EXECUTIVE SUMMARY

The City of Bozeman (City) has experienced varied population growth and anticipates that growth will continue in the future. The future growth trend of Bozeman is uncertain; however, the City recognizes that it possesses a finite supply of water that could potentially be surpassed as the demand for water increases with community growth. The City is located in a closed basin with respect to water rights, and existing water supplies relied upon by the City are susceptible to the impacts of drought and climate change, which could limit the availability of water on a seasonal or annual basis. Based on these concerns, the City retained Advanced Engineering and Environmental Services, Inc. (AE2S) and CH2M Hill to complete an Integrated Water Resources Plan (IWRP) that could conceivably address the water supply requirements over the next 30 to 50 years corresponding to planning horizons of 2042 and 2062.

The work completed for the IWRP consisted of identifying the existing water rights of the City and comparing them to future water demands that could be experienced in relation to community growth, climate change, and other factors. The comparison resulted in the ability to estimate the water balance gap that may occur in the future, which could also be defined as the amount of water needed to meet increasing demands. Based on a range of possible population growth trends, which are presented in Table EX-1, the estimated water balance gap for the planning horizons varies from approximately 2,000 to 18,000 acre-feet, and is presented in Table EX-2. Depending on population growth and the corresponding use of water, estimates indicate that the City could experience a water balance gap under a timeline of 2025 to 2030, as the population approaches approximately 57,000, if new water supply capacity development and/or water demand reductions are not implemented. The range of possibilities prompted the development of the IWRP under an approach that is relatively flexible and capable of being adapted as the City monitors the validity of assumptions and planning values used in the IWRP and updates the information to address actual future conditions.

Table EX-1: Moderate and High Growth Population Projections

Item Description	2012	2042	2062
Moderate Population Projection (2%/yr for 30-years, 1%/yr for next 20-yrs)	38,786	70,256	85,725
High Population Projection (3%/yr for 30-years, 2%/yr for next 20-yrs)	38,786	94,144	139,900

Table EX-2: Estimated Climate Adjusted Annual Water Balance Gap

Item Description	2042	2062	2042	2062
	Moderate Growth		High Growth	
Annual Water Demand (acre-feet/year)	13,500	17,790	17,900	28,700
Annual Firm Yield Supply (acre-feet/year)	11,237	10,948	11,237	10,948
Water Balance Gap (acre-feet/year)	**2,263**	**6,842**	**6,663**	**17,752**

Alternatives involving water conservation measures and concepts to increase the available water supply capacity were identified to meet the estimated water balance gap. Water conservation was given substantial consideration and credibility in the development of the IWRP as a strategic near-term initiative to be implemented by the City to reduce the rate of demand for water by its user classes. Monthly water demands, which serve as the basis for estimating the effectiveness of various water conservation measures, are presented in Table EX-3. The monthly water demand information also indicates the potential viability of other alternatives, such as non-potable irrigation, to meet seasonal (outdoor) demands.

The alternatives were initially screened with respect to a water rights legal assessment and qualitative criteria that were developed with assistance from the Technical Advisory Committee (TAC), which was created by the City to review documentation and provide stakeholder perspective at critical milestones. The alternatives selected through the water rights and

Table EX-3: Historical Indoor and Outdoor Water Use by Month

Month	Indoor Water Use	Outdoor Water Use	Total Water Use
January	106	0	106
February	112	0	112
March	109	0	109
April	109	0	109
May	116	50	166
June	117	87	204
July	118	190	308
August	122	176	298
September	115	107	222
October	129	0	129
November	110	0	110
December	106	0	106
Average Annual Water Demand			**165**

Note: Values presented in units of gallons per capita per day (gpcd)

qualitative screening processes were then combined in strategic ways to create 13 different portfolios. A life-cycle cost analysis was completed using the VOYAGE™ model and specific information developed for each of the portfolios. Cost estimates generally included capital and operating cost elements over the 50-year planning horizon. Resulting life-cycle costs reported are comparative and provided at a conceptual level, and estimates may not include all necessary costs for implementation.

The individual portfolios, which included varying levels of demand reduction via water conservation program implementation, were developed to meet the estimated water demands related to the moderate growth projections or the high growth projections. The alternatives comprising the portfolios were prioritized for implementation to achieve a balance between the demand and the available supply of water, such that the timing of alternatives could be completed to meet short-term and long-term demand requirements.

