OREGON WATER RESOURCES DEPARTMENT

2022 SOLICITATION

FEASIBILITY STUDY GRANTS

GRANT APPLICATION

APPLICATION DEADLINE: BY 5:00PM ON NOVEMBER 2, 2022

Application must be received by this date and time

Send application electronically to: WRD_DL_feasibilitystudygrants@water.oregon.gov

Mail application to:

OREGON WATER RESOURCES DEPARTMENT
Attention: Grant Program Coordinator
725 Summer Street NE, Suite A
Salem, OR 97301

APPLICATION SUBMISSION INSTRUCTIONS

1. **When completing your application, use the** Application Instructions available at the OWRD Funding Opportunities, Applications, Forms, and Guidance webpage: https://www.oregon.gov/owrd/programs/FundingOpportunities/FeasibilityStudyGrants/Pages/Forms.aspx

2. Complete all sections in the spaces provided. An application must be submitted on the attached form provided by the Department. An explanation must accompany the application if any of the information required cannot be provided [OAR 690-600-0020(6)].

3. Please ensure that the Certification portion of Section II is signed with a live signature by the Applicant and, if applicable, the Co-Applicant.

4. Taking part in a Pre-Application Conference prior to applying is ***highly*** recommended. The pre-application conference request form is available on the OWRD Funding Opportunities Forms webpage. To learn more contact the Department.

5. Complete and sign the application checklist.

6. Electronic submission of application is the preferred method. You may scan a copy of the signed signature page and submit with your application if both documents are included in the same email.

7. If application is submitted in hard copy - use 8 ½" x 11" single sided, unstapled pages. Provide any attachments to the application on 8 ½" x 11" single-sided, unstapled pages.

8. Contact the Department at 971-301-0718 or WRD_DL_feasibilitystudygrants@water.oregon.gov if you have any questions.

FEASIBILITY STUDY GRANT APPLICATION CHECKLIST

Instructions: Use this checklist to ensure that your application is complete. An incomplete application will not be eligible for further review and consideration. <u>This checklist must be completed and signed in order for your application to be considered complete.</u>

<u>SECTION A - Application</u>

I. Study Information
- ☒ Study name and type(s) is complete and correct.
- ☒ The requested grant amount and previous Feasibility Study Grants for the study do not exceed $500,000.
- ☒ The requested grant amount does not exceed 50% of the Total Cost of the Study.

II. Applicant Information
- ☒ All applicant and co-applicant name(s) and contact information is complete and correct.
- ☐ Application is signed by Applicant/Authorized Person.
- ☐ Application is signed by Co-Applicant/Authorized Person *OR* there is no co-applicant.

Note: *If the project is awarded funding the co-applicant will be required to sign and be party to the grant agreement.*

III. Study Location
- ☒ All questions have been addressed.
- ☒ Site plan map is attached.

IV. Feasibility Study Summary
- ☒ A brief (4-5 sentence) summary of the feasibility study and goal is included.

V. Feasibility Study Grant Specifics
- ☒ All questions have been addressed.
- ☒ Study tasks are identified.

VI. Feasibility Study Budget
- ☒ All tasks and budget items follow the Department's Budget Procedures and Allowable Costs guidance available on the OWRD Funding Opportunities Forms webpage.
- ☒ All budget information is accurate and complete.
- ☒ Administrative costs do not exceed 10% of total Grant Request.
- ☒ Tasks listed in budget match those identified in Questions 15 and 16.

VII. Match Funding Information
- ☒ Matching Funds total, at a minimum, 50% of the Total Cost of the Feasibility Study.
- ☒ Match fund letters, indicating pending or secured match, are attached and equal the amounts listed in VI. Feasibility Study Budget.

VIII. Storage-Specific Questions
- ☐ All questions have been addressed *OR* the application is not for a storage project.
- ☒ Minimum Storage Specific Study Requirements are met and are incorporated into the study and tasks.

SECTION B - Application Attachments

Instructions: Use this checklist to ensure required attachments are included with your application. **All attachments to the application must be numbered** as well as included in this list. For all attachments ensure documentation meets any criteria identified in the application instructions, Storage-Specific Guidance, and Guidance on Budget Procedures and Allowable Costs. For "other" optional attachments in excess of the three spaces provided, include a supplemental list.

Required Attachments:

☒ Attachment 1 – Site map (Question 3)

☐ Attachment 2 – Signed Landowner Agreement Forms (Question 5) to verify that you have authorized access to the lands on which the study would occur.

☒ Attachment 3 – Documentation of matching funds (Question 23) includes the following:

a) Match documentation for all match fund sources listed in the match fund table.

b) Match fund documentation that clearly identifies the dollar amount and describes the work to be accomplished with the match.

☒ Attachment 4 *(Select Storage Projects Only: if you answered "yes" to any part of Question 24)* – Description of approach to address storage-specific requirements; see the Storage-Specific Study Requirements: Application Guidance for the minimum requirements.

Optional Attachments:

☐ Letters of support (Question 14): Attachment #

☐ List and description of tasks (Question 15): Attachment #

☐ Secured permits and regulatory approvals needed to implement the study (Question 19): Attachment #

☒ Other: Initial Feasibility Evaluation of ASR Attachment # 5

☐ Other: Attachment #

☐ Other: Attachment #

All required items within Section A and B of the application checklist are completed and all identified criteria are addressed to the best of my knowledge.

Signature of Applicant/Authorized Person: [signature] Date: 10/19/22

Print Name: Ron Chandler Title: City Manager

OREGON WATER RESOURCES DEPARTMENT

FEASIBILITY STUDY GRANTS
2022 GRANT APPLICATION

I. Study Information

Study Name: Silverton ASR Feasibility Study

Type of Feasibility Study:
- ☐ Water Conservation
- ☐ Reuse
- ☐ Storage (Above-Ground)
- ☒ Storage (Below-Ground)
- ☐ Storage (Other)

Requested Grant Amount (must be no more than 50% of Total Study Cost): $ 250,000

Total Cost of Feasibility Study: $ 500,000

Note: Request(s) may not exceed $500,000 per project.

II. Applicant Information

Applicant Name: City of Silverton		**Co-Applicant Name:**	
Address:	306 S Water S	Address:	
	Silverton, OR 97381		
Phone:	503-873-8679	Phone:	
Fax:	503-873-3210	Fax:	
Email:		Email:	

Principal Contact: Bart Stepp		**Fiscal Officer: Kathleen Zaragoza**	
Address:	306 S Water Street	Address:	306 S Water Street
	Silverton, OR 97381		Silverton, OR 97381
Phone:	503-874-2209	Phone:	503-874-2203
Fax:		Fax:	503-873-3007
Email:	bstepp@silverton.or.us	Email:	kzaragoza@silverton.or.us

Certification: I certify that this application is a true and accurate representation of the proposed work for a project feasibility study and that I am authorized to sign as the Applicant or Co-Applicant. By the following signature, the Applicant and Co-Applicant (if applicable) certifies that they are aware of the requirements of an Oregon Water Resources Department grant, have read and agree to all conditions within the sample Feasibility Study Grant Agreement and are prepared to conduct the study if awarded.

Signature of Applicant/Authorized Person: Ronald F Chandler Date: 10/19/2022

Print Name: Ron Chandler Title: City Manager

Signature of Co-Applicant/Authorized Person: ____________ Date: ________

Print Name: ____________ Title: ____________

III. Feasibility Study Summary

1. Please provide a brief, 4-5 sentence summary of the feasibility study. This summary should include a brief description of the goal of the water conservation, reuse, or storage project being studied and the purpose of the study. Please refer to the Feasibility Study Grant Application Instructions for additional information on what to include in your study summary.

In 2021 the City of Silverton completed an initial feasibility evaluation to identify the best potential locations for an Aquifer and Storage Recovery (ASR) Project to store water in the winter underground so it can be pumped out and used in the summer. The completed evaluation identified 2 potential ASR locations. This proposed study would drill exploratory wells at those 2 locations to determine the potential ASR yield at each site. A pre-design level plan of infrastructure needed and estimated costs for an ASR project would then be completed for the site with the best ASR yield based on the well testing. The 2 exploratory wells will be drilled on existing City property. A completed ASR project would allow the City to reduce the reliance on taking water from our two surface water sources, Abiqua and Silver Creek, during the summer when streamflows are low providing a buffer for the City against drought.

IV. Study Location

Instructions: Please answer the following questions about the location of the feasibility study and project being evaluated.

2. Location. Please provide the following information about the study and project location.

a. Latitude/Longitude (in decimal degrees): **45.01°/ 122.77°, and 45.00°/122.79°**

b. County: **Marion**

c. Watershed/Basin (HUC 10 number): **Pudding River Watershed, HUC 17090010**

3. Site Plan Map. Please attach a site plan map showing the following and label as Attachment #1:

a. Feasibility study area boundaries
b. Project area (if implemented)
c. True north arrow
d. Map title and legend
e. Latitude and longitude
f. Property boundaries
g. Surface water bodies
h. Sampling locations (if proposed)
i. Points of Diversion and Place of Use, labeled for each water right (if applicable)

4. Properties Impacted or Accessed During Study. Check the box which best describes the properties involved in the proposed Feasibility Study.

a. ☐This Feasibility Study will **not** impact or access lands.
b. ☒This Feasibility Study will impact or access lands. Complete the table below to identify any properties where access is required for the feasibility study or on which the study would occur. *Add rows as needed.*
c. ☐This Feasibility Study will identify lands which may be impacted or accessed within the activities of this study. List the Task(s) describing this work:

Complete this table only if box “b” is checked.

Tax Map Number	Tax Lot Number	Ownership Type (✓ One)	Property Owner of Record
06 1W 34C	061W34C000700	☒Public ☐Private	City of Silverton
06 1W 26D	Public Right-of-Way	☒Public ☐Private	City of Silverton

5. **Landowner Agreement.** Attach a signed Landowner Agreement form for each property listed in Question 4 where access to the property is required or on which the Feasibility Study would occur. Attach Landowner Agreement form(s) only for those properties involved in the Feasibility Study and label Attachment #2. (Landowner Agreement forms may be found on the Applications, Forms and Guidance webpage.)

   Stop: Does not apply if 4.a. was selected above.

   a. Where a single landowner entity is the owner of record for multiple properties, one form may list the multiple properties owned by that entity.

   b. For *public* lands attach the landowner form or other documented authorization from the federal or state government property owner allowing the feasibility study activities **or** documentation that demonstrates such authorization is being pursued.

   c. If Question 4.c. was checked above, list the Task describing work to obtain landowner agreement approvals.

6. **Properties Impacted or Accessed During Implementation.** Check the box which best describes the properties involved in future project implementation. Identify any lands that would be impacted or accessed during future project implementation. Check all that apply and provide the requested information.

   a. ☐The proposed project, if implemented, will only impact or access lands already identified in Question 4 (must have selected box “b” under Question 4).

   b. ☒The proposed project, if implemented, will likely impact or access lands during implementation, but those lands have not been identified, OR this question is not applicable. If this box “6.b.” is checked, do not complete the table below.

   c. ☐The proposed project, if implemented, is highly likely to impact or access additional lands during implementation. If this box “6.c.” is checked, complete the table below to identify any additional properties (those not already identified under Question 4) where access is required for future project implementation. *Add rows as needed. No Landowner Agreement forms are required for lands listed only under this question.*

Tax Map Number	Tax Lot Number	Ownership Type (✓ One)	Property Owner of Record
		☐Public ☐Private	
		☐Public ☐Private	
		☐Public ☐Private	
		☐Public ☐Private	
		☐Public ☐Private	

V. Feasibility Study Specifics

Instructions: Please answer all questions in this section.

7. **Water Need, Issue, or Concern.** Describe the identified water need, issue, or concern that the study seeks to address. (local, regional, or statewide). Please provide data or a narrative substantiating the need, issue, or concern.

The City of Silverton obtains drinking water from two surface water sources, Abiqua and Silver Creeks. In the winter average daily demand is about 1.2 Million Gallons per Day (MGD) of 2.2 cfs. In the summer peak day demands are about 2.8 MGD or 5.0 cfs. The projected peak day demand in 2055 is 4.77 MGD or 8.6 cfs. The City has sufficient water rights to use 8.6 cfs but there are concerns that with climate change the water sources will not have enough flow in the summer to provide the City's needs and provide sufficient flows for fish and other users. An ASR project would allow the City to treat excess wintertime flows from the creeks, store them in an aquifer, and allow the City to pull that water out in the summer to meet peak demands. This would provide a redundant source in the summer for the City and reduce the amount of water the City needs to take from the surface water sources in the summer, providing instream flow benefit to the creeks.

8. **Study Goal.** Describe the feasibility study goal and how that goal addresses the water need, issue, or concern.

The goal of the feasibility study would be to determine the best location to install ASR infrastructure for Silverton and provide a cost estimate to complete the ASR project. The study would also determine how much water could be stored and used with ASR, discuss the water right permitting requirements needed to implement the project, and the impact on the water sources from using ASR.

The City can then compare the costs and project benefits of an ASR project to other projects like increased above ground storage or enhanced water conservation efforts to determine the best project or projects to implement for the City.

9. Study Scope. Describe how the proposed study would achieve the goal.

The study would start with 2 exploratory wells being drilled at the 2 preferred sites identified in the 2021 study. Test Well Site 1 would be in undeveloped right-of-way owned by Silverton near the industrial park area. Test Well Site 2 would be on an undeveloped portion of City property that is used for a senior center, skate park, and dog park. Both wells would be drilled to a depth to reach the Columbia River Basalt Group Aquifer, as recommended by the 2021 initial feasibility evaluation.

Pump testing, water level measurements, and water quality testing would be completed on both test wells that will help the City determine the following information about the site:

1) The potential storage volumes of the aquifer at the site. The 2021 evaluation estimated a range of 61 – 133 million gallons over a 140 day period in the winter.
2) The recovery rate, how much water could be pumped from the well every day, for an ASR well at the site. The 2021 evaluation results were based on the assumption that the City could achieve a recovery rate of 1 million gallons per day.
3) The sizing of the well and pumps needed for the ASR well to be a viable option for the City.
4) Water quality testing of the existing groundwater would be completed to determine the compatibility of the groundwater with the finished water from the Silverton Water System. This will help determine if any additional treatment would be needed at the ASR site.

Once all testing has been completed the consultant would analyze the results to determine the best site for an ASR well and then complete a preliminary design of the infrastructure including identifying any upgrades in the distribution system that are needed to send water from the existing water treatment plant to the ASR site. The completed study would provide information so the City could decide whether ASR was an appropriate project for the City and what the cost would be to design and construct the project.

10. Water Planning and Preparation. Identify the plan or planning effort that identifies the study or future project (if applicable). Describe how this study informs plans or preparations for a more secure water future.

The City completed a Water Master Plan in 2021 that looked at water demands and system needs over the next 20 years. That plan identified ASR as a potential solution to long term water needs for the City. Since the 2021 ASR evaluation had not been completed yet, the master plan did not have enough information to identify whether ASR would be a good solution for the City.

The City would use the proposed study to identify whether an ASR project should be included in the City's Water System Capital Improvement Plan. The City Council and staff would determine the priority of the ASR project in comparison with other improvements needed by the City.

11. **Water Availability.** Please provide evidence that water is available to meet the above described need, issue, or concern. Evidence can include regulatory and physical information regarding water availability.

The City has a surface water right from Abiqua Creek for 10 cubic feet per second (CFS) with a priority date of May 24, 1916. The City also has a surface water right of 5 CFS for Silver Creek with a priority date of March 16, 1911. In the winter these creeks provide plenty of flow to provide the allotted water. Flows in the summer though have the potential to drop below the City's available water right.

The 2021 master plan identified a peak day demand in 2040 of 5.94 CFS (3.84 MGD). While that is below the City's allocated water rights, if Abiqua and Silver Creek flows drop below that level in the summer, additional water would be needed. The City does have 1,300 acre-feet of backup capacity from Silver Creek Reservoir, but the source of that reservoir is Silver Creek so that source would also be subject to low flows in the summer and could be limited.

An ASR well would allow the City to pump water from the ground during the summer to meet the peak demands the surface water sources may not be able provide in the future. This study would also provide information on the amount of water needed for fish in each creek. An ASR project would keep water in the stream in the summer that would be beneficial for native and threatened species.

12. **Potential Impacts and Benefits.** Does this study investigate the potential impacts and benefits of project implementation on the economy, the environment, and/or the community? If applicable, list the tasks where that work will occur. *Note: Investigating potential impacts and benefits is one of a number of eligible study tasks.*
    Task numberand title -
    Task number and title -

13. **Community Engagement** Describe if any opportunities were provided for meaningful engagement, suitable for the public who may be interested in, or affected by the study or project implementation. Describe if there were any specific strategies to engage environmental justice communities.

This project was discussed at a September 20, 2021 City Council work session on the water system. At that meeting the Council had a discussion on proposed Capital Improvements for the water system and how an ASR project would fit in with overall Capital Improvement Program.

The project was discussed again at the November 1, 2021 City Council meeting when Council approved submitting this grant application for the study. The ASR study was also discussed at the January 24, 2022 City Council Workshop that was focused on capital improvement plans. This study was approved as part of Silverton's 5-Year Water System Capital Improvement Plan.

Submittal of this application to Oregon Water Resources Department was approved by City Council at the regular October 3, 2022 meeting.

If the ASR study is approved and the City decides to complete an ASR project, the City would conduct public outreach to inform the residents about the project and its impacts. An ASR well at test well site 1 may require the purchase of additional property and infrastructure construction impacts to the surrounding neighborhood. The park property of test well site 2 has sufficient undeveloped property that could be used to not impact the existing senior center, skate park, and dog park uses. But an ASR project on that site would reduce the amount of property available for other future uses at that site.

These site impacts and the impacts of ASR on the water system would be discussed with the public during the engineering design phase of the ASR project. Feedback received from the public would be implemented into the final design of the facility.

14. **Community Interests and Concerns**. If community interest or concerns were identified, describe the plans to address them in this study or future efforts. *(Note: You may attach Letters of Support to the application.)*

15. **Study Tasks.** Identify the study tasks necessary to conduct the feasibility study using the following format and including as many tasks as necessary to complete the study. In the event that your study receives grant funding, the tasks identified will be incorporated into your grant agreement as the "Statement of Work." Please note: Project management and administration are common functions within a specified task and not separate tasks themselves.

Task number. Task Title

- Task schedule: The approximate dates during which the task will be completed.
- Description of task activities: Include specific details of the task such as task purpose, planned approach, appropriate technical information, proposed methods, and rationale for the approach.
- Qualified personnel that will complete task: Include a description of the professional experience, professional qualifications and licensure of personnel necessary for task work.

Task 1. Consultant Selection

- Task schedule: 7 – 10/2023
- Description of task activities: City will publicly advertise a Request for Proposals from qualified consultants to complete the ASR feasibility study. City staff will review proposals and select the most qualified consultant to complete study. City Council will approve a professional services agreement with the consultant that includes an approved scope and fee that covers the tasks and requirements of the feasibility grant prior to the consultant beginning work.
- Qualified personnel that will complete task: City Council, City Engineer, Public Works Director, and other City Staff.

Task 2. Well Drilling and Testing

- Task schedule: 10 – 12/2023
- Description of task activities: 2 Exploratory wells will be drilled. Wells will then be pump tested and water quality testing conducted to determine the yield and water quality suitability of potential sites. Results will be compiled and tabulated to compare the 2 different ASR sites.
- Qualified personnel that will complete task: Engineering consultant and well drilling subcontractor.

Task 3. Data Analysis and predesign report

- Task schedule: 1/2024 – 5/2024
- Description of task activities: Based on the results from the well testing the best site for an ASR project will be identified. A conceptual plan of the improvements needed and a cost estimate will then be completed for that site. The study also will provide a description of the improvements needed. A final report of the study will be completed encapsulating the drilling, data analysis, and predesign report.
- Qualified personnel that will complete task: Engineering Consultant. City Engineer will review the report prior to completion.

Task 4. Storage Project Analysis

- Task schedule: 1/2024 – 5/2024
- Description of task activities:

  Consultant will answer question #24 items about proposed ASR project in the predesign report according to the Storage-Specific Study Requirements guidance document. Consultant will complete the work and present in the predesign report the following items:

  i. Analyses of by-pass, optimum peak, flushing and other ecological flows of the affected stream and the impact of the storage project on those flows.
  ii. Comparative analyses of alternative means of supplying water, including but not limited to the costs and benefits of water conservation and efficiency alternatives and the extent to which long-term water supply needs may be met using those alternatives.
  iii. Analyses of environmental harm or impacts from the proposed storage project.
  iv. Evaluation of the need for and feasibility of using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life and any other ecological values.
  v. *A*nalysis of local and regional water demand and the proposed storage project's relationship to existing and planned water supply projects.
- Qualified personnel that will complete task: Engineering Consultant

Copy and paste additional tasks as needed.

