$6.38	$363,100
	SUBTOTAL				**$10,039,000**
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	30 AF RAW WATER RESERVOIR, EARTHEN LINED	48,400	CY	$14.57	$705,188
3.2	RAW WATER PUMP STATION (LOW LIFT)	120	HP	$1,572	$188,664
3.3	FLOCCULATION/SEDIMENTATION BASINS	8,400	SF	$124	$1,037,652
3.4	GRANULAR MEDIA FILTERS (IN BLDG)	960	SF	$1,797	$1,724,928
3.5	CT BASIN AND CLEARWELL	750,000	GAL	$1.18	$884,363
3.6	FINISHED WATER PUMP STATION	350	HP	$1,572	$550,270
3.7	OPERATIONS BUILDING	3,000	SF	$160	$480,000
3.8	CHEMICAL FEED FACILITIES INCLUDING FLASH MIX	6.0	MGD	$112,300	$673,800
3.9	SOLIDS HANDLING	7,200	SF	$52	$371,952
3.10	YARD PIPING (10%)		LS	$661,700	$661,700
3.11	SITEWORK AND LANDSCAPING (5%)		LS	$312,200	$312,200
3.12	ELECTRICAL, INSTRUMENTATION & CONTROLS (18%)		LS	$1,124,100	$1,124,100
	SUBTOTAL				**$8,715,000**
3.0	**SUBTOTAL**				**$21,823,000**
4.0	**CONTINGENCY**		20%		$4,365,000
5.0	**ENGINEERING (DESIGN & CONSTRUCTION)**		12%		$3,143,000
	TOTAL ESTIMATED PROJECT COST				**$29,330,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	POWER	2,100	MWH	$65.40	$137,340
6.2	LABOR	5	FTE	$55,000	$275,000
6.3	CHEMICAL	438	MGY	$64.42	$28,216
6.4	SERVICES (LAB, ENG, LEGAL, ACCT, ETC.)	1	LS	$180,000	$180,000
6.5	FACILITY MAINTENANCE	5	%	5,220,000	$261,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$882,000**

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Item 2.1: Includes carbon steel pipe, cement mortar lining, tape wrap coating, delivered F.O.B. to site
Items 2.7 and 2.8: Steep slope install and preparation for first 1,100 LF of pipeline from pump station to canyon rim.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 11
ALTERNATIVE 2 - EAST INTAKE
MHAFB SNAKE RIVER WATER SUPPLY SYSTEM

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	3
CAPACITY:	6 mgd (8 mgd Ultimate)	**DATE :**	2/16/2016
JOB # :	780.0030	**BY :**	EL
LOCATION	Elmore County, ID	**REVIEWED :**	BH

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	150 HP VERTICAL TURBINE PUMP & MOTOR	2	EA	$109,400	$218,800
1.2	300 HP VERTICAL TURBINE PUMP & MOTOR	2	EA	$138,600	$277,200
1.3	MECHANICAL PIPING		LS	$346,500	$346,500
1.4	SURGE CONTROL		LS	$264,600	$264,600
1.5	YARD PIPING		LS	$151,200	$151,200
1.6	INTAKE SCREENS AND PIPING		LS	$453,600	$453,600
1.7	BUILDING STRUCTURE	2,000	SF	$180	$360,000
1.8	SITEWORK		LS	$50,400	$50,400
1.9	1200 kW STANDBY GENERATOR & ATS		LS	$478,800	$478,800
1.10	ELECTRICAL, INSTRUMENTATION & CONTROL		LS	$468,200	$468,200
	SUBTOTAL				**$3,069,000**
2.0	**RAW WATER PIPELINE**				
2.1	22-IN DIA CARBON STEEL PIPE, 0.25 IN WALL	2,100	LF	$160.91	$337,900
2.2	24-IN DIA HDPE PIPE, 4710 RESIN, DR17	11,088	LF	$53.28	$590,800
2.3	24-IN DIA HDPE PIPE, 4710 RESIN, DR21	26,928	LF	$44.15	$1,188,900
2.4	TRENCHING - NO ROCK (58%)	23,300	LF	$7.95	$185,300
2.5	TRENCHING - W/ ROCK (42%)	16,800	LF	$31.53	$529,800
2.6	PIPE INSTALL, BED, BACKFILL	39,416	LF	$21.26	$837,900
2.7	PIPE INSTALL, BED, BACKFILL (STEEP SLOPE)	700	LF	$158.52	$111,000
2.8	STEEP SLOPE PREPARATION	700	LF	$83.67	$58,600
2.9	WELD STEEL PIPE (48 FT LENGTHS+10%)	48	JOINT	$252.68	$12,200
2.10	FUSE HDPE PIPE (50 FT LENGTHS+10%)	836	JOINT	$510.40	$426,900
2.11	CATHODIC PROTECTION	2,100	LF	$5.84	$12,300
2.12	PIPELINE TESTING		LS	$25,200	$25,200
2.13	ISOLATION VALVES, AIR/VAC, AND BLOW OFF	40,116	LF	$6.38	$256,000
	SUBTOTAL				**$4,573,000**
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	30 AF RAW WATER RESERVOIR, EARTHEN LINED	48,400	CY	$14.57	$705,188
3.2	RAW WATER PUMP STATION (LOW LIFT)	120	HP	$1,572	$188,664
3.3	FLOCCULATION/SEDIMENTATION BASINS	8,400	SF	$124	$1,037,652
3.4	GRANULAR MEDIA FILTERS (IN BLDG)	960	SF	$1,797	$1,724,928
3.5	CT BASIN AND CLEARWELL	750,000	GAL	$1.18	$884,363
3.6	FINISHED WATER PUMP STATION	350	HP	$1,572	$550,270
3.7	OPERATIONS BUILDING	3,000	SF	$160	$480,000
3.8	CHEMICAL FEED FACILITIES INCLUDING FLASH MIX	6.0	MGD	$112,300	$673,800
3.9	SOLIDS HANDLING (SLUDGE DRYING BEDS)	7,200	SF	$52	$371,952
3.10	YARD PIPING (10%)		LS	$661,700	$661,700
3.11	SITEWORK AND LANDSCAPING (5%)		LS	$312,200	$312,200
3.12	ELECTRICAL, INSTRUMENTATION & CONTROLS (18%)		LS	$1,124,100	$1,124,100
	SUBTOTAL				**$8,715,000**
3.0	**SUBTOTAL**				**$16,357,000**
4.0	**CONTINGENCY**		20%		$3,271,000
5.0	**ENGINEERING (DESIGN & CONSTRUCTION)**		12%		$2,355,000
	TOTAL ESTIMATED PROJECT COST				**$21,980,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	POWER	2,100	MWH	$65.40	$137,340
6.2	LABOR	5	FTE	$55,000	$275,000
6.3	CHEMICAL	438	MG	$64.42	$28,216
6.4	SERVICES (LAB, ENG, LEGAL, ACCT, ETC.)	1	LS	$180,000	$180,000
6.5	FACILITY MAINTENANCE	5	%	4,940,000	$247,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$868,000**

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Item 2.1: Includes carbon steel pipe, cement mortar lining, tape wrap coating, delivered F.O.B. to site
Items 2.7 and 2.8: Steep slope install and preparation for 700 LF of pipeline from base of canyon to canyon rim.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 12
PROPOSED DISTRIBUTION SYSTEM IMPROVEMENTS
MHAFB SNAKE RIVER WATER SUPPLY SYSTEM

PROJECT : MHAFB Water Supply
CAPACITY: 6 mgd (8 mgd Ultimate)
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 3
DATE : 5/10/2016
BY : EL
REVIEWED : BH

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**DISTRIBUTION SYSTEM IMPROVEMENTS**				
1.1	INTERMEDIATE BOLTED STEEL TANK AT WTP	500,000	GAL	$0.92	$460,000
1.2	TRANSFER PUMP STATION (5-75 HP, 1-30 HP)	405	HP	$2,236	$905,600
1.3	12-IN DIA C-900 DR25 PVC WATER MAIN IN TRENCH	500	LF	$132.60	$66,300
1.4	16-IN DIA C-905 DR25 PVC WATER MAIN IN TRENCH	5,000	LF	$168.64	$843,200
1.5	8-IN DIA C-900 DR25 PVC WATER MAIN IN TRENCH	200	LF	$94.88	$18,976
1.6	FILL VALVE SHELTER FOR WELL 2 CONNECTION	100	SF	$288	$28,800
1.7	12-IN DIA C-900 DR25 PVC WATER MAIN IN TRENCH	2,000	LF	$132.60	$265,200
1.8	BOLTED STEEL WATER TANK AT LIBERATOR	500,000	GAL	$0.92	$460,000
1.9	BOOSTER PUMP STATION (3-50 HP, 1-30 HP)	180	HP	$3,637	$654,700
1.10	ROCK REMOVAL-AVE 2' ROCK IN 30" TRENCH	7,700	LF	$24	$184,800
	SUBTOTAL				**$3,888,000**
2.0	**CONTINGENCY**		20%		$778,000
3.0	**ENGINEERING (DESIGN & CONSTRUCTION)**		12%		$560,000
	TOTAL ESTIMATED PROJECT COST				**$5,230,000**

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Items 1.3, 1.4, 1.5, and 1.7 include pipe and fittings installed in trench.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

7.1 MEMBRANE WATER TREATMENT PLANT COST

The cost estimates presented in Tables 9, 10, and 11 include a Conventional WTP with granular media filters. As an alternative, low-pressure membrane filtration (microfiltration or ultrafiltration) could be used as described in Section 6. Table 12 presents the estimated cost for a 6 mgd membrane filtration plant using ultrafiltration modules. The total cost of the WTP is $15.6 million, which is approximately $4.1 million higher (36% higher) as compared to conventional treatment.

Operations and maintenance costs for the membrane filtration alternative are also somewhat higher as compared to conventional treatment, $1.1 million per year versus $0.9 million. Costs are somewhat higher for power and chemicals, and significantly higher for equipment maintenance due to membrane module replacement which will cost an estimated $1.0 million every 5 to 10 years. A 7-year replacement frequency is used in the cost estimate.

SPF WATER ENGINEERING

TABLE 13
MEMBRANE WATER TREATMENT PLANT
MHAFB SNAKE RIVER WATER SUPPLY SYSTEM

PROJECT : MHAFB Water Supply
CAPACITY: 6 mgd (8 mgd Ultimate)
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 3
DATE : 2/29/2016
BY : EL
REVIEWED : BH

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
3.0	**WATER TREATMENT PLANT (MEMBRANE FILTRATION)**				
3.1	30 AF RAW WATER RESERVOIR, EARTHEN LINED	48,400	CY	$14.57	$705,188
3.2	RAW WATER PUMP STATION (LOW LIFT)	120	HP	$1,572	$188,664
3.3	RAW WATER STRAINERS	4,200	GPM	$58	$243,600
3.4	ULTRAFILTRATION SYSTEM WITH CIP (IN BLDG)	6	MGD	$785,000	$4,710,000
3.5	CT BASIN AND CLEARWELL	750,000	GAL	$1.18	$884,363
3.6	FINISHED WATER PUMP STATION	350	HP	$1,572	$550,270
3.7	OPERATIONS BUILDING	3,000	SF	$160	$480,000
3.8	CHEMICAL FEED FACILITIES INCLUDING FLASH MIX	6.0	MGD	$112,300	$673,800
3.9	SOLIDS HANDLING (SLUDGE DRYING BEDS)	7,200	SF	$52	$371,952
3.10	YARD PIPING (10%)		LS	$880,800	$880,800
3.11	SITEWORK AND LANDSCAPING (5%)		LS	$421,800	$421,800
3.12	ELECTRICAL, INSTRUMENTATION & CONTROLS (18%)		LS	$1,518,500	$1,518,500
	SUBTOTAL				**$11,629,000**
4.0	**CONTINGENCY**		20%		$2,326,000
5.0	**ENGINEERING (DESIGN & CONSTRUCTION)**		12%		$1,675,000
	TOTAL ESTIMATED MEMBRANE WTP COST				**$15,630,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	POWER	3,150	MWH	$65.40	$206,010
6.2	LABOR	4.5	FTE	$55,000	$247,500
6.3	CHEMICAL	438	MG	$76.92	$33,691
6.4	SERVICES (LAB, ENG, LEGAL, ACCT, ETC.)	1	LS	$180,000	$180,000
6.5	FACILITY MAINTENANCE	7	%	6,110,000	$427,700
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,095,000**

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

8. PROJECT IMPLEMENTATION

Execution of a new water supply project of this scale is a multi-year process including planning, permitting, design, construction, and start-up phases. The planning phase is already underway. A preliminary project schedule has been prepared, and potential project delivery vehicles are briefly discussed below.

8.1 PRELIMINARY PROJECT SCHEDULE

A Preliminary Project Schedule showing major tasks during permitting, design, and construction of the project is presented as Table 14. The schedule is moderately aggressive in that one phase leads directly into the next with no significant float. The total project duration shown is approximately 4 years.

8.2 PLANNING PHASE

The proposed planning phase will involve preparation of preliminary designs for the Intake Pump Station, Pipeline, and Water Treatment Plant. The preliminary design for the Intake Pump Station and Pipeline will provide technical background for the NEPA process. At this point it appears that an EA will be required, and an Environmental Impact Statement will not be necessary based on the level of potential impacts and permitting experience on previous projects conducted for MHAFB. However, it is possible that an EIS could be required. The first step is to file a Notice of Intent (NOI) with BLM, and then BLM will determine whether an EA or EIS is required.

A water treatment Pilot Study is required for all new surface water treatment plants by the Idaho Department of Environmental Quality (IDEQ). The typical duration of a pilot study is 12 months to account for seasonal variation in water quality. It may be possible to negotiate a shorter Pilot Study with IDEQ since C.J. Strike Reservoir does not exhibit large seasonal variation in water quality as many surface water sources do. This is due to both the constant flow of consistent spring sources near Hagerman, Idaho and the dampening effect on water quality variation provided by the series of large Reservoirs on the Snake River upstream of C.J Strike Reservoir.

Preliminary design of the WTP and a Preliminary Engineering Report will be prepared based on pilot study results. Both the Pilot Study Report and the Preliminary Engineering Report will be submitted to IDEQ for review and approval.

An important milestone in the project schedule is the execution of a water supply agreement with MHAFB. It is recommended that this agreement be in place prior to initiating final design of the facilities.