Upon review of draft life-cycle cost analysis results, the TAC expressed interest in the development of an additional portfolio comprised of a more comprehensive list of alternatives to meet the high population growth scenario. Given the conceptual level of effort to generate the portfolios, City representatives also introduced the possibility of initiating parallel efforts that would build on the results of the IWRP and provide more precise information to better define the implementation requirements for the alternatives. Consequently, an additional portfolio (Portfolio 14) was created and evaluated using the VOYAGE™ model.

The estimated comparative net present value of Portfolio 14 is approximately $148 million, compared to a range of $113 million to $296 million for high growth scenarios, and is constructed to meet high growth demands on a monthly basis. Despite a modestly higher cost per unit of annual water volume provided, Portfolio 14 offers increased value as compared to the other portfolios developed to meet the high population growth scenario, based on several criteria developed by the TAC, staff, and the consultant team collaboratively. Portfolio 14 also represents a more diverse range of scalable options and provides increased flexibility and resiliency to the City with respect to changing conditions and uncertainty in the future. Based on this refined input, Portfolio 14 was tested as the basis for an IWRP strategy to be implemented by the City to meet a range of future growth scenarios through the 2042 and 2062 planning horizons:

- Initiating a water conservation program that considers the success of various conservation measures, public acceptance, and a comparison of cost with respect to water supply capacity development with the goal of meeting low to medium water demand reduction targets.
- Adding storage in Sourdough Canyon or Hyalite Reservoir via an infrastructure project to improve current withdrawals and treatment plant operations.
- Developing groundwater system capacity in the Gallatin Gateway area or other appropriate location to meet demand on an as-needed basis.
- Strategically purchasing shares from Hyalite Reservoir and senior surface water rights from Hyalite Creek and Sourdough Creek to obtain water in the near-term.

- Developing non-potable irrigation for new developments on an incremental basis.
- Optimizing the capacity of the Lyman Creek water source.
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The future water needs of the City of Bozeman will depend on future conditions, such as the rate of population growth, impacts of climate change, success of the City's water conservation program, availability of useful water rights, and other conditions that are not completely predictable. The IWRP was developed in recognition that future decisions by the City will be made in the context of these conditions as they evolve, and the IWRP is intended to be flexible enough to account for the conditions and contingencies created by these evolving conditions. The following recommendations were developed to represent a logistical strategy for the City to proceed in fulfilling the objectives of the IWRP:

Near-Term

- Implementation of Portfolio 14 should proceed with a robust economic and engineering feasibility analysis for each of the portfolio components, followed by a comparative analysis of the components based on the screening assessment framework established by the IWRP. These steps provide a sound basis for prioritized decision-making by the City of Bozeman regarding its water resource management.
- Incorporate the implementation of Portfolio 14 into the City of Bozeman Capital Improvement Planning budget such that anticipated costs are budgeted well into the future.
- A water conservation plan should be prioritized for implementation to reduce the rate of demand for water as a substantial contribution toward addressing the water balance gap identified for the 2042 and 2062 planning horizons.
- The installation of stream flow monitoring equipment in the watersheds should be implemented to provide useful information to the City for the purpose of assessing climate change impacts and better manage its water resources moving forward.
- Implementation of strategies to improve the capture efficiency of water requested and released from Hyalite Reservoir, such as reducing or potentially eliminating the conveyance efficiency factor and providing increased raw water and/or finished water storage.
- The formal application process with the DNRC should be initiated to secure water rights that are currently available to the City totaling approximately 6,750 acre-feet of water an annual basis. This value does not reflect a historical use analysis that will be conducted for any change applications, and should be noted to avoid any mistaken expectations about the amount of water that is potentially available.
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- Shares from Hyalite Reservoir and senior surface water rights from Hyalite Creek and Sourdough Creek should be purchased to the extent possible.

Long-Term

- Water supply and demand trends should be monitored to assess the need for additional water supply capacity development.
- Revisit population growth trends every 5 years, or on a more frequent interval if necessary.
- Additional water supply capacity should be developed by the City in accordance with the outcome of subsequent efforts to evaluate alternatives in more detail and planning objectives that will evolve with actual population growth and water demand trends.