16. Study Task Scheduling. Estimated duration of feasibility study: 7/2023 to 5/2024

Place an "X" in the appropriate column to indicate when each task of the project would take place. Study tasks should match those listed as part of your response to the previous question.

Feasibility Study Tasks (Add additional rows as needed)	**Grant year**				**Grant year**				**Grant year**			
	2023				2024							
Silverton ASR Site Study	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1: Consultant Selection	☐	☐	☒	☒	☐	☐	☐	☐	☐	☐	☐	☐
Task 2: Well Drilling and Testing	☐	☐	☐	☒	☒	☐	☐	☐	☐	☐	☐	☐
Task 3: Data Analysis and Predesign Report	☐	☐	☐	☐	☒	☒	☐	☐	☐	☐	☐	☐
Task 3: Storage Project Analysis	☐	☐	☐	☐	☒	☒	☐	☐	☐	☐	☐	☐

17. Feasibility Study Water Rights. Identify any water rights required to **conduct** the proposed Feasibility Study below. Check all of the following that apply and provide the information requested:

a. ☒ No water rights are required to complete the proposed study. Continue to Question 18.

b. ☐ The proposed study requires a new water right or other water right transactions to **conduct** the study. If checked, list the transaction(s) required (e.g., new right, transfer, etc.):

c. ☐ This Feasibility Study will identify water rights necessary to **conduct** the activities of this proposed study. List the Task(s) describing this work:

d. ☐ The applicant has legal access to a water right that will be used to **conduct** the study. The proposed study requires a water right, and the applicant holds or has been given permission to utilize the water right(s) for the proposed study. If checked, list all water rights required for the study in the table below, adding rows as needed. See the Application Instructions for further guidance, including how to find water right information.

This table is only required if you check box "d".

Water Right Number (Include prefixes, if applicable, e.g., CW 12345)	Is this an application, permit, certificate, limited license, special or final order, transfer, decree, lease, or claim? Enter "New right Needed" below if a new water right is needed to do this work.	Tax Lot IDs within the Place of Use where water will be used to complete the study

18. Project Implementation Water Rights. Identify any water rights needed to implement the proposed Project below. Check all of the following that apply and provide the information requested:

a. ☐ The applicant does not know what water rights or water right transactions are required for the project. That will be determined through this study or other effort at a future date. Continue to Question 19.

b. ☒ The proposed project requires a new water right or other water right transactions. If checked, list transaction(s) required (e.g., new right, transfer, etc.): **Prior to construction an ASR limited license would be needed to install the ASR well. Once the ASR well is completed and fully tested, an ASR Permit for the full system would be needed from OWRD. Additional surface water rights would not be needed.**

c. ☐ The applicants holds the water right(s) required for the project. If "c" is checked, include list of rights in the table below, adding rows as needed. See the Application Instructions for further instruction, including how to find water right information.

This table is only required if you check "c".

Water Right Number	Is this an application,	Water Right Amount	Tax Lot IDs within the Place

(Include prefixes, if applicable, e.g., G 00010)	permit, certificate, limited license, special or final order, transfer, decree, lease, or claim?	Max Volume (ac-ft)	Max Rate (cfs)	Duty (ac-ft/ac)	of Use where water will be used to implement the proposed project

19. **Feasibility Study Permits.** Provide a list of any other permits and regulatory approvals needed to **conduct the Feasibility Study** and indicate the status of each in the table below. If permits/approvals are required, please submit copies of secured permits/approvals **or** describe efforts to secure permits/approvals including status. If no permits or authorizations are required for the study, provide an explanation:

Permit/ Regulatory Approval	Permitting Entity	Status and Efforts To Date
Water Well Permit	Oregon Water Resources Dept.	Have not applied

20. **Project Implementation Permits.** Provide a list of the permits and regulatory approvals that you anticipate would be needed to implement the proposed **project** being studied. If permits/approvals are not required, please explain why and provide information regarding any agencies contacted to verify this determination:

Project Permit/Regulatory Approval *(add rows as needed)*	Permitting Entity
ASR Limited License and later an ASR Permit	Oregon Water Resources Dept.
ASR Engineering Design Approval	Oregon Health Authority/Drinking Water
Site Plan Approval	City of Silverton
1200 C Permit depending on overall project size)	Oregon DEQ

VI. Feasibility Study Budget

Instructions: Please answer the following questions about the study budget using the tables provided.

21. **Budget by Line Item or Category.** Please provide an estimated line item budget for the proposed feasibility study. Examples include: Direct project specific costs, such as in-house staff salary, contractual services, and administrative costs. Please note that indirect costs **are not** an allowable grant expense. See the Department's Budget Procedures and Allowable Costs for further guidance.

OVERALL STUDY BUDGET Line Items	**Number of Units*** *(e.g. # of Hours)*	**Unit Cost** *(e.g. hourly rate)*	**In-Kind Match**	**Cash Match Funds**	**OWRD Grant Funds**	**Total Cost**
Staff Salary/Benefits			$15,000			$15,000
Contractual/Consulting				$235,000	$250,000	$485,000
Equipment (must be approved)						
Supplies						
Travel						
Other:						
Administrative Costs**						
		Total	**$15,000**	**$235,000**	**$250,000**	**$500,000**

** The "Unit" should be per "hour" or "day" – not per "project" or "contract."* *Units x Unit Costs = Total Cost*
*** Administrative Costs may not exceed 10% of the total funding requested from the Department*

22. Budget by Task. Identify the budget for each task below. Tasks identified below should be the same as the tasks identified in Questions 14 and 15.

Feasibility Study Tasks (Add additional rows as needed)	**In-Kind Match**	**Cash Match Funds**	**OWRD Grant Funds**	**Total Cost**
Task 1: Selecting a Consultant	*$2,000*	*$0*	*$0*	*$2,000*
Task 2: Well Drilling and Testing	*$5,000*	*$175,000*	*$175,000*	*$355,000*
Task 3: Data Analysis and Predesign Report	*$5,000*	*$50,000*	*$60,000*	*$115,000*
Task 4: Storage Project Analysis	*$3,000*	*$10,000*	*$15,000*	*$30,000*
Total	**$15,000**	**$235,000**	**$250,000**	**$500,000**

VII. Match Funding

Instructions: Please answer the following question regarding matching funds.

23. Match Funding Table and Documentation. Please fill out the table below and attach the appropriate documentation for both the secured and pending match (add rows as needed). Keep in mind that applicants must demonstrate a minimum **dollar-for-dollar match**. Please note that a failure to meet this requirement or to attach documentation will result in an incomplete application that will not be considered for funding.

For secured funding, you must *attach a letter of support or award* from the match funding source that specifically mentions the dollar amount identified for this study and as shown in the "Amount/Dollar Value" column in the table below.

For pending resources, *other written documentation showing a request* for the matching funds must accompany the application or documentation must identify the date on which a future funding application will be submitted, identify the funding program, and provide evidence that the project is eligible for the funding program identified. Note that if awarded funds, pending commitments of the funding must be secured within 12 months from the date of the award.

Match Funding Source (if in-kind, briefly describe the nature of the contribution)	**Type (✓ Only One)**	**Status (✓ Only One)**	**Amount/ Dollar Value**	**Date Match Funds Available** *(Month/Year)*
City of Silverton Water Fund	☒cash ☐in-kind	☒secured ☐pending	$235,000	7/2022
City of Silverton Water Fund	☐cash ☒in-kind	☒secured ☐pending	$15,000	7/2022
	☐cash ☐in-kind	☐secured ☐pending		
	☐cash ☐in-kind	☐secured ☐pending		
	☐cash ☐in-kind	☐secured ☐pending		
Total of Match Funds			= $250,000	

VIII. Storage-Specific Questions

Instructions: If you indicated that your study is for a storage project, answer question 24 in this section. If your study is for above-ground storage, also answer question 25. Please refer to the document on Storage-Specific Study Requirements for guidance and information on completing this section, available on the OWRD Funding Opportunities, Applications, Forms, and Guidance webpage. **If your study is for a water conservation or reuse project, skip this section.**

24. All Storage Projects. Answer the following "Yes/No" questions about the storage project to be evaluated in the proposed study.

A. Will the project divert more than 500 acre-feet of surface water annually? Yes ☒ No ☐

B. Will the project impound surface water on a perennial stream? Yes ☐ No X

C. Will the project divert water from a stream that supports sensitive, threatened or endangered species? Yes ☒ No ☐

If you answered "yes" to any of the questions above, you are required to address the following analyses in your feasibility study. By signing this application, you are committing to include these required elements in your feasibility study.

If you answered "Yes" to (A), (B), or (C) above, attach a description of how you intend to address the following required elements in your feasibility study (please refer to the document on Storage-Specific Study Requirements for guidance and a description of the minimum acceptable standards regarding these study requirements).

You must include a Task in Question #15 for this work unless the work was previously conducted. If you are attaching results of previously conducted work, you must cite the relevant sections or pages.

vi. Analyses of by-pass, optimum peak, flushing and other ecological flows of the affected stream and the impact of the storage project on those flows.

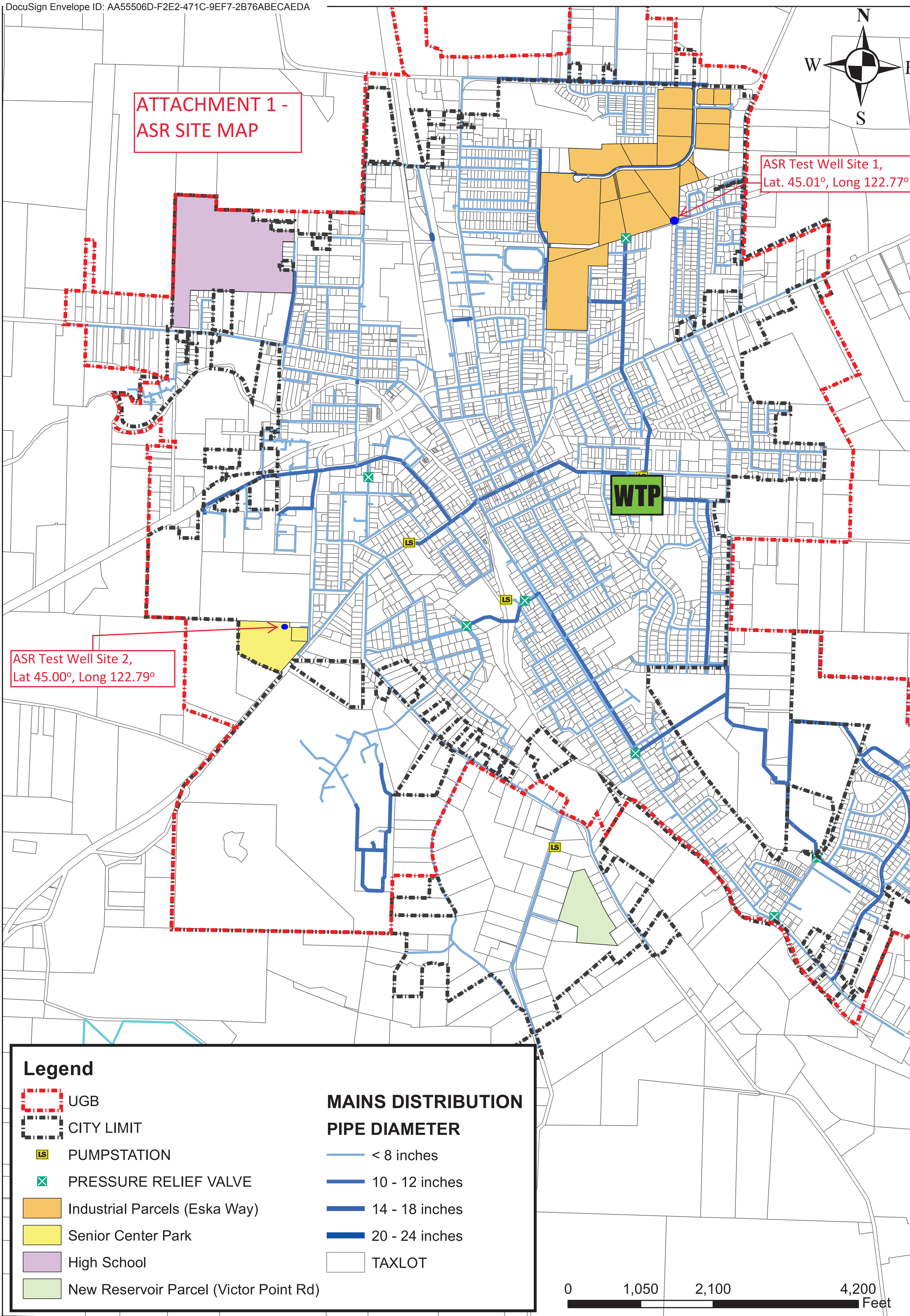
vii. Comparative analyses of alternative means of supplying water, including but not limited to the costs and benefits of water conservation and efficiency alternatives and the extent to which long-term water supply needs may be met using those alternatives.

viii. Analyses of environmental harm or impacts from the proposed storage project.

ix. Evaluation of the need for and feasibility of using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life and any other ecological values.

x. *For proposed storage projects for municipal use only* **–** For a proposed storage project that is for municipal use, analysis of local and regional water demand and the proposed storage project's relationship to existing and planned water supply projects.

25. For Above-Ground Storage Only. Describe whether or not the storage project would include provisions for using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life or other ecological values. As per statute and rule, above-ground storage projects that include these provisions receive preference for funding over other storage projects.



KELLER ASSOCIATES

Potential ASR Sites

Initial Feasibility Evaluation of ASR

CITY OF SILVERTON EST 1854 OREGON'S GARDEN CITY

Figure 4-1

City of Silverton, OR

BUDGET NARRATIVE
Fiscal Year 2022-2023

PROGRAM:	**WATER ADMINISTRATION**	**STAFF LEVEL 2023:**	**1.74 FTE**
DEPARTMENT:	**PUBLIC WORKS**	**STAFF LEVEL 2022:**	**1.74 FTE**
FUND:	**WATER**		

Program Description/Mission

This program accounts for the administration of the City's water treatment and distribution systems. This program is responsible for engineering and contract administration of projects related to the City's potable water treatment and distribution.

Personnel

Title	2022 FTE	2023 FTE	FTE Change
Public Works Director	0.49	0.49	
City Engineer	0.45	0.45	
Engineering Technician	0.40	0.40	
Administrative Assistant II	0.40	0.40	
Total	1.74	1.74	0.00

Budget Comments

- Account #61001 includes funds for all office and operating supplies.
- Account #61059 increased to account for City's match for the ASR Study ($250,000). Includes eastside access road to the reservoir agreements and preliminary design ($45,000), contracted services for bargaining ($4,500), outsourcing the printing and mailing of the monthly utility bills ($16,000) shared and other contracted services as necessary.
- Account #95050 increased to account for debt service for the Civic Center building allocation.
- Account #95228 increased to account for transfer to Second Street project fund.

CITY OF SILVERTON
EXPENDITURES
FISCAL YEAR 2022-2023

		2019-2020 FISCAL ACTUAL	2020-2021 FISCAL ACTUAL	2021-2022 FISCAL BUDGET	2022-2023 CITY MNGR PROPOSED	2022-2023 BDGT COMM APPROVED	2022-2023 COUNCIL ADOPTED
WATER FUND							
ADMINISTRATION							
PERSONNEL SERVICES:							
040-010-51001	FULL TIME SALARIES	122,984	157,015	151,134	144,016	144,016	144,016
040-010-51003	WORKERS COMP INS	1,207	1,647	1,954	2,251	2,251	2,251
040-010-51004	SOCIAL SECURITY/MEDICARE	8,712	11,944	11,562	11,017	11,017	11,017
040-010-51005	HEALTH INSURANCE	25,224	33,880	40,070	37,978	37,978	37,978
040-010-51006	LIFE/ DISABILITY INS	283	363	641	617	617	617
040-010-51007	PERS RETIREMENT	28,511	39,807	42,475	38,903	38,903	38,903
040-010-51009	OVERTIME SALARIES	0	28	0	0	0	0
	TOTAL PERSONNEL SERVICES	186,921	244,685	247,836	234,782	234,782	234,782
MATERIALS AND SERVICES:							
040-010-61001	SUPPLIES	1,911	2,018	1,800	2,000	2,000	2,000
040-010-61002	PUBLICATIONS	0	103	100	100	100	100
040-010-61003	ADVERTISING EXPENSE	27	182	200	200	200	200
040-010-61004	COMMUNICATION EXPENSE	1,443	1,591	1,600	1,600	1,600	1,600
040-010-61005	POSTAGE & FREIGHT	6,421	6,697	9,000	1,000	1,000	1,000
040-010-61009	PERMIT FEES	0	34	100	100	100	100
040-010-61015	TRAVEL, TRAINING & MEETINGS	1,293	1,158	3,200	3,200	3,200	3,200
040-010-61016	DUES & MEMBERSHIPS	359	374	500	1,200	1,200	1,200
040-010-61024	VEHICLE EXPENSE	18	0	200	500	500	500
040-010-61030	FUEL EXPENSES	0	0	100	300	300	300
040-010-61031	RECORDING FEES	0	32	100	100	100	100
040-010-61042	SAFETY EQP/ PROT CLTHNG	26	268	1,000	1,000	1,000	1,000
040-010-61045	EQUIPMENT RENTAL	747	729	1,000	1,000	1,000	1,000
040-010-61059	CONTRACTED SERVICES	62,127	23,312	89,500	356,000	356,000	356,000
040-010-61079	BANK & CHARGE CARD FEES	13,380	22,851	15,000	15,000	15,000	15,000
040-010-62573	MISCELLANEOUS EXPENSE	27	132	100	100	100	100
040-010-69950	PERS UAL DEPOSIT	79,625	0	0	0	0	0
040-010-71000	MINOR EQUIPMENT	371	249	500	700	700	700
040-010-71009	SOFTWARE	412	571	500	500	500	500
	TOTAL MATERIALS AND SERVICES	168,186	60,302	124,500	384,600	384,600	384,600
CAPITAL OUTLAY:							
040-010-81003	CAPITAL - REPLACEMENT	968	835	2,450	0	0	0
040-010-85003	CAPITAL - NEW	0	0	11,670	0	0	0
	TOTAL CAPITAL OUTLAY	968	835	14,120	0	0	0
CONTINGENCY & RESERVES:							
040-010-90001	CONTINGENCY	0	0	589,945	414,823	414,823	414,823
040-010-91009	RESERVE - DEBT SERVICE	0	0	193,726	65,000	65,000	65,000
040-010-91702	RESERVE - FUTURE EXPENDITURE	0	0	324,995	800,933	800,933	800,933
	TOTAL CONTINGENCY & RESERVES	0	0	1,108,666	1,280,756	1,280,756	1,280,756
TRANSFERS OUT:							
040-010-95001	TRANSFER TO GENERAL FUND	567,901	571,016	593,085	645,649	645,649	645,649
040-010-95050	TRANSFER TO DEBT SERVICE	25,310	26,701	26,326	100,012	100,012	100,012
040-010-95226	TRANSFER TO MCCLAINE IMP PROJ	335,623	0	0	0	0	0
040-010-95227	TRANSFER TO WESTERN IMP PROJ	0	0	139,019	0	0	0
040-010-95228	TRANSFER TO SECOND ST IMP PROJ	0	0	0	224,200	224,200	224,200
040-010-95340	TRANSFER TO WATER CIP FUND	480,000	599,660	720,981	200,000	200,000	200,000
040-010-95600	TRANSFER TO FLEET REPLACEMENT	23,402	23,402	23,402	23,402	23,402	23,402
040-010-95610	TRANSFER TO MAJOR EQUIP REP	20,413	20,413	20,413	20,413	20,413	20,413
	TOTAL TRANSFERS OUT	1,452,649	1,241,192	1,523,226	1,213,676	1,213,676	1,213,676
	TOTAL ADMINISTRATION	1,808,723	1,547,014	3,018,348	3,113,814	3,113,814	3,113,814

ATTACHMENT 4 - Approach to Address Storage-Specific Requirements (Section VIII, Question 24)

Describe how you intend to address the required elements in your planning study:

i. **Analyses of by-pass, optimum peak, flushing and other ecological flows of the affected stream and the impact of the storage project on those flows.**

At a minimum, analyses of by-pass, optimum peak, flushing and ecological flows for Abiqua Creek and Silver Creek will be included in this feasibility project. The streamflow of Abiqua Creek downstream of our intake is heavily influenced by agricultural irrigation in the summer. The City has a stream gage a few hundred feet upstream from our intake on Abiqua Creek. We are currently in the process of installing a solar powered telemetry system so the gage can be read remotely and flows can be tracked continuously. This data will help us in our analysis of flows. This project will also address how an ASR program would impact other site-specific ecological flows that are relevant to the study area.

ii. **Comparative analyses of alternative means of supplying water, including but not limited to the costs and benefits of water conservation and efficiency alternatives and the extent to which long-term water supply needs may be met using those alternatives.**

A comparative analysis of alternative means of supplying water will be performed as part of this feasibility study to meet the minimum requirements of the storage-specific criteria. The analysis will rely on information from Silverton's current Water Master Plan (2021), Water Management and Conservation Plan (WMCP), previous water supply alternative studies, as well as other relevant county and basin planning documents. Conservation methods include those Silverton is currently utilizing (meter reading, leak detection, updating rate schedules, outreach and education, water curtailment, water reuse to the Oregon Garden, etc.), as well as identifying new methods for conservation, such as the potential for expanding the water reuse program. The study will assess how long- term water supply could be met, or enhanced, by the development of an ASR program. Costs and benefits (both financial and ecological) to provide water using an ASR program will be compared to other water supply alternatives and conservation efforts. The comparison will address how the proposed ASR program will help Silverton meet future water demands, the costs and benefits of the alternative and applicable regulatory requirements.

iii. **Analyses of environmental harm or impacts from the proposed storage project.**

Potential for long-term impacts due to the construction of the ASR facility will be included in the study. This study will include an assessment of both the positive and negative outcomes of implementing an ASR program. In addition to evaluating impacts to the stream ecology (including native and threatened fish, water quality of surface water and groundwater, and riparian habitat), groundwater levels will be evaluated based on existing information for the basalt aquifer. The potential for ASR to provide a positive impact to the resiliency of the local ecosystem under future climate change will also be evaluated.

iv. Evaluation of the need for and feasibility of using stored water to augment in-stream flows to conserve, maintain and enhance aquatic life, fish life and any other ecological values.

This element will be evaluated by discussion with OWRD and ODFW staff regarding in-stream flow deficiencies during certain times. Due to the location of Abiqua Creek being several miles from the City's distribution system augmentation of Abiqua Creek does not make logistical or economic sense. Augmentation of Silver Creek, however, is a possibility. The feasibility study will include an analysis of water availability in the Silver Creek basin, existing instream protections, and project storage capacities (of the basalt aquifer system). An evaluation of the impact of this project, and the potential need to augment streamflow, will be identified based on water availability, the ecological flow assessment (from question i), and existing protections on Silver Creek.

To determine the potential of instream flow augmentation, existing data from Abiqua and Silver Creeks will be used to estimate inflow volumes at Silverton's intake. The goal of developing an ASR program for Silverton is to provide sufficient capacity to meet peak demands, thereby offsetting the need to increase their surface water diversion volumes in the summer when flows in Abiqua and Silver Creeks are at their lowest. Shifting the reliance from diverting additional live flow to stored water would in effect augment stream flows during the lower-flow times of the year.

v. For a proposed storage project that is for municipal use, analysis of local and regional water demand and the proposed storage project's relationship to existing and planned water supply projects.

This proposed project was conceived as a project described in Silverton's current water master plan. The project will be developed in part using information from this document, and will be evaluated relative to the City's current and projected water supply needs. Using ASR to meet the peak day demand will provide redundancy and resiliency in Silverton's water system. In addition, Silverton has implemented several water conservation measures to become more efficient at delivering water, and therefor increasing their supply to meet their growing demand. The 2021 Water Master Plan found the City was using the same amount of water or less than in 2006 despite substantial residential growth in the City during that time.

A review of Silverton's infrastructure will be performed to evaluate how the ASR project will be integrated into the current system. New infrastructure for the ASR program will include new deep basalt well accessing a single aquifer, associated pumps, appurtenances, and well building(s). The location(s) of the well(s) will be selected partially based on existing infrastructure and the ability to tie into water mains of appropriate size. Water mains may need to be upsized to provide sufficient flow to the ASR well from the water treatment plant.

The nearest public water system to Silverton is the Mt. Angel water system. When the City completed the initial feasibility study in 2021, it asked Mt. Angel if they had any interest in a ASR system that could benefit both systems. The City of Mt. Angel has a surplus capacity of water from their existing wells though, so they were not interested in participating in a project. Silverton is too far away from any other municipalities for any type of regional water supply project.

ATTACHMENT 5

GSI Water Solutions, Inc.

TECHNICAL MEMORANDUM

Initial Feasibility Evaluation of ASR, City of Silverton, Oregon

To: Bart Stepp, PE / City of Silverton Public Works Department

From: Christopher Wick / GSI Water Solutions, Inc.
Walt Burt, RG, LHG / GSI Water Solutions, Inc.
Luke Tabor / Keller Associates, Inc.
Peter Olsen, PE / Keller Associates, Inc.

Date: March 7, 2022

1. Introduction

This technical memorandum summarizes the results of GSI Water Solution's (GSI) preliminary evaluation of the feasibility of developing an Aquifer Storage and Recovery (ASR) system for the City of Silverton (City). This evaluation was completed in collaboration with Keller Associates, Inc. (KA). The City is identifying and exploring alternatives for developing resilient, sustainable, and cost-effective water sources to help meet the demands of its customers. Currently, the City meets existing water demands via surface water diversions from Abiqua Creek and Silver Creek. ASR has been identified as a potential alternative for future consideration as a supplemental supply source for meeting future peak demands and/or in the event that its surface supply sources are interrupted.

ASR is a technique for storing water in a suitable aquifer involving injecting treated drinking water through a well into the storage aquifer, and later recovering the water for its intended purpose using the same well. Water is usually stored during periods of when diversion and/or treatment capacity exceeds demands, commonly during the winter and spring months. The stored water can later be recovered and used during higher water demand periods, or for emergency use when the primary supply source has been interrupted. ASR is technically not a new source, but provides a way to better align existing source capacity with demands, reducing the size of or delaying expansion of its source and treatment infrastructure. ASR also is a tool to increase supply resiliency with reduced snowpack storage and less reliable stream flows because of climate change. ASR does not however serve the same function as an above-ground reservoir to regulate operational flows and provide fire or peak hour flows.

The purpose of this study is to evaluate whether ASR is a viable alternative to include in future water system master planning efforts by the City. The objective of the study is to complete a preliminary desk-top evaluation of ASR potential within the defined Study Area. The Study Area (**Figure 1-1**) includes areas within ¼-mile radius of the City's Urban Growth Boundary (UGB) and Highway 214 between Silverton and Mount Angel. The specific objectives of the study are to:

- Confirm the availability of a treated ASR source water supply and estimate potential rates and volumes of water available for storage
- Identify and evaluate potential candidate ASR storage aquifers in the Columbia River Basalt Group (CRBG) based on data from existing wells,

- Estimate potential injection/recovery rates and storage volumes.
- Identify potential fatal flaws to ASR development in the Study Area.
- Identify favorable areas for siting an ASR system based on hydrogeologic, water infrastructure and land ownership and use.
- Outline a roadmap for developing an ASR system, including uncertainties, risks and costs

2. Existing Water System and Proposed ASR System Criteria

2.1 Water Supply Needs

Historical and future water demand projections from the 2021 Water Master Plan (WMP) are presented in Table 2-1. Three different scenarios of future demands were developed. The WMP uses Scenario 2 demands in determining the adequacy of source, storage, treatment, and distribution system capacities for the water system. Scenario 2 (from the WMP) is described as residential per capita demands lower by 3% over the next 10 years and then remain constant. Commercial demand in 2021 is reduced with the closing of the BrucePac processing facility, but grows at a rate of 2.5% a year after that. **Table 2-1** below summarizes existing and future system demands for the WMP Scenario 2.

Table 2-1. WMP Future System Demands[1]

Year	2020	2030	2035	2040	2055
Population	**10,701**	**12,310**	**13,076**	**13,759**	**15,631**
Scenario 2 Average Annual Demand	1.41	1.46	1.59	1.72	2.17
Scenario 2 Average Summer Demand	2.05	2.18	2.37	2.56	3.18
Scenario 2 Average Winter Demand	1.04	1.05	1.15	1.25	1.58
Scenario 2 Peak Day Demand	3.08	3.27	3.56	3.84	4.77

Note

[1] Values are daily demands in million gallons (mg)

The City derives its water supply from intakes on two surface sources: Abiqua Creek and Silver Creek. Water diverted from these sources is conveyed to and treated at the Water Treatment Plant (WTP). The City can use both intakes, or one based on the time of the year and creek conditions. A transmission line break for one or both intake pipelines would cause a critical failure point to the existing system. Additionally, the surface source capacity may become deficient due to natural disasters. For example, fires spreading ash into the creeks or a spill into the creek upstream of the intakes. Currently, the intake at Abiqua Creek reportedly suffers from sediment build-up and blinding due to leaves during the fall season. Additionally, the intake is at risk of plugging with leaves during power outages, because the cleaning mechanism used to clear the screens does not have an emergency backup power supply.

Potential benefits to the City of an ASR system include: (1) supplementing system capacity to meet peak summer demands; and (2) providing redundancy at a different location than the WTP. As a redundant source, the ASR system would protect the City against supply interruptions caused by natural disasters that effect the intakes and WTP, or in the event of an algae bloom in Silver Creek Reservoir. An ASR system also potentially could provide a supplemental or backup source of wholesale supply to Mount Angel with an intertie.

2.2 Source Water Availability

The City derives its water supply from two surface sources: Abiqua Creek and Silver Creek. Water from Abiqua Creek is conveyed by gravity directly to the WTP. The City's Abiqua water right was established in 1916 (the oldest on the creek) and is for 10.0 cfs (or 6.5 MGD). The City has a current development limitation ("greenlight water") of 7.0 cfs (or 4.5 MGD) for this water right. The Silver Creek water right established in 1911 is for 5 cfs (or 3.2 MGD) and has no development limitations. The current measured pump capacity of the Silver Creek intake is 2.3 MGD with both pumps running. The City has a water right to use 14 cfs (9.0 MGD) of the water stored in the Silverton Reservoir. The 14 cfs can be released from the reservoir and diverted from the current intake on Silver Creek but the total annual volume that can be diverted is limited to 1,300 acre-feet (AF) per year, of which only 200 AF per year is greenlit. The total capacity of water rights is 15 cfs (or 9.7 MGD)..

2.3 Water System Information

The source water is comprised of two creeks (Abiqua and Silver Creek) that are fed from two different watersheds. This configuration makes the City's water supply less vulnerable to an event within one of the watersheds that would significantly alter the water quality being delivered to the treatment facility. While this provides some level of protection to the City, it also creates a unique challenge to the operation of the plants. The water sources, while similar, also have unique characteristics that change the treatment approach within the WTP. The City's primary and preferred source is Abiqua Creek, a perennial stream with good water quality. If flow in Abiqua Creek is low or has high turbidities, the City switches to water from Silver Creek.

Silverton has two treatment facilities at the WTP site, Plant 1 and Plant 2. Silverton's two plants operate independent of each other. Plant 1 was constructed in 1957 with upgrades in 1962 and 1972, and programmable logic control (PLC) upgrades in 1994. Plant 1 is only operated in the summer and has a capacity of 1.5 MGD. Plant 2 was constructed in 1982 and has a treatment capacity of 2.5 MGD. The treatment capabilities of both plants have been reduced due to age of the facilities and operator experience.

There are six pressure zones in the City's water system. Placement of an ASR well in different areas of the water distribution system will have varying impacts. Placing the ASR well in the High Level Zone or Edison Booster Zone will allow for redundancy at the highest hydraulic grade line, although require pumping to fill the above ground reservoir. Alternately, adding the ASR system to a low zone will require less energy. Potential future infrastructure needs for an ASR may include but are not limited to a new booster station, a stormwater detention pond, and larger pipes for the backbone of the system.

2.4 Water Availability

This section summarizes the capacity and limitations of the different elements of the City's water system, including water rights, intakes, the WTP and distribution system.

The City holds a combined Abiqua Creek and Silver Creek water right capacity of 15 cfs, as explained in section 2.2. Additionally, 14 cfs can be diverted from the Silver Creek Reservoir to the Silver Creek intake with an existing authorized development limitation of 200 AF per year. The full annual volume of the water right for the Silver Creek Reservoir is 1,300 AF per year.

The Abiqua Creek intake includes a gravity transmission line with a capacity of 6.5 MGD. The Silver Creek intake has an existing capacity limitation of 2.3 MGD, although the City will be replacing it with a 4.1 MGD intake structure in 2022. Combined, the City has sufficient intake capability as well. The City historically runs one intake at a time. This means the potential production limitation is 2.3 MGD, and the future production limitation is 4.1 MGD after the intake project is completed.

The existing treatment plant has a design seasonal capacity of 4.0 MGD in the summer and 2.5 MGD during the other seasons. With backwashing, the effective seasonal treatment capacities are 3.8 MGD and 2.3 MGD. The 2.3 MGD winter effective treatment capacity will limit existing ASR well recharge capabilities. The treatment capacity currently is the bottleneck for existing and future growth. A new treatment plant is currently under design and will provide a treatment capacity of 4.0 MGD year round.

Demands were determined from Scenario 2 of the water master plan, as explained in section 2.1. In theory, the ASR well would recharge in the winter and extract in the summer and/or peak day events. Because of the seasonal scenarios, average winter day is evaluated when recharging the well, and peak day is used when extracting from the well. The existing winter average day demand and peak day demands are 1.0 MGD and 3.1 MGD, respectively. The future winter average day demand and peak day demands are 1.6 MGD and 4.8 MGD, respectively. **Table 2-2** and **Table 2-3** summarize the existing and future volumes and rates of water available for an ASR well.

Table 2-2. Existing Water Balance

Scenario	Summer		Fall - Winter - Spring	
	gpm	MGD	gpm	MGD
Abiqua and Silver Creek - Water Rights (15 cfs)	6,732	9.7	6,732	9.7
Silver Creek Reservoir Water Right - Greenlight Water	124	0.2	124	0.2
Abiqua Creek Intake Capacity - Existing	4,514	6.5	4,514	6.5
Silver Creek Intake Capacity - Existing	1,597	2.3	1,597	2.3
Treatment Capability - Design Treatment Capacity	2,778	4.0	1,736	2.5
Treatment Capability - Effective Treatment Capacity	2,639	3.8	1,615	2.3
Average Day Demand (ADD) – Existing	1,424	2.1	722	1.0
Peak Day Demand (PDD) – Existing[1]	2,139	3.1		
Water Availability for ASR Storage (Effective WTP Capacity – ADD)			**893**	**1.3**

Note

1 Peak Day Demand is not specified by season in the 2021 Silverton Water Master Plan and assumed to occur during the summer.

Table 2-3. Future Water Balance

Scenario	Summer		Winter	
	gpm	MGD	gpm	MGD
Abiqua and Silver Creek - Water Rights (15 cfs)	6,732	9.7	6,732	9.7
Silver Creek Reservoir - Full Water Right	804	1.2	804	1.2
Abiqua Creek Intake Capacity - Future	4,514	6.5	4,514	6.5
Silver Creek Intake Capacity (2040 flows) - Future	2,826	4.1	2,826	4.1
Treatment Capability - After Improvements	2,778	4.0	2,778	4.0
Average Day Demand - 2055	2222	3.2	1,097	1.6
Peak Day Demand – 2055[1]	3,313	4.8		
Water Availability for ASR Storage (WTP Capacity – ADD Winter 2055)			**1,681**	**2.4**

Note

[1] Peak Day Demand is not specified by season in the 2021 Silverton Water Master Plan and assumed to occur during the summer.

As explained above, the existing Silver Creek intake has a production limitation of 2.3 MGD, although a new intake is set to be built in 2022 that will raise this to 4.1 MGD. Additionally, the Abiqua Creek intake has a capacity of 6.5 MGD. This means the existing treatment limitation of 2.5 MGD in the winter, and effective treatment capacity of 2.3 MGD after backwash will determine the amount of surplus water for ASR. With an existing winter average demand of 1.0 MGD, approximately 1.3 MGD is currently available for recharging in the winter. The existing peak day demand of 3.1 MGD, which most likely occurs in the summer, is less than the effective summer treatment capacity of 3.8 MGD.

In the future, the upgraded design WTP capacity will be 4.0 MGD. The 2055 peak day demand is 4.8 MGD which is 0.8 MGD more than production capacity. The 2055 Winter Average day is 1.6 MGD, leaving approximately 2.4 MGD available for ASR recharge. Thus, if an ASR system is developed, the City can use a portion of this available winter time WTP capacity for recharge and storage to meet the 0.8 MGD WTP capacity shortfall during summer peak demand periods.

3. Hydrogeologic Feasibility

3.1 Geologic Conditions

This section summarizes the general hydrogeologic framework of the Silverton area and potential ASR storage aquifer targets. **Figure 3-1** presents a map of the general geology in the Silverton area and outlines the City's UGB. The predominant geologic units of the area, from youngest to oldest, include alluvial deposits, basalt lava flows of the Columbia River Basalt Group (CRBG), and older marine sediments:

- **Alluvium:** The uppermost hydrogeologic unit in this area consists of alluvial deposits comprised of unconsolidated silt, clay, sand and gravel. This unit is relatively thin in areas of the City where it is exposed at surface and may be up to 250 feet thick in the northwest portions of the Study Area. The alluvium generally consists of an uppermost finer-grained silt unit and underlying coarser-grained Willamette Aquifer. Although the Willamette Aquifer typically has moderate to high permeability with more favorable well yields compared to the overlying silt unit, the aquifer is unconfined to semi-confined and has been shown to be in hydraulic connection with surface waters, rendering it generally less suitable for consideration as an ASR storage aquifer.

- **Columbia River Basalt Group:** The Columbia River Basalt Group (CRBG) hosts an aquifer system that within multiple layered sequences of flood basalts. Work by the USGS (Conlon, et. al., 2005) indicates that CRBG in the Study Area ranges in thickness between 100 and 600 feet. The thickest portion of CRBG (500 feet or greater) is defined by a trough located west-northwest of the City that extends in a northeasterly direction from the Salem area. The CRBG thins out east-southeast of the City.

  Groundwater within the CRBG aquifer system is hosted within thin permeable zones of fractured or rubbly material comprising the top of one flow and the base of the overlying flow. These zones are commonly referred to as “interflow zones” and may be highly transmissive, yielding 250 to >1,000 gpm (reported at various CRBG wells throughout the Willamette Valley). The interflow zones are separated by the dense, low permeability interiors of each basalt flow that inhibit the vertical movement of groundwater, and act as confining layers. The high yield of CRBG interflow zones, limited recharge and intrinsic storage characteristics (thin and confined) renders the CRBG aquifer system highly susceptible to depletion from overdraft (e.g., the Victor Point Groundwater Restricted Area (GRA) located in Silverton). Some of these same characteristics also often contribute to making the CRBG aquifer system highly suitable as an ASR storage aquifer. Approximately three-quarters of the 20+ operational ASR systems in Oregon and Washington are hosted by CRBG aquifers.

- **Marine Sediments (Older Rocks)**: This hydrogeologic unit consists of older consolidated siltstone, sandstone, and claystone that were deposited in ancient marine environments. The marine sediments represent the floor/basement unit of the Willamette Valley and underlie the CRBG in the immediate vicinity of the City and Study Area, with thicknesses estimated to be over 1,000 feet. Small exposures (outcrops) are present in the topographic higher areas to the east and southeast of the City. Groundwater within this unit is commonly saline and well yields are relatively low (<20 gpm). The marine sediments are generally not suitable for ASR because of poor yields.

A conceptual diagram of these hydrogeologic units in the central Willamette Valley is presented on Figure 2B.

3.2 Local Geologic Structures

Geologic structures, such as faults and folds, can act as barriers to groundwater movement, affecting well yields and storage volumes. In some cases, faults and folds can compartmentalize geologic units, limiting natural recharge to and discharge from aquifers. Structures have been found to affect the CRBG aquifer system in a number of ways including:

- Forming barriers to the lateral and vertical movement of groundwater; a series of faults can create hydrologically isolated areas.
- Providing a vertical pathway for hydraulic connection between otherwise confined CRBG aquifers.
- Exposing interflow zones and creating local opportunities for aquifer recharge and/or discharge.

Faults located along Silver Creek and in the southern Silverton area (USGS, 1999) could have potential impact on the occurrence and movement of groundwater through the underlying CRBG aquifers. In general, these structural faults appear to compartmentalize aquifer units and likely may limit the potential of loss of stored water during ASR. Additional evidence of aquifer compartmentalization is suggested by groundwater level declines that preceded declaration of the Victor Point GRA. Faulting appears to be less prominent in the northern and western portions of the City and Study Area, providing a larger area for storage in the CRBG aquifer system.

3.3 Hydrogeologic Conditions

The feasibility of implementing an ASR program for the City would be determined by local hydrogeologic conditions, engineering infrastructure, and source water considerations, which would ascertain the costs and benefits of the program. This section focuses on hydrogeologic considerations. General criteria used as guidelines for evaluating the hydrogeologic feasibility of ASR include the following:

- A productive aquifer capable of yielding target injection and recovery rates to reasonably efficient well, and sufficient storage volume to maintain recovery rates for the duration of critical demand periods. Well yields and injection rates are determined by the productivity of the aquifer and the efficiency of the well, and also are related to the static groundwater level in the well. Target yields for an ASR system have not been defined for the City. We are assuming for the purposes of this analysis that the desired minimum recovery capacity of 1 MGD recovery capacity (694 gpm) to meet the future projected 2055 peak day demand shortfall in WTP capacity of 0.8 MGD.
- The target aquifer is confined and has sufficient available space to store the desired volume of injected water, as determined by the boundaries of the aquifer and depth to groundwater (available "headroom").
- Other high-capacity wells that could capture stored water are not present.
- The aquifer, source water, and native groundwater are geochemically compatible such that chemical interactions will not result in clogging of the aquifer or adversely affect water quality.

The following sections summarize our analysis of these hydrogeologic feasibility criteria in the Silverton area.

3.3.1 Potential Storage Aquifers

Review of the hydrogeologic characteristics of geologic units in the Silverton area indicates that the CRBG is most suitable for hosting an ASR system, and the remainder of this study focuses on the CRBG as a potential ASR storage aquifer. The CRBG is commonly used to host ASR systems in Oregon because it is confined, contains productive storage zones and the native groundwater and host rock are typically geochemically compatible with the injection source water. The CRBG underlies the entire Silverton area, and thicker and deeper sequences of these basalt flows and interflows generally present greater potential for the presence of suitably productive aquifers for an ASR system.

3.3.2 Well Yield

Aquifer productivity within CRBG aquifers underlying the Silverton area appears to be favorable for ASR development as there are several wells with relatively high well yields and specific capacities that are similar to other successful ASR systems in the Willamette Valley. GSI focused its research within the Study Area on deeper basalt wells (greater than 200 feet bgs and generally drilled for irrigation purposes) with relatively high reported yields (greater than 100 gpm). Reported well yields from deeper CRBG-supply wells (greater than 200 feet bgs) in the Silverton area generally range from 100 to 1,800 gpm. **Figure 3-1** presents a spatial distribution of the wells that meet these criteria, including OWRD well code, well depth (in feet), and yield (in gpm). It is unknown how many of the wells shown on **Figure 3-1** have reported capacities that represent the full yield potential of CRBG water bearing-zones in this area, because drillers generally will only drill to a depth where the target yield is achieved, and many of the wells not shown on **Figure 3-1** are drilled for domestic supply, needing only 5 to 20 gpm of capacity.

Well yields generally increase with depth within the Study Area. Overall, the north, west, and southwest portions of Silverton and the Study Area appear to have wells with relatively high yields in thicker sections of CRBG. Conversely, areas in the southern and eastern portions of Silverton have thinner sections of CRBG; basalt wells in the Victor Point GRA were relatively deep but have relatively low yields (~5 - 20 gpm).

SC is another measurement of aquifer productivity that integrates the performance of a well and yield of the aquifer. The higher the specific capacity, the more productive the well and, generally, the higher aquifer transmissivity. Although specific capacity will vary with pumping rate, available drawdown, duration of pumping and well construction, it is still a useful estimate for the comparison of wells that yield water from the same aquifer and a reasonable approximation for the aquifer response anticipated for the recharge and recovery for ASR. Specific capacities for CRBG wells in the Silverton area vary considerably, but generally have been found to be between 4 and 12 gallons per minute of yield per foot of drawdown in the well (gpm/ft). The reported specific capacities for some higher capacity wells in the vicinity of Silverton include:

- The City of Mount Angel's three supply wells are open to between 160 ft and 460 ft of the same units of the CRBG aquifer system that are present in Silverton. The wells reported yields of 600 to 1,200 gpm and specific capacities ranging between 4 and 10 gpm/ft.
- The 24-hour specific capacity of the City of Stayton ASR test well was 49 gpm/ft at a pumping rate of approximately 500 gpm.
- Woody (2007) reported a specific capacity of 51 gpm/ft for the irrigation well in the Mount Angel area.

These values fall within range of specific capacities of municipal ASR wells in CRBG aquifers located in the Willamette Valley, which commonly range between 3 gpm/ft and 30 gpm/ft, with well yields range from 450 gpm to over 2,000 gpm.

3.3.3 Hydraulic Properties

Aquifer properties including transmissivity, storativity, and aquifer boundary conditions are also important characteristics for assessing the feasibility of ASR at a particular location and can be helpful to determine potential injection and recovery rates. Transmissivity is a measure of the productivity of an aquifer and is a function of its hydraulic conductivity and thickness. Storativity is a measure of the storage characteristics of an aquifer. CRBG aquifers typically have high transmissivities and low storativities. The implication of these characteristics is that the CRBG aquifers are often capable of accepting and yielding water at high rates, but are subject to relatively greater water level changes in response to the injection or pumping than many sedimentary aquifers.

Aquifer test data presented in Table 2 of *Ground-Water Hydrology of the Willamette Basin, Oregon* (Conlon, et. al., 2005) for wells completed in the CRBG in the Central Willamette area indicate a range of observed values for transmissivity between 14,500 to 32,000 ft^2/day. Hydraulic parameters for the CRBG aquifer system derived from pumping tests of wells in the vicinity of Silverton include:

1. Mount Angel Well 6 (located approximately 4 miles north of Silverton) has a reported range of transmissivity values from 18,000 to 23,000 ft^2/day.
2. The near-field (early time) transmissivity in the City of Stayton ASR test well is greater than 13,000 ft^2/day.
3. An irrigation well in the Mount Angel area was reported to have a transmissivity of 18,000 ft^2/day (Woody, 2007).

These values for transmissivity fall within the ranges observed at successful ASR systems utilizing the CRBG aquifer system elsewhere in the Willamette Valley.

Storativity values can vary between 0.00001 and 0.01 in the CRBG, and usually fall between 0.0001 and 0.001.

3.3.4 Water Levels

Depth to groundwater within the target aquifer is another criterion for assessing the feasibility of ASR. The depth to groundwater determines how much "headroom," or draw up is available for ASR recharge, and how much drawdown above the aquifer is available for recovery pumping. Injection headroom and available drawdown, together with the well performance and aquifer parameters, determine achievable long-term injection and recovery rates. While the preference is to inject without water levels exceeding ground surface, it is possible to design wellhead systems to inject under pressure, though with greater capital and operational costs.

Hydrographs for basalt wells in the Study Area with available long-term water level datasets from OWRD's Groundwater Information System Mapping Tool were reviewed for this study. Water levels in a majority of the basalt wells reviewed were observed to be at or near their historical lows and generally exhibit declining trends overall. Measurements from March 2020 reveal that depth to groundwater in CRBG wells within the Study Area varies from 34 ft to 210 ft below ground surface (bgs), corresponding to elevations of between 102 feet above mean sea level (msl) to 111 feet msl. Based on the available land and water surface elevation data, water levels below ground surface are anticipated to be shallower (i.e. less available headroom) in the north, northwest and west portions of the City and the Study Area. Water levels are anticipated to significantly deeper (more available head room) in the southern and eastern portions of the City, especially where there are topographic highs. Available drawdown in many of the wells with deep water levels (more headroom) may not have sufficient available drawdown to sustain desired yields. There are several deep basalt wells within the Victor Point GRA that have deep water levels and poor well yields, indicating limited recovery potential for ASR.

3.3.5 Groundwater Quality

Understanding water quality dynamics is essential to evaluating the technical feasibility of an ASR program. Only two different public-use basalt wells (MARI 19809 and MARI 56164) were located in the general Study Area; water quality data for these wells were available on the Oregon Public Health's Drinking Water Data Online website. Water quality data for the Mount Angel wells were also reviewed for this study. These wells are relatively proximal to the City (within 4 miles) and are constructed into CRBG aquifers. Below is a summary of the general groundwater quality characteristics for basalt wells in the region based on review of those available data sources.

The groundwater character of the local CRBG aquifers systems in the region appear to be predominant a mixed sodium- to calcium-bicarbonate ($Na\text{-}HCO_3$ to $Ca\text{-}HCO_3$) type, suggesting the water is somewhat evolved geochemically. Groundwater in the CRBG evolves from a calcium-bicarbonate type to a sodium bicarbonate-type along its flow path. Arsenic was also detected in two of the Mount Angel wells, but at concentration below current EPA Maximum Contaminant Levels (MCLs) for drinking water. There were also few detections for radiological constituents such as gross alpha, radium, and uranium in a few wells, but all detections were below their respective MCLs for drinking water. Overall, groundwater pumped from the Mount Angel wells is not chlorinated, does not require treatment, and meets all State and Federal drinking water requirements (MSA, 2010). There are no other known groundwater quality issues from basalt wells within and/or near the study area. Additional native basalt groundwater and ASR injection source water quality data should be collected and evaluated for geochemical compatibility as part of a next, proof-of-concept phase of a feasibility study.

3.3.6 Local ASR Systems

Municipalities throughout Washington and Oregon have been using ASR to store excess treated drinking water in CRBG-hosted aquifers since the mid- to late-1990s as a means to help optimize their water right portfolios, manage their water supply resources and provide drought resiliency. Eight ASR systems hosted in CRBG aquifers are currently operational in the Willamette Valley, and at least seven other CRBG-hosted systems are operating in eastern Oregon and Washington. Consequently, much is known about characterizing ASR feasibility, storage characteristics, geochemical compatibility, and well operations of these CRBG-hosted systems. Existing CRBG ASR systems that are proximal to Silverton include the City of Salem, and Fessler Nursery. In addition, areas near Silverton have been determined to have suitable storage aquifers, including the Mt Angel area (Woody, 2007), and recently, Stayton. Information regarding the ASR systems and evaluations in the general area is summarized below:

- City of Salem ASR: The City of Salem began pilot-testing their ASR system in 1997 using treated surface water from the North Santiam River as the ASR supply source. Salem currently operates four ASR wells completed in the CRBG aquifer system, and to date has successfully stored more than 1,900 acre-feet (620 million gallons, MG) annually for subsequent recovery and beneficial use. Salem is currently considering adding additional ASR wells and expanding their ASR program.
- Fessler Nursery: Fessler nursery operates a small-scale ASR system that utilizes the CRBG aquifer system to store water for irrigation purposes, the fourth such system used for irrigation in Oregon. Fessler Nursery is located approximately 6 miles north of Silverton.
- City of Mount Angel: Mt Angel, located approximately 4 miles to the north of Silverton, was identified as an area with favorable characteristics for ASR in a statewide evaluation of ASR Feasibility based on suitable aquifer storage for ASR and with 75% of optimal ASR parameters based on a study by Woody (2007).
- City of Stayton: As indicated earlier, Stayton is conducting an ASR feasibility study and initial findings indicate the presence of a suitable storage aquifer in the CRBG. The feasibility study will be completed in Spring 2022.

3.4 ASR Development Areas

Hydrogeologically, the most favorable areas for ASR development within the Study Area appear to be in the northern and western portions of the UGB, and along alignment of Highway 214 (**Figure 3-3**). Although CRBG aquifers underlie the entire City and Study Area, thicker sections of the CRBG, which are likely to encounter more suitable storage zones, are located in the north and west portions of the City and Study Area, and away from the upland areas to the east and south of the City, where the CRBG thins out.

Mapped geologic structures likely compartmentalize areas in the uplands south and east of Silverton, potentially constraining storage volumes and injection/recovery rates excessively. The Victor Point GRA is an area with relatively low well yields and historically declining water levels. The northern and western portions of the City and the Study Area appear to have higher well yields and are located outside the geologically compartmentalized areas to the south and east.

3.5 Potential Injection and Recovery Rates

3.5.1 Injection Rates

Injection rates depend on a variety of factors including aquifer characteristics and boundaries and well performance. In the absence of injection testing data, the injection capacity of a well can be estimated using available pumping specific capacity data. As discussed in Section 3.3.2, pumping specific capacity values from CRBG wells in the Study Area generally ranged from 4 to 12 gpm/ft. Potential injection rates are calculated according to the equation:

$$Q_{inj} = SC_{inj} * s_{inj}$$

Where

Q_{inj} = Injection rate (gpm)
Sc_{inj} = Injection specific capacity (gpm/ft)
s_{inj} = Injection head room or available draw up (ft)

The values used for injection specific capacity and headroom for this evaluation are based on the following assumptions:

Injection Specific Capacity: A pumping specific capacity value of 8 gpm/ft was used as basis to estimate potential injection rates for an ASR well in the Silverton area. This value is considered to be conservative as there is data for nearby wells to suggest specific capacity from deeper CRBG aquifers could be higher. In our experience and for these purposes, the injection specific capacity is conservatively assumed to be between 50% and 75% of the specific capacity of pumping, or approximately 4 to 6 gpm/ft.

Injection Headroom: Considering potential well interference, and average depths to water available head room or draw up in an ASR well is estimated to range between 75 and 125 ft during the wet season when injection would likely be conducted. Assuming that the injection water level in the well would be kept below the ground surface, and applying a safety factor of 15 feet, the total available draw up is 60 to 110 feet.

Using these assumptions, potential injection rates range between 300 gpm (0.4 MGD) and 694 gpm (1 MGD) using the average of specific capacities in the area. The estimated injection rates based on the higher end of the typical range of pumping specific capacities (12 gpm/ft) would be 450 gpm to greater than 1,000 gpm. Significantly higher rates could be achieved if the ASR system was designed to inject under pressure (injection head above land surface). ASR systems that inject under pressure are commonly designed for maximum pressures of 100 pounds per square inch (psi) and operated at pressures of approximately 50 psi, or an approximate elevation head of 115 feet above ground surface.

Final achievable injection rates would be determined with a test well drilling and testing program, as part of the next phase of the feasibility study. For comparison purposes, the injection rates for municipal systems using CRBG aquifers for ASR in the Willamette Valley range from 350 gpm to 1,400 gpm.

3.5.2 Recovery Rates

Using the hydrogeologic data collected from this evaluation, as well as other operational assumptions for ASR, potential recovery rates can be estimated for a new ASR well. For this recovery rate estimate, we have assumed the following aquifer and pumping parameters:

a. Ground surface elevation = 200 to 250 feet above mean sea level, amsl
b. Static water level elevation = 100 to 115 feet amsl
c. Depth to CRBG = 200 feet bgs
d. Top of CRBG elevation = 0 to 50 feet amsl
e. Depth to storage zone = 400 feet (200 feet into the CRBG)
f. Storage zone elevation = -200 to -150 feet amsl
g. Assumed minimum pump submergence = 40 feet (net positive suction head + 15 feet safety factor)
h. Maximum drawdown (elevation) = -160 to -110 feet amsl
i. Available drawdown (feet) = 210 to 275 feet

Based on the above parameters, if we assume a pumping specific capacity in the range of 6 to 8 gpm/ft, then estimated recovery rates theoretically could be on the order of 1.8 to 3.5 MGD (1,250 to 2,000 gpm). These estimated recovery rates do not account for potentially unknown aquifer boundaries that might be identified as part of a test well drilling program in the next phase of the feasibility study. None of the wells located near Silverton report pumping rates this high, but several report capacities in excess of the assumed target recovery rate of 1 MGD, and recovery rates in Salem ASR wells are within the lower end of the estimated range.

3.5.3 Potential Storage Volumes

Potential storage volumes were estimated based on the estimated range of injection rates and assuming a 5-month injection period consisting of 140 days of active injection. The remaining 10 days in the period are assumed to accommodate periodic backflushing events and for system maintenance. The estimated storage volumes over this time period based on the injection rates that assume injection is conducted under gravity-flow only range from 61 to 133 MG. Assuming an allowable recovery of 95 percent, this range of storage volumes would accommodate between 57 and 126 days of pumping at a target recovery rate of 1 MGD. We have reason to believe that the lower end of this storage volume may be highly conservative; however, the achievable recovery/injection rates and storage volumes remain uncertain until a test well or full-scale ASR well is completed.

4. Potential ASR Sites

Several properties located throughout the City were evaluated for potential well siting. Considerations included redundant offsite emergency water source, higher probability of reaching thicker CRBG layer, distribution network impacts, public vs private property, environmental permitting/land use impacts, and cost. Extracted water will need to be routed to stormwater infrastructure or to an authorized outfall, approximately 1,000 gpm for 30 minutes during each startup, or pump-to-waste process.

Potential properties were narrowed down to four sites (Figure 4-1): Silverton High School, New Reservoir site, Industrial Parcels, and the Senior Center Park. The Silverton High School, located in Northwest Silverton is connected to the treatment plant through 1.7 miles of pipeline. The site is zoned as public/semi-public and is in the low level zone. The New Reservoir site is in Southwest Silverton and is connected through 2.2 miles of pipeline. The Water Master Plan calls for a new reservoir to be built on this site. The site is zoned as public/semi-public and is in the Edison Booster Zone. The Industrial site located in Northeast Silverton and is connected through 0.9 miles of pipeline. The site is zoned as public/semi-public and is in the low level Zone. The Senior Center Park site is in the western side of Silverton and is connected through 1.3 miles of pipeline. The site is zoned as public/semi-public and is in the Anderson PRV Zone. The Selection Matrix scoring each site is summarized below in Table 4-1. The scores range from 1 to 5 with 5 being the best.

Table 4-1. Selection Matrix

	Redundant Offsite Emergency Water Source	Hydro-geologic ASR Suitability	Distribution Network Impacts	Public vs Private Property	Environ-mental Permitting / Land Use Impacts	Cost	Totals
Weighting	**15%**	**30%**	**15%**	**5%**	**5%**	**30%**	
High School	2	4	3	3	5	2	**3.0**
New Reservoir Location (Victor Pointe)	5	2	1	5	5	1	**2.3**
Industrial Parcels (Eska Way)	2	4	5	1	2	4	**3.6**
Senior Center Park	2	4	3	3	3	3	**3.2**

4.1 Planning-level cost estimates

AACE level 5 cost estimates were developed for the top two scored sites. **Table 4-2** and **Table 4-3** provide cost estimates for the Industrial Parcels and the Community Center Park sites, respectively. Actual construction costs may differ from the estimates presented, depending on specific design requirements and economic climate when a project is bid. An AACE Class 5 estimate is normally expected to be within -50 and +100 percent of the actual construction cost. As a result, the final costs will vary from the estimate presented in this document. The range of accuracy for a Class 5 cost estimate is broad, but these are typical accuracy levels for planning work.

The costs are based on experience with similar water distribution improvement and master planning projects. The cost estimates provide costs for well drilling and other well development costs (i.e permitting, testing). The total estimated probable project costs include contractor markups and 30% contingencies. Overall project costs include total construction costs, costs for engineering design, construction management services, inspection, as well as administrative costs.

Table 4-2. Industrial Parcels Cost Estimate

General Line Item	Est. Qty	Unit	Unit Price	Amount
Final Feasibility Study/Proof-of-Concept	1	LS	$400,000	$400,000
Contingency and Allowances	1	LS	30%	$120,000
Final Feasibility Subtotal				**$520,000**
10-inch DI Pipe - Excavation, Backfill, Fittings	1,700	LF	$280	$480,000
Full Lane Pavement Repair	200	LF	$100	$20,000
Traffic Control	200	LF	$15	$3,000
New Well – Drilling, Construction, and Testing	1	LS	$750,000	$750,000
New Well - Structural, Mechanical, Electrical, Site Work	1	LS	$1,745,000	$1,745,000
Pump-to-Waste and Stormwater Detention Pond	1	LS	$100,000	$100,000
Mobilization	1	LS	10%	$310,000
Contingency and Allowances	1	LS	30%	$929,000
Construction Subtotal (rounded)				**$4,337,000**
Engineering and CMS	1	LS	25%	$1,085,000
Legal and Admin	1	LS	5%	$217,000
Land Acquisition	1	LS	$100,000	$100,000
Permitting – ASR Well	1	LS	$65,000	$65,000
Permitting – Site Development	1	LS	$200,000	$200,000
Total Project Cost (rounded)				**$6,524,000**

Notes

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates and/or GSI has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates and/or GSI cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

Table 4-3. Senior Center Cost Estimates

General Line Item	Est. Qty	Unit	Unit Price	Amount
Final Feasibility/Proof-of-Concept	1	LS	$400,000	$400,000
Contingency and Allowances	1	LS	30%	$120,000
Final Feasibility Subtotal				**$ 520,000**
10-inch DI Pipe - Excavation, Backfill, Fittings	4,300	LF	$280	$1,204,000
Full Lane Pavement Repair	3,800	LF	$100	$380,000
Traffic Control	3,800	LF	$15	$57,000
New Well – Drilling, Construction, and Testing	1	LS	$750,000	$750,000
New Well - Structural, Mechanical, Electrical, