March 2017
Palouse Basin Aquifer Committee

Palouse Groundwater Basin Water Supply Alternatives Analysis Report

Prepared for Palouse Basin Aquifer Committee/University of Idaho

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ABBREVIATIONS

AF	acre-feet
AR	aquifer recharge
ASR	aquifer storage and recovery
CAC	criteria air contaminant
cfs	cubic feet per second
Consultant Team	Anchor QEA, LLC, HDR Engineering, and EA Engineering, Science and Technology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GHG	greenhouse gas
gpd	gallons per day
kWh	kilowatt hour
LCC	lifecycle cost
MG	million gallons
MGD	million gallons per day
MGY	million gallons per year
O&M	operation and maintenance
PBAC	Palouse Basin Aquifer Committee
SF	south fork
UI	University of Idaho
WSU	Washington State University
WW	wastewater
WWTP	wastewater treatment plant

Executive Summary

A Consultant Team was hired by the Palouse Basin Aquifer Committee (PBAC) to evaluate previously studied water supply projects to determine the most promising supply projects for meeting existing and future supply needs in the Palouse groundwater basin. This study was conducted as part of PBAC's mission to ensure a long-term, quality water supply for the Palouse Basin region, and associated goals (PBAC 2011). The evaluation study was jointly funded by PBAC and a grant from the Idaho Water Resource Board.

The evaluation process began in October 2015 and was completed in February 2017. The Consultant Team completed the following steps during this study, in coordination with PBAC:

- Developed a regional 50-year water demand projection and water supply target, with different levels of conservation savings applied.
- Developed a list of potential supply projects and management actions to evaluate in relationship to the water supply target and other factors.
- Applied a two-step screening and evaluation process for the list of supply projects and management actions.
- Formulated four different water supply alternatives and conducted a multi-criteria evaluation of these alternatives, including quantitative and qualitative measures. The four alternatives evaluated included the following:
  - Alternative 1 – Snake River Diversion and Pipeline to Pullman and Moscow
  - Alternative 2 – North Fork Palouse River Diversion and Pipelines to Pullman and Moscow plus Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow
  - Alternative 3 – Flannigan Creek Storage, Conveyance to and Treatment for Moscow and the University of Idaho, plus South Fork Direct Diversion for Pullman to Washington State University
  - Alternative 4 – Paradise Creek Aquifer Recharge for Moscow, South Fork Aquifer Storage and Recovery for Pullman, Pullman Wastewater Reuse, and Moscow Wastewater Reuse and Groundwater Recharge Plus Additional Conservation.
- Summarized findings, recommendations, data gaps, additional information needs, and next steps.

Thirteen factors were considered in the evaluation of these alternatives, including quantitative (e.g., capital and operations costs, yield variability) and qualitative (e.g., water quality impacts, environmental effects, permitting challenges) factors. A multi-criteria 50-year lifecycle cost analysis was conducted using direct inputs regarding the quantitative factors and incorporating project uncertainty and risk as reflected by the effects that the qualitatively assessed factors may have on features such as yield, schedule, and cost.

The results from this evaluation concluded that Alternative 1 would be the most expensive, but if water rights could be secured, could provide the simplest and perhaps the longest-term reliable supply. Alternatives 2 and 4 provided better value than the others based on lower capital costs and lifecycle costs, and lower environmental impacts, recognizing neither alternative meets the 2065 target as reliably as Alternatives 1 and 3. Between Alternatives 2 and 4, Alternative 2 is a better option overall, when considering not only cost and yield criteria, but also other evaluation criteria. It provides for 85% of the supplemental supply target through 2065 and also has opportunity for further refinements that could potentially further improve yield amount and reliability.

This analysis did not identify a recommended alternative that clearly stood above the rest in terms of the criteria considered. This finding, along with the potential for additional analyses to further refine the multi-criteria evaluation, leads to a recommendation to not remove any alternative from further consideration at this time. The merits of each should be re-evaluated in light of addressed data gaps and refined analysis.

Starting in 2017 and continuing during the next several years, PBAC will seek involvement from the public, communities, and stakeholders in selecting a preferred solution to meeting the supplemental water supply goal. This includes receiving input on the following items:

- The Final Draft Palouse Groundwater Basin Water Supply Study.
- Additional analyses and studies conducted to further evaluate and refine one or more alternatives and their associated project elements.
- Potential environmental effects anticipated from the projects and actions included in the alternatives.
- Related topics that might emerge during the public involvement process.

The PBAC decision timeline is to have a refined set of alternatives in place by 2020 and a plan ready for implementation by 2025. This timeline is consistent with the PBAC's Mission and Goals, which state that PBAC will develop and implement a balanced basin-wide Water Supply and Use Program by 2025 (PBAC 2011).

1 Introduction

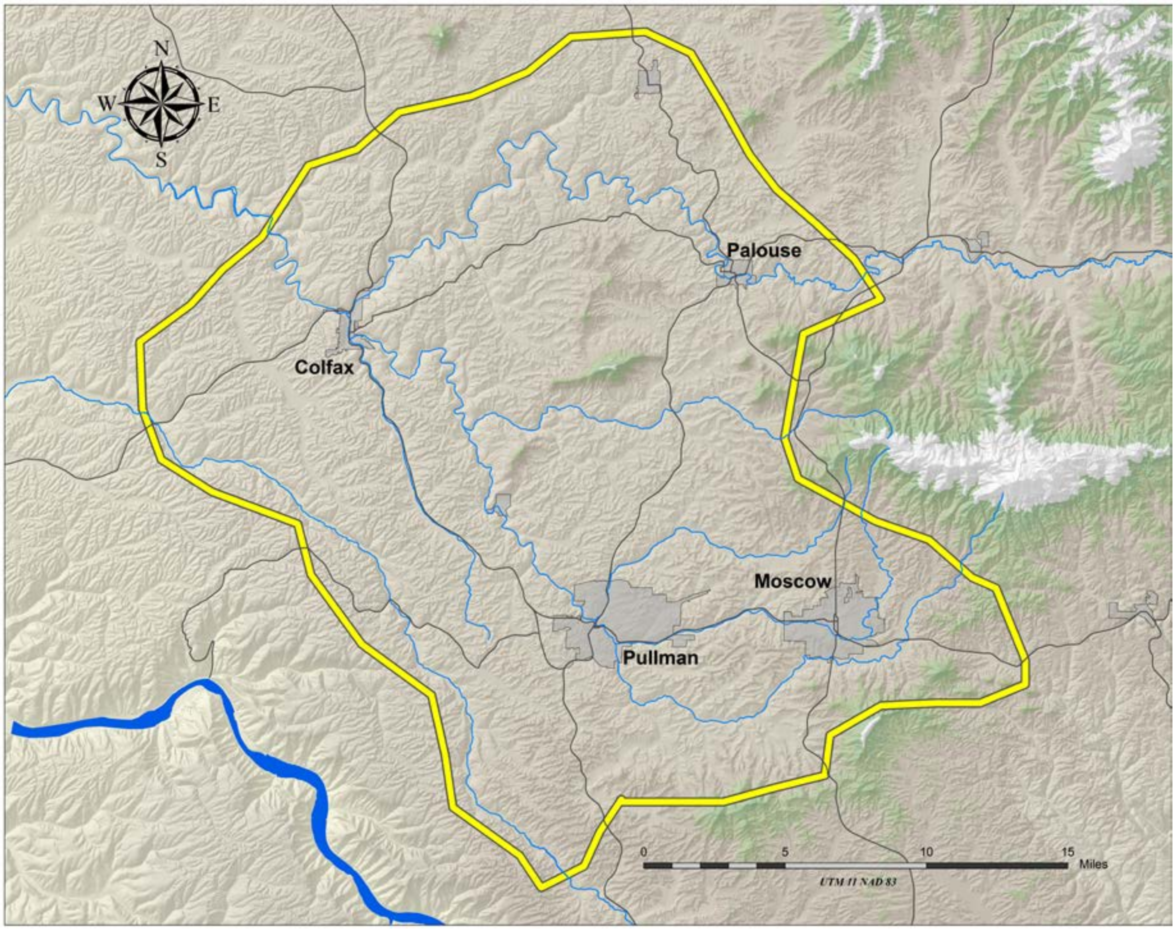
1.1 Study Purpose and Palouse Groundwater Basin Overview

Anchor QEA, LLC, HDR Engineering, and EA Engineering, Science and Technology (the Consultant Team) were hired by the Palouse Basin Aquifer Committee (PBAC) to evaluate previously studied water supply projects to determine the most promising supply projects for meeting existing and future supply needs in the Palouse groundwater basin. This study was conducted as part of PBAC's mission to ensure a long-term, quality water supply for the Palouse Basin region, and associated goals (PBAC 2011).

The evaluation process began in October 2015 and was completed in February 2017. The evaluation study was jointly funded by PBAC and a grant from the Idaho Water Resource Board. Several coordination meetings and conference calls were held with PBAC throughout the study process to discuss analysis methods, interim and updated findings and results, and recommended next steps. Updates were also made periodically to the Idaho Water Resource Board.

The Palouse groundwater basin primarily comprises the area around Moscow and the University of Idaho (UI), Pullman and Washington State University (WSU), and nearby outlying communities in Whitman County, Washington, and Latah County, Idaho (Figure 1). Throughout the growth and development of the cities and universities, they have depended on the Palouse Groundwater Basin for their water supply. The water supply for the basin is withdrawn from several different geologic formations within the Columbia River Basalt group, the most productive of which is the Grand Ronde Basalt.

Figure 1
Palouse Groundwater Basin

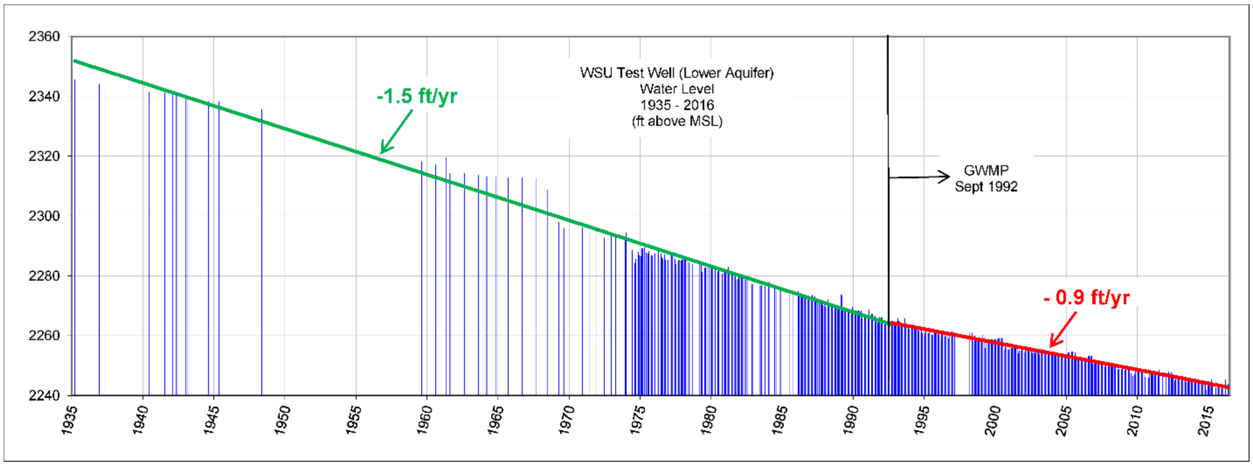


Source: Palouse Basin Aquifer Committee 2016

When the first wells were drilled in the region in the late 1800s, the aquifers were flowing artesian, rising to as much as 25 feet above the ground surface. Today, groundwater levels are declining (Figure 2), causing the basin to become the subject of numerous published studies, beginning in 1897 and continuing to the present. The cities and universities have implemented water conservation, wastewater reuse, and other management measures in an effort to reduce impacts on the aquifer.

Increased pumping that will be required to meet future water demands is expected to place additional stress on the deeper basalt aquifers and result in further aquifer declines. Not enough is known about groundwater to know how many years of additional pumping the deeper aquifer can sustain before the water supply begins to fail. PBAC and its member organizations are seeking to find out if alternate supplies might be available to serve a significant portion of projected long-term water supply needs to preserve the existing groundwater supply and meet projected future water demands.

Figure 2
Historical and Current Groundwater Levels



Source: Palouse Basin Aquifer Committee 2016
Note:
GMWP: Ground Water Management Plan

1.2 Prior Studies and Related Planning Documentation

This study relied on existing information on file at PBAC or from its member organizations. In 2014, PBAC developed an annotated document bibliography of all the studies on file with PBAC or member organizations related to water supply alternatives. The Consultant Team reviewed this bibliography and requested from PBAC and its members more than 40 studies and plans to include in the initial review and evaluation of relevant information sources, with some studies prepared as early as 1958 and others as recent as 2015. A list of these studies is provided in Appendix A. From these sources, another list was generated, including names and brief descriptions of the potential water supply projects and water management actions to include in the study evaluation, as further described in Section 3.

1.3 Study Process Overview

The Consultant Team completed the following steps during this study in coordination with PBAC:

- Developed a regional 50-year water demand projection and water supply target, with different levels of conservation savings applied.
- Developed a list of potential supply projects and management actions to evaluate in relationship to the water supply target and other factors.

- Applied a 2-step screening and evaluation process for the list of supply projects and management actions.
- Formulated four different water supply alternatives and conducted a multi-criteria evaluation of these alternatives, including quantitative and qualitative measures.
- Summarized findings, recommendations, data gaps, additional information needs, and next steps.

Each of these steps is discussed in detail in this report, with more summary information included in the main body of the report and additional information provided in appendices.

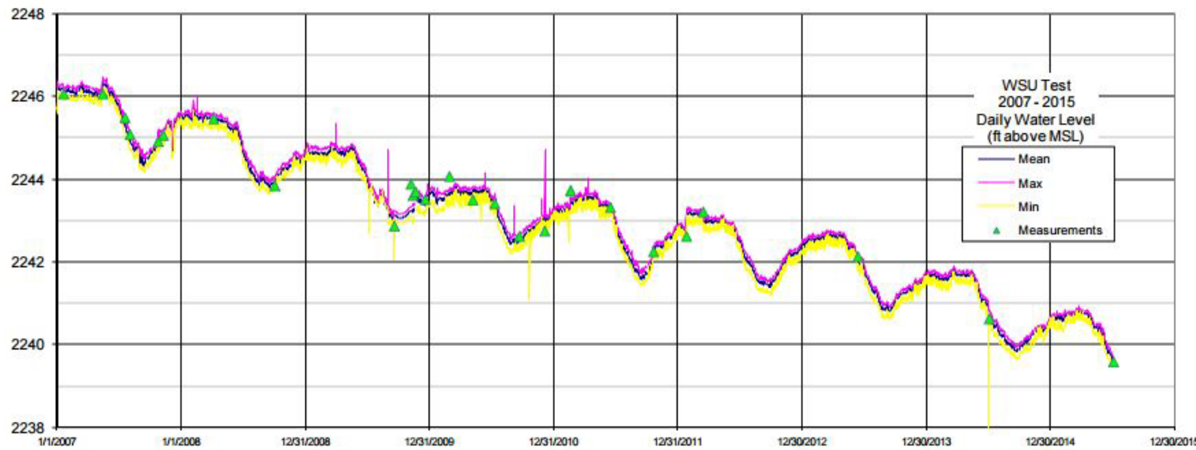
2 Water Demands and Regional Supplemental Supply Target

The Consultant Team worked with PBAC to identify a regional supplemental supply target to use as a measuring stick for evaluating water supply alternatives. The supplemental water supply target includes water supply that would need to be made available from a proposed project to offset projected increases in water demand and stabilize the existing decline of the aquifer. Water demand, conservation savings, Palouse aquifer fluctuations, and other information were discussed with PBAC as an initial step in developing the regional supplemental supply target.

During a series of meetings, PBAC selected a supplemental water supply target of 2,324 million gallons (MG; 7,130 acre feet [AF]) per year for combined regional use in evaluating the performance of water supply alternatives in meeting future water needs. This supplemental supply target represents the combination of the following two projected components of future water demand for water users within the Palouse Basin:

- **Projected Increase in Water Demand:** The first component, 1,588 MG (4,874 AF) is the projected increase in demand for the Palouse Basin region through the year 2065 over baseline demand based on population increase. Baseline demand represents current water use for water users within the Palouse Basin and was determined by averaging water usage in Pullman, Moscow, WSU, UI, and Palouse for the 2013 to 2015 period. Baseline demand is 2,464 MG per year.
- **Aquifer Stabilization:** The second component included in the supplemental water supply target was an aquifer stabilization volume of 735 MG (2,256 AF). The aquifer stabilization volume is equal to the estimated baseline irrigation demand, derived from estimated average irrigation usage from 2013 to 2015. Each year during and after the June through September irrigation season, the aquifer sees an accelerated rate of decline and then partial recovery (Figure 3) from the heavier pumping, where approximately 40 to 50% of the total annual water withdrawal typically occurs. Supply for this aquifer stabilization amount from an alternate source, other than groundwater, could result in a reduction in aquifer decline or perhaps even a stabilization of aquifer levels.

Figure 3
Water Levels – Grande Ronde Short-term



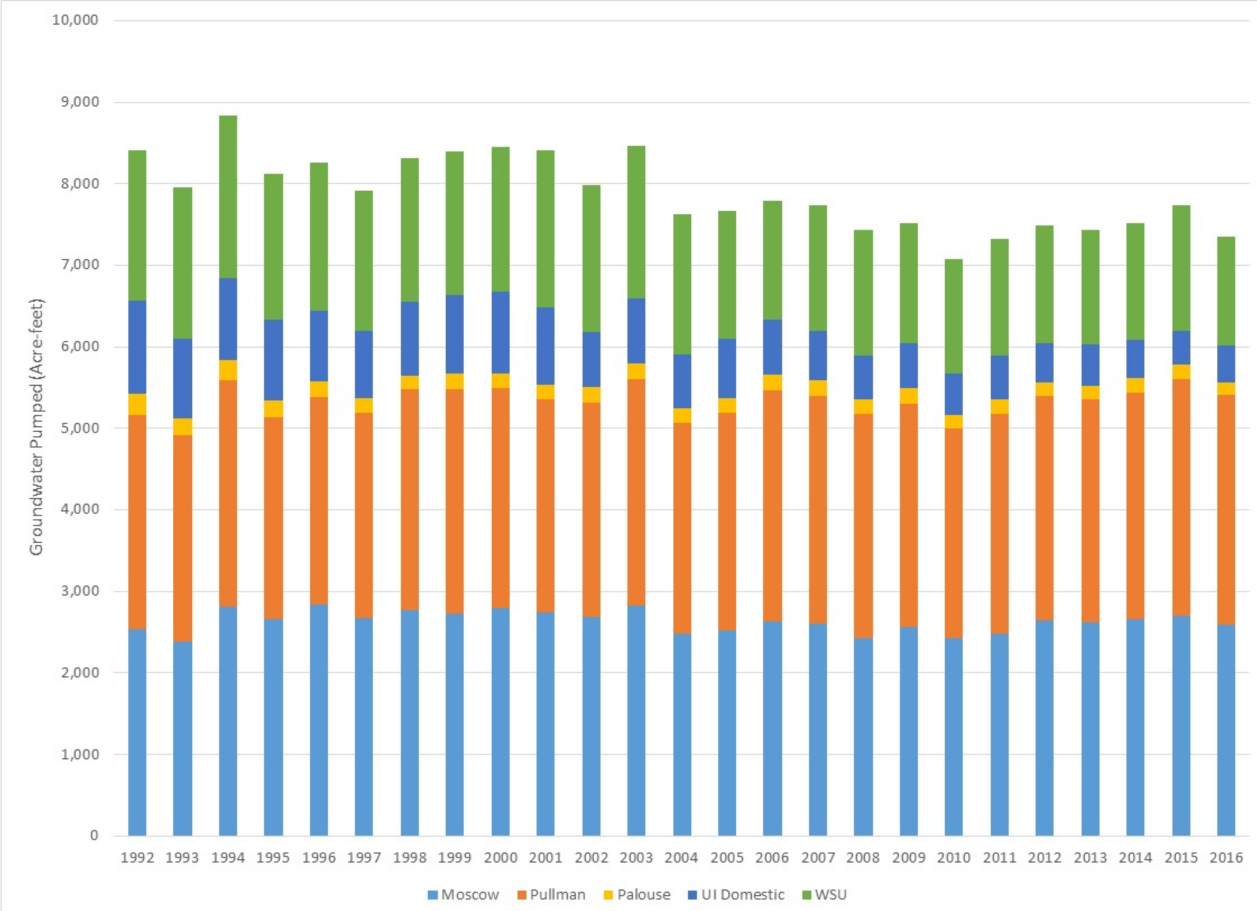
Source: PBAC (2015)
Note:
MSL: mean sea level

The remainder of this section provides additional detail on the information used in developing the regional supplemental water supply target, including a summary of historical water usage, projected future water demands, a description of how varying levels of conservation can further reduce demand, and a summary table and figure showing the projected demands with varying levels of conservation for Pullman, Moscow, WSU, UI, Palouse, and the Palouse Basin region.

2.1 Historical and Recent Water Use in the Palouse Basin

Figure 4 shows the overall pattern of water use in the Palouse Basin since 1992. Water use data was provided by PBAC. Throughout the past two decades, Pullman, Moscow and the two universities have made capital improvements and water management changes to preserve groundwater supply. Leak detection and replacement of aging pipes, steady emphasis on water conservation, community education, changes in landscape irrigation practices, wastewater reuse, and water use efficiency measures have reduced pumping levels and per capita demand consistent with annual and multi-year conservation goals while population has increased. Water use and groundwater pumping in the Palouse Basin peaked in 1994 with 8,832 acre-feet (AF) (2,878 MG) being pumped. A total of 7,356 AF (2,397 MG) was pumped in 2016, as reported by the major pumping entities (Pullman, Moscow, WSU, UI, and the City of Palouse), which is a reduction of 12.5% compared to 1992.

Figure 4
Palouse Basin Historic Groundwater Pumping, 1992 to 2016



Source of Data: PBAC Water Use Reports

2.2 Population and Projected Growth in the Palouse Basin

The communities and universities in the Palouse Basin have experienced steady growth in recent decades, and this growth is expected to continue. In 2013, the population for Pullman was 31,395 and 24,534 for Moscow, including those enrolled at the two universities. WSU Pullman's 2016 enrollment is approximately 19,600 (Taylor 2016), with approximately 6,300 served by the WSU water system. UI enrollment in Moscow for 2016 is approximately 11,780, with roughly 3,300 living on campus and served by the UI water utility. Both universities maintain separate water systems within the cities. The total Whitman County population in 2015 was 48,177 (Baker 2015), and the total Latah County population in 2014 was 38,411 (University of Idaho Extension 2015).

In recent years, Pullman, Moscow, and WSU have seen growth rates that are on average at, or in some cases, greater than 1%. UI student enrollment has been slightly declining. Growth rates and associated water demands have also been projected within individual water system plans at varying levels and for varying time periods for each city and university. Because of these variations in growth rates and time periods and challenges with integrating these projections, it was determined in discussions with PBAC that a simpler method of forecasting future demand might work better. For this analysis, an assumed 1% annual increase in regional water demand, which is consistent with long-term averages, was applied to the 2013 to 2015 average demand to arrive at the 2065 projected demand of an additional 1,588 MG (4,874 AF) more than current pumping levels. As described above, the projected demand was combined with an aquifer stabilization amount of 735 MG (2,256 AF) to arrive at the 2,324 MG (7,130 AF) additional supplemental supply target. Varying levels of conservation were then applied, as discussed below.

2.3 Demands with Additional Water Conservation

Additional water conservation and efficiency improvements beyond the many measures that have been implemented and the existing goals established for the cities and universities can further reduce future per capita demand, as it has in recent history as described above. To account for expected additional future water savings, the Consultant Team initially compiled a list of all the conservation measures in place or planned for each city and university, and the associated water savings expected (Appendix B). As experienced with the demand forecast, integrating the various measures and projected savings, and developing additional assumptions where needed to project future additional conservation through 2065, proved challenging. So, a simpler approach was decided on, again in coordination with PBAC.

To account for future conservation savings and associated impacts on future water supply needs beyond what is projected under existing conservation programs, PBAC opted to forecast ranges of additional conservation based on a percentage reduction from the baseline demands. This included considering three different levels of conservation: 4%, 7%, and 10% additional savings over the current level of conservation already reflected in the baseline demands. The baseline demands reflect conservation savings from measures that have already been implemented. Accordingly, the 4%, 7%, and 10% additional conservation savings would be additive to the existing savings already being realized.

2.4 Summary Results

Table 1 summarizes the water demand projections, the baseline additional supplemental supply target with currently projected conservation savings, and the adjusted supplemental supply targets based on varying higher levels of conservation savings. The projections summarized in Table 1 reflect the following for Moscow, Pullman, WSU, UI, Palouse, and the Palouse Basin region:

- Existing (Baseline) Demand – Includes irrigation and non-irrigation components.

- Baseline Projection – Projections for all systems were assumed to be equal to baseline demands plus an annual growth of 1% and including currently projected conservation savings.
- Baseline Demand with 4% Conservation – Projections for all systems were assumed to be equal to baseline demands plus an annual growth of 1%, but assume additional conservation will result in a 4% savings over the baseline projection.
- Baseline Demand with 7% Conservation – Projections for all systems were assumed to be equal to baseline demands plus an annual growth of 1%, but assume additional conservation will result in a 7% savings over the baseline projection.
- Baseline Demand with 10% Conservation – Projections for all systems were assumed to be equal to baseline demands plus an annual growth of 1%, but assume additional conservation will result in a 10% savings over the baseline projection.

The increase in demand varies based on the level of additional conservation savings assumed for each projection. The aquifer stabilization amount of the supplemental supply target, which represents current or baseline irrigation demand (735 MGY or 2,256 AFY), remains constant under each projection. From this list of potential supplemental supply targets, PBAC selected the 2,324 million gallons per day (MGD; 7,130 AFY) supplemental supply target as the most conservative approach for evaluating the performance of water supply alternatives in meeting future water needs. This is the target that would be needed to supply the increased demand and provide for aquifer stabilization for the baseline demand projection without additional conservation beyond what is currently projected.

Table 1
Summary Projected Palouse Groundwater Basin Water Demands

Year/Type of Demand	Moscow (MGY)	Pullman (MGY)	WSU (MGY)	UI (MGY)	Palouse (MGY)	Total (MGY)	Total (AF)
Existing (Baseline) Demands[1]							
Irrigation	241	278	153	46	17	735	2,256
Non-Irrigation	623	637	322	106	40	1,728	5,304
Total	**864**	**915**	**475**	**152**	**57**	**2,464**	**7,561**
Baseline Projection (Existing Baseline with Currently Projected Conservation + 1% Annual Growth)[2]							
2065	1,422	1,505	781	250	94	4,052	12,434
50-year Projected Increase[3]	**557**	**590**	**306**	**98**	**37**	**1,588**	**4,874**
Aquifer Stabilization[4]	**241**	**278**	**153**	**46**	**17**	**735**	**2,256**
Supplemental Supply Target[5]	**798**	**868**	**459**	**143**	**54**	**2,324**	**7,130**
Baseline Projection with 4% Additional Conservation Savings by 2065[6]							
2065	1,365	1,445	750	240	91	3,890	11,937
50-year Projected Increase[3]	**500**	**530**	**275**	**88**	**33**	**1,426**	**4,376**

Aquifer Stabilization[4]	**241**	**278**	**153**	**46**	**17**	**735**	**2,256**
Supplemental Supply Target[5]	**741**	**808**	**428**	**133**	**50**	**2,161**	**6,633**
Baseline Projection with 7% Additional Conservation Savings by 2065[7]							
2065	1,322	1,400	727	232	88	3,768	11,564
50-year Projected Increase[3]	**458**	**485**	**252**	**80**	**30**	**1,305**	**4,003**
Aquifer Stabilization[4]	**241**	**278**	**153**	**46**	**17**	**735**	**2,256**
Supplemental Supply Target[5]	**699**	**763**	**405**	**126**	**48**	**2,040**	**6,260**
Baseline Projection with 10% Additional Conservation Savings by 2065[8]							
2065	1,279	1,355	703	225	85	3,647	11,191
50-year Projected Increase[3]	**415**	**439**	**228**	**73**	**28**	**1,183**	**3,630**
Aquifer Stabilization[4]	**241**	**278**	**153**	**46**	**17**	**735**	**2,256**
Supplemental Supply Target[5]	**656**	**718**	**381**	**118**	**45**	**1,918**	**5,887**

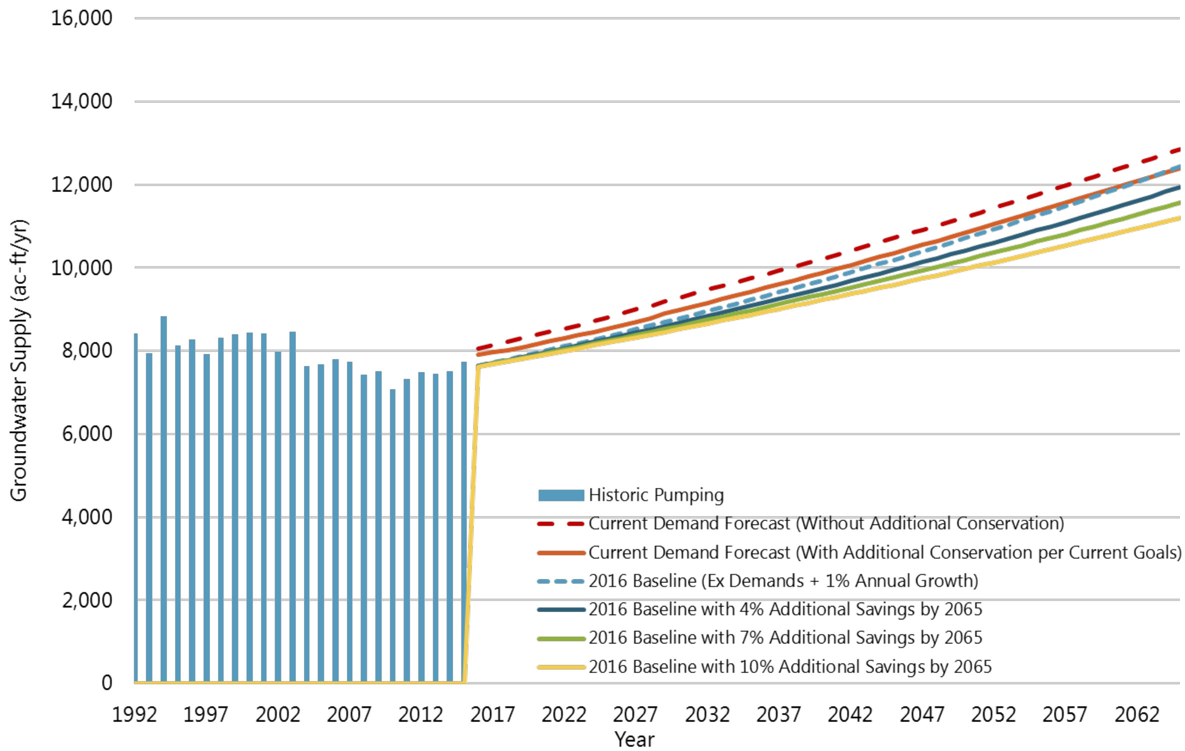
Notes:

1. Baseline demand equal to average demand from 2013 to 2015. Percent irrigation use based on monthly water use data from water system plans. Non-irrigation use assumed to be equal to average use from November through February.
2. Baseline projection equal to baseline plus 1% annual growth for each water system, including currently projected conservation.
3. Projected increase is the difference between the 2065 projected demand and the baseline demand.
4. Aquifer stabilization is equal to the estimated baseline irrigation demand.
5. The supplemental supply target is equal to the projected increase with varying levels of conservation savings plus the aquifer stabilization amount.
6. Includes an additional 4% reduction in demand beyond the baseline projection by 2065.
7. Includes an additional 7% reduction in demand beyond the baseline projection by 2065.
8. Includes an additional 10% reduction in demand beyond the baseline projection by 2065.

MGY: million gallons per year
AF: acre feet

Figure 5 includes a graphic depiction of historical pumping and projected demand forecasts for the Palouse Basin region. The Current Demand Forecast with and without additional conservation reflects the combined current demand projections from each water purveyors water system plan or water system demand forecasts. As discussed earlier, due to the variability in the way these projections were developed, a baseline demand projection was developed for the purpose of setting a supplemental supply target for evaluating water supply alternatives, which represents existing (average of 2013 to 2015) demands projected at a 1% annual growth rate. Figure 5 also shows baseline demand forecasted with additional levels of conservation (4, 7, and 10%).

Figure 5
Overall Palouse Basin – Historic Supply and Demand Forecast Data



Note: Overall Palouse Basin Supply and Demands include total estimated for Pullman, Moscow, WSU, UI, and Palouse.

3 Projects Evaluated

The Consultant Team compiled, reviewed, and synthesized information from all known and available previous studies and reports for potential water supply projects and water management actions. The Consultant Team reviewed more than 40 studies and plans on file at PBAC or provided by member organizations. A list of these studies is provided in Appendix A.

3.1 Project and Management Action Summaries

From the literature review, a list of potential projects and actions was developed and summarized in a large matrix, with each project assigned a project number. The initial list included 38 projects or management actions, including 30 surface or groundwater storage projects (Projects 1 to 30); three projects that include the combined conservation measures from the conservation programs currently adopted by Moscow, Pullman, and WSU (Projects 31 to 33), respectively; and five additional potential project concepts that are new or are variations of other projects previously considered (Projects 34 to 38). These new project concepts were developed with varying detail by the Consultant Team for PBAC consideration.

Each project was categorized by type (e.g., surface water, aquifer recharge, etc.), with a common description of summary information provided, as available, from the source documents:

- Source information, including study name, date the study was prepared, and the year of the cost estimate
- Project title and brief description
- Estimated supply in MG and AF; for surface water storage projects, this was primarily based on average annual yield for the basin supplying water
- Percentage of the regional baseline demand (without conservation) that could be met by the project
- Capital and operation and maintenance (O&M) costs for the project escalated to October 2016
- Project present value, as applicable, which included capital and annual operating costs in the calculation
- Capital and present value costs per acre-foot to provide a common basis for comparing costs and expected yield among the projects

Table 2 summarizes this information for each project. As mentioned above, conservation programs for Moscow, Pullman, and WSU were also included in the summary of projects. These represent a compilation of all the conservation measures identified from the *City Moscow Water Conservation Plan* (Baker 2015), the 2014 City of Pullman Water System Plan (Anchor QEA 2014), and the draft 2016 WSU Water System Plan (Taylor Engineering 2016). The sum of all the conservation measures included in each of these plans was inserted in the table, along with associated costs and other information items listed above, as applicable. UI also has a conservation program being implemented, including installing low-flow fixtures, conducting leak detection, and implementing other measures. Because the conservation plans are for different durations and serve different purposes, it was decided to not directly apply these programs into the evaluation, but rather to apply different levels of conservation, as explained in Section 2.3 and as also discussed in the summary of the alternatives analysis (Section 4).

Appendix C includes a more detailed table with additional information on each project or management action, including, as applicable, storage capacity, average annual yield, percent of local demand met (e.g., for Moscow), notes, and lists of preliminary additional information needs for each project. Appendix B includes a summary of the compiled conservation actions for Moscow, Pullman, and WSU.

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
1	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Flannigan Creek	Flannigan Creek - Alternative A1 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	1,430	4,400	35%	$ 62,845,000	$ 14,283	$ 2,740,000	$ 133,010,000	$ 195,855,000	$ 44,513	-6.8-square-mile watershed above reservoir -6,600-acre-foot reservoir (102-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 12.8 miles of pipeline -Treatment facilities in Moscow -Design capacity is 5.9 MGD or 4,100 gpm
2	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Hatter Creek	Hatter Creek - Alternative A2 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	782	2,400	19%	$ 76,572,000	$ 31,905	$ 1,756,000	$ 85,243,000	$ 161,815,000	$ 67,423	-3.5-square-mile watershed above reservoir -3,600-acre-foot reservoir (105-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 24.2 miles of pipeline -Treatment facilities in Moscow -Design capacity is 3.2 MGD or 2,200 gpm
3	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River	SF Palouse River - Alternative A3 Surface water supply alternative; Stored water conveyed to treatment; Treated water discharged directly to City of Moscow	228	700	6%	$ 30,079,000	$ 42,970	$ 499,000	$ 24,223,000	$ 54,302,000	$ 77,574	-1.3-square-mile watershed above reservoir -1,300-acre-foot reservoir (111-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Approximately 5.8 miles of pipeline -Treatment facilities in Moscow -Design capacity is 1.2 MGD or 800 gpm
4	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Felton Creek	Felton Creek - Alternative A4 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	424	1,300	10%	$ 37,481,000	$ 28,832	$ 850,000	$ 41,262,000	$ 78,743,000	$ 60,572	-2-square-mile watershed above reservoir -2,000-acre-foot reservoir (92-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 10.2 miles of pipeline -Treatment facilities in Moscow -Design capacity is 1.8 MGD or 1,240 gpm
5	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River - Non-potable Irrigation	SF Palouse River for Irrigation Supply - Alternative B3 Surface water supply alternative; Non-potable supply only; Stored water conveyed to City of Moscow in river; Pumped and distributed through irrigation system	196	600	5%	$ 5,674,000	$ 9,457	$ 75,000	$ 3,641,000	$ 9,315,000	$ 15,525	-1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Reservoir Capacity -Used for irrigation only (non-potable) -Conveyance in SF Palouse River Channel -Two intake pump stations in Moscow -Distribution piping in Moscow -Design capacity is 3.3 MGD or 2,260 gpm
6	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Felton Creek - Non-potable Irrigation	Felton Creek for Irrigation Supply - Alternative B4 Surface water supply alternative; Non-potable supply only; Stored water pumped and conveyed to City of Moscow; Distributed through irrigation system	126	385	3%	$ 14,896,000	$ 38,691	$ 67,000	$ 3,252,000	$ 18,148,000	$ 47,138	-2-square-mile watershed above reservoir -385-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Reservoir Capacity -Pumping facilities -Approximately 10.2 miles of pipeline -Distribution piping in Moscow -Design capacity is 2.1 MGD or 1,450 gpm

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
7	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	NF Palouse River - Direct Use	NF Palouse River - Alternative A5 Surface water supply alternative; Direct diversion from NF Palouse River in Idaho; Surface water pumped and conveyed to treatment in Moscow; Treated water discharged directly to City of Moscow	1,550	4,760	38%	$ 46,350,000	$ 9,737	$ 2,681,000	$ 130,146,000	$ 176,496,000	$ 37,079	-Direct diversion of NF Palouse water -Estimated Supply = 10 cfs from November to June -River intake pump station -Approximately 14 miles of pipeline -Treatment facilities in Moscow -Design capacity is 6.5 MGD or 4,500 gpm -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989)
8	Surface Water Alternative	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment (*Variation of ASR project*)	2006	2013	NF Palouse River - Pullman Direct Use	NF Palouse River Surface water supply alternative; Direct diversion from NF Palouse River in Washington; Surface water pumped and conveyed to treatment north of Pullman; Treated water conveyed to both City of Pullman and City of Moscow	1,550	4,760	38%	$ 45,137,000	$ 9,483	$ 1,457,000	$ 70,728,000	$ 115,865,000	$ 24,341	-Based on Table 11-1 of Multi-purpose Storage Report and Project Alternative A5 from Phase II Surface Feasibility Study (ID 7) -Direct diversion of NF Palouse water for regional use in both Pullman and Moscow -Estimated Supply = 10 cfs from November to June, same as Project Alternative A5 from Phase II Surface Feasibility Study (ID 7) -River intake and pump station near Palouse -Approximately 25 miles of pipelines -Treatment facilities 7 miles north of Pullman -Pipelines to both Pullman and Moscow for direct use or ASR
9	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Dworshak Reservoir	Dworshak Reservoir - Alternative A6 Surface water supply alternative; Direct diversion from Dworshak Reservoir; Surface water pumped and conveyed to treatment; Treated surface water delivered directly to Moscow and Pullman	7,270	22,300	179%	$ 165,773,000	$ 7,434	$ 3,315,000	$ 160,922,000	$ 326,695,000	$ 14,650	-Direct diversion from Dworshak Reservoir -Estimated Supply = Design Capacity -Design capacity is 31 cfs -Approximately 55 miles of pipeline -Pumping facilities at reservoir and Kendrick, Idaho -Treatment facilities in Moscow -Alternative is from USACE (1989), costs updated for 2013 Phase 2 Feasibility Study
10	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (USACE estimate)	Snake River Pipeline - Alternative A7a Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Moscow and Pullman	7,270	22,300	179%	$ 102,357,000	$ 4,590	$ 2,047,000	$ 99,369,000	$ 201,726,000	$ 9,046	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 31 cfs -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman or Moscow -Alternative is from USACE (1989), costs updated for 2013 Phase 2 Feasibility Study
11	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (Pipeline to Pullman and Moscow - scoped as regional project, SPF/TG cost estimate)	Snake River Pipeline - Alternative A7b Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman and Moscow; smaller capacity	1,967	6,040	49%	$ 77,646,000	$ 12,855	$ 5,262,000	$ 255,437,000	$ 333,083,000	$ 55,146	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 10 cfs (reduced from 31 cfs studied by USACE [1989]) -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman or Moscow -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989), reduced size evaluated for 2013 Phase 2 Feasibility Study -Annual supply capacity reduced to 10 cfs of pumping for 10 months -Included cost of water right at $2,000 per acre-foot for listed annual supply capacity

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
12	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (Pipeline to Pullman only, SPF/TG estimate)	Snake River Pipeline - Alternative A7c Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman potable water system; Smaller capacity; Delivery only to Pullman	2,360	7,240	58%	$ 51,579,000	$ 7,124	$ 6,030,000	$ 292,718,000	$ 344,297,000	$ 47,555	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 10 cfs (reduced from 31 cfs studied by USACE [1989]) -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman, no delivery to Moscow or conveyance, Pullman to Moscow -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989), reduced size evaluated for 2013 Phase 2 Feasibility Study
13	ASR/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River - ASR Purposes	ASR (Year-Round) - Alternative C3 Year-round ASR alternative; Water Storage Reservoir on SF Palouse River (Same as Project ID 5); Stored water conveyed to treatment; Treated water injected over 8-month period	196	600	5%	$ 15,806,000	$ 26,343	$ 637,000	$ 30,922,000	$ 46,728,000	$ 77,880	-1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Reservoir Capacity -Approximately 5.8 miles of pipeline -Treatment facilities in Moscow -ASR injection well, 8-month Injection Period -Design capacity is 1.2 MGD or 810 gpm
14	ASR/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Paradise Creek and/or SF Palouse River - Moscow ASR	ASR Using Spring Runoff - Alternative D3a ASR with in-city surface water diversion; Direct Diversion from Paradise Creek and/or SF Palouse River in Moscow; Treatment; Active injection of treated water in Moscow ASR wells during spring runoff; No Reservoir	358	1,100	9%	$ 15,154,000	$ 13,776	$ 673,000	$ 32,670,000	$ 47,824,000	$ 43,476	-Direct diversion of SF Palouse water -ASR during spring runoff (4 months) -Estimated Supply = 1,100 AF/4 months -River intake pump station -Piped conveyance to treatment -Treatment facilities near ASR facilities -ASR injection well, 4-month injection period -Design capacity is 3.0 MGD or 2,070 gpm
15	Aquifer Recharge/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Paradise Creek and/or SF Palouse River Passive Recharge to Wanapum Aquifer in Moscow	ASR Using Spring Runoff - Alternative D3b ASR with in-city surface water diversion; Direct Diversion from SF Palouse River; Passive Treatment and Recharge of Wanapum Aquifer in Moscow through Infiltration Basin; No Reservoir	358	1,100	9%	$ 1,424,000	$ 1,295	$ 63,000	$ 3,058,000	$ 4,482,000	$ 4,075	-Direct diversion of SF Palouse water -ASR during natural runoff period of 4 months -Estimated Supply = 1,100 AF/4 months -River intake pump station -Pipe conveyance to infiltration basin -Passive recharge -12-acre recharge site/infiltration basin -Design capacity is 3.0 MGD or 2,070 gpm
16	ASR/ Groundwater Storage	City of Pullman - Water System Plan	2014	2013	SF Palouse River - Pullman ASR	ASR Using Winter/Spring Runoff ASR with surface water diversion; Direct Diversion from SF Palouse River; Treatment; Active injection of treated water during late winter and spring runoff; No Reservoir	325	997	8%	$ 27,814,000	$ 27,898	$ 334,000	$ 16,214,000	$ 44,028,000	$ 44,160	-Direct diversion of SF Palouse water -ASR during natural runoff period -Assumes three ASR Wells -Estimated Supply = 325 MGY -Year 1 Pilot Testing for a single well ASR system is estimated $200,000 -2014 WSP updated costs to 2013 ($25 million for implementation, $300,00 for Year 1 of testing)