TABLE 14

PROPOSED PROJECT SCHEDULE
MHAFB SNAKE RIVER WATER SUPPLY PROJECT

	DURATION	START	FINISH
PLANNING			
INTAKE PUMP STATION AND PIPELINE			
Preliminary Design	3 mo	6/1/2016	8/31/2016
Environmental Permitting (EA or EIS)	12 mo	6/1/2016	5/31/2017
Pipeline & Pump Station Easements	3 mo	6/1/2017	8/31/2017
WATER TREATMENT PLANT			
Water Treatment Pilot Study	12 mo	6/1/2016	5/31/2017
Water Treatment Plant Siting	6 mo	12/1/2016	5/31/2017
WTP Preliminary Engineering Report	3 mo	6/1/2017	8/31/2017
WATER RIGHTS			
Retain WRs in Water Supply Bank	42 mo	6/1/2016	12/31/2019
Submit Permit Application Based on RAFN[1]	6 mo	6/1/2016	11/30/2016
Apply to Change Place of Use	6 mo	6/1/2016	11/30/2016
WATER SUPPLY AGREEMENT			
Negotiate Utility Agreement with MHAFB	12 mo	6/1/2016	5/31/2017
Execute Water Supply Agreement	Milestone		June 2017
DESIGN & PERMITTING			
INTAKE PUMP STATION AND PIPELINE			
Prepare Construction Documents	9 mo	9/1/2017	5/31/2018
IDWR Permitting	3 mo	6/1/2018	8/31/2018
IDEQ Permitting	3 mo	6/1/2018	8/31/2018
Army Corps of Engineers Permitting	3 mo	6/1/2018	8/31/2018
WATER TREATMENT PLANT			
Prepare Construction Documents	9 mo	9/1/2017	5/31/2018
IDEQ Permitting	3 mo	6/1/2018	8/31/2018
CONSTRUCTION & START-UP			
Bidding & Award of Construction Contracts	3 mo	9/1/2018	11/30/2018
Construct Intake Pump Station	18 mo	12/1/2018	5/31/2020
Construct Raw Water Pipeline	18 mo	12/1/2018	5/31/2020
Construct Water Treatment Plant	18 mo	12/1/2018	5/31/2020
Start-Up Facilities	3 mo	6/1/2020	8/31/2020
Deliver Water to MHAFB	Milestone		July 2020

8.3 DESIGN AND PERMITTING PHASE

Once the EA is complete and the BLM easement is obtained, detailed design of the Intake Pump Station and Pipeline can commence. The design will support the Joint Application for Permit for the Intake Pump Station. The Department of Army Corps of Engineers, the Idaho Department of Water Resources, and Idaho Department of Lands has established a joint process for activities impacting jurisdictional waterways that require review and/or approval of both the Corps and the State of Idaho.

Department of Army permits are required by Section 10 of the Rivers & Harbors Act of 1899 for any structures or work in or affecting navigable waters of the United States and by Section 404 of the Clean Water Act for the discharge of dredged or fill materials into waters of the United States, including adjacent wetlands. State permits are required under the State of Idaho, Stream Protection Act, Title 42, Chapter 38, Idaho Code and Lake Protection Act, Section 58, Chapter 13 et seq., Idaho Code. A snail survey will likely be required due to the presence of the special status gastropod in the general area. The Federal Energy Regulatory Commission will need to be consulted for any special permitting requirements associated with potential impacts to existing hydroelectric facilities downstream.

Preliminary design drawings of the intake pump station will be submitted with the application. While the permitting agencies conduct their review, final design will continue. The proposed schedule includes a 9-month design duration for preparation of the final plans and specifications for the Intake Pump Station and Pipeline.

Design of the Water Treatment Plant is anticipated to proceed in parallel with the design of the Intake Pump Station and Pipeline and will commence upon IDEQ approval of the Pilot Study Report and the Preliminary Engineering Report. Final Design of the WTP is anticipated to take 9 months. The final Plans and Specifications will be submitted to IDEQ for review and approval at which time the construction projects can be issued for bidding.

8.4 CONSTRUCTION PHASE

The proposed schedule contemplates three separate construction contracts (one each for the Intake Pump Station, the Raw Water Transmission Pipeline, and the Water Treatment Plant) with similar 18-month construction schedules. These three construction contracts would have distinct scopes with clearly identifiable piping and controls connection point and limited coordination requirements. The three contracts would have similar completion schedules such that the entire water supply system would be started up and commissioned simultaneously.

Each of the three construction contracts would be attractive for local contractors specialized in this type of work, and the conventional Design/Bid/Build approach would likely result in competitive bidding and potentially the lowest overall project cost, as compared to other project delivery methods described below.

8.5 PROJECT DELIVERY METHODS

The Design/Bid/Build approach described above is the most common project delivery method for municipal water and wastewater projects in the United States; however, there are other potential methods that could be employed for execution of the project. Given that the overall intent is for IWRB to enter into a long-term Water Utility Service Agreement with MHAFB, there are other models that may provide some advantages such as Design/Build, Design/Build/Own/Operate, and various combinations for the different major facilities.

One of the main advantages of a Turnkey approach is the ability to expedite the project if schedule is limiting, which does not appear to be the case for this project. Another advantage is that there can be fewer contracts to administer. It would be possible to enter into just one turnkey contract for design, construction, and long-term operation of the project. Alternately, the project could be divided into one, two, or three Design/Build contracts and a separate Operations contract. Turnkey delivery typically reduces the amount of project management effort required by the Owner, but it has the potential to relinquish control of details that are not explicitly addressed in the bid specifications. For complex municipal projects such as this, it is important to establish design criteria and a preliminary design level of 10% to 30% prior to soliciting bids for a Turnkey approach. In this fashion the Owner can have some assurance that the design is based on criteria that represent their best interests in balancing cost and quality.

9. RECOMMENDATIONS

In order to continue advancing the project and maintain the schedule outlined in Table 15, the following steps will need to be undertaken in the next two years:

INTAKE PUMP STATION AND PIPELINE

- Submit Notice of Intent (NOI) to BLM to initiate NEPA process
- Execute Memorandum of Understanding (MOU) with Idaho Power Co. (land owner) regarding site for Alternative 2 Intake Pump Station
- Prepare Preliminary Design of the Intake Pump Station and Pipeline to support Environmental Assessment
- Conduct EA for Intake Pump Station and Pipeline (or EIS as determined by BLM)
- Submit Joint Permit Application to Army Corps of Engineers for Intake
- Conduct Snail Survey (if required)
- Consult with Federal Energy Regulatory Commission on permitting requirements

WATER TREATMENT PLANT

- Commence Water Treatment Pilot Study and negotiate with IDEQ for reduced study duration if desired
- Confirm location of Water Treatment Plant Site and Raw Water Reservoir Site
- Prepare WTP Preliminary Engineering Report and Submit to IDEQ

WATER RIGHTS

- Retain water rights in the Water Supply Bank
- Submit permit application for new non-irrigation season appropriation based on reasonable anticipated future needs
- Apply transfer application to change place of beneficial use

PROJECT DELIVERY AND FINANCING

- Evaluate project delivery methods, i.e. Design-Bid-Build and Turnkey options
- Evaluate financing options

WATER SUPPLY UTILITY AGREEMENT

- Negotiate terms of water supply agreement
- Execute water supply agreement

10. REFERENCES

Alternative Water Supply Feasibility Study, Mountain Home Air Force Base, Elmore County, Idaho. AECOM, May 2012.

MHAFB Water Production Data, January 2009 - April 2015.

MIL-HDBK-1005/7A, Department of Defense Handbook, Water Supply Systems, 1999.

Annual Report of United Water Idaho to the Idaho Public Utilities Commission for the Year Ended December 31, 2014, United Water Idaho, 2015.

American Community Survey Five Year Estimates, United States Census Bureau, U.S. Department of Commerce, 2013.

Kawamura, Susumu, *Integrated Design and Operation of Water Treatment Facilities, 2nd Edition*, John Wiley & Sons, 2000.

McGivney, Kawamura, *Cost Estimating Manual for Water Treatment Facilities*, John Wiley & Sons, 2008.

King Hill - C.J. Strike Reservoir Subbasin Assessment and Total Maximum Daily Load, Idaho Department of Environmental Quality, 2006.

Corbitt, Robert A., *Standard Handbook of Environmental Engineering*, McGraw Hill Inc., 1999.

Water Treatment Plant Design, Fifth Edition, American Water Works Association and American Society of Civil Engineers, McGraw-Hill Inc., 2012.

Appendix A: Task 6 Memorandum
Evaluation of Water Delivery to Outside Stakeholders

TECHNICAL MEMORANDUM

DATE: May 9, 2016

TO: Randall Broesch, P.E. – Idaho Water Resource Board

FROM: Eric Landsberg, P.E. – SPF Water Engineering
Terry Scanlan, P.E., P.G. – SPF Water Engineering

RE: *MHAFB Water Supply System – Cost Estimates for Task 6*

This memorandum provides conceptual-level cost estimates for expansion of the proposed MHAFB water supply system to serve additional users. Three scenarios are evaluated:

> **Alternative A** - Delivery of treated water to the City of Mountain Home,
>
> **Alternative B** - Delivery of untreated water to the City of Mountain Home with a water treatment plant located at the City, and
>
> **Alternative C** - Delivery of untreated water to Mountain Home Reservoir.

System capacities ranging from 3,000 gallons per minute (gpm) to 12,000 gpm are considered, and costs estimates are presented for capital, operations and maintenance, and unit cost of delivered water.

1.0 CONCEPTUAL LEVEL COST ESTIMATES

Cost estimates were developed at a conceptual level, or Class 5 as defined by the Association for the Advancement of Cost Engineering International (AACEI). The estimates were based on actual costs of recently completed similar projects and capacity factored parametric models. Cost estimates at this level have an expected accuracy range of -30% to +50%.

The capital cost estimates include permitting, design, and construction of the facilities. Idaho State Sales Tax of 6% is included for all equipment and materials. Costs for land acquisition, easements, and legal work are not included in the estimates. Annual operations and maintenance cost estimates include costs for labor, power, maintenance, supplies, and support services.

2.0 ALTERNATIVE A - DELIVERY OF TREATED WATER TO CITY OF MOUNTAIN HOME

Delivery of treated water to the City of Mountain Home would require expansion of the proposed facilities to serve MHAFB (intake pump station, raw water pipeline, and water treatment plant) and the construction of a new pipeline from MHAFB to the City. The treated water pipeline would convey water approximately 9.2 miles from the proposed water treatment plant site at the Base, along Air Base Road (Hwy 51), to the vicinity of Mountain Home Wells 11 and 13, where it would tie into existing large-diameter distribution system piping.

Table 1 summarizes the cost estimates for delivery of treated water to the City of Mountain Home for system capacities of 3,000, 6,000, 9,000, and 12,000 gpm (4.3, 8.6, 13.0, and 17.3 million gallons per day (mgd)). For reference, the current maximum day demand (MDD) for the City is approximately 11,000 gpm. The seasonal peaking factor (ratio of MDD to winter baseload demand) is approximately 10; therefore the winter baseload demand is approximately 1,100 gpm.

Figure 1 presents cost curves for the unit price of delivered water, which ranges from $1.74 to $1.45 per 1,000 gallons, depending upon system capacity and annual volume delivered. An important assumption in determining the unit cost of water is the annual volume delivered, and these assumptions are presented in Tables 3 through 6 for the four system capacities evaluated.

Table 1

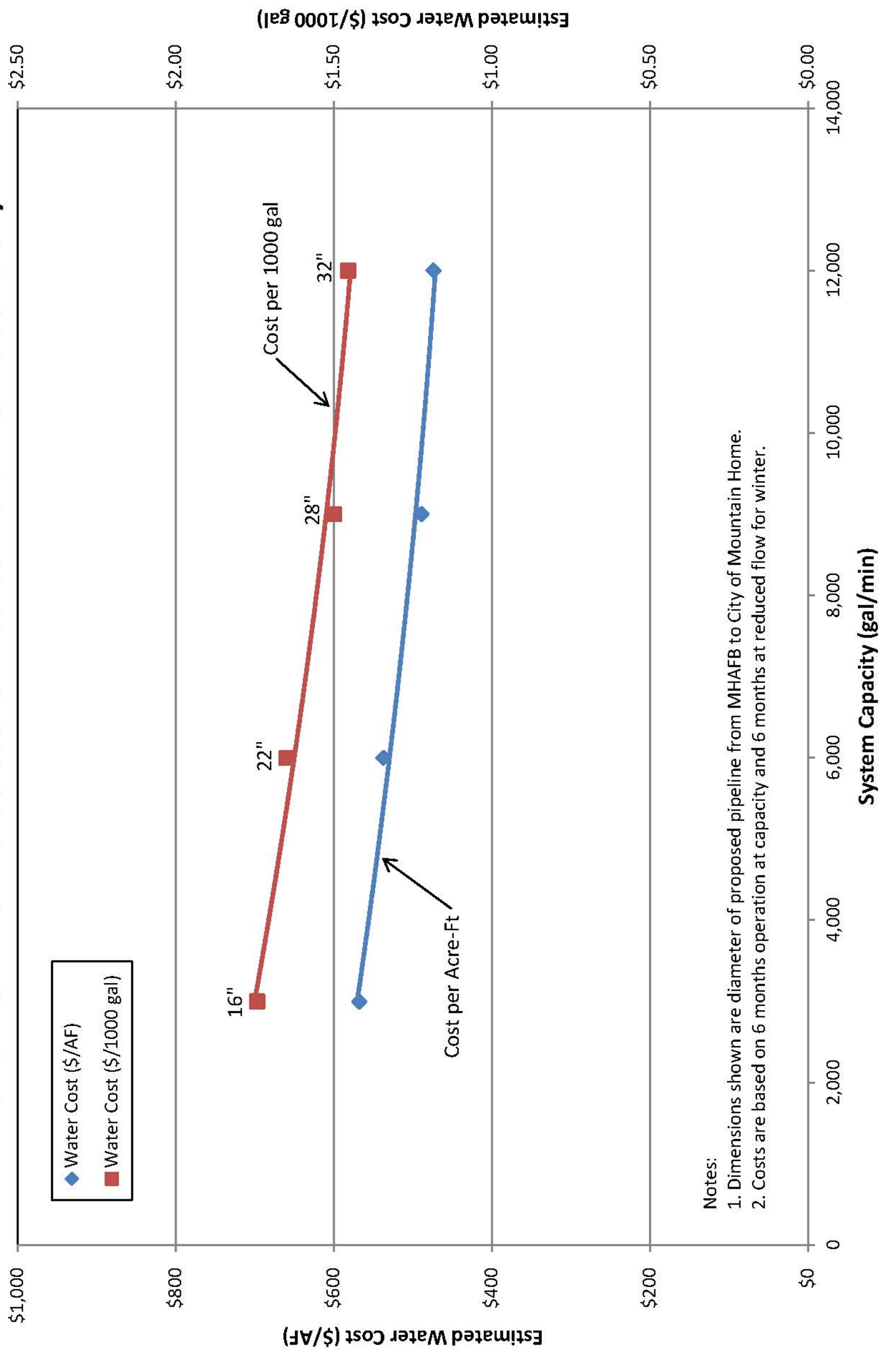
Cost Estimates for Alternative A - Delivery of Treated Water to City of Mountain Home

	System Capacity (gallons/min)			
	3,000 gpm	6,000 gpm	9,000 gpm	12,000 gpm
INTAKE PUMP STATION	$2,645,000	$4,932,000	$7,032,000	$9,000,000
RAW WATER PIPELINE	$1,152,000	$2,316,000	$3,180,000	$4,044,000
WATER TREATMENT PLANT	$7,512,000	$14,016,000	$19,956,000	$25,548,000
TREATED WATER PIPELINE	$5,604,000	$7,704,000	$9,792,000	$11,196,000
TOTAL CAPITAL COST	$16,913,000	$28,968,000	$39,960,000	$49,788,000
ANNUALIZED CAPITAL COST	$1,100,000	$1,885,000	$2,599,000	$3,239,000
ANNUAL O&M COST	$944,000	$1,338,000	$1,752,000	$2,117,000
ANNUAL VOLUME DELIVERED (AF)	3,600	6,000	8,900	11,300
COST OF WATER ($/AF)	$568	$537	$489	$474
COST OF WATER ($/1000 GAL)	$1.74	$1.65	$1.50	$1.45

Notes:
1. Costs shown for the intake pump station, raw water pipeline, and water treatment plant are for increasing the capacity of the facilities beyond that proposed for MHAFB.
2. Capital costs include permitting, design and construction. Capital costs do not include land acquisition, easements, power supply upgrades, or legal costs.
3. Operations and maintenance costs include power, operations labor, chemicals, equipment maintenance, and support services.
4. Unit costs of water are based on annual volumes shown and as described in Tables 4 through 7.
5. Water Treatment Plant Cost is for a conventional treatment process including granular media filters.
6. Facility costs include design and contingency as detailed in Tables 4 through 7.
7. Annualized capital cost assumes 30-year payback at 5%.

Figure 1

Alternative A - Estimated Cost of Treated Water Delivered to City



3.0 ALTERNATIVE B – DELIVERY OF UNTREATED WATER TO THE CITY OF MOUNTAIN HOME WITH TREATMENT AT THE CITY

Delivery of untreated water to the City of Mountain Home would require expansion of the proposed intake pump station and raw water pipeline to serve MHAFB, but it would not require expansion of the proposed water treatment plant (WTP) at MHAFB. Water would be diverted upstream of the proposed MHAFB WTP to a booster pump station and raw water pipeline that would convey water approximately 9.2 miles along Air Base Road (Hwy 51), to a new WTP on the west side of the city in the vicinity of Wells 11 and 13.

Table 2 summarizes the cost estimates for Alternative B for system capacities of 3,000, 6,000, 9,000, and 12,000 gpm (4.3, 8.6, 13.0, and 17.3 million gallons per day (mgd)). For reference, the current maximum day demand (MDD) for the City is approximately 11,000 gpm.

Figure 2 presents cost curves for the unit price of delivered water, which ranges from $1.90 to $1.55 per 1,000 gallons, depending upon system capacity and annual volume delivered. An important assumption in determining the unit cost of water is the annual volume delivered, and these assumptions are presented in Tables 4 through 8 for the four system capacities evaluated.

Table 2

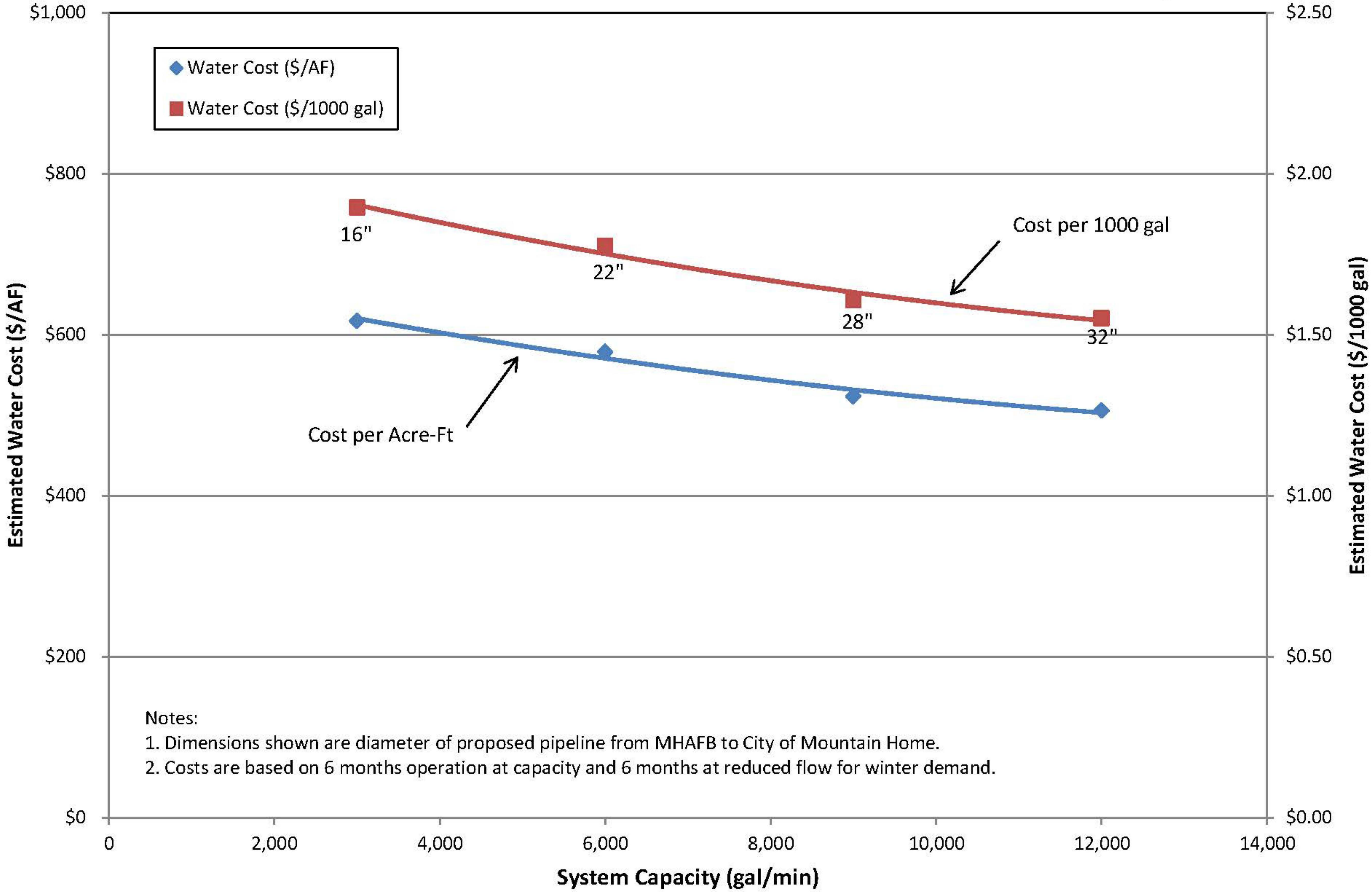
Cost Estimates for Alternative B – Treatment at City of Mountain Home

	System Capacity (gallons/min)			
	3,000 gpm	6,000 gpm	9,000 gpm	12,000 gpm
INTAKE PUMP STATION	$2,645,000	$4,932,000	$7,032,000	$9,000,000
RAW WATER PIPELINE	$1,152,000	$2,316,000	$3,180,000	$4,044,000
BOOSTER PUMP STATION	$900,000	$1,570,000	$2,171,000	$2,722,000
TREATED WATER PIPELINE	$5,604,000	$7,704,000	$9,792,000	$11,196,000
WATER TREATMENT PLANT	$9,360,000	$16,294,000	$22,540,000	$28,368,000
TOTAL CAPITAL COST	$19,661,000	$32,816,000	$44,715,000	$55,330,000
ANNUALIZED CAPITAL COST	$1,279,000	$2,135,000	$2,908,000	$3,599,000
ANNUAL O&M COST	$944,000	$1,338,000	$1,752,000	$2,117,000
ANNUAL VOLUME DELIVERED (AF)	3,600	6,000	8,900	11,300
COST OF WATER ($/AF)	$618	$579	$524	$506
COST OF WATER ($/1000 GAL)	$1.90	$1.78	$1.61	$1.55

Notes:

1. Costs shown for intake pump station and raw water pipeline are to increase the capacity of the facilities beyond that proposed for MHAFB.
2. Capital costs include permitting, design and construction. Capital costs do not include land acquisition, easements, power supply upgrades, or legal costs.
3. Operations and maintenance costs include labor, power, maintenance, supplies, and support services.
4. Unit costs of water are based on annual volumes shown and as described in Tables 8 through 11.
5. Water Treatment Plant Cost is for a conventional treatment process including granular media filters located at City of Mountain Home.
6. Facility costs include engineering and contingency as detailed in Tables 8 through 11.
7. Annualized capital cost assumes 30-year payback at 5%.

Figure 2
Alternative B - Estimated Cost of Treated Water with WTP at City



3.0 ALTERNATIVE C - DELIVERY OF UNTREATED WATER TO MOUNTAIN HOME RESERVOIR

Delivery of untreated water to Mountain Home Reservoir would require expansion of the proposed intake pump station and raw water pipeline to serve MHAFB. Water would be diverted upstream of the proposed water treatment plant to a separate raw water pipeline that would convey water approximately 13.6 miles to Mountain Home Reservoir. In general, the pipeline alignment would run east along Air Base Road (Hwy 51), then north around the City of Mountain Home, and then east to the reservoir. Exact routing was not determined for this analysis, as it would not greatly impact overall conceptual cost.

Table 3 summarizes cost estimates for delivery of untreated water to Mountain Home Reservoir with system capacities of 3,000, 6,000, 9,000, and 12,000 gpm. Figure 3 presents cost curves for the unit price of delivered water, which ranged from $300 to $225 per acre-ft ($0.92 to $0.69 per 1,000 gallons), depending upon system capacity and annual volume delivered. In determining unit costs, it was assumed that the system would operate at capacity year-round. If the system were operated less, then unit costs would be correspondingly higher. Annual volume assumptions are presented in Table 3 and Tables 12 through 15.

Table 3
Cost Estimates for Alternative C - Untreated Water to Mountain Home Reservoir

	System Capacity (gallons/min)			
	3,000 gpm	6,000 gpm	9,000 gpm	12,000 gpm
INTAKE PUMP STATION	$2,645,000	$4,934,000	$7,030,000	$8,996,000
PIPELINE TO MHAFB	$1,152,000	$2,316,000	$3,180,000	$4,044,000
WATER TREATMENT PLANT	$0	$0	$0	$0
PIPELINE TO RESERVOIR	$8,268,000	$11,376,000	$14,472,000	$16,548,000
TOTAL CAPITAL COST	$12,065,000	$18,626,000	$24,682,000	$29,590,000
ANNUALIZED CAPITAL COST	$785,000	$1,211,000	$1,605,000	$1,925,000
ANNUAL O&M COST	$657,000	$1,256,000	$1,827,000	$2,397,000
ANNUAL WATER DELIVERY (AF)	4,800	9,600	14,400	19,200
COST OF WATER ($/AF)	$300	$257	$238	$225
COST OF WATER ($/1000 GAL)	$0.92	$0.79	$0.73	$0.69

Notes:
1. Costs shown for the intake pump station and raw water pipeline are for increasing capacity of the facilities beyond that proposed for MHAFB.
2. Capital costs include permitting, design and construction. Capital costs do not include land acquisition, easements, power supply upgrades, or legal costs.
3. Operations and maintenance costs include power, operations labor, chemicals, equipment maintenance, and support services.
4. Unit cost of water are based on annual volumes shown and as described in Tables 12 through 15.
5. Facility costs include design and contingency as shown in Tables 12 through 15.
6. Annualized capital cost assumes 30-year payback at 5%.

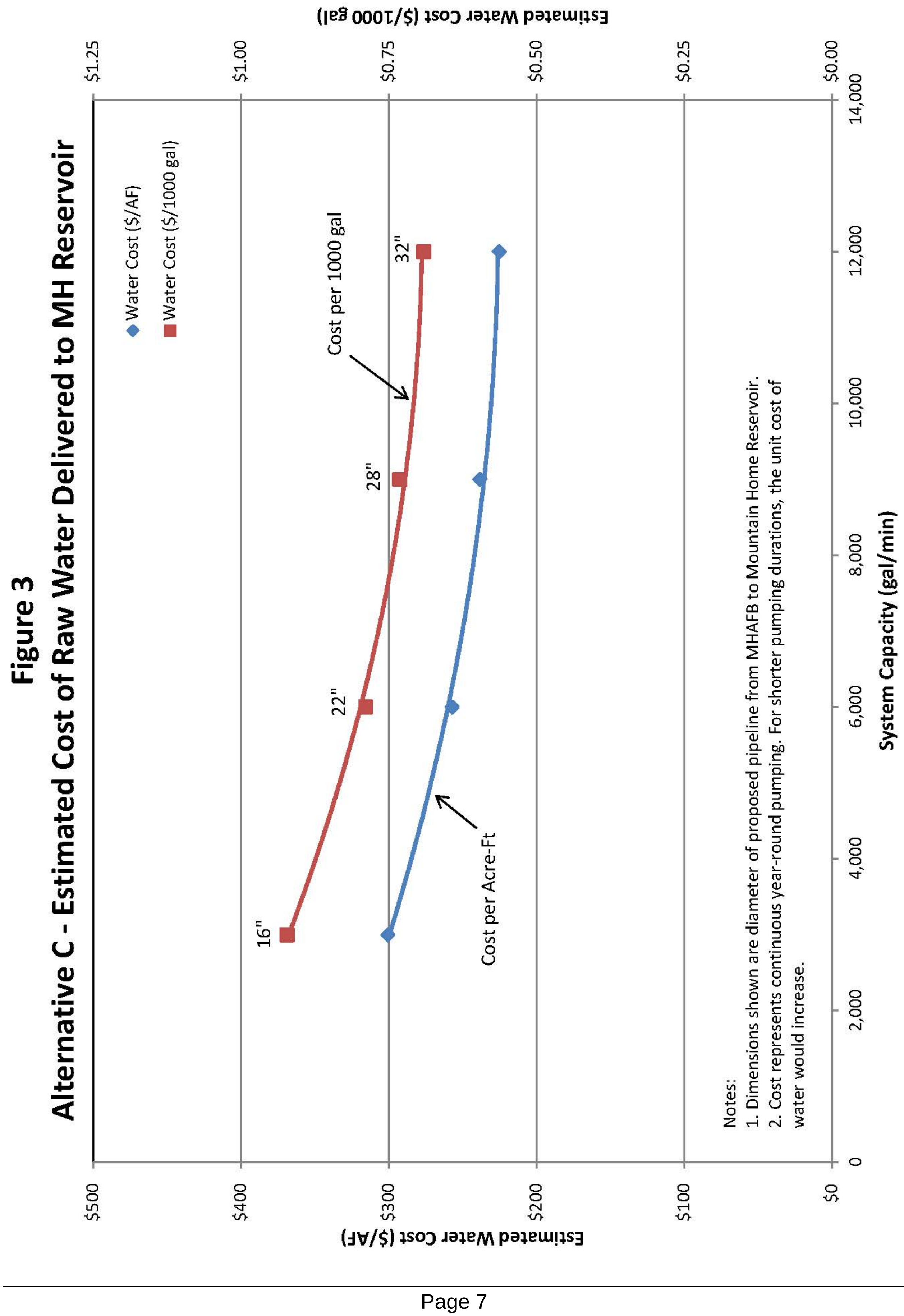


Figure 3
Alternative C - Estimated Cost of Raw Water Delivered to MH Reservoir
Water Cost ($/AF)
Water Cost ($/1000 gal)
Cost per 1000 gal
Cost per Acre-Ft
16"
22"
28"
32"
Notes:
1. Dimensions shown are diameter of proposed pipeline from MHAFB to Mountain Home Reservoir.
2. Cost represents continuous year-round pumping. For shorter pumping durations, the unit cost of water would increase.
System Capacity (gal/min)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Estimated Water Cost ($/AF)
$0
$100
$200
$300
$400
$500
Estimated Water Cost ($/1000 gal)
$0.00
$0.25
$0.50
$0.75
$1.00
$1.25

TABLE 4

ALTERNATIVE A
TREATED WATER TO CITY OF MOUNTAIN HOME
3,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 3,000 gpm Treated Water to City of Mountain Home
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 7,200 GPM	3,000	GPM	$735	$2,204,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 26" DIA	40,120	LF	$24	$960,000
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	UPSIZE FROM 4,200 GPM TO 7,200 GPM	3,000	GPM	$2,087	$6,260,000
4.0	**TREATED WATER PIPELINE**				
4.1	16" DIA HDPE PIPELINE TO CITY	48,600	LF	$96	$4,670,000
5.0	**CONTINGENCY**		20%		$2,820,000
	TOTAL ESTIMATED PROJECT COST				**$16,910,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,100,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	SUMMER PUMPING RATE (6 MO.)	3,000	GPM		
6.2	WINTER PUMPING RATE (6 MO.)	1,500	GPM		
6.3	ANNUAL WATER VOLUME DELIVERED	3,600	AF		
6.4	POWER	4,520	MWH	$65.40	$296,000
6.5	FACILITY OPERATIONS AND MAINTENANCE	3,600	AF	$180	$648,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$944,000**
7.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$568	
			$/1000 GAL	$1.74	
			$/GAL	$0.0017	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 5

ALTERNATIVE A
TREATED WATER TO CITY OF MOUNTAIN HOME
6,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 6,000 gpm Treated Water to City of Mountain Home
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 10,200 GPM	6,000	GPM	$685	$4,110,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 30" DIA	40,120	LF	$48	$1,930,000
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	UPSIZE FROM 4,200 GPM TO 10,200 GPM	6,000	GPM	$1,946	$11,680,000
4.0	**TREATED WATER PIPELINE**				
4.1	22" DIA HDPE PIPELINE TO CITY	48,600	LF	$132	$6,420,000
5.0	**CONTINGENCY**		20%		$4,830,000
	TOTAL ESTIMATED PROJECT COST				**$28,970,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,885,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	SUMMER PUMPING RATE (6 MO.)	6,000	GPM		
6.2	WINTER PUMPING RATE (6 MO.)	1,500	GPM		
6.3	ANNUAL WATER VOLUME DELIVERED	6,000	AF		
6.4	POWER	7,620	MWH	$65.40	$498,000
6.5	FACILITY OPERATIONS AND MAINTENANCE	6,000	AF	$140	$840,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,338,000**
7.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$537	
			$/1000 GAL	$1.65	
			$/GAL	$0.0016	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 6

ALTERNATIVE A
TREATED WATER TO CITY OF MOUNTAIN HOME
9,000 GAL/MIN

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	5
CAPACITY:	9,000 gpm Treated Water to City of Mountain Home	**DATE :**	3/28/2016
JOB # :	780.0030	**BY :**	EL
LOCATION :	Elmore County, ID	**REVIEWED :**	CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 13,200 GPM	9,000	GPM	$651	$5,860,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 33" DIA	40,120	LF	$66	$2,650,000
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	UPSIZE FROM 4,200 GPM TO 13,200 GPM	9,000	GPM	$1,848	$16,630,000
4.0	**TREATED WATER PIPELINE**				
4.1	28" DIA HDPE PIPELINE TO CITY	48,600	LF	$168	$8,160,000
5.0	**CONTINGENCY**		20%		$6,660,000
	TOTAL ESTIMATED PROJECT COST				**$39,960,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$2,599,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	SUMMER PUMPING RATE (6 MO.)	9,000	GPM		
6.2	WINTER PUMPING RATE (6 MO.)	2,000	GPM		
6.3	ANNUAL WATER VOLUME DELIVERED	8,900	AF		
6.4	POWER	11,130	MWH	$65.40	$728,000
6.5	FACILITY OPERATIONS AND MAINTENANCE	8,900	AF	$115	$1,023,500
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,752,000**
7.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$489	
			$/1000 GAL	$1.50	
			$/GAL	$0.0015	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 7

ALTERNATIVE A
TREATED WATER TO CITY OF MOUNTAIN HOME
12,000 GAL/MIN

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	5
CAPACITY:	12,000 gpm Treated Water to City of Mountain Home	**DATE :**	3/28/2016
JOB # :	780.0030	**BY :**	EL
LOCATION :	Elmore County, ID	**REVIEWED :**	CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 16,200 GPM	12,000	GPM	$625	$7,500,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 36" DIA	40,120	LF	$84	$3,370,000
3.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
3.1	UPSIZE FROM 4,200 GPM TO 13,200 GPM	12,000	GPM	$1,774	$21,290,000
4.0	**TREATED WATER PIPELINE**				
4.1	32" DIA HDPE PIPELINE TO CITY	48,600	LF	$192	$9,330,000
5.0	**CONTINGENCY**		20%		$8,300,000
	TOTAL ESTIMATED PROJECT COST				**$49,790,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$3,239,000**
6.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
6.1	SUMMER PUMPING RATE (6 MO.)	12,000	GPM		
6.2	WINTER PUMPING RATE (6 MO.)	2,000	GPM		
6.3	ANNUAL WATER VOLUME DELIVERED	11,300	AF		
6.4	POWER	14,220	MWH	$65.40	$930,000
6.5	FACILITY OPERATIONS AND MAINTENANCE	11,300	AF	$105	$1,186,500
	TOTAL ESTIMATED ANNUAL O&M COST				**$2,117,000**
7.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$474	
			$/1000 GAL	$1.45	
			$/GAL	$0.0015	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 8

ALTERNATIVE B
TREATED WATER TO CITY OF MOUNTAIN HOME
3,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 3,000 gpm WTP at City of Mountain Home
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 4/15/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 7,200 GPM	3,000	GPM	$735	$2,204,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 26" DIA	40,120	LF	$24	$960,000
3.0	**BOOSTER PUMP STATION**				
3.1	FROM MHAFB TO CITY OF MOUNTAIN HOME	3,000	GPM	$250	$750,000
4.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
4.1	AT CITY OF MOUNTAIN HOME	3,000	GPM	$2,600	$7,800,000
5.0	**TREATED WATER PIPELINE**				
5.1	16" DIA HDPE PIPELINE TO CITY	48,600	LF	$96	$4,670,000
6.0	**CONTINGENCY**		20%		$3,280,000
	TOTAL ESTIMATED PROJECT COST				**$19,660,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,279,000**
7.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
7.1	SUMMER PUMPING RATE (6 MO.)	3,000	GPM		
7.2	WINTER PUMPING RATE (6 MO.)	1,500	GPM		
7.3	ANNUAL WATER VOLUME DELIVERED	3,600	AF		
7.4	POWER	4,520	MWH	$65.40	$296,000
7.5	FACILITY OPERATIONS AND MAINTENANCE	3,600	AF	$180	$648,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$944,000**
8.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$618	
			$/1000 GAL	$1.90	
			$/GAL	$0.0019	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

TABLE 9

ALTERNATIVE B
TREATED WATER TO CITY OF MOUNTAIN HOME
6,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 6,000 gpm WTP at City of Mountain Home
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 4/15/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 10,200 GPM	6,000	GPM	$685	$4,110,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 30" DIA	40,120	LF	$48	$1,930,000
3.0	**BOOSTER PUMP STATION**				
3.1	FROM MHAFB TO CITY OF MOUNTAIN HOME	6,000	GPM	$218	$1,308,000
4.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
4.1	AT CITY OF MOUNTAIN HOME	6,000	GPM	$2,263	$13,578,000
5.0	**TREATED WATER PIPELINE**				
5.1	22" DIA HDPE PIPELINE TO CITY	48,600	LF	$132	$6,420,000
6.0	**CONTINGENCY**		20%		$5,470,000
	TOTAL ESTIMATED PROJECT COST				**$32,820,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$2,135,000**
7.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
7.1	SUMMER PUMPING RATE (6 MO.)	6,000	GPM		
7.2	WINTER PUMPING RATE (6 MO.)	1,500	GPM		
7.3	ANNUAL WATER VOLUME DELIVERED	6,000	AF		
7.4	POWER	7,620	MWH	$65.40	$498,000
7.5	FACILITY OPERATIONS AND MAINTENANCE	6,000	AF	$140	$840,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,338,000**
8.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$579	
			$/1000 GAL	$1.78	
			$/GAL	$0.0018	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

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TABLE 10

ALTERNATIVE B
TREATED WATER TO CITY OF MOUNTAIN HOME
9,000 GAL/MIN

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	5
CAPACITY:	9,000 gpm WTP at City of Mountain Home	**DATE :**	4/15/2016
JOB # :	780.0030	**BY :**	EL
LOCATION :	Elmore County, ID	**REVIEWED :**	CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 13,200 GPM	9,000	GPM	$651	$5,860,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 33" DIA	40,120	LF	$66	$2,650,000
3.0	**BOOSTER PUMP STATION**				
3.1	FROM MHAFB TO CITY OF MOUNTAIN HOME	9,000	GPM	$201	$1,809,000
4.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
4.1	AT CITY OF MOUNTAIN HOME	9,000	GPM	$2,087	$18,783,000
5.0	**TREATED WATER PIPELINE**				
5.1	28" DIA HDPE PIPELINE TO CITY	48,600	LF	$168	$8,160,000
6.0	**CONTINGENCY**		20%		$7,450,000
	TOTAL ESTIMATED PROJECT COST				**$44,710,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$2,908,000**
7.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
7.1	SUMMER PUMPING RATE (6 MO.)	9,000	GPM		
7.2	WINTER PUMPING RATE (6 MO.)	2,000	GPM		
7.3	ANNUAL WATER VOLUME DELIVERED	8,900	AF		
7.4	POWER	11,130	MWH	$65.40	$728,000
7.5	FACILITY OPERATIONS AND MAINTENANCE	8,900	AF	$115	$1,023,500
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,752,000**
8.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$524	
			$/1000 GAL	$1.61	
			$/GAL	$0.0016	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

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TABLE 11

ALTERNATIVE B
TREATED WATER TO CITY OF MOUNTAIN HOME
12,000 GAL/MIN

PROJECT :	MHAFB Water Supply	**ESTIMATE CLASS :**	5
CAPACITY:	12,000 gpm WTP at City of Mountain Home	**DATE :**	4/15/2016
JOB # :	780.0030	**BY :**	EL
LOCATION :	Elmore County, ID	**REVIEWED :**	CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 16,200 GPM	12,000	GPM	$625	$7,500,000
2.0	**RAW WATER PIPELINE**				
2.1	UPSIZE FROM 22" DIA TO 36" DIA	40,120	LF	$84	$3,370,000
3.0	**BOOSTER PUMP STATION**				
3.1	FROM MHAFB TO CITY OF MOUNTAIN HOME	12,000	GPM	$189	$2,268,000
4.0	**WATER TREATMENT PLANT (CONVENTIONAL TREATMENT)**				
4.1	AT CITY OF MOUNTAIN HOME	12,000	GPM	$1,970	$23,640,000
5.0	**TREATED WATER PIPELINE**				
5.1	32" DIA HDPE PIPELINE TO CITY	48,600	LF	$192	$9,330,000
6.0	**CONTINGENCY**		20%		$9,220,000
	TOTAL ESTIMATED PROJECT COST				**$55,330,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$3,599,000**
7.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
7.1	SUMMER PUMPING RATE (6 MO.)	12,000	GPM		
7.2	WINTER PUMPING RATE (6 MO.)	2,000	GPM		
7.3	ANNUAL WATER VOLUME DELIVERED	11,300	AF		
7.4	POWER	14,220	MWH	$65.40	$930,000
7.5	FACILITY OPERATIONS AND MAINTENANCE	11,300	AF	$105	$1,186,500
	TOTAL ESTIMATED ANNUAL O&M COST				**$2,117,000**
8.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$506	
			$/1000 GAL	$1.55	
			$/GAL	$0.0016	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

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TABLE 12

ALTERNATIVE C
TREATED WATER TO CITY OF MOUNTAIN HOME
3,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 3,000 gpm Untreated Water to Mountain Home Reservoir
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 7,200 GPM	3,000	GPM	$735	$2,204,000
2.0	**PIPELINE FROM SNAKE RIVER TO MHAFB**				
2.1	UPSIZE FROM 22" DIA TO 26" DIA	40,120	LF	$24	$960,000
3.0	**PIPELINE FROM MHAFB TO MH RESERVOIR**				
3.1	16" DIA HDPE PIPELINE TO RESERVOIR	71,800	LF	$96	$6,890,000
4.0	**CONTINGENCY**		20%		$2,010,000
		TOTAL ESTIMATED PROJECT COST			**$12,060,000**
		ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)			**$785,000**
5.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
5.1	YEAR ROUND PUMPING	3,000	GPM		
5.2	ANNUAL WATER DELIVERED	4,800	AF		
5.3	POWER	1,200	HP		
5.4	ELECTRICAL COST	7,840	MWH	$65.40	$512,736
5.5	OPERATIONS AND MAINTENANCE	4,800	AF	$30	$144,000
		TOTAL ESTIMATED ANNUAL O&M COST			**$657,000**
6.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$300	
			$/1000 GAL	$0.92	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

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TABLE 13

ALTERNATIVE C
TREATED WATER TO CITY OF MOUNTAIN HOME
6,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 6,000 gpm Untreated Water to Mountain Home Reservoir
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 10,200 GPM	6,000	GPM	$685	$4,112,000
2.0	**PIPELINE FROM SNAKE RIVER TO MHAFB**				
2.1	UPSIZE FROM 22" DIA TO 30" DIA	40,120	LF	$48	$1,930,000
3.0	**PIPELINE FROM MHAFB TO MH RESERVOIR**				
3.1	22" DIA HDPE PIPELINE TO RESERVOIR	71,800	LF	$132	$9,480,000
4.0	**CONTINGENCY**		20%		$3,100,000
	TOTAL ESTIMATED PROJECT COST				**$18,620,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,211,000**
5.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
5.1	YEAR ROUND PUMPING	6,000	GPM		
5.2	ANNUAL WATER DELIVERED	9,600	AF		
5.3	POWER	2,400	HP		
5.4	ELECTRICAL COST	15,680	MWH	$65.40	$1,025,472
5.5	OPERATIONS AND MAINTENANCE	9,600	AF	$24	$230,400
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,256,000**
6.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$257	
			$/1000 GAL	$0.79	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
Power costs from Idaho Power Co. Schedule 19 for Large Power Service, Secondary Service.

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SPF WATER ENGINEERING

TABLE 14

ALTERNATIVE C
TREATED WATER TO CITY OF MOUNTAIN HOME
9,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 9,000 gpm Untreated Water to Mountain Home Reservoir
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 13,200 GPM	9,000	GPM	$651	$5,858,000
2.0	**PIPELINE FROM SNAKE RIVER TO MHAFB**				
2.1	UPSIZE FROM 22" DIA TO 33" DIA	40,120	LF	$66	$2,650,000
3.0	**PIPELINE FROM MHAFB TO MH RESERVOIR**				
3.1	28" DIA HDPE PIPELINE TO RESERVOIR	71,800	LF	$168	$12,060,000
4.0	**CONTINGENCY**		20%		$4,110,000
	TOTAL ESTIMATED PROJECT COST				**$24,680,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,605,000**
5.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
5.1	YEAR ROUND PUMPING	9,000	GPM		
5.2	ANNUAL WATER DELIVERED	14,400	AF		
5.3	POWER	3,600	HP		
5.4	ELECTRICAL COST	23,530	MWH	$65.40	$1,538,862
5.5	OPERATIONS AND MAINTENANCE	14,400	AF	$20	$288,000
	TOTAL ESTIMATED ANNUAL O&M COST				**$1,827,000**
6.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$238	
			$/1000 GAL	$0.73	

Notes:
Costs do not include potential permitting, land acquisition, easements, environmental studies, and legal costs.
Costs do not include potential electrical supply facility upgrades.
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TABLE 15

ALTERNATIVE C
TREATED WATER TO CITY OF MOUNTAIN HOME
12,000 GAL/MIN

PROJECT : MHAFB Water Supply
CAPACITY: 12,000 gpm Untreated Water to Mountain Home Reservoir
JOB # : 780.0030
LOCATION : Elmore County, ID

ESTIMATE CLASS : 5
DATE : 3/28/2016
BY : EL
REVIEWED : CC

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1.0	**INTAKE PUMP STATION**				
1.1	UPSIZE FROM 4,200 GPM TO 16,200 GPM	12,000	GPM	$625	$7,497,000
2.0	**PIPELINE FROM SNAKE RIVER TO MHAFB**				
2.1	UPSIZE FROM 22" DIA TO 36" DIA	40,120	LF	$84	$3,370,000
3.0	**PIPELINE FROM MHAFB TO MH RESERVOIR**				
3.1	32" DIA HDPE PIPELINE TO RESERVOIR	71,800	LF	$192	$13,790,000
4.0	**CONTINGENCY**		20%		$4,930,000
	TOTAL ESTIMATED PROJECT COST				**$29,590,000**
	ANNUAL CAPITAL COST (ASSUME 30 YRS AT 5%)				**$1,925,000**
5.0	**ANNUAL OPERATIONS AND MAINTENANCE**				
5.1	YEAR ROUND PUMPING	12,000	GPM		
5.2	ANNUAL WATER DELIVERED	19,200	AF		
5.3	POWER	4,800	HP		
5.4	ELECTRICAL COST	31,370	MWH	$65.40	$2,051,598
5.5	OPERATIONS AND MAINTENANCE	19,200	AF	$18	$345,600
	TOTAL ESTIMATED ANNUAL O&M COST				**$2,397,000**
6.0	**ESTIMATED COST OF WATER**				
	ASSUME 30 YEAR CAPITAL PAYBACK AT 5%		$/AF	$225	
			$/1000 GAL	$0.69	

Notes:
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Costs do not include potential electrical supply facility upgrades.
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Appendix B: MHAFB Water Demand Data

APPENDIX B

MHAFB WATER PRODUCTION DATA
2009-2015

MONTH	DAYS	Well #2	Well #4	Well #6	Golf Course Well #8	Well #11	Well #12	Well #13	TOTAL	ADD (mgd)	ADD w/o Well 8 (mgd)	NOTES
J-09	31	5,714,782	255,105	41,529	0	7,898,946	450,576	0	14,360,938	0.46	0.46	
F-09	28	5,917,637	35,569	24,075	0	6,374,722	99,367	0	12,451,370	0.44	0.44	
M-09	31	5,045,258	256,578	3,495,711	0	17,042,019	24,683	0	25,864,249	0.83	0.83	
A-09	30	9,133,295	37,626	36,516	5,918,105	12,122,126	325,964	0	27,573,632	0.92	0.72	
M-09	31	9,943,697	249,466	3,495,711	15,643,027	17,042,019	7,450,355	0	53,824,275	1.74	1.23	
J-09	30	19,530,122	1,740,847	0	21,727,204	26,072,824	11,676,354	0	80,747,351	2.69	1.97	
J-09	31	23,254,544	6,075,982	0	33,165,179	34,184,790	15,034,661	0	111,715,156	3.60	2.53	
A-09	31	20,120,586	7,136,348	0	35,084,288	41,733,017	14,824,087	0	118,898,326	3.84	2.70	
S-09	30	15,281,471	7,330,804	0	19,487,379	33,005,592	7,600,585	0	82,705,831	2.76	2.11	
O-09	31	11,741,716	739,594	86,629	2,125,991	11,798,187	276,866	0	26,768,983	0.86	0.79	
N-09	30	4,984,702	1,046,825	0	0	6,408,080	106,905	0	12,546,512	0.42	0.42	
D-09	31	7,422,097	117,972	0	0	6,994,808	184,681	0	14,719,558	0.47	0.47	
J-10	31	7,422,097	117,972	0	0	6,994,808	184,681	0	14,719,558	0.47	0.47	SAME VALUES AS 12/09
F-10	28	6,280,882	56,429	0	0	2,202,800	24,204	0	8,564,315	0.31	0.31	
M-10	31	4,928,748	465,105	4,189,826	0	1,840,942	0	0	11,424,621	0.37	0.37	
A-10	30	6,468,300	301,955	6,205,103	13,080,112	3,748,423	27,868	6,205,103	36,036,864	1.20	0.77	
M-10	31	12,361,766	1,110,899	2,371,168	14,532,965	15,715,825	1,197,727	0	47,290,350	1.53	1.06	
J-10	30	17,335,006	2,125,146	3,545,768	18,544,652	23,087,241	3,761,933	0	68,399,746	2.28	1.66	
J-10	31	21,495,064	11,512,098	0	34,386,742	39,325,982	881,391	3,545,768	111,147,045	3.59	2.48	
A-10	31	22,473,322	7,649,031	18,257,987	36,605,454	31,168,759	9,780,709	18,257,987	144,193,249	4.65	3.47	HIGHEST MONTH
S-10	30	22,860,832	4,755,589	10,269,105	16,018,070	27,024,669	903,617	10,269,105	92,100,987	3.07	2.54	
O-10	31	7,358,595	130,482	0	0	3,416,735	90,367	4,457,265	15,453,444	0.50	0.50	
N-10	30	6,613,287	97,623	0	0	2,307,627	47,950	5,269,667	14,336,154	0.48	0.48	
D-10	31	7,153,952	90,422	0	0	2,764,009	112,116	4,363,248	14,483,747	0.47	0.47	
J-11	31	7,358,595	130,482	0	0	3,416,735	90,367	4,457,265	15,453,444	0.50	0.50	
F-11	28	6,662,537	469,466	0	0	3,002,338	47,215	3,575,984	13,757,540	0.49	0.49	
M-11	31	5,192,706	279,419	0	0	3,125,029	407,541	3,433,759	12,438,454	0.40	0.40	
A-11	30	9,677,646	51,528	0	0	7,666,384	44,369	4,906,748	22,346,675	0.74	0.74	
M-11	31	19,169,960	1,306,318	0	0	16,788,844	37,430	8,143,756	45,446,308	1.47	1.47	
J-11	30	18,368,185	2,756,441	0	22,210,255	20,096,992	274,316	5,738,520	69,444,709	2.31	1.57	
J-11	31	19,696,482	6,935,628	0	33,841,298	27,206,708	5,876,463	11,993,659	105,550,238	3.40	2.31	
A-11	31	18,448,456	5,962,685	0	28,820,844	30,666,619	10,749,901	13,286,172	107,934,677	3.48	2.55	
S-11	30	17,245,258	5,170,847	0	18,373,801	14,125,982	7,942,982	20,578,912	83,437,782	2.78	2.17	
O-11	31	602,060	134,483	0	928,089	3,562,198	760,252	8,251,825	14,238,907	0.46	0.43	
N-11	30	5,858,877	922,678	0	0	2,756,795	3,702	4,550,711	14,092,763	0.47	0.47	
D-11	31	6,590,801	125,797	0	34	2,723,820	0	3,689,506	13,129,958	0.42	0.42	
J-12	31	4,420,148	590,481	0	0	3,117,089	328,023	3,092,245	11,547,986	0.37	0.37	
F-12	29	5,510,031	35,251	0	0	3,796,114	48	1,609,459	10,950,903	0.38	0.38	
M-12	31	158,163	380,190	0	3,522,722	3,331,122	416,415	4,474,591	12,283,203	0.40	0.28	
A-12	30	8,702,325	1,007,639	0	18,716,546	3,280,357	0	5,591,047	37,297,914	1.24	0.62	
M-12	31	17,730,153	4,364,099	0	22,183,524	5,492,819	0	17,376,308	67,146,903	2.17	1.45	
J-12	30	22,969,287	5,916,006	0	24,859,621	10,426,129	33,314	20,336,560	84,540,917	2.82	1.99	
J-12	31	17,849,835	4,945,833	0	35,681,608	10,950,240	11,313,255	27,614,763	108,355,534	3.50	2.34	
A-12	31	17,849,835	4,945,833	0	35,681,608	10,950,240	11,313,255	27,614,763	108,355,534	3.50	2.34	SAME VALUES AS 7/12
S-12	30	15,161,928	5,642,888	0	23,016,638	3,876,230	558,131	21,218,014	69,473,829	2.32	1.55	
O-12	31	8,420,698	1,347,612	0	6,094,678	0	223,404	12,356,278	28,442,670	0.92	0.72	
N-12	30	4,905,331	516,754	0	0	0	32,911	7,077,290	12,532,286	0.42	0.42	
D-12	31	4,269,255	25,566	0	0	0	32,597	6,552,184	10,879,602	0.35	0.35	
J-13	31	5,067,573	32,767	0	0	0	36,395	7,372,763	12,509,498	0.40	0.40	
F-13	28	4,252,386	242,272	0	0	0	85,796	5,283,940	9,864,394	0.35	0.35	
M-13	31	5,380,458	140,732	0	0	0	58,596	5,790,033	11,369,819	0.37	0.37	
A-13	30	12,511,164	587,794	0	20,851,074	0	1,345,856	11,780,009	47,075,897	1.57	0.87	
M-13	31	15,018,419	9,745,771	0	16,749,057	0	4,582,362	30,443,297	76,538,906	2.47	1.93	
J-13	30	21,304,625	7,705,949	0	35,660,320	0	3,684,108	35,591,533	103,946,535	3.46	2.28	
J-13	31	20,280,490	6,608,179	0	34,221,350	22,333,544	8,520,462	15,985,218	107,949,244	3.48	2.38	
A-13	31	6,669,544	346,737	0	11,896,157	0	3,813,942	39,392,435	62,118,815	2.00	1.62	SAME VALUES AS 7/13
S-13	30	2,614,582	8,465,669	0	11,746,334	0	7,836,545	28,374,022	59,037,152	1.97	1.58	
O-13	31	952,675	4,971,334	0	9,253,847	0	1,787,604	9,005,328	25,970,788	0.84	0.54	
N-13	30	6,697,402	1,262,979	0	161,288	0	28,863	5,868,727	14,019,259	0.47	0.46	
D-13	31	6,971,690	257,667	0	0	0	34,994	5,866,579	13,130,930	0.42	0.42	
J-14	31	6,295,283	506,513	0	0	0	129,672	6,044,719	12,976,187	0.42	0.42	
F-14	28	5,314,928	18,431	0	0	0	55,888	5,344,978	10,734,225	0.38	0.38	
M-14	31	4,036,955	760,243	0	5,683,342	0	178,033	5,283,334	15,941,907	0.51	0.33	
A-14	30	8,537,233	1,291,012	0	24,197,059	0	2,294,246	9,187,226	45,506,776	1.52	0.71	
M-14	31	16,942,491	3,130,815	0	26,172,127	0	4,698,102	33,305,665	84,249,200	2.72	1.87	
J-14	30	14,488,916	3,297,122	0	27,647,107	0	8,065,903	34,399,936	87,898,984	2.93	2.01	
J-14	31	19,106,524	3,571,356	0	34,031,925	0	9,496,540	36,771,902	102,978,247	3.32	2.22	
A-14	31	20,675,229	2,240,328	0	27,186,872	0	11,512,929	43,361,573	104,976,931	3.39	2.51	
S-14	30	21,786,100	2,611,489	0	24,967,160	0	3,564,651	33,076,541	86,005,941	2.87	2.03	
O-14	31	12,316,176	1,121,907	0	10,403,506	0	421,695	9,733,573	33,996,857	1.10	0.76	
N-14	30	3,842,677	596,068	0	0	0	2,904	4,674,007	9,115,656	0.30	0.30	
D-14	31	4,655,596	98,784	0	0	0	8,792	4,407,732	9,170,904	0.30	0.30	
TOTAL		789,379,426	167,011,309	52,019,128	861,078,959	592,967,278	197,798,416	726,233,532	3,386,488,049			
		23%	5%	2%	25%	18%	6%	21%	100%			

Appendix C: C.J. Strike Water Quality Data

Analytical Laboratories, Inc.
1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 8/31/2015 1:11:30 PM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1535720

Attn: ERIC LANDSBERG
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
CJ STRIKE

Time of Collection: 11:00
Date of Collection: 8/24/2015
Date Received: 8/24/2015
Report Date: 8/31/2015

PWS#:

Field Temp: Temp Rcvd in Lab:

PWS Name:

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Escherichia coli		<1	MPN/100mL		SM 9223	8/26/2015	TJR
Aluminum, Al		<0.10	mg/L	0.10	EPA 200.7	8/28/2015	KC
Arsenic Low		0.005	mg/L	0.003	EPA 200.8	8/27/2015	JH
Iron, Fe		<0.05	mg/L	0.05	EPA 200.7	8/28/2015	KC
Manganese, Mn		<0.05	mg/L	0.05	EPA 200.7	8/28/2015	KC
Mercury, Hg		<0.0002	mg/L	0.0002	EPA 245.1	8/27/2015	JMS
Metals Digestion		*			EPA 200.9-11	8/26/2015	JMS
Nitrate (as N)		0.9	mg/L	0.2	EPA 300.0	8/25/2015	NC
Nitrite (as N)		0.03	mg/L	0.01	EPA 353.2	8/25/2015	CJS
Carbon, Total Organic, TOC		1.56	mg/L	0.1	EPA 415.1	8/28/2015	MDM
UV TRANSMITTANCE sample run as received no dilution		92.4	% @254 nm		SM 5910 B	8/28/2015	MDM
Alkalinity		165	mg/L CaCO3		EPA 310.1	8/27/2015	CJS
Fluoride, F		0.55	mg/L	0.10	EPA 300.0	8/25/2015	NC
Hardness		190	mg/L	5.0	SM 2340	8/27/2015	CJS
Turbidity		3.4	NTU	0.5	EPA 180.1	8/24/2015	NC

Thank you for choosing Analytical Laboratories for your testing needs.

If you have any questions about this report, or any future analytical needs, please contact your client manager:
James Hibbs

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Analytical Laboratories, Inc.

1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 10/6/2015 8:59:55 AM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1541358

Attn: ERIC LANDSBERG
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
MHAFB CJ STRIKE

Time of Collection: 12:20
Date of Collection: 9/25/2015
Date Received: 9/25/2015
Report Date: 10/6/2015

PWS#:
PWS Name:

Field Temp: Temp Rcvd in Lab:

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Escherichia coli		<1	MPN/100mL		SM 9223	9/26/2015	ZH
Aluminum, Al		<0.10	mg/L	0.10	EPA 200.7	10/1/2015	JH
Arsenic Low		0.004	mg/L	0.003	EPA 200.8	9/29/2015	JH
Calcium Hardness		106	mg/L	1.25	EPA 200.7	9/30/2015	JH
Calcium, Ca		42.3	mg/L	0.50	EPA 200.7	9/30/2015	JH
Iron, Fe		<0.05	mg/L	0.05	EPA 200.7	10/1/2015	JH
Magnesium, Mg		20.9	mg/L	0.50	EPA 200.7	9/30/2015	JH
Manganese, Mn		<0.05	mg/L	0.05	EPA 200.7	10/1/2015	JH
Mercury, Hg		<0.0002	mg/L	0.0002	EPA 245.1	9/29/2015	JMS
Nitrate (as N)		1.5	mg/L	0.2	EPA 300.0	9/25/2015	NC
Nitrite (as N)		0.02	mg/L	0.01	EPA 353.2	9/26/2015	CJS
Carbon, Total Organic, TOC		1.50	mg/L	0.1	EPA 415.1	10/2/2015	MDM
UV TRANSMITTANCE		90.8	% @254 nm		SM 5910 B	9/30/2015	MDM
Alkalinity		169	mg/L CaCO3		EPA 310.1	9/30/2015	CJS
Bromide, Br		54	ug/L	20	EPA 300.1	9/28/2015	NC
Fluoride, F		0.55	mg/L	0.10	EPA 300.0	9/25/2015	NC
Hardness		196	mg/L	5.0	SM 2340	9/30/2015	CJS
Turbidity		1.5	NTU	0.5	EPA 180.1	9/25/2015	CJS

Thank you for choosing Analytical Laboratories for your testing needs.

If you have any questions about this report, or any future analytical needs, please contact your client manager:
James Hibbs

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Analytical Laboratories, Inc.

1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Attn: TERRY SCANLAN, P.E.,P.G.
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
IWRB-CJ STRIKE

Time of Collection: 12:00
Date of Collection: 11/6/2015
Date Received: 11/6/2015
Report Date: 12/8/2015

Field Temp:
PWS:

Temp Rcvd in Lab: 9.3 °C
PWS Name

Laboratory Analysis Report

Sample Number: 1548509

NO FIELD TEMP GIVEN; EPA Methods 504.1, 505, 515.4, 525.2, 531.2, 547, and 549.2 were performed by Anatek Labs (ATL).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Calcium Hardness		117	mg/L	1.25	EPA 200.7	11/10/2015	KC
Barium, Ba		< 0.05	mg/L	0.05	EPA 200.7	11/11/2015	KC
Cadmium Low		< 0.0005	mg/L	0.0005	EPA 200.8	11/16/2015	JH
Chromium Low		< 0.002	mg/L	0.002	EPA 200.8	11/16/2015	JH
Mercury, Hg		< 0.0002	mg/L	0.0002	EPA 245.1	11/10/2015	JMS
Selenium Low		< 0.005	mg/L	0.005	EPA 200.8	11/16/2015	JH
Nickel, Ni		< 0.02	mg/L	0.02	EPA 200.7	11/11/2015	KC
Antimony Low		< 0.005	mg/L	0.005	EPA 200.8	11/16/2015	JH
Beryllium Low		< 0.0005	mg/L	0.0005	EPA 200.8	11/16/2015	JH
Thallium Low		< 0.001	mg/L	0.001	EPA 200.8	11/16/2015	JH
Arsenic Low		0.005	mg/L	0.003	EPA 200.8	11/16/2015	JH
Sodium, Na		31.7	mg/L	0.50	EPA 200.7	11/10/2015	KC
Aluminum, Al		< 0.10	mg/L	0.10	EPA 200.7	11/11/2015	KC
Calcium, Ca		46.7	mg/L	0.50	EPA 200.7	11/10/2015	KC
Copper, Cu		< 0.01	mg/L	0.01	EPA 200.7	11/11/2015	KC
Iron, Fe		< 0.05	mg/L	0.05	EPA 200.7	11/11/2015	KC

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Laboratory Analysis Report

Sample Number: 1548509

NO FIELD TEMP GIVEN; EPA Methods 504.1, 505, 515.4, 525.2, 531.2, 547, and 549.2 were performed by Anatek Labs (ATL).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Magnesium, Mg		21.8	mg/L	0.50	EPA 200.7	11/10/2015	KC
Manganese, Mn		< 0.05	mg/L	0.05	EPA 200.7	11/11/2015	KC
Potassium, K		4.7	mg/L	0.5	EPA 200.7	11/10/2015	KC
Silver Low		< 0.001	mg/L	0.001	EPA 200.8	11/16/2015	JH
Silica		34.2	mg/L	0.25	EPA 200.7	11/12/2015	KC
Zinc, Zn		< 0.01	mg/L	0.01	EPA 200.7	11/11/2015	KC
Uranium, U		3	ug/L	1	EPA 200.8	11/16/2015	JH
Lead Low		< 0.005	mg/L	0.005	EPA 200.8	11/16/2015	JH
Ammonia Direct (as N)		< 0.04	mg/L	0.04	EPA 350.1	11/13/2015	CJS
Nitrate + Nitrite (as N)		1.73	mg/L	0.02	EPA 353.2	11/10/2015	CJS
Nitrite (as N)		0.03	mg/L	0.01	EPA 353.2	11/7/2015	CJS
Nitrate (as N)		1.7	mg/L	0.2	EPA 353.2	11/10/2015	CJS
Ethylene Dibromide		<0.02	ug/L	0.02	EPA 504.1	11/13/2015	ATL
1,2-Dibromo-3-chloropropane		<0.02	ug/L	0.02	EPA 504.1	11/13/2015	ATL
Endrin		<0.02	ug/L	0.02	EPA 505	11/14/2015	ATL
gamma-BHC (Lindane)		<0.02	ug/L	0.02	EPA 505	11/14/2015	ATL
Methoxychlor		<0.1	ug/L	0.1	EPA 505	11/14/2015	ATL
Toxaphene		<1	ug/L	1	EPA 505	11/14/2015	ATL
Heptachlor		<0.04	ug/L	0.04	EPA 505	11/14/2015	ATL
Heptachlor epoxide		<0.02	ug/L	0.02	EPA 505	11/14/2015	ATL
Total PCB		<0.10	ug/L	0.1	EPA 505	11/14/2015	ATL
Chlordane(Total)		<0.1	ug/L	0.1	EPA 505	11/14/2015	ATL
Aldrin		<0.2	ug/L	0.2	EPA 505	11/14/2015	ATL
Dieldrin		<0.2	ug/L	0.2	EPA 505	11/14/2015	ATL
Dalapon		<1	ug/L	1	EPA 515.3	11/20/2015	ATL
Dicamba		<0.2	ug/L	0.2	EPA 515.3	11/20/2015	ATL
2,4-Dichlorophenoxyacetic acid (2,4-D)		<0.1	ug/L	0.1	EPA 515.3	11/20/2015	ATL
Dinoseb		<0.2	ug/L	0.2	EPA 515.3	11/20/2015	ATL
Pentachlorophenol		<0.04	ug/L	0.04	EPA 515.3	11/20/2015	ATL
Picloram		<0.1	ug/L	0.1	EPA 515.3	11/20/2015	ATL
Silvex		<0.2	ug/L	0.2	EPA 515.3	11/20/2015	ATL

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Laboratory Analysis Report

Sample Number: 1548509

NO FIELD TEMP GIVEN; EPA Methods 504.1, 505, 515.4, 525.2, 531.2, 547, and 549.2 were performed by Anatek Labs (ATL).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Bis(2-ethylhexyl)adipate		<0.2	ug-L	0.2	EPA 525.2	11/19/2015	ATL
Bis(2-ethylhexyl)phthalate		<0.6	ug-L	0.6	EPA 525.2	11/19/2015	ATL
Simazine		<0.15	ug/L	0.15	EPA 525.2	11/19/2015	ATL
Hexachlorocyclopentadiene		<0.2	ug/L	0.2	EPA 525.2	11/19/2015	ATL
Atrazine		<0.2	ug/L	0.2	EPA 525.2	11/19/2015	ATL
Alachlor (Lasso)		<0.4	ug/L	0.4	EPA 525.2	11/19/2015	ATL
Hexachlorobenzene		<0.2	ug/L	0.2	EPA 525.2	11/19/2015	ATL
Benzo(a)pyrene		<0.02	ug/L	0.02	EPA 525.2	11/19/2015	ATL
Butachlor		<0.4	ug/L	0.4	EPA 525.2	11/19/2015	ATL
Metolachlor		<1	ug/L	1	EPA 525.2	11/19/2015	ATL
Metribuzin		<0.2	ug/L	0.2	EPA 525.2	11/19/2015	ATL
Propachlor		<0.2	ug/L	0.2	EPA 525.2	11/19/2015	ATL
Aldicarb		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Aldicarb sulfone		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Aldicarb sulfoxide		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Carbaryl		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Carbofuran		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
3-Hydroxycarbofuran		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Methomyl		<2.0	ug/L	2	EPA 531.2	11/19/2015	ATL
Oxamyl		<4.0	ug/L	4	EPA 531.2	11/19/2015	ATL
Glyphosate		<10.0	ug/L	10	EPA 547	11/18/2015	ATL
Endothall		<10	ug/L	10	EPA 548.1	12/3/2015	CG
Diquat		<0.8	ug/L	0.8	EPA 549.2	11/17/2015	ATL
Benzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Carbon tetrachloride		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Chlorobenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,2-Dichlorobenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,4-Dichlorobenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,2-Dichloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1-Dichloroethene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
cis-1,2-Dichloroethene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY

MCL = Maximum Contamination Level
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Date Report Printed: 12/8/2015 8:15:12 A

Laboratory Analysis Report

Sample Number: 1548509

NO FIELD TEMP GIVEN; EPA Methods 504.1, 505, 515.4, 525.2, 531.2, 547, and 549.2 were performed by Anatek Labs (ATL).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
trans-1,2-Dichloroethene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,2-Dichloropropane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Ethylbenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Styrene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Tetrachloroethene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Toluene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,2,4-Trichlorobenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1,1-Trichloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1,2-Trichloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Trichloroethene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Vinyl chloride		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Bromodichloromethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Bromoform		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Chloroform		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Dibromochloromethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Total THM's		<2.0	ug/L	2	EPA 524.2	11/10/2015	CY
Xylene, Total		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Dichloromethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Methyl-tert-butylether		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1-Dichloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1-Dichloropropene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,2,3-Trichloropropane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1,1,2-Tetrachloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,1,2,2-Tetrachloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,3-Dichloropropene (cis&trans)		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
1,3-Dichloropropane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
2,2-Dichloropropane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Bromobenzene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Bromomethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Chloroethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Chloromethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Dibromomethane		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Laboratory Analysis Report

Sample Number: 1548509

NO FIELD TEMP GIVEN; EPA Methods 504.1, 505, 515.4, 525.2, 531.2, 547, and 549.2 were performed by Anatek Labs (ATL).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
2-Chlorotoluene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
4-Chlorotoluene		<0.5	ug/L	0.5	EPA 524.2	11/10/2015	CY
Dibromofluoromethane (Surr)		93.4	% 80-120		EPA 524.2	11/10/2015	CY
Toluene-d5 Surrogate		101	% 80-120		EPA 524.2	11/10/2015	CY
Bromofluorobenzene Surrogate		84.8	% 80-120		EPA 524.2	11/10/2015	CY
UV TRANSMITTANCE		92.8	% @254 nm		SM 5910 B	11/9/2015	MDM
Carbon, Total Organic, TOC		1.17	mg/L	0.1	EPA 415.1	11/10/2015	MDM
Temperature		*	C		Thermometer	11/6/2015	EL
* No field temperature submitted.							
Alkalinity		180	mg/L		EPA 310.1	11/11/2015	CJS
pH		8.0	S.U.		SM 4500-H B	11/6/2015	JMS
Corrosivity		+ 0.24			Langelier	11/18/2015	JH
Non Aggressive. No Field Temperature Provided, 16°C Used In the Calculation.							
Conductivity		518	umhos/cm	2	SM 2510B	11/6/2015	JMS
Turbidity		2.0	NTU	0.5	EPA 180.1	11/6/2015	JMS
Hardness		205	mg/L	5.0	SM 2340	11/11/2015	CJS
Fluoride, F		0.65	mg/L	0.10	EPA 300.0	11/11/2015	NC
Chloride, Cl		28	mg/L	1	EPA 300.0	11/11/2015	NC
Sulfate, SO4		51	mg/L	1	EPA 300.0	11/11/2015	NC
Cyanide, Total		< 0.005	mg/L	0.005	EPA 335.4	11/16/2015	DS
Bromide, Br		56	ug/L	20	EPA 300.1	11/9/2015	NC
Total Dissolved Solids		310	mg/L	25	160.1	11/10/2015	AR
Color		10	C.U.	5	SM 2120	11/9/2015	MDM
Threshold Odor		* 2	T.O.N.		EPA 140.1	11/9/2015	MDM
3 of 6 panel members detected a slight odor.							
Surfactants		0.08	mg/L	.01	SM 5540	11/11/2015	MDM
Hydrogen Sulfide		<0.05	mg/L	0.05	SM 4500-S2 D	11/10/2015	AR
Sand		4.0	mg/L	0.600	SM 2540 D	11/7/2015	GM

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Thank you for choosing Analytical Laboratories for your testing needs.
If you have any questions concerning this report,
please contact your client manager: **James Hibbs**

Date Report Printed: 12/8/2015 8:15:12 A

Analytical Laboratories, Inc.

1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 11/30/2015 8:51:33 AM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1548510

Attn: TERRY SCANLAN, P.E.,P.G.
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
IWRB-CJ STRIKE

Time of Collection: 12:00
Date of Collection: 11/6/2015
Date Received: 11/6/2015
Report Date: 11/30/2015

PWS#:

Field Temp: Temp Rcvd in Lab:

PWS Name:

Radiological testing was perrformed by Summit Environmental (SUM).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Gross Alpha		<3	pCi/L	3	EPA 900.0	11/25/2015	SUM
Gross Beta		<4	pCi/L	4	EPA 900.0	11/25/2015	SUM
Radium 226		<1	pCi/L	1	EPA 903.0	11/23/2015	SUM
Radium 228		<1	pCi/L	1	EPA 904.0	11/20/2015	SUM

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Analytical Laboratories, Inc.
1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 11/9/2015 9:23:55 AM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1548507

Attn: ERIC LANDSBERG
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
IWRB-CJ STRIKE

Time of Collection: 12:00
Date of Collection: 11/6/2015
Date Received: 11/6/2015
Report Date: 11/9/2015

PWS#:

Field Temp: Temp Rcvd in Lab: 9.3 °C

PWS Name:

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Escherichia coli		2	MPN/100mL		SM 9223	11/7/2015	MS

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MDL = Method/Minimum Detection Limit
UR = Unregulated

Analytical Laboratories, Inc.
1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 1/20/2016 8:22:33 AM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1601557

Attn: ERIC LANDSBERG
S P F WATER ENGINEERING, LLC
300 E MALLARD DR STE 350
BOISE, ID 83706

Collected By: E. LANDSBERG
Submitted By: E. LANDSBERG

Source of Sample:
MHAFB CJ STRIKE

Time of Collection: 11:30
Date of Collection: 1/12/2016
Date Received: 1/13/2016
Report Date: 1/20/2016

PWS#:

Field Temp: Temp Rcvd in Lab:

PWS Name:

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Escherichia coli		<1	MPN/100mL		SM 9223	1/14/2016	TJR
Aluminum, Al		<0.10	mg/L	0.10	EPA 200.7	1/15/2016	JMS
Arsenic Low		0.006	mg/L	0.003	EPA 200.8	1/15/2016	JH
Calcium Hardness		120	mg/L	1.25	EPA 200.7	1/14/2016	JMS
Calcium, Ca		48.1	mg/L	0.50	EPA 200.7	1/14/2016	JMS
Iron, Fe		<0.05	mg/L	0.05	EPA 200.7	1/15/2016	JMS
Magnesium, Mg		21.2	mg/L	0.50	EPA 200.7	1/14/2016	JMS
Manganese, Mn		<0.05	mg/L	0.05	EPA 200.7	1/15/2016	JMS
Mercury, Hg		<0.0002	mg/L	0.0002	EPA 245.1	1/15/2016	KC
Nitrate (as N)		2.1	mg/L	0.2	EPA 300.0	1/13/2016	NC
Nitrite (as N)		0.02	mg/L	0.01	EPA 353.2	1/14/2016	CJS
Carbon, Total Organic, TOC		1.03	mg/L	0.1	EPA 415.1	1/14/2016	MDM
UV TRANSMITTANCE		0.023	abs/254nm		SM 5910 B	1/15/2016	MDM
Alkalinity		179	mg/L CaCO3		EPA 310.1	1/14/2016	CJS
Bromide, Br		95	ug/L	20	EPA 300.1	1/13/2016	NC
Fluoride, F		0.50	mg/L	0.10	EPA 300.0	1/13/2016	NC
Hardness		203	mg/L	5.0	SM 2340	1/14/2016	CJS
Turbidity		3.1	NTU	0.5	EPA 180.1	1/13/2016	DS

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James Hibbs

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UR = Unregulated

Appendix D: Custom Soil Resource Reports for Pipeline Alignments

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Elmore County Area, Idaho, Parts of Elmore and Owyhee Counties
Survey Area Data: Version 4, Sep 16, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 20, 2011—Sep 14, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Elmore County Area, Idaho, Parts of Elmore and Owyhee Counties (ID685)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
7	Bahem silt loam, 0 to 4 percent slopes	152.0	32.4%
65	Garbutt silt loam, 0 to 4 percent slopes	9.5	2.0%
66	Garbutt silt loam, 4 to 8 percent slopes	9.0	1.9%
67	Garbutt-Strike complex, 0 to 2 percent slopes	8.1	1.7%
68	Garbutt-Strike-Trevino complex, 2 to 8 percent slopes	45.8	9.8%
103	Minidoka-Minveno silt loams, 0 to 4 percent slopes	74.3	15.8%
105	Minveno silt loam, 0 to 4 percent slopes	72.3	15.4%
107	Minveno-Minidoka silt loams, 0 to 8 percent slopes, stony	76.2	16.2%
132	Rock outcrop-Rubble land association	7.4	1.6%
154	Timmerman loamy sand, 2 to 20 percent slopes, rubbly	5.1	1.1%
161	Truesdale fine sandy loam, 0 to 4 percent slopes	8.9	1.9%
175	Water	1.2	0.3%
Totals for Area of Interest		**469.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Elmore County Area, Idaho, Parts of Elmore and Owyhee Counties

7—Bahem silt loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2r1d
Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 7 to 12 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Bahem and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bahem

Setting

Landform: Stream terraces, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess

Typical profile

AB - 0 to 15 inches: silt loam
Bk - 15 to 46 inches: silt loam
C - 46 to 60 inches: fine sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

65—Garbutt silt loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2r17
Elevation: 2,000 to 5,400 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Garbutt and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Garbutt

Setting

Landform: Lava plains, drainageways, fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Typical profile

A - 0 to 5 inches: silt loam
C - 5 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: SILTY 7-10 KRLA2/ACHY (R011XY009ID)

66—Garbutt silt loam, 4 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2r18
Elevation: 2,000 to 5,400 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Garbutt and similar soils: 75 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Garbutt

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Typical profile

A - 0 to 5 inches: silt loam
C - 5 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 4 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

67—Garbutt-Strike complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2r19
Elevation: 2,000 to 5,500 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Farmland of statewide importance, if irrigated

Map Unit Composition

Garbutt and similar soils: 50 percent
Strike and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Garbutt

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Typical profile

A - 0 to 5 inches: silt loam
C - 5 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: SILTY 7-10 KRLA2/ACHY (R011XY009ID)

Description of Strike

Setting

Landform: Lava plains, fan remnants

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and loess

Typical profile

A - 0 to 5 inches: loam
Bw - 5 to 19 inches: loam
Bkq - 19 to 24 inches: fine sandy loam
C1 - 24 to 30 inches: loam
C2 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to moderately saline (0.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

68—Garbutt-Strike-Trevino complex, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2r1b
Elevation: 2,000 to 5,500 feet
Mean annual precipitation: 6 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Garbutt and similar soils: 40 percent
Strike and similar soils: 35 percent
Trevino, very stony surface, and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Garbutt

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Typical profile

A - 0 to 5 inches: silt loam
C - 5 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 2 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: SILTY 7-10 KRLA2/ACHY (R011XY009ID)

Description of Strike

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and loess

Typical profile

A - 0 to 5 inches: loam
Bw - 5 to 19 inches: loam
Bkq - 19 to 24 inches: fine sandy loam
C1 - 24 to 30 inches: loam
C2 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to moderately saline (0.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Description of Trevino, Very Stony Surface

Setting

Landform: Lava plains, fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess over bedrock derived from basalt

Typical profile

A - 0 to 5 inches: stony silt loam
Bw - 5 to 12 inches: loam
Bk - 12 to 18 inches: fine sandy loam
R - 18 to 28 inches: bedrock

Properties and qualities

Slope: 2 to 8 percent
Percent of area covered with surface fragments: 2.0 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

103—Minidoka-Minveno silt loams, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2qwz

Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 95 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition
Minidoka and similar soils: 60 percent
Minveno and similar soils: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minidoka

Setting
Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess and/or lacustrine deposits

Typical profile
A - 0 to 4 inches: silt loam
Bw - 4 to 12 inches: silt loam
Bk - 12 to 27 inches: silt loam
Bkqm - 27 to 43 inches: cemented material
C - 43 to 60 inches: silt loam

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

Description of Minveno

Setting
Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess and/or mixed silty alluvium over bedrock derived from volcanic rock and/or basalt

Typical profile
A - 0 to 8 inches: silt loam
Bk - 8 to 14 inches: loam

Bkqm - 14 to 21 inches: cemented material
R - 21 to 31 inches: bedrock

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: 10 to 20 inches to duripan; 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups
Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

105—Minveno silt loam, 0 to 4 percent slopes

Map Unit Setting
National map unit symbol: 2qx1
Elevation: 2,500 to 5,000 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 95 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition
Minveno and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minveno

Setting
Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess and/or mixed silty alluvium over bedrock derived from volcanic rock and/or basalt

Typical profile
A - 0 to 8 inches: silt loam
Bk - 8 to 14 inches: loam

Bkqm - 14 to 21 inches: cemented material
R - 21 to 31 inches: bedrock

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 10 to 20 inches to duripan; 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

107—Minveno-Minidoka silt loams, 0 to 8 percent slopes, stony

Map Unit Setting

National map unit symbol: 2qx3
Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 95 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Minveno, stony surface, and similar soils: 55 percent
Minidoka, stony surface, and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minveno, Stony Surface

Setting

Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess and/or mixed silty alluvium over bedrock derived from volcanic rock and/or basalt

Typical profile

A - 0 to 8 inches: silt loam
Bk - 8 to 14 inches: loam

Bkqm - 14 to 21 inches: cemented material
R - 21 to 31 inches: bedrock

Properties and qualities
Slope: 0 to 8 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: 10 to 20 inches to duripan; 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups
Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

Description of Minidoka, Stony Surface

Setting
Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess and/or lacustrine deposits

Typical profile
A - 0 to 4 inches: silt loam
Bw - 4 to 12 inches: silt loam
Bk - 12 to 27 inches: silt loam
Bkqm - 27 to 43 inches: cemented material
C - 43 to 60 inches: silt loam

Properties and qualities
Slope: 0 to 8 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups
Land capability classification (irrigated): 4e

Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: LOAMY 8-12 - Provisional (R011XY001ID)

132—Rock outcrop-Rubble land association

Map Unit Composition
Rubble land: 40 percent
Rock outcrop: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Typical profile
R - 0 to 60 inches: bedrock

Properties and qualities
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Description of Rubble Land

Typical profile
C - 0 to 60 inches: stones, boulders

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

154—Timmerman loamy sand, 2 to 20 percent slopes, rubbly

Map Unit Setting
National map unit symbol: 2qys
Elevation: 2,200 to 3,000 feet
Mean annual precipitation: 8 to 10 inches
Mean annual air temperature: 52 degrees F
Frost-free period: 140 days
Farmland classification: Not prime farmland

Map Unit Composition
Timmerman, rubbly surface, and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Timmerman, Rubbly Surface

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

A - 0 to 7 inches: loamy sand
Bw - 7 to 16 inches: bouldery sandy loam
2C - 16 to 60 inches: bouldery coarse sand

Properties and qualities

Slope: 2 to 20 percent
Percent of area covered with surface fragments: 22.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY-HECOC8 (R011XY014ID)

161—Truesdale fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2qz1
Elevation: 2,200 to 4,500 feet
Mean annual precipitation: 7 to 11 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 170 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Truesdale and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truesdale

Setting

Landform: Lava plains, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or lacustrine deposits and/or loess

Typical profile

A - 0 to 5 inches: fine sandy loam
Bw - 5 to 18 inches: fine sandy loam
Bk - 18 to 27 inches: fine sandy loam
Bkqm - 27 to 60 inches: cemented material

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY-HECOC8 (R011XY014ID)

175—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Gully
- Short Steep Slope
- Other

Political Features
- Urban Areas
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:61,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Elmore Area, Idaho, Parts of Elmore, Owyhee and Ada Counties
Survey Area Data: Version 9, Jan 31, 2008

Date(s) aerial images were photographed: 6/22/2004

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Elmore Area, Idaho, Parts of Elmore, Owyhee and Ada Counties (ID672)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
7	Bahem silt loam, 0 to 4 percent slopes	122.0	14.4%
9	Bahem-Minidoka-Trevino complex, 0 to 4 percent slopes	61.8	7.3%
48	Davey-Quincy complex, 1 to 12 percent slopes	8.5	1.0%
50	Dors fine sandy loam, 0 to 4 percent slopes	12.0	1.4%
67	Garbutt-Weso complex, 0 to 2 percent slopes	23.1	2.7%
68	Garbutt-Weso-Trevino complex, 2 to 8 percent slopes	82.1	9.7%
69	Garbutt-Trevino association, 4 to 20 percent slopes	2.5	0.3%
84	Jacquith loamy sand, 4 to 12 percent slopes	30.6	3.6%
85	Jacquith loamy fine sand, 1 to 8 percent slopes	13.3	1.6%
98	Loray gravelly fine sandy loam, 0 to 12 percent slopes	4.2	0.5%
100	Mazuma fine sandy loam, 0 to 4 percent slopes	60.6	7.2%
103	Minidoka-Minveno silt loams, 0 to 4 percent slopes	9.8	1.2%
118	Power-Jenness complex, 0 to 2 percent slopes	59.2	7.0%
132	Rock outcrop-Rubble land association	43.0	5.1%
133	Royal fine sandy loam, 0 to 4 percent slopes	17.3	2.0%
137	Royal-Shano-Rock outcrop complex, 0 to 20 percent slopes	3.1	0.4%
156	Timmerman sandy loam, 4 to 12 percent slopes	8.1	1.0%
157	Trevino-Garbutt-Weso complex, 2 to 8 percent slopes	278.3	32.9%
165	Typic Torriorthents-Rubble land complex, 20 to 70 percent slopes	3.6	0.4%
175	Water	3.2	0.4%
Totals for Area of Interest		**846.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Elmore Area, Idaho, Parts of Elmore, Owyhee and Ada Counties

7—Bahem silt loam, 0 to 4 percent slopes

Map Unit Setting

Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 7 to 12 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 110 to 170 days

Map Unit Composition

Bahem and similar soils: 80 percent

Description of Bahem

Setting

Landform: Stream terraces, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water capacity: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 6c
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 15 inches: Silt loam
15 to 46 inches: Silt loam
46 to 60 inches: Fine sandy loam

9—Bahem-Minidoka-Trevino complex, 0 to 4 percent slopes

Map Unit Setting

Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 7 to 12 inches
Mean annual air temperature: 45 to 52 degrees F

Frost-free period: 100 to 170 days

Map Unit Composition

Bahem and similar soils: 45 percent
Minidoka and similar soils: 25 percent
Trevino and similar soils: 20 percent

Description of Bahem

Setting

Landform: Lava plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water capacity: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 6c
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 15 inches: Silt loam
15 to 46 inches: Silt loam
46 to 60 inches: Fine sandy loam

Description of Minidoka

Setting

Landform: Ridges, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess and/or lacustrine deposits

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 6s
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 4 inches: Silt loam
4 to 12 inches: Silt loam
12 to 27 inches: Silt loam
27 to 43 inches: Cemented material
43 to 60 inches: Silt loam

Description of Trevino

Setting

Landform: Lava plains, ridges
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess over bedrock derived from basalt

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 6s
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 5 inches: Stony loam
5 to 12 inches: Loam
12 to 18 inches: Fine sandy loam
18 to 28 inches: Unweathered bedrock

48—Davey-Quincy complex, 1 to 12 percent slopes

Map Unit Setting

Elevation: 200 to 4,500 feet
Mean annual precipitation: 6 to 12 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 100 to 200 days

Map Unit Composition

Davey and similar soils: 40 percent
Quincy and similar soils: 35 percent

Description of Davey

Setting

Landform: Stream terraces, fan remnants, dunes
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 1 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 6e
Ecological site: SAND 8-12 ARTRT/ACHY (R011XY011ID)

Typical profile

0 to 15 inches: Loamy fine sand
15 to 22 inches: Fine sandy loam
22 to 60 inches: Loamy sand

Description of Quincy

Setting

Landform: Stream terraces, fan remnants, dunes
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Mixed eolian sands and/or alluvium

Properties and qualities

Slope: 1 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 7e
Ecological site: SAND 8-12 ARTRT/ACHY (R011XY011ID)

Typical profile

0 to 3 inches: Fine sand
3 to 60 inches: Fine sand

50—Dors fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

Elevation: 2,300 to 3,000 feet
Mean annual precipitation: 6 to 8 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 130 to 150 days

Map Unit Composition

Dors and similar soils: 75 percent

Description of Dors

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 20 to 40 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water capacity: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability (nonirrigated): 7c
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 5 inches: Fine sandy loam
5 to 26 inches: Fine sandy loam
26 to 60 inches: Very gravelly sand

67—Garbutt-Weso complex, 0 to 2 percent slopes

Map Unit Setting

Elevation: 2,000 to 5,500 feet
Mean annual precipitation: 6 to 10 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days

Map Unit Composition

Garbutt and similar soils: 50 percent
Weso and similar soils: 30 percent

Description of Garbutt

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 1

Land capability (nonirrigated): 7c
Ecological site: SILTY 7-10 KRLA2/ACHY (R011XY009ID)

Typical profile
0 to 5 inches: Silt loam
5 to 60 inches: Very fine sandy loam

Description of Weso

Setting
Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and loess

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to moderately saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 45.0
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups
Land capability classification (irrigated): 2c
Land capability (nonirrigated): 7c
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile
0 to 5 inches: Loam
5 to 19 inches: Loam
19 to 60 inches: Stratified very gravelly loamy sand to fine sandy loam

68—Garbutt-Weso-Trevino complex, 2 to 8 percent slopes

Map Unit Setting
Elevation: 2,000 to 5,500 feet
Mean annual precipitation: 6 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days

Map Unit Composition
Garbutt and similar soils: 40 percent
Weso and similar soils: 35 percent

Trevino and similar soils: 15 percent

Description of Garbutt

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Properties and qualities

Slope: 2 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 7c
Ecological site: SILTY 7-10 KRLA2/ACHY (R011XY009ID)

Typical profile

0 to 5 inches: Silt loam
5 to 60 inches: Very fine sandy loam

Description of Weso

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and loess

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to moderately saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 45.0
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 7c

Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 5 inches: Loam
5 to 19 inches: Loam
19 to 60 inches: Stratified very gravelly loamy sand to fine sandy loam

Description of Trevino

Setting

Landform: Fan remnants, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess over bedrock derived from basalt

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 6e
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 5 inches: Stony silt loam
5 to 12 inches: Loam
12 to 18 inches: Fine sandy loam
18 to 28 inches: Unweathered bedrock

69—Garbutt-Trevino association, 4 to 20 percent slopes

Map Unit Setting

Elevation: 2,000 to 5,400 feet
Mean annual precipitation: 6 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days

Map Unit Composition

Garbutt and similar soils: 50 percent
Trevino and similar soils: 25 percent

Description of Garbutt

Setting

Landform: Drainageways, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Properties and qualities

Slope: 4 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 7e
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 5 inches: Silt loam
5 to 60 inches: Very fine sandy loam

Description of Trevino

Setting

Landform: Ridges, lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess over bedrock derived from basalt

Properties and qualities

Slope: 4 to 20 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0

Available water capacity: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability (nonirrigated): 6e
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 5 inches: Stony silt loam
5 to 12 inches: Loam
12 to 18 inches: Fine sandy loam
18 to 28 inches: Unweathered bedrock

84—Jacquith loamy sand, 4 to 12 percent slopes

Map Unit Setting

Elevation: 2,200 to 3,500 feet
Mean annual precipitation: 7 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 110 to 160 days

Map Unit Composition

Jacquith and similar soils: 80 percent

Description of Jacquith

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 4 to 12 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water capacity: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 7e
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY (R011XY014ID)

Typical profile

0 to 10 inches: Loamy sand
10 to 30 inches: Loamy sand
30 to 60 inches: Cemented gravelly loamy sand

85—Jacquith loamy fine sand, 1 to 8 percent slopes

Map Unit Setting

Elevation: 2,200 to 3,500 feet
Mean annual precipitation: 7 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 110 to 160 days

Map Unit Composition

Jacquith and similar soils: 75 percent

Description of Jacquith

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water capacity: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 7e
Ecological site: SAND 8-12 ARTRT/ACHY (R011XY011ID)

Typical profile

0 to 10 inches: Loamy fine sand
10 to 30 inches: Loamy sand
30 to 60 inches: Cemented gravelly loamy sand

98—Loray gravelly fine sandy loam, 0 to 12 percent slopes

Map Unit Setting

Elevation: 4,800 to 5,300 feet
Mean annual precipitation: 5 to 8 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 100 to 130 days

Map Unit Composition

Loray and similar soils: 75 percent

Description of Loray

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 12.0
Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 6 inches: Gravelly sandy loam
6 to 13 inches: Gravelly sandy loam
13 to 60 inches: Stratified extremely gravelly coarse sand to extremely gravelly loamy fine sand

100—Mazuma fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

Elevation: 2,300 to 3,100 feet

Mean annual precipitation: 7 inches
Frost-free period: 140 days

Map Unit Composition
Mazuma and similar soils: 75 percent

Description of Mazuma

Setting
Landform: Fan remnants, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Slightly saline to moderately saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water capacity: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability (nonirrigated): 7e
Ecological site: SALINE BOTTOM 8-12 SAVE4/LECI4 (R011XY002ID)

Typical profile
0 to 16 inches: Fine sandy loam
16 to 40 inches: Fine sandy loam
40 to 60 inches: Loam

103—Minidoka-Minveno silt loams, 0 to 4 percent slopes

Map Unit Setting
Elevation: 2,000 to 5,000 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 95 to 160 days

Map Unit Composition
Minidoka and similar soils: 60 percent
Minveno and similar soils: 20 percent

Description of Minidoka

Setting
Landform: Lava plains

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or loess and/or lacustrine deposits

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 6s
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 4 inches: Silt loam
4 to 12 inches: Silt loam
12 to 27 inches: Silt loam
27 to 43 inches: Cemented material
43 to 60 inches: Silt loam

Description of Minveno

Setting

Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess and/or mixed silty alluvium over bedrock derived from volcanic rock and/or basalt

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: 10 to 20 inches to duripan; 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability (nonirrigated): 6s

Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 8 inches: Silt loam
8 to 14 inches: Loam
14 to 21 inches: Cemented material
21 to 31 inches: Unweathered bedrock

118—Power-Jenness complex, 0 to 2 percent slopes

Map Unit Setting

Elevation: 2,000 to 4,600 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 170 days

Map Unit Composition

Power and similar soils: 50 percent
Jenness and similar soils: 30 percent

Description of Power

Setting

Landform: Fan remnants, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability (nonirrigated): 6c
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 6 inches: Silt loam
6 to 19 inches: Clay loam
19 to 26 inches: Loam

26 to 60 inches: Loam

Description of Jenness

Setting

Landform: Fan remnants, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous rock

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 2c
Land capability (nonirrigated): 6c
Ecological site: LOAMY BOTTOM 8-14 ARTRT/LECI4 (R011XY015ID)

Typical profile

0 to 6 inches: Loam
6 to 12 inches: Loam
12 to 36 inches: Sandy loam
36 to 60 inches: Gravelly loamy sand

132—Rock outcrop-Rubble land association

Map Unit Composition

Rubble land: 40 percent
Rock outcrop: 40 percent

Description of Rock Outcrop

Properties and qualities

Depth to restrictive feature: 0 inches to lithic bedrock

Typical profile

0 to 60 inches: Unweathered bedrock

Description of Rubble Land

Typical profile

0 to 60 inches: Fragmental material

133—Royal fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

Elevation: 2,300 to 3,500 feet
Mean annual precipitation: 8 to 10 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 120 to 150 days

Map Unit Composition

Royal and similar soils: 80 percent

Description of Royal

Setting

Landform: Fan remnants, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water capacity: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 6c
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY (R011XY014ID)

Typical profile

0 to 5 inches: Fine sandy loam
5 to 11 inches: Fine sandy loam
11 to 60 inches: Fine sandy loam

137—Royal-Shano-Rock outcrop complex, 0 to 20 percent slopes

Map Unit Setting

Elevation: 2,300 to 4,000 feet
Mean annual precipitation: 8 to 10 inches

Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 120 to 150 days

Map Unit Composition
Royal and similar soils: 30 percent
Shano and similar soils: 25 percent
Rock outcrop: 20 percent

Description of Royal

Setting
Landform: Lava plains, fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities
Slope: 0 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water capacity: Moderate (about 9.0 inches)

Interpretive groups
Land capability classification (irrigated): 4e
Land capability (nonirrigated): 6e
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY (R011XY014ID)

Typical profile
0 to 5 inches: Fine sandy loam
5 to 11 inches: Fine sandy loam
11 to 60 inches: Fine sandy loam

Description of Shano

Setting
Landform: Lava plains, fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess

Properties and qualities
Slope: 0 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 6e
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 2 inches: Loam
2 to 15 inches: Very fine sandy loam
15 to 60 inches: Fine sandy loam

Description of Rock Outcrop

Properties and qualities

Slope: 0 to 20 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Typical profile

0 to 60 inches: Unweathered bedrock

156—Timmerman sandy loam, 4 to 12 percent slopes

Map Unit Setting

Elevation: 2,200 to 3,000 feet
Mean annual precipitation: 8 to 11 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 160 days

Map Unit Composition

Timmerman and similar soils: 85 percent

Description of Timmerman

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 4 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent

Available water capacity: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 6e
Ecological site: SANDY LOAM 8-12 ARTRW8/ACHY (R011XY014ID)

Typical profile

0 to 6 inches: Sandy loam
6 to 17 inches: Sandy loam
17 to 60 inches: Coarse sand

157—Trevino-Garbutt-Weso complex, 2 to 8 percent slopes

Map Unit Setting

Elevation: 2,000 to 5,500 feet
Mean annual precipitation: 6 to 11 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 100 to 165 days

Map Unit Composition

Trevino and similar soils: 40 percent
Weso and similar soils: 20 percent
Garbutt and similar soils: 20 percent

Description of Trevino

Setting

Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or loess over bedrock derived from basalt

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 6e
Ecological site: LOAMY 8-12 ARTRW8/PSSPS-ACTH7 (R011XY001ID)

Typical profile

0 to 5 inches: Stony loam
5 to 12 inches: Loam
12 to 18 inches: Fine sandy loam
18 to 28 inches: Unweathered bedrock

Description of Garbutt

Setting

Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and/or lacustrine deposits and/or loess

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 7e
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 5 inches: Silt loam
5 to 60 inches: Very fine sandy loam

Description of Weso

Setting

Landform: Lava plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and loess

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to moderately saline (4.0 to 16.0 mmhos/cm)

Sodium adsorption ratio, maximum: 45.0
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 7c
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 5 inches: Loam
5 to 19 inches: Loam
19 to 60 inches: Stratified very gravelly loamy sand to fine sandy loam

165—Typic Torriorthents-Rubble land complex, 20 to 70 percent slopes

Map Unit Setting

Elevation: 2,400 to 3,000 feet
Mean annual precipitation: 7 inches
Mean annual air temperature: 54 degrees F

Map Unit Composition

Typic torriorthents and similar soils: 60 percent
Rubble land: 20 percent

Description of Typic Torriorthents

Setting

Landform: Canyons
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium and/or lacustrine deposits

Properties and qualities

Slope: 20 to 70 percent
Depth to restrictive feature: 2 to 6 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Available water capacity: Very low (about 0.5 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: CALCAREOUS LOAM 7-10 ATCO-PIDE4/ACHY-ACTH7 (R011XY010ID)

Typical profile

0 to 6 inches: Stony sandy loam
6 to 60 inches: Stratified extremely gravelly loamy sand to very gravelly sandy loam

Description of Rubble Land

Typical profile

0 to 60 inches: Fragmental material

175—Water

Map Unit Composition

Water: 100 percent

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://soils.usda.gov/

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://soils.usda.gov/

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://soils.usda.gov/

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.glti.nrcs.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://soils.usda.gov/