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
16B	Surface Water Alternative	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment (Variation of ASR project)/Modified from Pullman ASR (ID 16)/Costs Based on City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	SF Palouse River, Direct Diversion	Direct Diversion Using Winter/Spring Runoff Direct Diversion from SF Palouse River; Treatment; Delivery to City of Pullman Water System during late winter and spring runoff; No Reservoir	894	2,743	22%	$ 22,689,000	$ 8,272	$ 752,000	$ 36,505,000	$ 59,194,000	$ 21,580	-Direct diversion of SF Palouse water -ASR during natural runoff period of November to June -Estimated Supply = 894 MGY (2,743 AF) diverted when available from November to June -River intake pump station -Treatment -Capacity = 10 cfs, similar to Snake River and NF Palouse projects; capacity would not likely be available through entire runoff period -Direct delivery to City of Pullman Water System
17	Aquifer Recharge/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2013	NF Palouse River, Direct Diversion for ASR	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Treatment Plan and Injection Wells near Palouse; Treatment; Active Injection of Treated Water to Recharge Aquifer without Direct Retrieval	900	2,762	22%	$ 26,593,000	$ 9,628	$ 532,000	$ 25,825,000	$ 52,418,000	$ 18,978	-Direct diversion of NF Palouse River -ASR during natural runoff period within 2 miles of diversion -Diversion to include river intake and pumping facilities -Conveyance from river intake/pump station to injection well -Treatment prior to active injection -Estimated supply = 6 MGD -Capital Cost includes scaled cost associated with direct diversion and treatment of NF Palouse (ID 7/8, does not include conveyance and pumping to get to Moscow) + ASR well cost
18	ASR/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2006	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Pond for Enhanced Deep Aquifer Recharge	978	3,000	24%	$ 8,222,000	$ 2,741	$ 326,000	$ 15,825,000	$ 24,047,000	$ 8,016	-Enhanced recharge using infiltration pond -From Table 11-1 of Multi-purpose Storage Report, Wanapum-Grand Ronde + Kamiak Butte -Two pond sizes/configurations considered: 1 pond handling 1 cfs, 2 ponds each handling 5 cfs -Costs are for 2 ponds, each handling 5 cfs -$2,000,000 for 2 ponds (5 cfs) + $4,000,000 for conveyance costs -$38,000 for pond O&M + $200,000 for conveyance O&M
19	ASR/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2006	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Ditch for Enhanced Deep Aquifer Recharge	978	3,000	24%	$ 8,496,000	$ 2,832	$ 315,000	$ 15,291,000	$ 23,787,000	$ 7,929	-Enhanced recharge using infiltration ditch -From Table 11-1 of Multi-purpose Storage Report, Wanapum-Grand Ronde + Kamiak Butte -Two pond sizes/configurations considered: 1 pond handling 1 cfs, 2 ponds each handling 5 cfs -Costs are for 2 ponds, each handling 5 cfs -$2,200,000 for 2 ponds (5 cfs) + $4,000,000 for conveyance costs -$30,000 for pond O&M + $200,000 for conveyance O&M
20	Water Reuse	City of Pullman and WSU - Water Reclamation Project - Design Development Document Update	2015	2014	Pullman/WSU Water Reuse Project	Water Reuse Project WWTP Upgrades, Class A reclaimed water supply pumped to new water reuse system for irrigation at reuse sites in Pullman	148	454	4%	$ 20,134,000	$ 44,348	$ 179,000	$ 8,689,000	$ 28,823,000	$ 63,487	-Modifications to City WWTP to produce up to 1.35 MGD of Class A reclaimed water -Reclaimed water pumping facilities -710,000 gallons of storage -Conveyance pipeline, WWTP to BPS and Storage -Distribution pipelines -Estimated Supply = Annual demand for planned reuse sites -Annual water reuse demand = 148 MGY at planned reuse sites + 115 MGY at future planned sites (2002 Parametrix report estimates) -City's current peak water reuse estimate = 150,000 gpd, May to October

Table 2
Water Supply Projects Summary

ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			Notes
							Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	
21	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #1	Potential Wastewater Recycle using Scalping Plants Scalping Plant #1 to serve reuse sites in NE area (Area 1) of City of Moscow	17	53	0%	$ 5,621,000	$ 106,057	$ 59,000	$ 2,864,000	$ 8,485,000	$ 160,094	-Scalping Plant #1 to serve NE area of Moscow -North Mountain View Road and East B Street -Diversion structures -0.125-MGD MBR plant -Building, site work, aeration basin -80,000-gallon Storage Tank -Pumping Facilities -Distribution piping
22	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #2	Potential Wastewater Recycle using Scalping Plants Scalping Plant #2 to serve reuse sites in E area (Area 2) of City of Moscow	26	79	1%	$ 8,900,000	$ 112,658	$ 88,000	$ 4,272,000	$ 13,172,000	$ 166,734	-Scalping Plant #2 to serve E area of Moscow -Kenneth Avenue and Blaine Street -Diversion structures -0.300-MGD MBR plant -Building, site work, aeration basin -130,000-gallon Storage Tank -Pumping Facilities -Distribution piping
23	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #3	Potential Wastewater Recycle using Scalping Plants Scalping Plant #3 to serve reuse sites in S area (Area 3) of City of Moscow	11	33	0%	$ 3,865,000	$ 117,121	$ 59,000	$ 2,864,000	$ 6,729,000	$ 203,909	-Scalping Plant #3 to serve S area of Moscow -Near the South Sewage Lift Station -Diversion structures -0.075-MGD Membrane Bioreactor (MBR) plant -Building, site work -80,000-gallon Storage Tank -Pumping Facilities -Distribution piping
24	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Additional Storage and Distribution	Water Reuse Distribution System Storage and Distribution Piping to Area 1 (NE area) and Area 2 (E area)	44	136	1%	$ 9,252,000	$ 68,029	$ 41,000	$ 1,990,000	$ 11,242,000	$ 82,662	-Assumes expansion of existing WWTP, but expansion of WWTP included in this project or the associated estimates -Booster Pump Station -12-inch Pipeline, WWTP to Ghormley Park -12-inch Pipeline, Ghormley Park to Joseph St -12-inch Pipeline, Joseph St to Mountain View Park -5-MG HDPE-lined Storage Lagoon
25	Water Reuse	City of Moscow - WWTP Improvements Phase V Predesign Study			Alternative #9 Reuse	Water Reuse variation	Information not available/developed									Connected to Project 23
26	Surface Water Alternative - OLD	Interim Report, Phase One, Preliminary Reconnaissance and Consultation, Supplemental Water Supply for the City of Moscow, ID	1958	1958	Robinson Lake Site	Potential reservoir/dam site Surface water supply alternative; Stored water conveyed to City of Moscow	1,524	4,675	38%	$ -	$ -	$ -	$ -	$ -	$ -	-From original 1958 EBASCO Report -8.19-square-mile watershed above reservoir -2,700-acre-foot reservoir -Estimated Supply = Average Reservoir Yield -Minimum Estimated Yield = 3,230 acre-feet -Maximum Estimated Yield = 6,120 acre-feet -Conveyance not defined

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
27	Surface Water Alternative - OLD	Interim Report, Phase One, Preliminary Reconnaissance and Consultation, Supplemental Water Supply for the City of Moscow, ID	1958	1958	Gnat Creek Diversion	Diversion of Gnat Creek to increase yield of the Robinson Lake Site Surface water supply alternative; Gravity conveyance from Gant Creek Watershed to Robinson Lake	394	1,210	10%	$ -	$ -	$ -	$ -	$ -	$ -	-From original 1958 EBASCO Report -4.25-square-mile watershed above diversion -Estimated Supply = Average Reservoir Yield -Minimum Estimated Yield = 820 acre-feet -Maximum Estimated Yield = 1,600 acre-feet -Diversion and conveyance not defined
28	Surface Water Alternative - OLD	Water Supply Study, Pullman-Moscow Water Resources Committee	1970	1970	Potlatch River Project	Proposes diversion of water from the main Potlatch River at a point due south of Helmer, Idaho, and transmitting water from that point to the communities of Pullman and Moscow	7,300	22,400	180%	$ 119,639,000	$ 5,341	$ 11,658,000	$ 565,922,000	$ 685,561,000	$ 30,605	-From 1970 STR Study -22,000 acre-foot reservoir -Estimated supply = 20 MGD x 365 days -Gravity Releases to Potlach River -Gravity intake facilities near Helmer, Idaho -Treatment facilities at intake -Estimated Supply = Average Reservoir Yield -Conveyance to terminal storage near Moscow -Pumping facilities -Design capacity 15 MGD, future to 20 MGD, intended to be developed in three phases
29	Additional Groundwater Supplies	City of Moscow - Comprehensive Water System Plan	2012	2010	Moscow - Additional Groundwater Development	City of Moscow Additional Groundwater Well Development, from Moscow Comprehensive Water Plan	578	1,774	14%	$ 1,811,000	$ 1,021	$ 106,000	$ 5,146,000	$ 6,957,000	$ 3,922	-Cost to drill new well from Moscow Comprehensive Water Plan, Page 6-13 -Water Supply = 578 MGY -450-horsepower pumping, 12 hours/day
30	Additional Groundwater Supplies	2014 City of Pullman Water System Plan	2014	2013	Pullman - Additional Groundwater Development	City of Pullman Additional Groundwater Well Development, from Pullman Water System Plan	400	1,227	10%	$ 1,133,000	$ 923	$ 67,000	$ 3,252,000	$ 4,385,000	$ 3,574	-Additional source capacity needed by 2032 -Capacity not yet defined; capacity shown was assumed based on annual output of City's two largest wells; assumes a similar well would be drilled -Additional source yet to be defined, cost represents a placeholder
31	Conservation Measures	2015 City of Moscow - Water Conservation Plan	2015	2015	Moscow Conservation Measures	Sum of all conservation measures from the 2015 Moscow Conservation Plan	104	319	3%	$ 2,694,000	$ 8,445	$ -	$ -	$ 2,694,000	$ 8,445	-From Appendix C of Moscow Conservation Plan -Table Package C + Additional Items -Annual "Operating Costs" in Table 6-5 of 2012 Moscow Comprehensive Water Plan -See Demand Management Summary Table for breakout of conservation costs and benefits
32	Conservation Measures	2014 City of Pullman Water System Plan	2014	2014	Pullman Conservation Measures	Sum of all conservation measures from the 2014 Pullman Water System Plan	9	27	0%	$ 103,000	$ 3,815	$ -	$ -	$ 103,000	$ 3,815	-See Demand Management Summary Table for breakout of conservation costs and benefits
33	Conservation Measures	2008 WSU Water System Plan	2008	2008	WSU Conservation Measures	Sum of all conservation measures from the 2008 WSU Water System Plan	14	43	0%	$ 3,434,000	$ 79,860	$ -	$ -	$ 3,434,000	$ 79,860	-See Demand Management Summary Table for breakout of conservation costs and benefits

Table 2
Water Supply Projects Summary

							Estimated Supply and % Demand			Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs ($)			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
34	Surface Water Alternative - NEW	NEW	NA	2011	SF Palouse River and/or Paradise Creek - Variation on Surface Water Supply	SF Palouse River and/ or Paradise Creek Surface water supply alternative; Small Reservoir; Stored water conveyed to City of Moscow or City of Pullman in river; Pumped from river to treatment or to irrigation system; Treated water distributed to Moscow and/or Pullman potable water systems	228	700	6%	$ 13,340,000	$ 19,057	$ 574,000	$ 27,864,000	$ 41,204,000	$ 58,863	-Hybrid of Surface Water Alternatives A3 and B3 (ID 3 and 5) -1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Watershed Yield -Potable and/or water -Conveyance in SF Palouse River Channel -Two intake pump stations in Moscow or Pullman -Distribution piping in Moscow or Pullman -Design capacity is 3.3 MGD or 2,260 gpm -Treatment facilities in Moscow or Pullman
35	Water Reuse/ Groundwater Storage NEW	NEW	NA	NA	Water Reuse Combined with Infiltration or ASR	Water Reuse for Infiltration or ASR Water reuse for groundwater storage alternative; Class A recycled water from Moscow WWTP discharged to shallow infiltration area to enhance Wanapum aquifer groundwater storage	420	1,300	10%	$ 3,479,000	$ 2,676	$ 76,000	$ 3,689,000	$ 7,168,000	$ 5,514	-Hybrid of Water Reuse Alternatives (ID 20-25) and Passive Recharge Basin alternative (ID 15) -Class A discharge from WWTP discharged to shallow infiltration basin -Pipe conveyance to infiltration basin -Passive recharge -Recharge site/infiltration basin
36	Groundwater Storage and Retention NEW	NEW	NA	NA	Snake River Aquifer Recharge	Recharge the Grande Ronde Aquifer at point of discharge for the purposes of a) aquifer recharge, and b) hydraulic containment for the purpose of native groundwater retention	978	3,000	24%	$ 6,200,000	$ 2,067	$ 230,000	N/A	N/A	$ 7,571	-Explore the potential for RBF, and/or treatment at Snake elevation, and recharge at/near Snake Elevation -Has benefit of long deferring and/or mitigating any water quality changes associated with ASR
37	Groundwater Storage and Retention NEW	NEW	NA	NA	West Palouse Hydraulic Containment	Poorly defined, but essentially same concept as above at western discharge location using possible treated surface water or reclaimed water as the source	Information not available/developed									
38	Enhanced Grande Ronde Recharge NEW	NEW	NA	NA	Inter-Aquifer Transfer	Relying on the water balance concept, use recharge to the Wanapum (multiple options above) as source to passively recharge the Grande Ronde via packered wells; Grande Ronde recharge could be recovered downgradient	Information not available/developed									Has benefit of targeting the aquifer most at risk due to over-appropriation and limited recharge

Notes:

1. Estimated annual supply is the amount of additional water supply that will reliably (at least 50% of the time) be made available by implementing the proposed project. Notes indicating the assumed basis for estimating water supply are included under "Notes" column.
2. The average annual yield is the estimated average annual yield of the watershed captured by a proposed reservoir or tributary to a proposed diversion location.
3. The projected demands used as a basis for comparison are projected demands without additional conservation.

AF: acre-feet
ASR: aquifer storage and recovery
BPS: Booster pump station
cfs: cubic feet per second
E: east
EBASCO: EBASCO Consulting Firm
gpd: gallons per day
gpm: gallons per minute
HDPE: high-density polyethylene
MBR: Membrane Bioreactor
MG: million gallons
MGY: million gallons per year
MGD: million gallons per day
NA: not available
NE: northeast
NF: north fork
O&M: operations and maintenance
S: south
SF: south fork
SPF/TG: SPF Engineering/TerraGraphics
STR: Stevens, Thompson and Runyon
USACE = U.S. Army Corps of Engineers
WRIA: Water Resource Inventory Area
WSP: Water system plan
WSU: Washington State University
WWTP: wastewater treatment plant

3.2 Project Screening

The 38 water supply and conservation projects identified in Section 3.1 were evaluated through a 2-step screening process, which had the following purposes:

1. Eliminate projects that clearly would not produce significant supply relative to the forecasted supplemental supply target and/or be cost-effective on a cost per volume of water basis relative to other similar projects; and,
2. Rank the remaining projects based on a preliminary screening of yield, cost, technical certainty of success, complexity, permitting requirements, and public acceptability in order to identify the primary benefits and challenges that PBAC could consider when formulating alternatives from various combinations of projects.

The results of the screening process are summarized below.

3.2.1 Step 1: High-level Screening

The high-level screening identified projects to be removed from further consideration because they either have very high costs per unit volume of supply or there are other similar projects that are more cost-effective based on inspection of the information provided in previous studies. This review identified 23 projects for elimination and noted the reason for excluding each from further analysis, as provided in Table 3 below. The remaining 15 projects advanced to the Step 2 screening.

Table 3
Step 1 High-level Screening Results

Project No.	Name	Rationale for Removing from Further Consideration
2	Hatter Creek storage	Other surface supply options provide lower cost water for similar supply and yield.
3	South Fork Palouse storage	Other surface supply options provide lower cost water for more supply and yield.
4	Felton Creek storage/treatment	Other surface supply options provide lower cost water for more supply and yield.
6	Felton Creek storage/ non-potable irrigation	Other surface supply options provide lower cost water for more supply and yield.
9	Pumping from Dworshak reservoir	Other surface supply options provide lower cost water for similar supply and yield (i.e., Snake River).
10	Snake River – 31 cfs pipeline	Other Snake River options scaled smaller in size would meet needs; project scope too large for need.
13	Moscow South Fork Palouse Dam/aquifer recharge	Other surface with aquifer recharge supply options provide lower cost water for more supply and yield.
21 – 23	Moscow WW scalping plants	Low supply benefits for high cost.

Project No.	Name	Rationale for Removing from Further Consideration
24	Moscow – additional reused water distribution and storage	Low supply benefits for high cost.
25	Moscow wastewater reuse Alternative 9	Not enough information to evaluate (additional information could result in re-including this for further evaluation).
26	Robinson Lake storage	Other surface supply options provide more supply and yield; also missing cost and other information.
27	Gnat Creek Diversion (Robinson Lake)	Other surface supply options provide more supply and yield; also missing cost and other information.
28	Potlatch river storage/conveyance	Other surface supply options provide more supply and yield; also missing cost and other information.
29 – 30	New well development	Does not provide new supply to conserve existing groundwater supplies.
31 – 33	Water conservation	Included as percentages in alternatives analysis.
34	South Fork Palouse storage variation	Not substantially different from other South Fork Palouse project options.
37	West aquifer recharge	Limited information available; conceptual idea only at this point. Could be further evaluated in future.
38	Inter-aquifer transfers	Limited information available; conceptual idea only at this point. Could be further evaluated in future.

Notes:
cfs: cubic feet per second
WW: wastewater

3.2.2 Step 2: Detailed Screening

A detailed screening of the remaining projects was conducted to highlight the primary benefits and challenges associated with each and provide a preliminary comparison among the remaining projects to inform alternatives formulation.

The following eight criteria were considered at this screening stage:

1. Unit Cost of Supply
2. Long Term Supply Reliability
3. Technical Certainty of Success
4. Property Acquisition
5. Permitting Complexity – Water Rights
6. Permitting Complexity – Environmental
7. Extent of Regional Agreements Required
8. Public Acceptability

These criteria were weighted (on a scale of 0 to 10), allowing for some criteria to more strongly influence project prioritization than others. Each project was then scored against each criterion, based on a scale of 0 to 3 (with 3 representing the best or most favorable score). Appendix D provides detailed descriptions of the criteria, their weightings (as decided by PBAC consensus), and the scoring scale associated with each.

For use in the formulation of alternatives for further analysis, the projects were divided into three categories, based on the amount of annual yield expected, as described in Table 4:

Table 4
Annual Yield Categories

Category	Annual Yield Expected
High	>80% of Target (>1,800 MGY)
Medium	20-80% of Target (465-1,860 MGY)
Low	<20% of Target (<465 MGY)

A total weighted score was derived for each project, which then supported ranking the projects within each yield category. Table 5 summarizes the results of the Step 2 screening exercise. Table 5 depicts the following highlights of the results:

- There are only two projects within the high-yield category—the two variations of the Snake River surface water supply option (Projects 11 and 12). Because they are nearly identical, the projects score and rank similarly.
- Within the medium-yield category, the highest ranking projects are Projects 7 and 8 (two variations of using North Fork Palouse surface water). Compared to most other projects within this yield category, these projects scored high with respect to their technical certainty of success and lesser amount of regional agreements required for implementation. By contrast, Project 1 (the Flannigan Creek surface water supply) ranks the lowest, due primarily to its higher unit cost of supply and more limited technical certainty of success.
- Within the low-yield category, Project 5 (use of South Fork Palouse surface water for irrigation) ranked the highest, driven primarily by its low unit cost of supply and high degree of technical success. Project 20 (Pullman/WSU wastewater reuse) ranked second, even though it has the highest unit cost of supply within this category. This is from the project receiving high marks with respect to many other criteria.

Please note that Project 16B was added later, during formulation of alternatives, and not screened in the Step 2 exercise.

The list of prioritized projects was then used by PBAC during the formulation of alternatives, which is described in detail in Section 4.1.

Table 5
Palouse Basin Aquifer Committee (PBAC): Water Supply Alternatives – Preliminary Screening Results

ID	Project Type	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Total Present Value ($/AF of Annual Supply)	A. Unit Cost of Supply (based on $/AF)	B. Long-Term Supply Reliability	C. Technical Certainty of Success	D. Property Acquisition	E. Permitting Complexity – Water Rights	F. Permitting Complexity – Environmental	G. Extent of Regional Agreements Required	H. Public Acceptability	Total Score (Sum of Score x Weight)	Rank	Notes/Rationale
						Preliminary Screening Criteria – Weight (1-10):										
Supply Target = 2,324 MGY						10	8	8	6	6	6	3	6			
Grouping 1 – High Yield (Annual Supply > 80% of Target) [>1,860 MGY]																
11	Surface Water Alternative	Snake River (Pipeline to Pullman and Moscow - scoped as regional project, SPF/TG cost estimate)	Snake River Pipeline - Alternative A7b Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman and Moscow potable water system; Smaller capacity	1,967	$ 55,146	**0.39**	**3**	**3**	**1.5**	**1**	**0**	**1**	**1**	**76**	**2**	Multiple properties/easements to acquire for pipeline ROW; interstate water rights and federal power system adds complexity to permitting
12	Surface Water Alternative	Snake River (Pipeline to Pullman only, SPF/TG estimate)	Snake River Pipeline - Alternative A7c Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman potable water system; Smaller capacity; Delivery only to Pullman	2,360	$ 47,555	**0.75**	**3**	**3**	**1.5**	**1**	**0**	**1**	**1**	**80**	**1**	Multiple properties/easements to acquire for pipeline ROW; interstate water rights and federal power system adds complexity to permitting; adds complexity to regional agreement
Grouping 2 – Medium Yield (Annual Supply = 20–80% of Target) [465–1,860 MGY]																
7	Surface Water Alternative	North Fork Palouse River - Direct Use	NF Palouse River - Alternative A5 Surface water supply alternative; Direct diversion from NF Palouse River in Idaho; Surface water pumped and conveyed to treatment in Moscow; Treated water discharged directly to City of Moscow potable water system	1,550	$ 37,079	**1.25**	**1.5**	**3**	**1.5**	**2**	**1**	**3**	**2**	**96**	**2**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with storage and conveyance, winter water so should not impact existing rights as much
8	Surface Water Alternative	North Fork Palouse River - Pullman Direct Use	NF Palouse River Surface water supply alternative; Direct diversion from NF Palouse River in WA; Surface water pumped and conveyed to treatment north of Pullman; Treated water conveyed to both City of Pullman and City of Moscow potable water systems	1,550	$ 24,341	**1.85**	**1.5**	**3**	**1.5**	**2**	**1**	**3**	**2**	**102**	**1**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with storage and conveyance, winter water so should not impact existing rights as much
17	Aquifer Recharge/ Groundwater Storage	North Fork Palouse River, Direct Diversion for ASR	Direct Surface Water Diversion of NF Palouse in WA; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Treatment Plant and Injection Wells near Palouse; Treatment; Active Injection of Treated Water to Recharge Aquifer without Direct Retrieval	900	$ 18,978	**2.10**	**1.5**	**2**	**1.5**	**2**	**1**	**3**	**1**	**91**	**3**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with treatment/surface water quality, winter water so should not impact existing rights as much; public concerns about groundwater quality impacts

Table 5

Palouse Basin Aquifer Committee (PBAC): Water Supply Alternatives – Preliminary Screening Results

ID	Project Type	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Total Present Value ($/AF of Annual Supply)	Preliminary Screening Criteria: A. Unit Cost of Supply (based on $/AF)	B. Long-Term Supply Reliability	C. Technical Certainty of Success	D. Property Acquisition	E. Permitting Complexity – Water Rights	F. Permitting Complexity – Environmental	G. Extent of Regional Agreements Required	H. Public Acceptability	Total Score (Sum of Score x Weight)	Rank	Notes/Rationale
						Weight (1-10): 10	8	8	6	6	6	3	6			
Supply Target = 2,324 MGY																
1	Surface Water Alternative	Flannigan Creek	Flannigan Creek - Alternative A1 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow potable water system	1,430	$ 44,513	**0.90**	**1.5**	**1**	**1.5**	**2**	**1**	**3**	**2**	**77**	**7**	Dam adds complexity to technical certainty and requires more property to acquire, lower elevation drainage basin subject to climate change but offset by storage, complexity with storage and conveyance, winter water so should not impact existing rights as much
16B	Surface Water Alternative	SF Palouse River, Direct Diversion	Direct Diversion Using Winter/Spring Runoff Direct Diversion from SF Palouse River; Treatment; Delivery to City of Pullman Water System during late winter and spring runoff; No Reservoir	894	$ 21,580	This project was formulated in the alternatives analysis and not scored as part of the Step 2 screening.										
18	ASR/ Groundwater Storage	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in WA; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Pond for Enhanced Deep Aquifer Recharge	978	$ 8,016	**2.62**	**1.5**	**0**	**1.5**	**2**	**1**	**1**	**3**	**86**	**5**	Water supply available from NF Palouse but big question about whether water can recharge aquifer; recovery of stored water uncertain; enhancing natural recharge likely improve public acceptability
19	ASR/ Groundwater Storage	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in WA; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Ditch for Enhanced Deep Aquifer Recharge	978	$ 7,929	**2.63**	**1.5**	**0**	**1.5**	**2**	**1**	**1**	**3**	**86**	**4**	Water supply available from NF Palouse but big question about whether water can recharge aquifer and whether it will be recoverable; enhancing natural recharge will likely improve public acceptability
36	Groundwater Storage and Retention NEW	Snake River Aquifer Recharge	Recharge the Grande Ronde Aquifer at point of discharge for the purposes of a) aquifer recharge, and b) hydraulic containment for the purpose of native groundwater retention	978	$ 7,571	**2.64**	**1.5**	**0**	**1.5**	**2**	**1**	**1**	**2**	**80**	**6**	Estimated values added for supply and cost to support analysis; technical uncertainty and unknown effects on aquifer conditions

Table 5
Palouse Basin Aquifer Committee (PBAC): Water Supply Alternatives – Preliminary Screening Results

ID	Project Type	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Total Present Value ($/AF of Annual Supply)	Preliminary Screening Criteria: A. Unit Cost of Supply (based on $/AF)	B. Long-Term Supply Reliability	C. Technical Certainty of Success	D. Property Acquisition	E. Permitting Complexity – Water Rights	F. Permitting Complexity – Environmental	G. Extent of Regional Agreements Required	H. Public Acceptability	Total Score (Sum of Score x Weight)	Rank	Notes/Rationale
						Weight (1-10):										
Supply Target = 2,324 MGY						10	8	8	6	6	6	3	6			
Grouping 3 – Low Yield (Annual Supply < 20% of Target) [<465 MGY]																
14	ASR/ Groundwater Storage	Paradise Creek and/or South Fork Palouse River - Moscow ASR	ASR Using Spring Runoff - Alternative D3a ASR with in-city surface water diversion; Direct Diversion from Paradise Creek and/or SF Palouse River in Moscow; Treatment; Active injection of treated water in Moscow ASR wells during spring runoff; No Reservoir	358	$ 43,476	**0.95**	**1.5**	**2**	**1.5**	**2**	**1**	**3**	**1**	**79**	**6**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with treatment/surface water quality, winter water so should not impact existing rights as much; public concerns about groundwater quality impacts
15	Aquifer Recharge/ Groundwater Storage	Paradise Creek and/or South Fork Palouse River Passive Recharge to Wanapum Aquifer in Moscow	ASR Using Spring Runoff - Alternative D3b ASR with in-city surface water diversion; Direct Diversion from SF Palouse River; Passive Treatment and Recharge of Wanapum Aquifer in Moscow through Infiltration Basin; No Reservoir	358	$ 4,075	**2.81**	**1.5**	**1**	**1.5**	**2**	**1**	**3**	**1**	**90**	**4**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with treatment/surface water quality, winter water so should not impact existing rights as much; public concerns about groundwater quality impacts
16	ASR/ Groundwater Storage	SF Palouse River - Pullman ASR	ASR Using Winter/Spring Runoff ASR with surface water diversion; Direct Diversion from SF Palouse River; Treatment; Active injection of treated water during late winter and spring runoff; No Reservoir	325	$ 44,160	**0.91**	**1.5**	**3**	**1.5**	**2**	**1**	**3**	**1**	**87**	**5**	Estimated annual supply based on lower elevation drainage basin subject to climate change, complexity with treatment/surface water quality, winter water so should not impact existing rights as much; public concerns about groundwater quality impacts
5	Surface Water Alternative	South Fork Palouse River - Non-potable Irrigation	South Fork Palouse River for Irrigation Supply - Alternative B3 Surface water supply alternative; Non-potable supply only; Stored water conveyed to City of Moscow in river; Pumped and distributed through irrigation system	196	$ 15,525	**2.27**	**1.5**	**3**	**1.5**	**2**	**2**	**3**	**3**	**119**	**1**	Dam adds complexity to technical certainty and requires more property to acquire, lower elevation drainage basin subject to climate change, complexity with storage and conveyance, winter water so shouldn't impact existing rights as much

Table 5

Palouse Basin Aquifer Committee (PBAC): Water Supply Alternatives – Preliminary Screening Results

ID	Project Type	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Total Present Value ($/AF of Annual Supply)	A. Unit Cost of Supply (based on $/AF)	B. Long-Term Supply Reliability	C. Technical Certainty of Success	D. Property Acquisition	E. Permitting Complexity – Water Rights	F. Permitting Complexity – Environmental	G. Extent of Regional Agreements Required	H. Public Acceptability	Total Score (Sum of Score x Weight)	Rank	Notes/Rationale
						Preliminary Screening Criteria – Weight (1-10):										
Supply Target = 2,324 MGY						10	8	8	6	6	6	3	6			
20	Water Reuse	Pullman/WSU Water Reuse Project	Water Reuse Project WWTP Upgrades, Class A reclaimed water supply pumped to new water reuse system for irrigation at reuse sites in Pullman	148	$ 63,487	**0.00**	**1.5**	**3**	**3**	**2**	**3**	**3**	**2**	**105**	**2**	Project information and benefits pretty well understood; climate change may impact summer flow requirements
35	Water Reuse/ Groundwater Storage NEW	Water Reuse Combined with Infiltration or ASR	Water Reuse for Infiltration or ASR Water reuse for groundwater storage alternative; Class A recycled water from Moscow WWTP discharged to shallow infiltration area to enhance Wanapum aquifer groundwater storage	420	$ 5,514	**2.74**	**3**	**1**	**1.5**	**3**	**1**	**3**	**0**	**101**	**3**	Water supply known but public acceptance is likely to make permitting a long process; Washington State Department of Ecology willing to consider reclaimed ASR, and Quincy is breaking ground; Idaho has rules that may relinquish ownership of reclaimed water once it enters an aquifer

Notes:

Palouse demand includes the overall projected demand for the Palouse Groundwater Basin.

1. Estimated annual supply is the amount of additional water supply that will reliably (at least 50% of the time) be made available by implementing the proposed project. Notes indicating the assumed basis for estimating water supply are included under "Notes."

2. The average annual yield is the estimated average annual yield of the watershed captured by a proposed reservoir or tributary to a proposed diversion location.

3. The projected demand used as a basis for comparison are projected demands without additional conservation. Local system demand includes just the projected demand for the local system that would receive most or all of the water supply.

AF: acre-feet

ASR: aquifer storage and recovery

MG: million gallons

MGY: million gallons per year

NF: north fork

ROW: right of way

SF: south fork

SPF/TG: SPF Engineering/Terra-Graphics

WSU: Washington State University

WWTP: wastewater treatment plant

4 Formulate and Analyze Alternatives

This section describes the formulation and analysis of water supply alternatives, or combinations/portfolios of water supply and water conservation projects, designed to meet the regional supplemental water supply target. Four alternatives were developed, reflecting a range of approaches to providing a future water supply to supplement existing sources. The four alternatives were then analyzed using a multi-criteria evaluation approach to identify those alternatives that appear most favorable for further consideration and/or implementation.

4.1 Alternative Descriptions

Four alternatives were formulated for the evaluation. The four alternatives evaluated included:

- Alternative 1 – Snake River Diversion and Pipeline to Pullman and Moscow (Project 11)
- Alternative 2 – North Fork Palouse River Diversion and Pipelines to Pullman/Moscow (Project 8) plus Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow (Project 14)
- Alternative 3 – Flannigan Creek Storage, Conveyance to and Treatment for Moscow/UI (Project 1), plus South Fork Direct Diversion for Pullman/WSU (Project 16B)
- Alternative 4 – Paradise Creek Aquifer Recharge for Moscow (Project 14), South Fork Aquifer Storage and Recovery (ASR) for Pullman (Project 16), Pullman Wastewater Reuse (Project 20), and Moscow Wastewater Reuse and Groundwater Recharge (Project 35) plus additional conservation.

A brief description of each alternative follows, and more detailed descriptions with associated figures are provided in Appendix E.

4.1.1 Alternative 1

This would be a regional project based on the 1989 *Reconnaissance Report, Palouse River Basin, Idaho and Washington* (USACE 1989) as modified by the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* (SPF and TerraGraphics 2013). This alternative would include a regional project composed of a direct diversion from the Snake River and a delivery system that would convey water to Pullman, WSU, Moscow, and UI. The project would supply a portion of the projected future water demands in the Cities of Pullman and Moscow, and would also be used to offset existing irrigation, for the cities and universities, based on a 10-month (approximately 304-day) diversion period. The revised concept provided in the 2013 study would deliver up to 10 cubic feet per second (cfs) from the Snake River to Pullman and Moscow. The diversion would be on the Snake River near Wawawai Canyon, and water would be treated and carried through a 25-mile pipeline to Pullman and Moscow. The estimated annual water supply that would be made available by this alternative is 1,967 MG (6,040 AF), which is 85% of the 2,324 MG target.

4.1.2 Alternative 2

This would also be a regional alternative. It would include two diversions—one on the North Fork Palouse River and another on Paradise Creek or the South Fork Palouse River. The estimated amount of supply from this alternative is 1,908 MG (5,860 AF), which is 82% of the 2,324 MG target.

The North Fork Palouse River project would include a direct diversion (no storage) from the North Fork Palouse River, pumping and conveyance to a treatment plant 7 miles north of Pullman, and pumping, conveyance, and delivery of treated water to the City of Moscow and City of Pullman water systems. It would be a variation of the ASR project studied in the 2006 *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment* (Golder Associates 2006) and the North Fork Palouse – Direct Use Alternative (Alternative A5) from the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* (SPF and TerraGraphics 2013), designed to serve Pullman and Moscow.

The second diversion project, on Paradise Creek or the South Fork Palouse River, would include a direct diversion (no storage) to capture winter and spring runoff (generally January through April), treatment, and active injection of treated water to aquifer recharge wells in Moscow, as studied by the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011).

4.1.3 Alternative 3

This would be a regional alternative and would include two diversions—one from a proposed storage reservoir on Flannigan Creek and another on the South Fork Palouse River. The estimated amount of annual supply from this alternative is 2,324 MG (7,143 AF), which is equal to the targeted supplemental water supply for the Palouse Basin. The Flannigan Creek project would supply 1,430 MG (4,400 AF), and the South Fork Direct Diversion project would supply the additional 894 MG (2,743 AF) needed to meet the target.

The Flannigan Creek project would include a new storage reservoir on Flannigan Creek on the north side of Moscow Mountain, an intake structure and diversion at the new reservoir, pumping and conveyance to Moscow, treatment, and delivery to the City of Moscow and UI water systems. This project was identified and studied as Alternative A1 in the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011).

A second diversion would be located on the South Fork Palouse River to capture winter and spring runoff (as available, from November through June), for treatment and direct use (no storage) in the Pullman and WSU systems.

4.1.4 Alternative 4

This alternative would include a combination of projects that would collectively supply projected future water demands in Pullman and Moscow. The projects would also be used to offset existing irrigation, for the cities and universities, primarily through aquifer recharge in Moscow, ASR in Pullman, wastewater reuse, groundwater recharge, and additional conservation to come as close as possible to meet the annual 50-year supplemental supply target of 2,324 MG. The aquifer recharge and ASR projects would use South Fork Palouse River and Paradise Creek water during the natural runoff period of approximately 4 months (generally January through April). It would also include a wastewater reuse project in Pullman, a combination wastewater reuse and groundwater recharge project in Moscow, and additional conservation to provide 1,893 MG of supply. This amount is 81% of the 2,324 MG target. It is not expected that additional water conservation opportunities, even at the aggressive level assumed under this alternative, will be able to fully fill the gap (1,060 MG) between what the other four projects would provide and the target. A target of 15% additional conservation savings (609 MG) was assumed for this analysis, which is approaching a reduction in per capita demand similar to winter water usage.

The aquifer recharge project would include a direct diversion (no storage) on Paradise Creek by Moscow to capture winter and spring runoff (generally January through April), treatment, and active injection of treated water to recharge wells in Moscow, as studied by the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011). The ASR project on the South Fork Palouse River, in Pullman upstream of its confluence with Paradise Creek, would also include a direct diversion (no storage) to capture winter and spring runoff (generally January through April), treatment, and active injection of treated water to ASR Wells in Pullman, as studied by the 2014 *City of Pullman Water System Plan Update* (Anchor QEA 2014). A variation of this project could include direct use of treated water to the City of Pullman system without ASR.

The wastewater reuse project in Pullman would include an upgrade to the Pullman Wastewater Treatment Plant (WWTP) to produce Class A reclaimed water for distribution and reuse at selected sites within Pullman and the WSU campus. The wastewater reuse project in Moscow would include additional use of Class A reclaimed water from the Moscow WWTP for passive recharge within Moscow. Infiltration basins with an area of approximately one acre would be constructed to provide for passive infiltration of reclaimed water into the Wanapum basalt aquifer. It should be noted that this second part of the project, the ability to infiltrate into the Wanapum basalt aquifer, is not well understood and very likely may not be successful if pursued. Of all the elements of each of the four alternatives, this component is the most uncertain.

The conservation element of this alternative would include additional measures equating to 15% additional savings beyond the baseline projection (1,869 AF or 609 MG). This would include reducing landscape irrigation from measures that have yet to be determined. The additional conservation savings that would have to be realized to meet the supplemental water supply target (greater than 15%) would reduce demand to something that would be close to or even less than typical per capita winter, or indoor, water usage, which is approximately 75 gpd per person. Because this did not seem realistic, the additional conservation savings of 15% was selected for this alternative, which is still a very aggressive goal.

4.2 Evaluation Criteria

A multi-criteria evaluation approach was used to compare the four alternatives. A wide range of water supply project considerations was discussed within PBAC, resulting in 13 criteria selected for use in the analysis. Although some criteria are readily assessed in monetary terms, others are more appropriately considered in a qualitative fashion. Table 6 summarizes the 13 criteria and the manner in which they were included in the analysis. Descriptions of the criteria are provided in the sections that follow.

Table 6
Alternative Evaluation Criteria

No.	Name	Monetize	Quantify	Qualitatively Assess	
				Potential Impact on Schedule	Potential Impact on Cost
1	Capital Cost	X			
2	Annual Operating Cost	X			
3	Greenhouse Gas Emissions	X			
4	Criteria Air Contaminant Emissions	X			
5	Risk Associated with Yield Variability		X		
6	Water Quality Impacts				X
7	Aquifer Data/Model Accuracy				X
8	Water Rights Complexity			X	X
9	Permitting Challenges – State/Local			X	X
10	Permitting Challenges – Federal			X	X
11	Extent of Regional Agreements Required			X	X
12	Willingness of Property Owners to Participate			X	X
13	Public Acceptance			X	X

4.2.1 Criteria Assessed Monetarily

Those criteria that were assessed in a monetary fashion are described below, including a summary of key inputs and assumptions.

Capital Costs

This reflects the total costs associated with planning, designing, and constructing the project elements that are included in each alternative's portfolio of projects. Costs include planning studies, design engineering, permitting, land acquisition, construction, and construction management.

Capital costs were prepared based on information contained in prior studies related to the selected projects. Adjustments to prior cost estimates, as discussed in Section 3, included:

- Escalation of costs to October 2016 using the Engineering News Record Construction Cost Index.
- Scaling of costs if project target yield or capacity is different than that presented in prior studies.
- Permitting and cost related to water rights were explicitly depicted as components within each project total cost, where such detail is available from prior studies, so those levels of costs are readily viewed.
- Previously defined contingencies were removed and replaced with a wider project contingency range that was applied in such a way as to reflect the varying levels of uncertainty in costs among the projects. This is discussed in detail in Section 4.3.3.

Annual Operating Costs

This reflects the total costs associated with operating and maintaining the projects that are included in each alternative. Such costs include materials and energy (e.g., pumping) costs, equipment maintenance costs, and operational labor costs. Similar to capital costs, annual operating costs are based on information contained in prior studies related to the selected projects, and are adjusted for escalation and scaling as necessary using the methodologies noted above.

Greenhouse Gas Emissions

Changes in energy consumption (e.g., through pumping) cause changes in greenhouse gas (GHG) emissions (carbon dioxide, methane, and nitrous oxide) that result from the use of fossil fuels in energy production. Such changes can be monetized by applying social costs of GHG (typically expressed in $/ton) to the estimated change in the amount of GHG emissions from energy consumption.

The following key inputs are used in this calculation:

- Annual pumping energy (kilowatt hours [kWh] per year) is an input obtained from prior studies or, as needed, updated calculations based on projected supplemental supply targets and energy required to pump unit volumes of water.
- GHG emissions per energy use (tons per kWh) is data published by the U.S. Environmental Protection Agency (EPA), as discussed in more detail in Section 4.3.1. This is adjusted to reflect

the typical sources of electrical energy in the Palouse Basin, to account for non-fossil -fuel-related sources.
- Social cost of GHG emissions ($/ton), is data published by EPA and the International Governmental Panel on Social Cost of Carbon.

Criteria Air Contaminant Emissions

Similar to GHG emissions, changes in energy consumption (e.g., through pumping) cause changes in criteria air contaminant (CAC) emissions (sulfur oxides, particulate matter, volatile organic compounds, and nitrogen oxide) that result from the use of fossil fuels in energy production. Such changes can be monetized by applying social costs of CAC (typically expressed in $/ton) to the estimated change in the amount of CAC emissions from energy consumption.

The following key inputs were used in this calculation:

- Annual pumping energy (kWh per year) is an input obtained from prior studies or, as needed, updated calculations based on projected supplemental supply targets and energy required to pump unit volumes of water.
- CAC emissions per energy use (tons per kWh) is data published by EPA. This is adjusted to reflect the typical sources of electrical energy in the Palouse Basin, to account for non-fossil-fuel-related sources.
- Social cost of CAC emissions ($/ton) is data published by EPA and the International Governmental Panel on Social Cost of Carbon.

4.2.2 Criteria Assessed Quantitatively

Risk Associated with Yield Variability

This refers to a project's expected ability to provide all or a portion of the target water demand across an anticipated range of climatic conditions (e.g., wet, normal, dry). Although not monetized, this criterion was evaluated in a quantitative fashion and also captured the probabilities to which certain hydrologic conditions were expected to occur. This is discussed in detail in Section 4.3.4.

4.2.3 Criteria Assessed Qualitatively

Those criteria that were assessed in a qualitative fashion are described below. The detailed scoring approach used in analyzing these criteria and how that was included in the uncertainty analysis is described in Section 4.3.

Water Quality Impacts

Water quality impacts refer to the degree to which a project may impact the water quality of any or all of the following:

1. Bodies of water where new diversions for surface water supply are proposed – From this perspective, the criterion will consider impacts such as the potential for degraded water quality of streams if flows are reduced due to increased diversions for water supply (e.g., increases in temperature due to shallower stream levels).
2. Bodies of water into which water may be moved/stored (e.g., Grande Ronde or Wanapum basalt aquifers used for aquifer recharge and ASR purposes) – This considers the potential changes to groundwater quality through introduction of surface water or reclaimed water into the subsurface.
3. Drinking water distribution systems – This considers the potential changes to distribution system water quality resulting from the introduction of new and/or blended sources of water.

This criterion is intended to address impacts solely from a technical perspective. To the extent that potential water quality impacts may influence public opinion of alternatives, this is to be reflected in the scoring of Criterion #13 (Public Acceptability).

Aquifer Data/Model Accuracy

Aquifer data/model accuracy refers to the level of accuracy and detail regarding the technical data and models/analysis tools associated with the projects within an alternative. For example, a high score would be assigned to projects with well understood hydrologic and hydrogeologic data to support their evaluation, and a low score might be assigned to an aquifer recharge project where there are little data on whether the desired geologic and aquifer conditions exist to support successful water withdrawal.

Water Rights Complexity

Acquiring water rights today for new water supply projects can be difficult and complex. This criterion addresses how challenging the water right path will be. Projects are scored higher if there is a high probability of securing the necessary water rights and mitigation needs are minimal.

Permitting Challenges – State/Local

Environmental permitting can be critical to project success. For this criterion, projects are scored higher if the project is not expected to require complex and challenging state/local permitting activities (e.g., those associated with surface water withdrawals, river crossings, groundwater anti-degradation rules), does not cross environmentally sensitive land, and has low mitigation costs.

Permitting Challenges – Federal

These challenges are similar to state and local challenges, but also have challenges and complexities unique to federal permitting. For this criterion, projects are scored higher if the alternative is not expected to trigger federal permitting requirements (e.g., National Environmental Policy Act, Clean Water Act, or Federal Energy Regulatory Commission), and schedule will not be impacted by such complexities.

Extent of Regional Agreements Required

This criterion addresses the anticipated jurisdictional complexity of the proposed alternatives. The scoring gives priority to alternatives that require fewer agreeing parties and fewer funding parties.

Willingness of Property Owners to Participate

This criterion considers the anticipated ease or difficulty expected in acquiring the property and right of way necessary to implement the alternative. Projects with long portions of pipelines requiring right of way in properties having multiple ownership, or that require land purchase in sensitive lands, land owned by the federal government, or land owners that have been known to be difficult to work with in the past, will score lower.

Public Acceptance

Public acceptance refers to a project's expected ability to garner support from parties that will benefit from the project and not receive criticism from parties who may not necessarily benefit from the project, but who might be impacted by the project. Higher scored alternatives are those that are expected to have greater support and fewer critics.

4.3 Evaluation Methods

The multi-criteria evaluation approach is predicated on a lifecycle cost (LCC) analysis that considers inputs throughout a 50-year planning horizon regarding the monetized criteria (i.e., Criteria 1 through 4). Project uncertainty and risk is reflected by incorporating into the LCC analysis the effects of the quantitatively and qualitatively assessed criteria (i.e., Criteria 5 through 13) upon features such as yield, schedule, and cost.

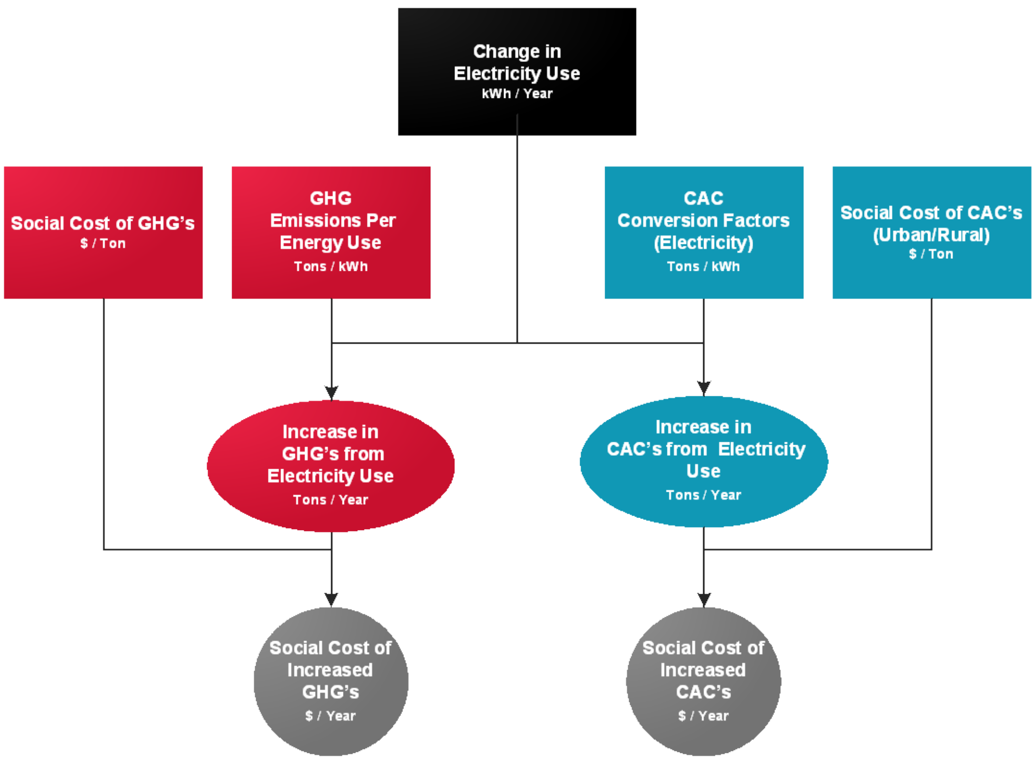
4.3.1 Lifecycle Cost Analysis Assumptions

The following key assumptions supported the LCC analysis:

- Planning period is assumed to be the 50-year period between 2015 and 2065.
- All future costs are discounted to 2015 in this present value analysis using a real discount rate of 3.125%.
- Capital and annual O&M costs are based on information contained in prior studies, as discussed in Section 3.

- The social value of GHG and CAC are calculated per the algorithm depicted in Figure 6, which makes use of the following monetary unit values, as published by the EPA[1]:
  - GHG
    - Emissions per Energy Use = 0.114 pounds/kWh
    - Social Cost of GHG = $42/ton
  - CAC
    - Conversion Factor = 0.0002 pounds/kWh
    - Social Cost of CAC = $0.00014/ton

Figure 6
Calculation for Social Cost of Increased GHG and CACs



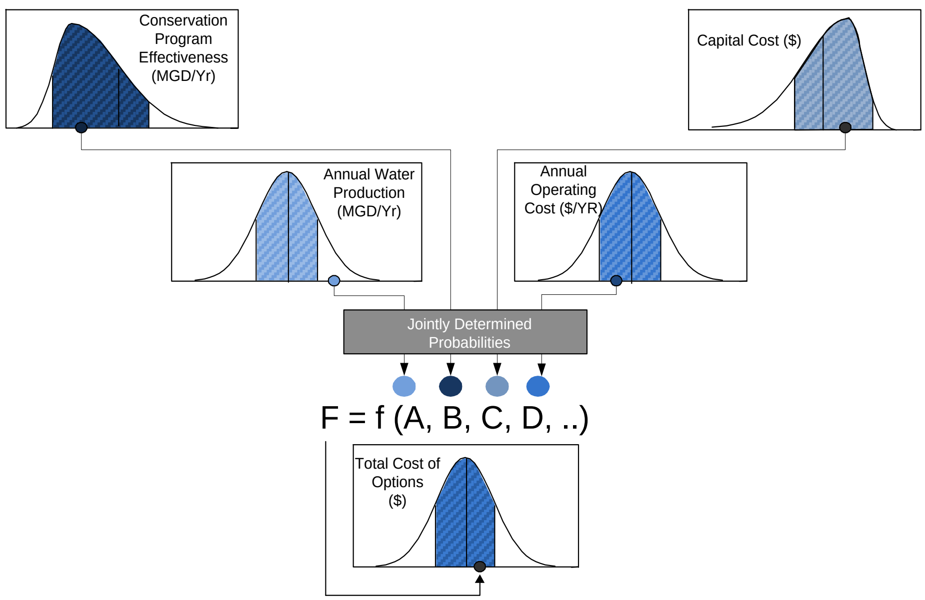
4.3.2 Modeling Uncertainty and Risk

It is important to note that each dimension of an alternatives analysis, including cost, schedule, and community and environmental impacts, entails uncertainties. These uncertainties directly influence the level of confidence that a decision maker can have in selecting the right combination of options. Where these uncertainties are high, best practices in due diligence call for the application of risk

[1] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised November 2013), page 3. Note that GHG values per ton increase annually as per guidelines.

analysis to comprehensively assess the impact of these uncertainties on decisions. Risk analysis is a sound approach to evaluating these uncertainties. It entails the quantitative specification of uncertainties with probability distributions using Monte Carlo simulation methods to determine the probabilistic range of outcomes. These results can then be interpreted with respect to the upside and downside risk in deciding on a specific alternative over another. Figure 7 illustrates the Monte Carlo simulation process in which uncertainties in multiple variables are combined to yield a distribution of potential outcomes.

Figure 7
Diagram of Monte Carlo Simulation Process



In this multi-criteria evaluation, uncertainties were captured in three variables contained within the LCC analysis—cost, schedule, and yield. This was done by applying probability distributions to ranges of values for each variable and then running numerous scenarios (i.e., various combinations of variables throughout the 50-year planning period per the Monte Carlo process described above). Details regarding the approach to the uncertainty analysis for these variables is provided in the following sections.

4.3.3 Cost and Schedule Uncertainty

Defining Ranges of Values

The projects included in the analyzed alternatives have been defined and evaluated at a screening or feasibility level (i.e., typically 0 to 2% of project definition). Thus, a cost contingency range of -30% to +50% was applied to the total base project capital cost and annual O&M costs, to reflect the uncertainties in costs at this screening level of analysis[2]. It is to this contingency range that probability distributions were applied for each project.

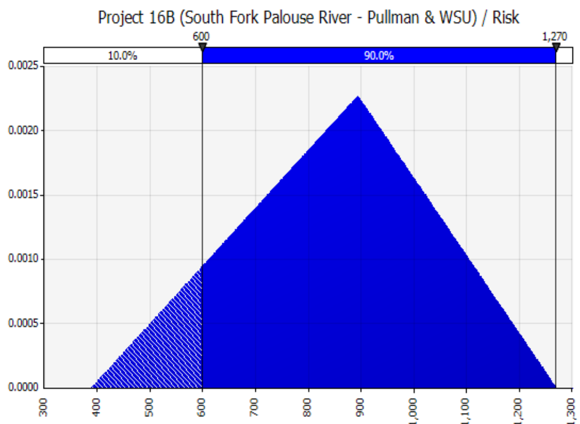
Regarding schedule, the analysis assumes the design and permitting of the first project to be implemented within each alternative would not begin until 2020. Other projects would not be implemented until the projected water demand requires additional source development. The duration for the design and permitting phase for all projects beginning in 2020 is assumed to be between 2 and 6 years, while the planning/design phases of all other future projects are assumed to have a 2-year duration. It is to this planning/design phase range that probability distributions were applied for each project. Construction duration is assumed to take 2 to 5 years, depending on the size and complexity of the project.

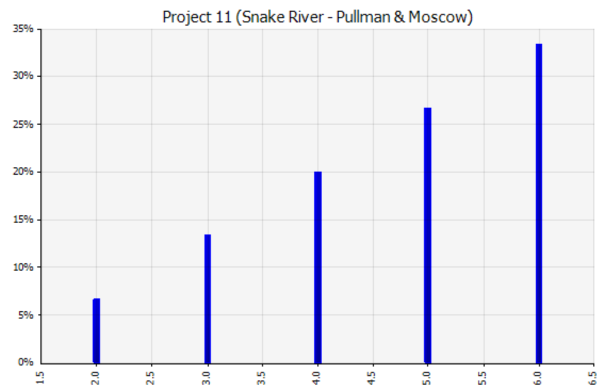
Defining Probability Distributions

A simple approach to applying probability distributions to the above uncertainty ranges is to assume an equal probability for each value with range. However, in a multi-criteria evaluation, qualitatively assessed criteria can be used to inform the type or shape of distribution curve utilized to better reflect the uncertainties specific to given projects. For example, it is likely that a project with more significant potential water quality impacts or more complicated water rights mitigation needs will incur higher project development costs and longer permitting timelines than projects without such considerations. Thus, it is reasonable to assume the probability distributions for cost contingency and schedule duration ranges for more complicated projects would be skewed in the direction of higher costs and longer schedule. Figure 8 depicts two examples of probability distribution curves (continuous and discreet) employed in this analysis.

[2] In this analysis, screening or feasibility level cost estimates are considered to be the same as AACE International Class 5 estimates.

Figure 8
Example Probability Distribution Curves





Distribution Notes:
- Continuous: all possible yield values
- 10% chance of 600 MG or less
- Most likely value = 894 MG
- Maximum value = 1,270 MG

Distribution Notes:
- Discrete: Only 2, 3, 4, 5, or 6 years (for design/permitting)
- Six years is most likely
- Shorter durations have declining probability of occurring

Using Qualitative Assessments to Inform Probability Distributions

The probability distribution curves for the range of cost contingency and schedule values applied to each project were defined by the evaluation of the qualitatively assessed criteria described in Section 4.2.3. Each project within the four alternatives was scored against each of the qualitatively assessed criteria, with those scores then translating to the "most likely value" in the probability distributions applied to the cost contingency and permitting/design phase schedule duration ranges.

The criteria scoring approach is based on a scale of -2 to +2, with the scales defined specifically for each criterion. Appendix F contains the scoring scale details. Table 7 summarizes the scoring results for the qualitative criteria and also provides the detail of how these scores were translated to cost and schedule impacts.

Table 7
Assessment of Qualitative Criteria and Impacts to Cost/Schedule

Criteria	Weight (Cost Impacts)	1: Project 11 Snake River	2: Project 8 North Fork	2: Project 14 Aquifer Recharge –	3: Project 16 South Fork	3: Project 1 Flannigan Creek	4: Project 35 Wastewater Reuse –	4: Additional Construction	4: Project 14 Aquifer Recharge –	4: Project 16 ASR Pullman	4: Project 20 Wastewater Reuse –
6. Water Quality Impacts	20%	0	0	-1	0	0	-2	0	-1	-1	0
7. Aquifer Data/Model Accuracy	25%	1	1	0	1	0	-2	-1	0	1	1
8. Water Rights Complexity	10%	-1	1	0	2	2	-2	2	0	2	0
9. Permitting – State/Local	10%	-1	-1	0	-1	-2	-1	2	0	0	0
10. Permitting – Federal	10%	-2	1	1	2	0	2	2	1	2	2
11. Regional Agreements	5%	-2	-2	1	-1	1	2	1	1	-1	2
12. Property Owner Participation	10%	-1	2	2	2	-2	-1	0	2	2	2
13. Public Acceptance	10%	2	0	-1	0	-1	-2	1	-1	-1	1
Total Weighted Score (impacts cost)		**-0.15**	**0.45**	**0.05**	**0.70**	**-0.25**	**-1.20**	**0.50**	**0.05**	**0.50**	**0.85**
Lowest Score of Criteria 8-13 (impacts schedule)		**-2**	**-2**	**-1**	**-1**	**-2**	**-2**	**0**	**-1**	**-1**	**0**

Note:
Scoring based on a range of -2 to 2 (per previously established criteria scoring definitions).

Converting Score to Cost Impact	Converting Score to Design/Permitting Schedule Impact
Cost Contingency Range is -30% to +50% of base cost A score of -2 = Most likely value in cost contingency range is +50% A score of 2 = Most likely value in cost contingency range is -30%	Design/Permitting Schedule Range is 2-6 years A score of -2 = Most likely value in schedule range is 6 years A score of 2 = Most likely value in schedule range is 2 years

The results of applying this approach are depicted for each project in Table 8 and Table 9, for cost contingency and schedule duration, respectively. Appendix G provides graphical depictions of the LCC model output for cost and schedule once these ranges are applied to the Monte Carlo simulation.

Table 8
Uncertainties in Cost Contingencies

Alternatives	Projects	Capital Cost ($M)	O&M Cost ($/MG)	Cost Range (% of Baseline) Low	Mid[1]	High
Alternative 1	Project 11 (Snake River)	$74	$2,551	-30%	13%	50%

Alternatives	Projects	Capital Cost ($M)	O&M Cost ($/MG)	Cost Range (% of Baseline)		
				Low	Mid[1]	High
Alternative 2	Project 8 (North Fork Palouse River)	$43	$897	-30%	1%	50%
	Project 14 (Aquifer Recharge – Moscow)	$14.4	$1,793	-30%	9%	50%
Alternative 3	Project 16B (South Fork Palouse River)	$21.5	$844	-30%	-4%	50%
	Project 1 (Flannigan Creek Storage)	$59.9	$1,827	-30%	15%	50%
Alternative 4	Project 35 (Wastewater Reuse/Passive Recharge)	$3.3	$180	-30%	34%	50%
	Additional Conservation	$18.7	Not Separately Identified[2]	-30%	0%	50%
	Project 14 (Aquifer Recharge – Moscow)	$14.4	$1,793	-30%	9%	50%
	Project 16 (ASR – Pullman)	$14.4	$1,793	-30%	0%	50%
	Project 20 (Wastewater Reuse – Pullman)	$19.2	$1,245	-30%	-7%	50%

Notes:

1. Mid-point (most likely value) of Cost Range is based on qualitative scoring.
2. This information was not separately identified in this analysis, but it is included as part of the Capital Cost element. This cost could be separately identified in future evaluations.

Table 9
Uncertainties in Schedule

Alternatives	Projects	Year Project Activities Begin	Design/Permit Duration (years)			Construction Duration (years)		
			Low	Mid	High	Low	Mid	High
Alternative 1	Project 11 (Snake River)	2020	2	6	6	4	4.5	3
Alternative 2	Project 8 (North Fork Palouse River)	2020	2	6	6	2	2.5	3
	Project 14 (Aquifer Recharge – Moscow)	2040	2	2	2	2	2.5	3
Alternative 3	Project 16B (South Fork Palouse River)	2020	2	5	6	2	2.5	3
	Project 1 (Flannigan Creek Storage)	2024	2	2	2	4	4.5	5
Alternative 4	Project 35 (Wastewater Reuse/Passive Recharge)	2020	2	6	6	2	2.5	3
	Additional Conservation	2020	2	4	6	0	0	0
	Project 14 (Aquifer Recharge – Moscow)	2024	2	2	2	2	2.5	3
	Project 16 (ASR – Pullman)	2030	2	2	2	2	2.5	3
	Project 20 (Wastewater Reuse – Pullman)	2043	2	2	2	2	2.5	3

Note:
Mid-point (most likely value) of Design/Permit Duration is based on qualitative scoring.

4.3.4 Yield Uncertainty

Each project included in the evaluated alternatives has a projected annual yield, as described in Section 4.1. However, there are uncertainties associated with each of these yield estimates that primarily reflect the natural variability in hydrologic conditions year-to-year, but which also can reflect the limited understanding of certain project yields based on the conceptual level to which the projects have been defined to-date. In addition, it is important to capture fatal flaws, if they exist, in this analysis that may lead to certain projects not being feasible. Such potential fatal flaws do exist for Project 35 (Wastewater Reuse and Passive Recharge in Moscow), because this project is the least defined of all projects considered and has significant uncertainty with respect to groundwater infiltration, as described in Section 4.1. As such, Project 35 is the only project that is shown to have the potential to have no yield (i.e., there is a 50% probability that, after further study, this project is determined to not be able to be implemented).

Appendix H provides the detailed bases for yield variability ranges, and Table 10 summarizes the ranges.

Table 10
Uncertainties in Yield

Alternatives	Projects	Design MGY	Annual Yield Variability		
			Low	Mid	High
Alternative 1	Project 11 (Snake River)	1,967	1,575	1,967	2,360
Alternative 2	Project 8 (North Fork Palouse River)	1,550	780	1,550	1.550
	Project 14 (Aquifer Recharge from Paradise Creek or South Fork Palouse River] – Moscow)	358	270	358	358
Alternative 3	Project 16B (South Fork Palouse River)	894	600	894	1,270
	Project 1 (Flannigan Creek Storage)	1,430	1,287	1,430	1,573
Alternative 4	Project 35 (Wastewater Reuse/Passive Recharge)*	430	210	430	462
	Additional Conservation	609	203	609	609
	Project 14 (Aquifer Recharge [Paradise Creek] – Moscow)	358	0	67	358
	Project 16 (ASR – Pullman)	358	358	358	358
	Project 20 (Wastewater Reuse – Pullman)	148	118	148	148

Notes:
*Project 35 has a 50% chance that it is not feasible.
MGY: million gallons per year

4.4 Results

The results of the multi-criteria LCC analysis are depicted in two ways:

1. Cost-effectiveness – This compares the unit cost (i.e., total 50-year LCC divided by total 50-year volume of water provided) of the alternatives.
2. Water Delivery Reliability – This reflects the extent to which each alternative meets the target water demand throughout the 50-year planning period.

Figure 9 summarizes the results of the cost-effectiveness comparison. In this box-and-whisker format, the lower and upper bounds of the boxes relate to the 25th and 75th percentiles of analysis output, respectively. The lower and upper whiskers relate to the 10th and 90th percentiles, respectively.

The following key findings were depicted from these results:

- Alternatives 2 and 4 have the lowest unit LCCs. They each have approximately an equal probability of being the lower cost option, per unit volume of water delivered.
- Alternative 1 has the highest unit LCC, by a significant margin, when compared to the other alternatives.

- Alternative 3 has the potential to be the best value, but with very low probability (i.e., only under the condition that its unit cost is less than approximately the 10th percentile of possible values, while the unit costs of Alternatives 2 and 4 are greater than approximately the 90th percentile of their possible values).

Figure 9
Cost-effectiveness Comparison of Alternatives

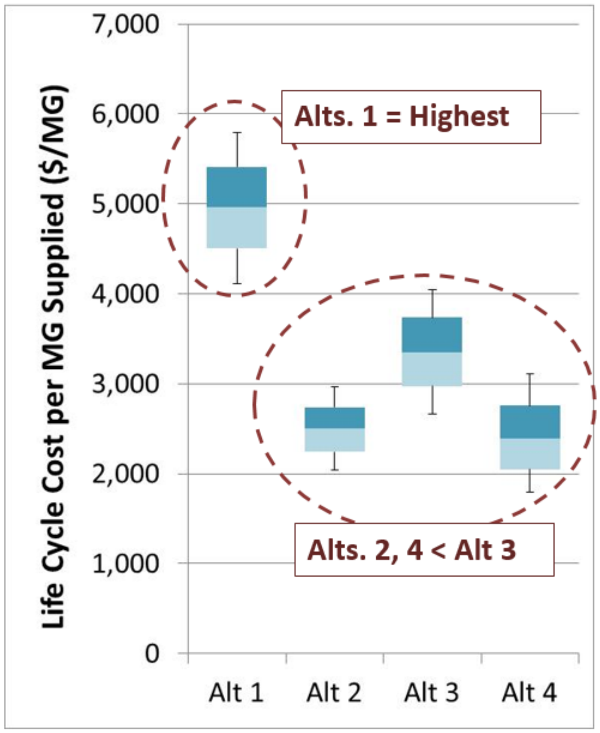


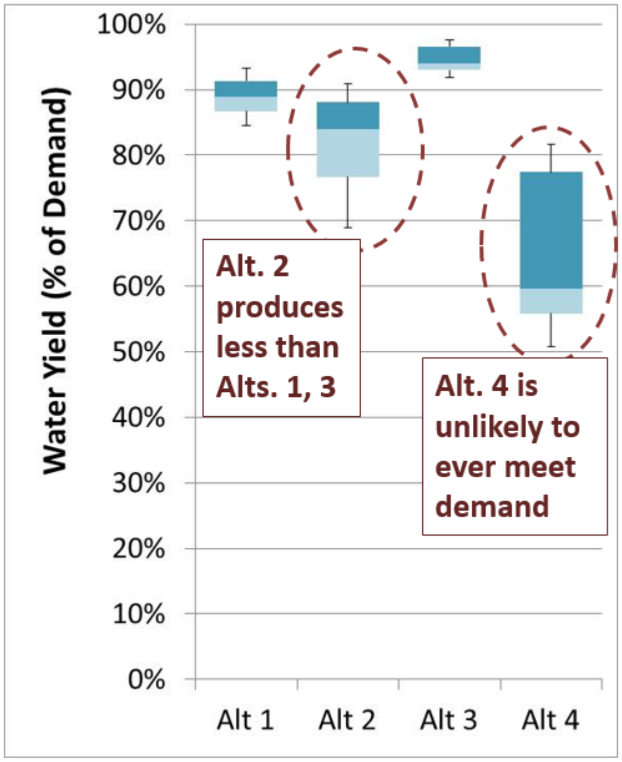
Figure 10 summarizes the results of the water delivery reliability comparison. The box-and-whisker presentation is similar to that of Figure 9.

The following key findings were depicted from these results:

- Alternative 3 meets the target demand nearly all of the time (i.e., greater than 92% of demand is provided). This reflects the least amount of uncertainty in supply yield amongst the four alternatives.
- Alternative 1 meets the target demand, but only until approximately 2055, when the design supply is not sufficient to fully meet future needs. Thus, during the entire 50-year planning period, it performs slightly below Alternative 3 in meeting the total water demand target.
- Alternative 2 has more variability than Alternatives 1 and 3, with a 50% chance of providing at least 85% of the target demand over the planning period.

- Alternative 4 clearly has the greatest variability and does not provide greater than 85% of the total target demand in any of the cases.

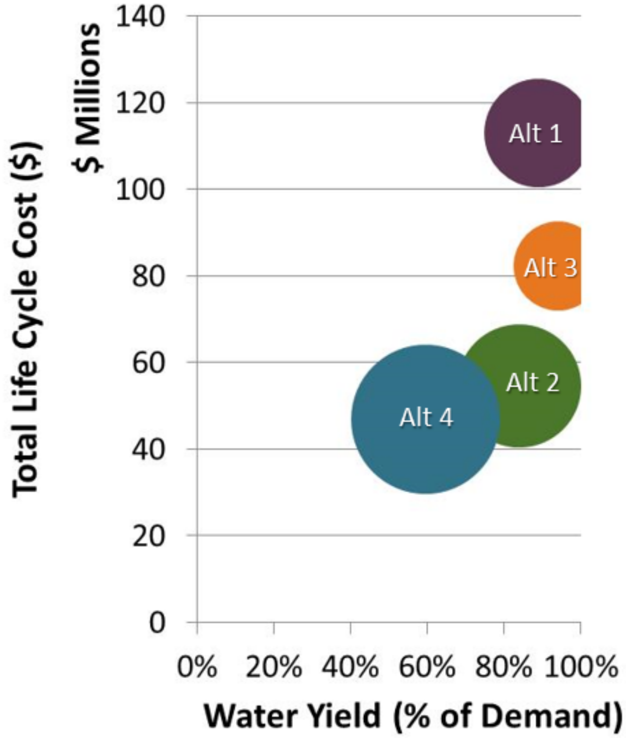
Figure 10
Water Delivery Reliability Comparison of Alternatives



These results can be combined to show total LCC and water delivery reliability, while also indicating the level of uncertainty with respect to both dimensions. This is shown in Figure 11. This interpretation of the results has the following highlights:

- Alternatives 1 and 3 meet higher levels of water demand more reliably but cost significantly more.
- Alternative 3 provides better value compared to Alternative 1, with lower cost and higher yield.
- Alternative 2 delivers more water but costs more than Alternative 4.
- Alternatives 2 and 4 have higher degrees of uncertainty compared to Alternatives 1 and 3.

Figure 11
Lifecycle Cost Versus Water Delivery Reliability



Note: Size of bubble indicates degree of uncertainty.

In addition to these summary results of the quantitative LCC analysis, it is important to remember the results of the qualitatively assessed criteria discussed previously. Although that part of the evaluation did directly inform the quantitative analysis, the scoring of the qualitative criteria also provides additional insight into the overall feasibility of implementation for the projects. As depicted in Table 7, Alternatives 3 and 4 contain projects that scored the highest (e.g., Pullman Wastewater Reuse and South Fork Palouse River Direct Use) and lowest (e.g., Moscow Wastewater Reuse/Recharge and Flannigan Creek) in this assessment; Alternatives 1 and 2 received scores in the middle of the range of the results.

5 Findings and Recommendations

Four alternatives were formulated to meet the 2065 supplemental water supply target of 2,324 MG, which includes additional projected demand for Pullman, Moscow, UI, and WSU, and to offset groundwater declines in the basalt aquifer that typically occur with each year's irrigation season.

The four alternatives evaluated were:

- Alternative 1 – Snake River Diversion and Pipeline to Pullman and Moscow
- Alternative 2 – North Fork Palouse River Diversion and Pipelines to Pullman/Moscow plus Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow
- Alternative 3 – Flannigan Creek Storage, Conveyance and Treatment to Moscow/UI plus South Fork Direct Diversion for Pullman/WSU
- Alternative 4 – Paradise Creek Aquifer Recharge for Moscow, South Fork ASR for Pullman, Pullman Wastewater Reuse, and Moscow Wastewater Reuse and Groundwater Recharge plus Additional Conservation

Thirteen factors were considered in the evaluation of these alternatives, including both quantitative (e.g., capital and operations costs, yield variability) and qualitative (e.g., water quality impacts, environmental effects, permitting challenges) factors. A multi-criteria 50-year lifecycle cost analysis was conducted using direct inputs regarding the quantitative factors, and incorporating project uncertainty and risk as reflected by the effects that the qualitatively assessed factors may have on features such as yield, schedule, and cost. Table 11 provides a summary of the key findings of the multi-criteria analysis, which are expressed primarily in terms of cost-effectiveness (i.e., cost per unit volume of water delivered) and water supply reliability (i.e., amount of the supplemental water supply target met).

The results from this evaluation concluded that Alternative 1 would be the most expensive, but if water rights could be secured, could provide the simplest and perhaps the longest-term reliable supply. Alternatives 2 and 4 provided better value than the others based on lower capital costs and lifecycle costs, and lower environmental impacts, recognizing neither alternative meets the 2065 target as reliably as the Alternatives 1 and 3. Between Alternatives 2 and 4, Alternative 2 is a better option overall, when considering not only cost and yield criteria, but also other evaluation criteria. It provides for 85% of the supplemental supply target through 2065, and also has opportunity for further refinements that could potentially further improve yield amount and reliability.

This analysis did not identify a recommended alternative that clearly stood above the rest in terms of the criteria considered. This finding, along with the potential for additional analyses to further refine the multi-criteria evaluation, as described in Section 6, leads to a recommendation to not remove any alternative from further consideration at this time. The merits of each should be re-evaluated in light of addressed data gaps and refined analysis within this framework, as discussed further in Section 6 and Appendix I.

Table 11
Summary of Key Findings

Multi-Criteria Evaluation Results[1]		
Alternative	**Cost-Effectiveness[2]**	**Water Supply Reliability[3]**
1 – Snake River	• Ranks lowest • Highest cost (median cost of ~$5,000/MG), and by a significant margin compared to others • Greatest amount of uncertainty in cost, but with no probability of being lower cost than any other alternative	• Ranks second • Meets supplemental water supply target fully until 2055, with shortfalls occurring thereafter based on current design
2 – North Fork Palouse Diversion/ Paradise Creek or South Fork Palouse Aquifer Recharge	• Ranks highest (i.e., having lowest cost, at ~$2,500/MG), along with Alternative 4 • Least amount of uncertainty in cost	• Ranks third • 50% probability of providing >85% of supplemental water supply target • Significantly greater uncertainty compared to Alternatives 1 and 3
3 – Flannigan Creek Storage/ South Fork Diversion	• Slightly less cost-effective than Alternatives 2 and 4, with a median cost of ~$3,400/MG	• Ranks highest • Meets supplemental water supply target demand >92% of the time • Least amount of uncertainty or variability in yield year-to-year
4 – Paradise Creek Aquifer Recharge/South Fork ASR/ Pullman Wastewater Reuse/Moscow Wastewater Reuse/Recharge/Additional Conservation	• Ranks highest (i.e., having lowest cost, at ~2,500/MG), along with Alternative 2	• Ranks lowest • Most likely to provide 60% of supplemental water supply target • No probability of providing >85% of target • Greatest amount of uncertainty

Notes:
MG: million gallons
1. See Section 4.4 for a detailed presentation of analysis results.
2. This compares the unit cost (i.e., total 50-year lifecycle cost divided by total 50-year volume of water provided) of the alternatives. See Figure 9 for details.
3. This reflects the extent to which each alternative meets the supplemental water supply target over the 50-year planning period. See Figure 10 for details.

6 Data Gaps, Information Needs, and Next Steps,

PBAC has requested data gaps, information needs and next steps be outlined for each of the four alternatives. This includes identifying additional actions, sequencing and timing of activities, and updated alternatives analysis. This additional information can help support the decision process for selecting the most promising project(s) to pursue.

Data gaps are defined as data or other information important to determining project feasibility that are not currently available. This could be information that could lead to a fatal flaw or result in significant changes or refinements to analysis input(s) that could translate into significantly different results. Data gaps are different from additional project detail needed to further refine a design of a project that has been determined, at least at a conceptual level, to be technically feasible (without an identified fatal flaw). In these cases, additional information can help further refine project elements and cost, and improve understanding of expected project performance in meeting identified goals.

Based on the alternatives evaluation results, data gaps and additional information needs are summarized for each alternative below and in greater detail in a memorandum provided in Appendix I. Information needs, next steps, priority, and timing of follow-up actions are provided for the projects included in each alternative. First, second and third priority items are identified, relative to the suite of actions specific to each alternative. This prioritization approach does not indicate that second- or third- priority items are not important; all the actions would be important in the development of a project selected to pursue, but the priority relates to timing and sequencing of these actions. First priority actions are those identified as the immediate next set of actions to be taken. Second priority actions are the next set of actions to pursue, followed by the third priority actions. Conducting public involvement is shown as a first priority action for all of the alternatives, along with other actions.

Starting in 2017 and continuing over the next several years, PBAC will seek involvement from the public, communities and stakeholders in selecting a preferred solution to meeting the supplemental water supply goal. This includes receiving input on:

- The Final Draft Palouse Groundwater Basin Water Supply Study.
- Additional analyses and studies conducted to further evaluate and refine one or more alternatives and their associated project elements.
- Potential environmental effects anticipated from the projects and actions included in the alternatives.
- Related topics that might emerge during the public involvement process.

The PBAC decision timeline is to have a refined set of alternatives in place by 2020 and a plan ready for implementation by 2025. This timeline is consistent with the PBAC's Mission and Goals, which states that PBAC will develop and implement a balanced basin wide Water Supply and Use Program by 2025 (PBAC 2011).

6.1 Alternative 1

For this project, physically diverting, treating, and conveying surface water from the Snake River to Pullman and Moscow appears feasible. What is in question is the feasibility of securing a water right and other regulatory approvals that would allow for project implementation. If PBAC were to pursue this project, at least two data gaps would need to be addressed, including:

- Surface water right – It would need to be determined if there is an ability to secure a new Washington or Idaho Snake River surface water right, or secure and transfer an existing Washington or Idaho Snake River surface water right(s) with instantaneous and annual quantities needed to meet the demand target. Confirming the expected cost range for water rights acquisition will also be important.
- Endangered Species Act (ESA) and other permitting approvals – Even if a water right with sufficient instantaneous and annual quantities was available, it would need to be determined if a new diversion and withdrawal on the Snake River at the desired diversion location would successfully be granted ESA and other permitting approvals needed to construct the diversion and withdraw the water.

It is recommended that additional work be done on addressing these data gaps prior to moving forward with other activities to better define the more specific project elements, as identified in Appendix I, Table 1.

6.2 Alternative 2

For this alternative, physically diverting and conveying surface water from the North Fork Palouse River to Pullman and Moscow appears feasible. What is in question is the feasibility of treating diverted water during higher runoff periods and, in light of the duration and frequency of turbidity events, if treatable water is available in sufficient quantities to warrant the investment of intake, treatment, and conveyance facilities. Better understanding water right conditions and constraints would also be important prior to additional design activities, recognizing the analysis has been conducted with the assumption that such a water right could likely be secured.

If PBAC were to pursue this project, at least the following data gaps would need to be addressed, including:

- Surface water treatability –The typical timing, frequency, and duration of surface water turbidity events that would prevent water diversion would need to be determined, along with determining whether sufficient water would be available during the targeted late fall, winter, and spring diversion time-period. The expected diversion rates to meet the targeted amount would also need to be determined.

- Surface water right – The ability to secure a new Idaho or Washington surface water right with instantaneous and annual quantities needed to meet the supplemental supply target would need to be determined, as would the likely conditions to accompany such a right.
- Evaluate water availability and average day demand in Moscow, Pullman, WSU, and UI, during the targeted diversion period, and how that relates to the amount of water projected to be available for diversion. This evaluation should address whether the cities and universities would be able to rely completely on surface water, or whether they would also need to pump groundwater for a significant part of winter or include a storage component to make this alternative more viable.
- Determine what impacts, if any, might be expected in City and University water distribution systems if surface water (with a different chemical composition from groundwater) is placed into systems that have only conveyed Palouse Basin groundwater. This would include comparing historical groundwater quality data collected by each entity with water quality for the North Fork Palouse surface water.
- Outline options for a regional organization to develop and operate a regional water system with authorities, responsibilities, timelines, estimated costs to develop and other elements. The findings from this effort would also be applicable to Alternative 1 and potentially Alternative 3, depending upon how these projects were developed and water supplied.

Additionally, opportunity exists for refining this project concept. A proposed variation is to consider whether additional water might be available for withdrawal during higher flow periods, conveyed, treated, and stored in ground through aquifer recharge utilizing the North Fork Palouse system proposed. This could potentially be an additional project component, or serve as a substitute for the second part of the aquifer recharge alternative. Also, other piping alignments could be considered, such as an alignment along an existing railroad right-of-way.

It is recommended that additional work be done on addressing these data gaps and further project refinement be made prior to moving forward with the activities to better define the more specific project elements, as identified in Appendix I, Tables 2A and 2B.

6.3 Alternative 3

For this alternative, the feasibility of a Flannigan Creek storage site will help determine whether it is warranted to pursue additional next steps under this alternative.

If PBAC were to pursue this project, at least the three information needs should be addressed, including:

- Surface water storage – General geotechnical evaluation of potential dam locations should be conducted to ensure stable foundational soil conditions.
- Property acquisition – It should be determined if there are landowners potentially willing to sell the property needed for a dam location and for water conveyance right of way. Property ownership should be evaluated and landowners contacted to determine if they are open to discussing sale of property or providing an easement, as applicable.
- Surface water right – It should be determined if there is an ability to secure a new surface water right with instantaneous and annual quantities needed to meet the supplemental supply target, as well as the likely conditions to accompany such a right.

It is recommended that additional work be done on addressing these data gaps prior to moving forward with other activities to better define the more specific project elements, as identified in Appendix I, Tables 3A and 3B.

6.4 Alternative 4

For this alternative, the same activities and associated timing and sequence for the Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow as described for Alternative 2 in Appendix E, also apply. Additionally, much is known about the Pullman Wastewater Reuse project, because a 30% design report has been developed, describing this project in greater detail than any other project included in any of the alternatives.

However, this alternative is different from the others in that there are significant questions about the feasibility of the Moscow Water Wastewater Reuse and Groundwater Recharge project, and whether the concept could work. If PBAC were to pursue this project, the following data gaps would need to be addressed:

- Sediment vertical permeability in project area – This is directly proportional to infiltration rate and infiltration facility size. Could be low enough to make infeasible.
- Flow top weathering in project area – If top of Wanapum is weathered to clay, or has clay-infilled fractures, this portion of the subsurface could exhibit lower vertical permeability than the overlaying sediments, inhibiting water migration downward into the basalt.
- Flow interior fracturing – If the flow interior/entablature of the upper Wanapum flow does not have significant fracture or joint permeability, then vertical water movement could be extremely limited.
- Uppermost interflow depth, saturation, thickness, permeability (with respect to air), and chemical composition – If infiltrated water is to be recovered, a recovery well or wells would most likely be installed in the uppermost zone that becomes saturated with infiltrate. The

mechanism for how and where this water could enter the existing saturated portion of the confined aquifer is increasingly complex with depth and the number of unsaturated interflows. Characterizing the uppermost interflow is needed to assess:

- Whether groundwater is present or if the infiltration would fully saturate this zone.
- Whether water would begin to migrate laterally before fully saturating the zone, leading to saturated and unsaturated wetting and drying conditions that encourage biological growth.
- The geochemical composition of sediments, clays, or fracture-lining minerals, in order to assess the potential for undesirable changes in infiltrate water quality in a zone not currently in chemical equilibrium with a stable groundwater.

Additional conservation under this alternative has been identified as a way to partially meet the additional supply needs. Achieving the 15% reduction in water usage on top of the measures in place or planned by the cities and universities to meet current conservation goals would require some fundamental regional changes in landscaping and associated irrigation practices. Public involvement planned for the four alternatives should include receiving input from the public on interest and openness to fundamentally changing the way landscape irrigation is currently conducted.

6.5 First Priority Actions for Alternatives

As described above, each alternative would benefit from some additional analysis and follow up work that would strengthen and further refine the evaluation results. Accordingly, the activities summarized in Table 12 are identified as first priority actions.

Table 12
First Priority Actions

Alternative	Action	Description
Alternative 1	Water Rights	For the Snake River, potential water rights for acquisition should be researched in both Idaho and Washington, in coordination with IDWR and Ecology. Identify the top 2 or 3 options and refine the estimated purchase costs, and outline the steps and timeline for acquiring and transferring the point of diversion location. Recommend meeting with Ecology's Office of Columbia River to see if the programs administered under this office could help in securing water supply.
	ESA/Permitting – Preliminary Meetings	In parallel with evaluating water right acquisition opportunities, hold preliminary discussions with NMFS, USFWS, and USACE on the likely ESA and associated environmental review/permitting steps and timeline.
Alternative 2	Water Rights	Many of the water rights evaluation process steps for the North Fork Palouse River and Flannigan Creek are common and can be applied to both projects, with additional evaluation of existing water rights, potential impairment considerations, and recommended water availability periods for both project locations. Work on this evaluation should also identify the steps and likely timeline for securing a water permit.

Alternative	Action	Description
	Surface Water Treatability	Conduct a study evaluating existing water quality data collected in both Idaho and Washington during the proposed diversion period, and identify the frequency and duration of events where turbidity would prevent effective treatment of drinking water. Summarize findings and results.
	Evaluate North Fork Palouse Flows for Groundwater Recharge Potential	Evaluate whether additional water might be available for withdrawal during higher flow periods then conveyed, treated, and stored in-ground through aquifer recharge utilizing the proposed North Fork Palouse River system. Update project description.
Alternative 3	Explore Property Acquisition Potential for Flannigan Creek	Evaluate property ownership and meet with landowners to determine if any potential issues might exist for acquiring property.
	Water Rights	See Alternative 2 description of actions.
All Alternatives	Develop Public Involvement Strategy and Plan	Incorporate study's findings into the PBAC communication action plan strategies, tactics, and timelines to better engage the public, communities, and stakeholders. As part of receiving stakeholder input, seek specific input on the supply study analyses, formulated alternatives, and findings from those knowledgeable on the Palouse Groundwater Basin, including individuals at the universities and others with expertise in groundwater, surface water, water quality, and related topics.
	Brief Elected Officials	Share report findings, recommended actions, and next steps. Keep officials updated as actions are completed.
	Develop Regional Organization Approach	Begin to outline elements of a regional agreement for applicable alternatives, including defining participants, roles and responsibilities, decision-making structure, and other elements.
	Update Multi-criteria Evaluation	Using the information from the actions listed above, update the evaluations for each of the alternatives.
	Develop Implementation Plan	Develop an implementation plan that confirms first, second, and third priority actions and includes additional detail on next steps, timing, and sequencing of activities.

Notes:
Ecology: Washington State Department of Ecology
IDWR: Idaho Department of Water Resources
NMFS: National Marine Fisheries Service
USACE: U.S. Army Corps of Engineers
USFWS: U.S. Fish and Wildlife Service

7 References

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USACE (U.S. Army Corps of Engineers), 1989. *Reconnaissance Report, Palouse River Basin, Idaho and Washington.* March 1989.

Appendix A
Chronological List of Palouse Basin Water Supply and Conservation Related Documents

Study or Reference	**Title**
1958 EBASCO Services	*Supplemental Water Supply for Moscow, Idaho: Interim Report Phase 1 Preliminary Reconnaissance and Consultation*
1968 Jones, R.W., S.H. Ross, and R.E. Williams	*Feasibility of Artificial Recharge of a Small Ground Water Basin by Utilizing Seasonal Runoff from Intermittent Streams*
1969 Williams, R.E., D.D. Eier, and A.T. Wallace	*Feasibility of Re-Use of Treated Wastewater for Irrigation, Fertilization and Ground-Water Recharge in Idaho*
1970 Stevens, Thompson & Runyan, Inc.	*Water Supply Study*
1973 Stevens, Thompson & Runyan, Inc.	*The Feasibility of Union Flat Creek Pumped Storage*
1973 Siath, J.	*Water Supply Study for the City of Moscow*
1981 Nadler, M.	*Feasibility Study: Reclaimed Wastewater for Ground Water Recharge at Moscow, Idaho*
1984 Ten Eyck, G., and C. Warnick	*Catalog of Water Reports Pertinent to the Municipal Water Supply of Pullman, Washington and Moscow, Idaho – A Summary*
1986 Machlis, G.E.	*The Conservation of Water in Moscow, Idaho: A Survey of Public Opinion*
1989 U.S. Army Corps of Engineers	*Reconnaissance Report Palouse River Basin Idaho and Washington*
1993 Parametrix	*Wastewater Treatment Plant Effluent Reuse: Irrigation at Pullman High School, Military Hill Park and Proposed Golf Course*
1998 Parametrix/Kimball Engineering/Esvelt Environmental Engineering	*City of Pullman General Sewer Plan*
2000 Parametrix, Inc.	*Washington State University Water Reclamation Project Pre-Design Study*
2001 Idaho Department of Environmental Quality (DEQ)	*City of Moscow Source Water Assessment Final Report*
2001 Kimball Engineering	*Reuse Study for the City of Moscow*
2002 Parametrix, Inc.	*Washington State University Water Reclamation Project Design Development Document*
2004 EES	*City of Moscow Water Conservation Plan*
2006 Golder Associates	*Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment, Final Report*
2007, WestWater Research, LLC	*Water Right Summary, Proof of Beneficial Use, and Impairment Analysis for Application No. WHIT-07-04*
2008 HDR, Inc.	*City of Pullman Water System Plan*

Study or Reference	Title
2008 Taylor Engineering	*Water System Plan Update, Washington State University*
2009 City of Moscow	*Moscow Comprehensive Plan, Chapter 5, Public Utilities, Services, and Growth Capacity*
2010 HDR/Taylor Engineering	*General Sewer Plan Update*
2011 TerraGraphics/SPF Engineers	*City of Moscow Surface Water Reservoir Feasibility Study – Phase 1*
2011 Keller Associates	*City of Moscow Comprehensive Sewer System Plan*
2011 JUB Engineers	*Wastewater Treatment Evaluation Temperature Report*
2011 CH2M Hill	*City of Moscow Operational Efficiency Evaluation and Review of Revenue Collection Procedures*
2012 HDR, Inc.	*City of Moscow Comprehensive Water System Plan*
2012 Washington DOE (Letter)	*Confirmation of 2003 water quantities evaluation*
2012 JUB Engineers	*Water Reclamation Project – Potential Reclaimed Water Demand Analysis*
2012 JUB Engineers	*Water Reclamation Project – Water Rights Evaluation*
2013 TerraGraphics/SPF Engineers	*City of Moscow Surface Water Reservoir Feasibility Study – Phase 2*
2013 FCS Group	*City of Moscow Sanitation, Water, and Wastewater Rate Study*
2013 Anchor QEA, LLC	*City of Pullman Water Conservation Goals Workshop Summary Memorandum*
2013 City of Pullman	*Water Conservation Program – Public Meeting Memorandum*
2014 Palouse Basin Aquifer Committee	*Framework Project Bibliography*
2014 Anchor QEA, LLC	*City of Pullman Water System Plan Update*
2014 J-U-B Engineers, Inc.	*WSU/Pullman Water Reuse System, Design Update*
2014 City of Moscow	*Sewer Utility Cost of Service Rate Update*
2014 City of Moscow	*Sanitation Utility Cost of Service Rate Update*
2014 City of Moscow	*Water Utility Cost of Service Rate Update*
2015 City of Moscow	*City of Moscow Water Conservation Plan*

Appendix B
Conservation Actions Summary

Palouse Basin Aquifer Committee (PBAC)
Conservation Actions Summary

										Costs from Study		Costs Escalated to Fall 2016			
Study	Year of Study	Project Title	Project Description	Estimated Annual Water Savings (MG/year)	Estimated Annual Water Savings (AF/year)	% of Projected Local System 2025 Demand	% of Projected Local System 2065 Demand	% of Projected Palouse Basin 2025 Demand	% of Projected Palouse Basin 2065 Demand	Cost to Implement ($)	Annual Operational Cost ($)	Cost to Implement ($)	Cost to Implement ($/AF/year)	Annual Operational Cost ($)	Notes/Comments/Data Gaps
City of Pullman - Water System Plan	2014	Conservation Pricing	Conservation Measure - Conservation Pricing	Not Quantified								$ -		$ -	No clear quantities for this.
City of Pullman - Water System Plan	2014	Bills Showing Consumptive History	Conservation Measure - Bills Showing Consumptive History	Not Quantified								$ -		$ -	No clear quantities for this.
City of Pullman - Water System Plan	2014	Landscape Management Practices on City Property	Conservation Measure - Landscape Management Practices on City Property	Not Quantified								$ -		$ -	No clear quantities for this.
City of Pullman - Water System Plan	2014	Education	Conservation Measure - Education	Not Quantified								$ -		$ -	No clear quantities for this.
City of Pullman - Water System Plan	2014	Free Toliet Leak Detection Dye Tablets	Conservation Measure - Free Toliet Leak Detection Dye Tablets	1.42	4.36	0.13%	0.09%	0.04%	0.03%	$ 1,980		$ 2,145	$ 492	$ -	3,902 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Free Bathroom Faucet Aerators	Conservation Measure - Free Bathroom Faucet Aerators	2.11	6.48	0.19%	0.13%	0.06%	0.04%	$ 2,880		$ 3,120	$ 482	$ -	5,777 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Free Showerheads	Conservation Measure - Free Showerheads	0.89	2.73	0.08%	0.06%	0.03%	0.02%	$ 7,200		$ 7,799	$ 2,855	$ -	2,427 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Toilet Rebates	Conservation Measure - Toilet Rebates	0.46	1.41	0.04%	0.03%	0.01%	0.01%	$ 12,960		$ 14,038	$ 9,944	$ -	Average of 1,247.4 gpd x 365 days x 1 MG/1,000,000 gallons. Costs averaged as well.
City of Pullman - Water System Plan	2014	Washing Machine Rebates	Conservation Measure - Washing Machine Rebates	2.04	6.26	0.18%	0.13%	0.06%	0.04%	$ 20,000		$ 21,664	$ 3,460	$ -	5,600 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Water Use Surveys	Conservation Measure - Water Use Surveys	1.39	4.27	0.12%	0.09%	0.04%	0.03%	$ 42,000		$ 45,494	$ 10,665	$ -	3,818 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Lawn Removal Credits	Conservation Measure - Lawn Removal Credits	0.15	0.46	0.01%	0.01%	0.00%	0.00%	$ 3,600		$ 3,899	$ 8,471	$ -	421 gpd x 365 days x 1 MG/1,000,000 gallons
City of Pullman - Water System Plan	2014	Watering Timers	Conservation Measure - Watering Timers	0.432	1.33	0.04%	0.03%	0.01%	0.01%	$ 4,500		$ 4,874	$ 3,677	$ -	1,183 gpd x 365 days x 1 MG/1,000,000 gallons
City of Moscow - Water Conservation Plan	2015	Ultra low flow toliet (ULFT) rebates - 1.6 gbf	Conservation Measure - Ultra low flow toliet (ULFT) rebates - 1.6 gbf	21.3	65.37	2.06%	1.24%	0.63%	0.43%	$ 387,781		$ 406,685	$ 6,222	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	High efficiency toliet (HET) rebates -1.0 gpf	Conservation Measure - High efficiency toliet (HET) rebates (1.0-1.28 gpf)	3.76	11.54	0.36%	0.22%	0.11%	0.08%	$ 73,076		$ 76,638	$ 6,642	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Low volume urinal rebates - 1.0 gpf	Conservation Measure - Low volume urinal rebates - 1.0 gpf	0.78	2.39	0.08%	0.05%	0.02%	0.02%	$ 8,508		$ 8,923	$ 3,728	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Waterless urinal rebates	Conservation Measure - Waterless urinal rebates	0.34	1.04	0.03%	0.02%	0.01%	0.01%	$ 4,110		$ 4,310	$ 4,131	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free toliet-leak detection tablets and repair information	Conservation Measure - Free toliet-leak detection tablets and repair information	3.14	9.64	0.30%	0.18%	0.09%	0.06%	$ 774		$ 812	$ 84	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free toliet-tank displacement devices	Conservation Measure - Free toliet-tank displacement devices	5.31	16.30	0.51%	0.31%	0.16%	0.11%	$ 6,627		$ 6,950	$ 426	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage reduced toliet flushes	Conservation Measure - Encourage reduced toliet flushes	2.91	8.93	0.28%	0.17%	0.09%	0.06%	$ -		$ -	$ -	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free low-flow showerheads - 2.5 gpm	Conservation Measure - Free low-flow showerheads - 2.5 gpm	5.64	17.31	0.55%	0.33%	0.17%	0.11%	$ 18,097		$ 18,979	$ 1,097	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage reduced shower use (5-minute timer)	Conservation Measure - Encourage reduced shower use (5-minute timer)	2.38	7.30	0.23%	0.14%	0.07%	0.05%	$ 35,462		$ 37,191	$ 5,092	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Instant hot water valve rebate	Conservation Measure - Instant hot water valve rebate	11.42	35.05	1.11%	0.67%	0.34%	0.23%	$ 92,317		$ 96,817	$ 2,763	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free bathroom faucet aerators - 2.2 gpm	Conservation Measure - Free bathroom faucet aerators - 2.2 gpm	8.6	26.39	0.83%	0.50%	0.25%	0.17%	$ 2,331		$ 2,445	$ 93	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free kitchen faucet aerators - 2.2 gpm	Conservation Measure - Free kitchen faucet aerators - 2.2 gpm	1.85	5.68	0.18%	0.11%	0.05%	0.04%	$ 5,215		$ 5,469	$ 963	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage reduced faucet use	Conservation Measure - Encourage reduced faucet use	2.92	8.96	0.28%	0.17%	0.09%	0.06%	$ -		$ -	$ -	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)

Palouse Basin Aquifer Committee (PBAC)
Conservation Actions Summary

Study	Year of Study	Project Title	Project Description	Estimated Annual Water Savings (MG/year)	Estimated Annual Water Savings (AF/year)	% of Projected Local System 2025 Demand	% of Projected Local System 2065 Demand	% of Projected Palouse Basin 2025 Demand	% of Projected Palouse Basin 2065 Demand	Costs from Study: Cost to Implement ($)	Costs from Study: Annual Operational Cost ($)	Costs Escalated to Fall 2016: Cost to Implement ($)	Costs Escalated to Fall 2016: Cost to Implement ($/AF/year)	Costs Escalated to Fall 2016: Annual Operational Cost ($)	Notes/Comments/Data Gaps
City of Moscow - Water Conservation Plan	2015	Efficient clothes washer rebates	Conservation Measure - Efficient clothes washer rebates	3.9	11.97	0.38%	0.23%	0.11%	0.08%	$ 196,366		$ 205,939	$ 17,207	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage reduced partial clothes washer loads	Conservation Measure - Encourage reduced partial clothes washer loads	1.22	3.74	0.12%	0.07%	0.04%	0.02%	$ -		$ -	$ -	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free audits for automatic irrigation	Conservation Measure - Free audits for automatic irrigation	11.59	35.57	1.12%	0.68%	0.34%	0.24%	$ 475,715		$ 498,906	$ 14,027	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free audits for manual irrigation	Conservation Measure - Free audits for manual irrigation	7.97	24.46	0.77%	0.46%	0.23%	0.16%	$ 868,840		$ 911,195	$ 37,254	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free outdoor irrigation devices	Conservation Measure - Free outdoor irrigation devices	0.77	2.36	0.07%	0.04%	0.02%	0.02%	$ 49,166		$ 51,563	$ 21,821	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free low water use plant guidebook	Conservation Measure - Free low water use plant guidebook	0.61	1.87	0.06%	0.04%	0.02%	0.01%	$ 1,300		$ 1,363	$ 728	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Rain barrel rebates - 50 gallon	Conservation Measure - Rain barrel rebates - 50 gallon	0.0983	0.30	0.01%	0.01%	0.00%	0.00%	$ 6,881		$ 7,216	$ 23,922	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage less lawn	Conservation Measure - Encourage less lawn	4.26	13.07	0.41%	0.25%	0.13%	0.09%	$ 102,978		$ 107,998	$ 8,261	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Free efficient restaurant spray heads	Conservation Measure - Free efficient restaurant spray heads	0.143	0.44	0.01%	0.01%	0.00%	0.00%	$ 1,168		$ 1,225	$ 2,791	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Encourage reduced hotel bedding and towel washing	Conservation Measure - Encourage reduced hotel bedding and towel washing	0.016	0.05	0.00%	0.00%	0.00%	0.00%	$ -		$ -	$ -	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
City of Moscow - Water Conservation Plan	2015	Sub-meter multi-family households	Conservation Measure - Sub-meter multi-family households	2.89	8.87	0.28%	0.17%	0.08%	0.06%	$ 231,688		$ 242,983	$ 27,397	$ -	From Draft Conservation Plan - Appendix C. Total of Single Family Indoor, Multi-Family Indoor, Commercial Indoor Estimated Savings (excludes free riders)
WSU Water System Plan	2008	Service Meters	Conservation Measure - Upgrade Service Meters	Not Quantified						$ 1,650,000		$ 2,109,008		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	System Leak Detection and Repair	Conservation Measure - Leak Detection and Repair	Not Quantified						$ 10,000		$ 12,782		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Technical Studies	Conservation Measure - Technical Studies	Not Quantified						$ 252,000		$ 322,103		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Landscape Management	Conservation Measure - Landscape Management	5.04	15.47	1.04%	0.84%	0.15%	0.10%	$ 600,000		$ 766,912	$ 49,583	$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Agricultural Management	Conservation Measure - Agricultural Management	0.41	1.27	0.09%	0.07%	0.01%	0.01%			$ -	$ -	$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Upgrades to Plumbing Fixtures	Conservation Measure - Upgrades to Plumbing Fixtures	Not Quantified								$ -		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Reduction/Elimination of Water Cooled Equipment	Conservation Measure - Reduction/Elimination of Water Cooled Equipment	Not Quantified								$ -		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Education	Conservation Measure - Education	Not Quantified								$ -		$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Closewashers	Conservation Measure - Upgrade to Efficient Closewashers	8.71	26.71	1.79%	1.45%	0.26%	0.18%	$ 175,000		$ 223,683	$ 8,373	$ -	From Table 4-3 of 2008 WSU Water System Plan
WSU Water System Plan	2008	Reclaimed Water	Conservation Measure - Reclaimed Water	Not Quantified								$ -		$ -	From Table 4-3 of 2008 WSU Water System Plan

Appendix C
Project and Management Action Detailed Summary

Appendix C
Water Supply Project Summary Matrix

							Estimated Supply and % Demand				Comparison to Projected Demand[3]				Costs from Study		Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	% of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Annual Operating Cost ($)	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
1	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Flannigan Creek	Flannigan Creek - Alternative A1 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	1,430	4,400	6,600	4,400	150%	101%	53%	35%	$ 53,664,000	$ 2,340,000	$ 62,845,000	$ 14,283	$ 2,740,000	$ 133,010,000	$ 195,855,000	$ 44,513	-6.8-square-mile watershed above reservoir -6,600-acre-foot reservoir (102-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 12.8 miles of pipeline -Treatment facilities in Moscow -Design capacity is 5.9 MGD or 4,100 gpm
2	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Hatter Creek	Hatter Creek - Alternative A2 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	782	2,400	3,600	2,400	82%	55%	29%	19%	$ 65,386,000	$ 1,499,600	$ 76,572,000	$ 31,905	$ 1,756,000	$ 85,243,000	$ 161,815,000	$ 67,423	-3.5-square-mile watershed above reservoir -3,600-acre-foot reservoir (105-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 24.2 miles of pipeline -Treatment facilities in Moscow -Design capacity is 3.2 MGD or 2,200 gpm
3	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River	SF Palouse River - Alternative A3 Surface water supply alternative; Stored water conveyed to treatment; Treated water discharged directly to City of Moscow	228	700	1,300	700	24%	16%	8%	6%	$ 25,685,000	$ 426,200	$ 30,079,000	$ 42,970	$ 499,000	$ 24,223,000	$ 54,302,000	$ 77,574	-1.3-square-mile watershed above reservoir -1,300-acre-foot reservoir (111-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Approximately 5.8 miles of pipeline -Treatment facilities in Moscow -Design capacity is 1.2 MGD or 800 gpm
4	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Felton Creek	Felton Creek - Alternative A4 Surface water supply alternative; Stored water pumped and conveyed to treatment; Treated water discharged directly to City of Moscow	424	1,300	2,000	1,300	44%	30%	16%	10%	$ 32,005,000	$ 725,900	$ 37,481,000	$ 28,832	$ 850,000	$ 41,262,000	$ 78,743,000	$ 60,572	-2-square-mile watershed above reservoir -2,000-acre-foot reservoir (92-foot-tall dam) -Estimated Supply = Average Reservoir Yield -Pumping facilities -Approximately 10.2 miles of pipeline -Treatment facilities in Moscow -Design capacity is 1.8 MGD or 1,240 gpm
5	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River - Non-potable Irrigation	SF Palouse River for Irrigation Supply - Alternative B3 Surface water supply alternative; Non-potable supply only; Stored water conveyed to City of Moscow in river; Pumped and distributed through irrigation system	196	600	600	700	21%	14%	7%	5%	$ 4,845,000	$ 63,700	$ 5,674,000	$ 9,457	$ 75,000	$ 3,641,000	$ 9,315,000	$ 15,525	-1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot tall dam) -Estimated Supply = Reservoir Capacity -Used for irrigation only (non-potable) -Conveyance in SF Palouse River Channel -Two intake pump stations in Moscow -Distribution piping in Moscow -Design capacity is 3.3 MGD or 2,260 gpm

Appendix C
Water Supply Project Summary Matrix

							Estimated Supply and % Demand				Comparison to Projected Demand[3]				Costs from Study		Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	% of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Annual Operating Cost ($)	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
6	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Felton Creek - Non-potable Irrigation	Felton Creek for Irrigation Supply - Alternative B4 Surface water supply alternative; Non-potable supply only; Stored water pumped and conveyed to City of Moscow; Distributed through irrigation system	126	385	385	1,300	13%	9%	5%	3%	$ 12,720,000	$ 57,200	$ 14,896,000	$ 38,691	$ 67,000	$ 3,252,000	$ 18,148,000	$ 47,138	-2-square-mile watershed above reservoir -385-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Reservoir Capacity -Pumping facilities -Approximately 10.2 miles of pipeline -Distribution piping in Moscow -Design capacity is 2.1 MGD or 1,450 gpm
7	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	NF Palouse River - Direct Use	NF Palouse River - Alternative A5 Surface water supply alternative; Direct diversion from NF Palouse River in Idaho; Surface water pumped and conveyed to treatment in Moscow; Treated water discharged directly to City of Moscow	1,550	4,760	NA	NA	162%	109%	57%	38%	$ 41,660,000	$ 2,410,000	$ 46,350,000	$ 9,737	$ 2,681,000	$ 130,146,000	$ 176,496,000	$ 37,079	-Direct diversion of NF Palouse water -Estimated Supply = 10 cfs from November to June -River intake pump station -Approximately 14 miles of pipeline -Treatment facilities in Moscow -Design capacity is 6.5 MGD or 4,500 gpm -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989)
8	Surface Water Alternative	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment (*Variation of ASR project*)	2006	2013	NF Palouse River - Pullman Direct Use	NF Palouse River Surface water supply alternative; Direct diversion from NF Palouse River in Washington; Surface water pumped and conveyed to treatment north of Pullman; Treated water conveyed to both City of Pullman and City of Moscow	1,550	4,760	NA	NA	153%	103%	57%	38%	$ 40,570,000	$ 1,310,000	$ 45,137,000	$ 9,483	$ 1,457,000	$ 70,728,000	$ 115,865,000	$ 24,341	-Based on Table 11-1 of Multi-purpose Storage Report and Project Alternative A5 from Phase II Surface Feasibility Study (ID 7) -Direct diversion of NF Palouse water for regional use in both Pullman and Moscow -Estimated Supply = 10 cfs from November to June, same as Project Alternative A5 from Phase II Surface Feasibility Study (ID 7) -River intake and pump station near Palouse -Approximately 25 miles of pipelines -Treatment facilities 7 miles north of Pullman -Pipelines to both Pullman and Moscow for direct use or ASR
9	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Dworshak Reservoir	Dworshak Reservoir - Alternative A6 Surface water supply alternative; Direct diversion from Dworshak Reservoir; Surface water pumped and conveyed to treatment; Treated surface water delivered directly to Moscow and Pullman	7,270	22,300	NA	NA	761%	511%	267%	179%	$ 149,000,000	$ 2,980,000	$ 165,773,000	$ 7,434	$ 3,315,000	$ 160,922,000	$ 326,695,000	$ 14,650	-Direct diversion from Dworshak Reservoir -Estimated Supply = Design Capacity -Design capacity is 31 cfs -Approximately 55 miles of pipeline -Pumping facilities at reservoir and Kendrick, Idaho -Treatment facilities in Moscow -Alternative is from USACE (1989), Costs updated for 2013 Phase 2 Feasibility Study

Appendix C
Water Supply Project Summary Matrix

ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Supply and % Demand: Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	Comparison to Projected Demand[3]: % of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Costs from Study: Capital Cost to Implement ($)	Annual Operating Cost ($)	Costs Escalated to Fall 2016: Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
10	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (USACE estimate)	Snake River Pipeline - Alternative A7a Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Moscow and Pullman	7,270	22,300	NA	NA	761%	511%	267%	179%	$ 92,000,000	$ 1,840,000	$ 102,357,000	$ 4,590	$ 2,047,000	$ 99,369,000	$ 201,726,000	$ 9,046	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 31 cfs -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman or Moscow -Alternative is from USACE (1989), costs updated for 2013 Phase 2 Feasibility Study
11	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (Pipeline to Pullman and Moscow - scoped as regional project, SPF/TG cost estimate)	Snake River Pipeline - Alternative A7b Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman and Moscow; smaller capacity	1,967	6,040	NA	NA	206%	138%	72%	49%	$ 69,790,000	$ 4,730,000	$ 77,646,000	$ 12,855	$ 5,262,000	$ 255,437,000	$ 333,083,000	$ 55,146	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 10 cfs (reduced from 31 cfs studied by USACE [1989]) -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman or Moscow -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989), reduced size evaluated for 2013 Phase 2 Feasibility Study -Annual supply capacity reduced to 10 cfs of pumping for 10 months -Included cost of water right at $2,000 per acre-foot for listed annual supply capacity
12	Surface Water Alternative	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Snake River (Pipeline to Pullman only, SPF/TG estimate)	Snake River Pipeline - Alternative A7c Surface water supply alternative; Direct diversion from Snake River; Surface water pumped and conveyed to treatment; Treated surface water delivered to Pullman potable water system; Smaller capacity; Delivery only to Pullman	2,360	7,240	NA	NA	233%	157%	87%	58%	$ 46,360,000	$ 5,420,000	$ 51,579,000	$ 7,124	$ 6,030,000	$ 292,718,000	$ 344,297,000	$ 47,555	-Direct diversion of Snake River Water -Estimated Supply = Design Capacity -Design capacity is 10 cfs (reduced from 31 cfs studied by USACE [1989]) -Approximately 25 miles of pipeline -Pumping facilities -Treatment facilities in Pullman, no delivery to Moscow or conveyance, Pullman to Moscow -Developed from NF Palouse alternatives studied by STR (1970) and USACE (1989), reduced size evaluated for 2013 Phase 2 Feasibility Study
13	ASR/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	SF Palouse River - ASR Purposes	ASR (Year-Round) - Alternative C3 Year-round ASR alternative; Water Storage Reservoir on SF Palouse River (Same as Project ID 5); Stored water conveyed to treatment; Treated water injected over 8-month period	196	600	600	700	21%	14%	7%	5%	$ 13,497,000	$ 544,100	$ 15,806,000	$ 26,343	$ 637,000	$ 30,922,000	$ 46,728,000	$ 77,880	-1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Reservoir Capacity -Approximately 5.8 miles of pipeline -Treatment facilities in Moscow -ASR injection well, 8-month Injection Period -Design capacity is 1.2 MGD or 810 gpm

Appendix C
Water Supply Project Summary Matrix

							Estimated Supply and % Demand				Comparison to Projected Demand[3]				Costs from Study		Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	% of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Annual Operating Cost ($)	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
14	ASR/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 1	2011	2011	Paradise Creek and/or SF Palouse River - Moscow ASR	ASR Using Spring Runoff - Alternative D3a ASR with in-city surface water diversion; Direct Diversion from Paradise Creek and/or SF Palouse River in Moscow; Treatment; Active injection of treated water in Moscow ASR wells during spring runoff; No Reservoir	358	1,100	NA	NA	37%	25%	13%	9%	$ 12,940,000	$ 574,700	$ 15,154,000	$ 13,776	$ 673,000	$ 32,670,000	$ 47,824,000	$ 43,476	-Direct diversion of SF Palouse water -ASR during spring runoff (4 months) -Estimated Supply = 1,100 AF/4 months -River intake pump station -Piped conveyance to treatment -Treatment facilities near ASR facilities -ASR injection well, 4-month injection period -Design capacity is 3.0 MGD or 2,070 gpm
15	Aquifer Recharge/ Groundwater Storage	City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	Paradise Creek and/or SF Palouse River Passive Recharge to Wanapum Aquifer in Moscow	ASR Using Spring Runoff - Alternative D3b ASR with in-city surface water diversion; Direct Diversion from SF Palouse River; Passive Treatment and Recharge of Wanapum Aquifer in Moscow through Infiltration Basin; No Reservoir	358	1,100	NA	NA	37%	25%	13%	9%	$ 1,280,000	$ 57,000	$ 1,424,000	$ 1,295	$ 63,000	$ 3,058,000	$ 4,482,000	$ 4,075	-Direct diversion of SF Palouse water -ASR during natural runoff period of 4 months -Estimated Supply = 1,100 AF/4 months -River intake pump station -Pipe conveyance to infiltration basin -Passive recharge -12-acre recharge site/infiltration basin -Design capacity is 3.0 MGD or 2,070 gpm
16	ASR/ Groundwater Storage	City of Pullman - Water System Plan	2014	2013	SF Palouse River - Pullman ASR	ASR Using Winter/Spring Runoff ASR with surface water diversion; Direct Diversion from SF Palouse River; Treatment; Active injection of treated water during late winter and spring runoff; No Reservoir	325	997	NA	NA	32%	22%	12%	8%	$ 25,000,000	$ 300,000	$ 27,814,000	$ 27,898	$ 334,000	$ 16,214,000	$ 44,028,000	$ 44,160	-Direct diversion of SF Palouse water -ASR during natural runoff period -Assumes 3 ASR Wells -Estimated Supply = 325 MGY -Year 1 Pilot Testing for a single well ASR system is estimated $200,000 -2014 WSP updated costs to 2013 ($25 million for implementation, $300,00 for Year 1 of testing)

Appendix C
Water Supply Project Summary Matrix

ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Supply and % Demand: Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	Comparison to Projected Demand[3]: % of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Costs from Study: Capital Cost to Implement ($)	Annual Operating Cost ($)	Costs Escalated to Fall 2016: Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
16B	Surface Water Alternative	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment (Variation of ASR project)/Modified from Pullman ASR (ID 16)/Costs Based on City of Moscow - Surface Water Feasibility Study - Phase 2	2013	2013	SF Palouse River, Direct Diversion	Direct Diversion Using Winter/Spring Runoff Direct Diversion from SF Palouse River; Treatment; Delivery to City of Pullman Water System during late winter and spring runoff; No Reservoir	894	2,743	NA	NA	88%	59%	33%	22%	$ 20,393,280	$ 675,600	$ 22,689,000	$ 8,272	$ 752,000	$ 36,505,000	$ 59,194,000	$ 21,580	-Direct diversion of SF Palouse water -ASR during natural runoff period of November to June -Estimated Supply = 894 MGY (2,743 AF) diverted when available from November to June -River intake pump station -Treatment -Capacity = 10 cfs, similar to Snake River and NF Palouse projects; capacity would not likely be available through entire runoff period -Direct delivery to City of Pullman Water System
17	Aquifer Recharge/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2013	NF Palouse River, Direct Diversion for ASR	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Treatment Plan and Injection Wells near Palouse; Treatment; Active Injection of Treated Water to Recharge Aquifer without Direct Retrieval	900	2,762	NA	NA	89%	60%	33%	22%	$ 23,902,400	$ 478,048	$ 26,593,000	$ 9,628	$ 532,000	$ 25,825,000	$ 52,418,000	$ 18,978	-Direct diversion of NF Palouse River -ASR during natural runoff period within 2 miles of diversion -Diversion to include river intake and pumping facilities -Conveyance from river intake/pump station to injection well -Treatment prior to active injection -Estimated supply = 6 MGD -Capital Cost includes scaled cost associated with direct diversion and treatment of NF Palouse (ID 7/8, does not include conveyance and pumping to get to Moscow) + ASR well cost
18	ASR/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2006	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Pond for Enhanced Deep Aquifer Recharge	978	3,000	NA	3,000	NA	NA	36%	24%	$ 6,000,000	$ 238,000	$ 8,222,000	$ 2,741	$ 326,000	$ 15,825,000	$ 24,047,000	$ 8,016	-Enhanced recharge using infiltration pond -From Table 11-1 of Multi-purpose Storage Report, Wanapum-Grand Ronde + Kamiak Butte -Two pond sizes/configurations considered: 1 pond handling 1 cfs, 2 ponds each handling 5 cfs -Costs are for 2 ponds, each handling 5 cfs -$2,000,000 for 2 ponds (5 cfs) + $4,000,000 for conveyance costs -$38,000 for pond O&M + $200,000 for conveyance O&M

Appendix C
Water Supply Project Summary Matrix

							Estimated Supply and % Demand				Comparison to Projected Demand[3]				Costs from Study		Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	% of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Annual Operating Cost ($)	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
19	ASR/ Groundwater Storage	Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment	2006	2006	Deep Aquifer Recharge	Direct Surface Water Diversion of NF Palouse in Washington; Aquifer Storage Using Winter/Spring Runoff; Conveyance to Infiltration Ditch for Enhanced Deep Aquifer Recharge	978	3,000	NA	3,000	NA	NA	36%	24%	$ 6,200,000	$ 230,000	$ 8,496,000	$ 2,832	$ 315,000	$ 15,291,000	$ 23,787,000	$ 7,929	-Enhanced recharge using infiltration ditch -From Table 11-1 of Multi-purpose Storage Report, Wanapum-Grand Ronde + Kamiak Butte -Two pond sizes/configurations considered: 1 pond handling 1 cfs, 2 ponds each handling 5 cfs -Costs are for 2 ponds, each handling 5 cfs -$2,200,000 for 2 ponds (5 cfs) + $4,000,000 for conveyance costs -$30,000 for pond O&M + $200,000 for conveyance O&M
20	Water Reuse	City of Pullman and WSU - Water Reclamation Project - Design Development Document Update	2015	2014	Pullman/ WSU Water Reuse Project	Water Reuse Project WWTP Upgrades, Class A reclaimed water supply pumped to new water reuse system for irrigation at reuse sites in Pullman	148	454	NA	NA	15%	10%	5%	4%	$ 18,587,922	$ 165,000	$ 20,134,000	$ 44,348	$ 179,000	$ 8,689,000	$ 28,823,000	$ 63,487	-Modifications to City WWTP to produce up to 1.35 MGD of Class A reclaimed water -Reclaimed water pumping facilities -710,000 gallons of storage -Conveyance pipeline, WWTP to BPS and Storage -Distribution pipelines -Estimated Supply = Annual demand for planned reuse sites -Annual water reuse demand = 148 MGY at planed reuse sites + 115 MGY at future planned sites (2002 Parametrix report estimates) -City's current peak water reuse estimate = 150,000 gpd, May to October
21	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #1	Potential Wastewater Recycle using Scalping Plants Scalping Plant #1 to serve reuse sites in NE area (Area 1) of City of Moscow	17	53	NA	NA	2%	1%	1%	0%	$ 4,800,000	$ 50,000	$ 5,621,000	$ 106,057	$ 59,000	$ 2,864,000	$ 8,485,000	$ 160,094	-Scalping Plant #1 to serve NE area of Moscow -North Mountain View Road and East B Street -Diversion structures -0.125-MGD MBR plant -Building, site work, aeration basin -80,000-gallon Storage Tank -Pumping Facilities -Distribution piping
22	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #2	Potential Wastewater Recycle using Scalping Plants Scalping Plant #2 to serve reuse sites in E area (Area 2) of City of Moscow	26	79	NA	NA	3%	2%	1%	1%	$ 7,600,000	$ 75,000	$ 8,900,000	$ 112,658	$ 88,000	$ 4,272,000	$ 13,172,000	$ 166,734	-Scalping Plant #2 to serve E area of Moscow -Kenneth Avenue and Blaine Street -Diversion structures -0.300-MGD MBR plant -Building, site work, aeration basin -130,000-gallon Storage Tank -Pumping Facilities -Distribution piping

Appendix C
Water Supply Project Summary Matrix

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23	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Potential Wastewater Recycle using Scalping Plants - Scalping Plant #3	Potential Wastewater Recycle using Scalping Plants Scalping Plant #3 to serve reuse sites in S area (Area 3) of City of Moscow	11	33	NA	NA	1%	1%	0%	0%	$ 3,300,000	$ 50,000	$ 3,865,000	$ 117,121	$ 59,000	$ 2,864,000	$ 6,729,000	$ 203,909	-Scalping Plant #3 to serve S area of Moscow -Near the South Sewage Lift Station -Diversion structures -0.075-MGD MBR plant -Building, site work -80,000-gallon Storage Tank -Pumping Facilities -Distribution piping
24	Water Reuse	City of Moscow - Comprehensive Sewer System Plan	2011	2011	Additional Storage and Distribution	Water Reuse Distribution System Storage and Distribution Piping to Area 1 (NE area) and Area 2 (E area)	44	136	NA	NA	5%	3%	2%	1%	$ 7,900,000	$ 35,000	$ 9,252,000	$ 68,029	$ 41,000	$ 1,990,000	$ 11,242,000	$ 82,662	-Assumes expansion of existing WWTP, but expansion of WWTP included in this project or the associated estimates -Booster Pump Station -12-inch Pipeline, WWTP to Ghormley Park -12-inch Pipeline, Ghormley Park to Joseph Street -12-inch Pipeline, Joseph Street to Mountain View Park -5-MG HDPE-lined Storage Lagoon
25	Water Reuse	City of Moscow - WWTP Improvements Phase V Predesign Study			Alternative #9 Reuse	Water Reuse variation	Information not available/developed																Connected to Project 23
26	Surface Water Alternative - OLD	Interim Report, Phase One, Preliminary Reconnaissance and Consultation, Supplemental Water Supply for the City of Moscow, ID	1958	1958	Robinson Lake Site	Potential reservoir/dam site Surface water supply alternative; Stored water conveyed to City of Moscow	1,524	4,675	2,700	4,675	160%	107%	56%	38%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-From original 1958 EBASCO Report -8.19-square-mile watershed above reservoir -2,700-acre-foot reservoir -Estimated Supply = Average Reservoir Yield -Minimum Estimated Yield = 3,230 acre-feet -Maximum Estimated Yield = 6,120 acre-feet -Conveyance not defined

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Water Supply Project Summary Matrix

							Estimated Supply and % Demand				Comparison to Projected Demand[3]				Costs from Study		Costs Escalated to Fall 2016			Present Value of Costs (Fall 2016) of Annual Operating Costs			
ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	% of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Capital Cost to Implement ($)	Annual Operating Cost ($)	Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
27	Surface Water Alternative - OLD	Interim Report, Phase One, Preliminary Reconnaissance and Consultation, Supplemental Water Supply for the City of Moscow, ID	1958	1958	Gnat Creek Diversion	Diversion of Gnat Creek to increase yield of the Robinson Lake Site Surface water supply alternative; Gravity conveyance from Gnat Creek Watershed to Robinson Lake	394	1,210	NA	1,210	41%	28%	14%	10%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-From original 1958 EBASCO Report -4.25-square-mile watershed above diversion -Estimated Supply = Average Reservoir Yield -Minimum Estimated Yield = 820 acre-feet -Maximum Estimated Yield = 1,600 acre-feet -Diversion and conveyance not defined
28	Surface Water Alternative - OLD	Water Supply Study, Pullman-Moscow Water Resources Committee	1970	1970	Potlatch River Project	Proposes diversion of water from the main Potlatch River at a point due south of Helmer, Idaho, and transmitting water from that point to the communities of Pullman and Moscow	7,300	22,400	NA	NA	765%	513%	268%	180%	$ 15,555,000	$ 1,515,700	$ 119,639,000	$ 5,341	$ 11,658,000	$ 565,922,000	$ 685,561,000	$ 30,605	-From 1970 STR Study -22,000 acre-foot reservoir -Estimated supply = 20 MGD x 365 days -Gravity Releases to Potlach River -Gravity intake facilities near Helmer, Idaho -Treatment facilities at intake -Estimated Supply = Average Reservoir Yield -Conveyance to terminal storage near Moscow -Pumping facilities -Design capacity 15 MGD, future to 20 MGD, intended to be developed in three phases
29	Additional Groundwater Supplies	City of Moscow - Comprehensive Water System Plan	2012	2010	Moscow - Additional Groundwater Development	City of Moscow Additional Groundwater Well Development, from Moscow Comprehensive Water Plan	578	1,774	NA	NA	61%	41%	21%	14%	$ 1,500,000	$ 88,200	$ 1,811,000	$ 1,021	$ 106,000	$ 5,146,000	$ 6,957,000	$ 3,922	-Cost to drill new well from Moscow Comprehensive Water Plan, Page 6-13 -Water Supply = 578 MGY -450-horsepower pumping, 12 hours/day
30	Additional Groundwater Supplies	2014 City of Pullman Water System Plan	2014	2013	Pullman - Additional Groundwater Development	City of Pullman Additional Groundwater Well Development, from Pullman Water System Plan	400	1,227	NA	NA	40%	27%	15%	10%	$ 1,018,800	$ 60,000	$ 1,133,000	$ 923	$ 67,000	$ 3,252,000	$ 4,385,000	$ 3,574	-Additional source capacity needed by 2032 -Capacity not yet defined; capacity shown was assumed based on annual output of City's two largest wells; assumes a similar well would be drilled -Additional source yet to be defined, cost represents a placeholder
31	Conservation Measures	2015 City of Moscow - Water Conservation Plan	2015	2015	Moscow Conservation Measures	Sum of all conservation measures from the 2015 Moscow Conservation Plan	104	319	NA	NA	11%	7%	4%	3%	$ 2,568,400	$ -	$ 2,694,000	$ 8,445	$ -	$ -	$ 2,694,000	$ 8,445	-From Appendix C of Moscow Conservation Plan -Table Package C + Additional Items -Annual "Operating Costs" in Table 6-5 of 2012 Moscow Comprehensive Water Plan -See Demand Management Summary Table for breakout of conservation costs and benefits

Appendix C
Water Supply Project Summary Matrix

ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Supply and % Demand: Estimated Annual Supply (MG)[1]	Estimated Supply and % Demand: Estimated Annual Supply (AF)	Estimated Supply and % Demand: Storage Capacity (AF)	Estimated Supply and % Demand: Average Annual Yield (AF)[2]	Comparison to Projected Demand[3]: % of Projected Local System 2025 Demand[3]	Comparison to Projected Demand[3]: % of Projected Local System 2065 Demand[3]	Comparison to Projected Demand[3]: % of Projected Palouse Basin 2025 Demand[3]	Comparison to Projected Demand[3]: % of Projected Palouse Basin 2065 Demand[3]	Costs from Study: Capital Cost to Implement ($)	Costs from Study: Annual Operating Cost ($)	Costs Escalated to Fall 2016: Capital Cost to Implement ($)	Costs Escalated to Fall 2016: Capital Cost to Implement ($/AF of Annual Supply)	Costs Escalated to Fall 2016: Annual Operating Cost ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Present Value of Annual Operating Costs ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Total Present Value (Capital Cost + Annual Operating Cost) ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Total Present Value ($/AF of Annual Supply)	Notes
32	Conservation Measures	2014 City of Pullman Water System Plan	2014	2014	Pullman Conservation Measures	Sum of all conservation measures from the 2014 Pullman Water System Plan	9	27	NA	NA	1%	1%	0%	0%	$ 95,120	$ -	$ 103,000	$ 3,815	$ -	$ -	$ 103,000	$ 3,815	-See Demand Management Summary Table for breakout of conservation costs and benefits
33	Conservation Measures	2008 WSU Water System Plan	2008	2008	WSU Conservation Measures	Sum of all conservation measures from the 2008 WSU Water System Plan	14	43	NA	NA	3%	2%	1%	0%	$ 2,687,000	$ -	$ 3,434,000	$ 79,860	$ -	$ -	$ 3,434,000	$ 79,860	-See Demand Management Summary Table for breakout of conservation costs and benefits
34	Surface Water Alternative - NEW	NEW	NA	2011	SF Palouse River and/or Paradise Creek - Variation on Surface Water Supply	SF Palouse River and/ or Paradise Creek Surface water supply alternative; Small Reservoir; Stored water conveyed to City of Moscow or City of Pullman in river; Pumped from river to treatment or to irrigation system; Treated water distributed to Moscow and/or Pullman potable water systems	228	700	600	700	24%	16%	8%	6%	$ 11,391,150	$ 489,900	$ 13,340,000	$ 19,057	$ 574,000	$ 27,864,000	$ 41,204,000	$ 58,863	-Hybrid of Surface Water Alternatives A3 and B3 (ID 3 and 5) -1.3-square-mile watershed above reservoir -600-acre-foot reservoir (40-foot-tall dam) -Estimated Supply = Watershed Yield -Potable and/or water -Conveyance in SF Palouse River Channel -Two intake pump stations in Moscow or Pullman -Distribution piping in Moscow or Pullman -Design capacity is 3.3 MGD or 2,260 gpm -Treatment facilities in Moscow or Pullman
35	Water Reuse/ Groundwater Storage NEW	NEW	NA	NA	Water Reuse Combined with Infiltration or ASR	Water Reuse for Infiltration or ASR Water reuse for groundwater storage alternative; Class A recycled water from Moscow WWTP discharged to shallow infiltration area to enhance Wanapum aquifer groundwater storage	420	1,300	NA	NA	80%	54%	16%	10%	NA	NA	$ 3,479,000	$ 2,676	$ 76,000	$ 3,689,000	$ 7,168,000	$ 5,514	-Hybrid of Water Reuse Alternatives (ID 20-25) and Passive Recharge Basin alternative (ID 15) -Class A discharge from WWTP discharged to shallow infiltration basin -Pipe conveyance to infiltration basin -Passive recharge -Recharge site/infiltration basin
36	Groundwater Storage and Retention NEW	NEW	NA	NA	Snake River Aquifer Recharge	Recharge the Grande Ronde Aquifer at point of discharge for the purposes of a) aquifer recharge, and b) hydraulic containment for the purpose of native groundwater retention	978	3,000	NA	3,000	NA	NA	36%	24%	$ 6,200,000	$ 230,000	$ 6,200,000	$ 2,067	$ 230,000	NA	NA	$ 7,571	-Explore the potential for RBF, and/or treatment at Snake elevation, and recharge at/near Snake Elevation. -Has benefit of long deferring and/or mitigating any water quality changes associated with ASR
37	Groundwater Storage and Retention NEW	NEW	NA	NA	West Palouse Hydraulic Containment	Poorly defined, but essentially same concept as above at western discharge location using possible treated surface water or reclaimed water as the source	Information not available/developed																

Appendix C
Water Supply Project Summary Matrix

ID	Project Type	Study	Year of Study	Year of Cost Estimate	Project Title	Project Description	Estimated Supply and % Demand: Estimated Annual Supply (MG)[1]	Estimated Annual Supply (AF)	Storage Capacity (AF)	Average Annual Yield (AF)[2]	Comparison to Projected Demand[3]: % of Projected Local System 2025 Demand[3]	% of Projected Local System 2065 Demand[3]	% of Projected Palouse Basin 2025 Demand[3]	% of Projected Palouse Basin 2065 Demand[3]	Costs from Study: Capital Cost to Implement ($)	Annual Operating Cost ($)	Costs Escalated to Fall 2016: Capital Cost to Implement ($)	Capital Cost to Implement ($/AF of Annual Supply)	Annual Operating Cost ($)	Present Value of Costs (Fall 2016) of Annual Operating Costs: Present Value of Annual Operating Costs ($)	Total Present Value (Capital Cost + Annual Operating Cost) ($)	Total Present Value ($/AF of Annual Supply)	Notes
38	Enhanced Grande Ronde Recharge NEW	NEW	NA	NA	Inter-Aquifer Transfer	Relying on the water balance concept, use recharge to the Wanapum (multiple options above) as source to passively recharge the Grande Ronde via packered wells; Grande Ronde recharge could be recovered downgradient	Information not available/developed																Has benefit of targeting the aquifer most at-risk doe to over-appropriation and limited recharge.

Notes:

1. Estimated annual supply is the amount of additional water supply that will reliably (at least 50% of the time) be made available by implementing the proposed project. Notes indicating the assumed basis for estimating water supply are included under "Notes."

2. The average annual yield is the estimated average annual yield of the watershed captured by a proposed reservoir or tributary to a proposed diversion location.

3. The projected demands used as a basis for comparison are projected demands without additional conservation. Local system demand includes just the projected demand for the local system that would receive most or all of the water supply. Palouse demand includes the overall projected demand for the Palouse Groundwater Basin.

References:

EBASCO, 1958

Parametrix, 2002

STR, 1970

USACE, 1989

AF: acre-feet
ASR: aquifer storage and recovery
BPS: Booster pump station
cfs: cubic feet per second
E: east
EBASCO: EBASCO Consulting Firm
gpd: gallons per day
gpm: gallons per minute
HDPE: high-density polyethylene
MBR: Membrane Bioreactor
MG: million gallons
MGY: milligrams per year
MGD: million gallons per day
NA: not available
NE: northeast
NF: north fork
O&M: operations and maintenance
S: south
SF: south fork
SPF/TG: SPF Engineering/TerraGraphics
STR: Stevens, Thompson and Runyon
USACE = U.S. Army Corps of Engineers
WRIA: Water Resource Inventory Area
WSP: Water System Plan
WSU: Washington State University
WWTP: wastewater treatment plant

Appendix D
Criteria for Comparing Projects

Criteria for Comparing Projects

Eight criteria are proposed for comparing projects, intended to address the primary benefits and challenges associated with the projects considered. Each criterion has a scoring system that can be used to calculate a project priority score.

In addition to the raw scores, each of these criteria can be weighted. This allows some criteria to more strongly influence the selection and prioritization of projects. The eight criteria together with suggested weights are shown below.

Criteria	Weights
1. Unit Cost of Supply	10
2. Long Term Supply Reliability	8
3. Technical Certainty of Success	8
4. Property Acquisition	6
5. Permitting Complexity – Water Rights	6
6. Permitting Complexity - Environmental	6
7. Extent of Regional Agreements Required	3
8. Public Acceptability	6

Criteria Definitions and Scoring

This section provides a system for scoring each project based on the eight criteria listed above. It should be noted that any given project may be proposed in order to meet a specific need represented by a single criterion. However, many projects offer ancillary benefits (and conversely, may have multiple challenges) as well. Therefore each project should be reviewed for the full range of criteria listed.

The criteria are to be used as a starting point for PBAC to evaluate which capital projects should be further considered for use in developing supply alternatives (i.e., combinations of projects to meet the total supply target). The criteria are meant to provide a consistent basis for ranking projects and to document the rationale for advancing those projects for further evaluation.

Unit Cost of Supply

This criterion reflects the cost per unit volume of water supplied. It would give priority to projects that have a low cost per volume of water supplied.

Project Ranking Scores	
Unit Cost of Supply **Weight = 10**	**Ranking Score**
Project has the highest unit cost of all projects ($60,463/AF)	0
Projects are scored relative to one another on the 0-3 scale, based on normalization against the highest unit cost project	Normalized against highest cost
Project has low unit cost (i.e., approaching $0/AF)	3

Long Term Supply Reliability

Refers to a project's expected ability to provide all or a portion of the estimated 50-year water demand across an anticipated range of climatic conditions (e.g., wet, normal, dry) and meeting acceptable service standards during catastrophic events such as a severe drought (adapted from California Urban Water Association or CUWA August 2012 report - see http://www.cuwa.org/pubs/CUWA_WaterSupplyReliability.pdf).

The scoring gives priority to projects that are expected to maintain the projected quantity by having more resistance to climatic shifts and other sources of variability.

Project Ranking Scores	
Long Term Supply Reliability **Weight = 8**	**Ranking Score**
Project may have great variability in yield year-to-year and does not have significant resiliency relative to climate change	0
Project is expected to have moderate variability in yield year-to-year and moderate resiliency relative to climate change	1.5
Project is expected to offer 50 years of relatively consistent supply, and has climate change resiliency	3

Technical Certainty of Success

Technical certainty considers whether or not the technical data and operating experience regarding a given project or its proposed type of technology supports a high level of likely success. For example, a high score would be assigned to a project that utilizes known and proven technology, while a low score might be assigned to an aquifer recharge project where there are little data on whether the desired geologic and aquifer conditions exist to support successful water withdrawal, or a water reclamation technology that has been in use for a relatively short period of time, i.e., less than is necessary to verify the technical efficacy of the technology.

Project Ranking Scores	
Technical Certainty of Success	**Ranking Score**
Weight = 8	
Project technical basis data does not exist or there is no technology operating record available	0
Project technical basis data is limited or technology operating record are not well established	1
Project technical basis data well established and accepted, but the operating record is less than necessary to verify the technology efficacy	2
Project technical basis data and technology operating record are established and accepted with a long history of success	3

Property Acquisition

This criterion considers the anticipated ease or difficulty expected in acquiring the property and right of way necessary to implement the project. Projects with long portions of pipelines requiring right of way in, or that require land purchase in sensitive lands, land owned by the federal government, or land owners that have been known to be difficult to work with in the past will score lower.

Project Ranking Scores	
Property Acquisition	**Ranking Score**
Weight = 6	
Project crosses multiple properties with diverse ownership, including likely problematic property/easement acquisitions; or, there is at least one property for which acquisition is expected to be extremely problematic	0
Project partially within existing right of ways and will require a medium level of property acquisition	1.5
Project primarily within existing right of ways and requires minimal to no property acquisition	3

Permitting Complexity – Water Rights

Acquiring new water rights today can be difficult and complex. This criterion addresses whether the water right path will be both difficult and complex. Projects are scored higher if the water rights path is not expected to be contentious with other appropriators and in-stream rights.

Project Ranking Scores	
Permitting Complexity – Water Rights	**Ranking Score**
Weight = 6	
Project is expected to encounter resistance from other appropriators and in-stream rights	0
Project is expected to encounter resistance for in-stream rights	1
Project is expected to encounter resistance from other appropriators	2
Project is not expected to encounter resistance from other appropriators and in-stream rights	3

Permitting Complexity – Environmental

Environmental permitting can be critical to project success. For this criterion projects are scored higher if the project is not expected to trigger federal permitting requirements, e.g., NEPA or CWA, state ASR permitting, and does not cross environmentally sensitive land.

Project Ranking Scores	
Permitting Complexity – Environmental	**Ranking Score**
Weight = 6	
Project is expected to have significant environmental permitting complexity (e.g., triggers federal permitting, requires ASR or anti-degradation related permitting, and/or crosses sensitive land)	0
Project is expected to have moderately complex environmental permitting	1
Project is not expected to trigger federal permitting or ASR permitting, but is expected to cross sensitive land	2
Project is expected to have minimal environmental permitting requirements (i.e., does not trigger federal permitting, require ASR or anti-degradation related permitting, or cross sensitive land)	3

Extent of Regional Agreements Required

This criterion addresses the anticipated jurisdictional complexity of the proposed projects. The scoring gives priority to projects that require fewer agreeing parties and fewer funding parties.

Project Ranking Scores	
Extent of Regional Agreements Required	**Ranking Score**
Weight = 3	
Project requires regional agreements and regional funding approaches	1
Project does not require regional agreements and regional funding approaches	3

Public Acceptability

Refers to a project's expected ability to garner support from parties that will benefit from the project and not receive criticism from parties who will not benefit from the project, but who might be impacted by the project. Higher score projects are those that are expected to have greater support and fewer critics.

Project Ranking Scores	
Public Acceptability	**Ranking Score**
Weight = 6	
Project is expected to receive little support from beneficiaries and be challenged at multiple steps by critical affected parties	0
Project is expected to receive strong support from beneficiaries and be challenged at multiple steps by critical affected parties	1
Project is expected to receive little support from beneficiaries and to have few critical affected parties	2
Project is expected to receive strong support from beneficiaries and to have few critical affected parties	3

Applying Criteria

The Anchor/HDR team has developed a simple spreadsheet for use in conjunction with the above ranking criteria. The spreadsheet calculates scores for each project by applying the individual criteria scores and weights. Results are provided in a separate document.

Appendix E
Descriptions of Alternatives

Alternative 1 – Snake River Diversion and Pipeline to Pullman and Moscow (Project 11, Regional)

Description	Estimated Annual Supply (MG)	Total Present Value ($/AF of annual supply)
	1,967	$55,146

This is a regional project based on the 1989 *Reconnaissance Report, Palouse River Basin, Idaho and Washington* (USACE 1989), as modified by the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* (SPF and TerraGraphics 2013). The project would supply a portion of the projected future water demands in the Cities of Pullman and Moscow, and also be used to offset existing irrigation, for both the cities and the universities, based on a 10-month (approximately 304-day) diversion period. The revised concept provided in the 2013 study would deliver up to 10 cubic feet per second (cfs) from the Snake River to Pullman and Moscow, which is smaller than the 31-cfs capacity that was originally evaluated by the U.S. Army Corps of Engineers (USACE). The estimated annual water supply from this alternative is 1,967 million gallons (MG), which is 357 MG less than the 2,324-MG supplemental supply target. If this supply was available throughout the year, instead of restricted to 10 months, the annual supply would be 2,360 MG and would exceed the 2,324-MG target. It would include the following facilities:

- **Intake** – A river intake structure would be constructed on the east bank of the Snake River near Wawawai Canyon. The intake would be a reinforced-concrete structure from which water would be routed to a nearby pump station.
- **Pumping** – Five pump stations, ranging in size from 350 to 600 horsepower, and four storage tanks would be required to maintain the hydraulic gradient in the system. Three pump stations would be required to lift water from the Snake River up through the Wawawai Canyon, and two pump stations would be required to lift water over hills near Pullman and from Pullman to Moscow.
- **Pipelines** – Water would be conveyed to Moscow and Pullman in a 20-inch, welded-steel pipeline along a public right-of-way route that would follow the Wawawai-Pullman Road to Old Country Club Road, then skirt south of Pullman to connect to the Old Moscow Road, and deliver water to south Moscow. This would result in a longer pipeline route than was contemplated by USACE. The total pipeline length of conveyance would be approximately 25 miles. The maximum elevation gain for the pipeline conveying water from the Snake River to Moscow would be approximately 1,950 feet. Maximum pressures would be approximately 355 pounds per square inch (psi), which is too high for use of high-density polyethylene (HDPE) pipe. Therefore, American Water Works Association C200 spirally welded steel pipe was assumed for the entire length of the project.
- **Treatment** – Direct use of Snake River water would require a water treatment plant. The treatment plant could be located near the intake or near Pullman, and water would then be conveyed from the treatment plant to Pullman, Moscow, Washington State University (WSU), and University of Idaho (UI).
- **Annual Supply** – The estimated annual supply of the proposed alternative would be 6,040 acre-feet (AF) per year, or 1,967 MG, which is equal to the design capacity multiplied by 10 months of operation. The *City of Moscow Surface Water Feasibility Study – Phase 2* assumed operation for 365 days per year, but annual withdrawals would likely be limited to 10 months due to instream flow restrictions in the Snake River.

Water would be withdrawn from the Snake River, except during low-flow periods (expected to be July and August typically). During these periods when surface water is not available or when demands exceed the surface water system capacity, the cities and universities would rely on groundwater to meet water demands.

Implementation Timing and Sequencing Assumptions for Analysis

Because this alternative only includes one project, timing and sequencing considerations are less important when compared to other alternatives. If this alternative is selected for implementation, a project-specific development schedule will be established at that time.

Cost Elements
Capital (see Attachment 1) • Total Estimated Project Cost = $77,646,000 • Cost per Delivered Acre-foot = $12,855; Cost per Delivered MG = $39,474
Operation and Maintenance (O&M; see Attachment 1) • Total Estimated Annual O&M Costs = $5,262,000 • O&M per Delivered Acre-foot = $871; O&M per Delivered MG = $2,675
Project Considerations (what we know/anticipate)
• Multiple properties/easements to acquire for pipeline right-of-way • Interstate water rights and federal power system adds complexity to permitting • Permitting and associated studies • Environmental impacts and constraints • Will need additional geotechnical information • Will need to understand power extension requirements and costs • Opportunities for generating electricity via turbine on downhill sections should be evaluated to see if there are opportunities to offset some lifting costs and reduce pressure requirements in some downstream sections. Additionally, could be potential for pump storage to be a component of this project. • Water rights may need to potentially be purchased upstream in Washington or Idaho. Costs for water rights have been added to the estimate of total project cost for this project and are reflected in the cost elements listed above as follows: 6,040 AF multiplied by $2,000/acre-foot = approximately $12 million, plus administrative and legal costs of 5%.

References:

SPF and TerraGraphics (SPF Water Engineering, LLC, and TerraGraphics Environmental Engineering, Inc.), 2013. *City of Moscow Surface Water Feasibility Study – Phase 2*. November 19, 2013.

USACE (U.S. Army Corps of Engineers), 1989. *Reconnaissance Report, Palouse River Basin, Idaho and Washington*. Prepared by the USACE Walla Walla District. March 1989.

<table>
<tr><th colspan="3">Alternative 2 – North Fork Palouse River Diversion (Project 8) and Pipeline to Pullman plus Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow (Project 14)</th></tr>
<tr><td rowspan="2">Description</td><td>Estimated Annual Supply (MG)</td><td>Total Present Value ($/AF of annual supply)</td></tr>
<tr><td>1,550 + 358 = 1,908</td><td>$27,933</td></tr>
</table>

This is a regional project that would supply a portion of the projected future water demands in Pullman and Moscow, and also be used to offset existing irrigation, for both the cities and the universities. It would include two diversions—one on the North Fork Palouse River and another on Paradise Creek or the South Fork Palouse River. The estimated amount of supply from this alternative is 1,908 million gallons (MG), which is 416 MG less than the 2,324-MG supplemental supply target.

The North Fork Palouse River project would include a direct diversion (no storage) from the North Fork Palouse River, pumping and conveyance to a water treatment plant 7 miles north of Pullman, and pumping, conveyance, and delivery of treated water to the both the City of Moscow and City of Pullman water systems. It would be a variation of the aquifer storage and recharge (ASR) project studied in the 2006 *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment* (Golder Associates 2006) and the North Fork Palouse – Direct Use Alternative (Alternative A5) from the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* (SPF and TerraGraphics 2013), designed to serve both Pullman and Moscow. Different potential pipeline routes and intake locations were evaluated as part of this alternatives analysis to try to identify the most efficient configuration. The refined North Fork Palouse River direct diversion project would include the following:

- **Intake** – A river intake structure would be located on the south side of the North Fork Palouse River near the Town of Palouse, Washington, adjacent to the Palouse Highway.
- **Pumping** – A pump station at or near the river intake would boost water through a pipeline over the hill to a water treatment plant located in the vicinity of Palouse Highway and Estes Road. Another pump station, which would include a storage tank and two sets of pumps, would boost water from the treatment plant through pipelines to Pullman and Moscow.
- **Treatment** – Direct use of North Fork Palouse River water would require a water treatment plant. The treatment plant for this portion of the alternative would be located approximately 7 miles north of Pullman, near Palouse Highway and Estes Road, and would have a capacity of approximately 6.47 million gallons per day (MGD).
- **Pipelines** – Water would be conveyed from the intake to the treatment plant through a 24-inch, high-density polyethylene (HDPE) pipeline. Where possible, the pipeline would be aligned in the public right-of-way. The system would branch at the treatment plant. An 18-inch pipeline would convey up to 5 cubic feet per second (cfs) from the treatment plant to Pullman along Palouse Highway. An 18- to 20-inch pipeline would convey up to 5 cfs from the treatment plant to Moscow along Estes Road and Highway 95. The exact route of the pipelines would be refined through additional analysis. The length and size of the pipelines may vary depending on the route of the pipelines.
- **Energy Recovery** – Opportunities for generating electricity via turbine on downhill sections would help recoup some lifting costs and would reduce pressure requirements in some downstream pipeline sections. The North Fork Palouse – Direct Use Alternative (Alternative A5) evaluated by the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* included two hydropower facilities. The refined alternative would convey water from Palouse to a treatment plant north of Pullman, and then from the treatment plant to Pullman and Moscow. The route would be less up and down, would require less pumping, and would provide fewer opportunities for energy recovery. A small hydropower facility could be installed to recover energy on each branch of the system between the water treatment plant and Moscow or Pullman.
- **Annual Supply** – The estimated annual supply of the proposed project would be 4,760 (AF) per year, or 1,550 MG, which is based on a 10-cfs (4,490-gallon per minute [gpm] or 6.47-MGD) diversion from the North

Fork Palouse River when water is available (from November through June). During dry years, if the 10-cfs diversion was limited to 4 months, the diversion would yield approximately 780 MG.

The second diversion project, on Paradise Creek or the South Fork Palouse River, would include a direct diversion (no storage) to capture winter and spring runoff (generally January through April), treatment, and active injection of treated water to recharge wells in Moscow, as studied by the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011). The recharge project would include the following:

- **Intake** – A river intake structure would be located on either Paradise Creek or the South Fork Palouse River, in or near Moscow.
- **Pumping** – A river intake pump station would convey water from the river or creek to a nearby water treatment plant.
- **Treatment** – Diversion of Paradise Creek water or the South Fork Palouse River for aquifer recharge would require treatment to drinking water standards. The treatment plant for this portion of the alternative could be located near the river intake or near the recharge well.
- **Recharge Well** – The treated water would be injected into the Grande Ronde or Wanapum basalt aquifer through an aquifer recharge facility.
- **Annual Supply** – The estimated annual supply of the proposed aquifer recharge project would be 1,100 AF, or 358 MG, which is based on a 3.0-MGD (2,070-gpm or 4.6-cfs) diversion from the South Fork Palouse River or Paradise Creek during 4 months, from January through April.

The two projects would combine to provide an estimated total annual supply of 5,860 AF or 1,908 MG. Both direct diversion projects would rely on the availability of surface water. When surface water is not available or when demands exceed the surface water system capacity, the cities and universities would rely on existing groundwater sources to meet water demands.

The following are additional assumptions/considerations:

- The project assumes the North Fork Palouse River water would be conveyed to Pullman and Moscow, rather than just Moscow as evaluated in the 2011 study. The route of the North Fork Palouse River project would be modified to optimize the distance and profile between the North Fork Palouse River and Pullman and Moscow. The route length and size of the pipelines, and the location of pumping and hydroelectric facilities, may vary depending on the route of the pipeline between the North Fork Palouse River and the two cities.
- For the North Fork Palouse River project, opportunities for generating electricity via turbine on downhill sections would help offset some lifting costs and would reduce pressure requirements in some downstream sections.
- For the North Fork Palouse River project, a maximum anticipated pressure in the pipeline of approximately 199 pounds per square inch was estimated for the 2011 study. Pressures may be different based on the modified route. It is assumed pressures will still allow the use of HDPE piping for the full extent of the pipeline.
- The North Fork Palouse River project would serve Pullman/Moscow and Washington State University (WSU)/University of Idaho (UI), and the South Fork Palouse River or Paradise Creek project would only serve Moscow and UI.

Implementation Timing and Sequencing Assumptions for Analysis

For this alternative, certain assumptions on project development were made for conducting the multi-criteria alternatives analysis. These assumptions and, in particular, the associated timing of project activities, were developed for analysis purposes only. If this alternative is selected for implementation, a project-specific development schedule will be established at that time.

Under this alternative, the first project developed would be the North Fork Palouse River project, followed by the South Fork Palouse River or Paradise Creek project. Projects would come online consistent with forecast future demands. Sequencing is based on cost-effectiveness, with the highest expected benefit/least cost project being developed first.

Cost Elements
Capital (see Attachment 1) • North Fork Palouse River (Project 8) – Total Estimated Project Cost = $45,137,000 – Cost per Delivered Acre-foot = $9,483; Cost per Delivered MG = $29,121 • Paradise Creek Aquifer Recharge for Moscow (Project 14) – Total Estimated Project Cost = $15,154,000 – Cost per Delivered Acre-foot = $13,776; Cost per Delivered MG = $42,330 • Total for this Alternative – Total Estimated Project Cost = $60,291,000 – Cost per Delivered Acre-foot = $10,290; Cost per Delivered MG = $31,600
Operations and Maintenance (O&M; see Attachment 1) • North Fork Palouse River Diversion (Project 8) – Total Estimated Annual O&M Costs = $1,457,000 – O&M per Delivered Acre-foot = $306; O&M per Delivered MG = $940 • Paradise Creek Aquifer Recharge for Moscow (Project 14) – Total Estimated Annual O&M Costs = $673,000 – O&M per Delivered Acre-foot = $612; O&M per Delivered MG = $1,880 • Total for this Alternative – Total Estimated Annual O&M Costs = $2,130,000 – O&M per Delivered Acre-foot = $363; O&M per Delivered MG = $1,116
Project Considerations (what we know/anticipate)
• Flow based on low-elevation drainage basins subject to: – Climate change – Complexity with storage and conveyance • Surface water is diverted in winter, so it should not impact existing water rights significantly • Public concerns about groundwater quality impacts • Concerns about turbidity from surface supplies limiting water diversion during certain storm events and high runoff periods • Permitting and associated studies • Environmental impacts and constraints • Will need to better understand capacity of Aquifer Recharge facility • Will need additional geotechnical information • Will need to understand power extension requirements and costs

References:

Golder Associates, 2006. *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment*. Prepared for Palouse Watershed (WRIA 34) Planning Unit. November 2006.

SPF and TerraGraphics (SPF Water Engineering, LLC, and TerraGraphics Environmental Engineering, Inc.), 2011. *City of Moscow Surface Water Feasibility Study – Phase 1*. November 17, 2011.

SPF and TerraGraphics, 2013. *City of Moscow Surface Water Feasibility Study – Phase 2*. November 19, 2013.

Alternative 3 – Flannigan Creek Storage, Conveyance, and Treatment to Moscow/UI (Project 1) plus South Fork Direct Diversion for Pullman/WSU (Project 16)		
Description	**Estimated Annual Supply (MG)**	**Total Present Value ($/AF of annual supply)**
	1,430 + 894 = 2,324	$35,706

This is a regional project that would supply a portion of the projected future water demands in Pullman and Moscow, and also be used to offset existing irrigation, for both the cities and the universities. It would include two diversions—one from a proposed storage reservoir on Flannigan Creek and another on the South Fork Palouse River. The estimated amount of annual supply from this alternative is 2,324 million gallons (MG), which is equal to the supplemental water supply target. The Flannigan Creek project would supply 1,430 MG (4,400 acre-feet (AF) per year), and the South Fork Direct Diversion project would supply the additional 894 MG (2,743 AF) needed to meet the target. Data provided in the *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment* (Golder Associates 2006) indicate that more than 3,900 AF would be available from the South Fork Palouse River near Pullman if diversions were limited to 20% of the 50% exceedance flow rate from November through May. The data indicate that the 2,743 AF needed to meet the supplemental supply target would be within the yield of the South Fork Palouse River near Pullman, even during somewhat dry conditions.

The Flannigan Creek project would include a new storage reservoir on Flannigan Creek on the north side of Moscow Mountain, an intake structure and diversion at the new reservoir, pumping and conveyance to Moscow, treatment, and delivery to the City of Moscow and University of Idaho (UI) water systems. This alternative was identified and studied as Alternative A1 in the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011). The Flannigan Creek project would include the following:

- **Storage** – This project would include construction of a 102-foot-tall dam on Flannigan Creek on the north side of Moscow Mountain. The dam would create a 6,600-acre-foot reservoir with an average annual yield of 4,400 AF. Water would be stored from Flannigan Creek in winter and early spring months.
- **Intake** – An intake structure would be located at the proposed reservoir.
- **Pumping** – Two pump stations and storage tank would be required to convey water from the reservoir to Moscow and maintain the hydraulic gradient in the system. An opportunity for generating electricity via turbine on a downhill section would help recoup some lifting costs and would reduce pressure requirements in some downstream pipeline sections. The alternative includes a hydropower facility that would reduce pressure in the pipeline by approximately 170 pounds per square inch (psi).
- **Pipelines** – The Flannigan Creek alternative would include approximately 12.8 miles of high-density polyethylene (HDPE) pipeline (mainly along Four Mile Road, Saddle Ridge Road, and Highway 95), ranging in size from a 22-inch to 24-inch diameter. In addition, the project could be expanded to deliver treated water to Pullman by including an 18-inch-diameter pipeline along 9.1 miles of Highway 270 between Moscow and Pullman.
- **Treatment** – Direct use of Flannigan Creek water would require a water treatment plant. The treatment plant for this portion of the alternative would be located near Moscow, and treated water would be delivered directly to the Moscow and UI water systems, and potentially to the Pullman, and Washington State University (WSU) water systems.
- **Annual Supply** – The estimated annual supply of the proposed project would be 4,400 AF, or 1,430 MG, which is based on the annual average yield of the reservoir. The design capacity of the pumping, conveyance, and treatment facilities would be 4,100 gallons per minute (gpm) (9.1 cubic feet per second [cfs] or 5.9 million gallons per day [MGD]).

The second diversion on the South Fork Palouse River would include a direct diversion (no storage) to capture winter and spring runoff (as available, from November through June), treatment, and direct use in the Pullman and WSU systems. The project would include the following: • **Intake** – A river intake structure would be located on the South Fork Palouse River, in or near Pullman. • **Pumping** – A river intake pump station would convey water from the river to a nearby water treatment plant. • **Treatment** – Direct use of the South Fork Palouse River would require treatment to drinking water standards. The treatment plant for this portion of the alternative would be located near the river intake in Pullman. • **Pipelines** – The treated water would be delivered through a pipeline directly to the City of Pullman Water System for use in the City of Pullman and WSU systems. • **Annual Supply** – The estimated annual supply of the proposed project would be 2,743 AF, or 894 MG, which is what would be needed to meet the supplemental supply target of 2,324 MG with the 1,430 MG that would be available from Flannigan Creek. Supply facilities would be designed to divert up to 6.47 MGD (4,490 gpm or 10 cfs) from the South Fork Palouse River when that amount of supply is available, from November through June. The flow data provided in the *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment* indicate that the 50% exceedance flow in the South Fork Palouse River at Pullman exceeds 10 cfs from December through May. The 90% exceedance flow exceeds 10 cfs from February through April. The data indicate that a total of 894 AF should be available for diversion, even during somewhat dry years. Additional water may be available most years. The two projects would combine to provide an estimated total annual supply of 7,143 AF, or 2,324 MG. The following are additional assumptions: • The cost elements for the South Fork Palouse Direct Use project were based on projects with similar capacity for the North Fork Palouse River and Snake River studied by the 2013 *City of Moscow Surface Water Feasibility Study – Phase 2* (SPF and TerraGraphics 2013) • An additional 4,000 feet of pipeline was assumed for conveying treated South Fork Palouse River surface water to a connection with the City of Pullman and WSU systems. The actual length of pipeline would depend on siting of intake and treatment facilities in Pullman. • Both projects would be limited by the hydrology of the watersheds above the point of diversion. The Flannigan Creek diversion would be limited by the watershed yield above the reservoir. The South Fork Palouse River diversion would be limited by the watershed yield above the point of diversion. • For the Flannigan Creek project, opportunities for generating electricity via turbine on downhill sections would help offset some lifting costs and would reduce pressure requirements in some downstream sections. • For the Flannigan Creek project, the maximum anticipated pressure in the pipeline is approximately 215 psi, allowing the use of HDPE piping for the full extent of the pipeline. • The Flannigan Creek project would serve Moscow and UI, and the South Fork Palouse River project would serve Pullman and WSU.
Implementation Timing and Sequencing Assumptions for Analysis
For this alternative, certain assumptions on project development were made for conducting the multi-criteria alternatives analysis. These assumptions and, in particular, the associated timing of project activities, were developed for analysis purposes only. If this alternative is selected for implementation, a project-specific development schedule will be established at that time. Under this alternative, the first project developed would be the South Fork Palouse River project, followed by the Flannigan Creek project. Projects would come online consistent with forecast future demands. Sequencing is based on cost-effectiveness, with the highest expected benefit/least cost project being developed first.
Cost Elements
Capital (see Attachment 1) • Flannigan Creek (Project 1)

– Total Estimated Project Cost = $62,845,000 – Cost per Delivered Acre-foot = $14,283; Cost per Delivered MG = $43,948 • South Fork (variation of Project 16) – Total Estimated Project Cost = $22,689,000 – Cost per Delivered Acre-foot = $8,272; Cost per Delivered MG = $25,379 • Total for this Alternative – Total Estimated Project Cost = $85,534,000 – Cost per Delivered Acre-foot = $11,975; Cost per Delivered MG = $36,805
Operations and Maintenance (O&M; see Attachment 1) • Flannigan Creek (Project 1) – Total Estimated Annual O&M Costs = $2,740,000 – O&M per Delivered Acre-foot = $623; O&M per Delivered MG = $1,916 • South Fork (variation of Project 16) – Total Estimated Annual O&M Costs = $752,000 – O&M per Delivered Acre-foot = $288; O&M per Delivered MG = $885 • Total for this Alternative – Total Estimated Annual O&M Costs = $3,492,000 – O&M per Delivered Acre-foot = $489; O&M per Delivered MG = $1,503
Project Considerations (what we know/anticipate)
• Dam adds complexity to technical certainty and permitting, and requires property acquisition • Lower elevation drainage basin subject to climate change, but offset by storage • Complexity with storage and conveyance • Surface water is diverted in winter/spring, so it should not significantly impact existing water rights • Water availability and yield need to be more clearly defined • Environmental impacts and constraints • Will need additional geotechnical information • Will need to understand power extension requirements and costs

References:

Golder Associates, 2006. *Palouse Watershed (WRIA 34) Multi-Purpose Storage Assessment*. Prepared for Palouse Watershed (WRIA 34) Planning Unit. November 2006.

SPF and TerraGraphics (SPF Water Engineering, LLC, and TerraGraphics Environmental Engineering, Inc.), 2011. *City of Moscow Surface Water Feasibility Study – Phase 1*. November 17, 2011.

SPF and TerraGraphics, 2013. *City of Moscow Surface Water Feasibility Study – Phase 2*. November 19, 2013.

Alternative 4 – Paradise Creek Aquifer Recharge – Moscow (14), South Fork Palouse ASR – Pullman (16), Pullman Wastewater Reuse (20), and Moscow Water Reuse and Passive Groundwater Recharge (35) plus Additional Conservation		
Description	**Estimated Annual Supply (MG)**	**Total Present Value ($/AF of annual supply)**
	1,893	$25,816

This is a combination of projects that would collectively supply a portion of the projected future water demands in Pullman and Moscow. The projects would also be used to offset existing irrigation, for both the cities and the universities, primarily through aquifer recharge, aquifer storage and recovery (ASR), wastewater reuse in Pullman, wastewater reuse with passive groundwater recharge in Moscow, and additional conservation to come as close as possible to meet the 50-year supplemental supply target of 2,324 million gallons (MG). The projects would include one aquifer recharge site utilizing Paradise Creek water and one ASR project using South Fork Palouse River water during the natural runoff period of approximately 4 months (generally January through April). The alternative would also include a wastewater reuse project in Pullman, a combination wastewater reuse and passive groundwater recharge project in Moscow, and additional conservation to provide 1,893 MG of supply. This amount is 431 MG less than the 2,324-MG target because it is not expected that additional water conservation opportunities will be able to fully meet the delta (1,060 MG) between what the other four projects would provide and the target. Accordingly, a target of 15% additional conservation savings (609 MG) was assumed for this analysis.

The Paradise Creek aquifer recharge project would include a direct diversion (no storage) on Paradise Creek by Moscow to capture winter and spring runoff (generally January through April), treatment, and active recharge into wells in Moscow, as studied by the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011). The project would include the following:

- **Intake** – A river intake structure would be located on Paradise Creek in or near Moscow.
- **Pumping** – A river intake pump station would convey water from the river or creek to a nearby water treatment plant.
- **Treatment** – Direct use of Paradise Creek water for aquifer recharge would require treatment to drinking water standards. The treatment plant for this portion of the alternative would be located near the stream intake.
- **Recharge Well** – The treated water would be injected into the Grande Ronde or Wanapum basalt aquifer through an aquifer recharge Well facility.
- **Annual Supply** – The estimated annual supply of the proposed aquifer recharge project would be 1,100 acre-feet per year (AF), or 358 MG, which is based on a 3.0-million gallon per day (MGD) (2,070-gallon per minute [gpm] or 4.6-cubic foot per second [cfs]) diversion from Paradise Creek during 4 months (from January through April).

An ASR project on the South Fork Palouse River, in Pullman upstream of its confluence with Paradise Creek, would also include a direct diversion (no storage) to capture winter and spring runoff (generally January through April), treatment, and active injection of treated water to ASR Wells in Pullman, as studied by the 2014 *City of Pullman Water System Plan Update* (Anchor QEA 2014). However, the costs and supply capacity used for the analysis are the same as those estimated for the aquifer recharge project in Moscow, as studied by the 2011 *City of Moscow Surface Water Feasibility Study – Phase 1* (SPF and TerraGraphics 2011), because the costs and size provided in the 2011 study are assumed to be more current and accurate, and provide for a more consistent comparison. They would include the following:

- **Intake** – A river intake structure would be located on the South Fork Palouse River, in or near Pullman.
- **Pumping** – A river intake pump station would convey water to a nearby water treatment plant.

- **Treatment** – Use of the South Fork Palouse River for ASR would require treatment to drinking water standards. The treatment plant for this portion of the alternative would be located near the river intake.
- **ASR Well** – The treated water would be injected into the Grande Ronde or Wanapum basalt aquifer through an ASR Well facility.
- **Annual Supply** – The estimated annual supply of the proposed ASR project would be 1,100 AF, or 358 MG, which is based on a 3.0-MGD (2,070-gpm or 4.6-cfs) diversion from the South Fork Palouse River during 4 months (from January through April).

The wastewater reuse project in Pullman would include an upgrade to the Pullman Wastewater Treatment Plant (WWTP) to produce Class A reclaimed water for distribution and reuse at selected sites within Pullman, and potentially at Washington State University (WSU) (City of Pullman and WSU 2015). The project would include the following:

- **WWTP** – This project would include upgrades to the Pullman WWTP to produce up to 1.35 MGD of Class A reclaimed water.
- **Pumping** – A reclaimed water pump station would be required to deliver pressurized reclaimed water for distribution to selected sites throughout Pullman.
- **Storage** – The proposed reclaimed water system would include 710,000 gallons of storage.
- **Transmission/Distribution** – The proposed reclaimed water system would include transmission lines from the WWTP to the pump station and from the pump station to the storage tank. The system would also include distribution to wastewater reuse sites in Pullman and at WSU.
- **Annual Supply** – The estimated annual supply of the proposed wastewater reuse project would be 454 AF, or 148 MG, which is based on the annual demand estimated for wastewater reuse sites within Pullman. The peak capacity of the proposed water reclamation system would be 1.35 MGD. Wastewater reuse would occur from May through October.

The wastewater reuse project in Moscow would include additional use of Class A reclaimed water from the Moscow WWTP for passive recharge within Moscow (Keller Associates 2011). The project would include the following:

- **Study** – A study that evaluates whether surface infiltration will recharge the targeted groundwater aquifer.
- **Treatment** – Upgrades to Moscow's WWTP are needed to meet Class A reclaimed water requirements, with the primary upgrade being to disinfection facilities.
- **Pumping** – A reclaimed water pump station would be required to deliver pressurized reclaimed water from the Moscow WWTP to the recharge site.
- **Transmission/Distribution** – The proposed reclaimed water system would include approximately 1,000 feet of 12-inch, high-density polyethylene (HDPE) transmission pipeline. This assumes an appropriate infiltration basin can be constructed within 1,000 feet of the Moscow WWTP plant discharge.
- **Infiltration Basins** – Infiltration basins with an area of approximately 42,680 square feet would be constructed to provide for passive infiltration of reclaimed water into the Wanapum basalt aquifer. The infiltration basins would include a small berm to support a water depth of several feet and planted area over soils with sufficient permeability to infiltrate the reclaimed water.
- **Annual Supply** – The estimated annual supply of the proposed wastewater reuse project would be on the order of 1,260 AF, or 420 MG. This is based on the following assumptions:
  - May to October (summer): 225 MG; calculated as total wastewater effluent volume (317 MG) (as stated in *City of Moscow 2011 Comprehensive Sewer System Plan*), less average amount used by University of Idaho (UI) for irrigation (77 MG), less additional 20% (15 MG) allowance for increased irrigation use by UI and City
  - December and January (winter): 74 MG; calculated as average winter day flow (2.4 MGD) x 62 days x 50% infiltration efficiency (i.e., assuming infiltration capacity is lessened in coldest months)
  - February to April and November (shoulder season): 264 MG; calculated as average day flow (2.2 MGD) x 120 days (assumes no irrigation use of reclaimed water; therefore, potentially all water available for infiltration)

- Therefore, total annual volume of reclaimed water available for infiltration = 225 + 74 + 264 = 563 MG
- However, it is assumed that the volume of groundwater available for withdrawal is a percentage of the infiltrated water, due to, for example, evaporative losses; for planning purposes, this conversion is assumed to be 75%; therefore, 563 x 75% = 420 MG

The conservation element of this alternative would include additional measures equating to 15% additional savings beyond the baseline projection (1,869 AF or 609 MG). This would include reducing landscape irrigation from measures that would have to be determined. This amount, combined with the other water supply projects in this alternative, does not add up to the supplemental water supply target (2,324 MG). The additional conservation savings that would have to be realized to meet the target water supply goal would reduce demand to something that would be close to or even less than typical per capita winter, or indoor, water usage. This does not seem realistic. Hence, the additional conservation savings of 15%, which is still a very aggressive goal, was selected for this alternative.

An assumed cost of $10,000 per acre-foot was used to develop conservation savings costs, based on an average unit cost of conservation measures included in the Moscow, Pullman, and WSU conservation programs ($9,293), rounded up to include some administrative costs. It should be noted that implementing conservation measures beyond what is included in the current conservation plans may be challenging, because the conservation plans have generally identified the most feasible and ready to implement measures. Future or new conservation measures may likely be more costly to implement than those in the existing plans.

The following are additional assumptions:

- Prior assumptions for projects described in other alternatives
- No additional treatment beyond Class A will be required for passive recharge purposes, based on current Idaho reclaimed water regulations
- Conservation savings of 15% more than the baseline future supply needs forecast at $10,000 per acre-foot cost

Implementation Timing and Sequencing Assumptions for Analysis

Under this alternative, the first project developed would be the Wastewater Reuse and Passive Groundwater Recharge Project, followed by (in order listed) additional conservation, Paradise Creek Aquifer Recharge for Moscow, South Fork Palouse ASR for Pullman, and Pullman Wastewater Reuse projects. Projects would come online consistent with forecast future demands. Sequencing is based on cost-effectiveness, with the highest expected benefit/least cost project being developed first.

Cost Elements

Capital (see Attachment 1)

- Paradise Creek Aquifer Recharge for Moscow (Project 14)
  - Total Estimated Project Cost = $15,154,000
  - Cost per Delivered Acre-foot = $13,776; Cost per Delivered MG = $42,330
- South Fork Palouse ASR for Pullman (Project 16)
  - Total Estimated Project Cost = $15,154,000
  - Cost per Delivered Acre-foot = $13,776; Cost per Delivered MG = $42,330
- Wastewater Reuse for Pullman (Project 20)
  - Total Estimated Project Cost = $20,134,000
  - Cost per Delivered Acre-foot = $44,348; Cost per Delivered MG = $136,041
- Wastewater Reuse and Passive Groundwater Recharge for Moscow (Project 35)
  - Total Estimated Project Cost = $3,479,000
  - Cost per Delivered Acre-foot = $2,676; Cost per Delivered MG = $8,283

- Additional Conservation
  - Total Estimated Project Cost = $18,690,000
  - Cost per Delivered Acre-foot = $10,000; Cost per Delivered MG = $30,690
- Total for this Alternative
  - Total Estimated Project Cost = $72,611,000
  - Cost per Delivered Acre-foot = $12,470; Cost per Delivered MG = $38,358

Operations and Maintenance (O&M; see Attachment 1)

- Paradise Creek Aquifer Recharge for Moscow (Project 14)
  - Total Estimated Annual O&M Costs = $673,000
  - O&M per Delivered Acre-foot = $612; O&M per Delivered MG = $1,880
- South Fork Palouse ASR for Pullman (Project 16)
  - Total Estimated Annual O&M Costs = $673,000
  - O&M per Delivered Acre-foot = $612; O&M per Delivered MG = $1,880
- Wastewater Reuse for Pullman (Project 20)
  - Total Estimated Annual O&M Costs = $179,000
  - O&M per Delivered Acre-foot = $394; O&M per Delivered MG = $1,208
- Wastewater Reuse and Passive Groundwater Recharge for Moscow (Project 35)
  - Total Estimated Annual O&M Costs = $76,000
  - O&M per Delivered Acre-foot = $58; O&M per Delivered MG = $181
- Additional Conservation
  - Total Estimated Annual O&M Costs = included in capital costs above
- Total for this Alternative
  - Total Estimated Annual O&M Costs = $1,601,000
  - O&M per Delivered Acre-foot = $405; O&M per Delivered MG = $1,247

Project Considerations (what we know/anticipate)

- Flow based on low elevation drainage basins subject to:
  - Climate change
  - Complexity with storage and conveyance
- Surface water is diverted in winter so should not significantly impact existing water rights
- Public concerns about groundwater quality impacts
- Project information and benefits are understood well in some cases and not well understood in others
- Climate change may impact summer flow requirements
- Achieving projected conservation savings would be extremely difficult and would require fundamental changes in development and summer irrigation practices

References:

Anchor QEA, (Anchor QEA, LLC), 2014. *City of Pullman Water System Plan Update*. Prepared for the City of Pullman. August 22, 2014.

City of Pullman and Washington State University, 2015. *Water Reclamation Project – Design Development Document Update. Technical Memorandum No. 11 – Recommendations, Cost Estimates, and Phasing.* May 2015.

Keller Associates, 2011. *City of Moscow Comprehensive Sewer System Plan.* September 2011.

JUB Engineers, 2015. Memorandum to University of Idaho. *Class A Reuse Feasibility Evaluation*. March 19, 2015.

SPF and TerraGraphics (SPF Water Engineering, LLC, and TerraGraphics Environmental Engineering, Inc.), 2011. *City of Moscow Surface Water Feasibility Study – Phase 1*. November 17, 2011.

Attachment 1

Figures

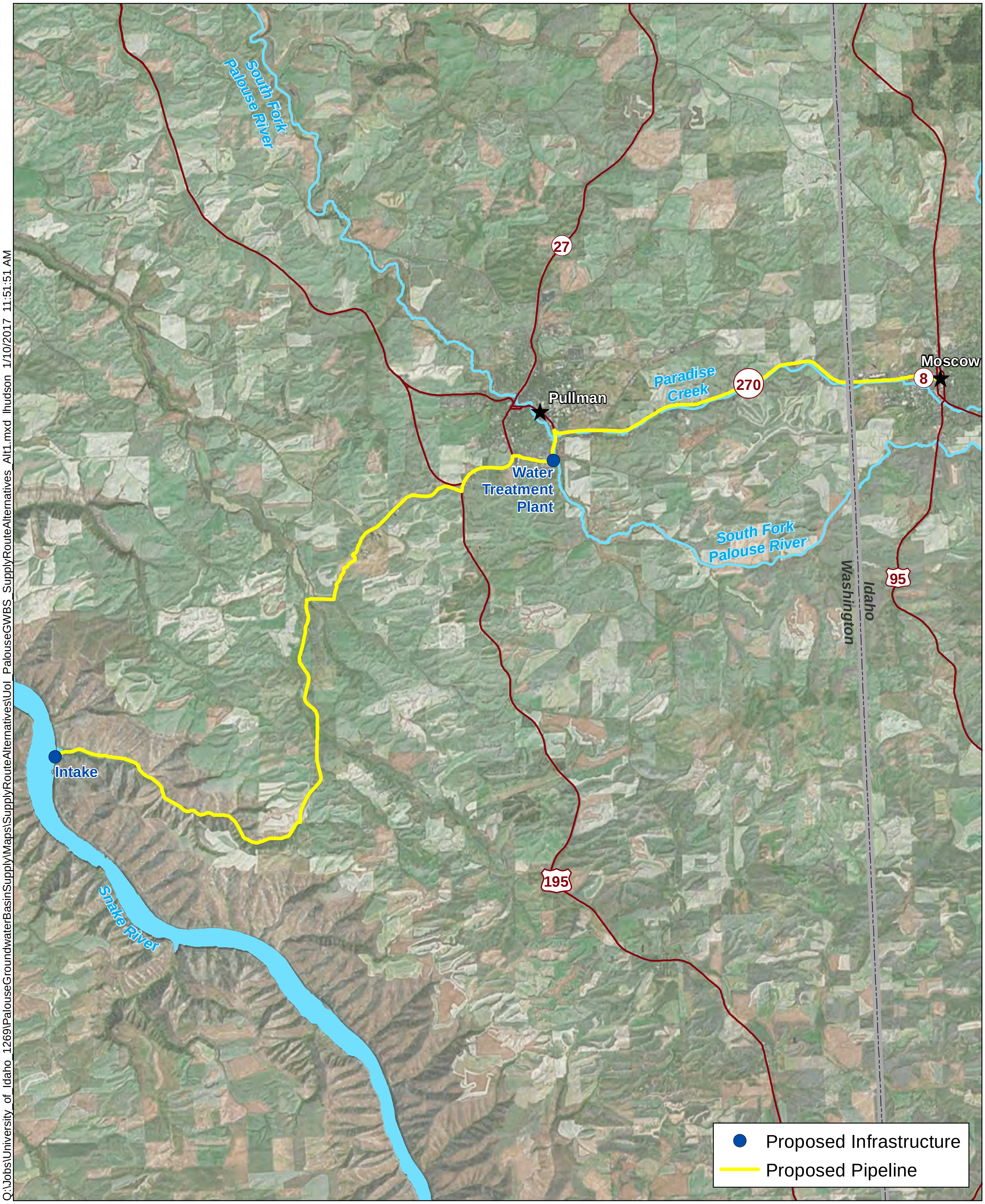

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Figure 1
Alternative 1
Supply Route Alternatives
Palouse Groundwater Basin Supply

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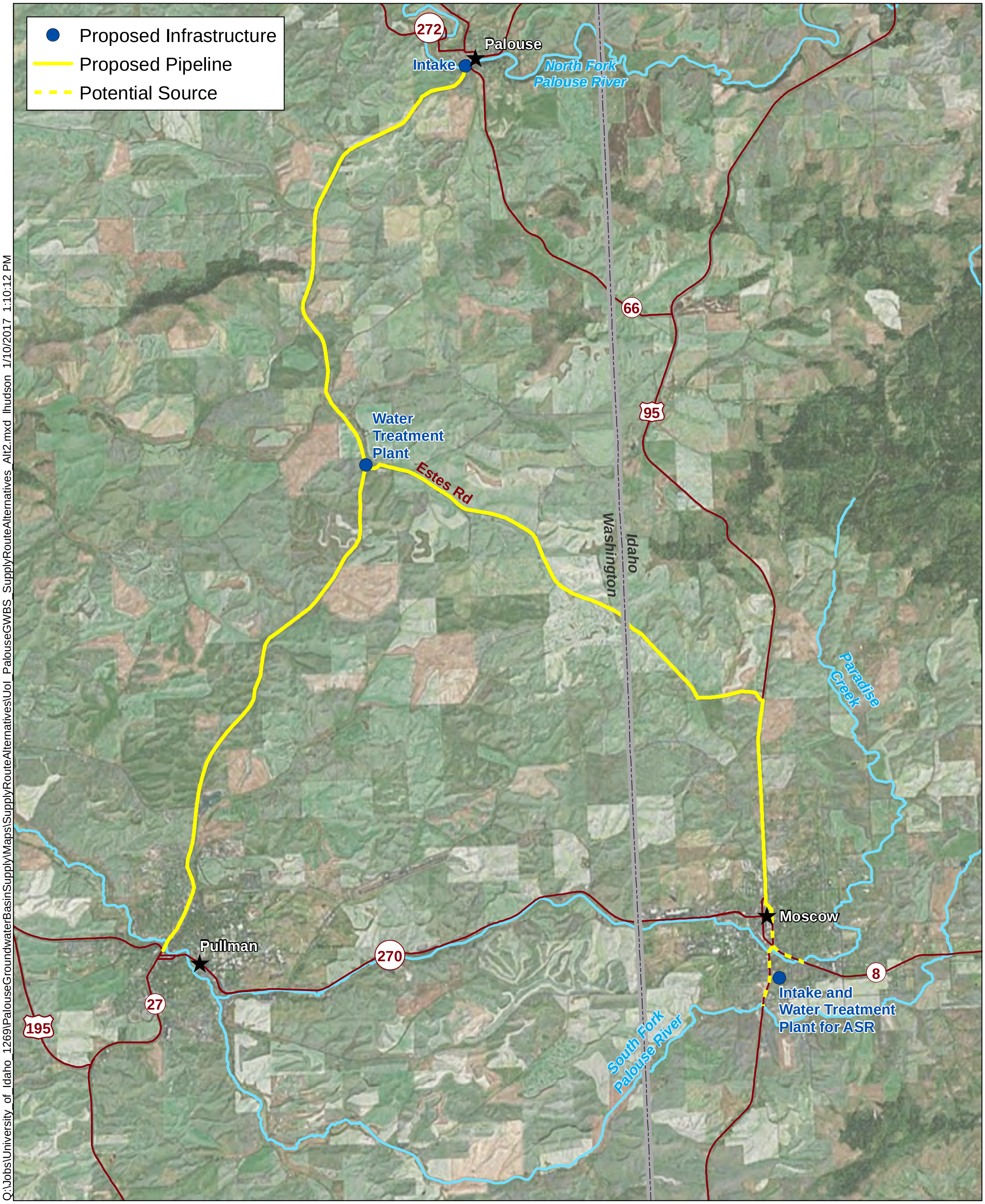

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Figure 2
Alternative 2
Supply Route Alternatives
Palouse Groundwater Basin Supply

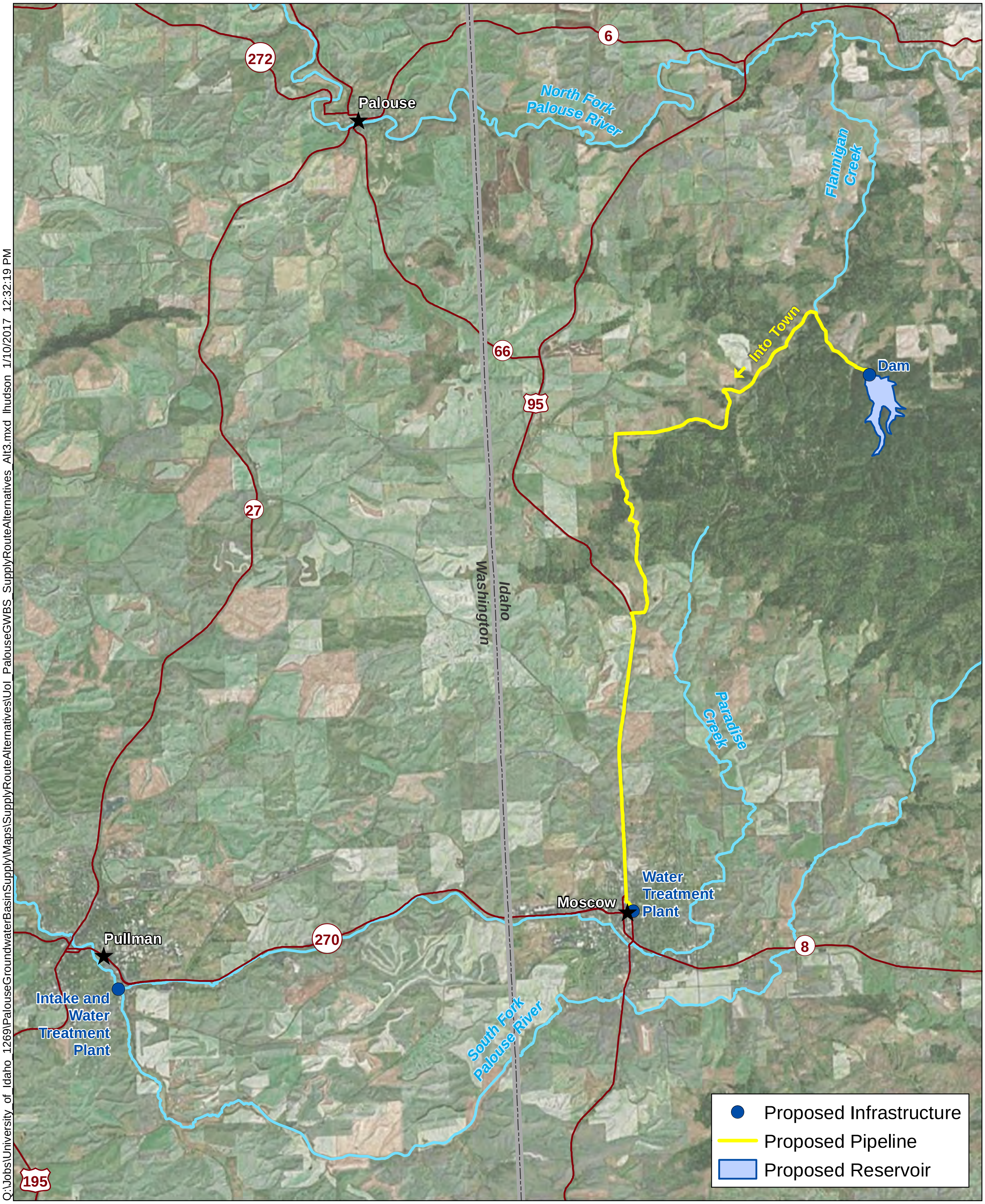

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Figure 3
Alternative 3
Supply Route Alternatives
Palouse Groundwater Basin Supply

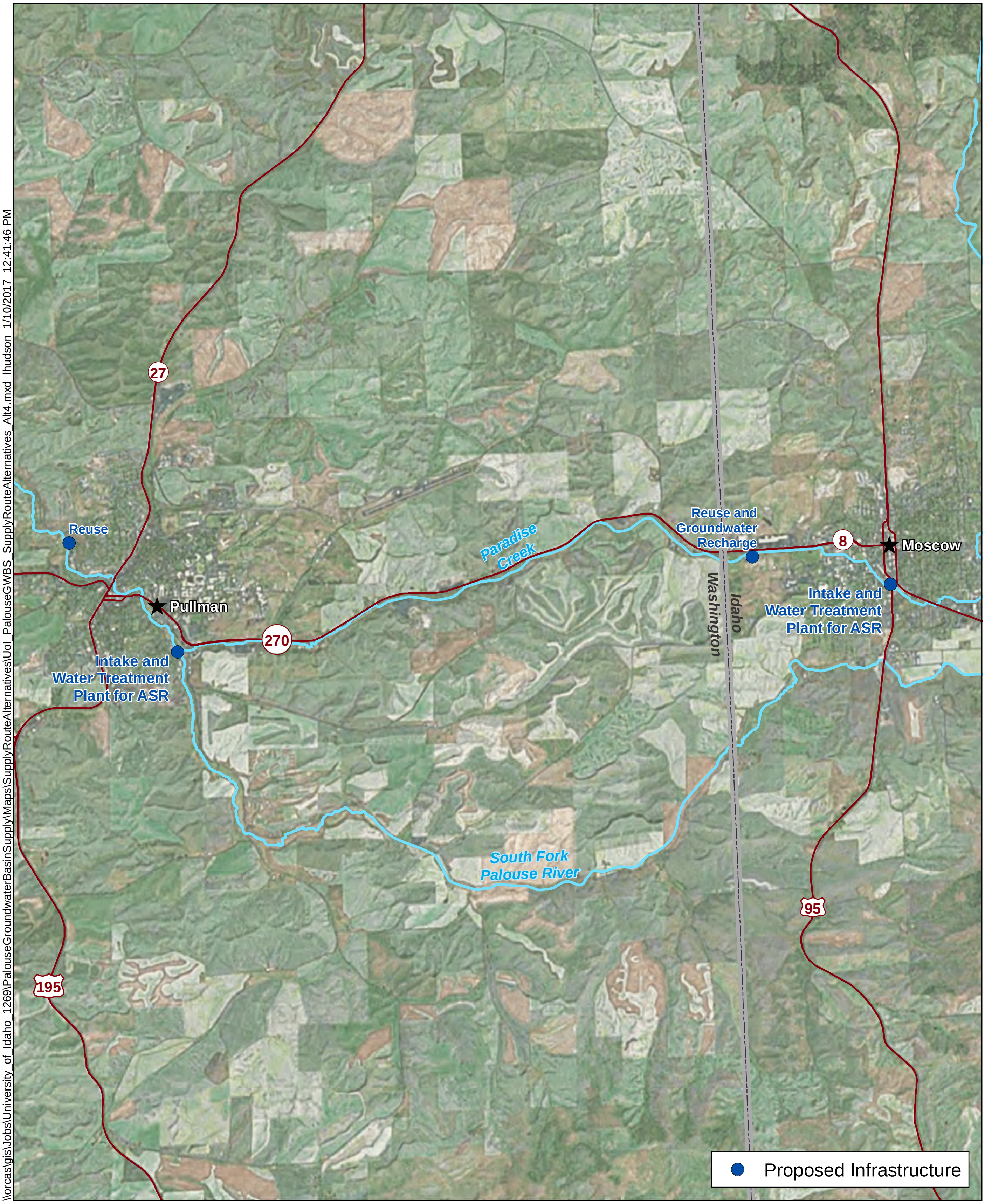

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Figure 4
Alternative 4
Supply Route Alternatives
Palouse Groundwater Basin Supply

Attachment 2
Water Supply Project Cost Summaries

Project 11 ***- Alternative A7b from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics)***

Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix D)

Alternative A7b: Snake River - Water Conveyance
Estimated Annual Supply: 2,360 MG (7,240 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD)

Capital Costs for Alternative 1 - Snake River Diversion and Pipeline to Pullman and Moscow							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
1.00	**River Intake**				**$ 50,000**	**$ 55,629**	
1.01	River Intake	EA	1	$ 50,000	$ 50,000	$ 55,629	
2.00	**Pump Station #1**				**$ 2,072,000**	**$ 2,305,250**	
2.01	600 HP Vertical Turbine Pump	EA	3	$ 310,332	$ 931,000	$ 1,035,805	
2.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	
2.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	
2.04	Building Structure	SF	2,000	$ 200	$ 400,000	$ 445,029	
2.05	Electrical, Instrumentation, & Control	LS	1	$ 302,200	$ 302,200	$ 336,219	
2.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 178,012	
2.07	Sitework and Landscaping (5%)	LS	1	$ 98,660	$ 98,660	$ 109,766	
3.00	**Pump Station #2 & Storage Tank**				**$ 3,458,000**	**$ 3,847,276**	
3.01	600 HP Vertical Turbine Pump	EA	3	$ 310,332	$ 930,996	$ 1,035,801	
3.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	
3.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	
3.04	Building Structure	SF	2,500	$ 200	$ 500,000	$ 556,286	
3.05	Electrical, Instrumentation, & Control	LS	1	$ 322,200	$ 322,200	$ 358,471	
3.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 178,012	
3.07	Bolted Steel Storage Tank	GAL	1,000,000	$ 1.20	$ 1,200,000	$ 1,335,087	
3.08	Sitework and Landscaping (5%)	LS	1	$ 164,660	$ 164,660	$ 183,196	
4.00	**Pump Station #3 & Storage Tank**				**$ 3,458,000**	**$ 3,847,276**	
4.01	600 HP Vertical Turbine Pump	EA	3	$ 310,332	$ 930,996	$ 1,035,801	
4.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	
4.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	
4.04	Building Structure	SF	2,500	$ 200	$ 500,000	$ 556,286	
4.05	Electrical, Instrumentation, & Control	LS	1	$ 322,200	$ 322,200	$ 358,471	
4.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 178,012	

***Project 11* - Alternative A7b from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix D)

Alternative A7b: Snake River - Water Conveyance
Estimated Annual Supply: 2,360 MG (7,240 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD)

Capital Costs for Alternative 1 - Snake River Diversion and Pipeline to Pullman and Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
4.07	Bolted Steel Storage Tank	GAL	1,000,000	$ 1.20	$ 1,200,000	$ 1,335,087	
4.08	Sitework and Landscaping (5%)	LS	1	$ 164,660	$ 164,660	$ 183,196	
5.00	**Pump Station #4 & Storage Tank**				**$ 2,876,000**	**$ 3,199,759**	
5.01	400 HP Vertical Turbine Pump	EA	3	$ 156,332	$ 468,996	$ 521,792	
5.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	
5.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	
5.04	Building Structure	SF	2,500	$ 200	$ 500,000	$ 556,286	
5.05	Electrical, Instrumentation, & Control	LS	1	$ 229,800	$ 229,800	$ 255,669	
5.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 178,012	
5.07	Bolted Steel Storage Tank	GAL	1,000,000	$ 1.20	$ 1,200,000	$ 1,335,087	
5.08	Sitework and Landscaping (5%)	LS	1	$ 136,940	$ 136,940	$ 152,355	
6.00	**Pump Station #5 & Storage Tank**				**$ 2,796,000**	**$ 3,110,753**	
6.01	350 HP Vertical Turbine Pump	EA	3	$ 135,332	$ 406,000	$ 451,704	
6.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	
6.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	
6.04	Building Structure	SF	2,500	$ 200	$ 500,000	$ 556,286	
6.05	Electrical, Instrumentation, & Control	LS	1	$ 217,200	$ 217,200	$ 241,651	
6.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 178,012	
6.07	Bolted Steel Storage Tank	GAL	1,000,000	$ 1	$ 1,200,000	$ 1,335,087	
6.08	Sitework and Landscaping (5%)	LS	1	$ 133,160	$ 133,160	$ 148,150	
7.00	**Pipeline**				**$ 14,391,000**	**$ 16,011,031**	
7.01	20-in Dia. C200 Welded Steel Pipe (18.5-in I.D.)	LF	132,000	$ 83.95	$ 11,081,400	$ 12,328,861	
7.02	Trench and Pipe Bedding	LF	132,000	$ 21.07	$ 2,781,240	$ 3,094,331	
7.03	Air Release and Blow Off Facilities	LF	132,000	$ 4	$ 528,000	$ 587,438	

Project 11 ***- Alternative A7b from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics)***
Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix D)

Alternative A7b: Snake River - Water Conveyance
Estimated Annual Supply: 2,360 MG (7,240 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD)

Capital Costs for Alternative 1 - Snake River Diversion and Pipeline to Pullman and Moscow							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
8.00	**Water Treatment Facility**				**$ 13,648,000**	**$ 15,184,390**	
8.01	Prescreening	MGD	6.47	$ 50,000	$ 323,500	$ 359,917	
8.02	Proprietary Membrane Filtration Equipment	MGD	6.47	$ 900,000	$ 5,823,000	$ 6,478,510	
8.03	Chemical Feed Facilities	MGD	6.47	$ 160,000	$ 1,035,200	$ 1,151,735	
8.04	Rapid Mix	MGD	6.47	$ 20,000	$ 129,400	$ 143,967	
8.05	Chemical Cleaning System	LS	1	$ 180,000	$ 180,000	$ 200,263	
8.06	Building Structure	SF	10,400	$ 150	$ 1,560,000	$ 1,735,613	
8.07	Clearwell (CT Basin)	GAL	1,000,000	$ 1.80	$ 1,800,000	$ 2,002,631	
8.08	Finished Water Pump Station	HP	375	$ 1,800	$ 675,000	$ 750,986	
8.09	Solids Handling	SF	10,000	$ 25	$ 250,000	$ 278,143	
8.10	Yard Piping (10%)	LS	1	$ 1,152,610	$ 1,152,610	$ 1,282,362	
8.11	Sitework and Landscaping (5%)	LS	1	$ 143,787	$ 143,787	$ 159,973	
8.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 575,148	$ 575,148	$ 639,894	
9.00	**Subtotal**				**$ 42,749,000**	**$ 47,561,000**	
10.00	**Contingency**				**$ 8,550,000**	**$ 9,512,000**	
10.01	Contingency (20%)	LS	1	$ 8,549,800	$ 8,550,000	$ 9,512,000	
11.00	**Engineering (Design & Construction)**				**$ 6,412,000**	**$ 7,134,000**	
11.01	Engineering (Design & Construction) (15%)	LS	1	$ 6,412,350	$ 6,412,000	$ 7,134,000	
12.00	**Water Rights**				**$ 12,080,000**	**$ 13,440,000**	
12.01	Upstream Water Rights Purchase	AF	6,040	$ 2,000	$ 12,080,000	$ 13,440,000	Water Rights Cost Added
12.02	Administrative and Legal Costs	LS	1	$ 604,000	$ 604,000	$ 672,000	Water Rights Cost Added
				Total Estimated Project Total	**$ 69,790,000**	**$ 77,646,000**	

Project 11 ***- Alternative A7b from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics)***

Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix D)

Alternative A7b: Snake River - Water Conveyance
Estimated Annual Supply: 2,360 MG (7,240 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD)

Capital Costs for Alternative 1 - Snake River Diversion and Pipeline to Pullman and Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
	Cost Per Delivered Acre-Foot	**AF/YR**	**6,040**		**$ 11,555**	**$ 12,855**	**AF/YR Adjusted for 10-month Use**
	Cost Per Delivered MG	**MG/YR**	**1,967**		**$ 35,480**	**$ 39,474**	**MG/YR Adjusted for 10-month Use**
				Cost to Pump to Moscow	**$ 69,790,000**	**$ 77,646,000**	
				Cost to Pump to Pullman Only	**$ 48,462,000**	**$ 53,917,000**	

O&M Costs for Alternative 1 - Snake River Diversion and Pipeline to Pullman and Moscow

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	28,253,300	$ 0.08	$ 2,260,264	$ 2,514,708	Adjusted for 10-month Use
1.02	Water Treatment Facility Operations	MG/YR	1,967	$ 600	$ 1,180,200	$ 1,313,058	Adjusted for 10-month Use
1.03	Maintenance of Facilities (5%)	LS	1	$ 25,737,600	$ 1,286,880	$ 1,431,747	
	Total Estimated Annual Operation & Maintenance Cost Total				**$ 4,730,000**	**$ 5,262,000**	
				O&M Per Delivered Acre-Foot	**$ 783**	**$ 871**	
				O&M Per Delivered MG	**$ 2,405**	**$ 2,675**	

***Project 8* - NF Palouse based on Alternative A5 from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics), Modified to be a Regional Project, with Delivery to Both Pullman and Moscow, Optimized Routes, and Single Treatment Plant**

Unit Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix B)

Quantities and Items Modified to Represent More Optimal Regional Configuration and Alignments

Alternative A5 (Modified to Deliver Water to Pullman and Moscow): NF Palouse River - Water Conveyance
Estimated Annual Supply: 1,550 MG (4,760 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, from Nov through Jun)

Construction Costs for Alternative 2 - North Fork Palouse River Diversion and Pipeline to Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
1.00	**River Intake**				**$ 50,000**	**$ 55,629**	
1.01	River Intake	EA	1	$ 50,000	$ 50,000	$ 55,629	Unit Costs from Original NF Project
2.00	**Pump Station #1 (At Intake)**				**$ 1,008,000**	**$ 1,121,473**	
2.01	150 HP Vertical Turbine Pump	EA	3	$ 45,000	$ 135,000	$ 150,197	Unit Costs from Original NF Project
2.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	Unit Costs from Original NF Project
2.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	Unit Costs from Original NF Project
2.04	Building Structure	SF	2,000	$ 200	$ 400,000	$ 445,029	Unit Costs from Original NF Project
2.05	Electrical, Instrumentation, & Control	LS	1	$ 145,400	$ 145,400	$ 161,768	Unit Costs from Original NF Project
2.06	350 kW Standby Generator	LS	1	$ 100,000	$ 100,000	$ 111,257	Unit Costs from Original NF Project
2.07	Sitework and Landscaping (5%)	LS	1	$ 48,020	$ 48,020	$ 53,426	Unit Costs from Original NF Project
3.00	**Pipeline (Intake to Estes Rd)**				**$ 4,369,000**	**$ 4,860,829**	
3.01	24-in Dia. SDR 13.5 HDPE Pipe (20.23-in I.D.)	LF	37,000	$ 93.00	$ 3,441,000	$ 3,828,362	Unit Costs from Original NF Project
3.02	Trench and Pipe Bedding	LF	37,000	$ 21.07	$ 779,590	$ 867,350	Unit Costs from Original NF Project
3.03	Air Release and Blow Off Facilities	LF	37,000	$ 4	$ 148,000	$ 164,661	Unit Costs from Original NF Project
4.00	**Water Treatment Facility (Near Palouse Hwy and Estes Rd)**				**$ 13,576,000**	**$ 15,104,285**	
4.01	Prescreening	MGD	6.47	$ 50,000	$ 323,500	$ 359,917	Same as Original NF Project
4.02	Proprietary Membrane Filtration Equipment	MGD	6.47	$ 900,000	$ 5,823,000	$ 6,478,510	Same as Original NF Project
4.03	Chemical Feed Facilities	MGD	6.47	$ 160,000	$ 1,035,200	$ 1,151,735	Same as Original NF Project
4.04	Rapid Mix	MGD	6.47	$ 20,000	$ 129,400	$ 143,967	Same as Original NF Project
4.05	Chemical Cleaning System	LS	1	$ 180,000	$ 180,000	$ 200,263	Same as Original NF Project
4.06	Building Structure	SF	10,400	$ 150	$ 1,560,000	$ 1,735,613	Same as Original NF Project
4.07	Clearwell (CT Basin)	GAL	1,000,000	$ 1.80	$ 1,800,000	$ 2,002,631	Same as Original NF Project
4.08	Finished Water Pump Station	HP	375	$ 1,800	$ 675,000	$ 750,986	Same as Original NF Project
4.09	Solids Handling	SF	10,000	$ 25	$ 250,000	$ 278,143	Same as Original NF Project

***Project 8* - NF Palouse based on Alternative A5 from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics), Modified to be a Regional Project, with Delivery to Both Pullman and Moscow, Optimized Routes, and Single Treatment Plant**

Unit Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix B)

Quantities and Items Modified to Represent More Optimal Regional Configuration and Alignments

Alternative A5 (Modified to Deliver Water to Pullman and Moscow): NF Palouse River - Water Conveyance
Estimated Annual Supply: 1,550 MG (4,760 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, from Nov through Jun)

Construction Costs for Alternative 2 - North Fork Palouse River Diversion and Pipeline to Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
4.10	Yard Piping (10%)	LS	1	$ 1,152,610	$ 1,152,610	$ 1,282,362	Same as Original NF Project
4.11	Sitework and Landscaping (5%)	LS	1	$ 129,360	$ 129,360	$ 143,922	Same as Original NF Project
4.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 517,440	$ 517,440	$ 575,690	Same as Original NF Project
5.00	**Pump Station #2 (WTP to Pullman), Pump Station #3 (WTP to Moscow), & Storage Tank**				**$ 2,942,000**	**$ 3,273,188**	
5.01	30 HP Vertical Turbine Pump	EA	3	$ 18,000	$ 54,000	$ 60,079	Unit Costs from Original NF Project
5.02	90 HP Vertical Turbine Pump	EA	3	$ 36,000	$ 108,000	$ 120,158	Unit Costs from Original NF Project
5.03	Mechanical Piping	LS	1	$ 240,000	$ 240,000	$ 267,017	Unit Costs from Original NF Project
5.04	Surge Control	LS	1	$ 120,000	$ 120,000	$ 133,509	Unit Costs from Original NF Project
5.05	Building Structure	SF	3,000	$ 200	$ 600,000	$ 667,544	Unit Costs from Original NF Project
5.06	Electrical, Instrumentation, & Control	LS	1	$ 400,000	$ 400,000	$ 445,029	Unit Costs from Original NF Project
5.07	300 kW Standby Generator	LS	1	$ 80,000	$ 80,000	$ 89,006	Unit Costs from Original NF Project
5.08	Bolted Steel Storage Tank	GAL	1,000,000	$ 1.20	$ 1,200,000	$ 1,335,087	Unit Costs from Original NF Project
5.09	Sitework and Landscaping (5%)	LS	1	$ 140,100	$ 140,100	$ 155,871	Unit Costs from Original NF Project
6.00	**Pipeline (Pump Station #2 to Hydropower Facility #1, Pullman Branch)**				**$ 2,177,000**	**$ 2,422,070**	
6.01	18-in Dia. SDR 21 HDPE Pipe (16.18-in I.D.)	LF	29,000	$ 50.00	$ 1,450,000	$ 1,613,230	Unit Costs from Original NF Project
6.02	Trench and Pipe Bedding	LF	29,000	$ 21.07	$ 611,030	$ 679,815	Unit Costs from Original NF Project
6.03	Air Release and Blow Off Facilities	LF	29,000	$ 4	$ 116,000	$ 129,058	Unit Costs from Original NF Project
7.00	**Hydropower Facility #1 (Pullman Branch)**				**$ 243,000**	**$ 270,355**	
7.01	45 kW Turbine System	LS	1	$ 25,000	$ 25,000	$ 27,814	Unit Costs from Original NF Project
7.02	Mechanical Piping	LS	1	$ 35,000	$ 35,000	$ 38,940	Unit Costs from Original NF Project
7.03	Building Structure	SF	800	$ 150	$ 120,000	$ 133,509	Unit Costs from Original NF Project
7.04	Electrical, Instrumentation, & Control	LS	1	$ 51,000	$ 51,000	$ 56,741	Unit Costs from Original NF Project
7.05	Sitework and Landscaping (5%)	LS	1	$ 11,550	$ 11,550	$ 12,850	Unit Costs from Original NF Project

<u>Project 8</u> - NF Palouse based on Alternative A5 from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics), Modified to be a Regional Project, with Delivery to Both Pullman and Moscow, Optimized Routes, and Single Treatment Plant

Unit Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix B)

Quantities and Items Modified to Represent More Optimal Regional Configuration and Alignments

Alternative A5 (Modified to Deliver Water to Pullman and Moscow): NF Palouse River - Water Conveyance
Estimated Annual Supply: 1,550 MG (4,760 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, from Nov through Jun)

Construction Costs for Alternative 2 - North Fork Palouse River Diversion and Pipeline to Pullman										
Line	**Item**	**Unit**	**Quantity**	**Unit Price**		**Cost - From Original Study**		**Inflated Costs - To Oct 2016**		**Notes**
8.00	**Pipeline (Hydropower Facility #1 to Pullman, Pullman Branch)**					**$**	**739,000**	**$**	**822,191**	
8.01	18-in Dia. SDR 32.5 HDPE Pipe (16.83-in I.D.)	LF	11,900	$	37.00	$	440,300	$	489,866	Unit Costs from Original NF Project
8.02	Trench and Pipe Bedding	LF	11,900	$	21.07	$	250,733	$	278,959	Unit Costs from Original NF Project
8.03	Air Release and Blow Off Facilities	LF	11,900	$	4	$	47,600	$	52,958	Unit Costs from Original NF Project
9.00	**Pipeline (Pump Station #3 to Hydropower Facility #2, Moscow Branch)**					**$**	**2,602,000**	**$**	**2,894,914**	
9.01	20-in Dia. SDR 11 HDPE Pipe (16.15-in I.D.)	LF	25,000	$	79.00	$	1,975,000	$	2,197,331	Unit Costs from Original NF Project
9.02	Trench and Pipe Bedding	LF	25,000	$	21.07	$	526,750	$	586,048	Unit Costs from Original NF Project
9.03	Air Release and Blow Off Facilities	LF	25,000	$	4	$	100,000	$	111,257	Unit Costs from Original NF Project
10.00	**Hydropower Facility #2**					**$**	**232,000**	**$**	**258,117**	
10.01	20 kW Turbine System	LS	1	$	15,000	$	15,000	$	16,689	Unit Costs from Original NF Project
10.02	Mechanical Piping	LS	1	$	35,000	$	35,000	$	38,940	Unit Costs from Original NF Project
10.03	Building Structure	SF	800	$	150	$	120,000	$	133,509	Unit Costs from Original NF Project
10.04	Electrical, Instrumentation, & Control	LS	1	$	51,000	$	51,000	$	56,741	Unit Costs from Original NF Project
10.05	Sitework and Landscaping (5%)	LS	1	$	11,050	$	11,050	$	12,294	Unit Costs from Original NF Project
11.00	**Pipeline (Hydropower Facility #2 to Moscow, Moscow Branch)**					**$**	**2,117,000**	**$**	**2,355,316**	
11.01	18-in Dia. SDR 21 HDPE Pipe (16.18-in I.D.)	LF	28,200	$	50.00	$	1,410,000	$	1,568,727	Unit Costs from Original NF Project
11.02	Trench and Pipe Bedding	LF	28,200	$	21.07	$	594,174	$	661,062	Unit Costs from Original NF Project
11.03	Air Release and Blow Off Facilities	LF	28,200	$	4	$	112,800	$	125,498	Unit Costs from Original NF Project
12.00	**Subtotal**					**$**	**30,055,000**	**$**	**33,440,000**	
13.00	**Contingency**					**$**	**6,011,000**	**$**	**6,688,000**	
13.01	Contingency (20%)	LS	1	$	6,011,000	$	6,011,000	$	6,688,000	

***Project 8* - NF Palouse based on Alternative A5 from Moscow Surface Water Feasibility Study Phase 2 (SPF Water Engineering/TerraGraphics),**
Modified to be a Regional Project, with Delivery to Both Pullman and Moscow, Optimized Routes, and Single Treatment Plant
Unit Costs based on those generated on 11/12/2013 for Moscow Surface Water Feasibility Study Phase 2 (Appendix B)
Quantities and Items Modified to Represent More Optimal Regional Configuration and Alignments

Alternative A5 (Modified to Deliver Water to Pullman and Moscow): NF Palouse River - Water Conveyance
Estimated Annual Supply: 1,550 MG (4,760 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, from Nov through Jun)

Construction Costs for Alternative 2 - North Fork Palouse River Diversion and Pipeline to Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
14.00	**Engineering (Design & Construction)**				**$ 4,508,000**	**$ 5,015,000**	
14.01	Engineering (Design & Construction) (15%)	LS	1	$ 4,508,250	$ 4,508,000	$ 5,015,000	
				Total Estimated Project Total	**$ 40,570,000**	**$ 45,137,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**4,760**		**$ 8,523**	**$ 9,483**	
	Cost Per Delivered MG	**MG/YR**	**1,550**		**$ 26,174**	**$ 29,121**	

Notes:

1) Unit costs from Alternative A5 (NF Palouse River - Water Conveyance) from the 2013 *City of Moscow Surface Water Feasibility Study - Phase 2* were used.

Where a type and diameter of pipe was not included in the Phase 2 Study, the unit cost was interpolated from the unit costs used in that report.

O&M Costs for Alternative 2 - North Fork Palouse River Diversion and Pipeline to Pullman

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	3,475,872	$ 0.08	$ 278,070	$ 309,373	Full pumping capacity X 240 Days
1.02	Hydropower Generation	KWH/YR	374,400	$ (0.08)	$ (29,952)	$ (33,324)	
1.03	Water Treatment Facility Operations	MG/YR	1,550	$ 600	$ 930,000	$ 1,034,692	
1.04	Maintenance of Facilities (5%)	LS	1	$ 2,621,280	$ 131,064	$ 145,818	5% of Pumps, Tanks, and Electrical Equip.
				Total Estimated Annual Operation & Maintenance Cost Total	**$ 1,310,000**	**$ 1,457,000**	
				O&M Per Delivered Acre-Foot	**$ 275**	**$ 306**	
				O&M Per Delivered MG	**$ 845**	**$ 940**	

Project 14 ***- Alternative D3a from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)***

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 2 - Paradise Creek or South Fork Palouse ASR for Moscow							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
1.00	**Intake and Pump Station**				**$ 559,000**	**$ 654,636**	
1.01	River Intake	GPM	2,070	$ 120	$ 248,400	$ 290,897	
1.02	Pump Station	GPM	2,070	$ 150	$ 310,500	$ 363,622	
2.00	**Water Treatment Facility**				**$ 8,726,000**	**$ 10,218,877**	
2.01	Prescreening	MGD	3	$ 60,000	$ 180,000	$ 210,795	
2.02	Proprietary Membrane Filtration Equipment	MGD	3	$ 1,000,000	$ 3,000,000	$ 3,513,251	
2.03	Chemical Feed Facilities	MGD	3	$ 300,000	$ 900,000	$ 1,053,975	
2.04	Rapid Mix	MGD	3	$ 30,000	$ 90,000	$ 105,398	
2.05	Chemical Cleaning System	LS	1	$ 150,000	$ 150,000	$ 175,663	
2.06	Building Structure	SF	7,000	$ 150	$ 1,050,000	$ 1,229,638	
2.07	Clearwell (CT Basin)	GAL	300,000	$ 2.00	$ 600,000	$ 702,650	
2.08	Finished Water Pump Station	HP	200	$ 1,800	$ 360,000	$ 421,590	
2.09	Solids Handling	SF	6,000	$ 30	$ 180,000	$ 210,795	
2.10	Yard Piping (10%)	LS	1	$ 633,000	$ 633,000	$ 741,296	
2.11	Sitework and Landscaping (5%)	LS	1	$ 316,500	$ 316,500	$ 370,648	
2.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 1,266,000	$ 1,266,000	$ 1,482,592	
3.00	**ASR Injection and Well Facility**				**$ 300,000**	**$ 351,325**	
3.01	Borehole	LF	400	$ 250	$ 100,000	$ 117,108	
3.02	Pumping Equipment	LS	1	$ 40,000	$ 40,000	$ 46,843	
3.03	Flow Control & Mechanical Piping	LS	1	$ 80,000	$ 80,000	$ 93,687	
3.04	Well House	SF	400	$ 200	$ 80,000	$ 93,687	
4.00	**Subtotal**				**$ 9,585,000**	**$ 11,225,000**	
5.00	**Contingency**				**$ 1,917,000**	**$ 2,245,000**	
5.01	Contingency (20%)	LS	1	$ 1,917,000	$ 1,917,000	$ 2,245,000	

***Project 14* - Alternative D3a from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 2 - Paradise Creek or South Fork Palouse ASR for Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
6.00	**Engineering (Design & Construction)**				**$ 1,438,000**	**$ 1,684,000**	
6.01	Engineering (Design & Construction) (15%)	LS	1	$ 1,437,750	$ 1,438,000	$ 1,684,000	
				Total Estimated Project Total	**$ 12,940,000**	**$ 15,154,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**1,100**		**$ 11,764**	**$ 13,776**	
	Cost Per Delivered MG	**MG/YR**	**358**		**$ 36,145**	**$ 42,330**	

O&M Costs for Alternative 2 - Paradise Creek or South Fork Palouse ASR for Moscow

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	160,000	$ 0.08	$ 12,800	$ 14,990	
1.02	Hydropower Generation	KWH/YR	-	$ (0.08)	$ -	$ -	
1.03	Water Treatment Facility Operations	MG/YR	358	$ 600	$ 214,800	$ 251,549	
1.04	Maintenance of Facilities (5%)	LS	1	$ 6,941,500	$ 347,075	$ 406,454	
				Total Estimated Annual Operation & Maintenance Cost Total	**$ 574,700**	**$ 673,000**	
				O&M Per Delivered Acre-Foot	**$ 522**	**$ 612**	
				O&M Per Delivered MG	**$ 1,605**	**$ 1,880**	

***Project 1* - Alternative A1 from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix B and Appendix D)

Alternative A1: Flannigan Creek - Water Storage, Conveyance, and Treatment
Estimated Annual Supply: 1,430 MG (4,400 AF)
Estimated Reservoir Volume: 6,600 AF
Design Capacity: 9.1 cfs (5.9 MGD or 4,100 GPM)

Construction Costs for Alternative 3 - Flannigan Creek - Storage, Conveyance, and Treatment							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
Reservoir Costs (Based on Appendix B of Phase 1 Study, Flannigan Creek, 102-foot High Dam)							
1.00	**Reservoir and Dam**				**$ 10,481,590**	**$ 12,275,000**	
1.01	Land and Land Rights	LS	1	$ -	$ -	$ -	
1.02	Buildings and Improvements	LS	1	$ 287,000	$ 287,000	$ 336,101	
1.03	Reservoir and Dam	LS	1	$ 10,194,590	$ 10,194,590	$ 11,938,719	
2.00	**Subtotal - Reservoir and Dam**				**$ 10,481,590**	**$ 12,275,000**	
3.00	**Contingency**				**$ 3,144,000**	**$ 3,682,000**	
3.01	Contingency (30%)	LS	1	$ 3,144,477	$ 3,144,000	$ 3,682,000	
4.00	**Construction Subtotal - Reservoir and Dam**				**$ 13,626,000**	**$ 15,957,000**	
5.00	**Sales Taxes**				**$ 818,000**	**$ 958,000**	
5.01	Sales Taxes (6%)	LS	1	$ 817,560	$ 818,000	$ 958,000	
6.00	**Subtotal - Reservoir and Dam**				**$ 14,444,000**	**$ 16,915,000**	
7.00	**Engineering (Design & Construction)**				**$ 2,889,000**	**$ 3,383,000**	
7.01	Engineering and CM (20%)	LS	1	$ 2,888,800	$ 2,889,000	$ 3,383,000	
				Reservoir Total	**$ 17,333,000**	**$ 20,298,000**	
Conveyance and Treatment Costs (Based on Appendix D of Phase 1 Study)							
1.00	**Pump Station**				**$ 1,126,000**	**$ 1,318,640**	
1.01	150 HP Vertical Turbine Pump	EA	4	$ 45,000	$ 180,000	$ 210,795	
1.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 140,530	
1.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 70,265	

Project 1 ***- Alternative A1 from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)***

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix B and Appendix D)

Alternative A1: Flannigan Creek - Water Storage, Conveyance, and Treatment
Estimated Annual Supply: 1,430 MG (4,400 AF)
Estimated Reservoir Volume: 6,600 AF
Design Capacity: 9.1 cfs (5.9 MGD or 4,100 GPM)

Construction Costs for Alternative 3 - Flannigan Creek - Storage, Conveyance, and Treatment							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
1.04	Building Structure	SF	2,000	$ 200	$ 400,000	$ 468,434	
1.05	Electrical, Instrumentation, & Control	LS	1	$ 152,000	$ 152,000	$ 178,005	
1.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 187,373	
1.07	Sitework and Landscaping (5%)	LS	1	$ 53,600	$ 53,600	$ 62,770	
2.00	**Pipeline**				**$ 8,493,000**	**$ 9,946,015**	
2.01	24-in Dia. SDR 9 HDPE Pipe (18.35-in I.D.)	LF	26,900	$ 109.81	$ 2,953,889	$ 3,459,252	
2.02	22-in Dia. SDR 11 HDPE Pipe (17.76-in I.D.)	LF	40,700	$ 94.46	$ 3,844,522	$ 4,502,257	
2.03	Trench and Pipe Bedding	LF	67,600	$ 21.07	$ 1,424,332	$ 1,668,012	
2.04	Air Release and Blow Off Facilities	LF	67,600	$ 4	$ 270,400	$ 316,661	
3.00	**Pump Station & Storage Tank**				**$ 2,071,000**	**$ 2,425,315**	
3.01	150 HP Vertical Turbine Pump	EA	4	$ 45,000	$ 180,000	$ 210,795	
3.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 140,530	
3.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 70,265	
3.04	Building Structure	SF	2,000	$ 200	$ 400,000	$ 468,434	
3.05	Electrical, Instrumentation, & Control	LS	1	$ 152,000	$ 152,000	$ 178,005	
3.06	600 kW Standby Generator	LS	1	$ 160,000	$ 160,000	$ 187,373	
3.07	Bolted Steel Storage Tank	GAL	1,000,000	$ 0.90	$ 900,000	$ 1,053,975	
3.08	Sitework and Landscaping (5%)	LS	1	$ 98,600	$ 98,600	$ 115,469	
4.00	**Hydropower Facility**				**$ 464,000**	**$ 543,383**	
4.01	220 kW Turbine System	LS	1	$ 120,000	$ 120,000	$ 140,530	
4.02	Mechanical Piping	LS	1	$ 70,000	$ 70,000	$ 81,976	
4.03	Building Structure	SF	1,000	$ 150	$ 150,000	$ 175,663	
4.04	Electrical, Instrumentation, & Control	LS	1	$ 102,000	$ 102,000	$ 119,451	
4.05	Sitework and Landscaping (5%)	LS	1	$ 22,100	$ 22,100	$ 25,881	

***Project 1* - Alternative A1 from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix B and Appendix D)

Alternative A1: Flannigan Creek - Water Storage, Conveyance, and Treatment
Estimated Annual Supply: 1,430 MG (4,400 AF)
Estimated Reservoir Volume: 6,600 AF
Design Capacity: 9.1 cfs (5.9 MGD or 4,100 GPM)

Construction Costs for Alternative 3 - Flannigan Creek - Storage, Conveyance, and Treatment							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
5.00	**Water Treatment Facility**				**$ 14,758,000**	**$ 17,282,855**	
5.01	Prescreening	MGD	6	$ 50,000	$ 295,000	$ 345,470	
5.02	Proprietary Membrane Filtration Equipment	MGD	6	$ 900,000	$ 5,310,000	$ 6,218,455	
5.03	Chemical Feed Facilities	MGD	6	$ 160,000	$ 944,000	$ 1,105,503	
5.04	Rapid Mix	MGD	6	$ 20,000	$ 118,000	$ 138,188	
5.05	Chemical Cleaning System	LS	1	$ 180,000	$ 180,000	$ 210,795	
5.06	Building Structure	SF	9,500	$ 150	$ 1,425,000	$ 1,668,794	
5.07	Clearwell (CT Basin)	GAL	1,000,000	$ 1.80	$ 1,800,000	$ 2,107,951	
5.08	Finished Water Pump Station	HP	375	$ 1,800	$ 675,000	$ 790,482	
5.09	Solids Handling	SF	10,000	$ 25	$ 250,000	$ 292,771	
5.10	Yard Piping (10%)	LS	1	$ 1,074,700	$ 1,074,700	$ 1,258,564	
5.11	Sitework and Landscaping (5%)	LS	1	$ 537,350	$ 537,350	$ 629,282	
5.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 2,149,400	$ 2,149,400	$ 2,517,128	
13.00	**Subtotal - Conveyance and Treatment**				**$ 26,912,000**	**$ 31,516,000**	
14.00	**Contingency**				**$ 5,382,000**	**$ 6,303,000**	
14.01	Contingency (20%)	LS	1	$ 5,382,400	$ 5,382,000	$ 6,303,000	
15.00	**Engineering (Design & Construction)**				**$ 4,037,000**	**$ 4,728,000**	
15.01	Engineering (Design & Construction) (15%)	LS	1	$ 4,036,800	$ 4,037,000	$ 4,728,000	
				Conveyance and Treatment Total	**$ 36,331,000**	**$ 42,547,000**	
	Total Estimated Project Cost (Storage, Conveyance, and Treatment)				**$ 53,664,000**	**$ 62,845,000**	

***Project 1* - Alternative A1 from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix B and Appendix D)

Alternative A1: Flannigan Creek - Water Storage, Conveyance, and Treatment
Estimated Annual Supply: 1,430 MG (4,400 AF)
Estimated Reservoir Volume: 6,600 AF
Design Capacity: 9.1 cfs (5.9 MGD or 4,100 GPM)

Construction Costs for Alternative 3 - Flannigan Creek - Storage, Conveyance, and Treatment

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
	Cost Per Delivered Acre-Foot	**AF/YR**	**4,400**		**$ 12,196**	**$ 14,283**	
	Cost Per Delivered MG	**MG/YR**	**1,430**		**$ 37,527**	**$ 43,948**	

O&M Costs for Alternative 3 - Flannigan Creek - Storage, Conveyance, and Treatment

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	7,249,000	$ 0.08	$ 579,920	$ 679,135	
1.02	Hydropower Generation	KWH/YR	1,891,000	$ (0.08)	$ (151,280)	$ (177,162)	
1.03	Water Treatment Facility Operations	MG/YR	2,150	$ 600	$ 1,290,000	$ 1,510,698	
1.04	Maintenance of Facilities (5%)	LS	1	$ 12,477,800	$ 623,890	$ 730,627	
Total Estimated Annual Operation & Maintenance Cost Total					**$ 2,340,000**	**$ 2,740,000**	
O&M Per Delivered Acre-Foot					**$ 532**	**$ 623**	
O&M Per Delivered MG					**$ 1,636**	**$ 1,916**	

Project 16B ***- Surface Water Diversion and Direct Use - South Fork Palouse River for City of Pullman***

Project concept modified from ASR Concept for City of Pullman from City of Pullman Water System Plan, Direct Use Assumed Instead of ASR

Costs based on those generated on 03/28/2011 for Alternative D3a, Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff), Modified to Include Direct Use Rather than ASR
Estimated Annual Supply: 894 MG (2,743 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, when supply is available from Nov-Jun)

Construction Costs for Alternative 3 - South Fork Palouse Direct Use for City of Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
1.00	**River Intake**				**$ 50,000**	**$ 55,629**	
1.01	River Intake	EA	1	$ 50,000	$ 50,000	$ 55,629	Assumed Same as NF Palouse
2.00	**Pump Station #1 (At Intake)**				**$ 1,008,000**	**$ 1,121,473**	
2.01	150 HP Vertical Turbine Pump	EA	3	$ 45,000	$ 135,000	$ 150,197	Assumed Same as NF Palouse
2.02	Mechanical Piping	LS	1	$ 120,000	$ 120,000	$ 133,509	Assumed Same as NF Palouse
2.03	Surge Control	LS	1	$ 60,000	$ 60,000	$ 66,754	Assumed Same as NF Palouse
2.04	Building Structure	SF	2,000	$ 200	$ 400,000	$ 445,029	Assumed Same as NF Palouse
2.05	Electrical, Instrumentation, & Control	LS	1	$ 145,400	$ 145,400	$ 161,768	Assumed Same as NF Palouse
2.06	350 kW Standby Generator	LS	1	$ 100,000	$ 100,000	$ 111,257	Assumed Same as NF Palouse
2.07	Sitework and Landscaping (5%)	LS	1	$ 48,020	$ 48,020	$ 53,426	Assumed Same as NF Palouse
3.00	**Water Treatment Facility**				**$ 13,576,000**	**$ 15,104,285**	
3.01	Prescreening	MGD	6.47	$ 50,000	$ 323,500	$ 359,917	Assumed Same as NF Palouse
3.02	Proprietary Membrane Filtration Equipment	MGD	6.47	$ 900,000	$ 5,823,000	$ 6,478,510	Assumed Same as NF Palouse
3.03	Chemical Feed Facilities	MGD	6.47	$ 160,000	$ 1,035,200	$ 1,151,735	Assumed Same as NF Palouse
3.04	Rapid Mix	MGD	6.47	$ 20,000	$ 129,400	$ 143,967	Assumed Same as NF Palouse
3.05	Chemical Cleaning System	LS	1	$ 180,000	$ 180,000	$ 200,263	Assumed Same as NF Palouse
3.06	Building Structure	SF	10,400	$ 150	$ 1,560,000	$ 1,735,613	Assumed Same as NF Palouse
3.07	Clearwell (CT Basin)	GAL	1,000,000	$ 1.80	$ 1,800,000	$ 2,002,631	Assumed Same as NF Palouse
3.08	Finished Water Pump Station	HP	375	$ 1,800	$ 675,000	$ 750,986	Assumed Same as NF Palouse
3.09	Solids Handling	SF	10,000	$ 25	$ 250,000	$ 278,143	Assumed Same as NF Palouse
3.10	Yard Piping (10%)	LS	1	$ 1,152,610	$ 1,152,610	$ 1,282,362	Assumed Same as NF Palouse
3.11	Sitework and Landscaping (5%)	LS	1	$ 129,360	$ 129,360	$ 143,922	Assumed Same as NF Palouse
3.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 517,440	$ 517,440	$ 575,690	Assumed Same as NF Palouse
4.00	**Pipelines**				**$ 472,280**	**$ 525,446**	

***Project 16B** - Surface Water Diversion and Direct Use - South Fork Palouse River for City of Pullman*

Project concept modified from ASR Concept for City of Pullman from City of Pullman Water System Plan, Direct Use Assumed Instead of ASR

Costs based on those generated on 03/28/2011 for Alternative D3a, Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff), Modified to Include Direct Use Rather than ASR
Estimated Annual Supply: 894 MG (2,743 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, when supply is available from Nov-Jun)

Construction Costs for Alternative 3 - South Fork Palouse Direct Use for City of Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
4.01	24-in Dia. SDR 13.5 HDPE Pipe (20.23-in I.D.)	LF	4,000	$ 93.00	$ 372,000	$ 413,877	Unit Costs from NF Palouse Project
4.02	Trench and Pipe Bedding	LF	4,000	$ 21.07	$ 84,280	$ 93,768	Unit Costs from NF Palouse Project
4.03	Air Release and Blow Off Facilities	LF	4,000	$ 4	$ 16,000	$ 17,801	Unit Costs from NF Palouse Project
5.00	**Subtotal**				**$ 15,106,280**	**$ 16,807,000**	
6.00	**Contingency**				**$ 3,021,000**	**$ 3,361,000**	
6.01	Contingency (20%)	LS	1	$ 3,021,256	$ 3,021,000	$ 3,361,000	
7.00	**Engineering (Design & Construction)**				**$ 2,266,000**	**$ 2,521,000**	
7.01	Engineering (Design & Construction) (15%)	LS	1	$ 2,265,942	$ 2,266,000	$ 2,521,000	
				Total Estimated Project Total	**$ 20,393,280**	**$ 22,689,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**2,743**		**$ 7,435**	**$ 8,272**	
	Cost Per Delivered MG	**MG/YR**	**894**		**$ 22,811**	**$ 25,379**	

Notes:

1) Unit costs from similarly sized projects from the 2013 *City of Moscow Surface Water Feasibility Study - Phase 2* were used.

O&M Costs for Alternative 3 - South Fork Palouse Direct Use for City of Pullman

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	1,528,740	$ 0.08	$ 122,299	$ 136,066.73	Full pumping capacity X 190 Days
1.02	Hydropower Generation	KWH/YR	-	$ (0.08)	$ -	$ -	
1.03	Water Treatment Facility Operations	MG/YR	894	$ 600	$ 536,400	$ 596,784	
1.04	Maintenance of Facilities (5%)	LS	1	$ 336,480	$ 16,824	$ 18,718	5% of Pumps and Electrical Equip.

***Project 16B* - Surface Water Diversion and Direct Use - South Fork Palouse River for City of Pullman**

Project concept modified from ASR Concept for City of Pullman from City of Pullman Water System Plan, Direct Use Assumed Instead of ASR

Costs based on those generated on 03/28/2011 for Alternative D3a, Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff), Modified to Include Direct Use Rather than ASR
Estimated Annual Supply: 894 MG (2,743 AF)
Design Capacity: 10 cfs (4,490 GPM OR 6.47 MGD, when supply is available from Nov-Jun)

Construction Costs for Alternative 3 - South Fork Palouse Direct Use for City of Pullman							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
Total Estimated Annual Operation & Maintenance Cost Total					**$ 675,600**	**$ 752,000**	
O&M Per Delivered Acre-Foot					**$ 246**	**$ 288**	
O&M Per Delivered MG					**$ 756**	**$ 885**	

<u>Project 14</u> - Alternative D3a from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 4 - Paradise Creek or South Fork Palouse ASR for Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
1.00	**Intake and Pump Station**				**$ 559,000**	**$ 654,636**	
1.01	River Intake	GPM	2,070	$ 120	$ 248,400	$ 290,897	
1.02	Pump Station	GPM	2,070	$ 150	$ 310,500	$ 363,622	
2.00	**Water Treatment Facility**				**$ 8,726,000**	**$ 10,218,877**	
2.01	Prescreening	MGD	3	$ 60,000	$ 180,000	$ 210,795	
2.02	Proprietary Membrane Filtration Equipment	MGD	3	$ 1,000,000	$ 3,000,000	$ 3,513,251	
2.03	Chemical Feed Facilities	MGD	3	$ 300,000	$ 900,000	$ 1,053,975	
2.04	Rapid Mix	MGD	3	$ 30,000	$ 90,000	$ 105,398	
2.05	Chemical Cleaning System	LS	1	$ 150,000	$ 150,000	$ 175,663	
2.06	Building Structure	SF	7,000	$ 150	$ 1,050,000	$ 1,229,638	
2.07	Clearwell (CT Basin)	GAL	300,000	$ 2.00	$ 600,000	$ 702,650	
2.08	Finished Water Pump Station	HP	200	$ 1,800	$ 360,000	$ 421,590	
2.09	Solids Handling	SF	6,000	$ 30	$ 180,000	$ 210,795	
2.10	Yard Piping (10%)	LS	1	$ 633,000	$ 633,000	$ 741,296	
2.11	Sitework and Landscaping (5%)	LS	1	$ 316,500	$ 316,500	$ 370,648	
2.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 1,266,000	$ 1,266,000	$ 1,482,592	
3.00	**ASR Injection and Well Facility**				**$ 300,000**	**$ 351,325**	
3.01	Borehole	LF	400	$ 250	$ 100,000	$ 117,108	
3.02	Pumping Equipment	LS	1	$ 40,000	$ 40,000	$ 46,843	
3.03	Flow Control & Mechanical Piping	LS	1	$ 80,000	$ 80,000	$ 93,687	
3.04	Well House	SF	400	$ 200	$ 80,000	$ 93,687	
4.00	**Subtotal**				**$ 9,585,000**	**$ 11,225,000**	
5.00	**Contingency**				**$ 1,917,000**	**$ 2,245,000**	
5.01	Contingency (20%)	LS	1	$ 1,917,000	$ 1,917,000	$ 2,245,000	

***Project 14* - Alternative D3a from Moscow Surface Water Feasibility Study Phase 1 (SPF Water Engineering/TerraGraphics)**

Costs based on those generated on 03/28/2011 for Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 4 - Paradise Creek or South Fork Palouse ASR for Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
6.00	**Engineering (Design & Construction)**				**$ 1,438,000**	**$ 1,684,000**	
6.01	Engineering (Design & Construction) (15%)	LS	1	$ 1,437,750	$ 1,438,000	$ 1,684,000	
	Total Estimated Project Total				**$ 12,940,000**	**$ 15,154,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**1,100**		**$ 11,764**	**$ 13,776**	
	Cost Per Delivered MG	**MG/YR**	**358**		**$ 36,145**	**$ 42,330**	

O&M Costs for Alternative 4 - Paradise Creek or South Fork Palouse ASR for Moscow

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	160,000	$ 0.08	$ 12,800	$ 14,990	
1.02	Hydropower Generation	KWH/YR	-	$ (0.08)	$ -	$ -	
1.03	Water Treatment Facility Operations	MG/YR	358	$ 600	$ 214,800	$ 251,549	
1.04	Maintenance of Facilities (5%)	LS	1	$ 6,941,500	$ 347,075	$ 406,454	
	Total Estimated Annual Operation & Maintenance Cost Total				**$ 574,700**	**$ 673,000**	
	O&M Per Delivered Acre-Foot				**$ 522**	**$ 612**	
	O&M Per Delivered MG				**$ 1,605**	**$ 1,880**	

***Project 16* - Aquifer Storage and Recharge - South Fork Palouse River for City of Pullman**

Project concept from City of Pullman Water System Plan and prior documents that evaluated ASR in Pullman,

Costs based on those generated on 03/28/2011 for Alternative D3a, Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 4 - South Fork Palouse ASR for City of Pullman

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
1.00	**Intake and Pump Station**				**$ 559,000**	**$ 654,636**	
1.01	River Intake	GPM	2,070	$ 120	$ 248,400	$ 290,897	
1.02	Pump Station	GPM	2,070	$ 150	$ 310,500	$ 363,622	
2.00	**Water Treatment Facility**				**$ 8,726,000**	**$ 10,218,877**	
2.01	Prescreening	MGD	3	$ 60,000	$ 180,000	$ 210,795	
2.02	Proprietary Membrane Filtration Equipment	MGD	3	$ 1,000,000	$ 3,000,000	$ 3,513,251	
2.03	Chemical Feed Facilities	MGD	3	$ 300,000	$ 900,000	$ 1,053,975	
2.04	Rapid Mix	MGD	3	$ 30,000	$ 90,000	$ 105,398	
2.05	Chemical Cleaning System	LS	1	$ 150,000	$ 150,000	$ 175,663	
2.06	Building Structure	SF	7,000	$ 150	$ 1,050,000	$ 1,229,638	
2.07	Clearwell (CT Basin)	GAL	300,000	$ 2.00	$ 600,000	$ 702,650	
2.08	Finished Water Pump Station	HP	200	$ 1,800	$ 360,000	$ 421,590	
2.09	Solids Handling	SF	6,000	$ 30	$ 180,000	$ 210,795	
2.10	Yard Piping (10%)	LS	1	$ 633,000	$ 633,000	$ 741,296	
2.11	Sitework and Landscaping (5%)	LS	1	$ 316,500	$ 316,500	$ 370,648	
2.12	Electrical, Instrumentation, & Control (20%)	LS	1	$ 1,266,000	$ 1,266,000	$ 1,482,592	
3.00	**ASR Injection and Well Facility**				**$ 300,000**	**$ 351,325**	
3.01	Borehole	LF	400	$ 250	$ 100,000	$ 117,108	
3.02	Pumping Equipment	LS	1	$ 40,000	$ 40,000	$ 46,843	
3.03	Flow Control & Mechanical Piping	LS	1	$ 80,000	$ 80,000	$ 93,687	
3.04	Well House	SF	400	$ 200	$ 80,000	$ 93,687	
4.00	**Subtotal**				**$ 9,585,000**	**$ 11,225,000**	
5.00	**Contingency**				**$ 1,917,000**	**$ 2,245,000**	
5.01	Contingency (20%)	LS	1	$ 1,917,000	$ 1,917,000	$ 2,245,000	

***Project 16* - Aquifer Storage and Recharge - South Fork Palouse River for City of Pullman**

Project concept from City of Pullman Water System Plan and prior documents that evaluated ASR in Pullman,

Costs based on those generated on 03/28/2011 for Alternative D3a, Moscow Surface Water Feasibility Study Phase 1 (Appendix D)

Alternative D3a: Paradise Creek or SF Palouse River - Aquifer Storage and Recovery (During Runoff)
Estimated Annual Supply: 358 MG (1,100 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD, 4 Months from Jan through Apr)

Construction Costs for Alternative 4 - South Fork Palouse ASR for City of Pullman							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
6.00	**Engineering (Design & Construction)**				**$ 1,438,000**	**$ 1,684,000**	
6.01	Engineering (Design & Construction) (15%)	LS	1	$ 1,437,750	$ 1,438,000	$ 1,684,000	
				Total Estimated Project Total	**$ 12,940,000**	**$ 15,154,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**1,100**		**$ 11,764**	**$ 13,776**	
	Cost Per Delivered MG	**MG/YR**	**358**		**$ 36,145**	**$ 42,330**	

O&M Costs for Alternative 4 - South Fork Palouse ASR for City of Pullman							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost**	**Inflated Costs**	**Notes**
1.00	**Annual O&M Costs**						
1.01	Pumping	KWH/YR	160,000	$ 0.08	$ 12,800	$ 14,990	
1.02	Hydropower Generation	KWH/YR	-	$ (0.08)	$ -	$ -	
1.03	Water Treatment Facility Operations	MG/YR	358	$ 600	$ 214,800	$ 251,549	
1.04	Maintenance of Facilities (5%)	LS	1	$ 6,941,500	$ 347,075	$ 406,454	
				Total Estimated Annual Operation & Maintenance Cost Total	**$ 574,700**	**$ 673,000**	
				O&M Per Delivered Acre-Foot	**$ 522**	**$ 612**	
				O&M Per Delivered MG	**$ 1,605**	**$ 1,880**	

Project 20 ***- Water Reuse - Pullman and WSU***

Costs based on those generated in October 2014 for City of Pullman and WSU Water Reclamation Project Design Development Document Update

Pullman/WSU Water Reclamation Project
Estimated Annual Supply: 148 MG (454 AF)
Design Capacity: 2.1 cfs (938 GPM OR 1.35 MGD)

Construction Costs for Alternative 4 - Water Reuse for Pullman and WSU							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost - From Original Study**	**Inflated Costs - To Oct 2016**	**Notes**
1.00					**$ 10,970,000**		
1.01	Site Work & Yard Piping	LS	1	$ 243,000	$ 243,000		
1.02	Filter Feed	LS	1	$ 150,000	$ 150,000		
1.03	Filtration	LS	1	$ 1,697,000	$ 1,697,000		
1.04	Disinfection (UV)	LS	1	$ 1,910,000	$ 1,910,000		
1.05	Reclaimed Water Pump Station	LS	1	$ 311,000	$ 311,000		
1.06	Filter Reject	LS	1	$ 103,000	$ 103,000		
1.07	Transmission	LS	1	$ 2,650,000	$ 2,650,000		
1.08	Storage	LS	1	$ 1,548,000	$ 1,548,000		
1.09	Distribution	LS	1	$ 478,200	$ 478,200		
1.10	Electrical & Controls	LS	1	$ 882,000	$ 882,000		
1.11	Mobilization and Bonds (10%)	LS	1	$ 997,000	$ 997,000		
2.00	**Construction Subtotal**				**$ 10,969,200**		
3.00	**Planning Level Construction Contingency**				**$ 2,193,840**		
3.01	Contingency (20%)	LS	1	$ 2,193,840	$ 2,193,840		
4.00	**Construction Total**				**$ 13,163,040**		
5.00	**Other**				**$ 4,291,151**		
5.01	Sales Tax (7.6%)	LS	1	$ 1,000,391	$ 1,000,391		
5.02	Survey & Design Engineering (10%)	LS	1	$ 1,316,304	$ 1,316,304		
5.03	vation, Startup, O&M Manual, & Record Drawings (10%)	LS	1	$ 1,316,304	$ 1,316,304		
5.04	Legal, Admin, & Grant Administration Fees (5%)	LS	1	$ 658,152	$ 658,152		
Planning Level Project Costs (Original Opinion - March 2012)					**$ 17,454,191**		

Planning Level Project Costs (Revised - October 2014)					**$ 18,587,922**	**$ 20,134,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**454**		**$ 40,943**	**$ 44,348**	
	Cost Per Delivered MG	**MG/YR**	**148**		**$ 125,594**	**$ 136,041**	

O&M Costs for Alternative 4 - Water Reuse for Pullman and WSU							
Line	**Item**	**Unit**	**Quantity**	**Unit Price**	**Cost**	**Inflated Costs**	**Notes**
1.00	**Annual O&M Costs**						
1.01	Labor	LS	1	$ 61,000.00	$ 61,000	$ 66,074.40	
1.02	Consumables	LS	1	$ 104,000.00	$ 104,000	$ 112,651.43	
Total Estimated Annual Operation & Maintenance Cost Total					**$ 165,000**	**$ 179,000**	
O&M Per Delivered Acre-Foot					**$ 363**	**$ 394**	
O&M Per Delivered MG					**$ 1,115**	**$ 1,208**	

Project 35 ***- Water Reuse and Recharge - Moscow***

Costs estimated by HDR based on unit prices generated from 11/12/2013 for the Moscow Surface Water Feasibility Study Phase 2 (Appendix G) for Alternative D3b (ASR - Passive Recharge in Moscow)

Reuse with Passive Infiltration in Moscow
Estimated Annual Supply: 420 MG (1,260 AF)
Design Capacity: 4.6 cfs (2,070 GPM OR 3.0 MGD)

Construction Costs for Alternative 4 - Water Reuse and Recharge in Moscow

Line	Item	Unit	Quantity	Unit Price	Cost - From Original Study	Inflated Costs - To Oct 2016	Notes
1.00	**Class A Treatment Upgrades**				**$ 1,423,000**	**$ 1,492,000**	
1.01	Infiltration Feasibility Study	LS	1	$ 500,000	$ 500,000	$ 524,000	Assumed study costs
1.02	Permitting and Engineering Evaluation	LS	1	$ 75,000	$ 75,000	$ 79,000	JUB Engineers Memo*
1.03	SCADA Modifications - Control Gate	LS	1	$ 25,000	$ 25,000	$ 26,000	
1.04	SCADA Modifications - Class A Monitoring Requests	LS	1	$ 25,000	$ 25,000	$ 26,000	
1.05	U of I Cl Contact Chamber Outlet Mod	LS	1	$ 7,500	$ 7,500	$ 8,000	
1.06	Standby Power for Disinfection System	LS	1	$ 75,000	$ 75,000	$ 79,000	
1.07	Redundancy Cl Analyzer	LS	1	$ 25,000	$ 25,000	$ 26,000	
1.08	Redundant Turbidimeter	LS	1	$ 15,000	$ 15,000	$ 16,000	
1.09	Redundant Turbidimeter (5 banks)	LS	1	$ 75,000	$ 75,000	$ 79,000	
1.10	Retrofit Pumping/Piping/Signage	LS	1	$ 100,000	$ 100,000	$ 105,000	
1.11	Increase Cl Contact Chamber Volume and/or CT	LS	1	$ 500,000	$ 500,000	$ 524,000	
2.00	**Pump Station**				**$ 104,000**	**$ 116,000**	
2.01	15 hp vertical turbine pump	EA	2	$ 29,400	$ 58,800	$ 65,000	
2.02	Mechanical piping	LS	1	$ 30,000	$ 30,000	$ 33,000	
2.03	Electrical, instrumentation & controls	LS	1	$ 10,000	$ 10,000	$ 11,000	
2.04	Sitework and landscaping (5%)	LS	1	$ 4,940	$ 4,900	$ 5,000	
3.00	**Pipeline**				**$ 55,000**	**$ 61,000**	
3.01	12-in dia SDR 32.5 HDPE pipe (11.9-in ID)	LF	1,000	$ 40	$ 40,000	$ 45,000	
3.02	Trench and pipe bedding	LF	1,000	$ 15	$ 15,000	$ 17,000	
4.00	**Infiltration Basins**				**$ 287,000**	**$ 319,000**	
4.01	Import Berm Material, Placed and Compacted	CY	15,037	$ 12	$ 180,400	$ 201,000	
4.02	Riprap, delivered and placed	CY	276	$ 50	$ 13,800	$ 15,000	
4.03	Gravel, roadway	CY	689	$ 12	$ 8,300	$ 9,000	
4.04	Grass sod, installed	SF	42,680	$ 0.48	$ 20,500	$ 23,000	

4.05	Irrigation system, installed	SF	42,680	$ 1.50	$ 64,000	$ 71,000	
5.00	**Subtotal**				**$ 1,869,000**	**$ 1,988,000**	
6.00	**Contingency**				**$ 934,500**	**$ 994,000**	
6.01	Contingency (50%)				$ 934,500	$ 994,000	
7.00	**Engineering (Design & Construction)**				**$ 467,250**	**$ 497,000**	
7.01	Engineering (Design & Construction) (25%)				$ 467,250	$ 497,000	
				Total Estimated Project Total	**$ 3,270,750**	**$ 3,479,000**	
	Cost Per Delivered Acre-Foot	**AF/YR**	**1,300**		**$ 2,516**	**$ 2,676**	
	Cost Per Delivered MG	**MG/YR**	**420**		**$ 7,788**	**$ 8,283**	

* All treatment costs (excluding infiltration feasibility study) based on JUB Engineers memo to University of Idaho, Class A Reuse Feasibility Evaluation (March 19, 2015).

O&M Costs for Alternative 4 - Water Reuse and Recharge in Moscow

Line	Item	Unit	Quantity	Unit Price	Cost	Inflated Costs	Notes
1.00	**Annual O&M Costs**						
1.01	Electric (Pumping)	72,000	KWH/YR	$ 0.08		$ 5,800	
	Maintenance of Facilities and Chemical use	10%	Equip	$ 700,000		$ 70,000	
					Total Estimated Annual Operation & Maintenance Cost Total	**$ 76,000**	
					O&M Per Delivered Acre-Foot	**$ 58**	
					O&M Per Delivered MG	**$ 181**	

Appendix F
Scoring of Qualitatively Assessed Criteria

Scoring of Qualitatively Assessed Criteria

PBAC has identified criteria that are important to the overall evaluation of water supply projects but that cannot be quantitatively analyzed, due primarily to a lack of sufficient data. Such criteria are qualitatively assessed.

In this process, criteria are scored according to the potential impact (or effect) a given criterion would have upon each project, using a scale of -2 (very negative impact) to +2 (very positive impact). This calculation allows for the relative comparison of each project within the context of the individual criteria.

Below is the proposed system for assigning an impact score to each project for all of the qualitatively assessed criteria.

6. Water Quality Impacts

Impact Scoring	
Water Quality Impacts	**Impact Score**
Weight = 20	
Project may have significant negative impacts on water quality related to one of the bodies of water described above, and/or minimal impacts on water quality related to two of the bodies of water described above.	-2
Project may have minimal negative impacts on water quality related to at least one of the bodies of water described above.	-1
No impact.	0
Project may have minimal positive impacts on water quality related to at least one of the bodies of water described above.	+1
Project may have significant positive impacts on water quality related to one of the bodies of water described above, and/or minimal impacts on water quality related to two of the bodies of water described above.	+2

7. Project Data / Model Accuracy

Impact Scoring	
Project Data / Model Accuracy	**Impact Score**
Weight = 25	
Projects' technical basis data does not exist or there is no model available for analysis.	-2
Projects' technical basis data or model is limited.	-1
No discernable negative or positive impact.	0
Projects' technical basis data well established, but models/analysis tools limited.	+1
Projects' technical basis data and models/analysis tools well established.	+2

8. Water Rights Complexity

Impact Scoring	
Water Rights Complexity	**Impact Score**
Weight = 10	
Low probability of securing necessary water rights (e.g., there is limited availability of existing rights that could potentially be purchased and/or there is insufficient water to support acquiring new rights) and mitigation needs are significant/costly.	-2
Medium to high probability of securing necessary water rights (e.g., there is availability of existing rights that could potentially be purchased and/or there is sufficient water to support acquiring new rights), but mitigation needs are significant/costly. .	-1
No discernable negative or positive impact.	0
Medium probability of securing necessary water rights (e.g., there are uncertainties regarding availability of existing rights that could potentially be purchased and/or sufficiency of water to support acquiring new rights), but mitigation needs are likely to be minimal.	+1
High probability of securing necessary water rights (e.g., there is high availability of existing rights that could potentially be purchased and/or there is sufficient water to support acquiring new rights) and mitigation needs are minimal.	+2

9. Permitting Challenges – State/Local

Impact Scoring	
Permitting Challenges – State/Local	**Impact Score**
Weight = 10	
Project is expected to have significant state/local permitting complexity (e.g., requires river crossing or anti-degradation related permitting, and/or crosses sensitive land) and/or high mitigation costs (e.g., >5% of total project costs).	-2
Project is expected to have moderately complex state/local permitting (e.g., fewer approvals than projects scored lower) and moderate mitigation costs (e.g., 2-5% of total project costs).	-1
No discernable negative or positive impact.	0
Project is not expected to trigger complex state/local permitting, but is expected to cross sensitive land and therefore have moderate mitigation costs (e.g., 2-5% of total project costs).	+1
Project is expected to have minimal state/local permitting requirements (e.g., does not require river crossing or anti-degradation related permitting, or cross sensitive land) and minimal mitigation costs (e.g., <2% of total project costs).	+2

10. Permitting Challenges – Federal

Impact Scoring	
Permitting Challenges – Federal	**Impact Score**
Weight = 10	
Project is expected to trigger federal permitting requirements that may significantly impact schedule.	-2
Project is expected to trigger federal permitting requirements that will likely not significantly impact schedule.	-1
No discernable negative or positive impact.	0
Project is expected to not trigger federal permitting requirements that may significantly impact schedule.	+1
Project is expected to not trigger federal permitting requirements beyond jurisdictional reviews.	+2

11. Extent of Regional Agreements Required

Impact Scoring	
Extent of Regional Agreements Required	**Impact Score**
Weight = 5	
Project requires regional agreements and regional funding approaches.	-2
Project requires regional agreements, but not regional funding approaches.	-1
No discernable negative or positive impact.	0
Project is expected to require jurisdictional coordination, but not require agreements or funding.	+1
Project does not require regional agreements or regional funding approaches.	+2

12. Willingness of Property Owners to Participate

Impact Scoring	
Willingness of Property Owners to Participate	**Impact Score**
Weight = 10	
Project crosses multiple properties with diverse ownership, including likely problematic property/easement acquisitions.	-2
Project partially within existing rights of way and will require a medium level of property acquisition.	-1
No discernable negative or positive impact.	0
Project partially within existing rights of way and will require a minimum level of	+1

property acquisition.	
Project primarily within existing rights of way and requires minimal to no property acquisition.	+2

13. Public Acceptability

Impact Scoring	
Public Acceptability	**Impact Score**
Weight = 10	
Project is expected to be opposed by those who would benefit, and be challenged at multiple steps by critical affected parties.	-2
Project is expected to not be opposed by those who would benefit, and be challenged at multiple steps by critical affected parties.	-1
No discernable negative or positive impact.	0
Project is expected to receive some support from those who would benefit, and to have few critical affected parties.	+1
Project is expected to receive strong support from those who would benefit, and to have few critical affected parties.	+2

Appendix G
Cost and Schedule Uncertainty Model Output

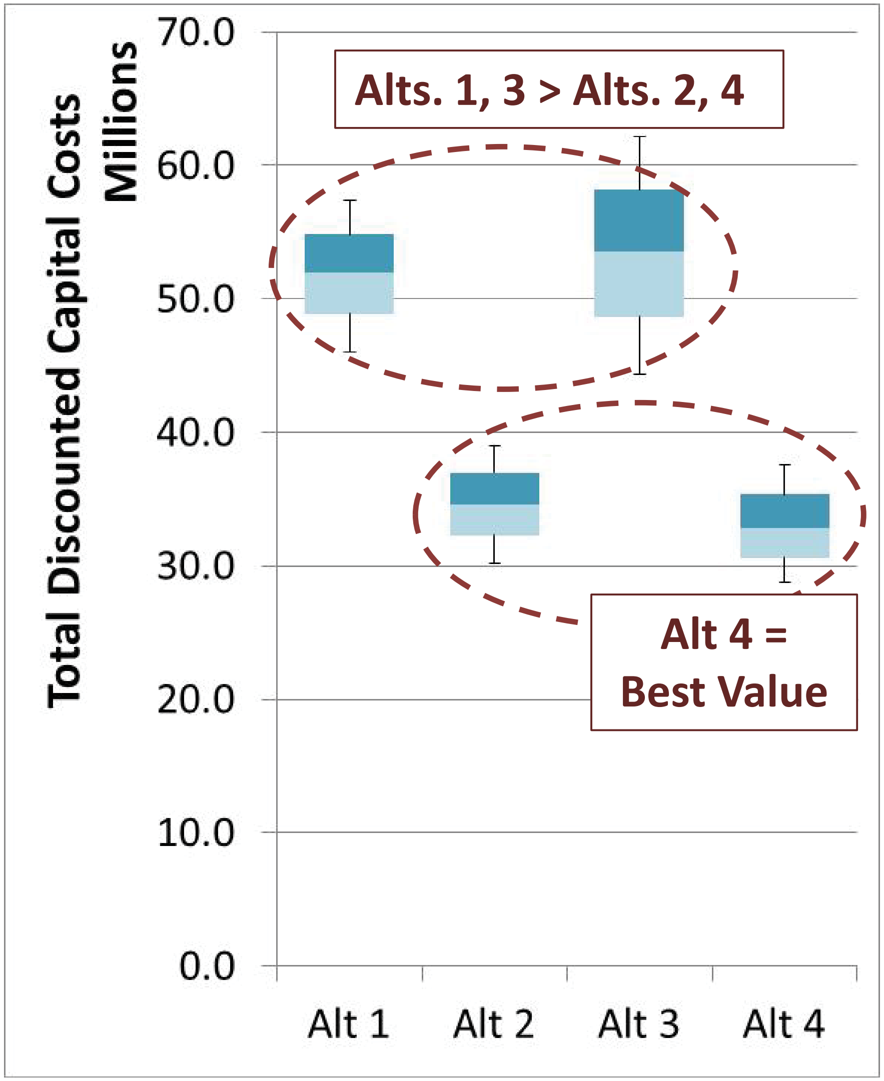
Appendix G

Cost and Schedule Uncertainty Model Output

Cost

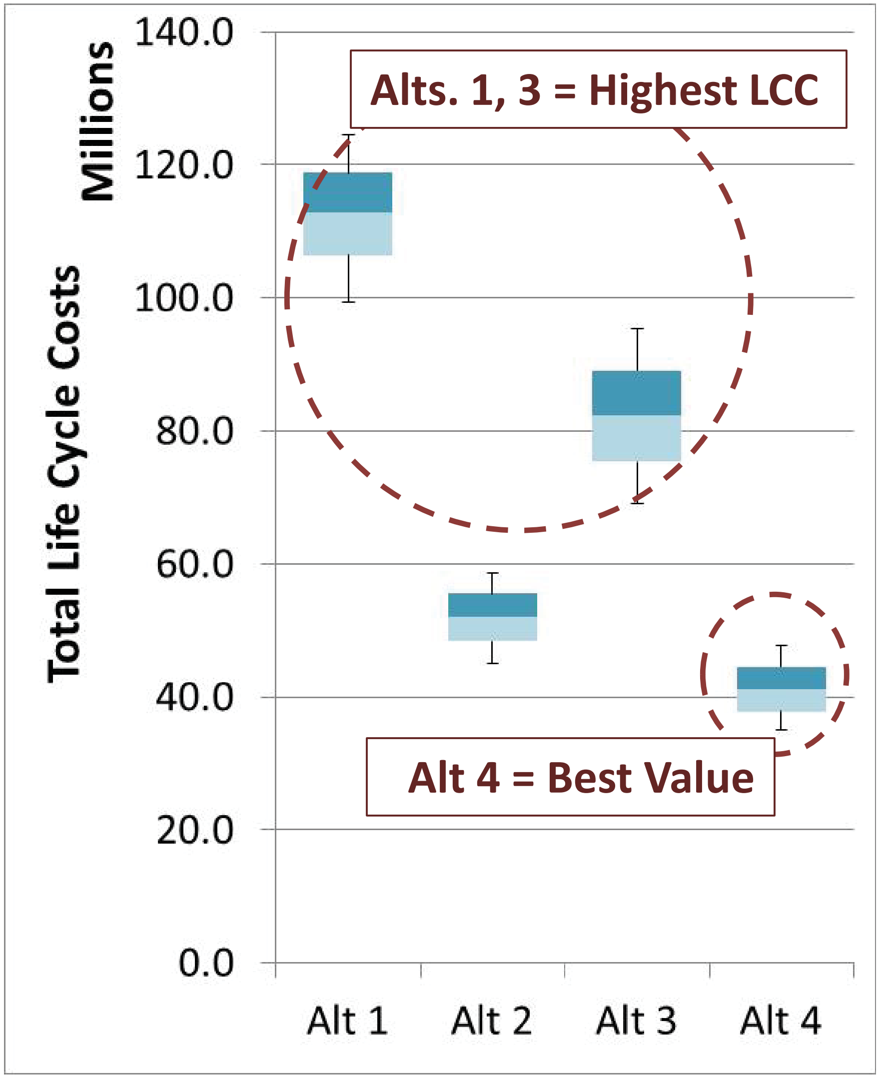
Total Capital Cost Uncertainty

- Alts 1 and 3 have similar expected costs, which are significantly higher than expected costs of Alts 2 and 4
- Alts 1 and 3 costs are higher than Alts 2 and 4, even at their lowest cost and highest cost for Alts 2 and 4
- Alts 2 and 4 cost ranges are largely overlapping, and narrower than Alts 1 and 3
- Best value is Alt 4



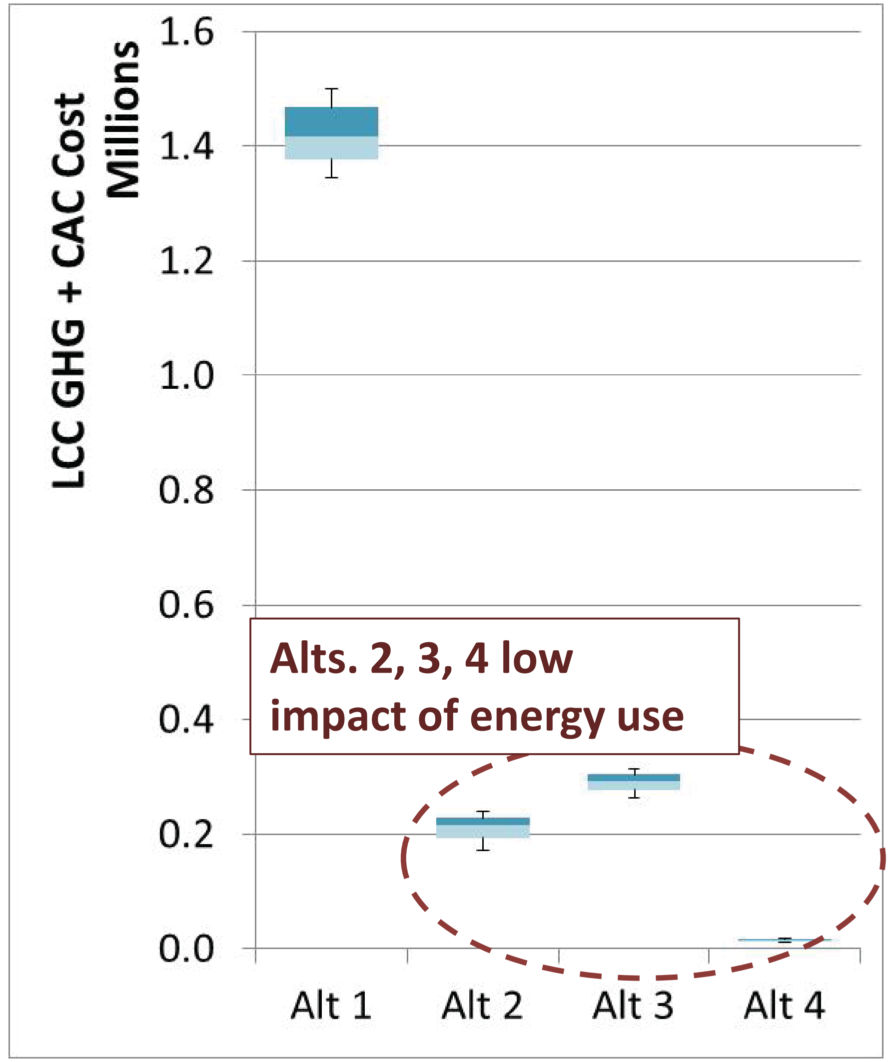
Total Life Cycle Cost Uncertainty

- Rank of life cycle costs similar to capital costs
- Alts 1 and 3 having highest, widest range
- Relatively higher operating costs for Alt 1 drive it to highest life cycle costs
- Alts 2 and 4 have lower and narrower cost ranges
- Alt 4 life cycle costs are likely to be lower than Alt 2
- Probability of Alt 4 having lowest life cycle costs is >99%
- Best value is Alt 4



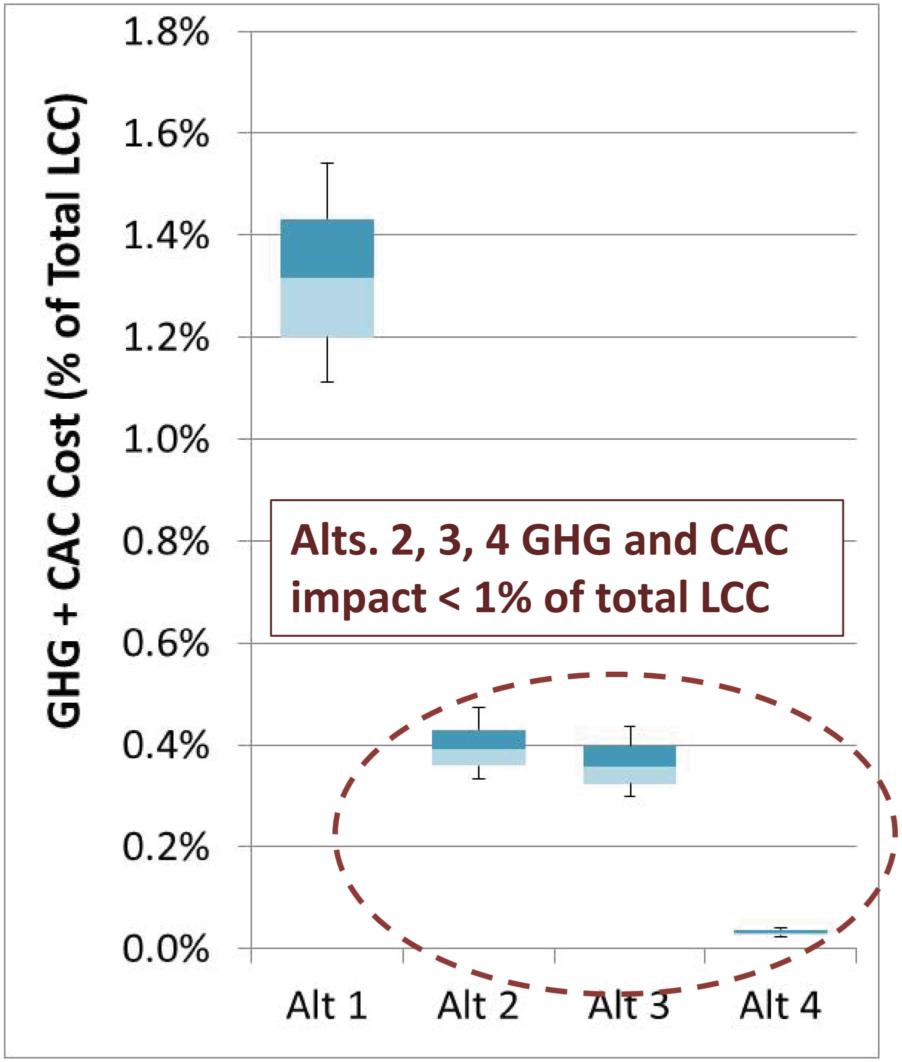
Life Cycle GHG, CAC Costs

- Alt 1 has widest and highest externality costs
- Alts 2 and 3 have next highest life cycle externality costs, but both are small
- Alt 4 has very low externality costs because of the low energy use



Life Cycle GHG, CAC Costs as a Percentage of Total Life Cycle Costs

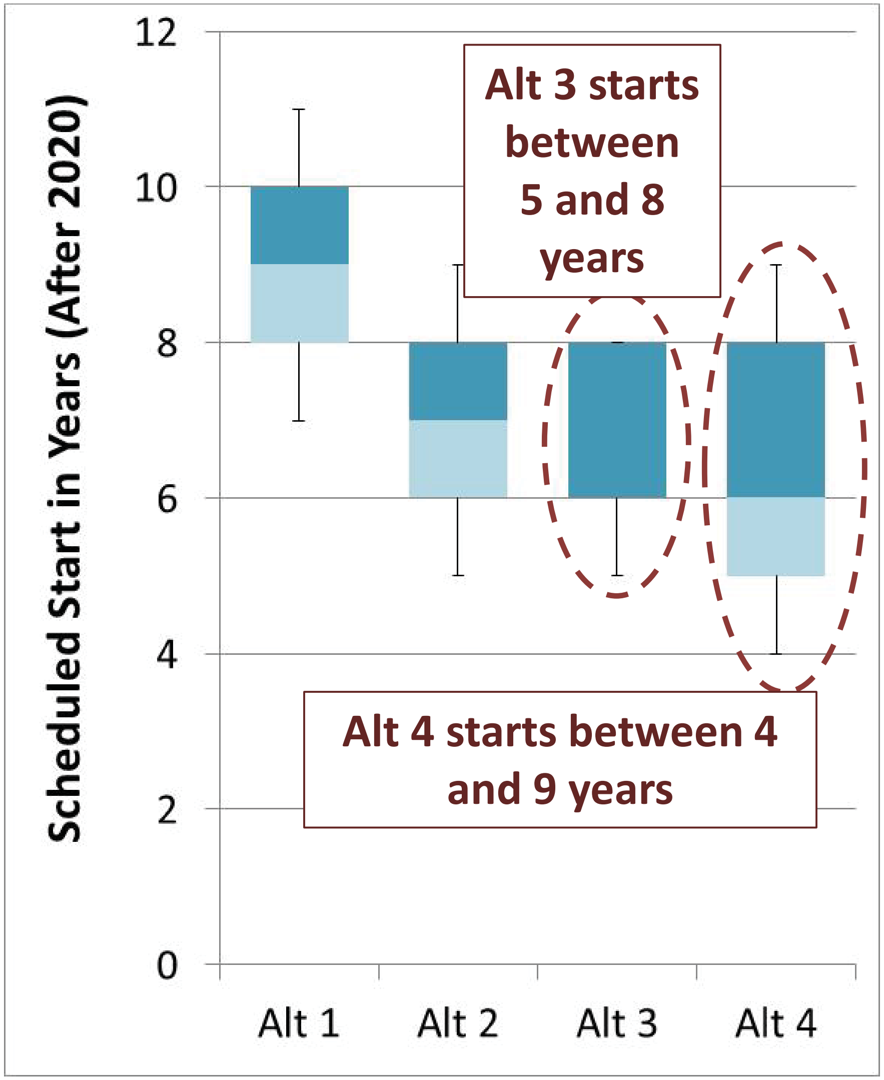
- Relative to financial life cycle costs (“LCC”), all GHG and CAC costs combined are small
- Alt 4 has the lowest LCC GHG and CAC relative to total financial LCC



Schedule

First Year of Operation Uncertainty

- Alt 1 would face longest delay in producing water
- Among Alt 2, 3, and 4, Alt 4 has best chance of generating water earlier than others, but also potential to be longest delay
- Alt 3 has best chance of producing water within 6 years and before 8 years



Appendix H
Quantitative Analysis Yield Ranges by Project

PBAC Water Supply Alternatives Yield Ranges by Project Supplemental Information

Project	Yield (MG) Low	Yield (MG) Expected	Yield (MG) High	Notes on Low and High Yield Assumptions [1] Low	Notes on Low and High Yield Assumptions [1] High	Notes on Probability Distribution	Additional Notes
Alternative 1 (Direct SW Use)							
Project 11 (Snake River - Pullman & Moscow)	1,575	1,967	2,360	8 months of diversion, as opposed to 10 months (Expected case).	12 months of diversion, as opposed to 10 months (Expected case).	Triangular. Endpoints defined by Low/High. Peak of triangle at Expected.	There is some uncertainty regarding Lower Granite Dam operations, and potential impacts upon available flows. However, no readily available data/means by which to estimate this. The Expected value assumes 2 months when withdrawals are not allowed, to preserve instream flows. The Low value assumes not enough upstream water rights are able to be purchased to support the Expected case. The High value assumes there are no instream flow restrictions.
Alternative 2 (Direct SW Use + ASR)							
Project 8 (North Fork Palouse River - Pullman & Moscow)	780	1,550	1,550	Only 4 months of diversion at 10 cfs available in dry years, as opposed to 8 months (Expected case). Based on hydrographs (details in Alternatives Description document).	Equal to Expected (i.e., little to no probability that available annual volumes will be greater than Expected). Also limited by design capacity of intake/treatment (10cfs).	Triangular. High endpoint defined by Expected/High. Peak of triangle starts at High. Low represents cumulative 10% point of triangle (i.e., there is a 10% chance flow are at Low or less). Bottom-line, much greater chance of the Expected/High value occurring, relative to the low.	The Low and Expected/High assume that up to 25% of flow in NF Palouse is available for diversion (per Phase 2 report).
Project 14 (ASR - Moscow) [S. Fork Palouse River as assumed surface water supply]	270	358	358	Based on 90% exceedance curve, which indicates ~5 cfs is available for 3 months, while maintaining 5 cfs in the South Fork Palouse (the assumed minimum flow to retain in stream, in the Phase 2 Report).	Equal to Expected, which is predicated on a 4-month diversion (Jan-Apr) of ~5 cfs while maintaining a minimum of 5 cfs in South Fork Palouse.	Triangular, based on: High point = Expected/High 25% chance of seeing Low or less 15% chance of seeing 0 cfs	It is possible during wet years for the design flow of 5 cfs to be available for more than 4 months, but the ASR well(s) design capacity is assumed to limit total volume to the Expected.
Alternative 3 (Storage and Direct SW Use)							
Project 16B (South Fork Palouse River - Pullman & WSU)	600	894	1,270	Based on 90% exceedance curve, which indicates 5 cfs is available for 3 months, while maintaining minimum flows (5-10 cfs) in stream during spring.	Additional amount available according to hydrographs (details in Alternatives Description document).	Triangular, based on: Absolute high end = 1270 High point of triangle (highest probability) = Expected 10% chance of seeing 600 cfs or less	Expected is based on amount needed to complement Flannigan Creek in meeting target, under Expected conditions.
Project 1 (Flannigan Creek Storage - Moscow & UI)	1,287	1,430	1,573	10% reduction in available flows assumed in drier years.	10% increase in available flows assumed in wetter years.	Triangular, based on: Absolute high end = High High point of triangle (highest probability) = Expected Absolute low end = Low	Expected is based on 8 months of supply at 5.9 mgd, which equals average annual yield of watershed (4400 af). No hydrologic data of Flannigan Creek watershed available to inform seasonable variability, so +/- 10% range utilized. Because of presence of storage, fluctuations expected to be minimal (i.e., absorbed in part by excess storage in reservoir).
Alternative 4 (ASR - Moscow, ASR - Pullman, Reuse - Pullman, Reuse/Recharge - Moscow, Add. Conservation)							
Project 35 (Reuse/Passive Recharge - Moscow)	0	420	462	Assumes, after further evaluation is conducted, that the project is not viable (infiltrated water will not be "recoverable", either physically or in terms of water rights).	10% increase in flow (above Expected) that can be infiltrated into aquifer and translated into recoverable quantity.	Triangular. Endpoints defined by Low/High. Shape is such that: • 50% chance of Low occurring • 10% chance of seeing values between Expected and High • 40% chance of seeing values between Low and Expected (with probability increasing the closer you get to Expected)	Least defined project. Most uncertainties and potential for fatal flaw. Model will assume project cost is reduced to $500,000 for those scenarios where fatal flaw occurs (i.e., feasibility study costs are incurred, but no construction costs).
Project X (Additional Conservation)	203	609	609	1/3 of Expected value, based on lower level of conservation achievable.	Equal to Expected (i.e., little to no probability that available annual volumes will be greater than Expected).	Triangular. Endpoints defined by Low/High. Peak of triangle (i.e., highest probability) starts at Expected/High.	
Project 14 (ASR - Moscow) [Paradise Creek as assumed surface water supply]	67	358	358	Based on 75% exceedance curve, which indicates ~2.5 cfs is available for 1.5 months, while maintaining 5 cfs in Paradise Ck. The Paradise Creek 90% exceedance curve is below 5 cfs (the assumed minimum flow to retain in stream, in the Phase 2 Report) for the entire year, indicating that no flow would be available for withdrawal in low-flow years.	Equal to Expected, which is predicated on a 4-month diversion (Jan-Apr) of ~5 cfs while maintaining a minimum of 5 cfs in Paradise Ck at the 50% exceedance.	Triangular, based on: High point = Expected/High 25% chance of seeing Low or less 15% chance of seeing 0 cfs	It is possible during wet years for the design flow of 5 cfs to be available for more than 4 months, but the ASR well(s) design capacity is assumed to limit total volume to the Expected.
Project 16 (ASR - Pullman)	358	358	358	The Expected level of flow is available in all years, based on hydropgraphs in Phase 2 report.	Equal to Expected, based on design capacity and assumptions in Alternatives Summary document.	Discreet. 100% of Expected.	See values/notes above regarding Project 16B, which is the direct diversion version of this project. The design capacity of this project is less than the Low value of Project 16B.
Project 20 (Reuse - Pullman)	118	148	148	20% reduction in available flows. Assumes all planned infrastructure is built (i.e., no change in distribution system costs), but fewer customers and/or usage realized.	Equal to Expected (i.e., little to no probability that available annual volumes will be greater than Expected).	Triangular. Endpoints defined by Low/High. Peak of triangle (i.e., highest probability) starts at Expected/High.	

(1) The "Expected" value for all projects is the "Estimated Annual Supply" (i.e., design value) noted in the Alternatives Description. Details/assumptions regarding the Expected values are in that document.

Appendix I
Memorandum – Water Supply Study Data Gaps and Information Needs for Next Steps

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Memorandum

March 15, 2017

To: Palouse Basin Aquifer Committee

From: Ben Floyd and Dave Rice, Anchor QEA; Jay Decker and Jeff Hansen, HDR Engineering

Re: Water Supply Study Data Gaps and Information Needs for Next Steps

This memorandum includes a definition and summary of data gaps and follow up activities applicable to the alternatives and associated projects analyzed in the multi-criteria evaluation process. Four alternatives were formulated to meet the 2065 supplemental supply target of 2,324 million gallons, which includes additional projected demand for Pullman, Moscow, University of Idaho (UI), and Washington State University (WSU), and a volume of water to offset groundwater declines in the basalt aquifer that typically occur with each year's irrigation season.

The four alternatives evaluated included:

- Alternative 1 – Snake River Diversion and Pipeline to Pullman and Moscow (Project 11)
- Alternative 2 – North Fork Palouse River Diversion and Pipelines to Pullman/Moscow (Project 8) plus Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow (Project 14)
- Alternative 3 – Flannigan Creek Storage, Conveyance to and Treatment for Moscow/UI (Project 1), plus South Fork Direct Diversion for Pullman/WSU (Project 16B)
- Alternative 4 – Paradise Creek Aquifer Recharge for Moscow (Project 14), South Fork Aquifer Storage and Recovery (ASR) for Pullman (Project 16), Pullman Wastewater Reuse (Project 20), and Moscow Wastewater Reuse and Groundwater Recharge (Project 35), plus additional conservation

Thirteen factors were considered in the evaluation of these alternatives, including both quantitative (e.g., capital and operations costs, yield variability) and qualitative (e.g., water quality impacts, permitting challenges) factors. The results from this evaluation concluded that Alternative 1 would be the most expensive but, if water rights could be secured, could provide the simplest and perhaps the longest-term reliable supply. Alternatives 2 and 4 provided better value than the others based on lower capital costs and lifecycle costs, and lower environmental impacts, recognizing neither alternative meets the 2065 target as reliably as the Alternatives 1 and 3. Between Alternatives 2 and 4, Alternative 2 is a better option overall, when considering not only cost and yield criteria, but also other evaluation criteria. It provides for 85% of the demand target through 2065, and also has opportunity for further refinements that could potentially further improve yield amount and reliability.

The Palouse Basin Aquifer Committee (PBAC) has requested next steps, including sequencing and timing of activities, be outlined for the alternatives, as each has merit for further consideration. This information is provided as follows.

Data Gaps and Additional Information Needs

For this evaluation, data gaps are defined as data or other information important to determining project feasibility that are not available. This is information that could lead to a fatal flaw or result in significant changes or refinements to analysis inputs that could translate into significantly different results. Data gaps in this context are missing information needed to support a decision about whether a project is feasible and should be pursued further or not.

Data gaps are different from additional project detail needed to further refine design of a project that has been determined, at least at a conceptual level, to be technically feasible (without an identified fatal flaw). In these cases, additional information can help further refine project elements and cost and improve understanding of expected project performance in meeting identified goals.

Based on the alternatives evaluation results, data gaps and additional information needs are identified in this memorandum for each alternative. Information needs, next steps, priority, and timing are provided for the projects included in each alternative. First, second and third priority items are identified, relative to the suite of actions identified for a specific alternative. This prioritization approach does not indicate second- or third- priority items are not important; all the actions would be important in the development of a project, if pursued, but the priority relates to timing and sequencing of these actions. First priority actions are those identified as the immediate next set of actions to be taken. Second priority actions are the next set of actions to pursue, followed by the third priority actions. Conducting public outreach is shown as a first priority action for all of the alternatives, along with other actions.

This information is followed by findings, recommendations, and suggested next steps for PBAC consideration, including a suggested timeline over the next 3 years.

Alternative 1 Project – Data Gaps and Information Needs

Data Gaps

For this project, physically diverting, treating, and conveying surface water from the Snake River to Pullman and Moscow appears feasible. What is in question is the feasibility of securing a water right and other regulatory approvals that would allow this project to move forward. If PBAC were to pursue this project, at least two data gaps would need to be addressed, including:

- Surface water rights – It would need to be determined if there is an ability to secure a new Washington or Idaho Snake River surface water right, or secure and transfer an existing

Washington or Idaho Snake River surface water right with instantaneous and annual quantities needed to meet the demand target. Confirming the expected cost range for water rights acquisition will also be important.

- Endangered Species Act (ESA) and other permitting approvals – Even if a water right with sufficient instantaneous and annual quantities was available, it would need to be determined if a new diversion and withdrawal on the Snake River at the desired diversion location would successfully be granted the ESA and other permitting approvals needed to construct the diversion and withdraw the water.

It is recommended that additional work be done on addressing these data gaps prior to moving forward with second or third priority activities outlined in Table 1.

Information Needs

Table 1 includes additional information needs for the Snake River Diversion and Pipeline to Pullman and Moscow project.

Table 1
Alternative 1, Project 11 – Snake River Diversion and Pipeline to Pullman and Moscow

Activity	Current Status	Next Step	Relative Priority (1, 2, 3)
Concept refinement: intake, piping/routing, and treatment facility locations to optimize capital and operating costs	Less than 5%	10% design	2
Opportunities for generating electricity via turbines on water conveyance downhill sections to potentially offset lifting costs and reduce pressure requirements	Not yet evaluated	Evaluate	2
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	2
Cost estimate	Initial estimate developed	Update with refined design info	2
Long-term operating costs	Initial estimate developed	Update with refined design info	2
Distribution system water quality evaluation for mixing surface water with groundwater supply	Not evaluated	Evaluate	3
Potential climate change constraints	Not evaluated	Evaluate	2
Identify environmental impacts and constraints	Very preliminary evaluation	Evaluate	1
Permitting and mitigation strategy	Not developed	Develop	1
Water rights permitting strategy	Not developed	Develop	1
Develop financing plan and secure funding	Not developed	Develop	3
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	3
Implement strategy	Not developed	Develop	3

Alternative 2 Projects – Data Gaps and Information Needs

Data Gaps

For this alternative, physically diverting and conveying surface water from the North Fork Palouse River to Pullman and Moscow appears feasible. What is in question is the feasibility of treating diverted water during higher runoff periods, and considering the duration and frequency of turbidity events, if treatable water is available in sufficient quantities to warrant the investment of intake, treatment, and conveyance facilities. Better understanding of water right conditions and constraints would also be important prior to additional design activities, recognizing the analysis has been conducted with the assumption that such a water right could likely be secured.

If PBAC were to pursue this project, at least the following data gaps would need to be addressed, including:

- Surface water treatability – What is the typical timing, frequency, and duration of surface water turbidity events that would prevent water diversion, and would there still be sufficient water available during the targeted late fall, winter, and spring diversion time period and at the expected diversion rates to meet the targeted amount?
- Surface water rights – Is there an ability to secure a new Washington or Idaho surface water right with instantaneous and annual quantities needed to meet the demand target, and what are the likely conditions to accompany such a right?
- Evaluate water availability and average day demand in Moscow, Pullman, WSU, and UI, during the targeted diversion period, and how that relates to the amount of water projected to be available for diversion. This evaluation should address whether the cities and universities would be able to rely completely on surface water, or whether they would also need to pump groundwater for a significant part of winter or include a storage component to make this alternative more viable.
- Determine what impacts, if any, might be expected in City and University water distribution systems if surface water (with a different chemical composition from groundwater) is placed into systems that have only conveyed Palouse Basin groundwater. This would include comparing historical groundwater quality data collected by each entity with water quality for the North Fork Palouse surface water.
- Outline options for a regional organization to develop and operate a regional water system with authorities, responsibilities, timelines, estimated costs to develop and other elements. The findings from this effort would also be applicable to Alternatives 1 and 3.

Additionally, opportunity exists for refining this project concept. A proposed variation is to consider whether additional water might be available for withdrawal during higher flow periods then conveyed, treated, and stored in-ground through aquifer recharge, utilizing the North Fork Palouse River system that is proposed. This could potentially be an additional project component, or as a substitute for the second part of the aquifer recharge alternative. Also, other piping alignments could be considered such as an alignment along an existing railroad right-of-way. It is recommended that additional work be done to address these data gaps and further project refinement prior to moving forward with the activities to better define the more specific project elements, as identified in the following tables.

Information Needs

Tables 2A and 2B include information for the two projects comprising Alternative 2 – North Fork Palouse River Diversion and Pipelines to Pullman and Moscow, and Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow.

Table 2A
Alternative 2, Project 8 – North Fork Palouse River Diversion and Pipelines to Pullman/Moscow

Activity	Current Status	Next Step	Relative Priority (1, 2, 3)
Concept refinement: intake, piping/routing, and treatment, and opportunity for integration with aquifer recharge[1]	Less than 5%	10% design	2
Refined runoff, yield estimates, and evaluation of gaging data	Basin scale evaluated	Evaluate at point of diversion	1
Surface water quality constraints, turbidity limiting diversion during storm events, and high runoff periods	Not yet evaluated	Evaluate	1
Opportunities for generating electricity via turbines on water conveyance downhill sections to potentially offset lifting costs and reduce pressure requirements	Not yet evaluated	Evaluate	2
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	2
Cost estimate	Initial estimate developed	Update with refined design info	2
Long-term operating costs	Initial estimate developed	Update with refined design info	2
Distribution system water quality evaluation for mixing surface water with groundwater supply	Not evaluated	Evaluate	3
Potential climate change constraints	Not evaluated	Evaluate	2
Identify environmental impacts and constraints	Very preliminary evaluation	Evaluate	2
Permitting and mitigation strategy	Not developed	Develop	2
Water rights permitting strategy	Not developed	Develop	1
Develop financing plan and secure funding	Not developed	Develop	2
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1

Activity	Current Status	Next Step	Relative Priority (1, 2, 3)
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	2
Implement strategy	Not developed	Develop	3

Note:

1. Look at variation of water supply benefits from diverting additional flow beyond the assumed amount when available, and using this water for aquifer recharge/aquifer storage and recovery, as an additional project component, or as a substitute for the second part of this alternative, Project 14, described in Table 2B. This could also save from potentially having two surface water treatment plants.

Table 2B
Alternative 2, Project 14 – Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow

Activity	Current Status	Next Step(s)	Relative Priority (1, 2, 3)
Concept refinement: intake, piping/routing, and treatment, and aquifer recharge project	Less than 5%	10% design	2
Refined runoff, yield estimates, and evaluation of gaging data and identification of preferred point of diversion	Basin-scale – limited evaluation	Evaluate and select point of diversion	2
Address the following: • Recovery efficiency objectives • Is riverbank filtration feasible to help manage turbidity and reduce overall treatment costs? • ID target aquifer and its characteristics with drilling/testing or evaluation of existing wells; using this information, evaluate site-specific well and aquifer storage zone characteristics • Develop treatment and permitting path forward	Limited evaluation	Siting study: locations, sediment permeability sampling, background GW water quality assessment, and infiltration system pre-design Source (post-treatment) WQ projection, background GW WQ, geochemical compatibility analysis, anti-degradation assessment, AKART	2
Surface water quality constraints, turbidity limiting diversion during storm events, and high runoff periods	Not yet evaluated	Evaluate	1
Opportunities for generating electricity via turbines on water conveyance downhill sections to potentially offset lifting costs and reduce pressure requirements	Not yet evaluated	Evaluate	2

Activity	Current Status	Next Step(s)	Relative Priority (1, 2, 3)
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	2
Cost estimate	Initial estimate developed	Update with refined design info	2
Long-term operating costs	Initial estimate developed	Update with refined design info	2
Distribution system water quality evaluation for mixing surface water with groundwater supply	Not evaluated	Evaluate	3
Potential climate change constraints	Not evaluated	Evaluate	2
Identify environmental impacts and constraints	Very preliminary evaluation	Evaluate	2
Permitting and mitigation strategy	Not developed	Develop	2
Water rights permitting strategy	Not developed	Develop	1
Develop financing plan and secure funding	Not developed	Develop	2
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	3
Implement strategy	Not developed	Develop	3

Notes:
AKART: All Known, Available, and Reasonable Technologies
GW: groundwater
WQ: water quality

Alternative 3 Projects – Data Gaps and Information Needs

Data Gaps

For this alternative, the feasibility of a Flannigan Creek storage site will help determine whether it is warranted to pursue additional next steps under this alternative.

If PBAC were to pursue this project, at least three information needs should be addressed, including:

- Surface water storage – Conduct general geotechnical evaluation of potential dam location to verify stable foundational soil conditions.
- Property acquisition – It should be determined if there are landowners potentially willing to sell the property needed for a dam location and for water conveyance right-of-way. Property ownership should be evaluated and landowners contacted to determine if they are open to discussing sale of property or providing an easement, as applicable.
- Surface water right – It should be determined if there is an ability to secure a new surface water right with instantaneous and annual quantities needed to meet the supplemental supply target, as well as the likely conditions to accompany such a right.

It is recommended that additional work be done on addressing these data gaps prior to moving forward with other activities to better define the more specific project elements, as identified in the following tables.

Information Needs

Tables 3A and 3B include information for the two projects comprising Alternative 3 – North Fork Palouse River Diversion and Pipelines to Pullman and Moscow, and Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow.

Table 3A
Alternative 3, Project 1 – Flannigan Creek Storage, Conveyance to and Treatment for Moscow/UI

Activity	Current Status	Next Step	Relative Priority (1, 2, 3)
Concept refinement: dam storage facility and location, piping/routing and treatment, and opportunity for integration with aquifer recharge	Less than 5%	10% design	2
Refined runoff, yield estimates, and evaluation of gaging data	Basin-scale –evaluated	Evaluate at point of diversion	2
Surface water quality constraints, turbidity limiting diversion during storm events, and high runoff periods	Not yet evaluated	Evaluate	2
Opportunities for generating electricity via turbines on water conveyance downhill sections to potentially offset lifting costs and reduce pressure requirements	Not yet evaluated	Evaluate	2
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	1
Cost estimate	Initial estimate developed	Update with refined design info	2
Long-term operating costs	Initial estimate developed	Update with refined design info	2
Distribution system water quality evaluation for mixing surface water with groundwater supply	Not evaluated	Evaluate	3
Potential climate change constraints	Not evaluated	Evaluate	2
Identify environmental impacts and constraints	Very preliminary evaluation	Evaluate	2
Permitting and mitigation strategy	Not developed	Develop	2
Water rights permitting strategy	Not developed	Develop	1
Develop financing plan and secure funding	Not developed	Develop	3
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners at potential dam location and along potential alignment for right-of-way acquisition	Not developed	Develop	1
Implement strategy	Not developed	Develop	3

Table 3B
Alternative 3, Project 16B – South Fork Direct Diversion for Pullman/WSU

Activity	Current Status	Next Step(s)	Relative Priority (H, M, L)
Concept refinement: intake, piping/routing, and treatment, and aquifer recharge project	Less than 5%	10% design	2
Refined runoff, yield estimates, and evaluation of gaging data and identification of preferred point of diversion	Basin-scale – limited evaluation	Evaluate and select point of diversion	2
Surface water quality constraints, turbidity limiting diversion during storm events, and high runoff periods	Not yet evaluated	Evaluate	1
Opportunities for generating electricity via turbines on water conveyance downhill sections to potentially offset lifting costs and reduce pressure requirements	Not yet evaluated	Evaluate	2
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	2
Cost estimate	Initial estimate developed	Update with refined design info	2
Long-term operating costs	Initial estimate developed	Update with refined design info	2
Distribution system water quality evaluation for mixing surface water with groundwater supply	Not evaluated	Evaluate	3
Potential climate change constraints	Not evaluated	Evaluate	2
Identify environmental impacts and constraints	Very preliminary evaluation	Evaluate	2
Permitting and mitigation strategy	Not developed	Develop	2
Water rights permitting strategy	Not developed	Develop	1
Develop financing plan and secure funding	Not developed	Develop	3
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	3
Implement strategy	Not developed	Develop	3

Alternative 4 Projects – Data Gaps and Information Needs

For this alternative, the same activities and associated timing and sequence for the Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow as described for Alternative 2 also apply. Additionally, much is known about the Pullman Wastewater Reuse project, as a 30% design report has been developed, describing this project in greater detail than any other project included in the alternatives.

This alternative, however, is different from the others in that there are significant questions about the feasibility of Project 35, Moscow Wastewater Reuse and Groundwater Recharge, and whether the concept could work. Tables 4A to 4C include information for the three projects and increased conservation measures comprising Alternative 4 –Paradise Creek or South Fork Palouse Aquifer Recharge for Moscow (see above); Pullman Wastewater Reuse; Moscow Wastewater Reuse and Groundwater Recharge; and Additional Conservation. Data gaps for Moscow Wastewater Reuse and Groundwater Recharge are also provided prior to Table 4B.

Additional conservation under this alternative has been identified as a way to partially meet the additional supply needs. Achieving the 15% reduction in water usage on top of the measures in place or planned by the cities and universities to meet current conservation goals would require some fundamental regional changes in landscaping and associated irrigation practices. Public involvement planned for the four alternatives should include receiving input from the public on interest and openness to fundamentally changing the way landscape irrigation is currently conducted.

Table 4A
Alternative 4, Project 20 – Pullman Wastewater Reuse

Activity	Current Status	Next Step	Relative Priority (1, 2, 3)
Complete 60%, 90%, and final design, addressing capacity and feasibility of water reclamation facility	30% design	60% design	3
Routing to specific properties for landscape irrigation/refined locations and demands for reuse site	30% design	60% design	3
Construction cost estimate	Initial estimate developed	Update with refined design info	3
Long-term operating costs	Initial estimate developed	Update with refined design info	3
Environmental review and permitting	Preliminary evaluation	Conduct environmental review and prepare permitting	3
Develop financing plan and secure funding	Funding request developed based on 30% design	Evaluate additional options for funding, if project pursued	3
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	3

Data Gaps

This project is different from the others in that there are significant questions about the feasibility of this project, and whether the concept could work. If PBAC were to pursue this project, several data gaps would need to be addressed, including:

- Sediment vertical permeability in the project area – This is directly proportional to the infiltration rate and infiltration facility size and could be low enough to make infeasible.
- Flow top weathering in project area – If the top of Wanapum is weathered to clay, or has clay-infilled fractures, this portion of the subsurface could exhibit lower vertical permeability than the overlaying sediments, inhibiting water migration downward into the basalt.
- Flow interior fracturing – If the flow interior/entablature of the upper Wanapum flow does not have significant fracture or joint permeability, then vertical water movement could be extremely limited.
- Uppermost interflow depth, saturation, thickness, permeability (with respect to air), and chemical composition – If infiltrated water is to be recovered, a recovery well or wells would most likely be installed in the uppermost zone that becomes saturated with infiltrated water. The mechanism for how and where this water could enter the existing saturated portion of the confined aquifer is increasingly complex with depth and then number of unsaturated interflows. Characterizing the uppermost interflow is needed to assess the following:
  - Whether groundwater is present, or if the infiltration would fully saturate this zone
  - Whether water would begin to migrate laterally before fully saturating the zone, leading to saturated/unsaturated wetting and drying conditions that encourage biological growth
- Geochemical composition of sediments, clays, or fracture-lining minerals – To assess the potential for undesirable changes in infiltrated water quality in a zone not currently in chemical equilibrium with a stable groundwater.

Additional information needs for the project beyond the data gaps above are described in Table 2B.

Table 4B
Alternative 4, Project 35 – Moscow Wastewater Reuse and Groundwater Recharge

Activity	Current Status	Next Step	Relative Priority (H, M, L)
Hydrogeologic conditions for infiltration locations: • Review background groundwater quality. • Would alternative benefit (i.e., indirect recovery) be possible to make recharge appear more feasible? • Conduct groundwater quality impact assessments for alternatives with groundwater recharge components involve a complete source water characterization needed to complete geochemical compatibility and recovered water quality projections. • Discern the number of wells needed to establish hydraulic control, containment, and recoverability of infiltrated water.	Not yet evaluated	Conduct study to address	TBD
Concept refinement: intake, piping/routing/wastewater treatment to Class A standards	Less than 5%	10% design	TBD
Power extension requirements	Not yet evaluated	Evaluate	3
Geotechnical assessment	Not yet evaluated	Evaluate	3
Accessibility of property and easements	Not yet evaluated	Evaluate	3
Cost estimate	Initial estimate developed	Update with refined design info	3
Long-term operating costs	Initial estimate developed	Update with refined design info	3
Potential climate change constraints	Not evaluated	Evaluate	3
Permitting and mitigation strategy	Not developed	Develop	3
Develop financing plan and secure funding	Not developed	Develop, if data gaps resolved and project pursued	TBD
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Outreach to landowners along potential alignment for right-of-way acquisition	Not developed	Develop	3
Implement strategy	Not developed	Develop	3

Table 4C
Alternative 4 – Additional Conservation

Activity	Current Status	Next Step	Relative Priority (H, M, L)
Develop plan to achieve targeted percent of conservation savings	Water conservation plans identify measures	Identify additional measures and strategies to achieve targeted conservation savings	2
Develop strategy for additional funding, if needed	Not developed	Evaluate additional options for funding, if additional conservation pursued	2
Develop and implement strategy for sharing concept with public and receiving public input	Not developed	Develop	1
Implement strategy	Not developed	Develop	3

Next Steps

As described above, each alternative would benefit from some additional analysis and follow up work that would strengthen and further refine the evaluation results. Accordingly, the activities summarized in Table 5 are identified as first priority actions.

Table 5
First Priority Actions

Alternative	Action	Description
Alternative 1	Water Rights	For the Snake River, potential water rights for acquisition should be researched in both Idaho and Washington, in coordination with IDWR and Ecology. Identify the top 2 or 3 options and refine the estimated purchase costs, and outline the steps and timeline for acquiring and transferring the point of diversion location. Recommend meeting with Ecology's Office of Columbia River to see if the programs administered under this office could help in securing water supply.
	ESA/Permitting – Preliminary Meetings	In parallel with evaluating water right acquisition opportunities, hold preliminary discussions with NMFS, USFWS, and USACE on the likely ESA and associated environmental review/permitting steps and timeline.
Alternative 2	Water Rights	Many of the water rights evaluation process steps for the North Fork Palouse River and Flannigan Creek are common and can be applied to both projects, with additional evaluation of existing water rights, potential impairment considerations, and recommended water availability periods for both project locations. Work on this evaluation should also identify the steps and likely timeline for securing a water permit.
	Surface Water Treatability	Conduct a study evaluating existing water quality data collected in both Idaho and Washington during the proposed diversion period, and identify the frequency and duration of events where turbidity would prevent effective treatment of drinking water. Summarize findings and results.
	Evaluate North Fork Palouse Flows for Groundwater Recharge Potential	Evaluate whether additional water might be available for withdrawal during higher flow periods then conveyed, treated, and stored in-ground through aquifer recharge utilizing the proposed North Fork Palouse River system. Update project description.
Alternative 3	Explore Property Acquisition Potential for Flannigan Creek	Evaluate property ownership and meet with landowners to determine if any potential issues might exist for acquiring property.
	Water Rights	See Alternative 2 description of actions.

Alternative	Action	Description
All Alternatives	Develop Public Involvement Strategy and Plan	Incorporate study's findings into the PBAC communication action plan strategies, tactics, and timelines to better engage the public, communities, and stakeholders. As part of receiving stakeholder input, seek specific input on the supply study analyses, formulated alternatives, and findings from those knowledgeable on the Palouse Groundwater Basin, including individuals at the universities and others with expertise in groundwater, surface water, water quality, and related topics.
	Brief Elected Officials	Share report findings, recommended actions, and next steps. Keep officials updated as actions are completed.
	Develop Regional Organization Approach	Begin to outline elements of a regional agreement for applicable alternatives, including defining participants, roles and responsibilities, decision-making structure, and other elements.
	Update Multi-criteria Evaluation	Using the information from the actions listed above, update the evaluations for each of the alternatives.
	Develop Implementation Plan	Develop an implementation plan that confirms first, second, and third priority actions and includes additional detail on next steps, timing, and sequencing of activities.

Notes:
Ecology: Washington State Department of Ecology
ESA: Endangered Species Act
IDWR: Idaho Department of Water Resources
NMFS: National Marine Fisheries Service
USACE: U.S. Army Corps of Engineers
USFWS: U.S. Fish and Wildlife Service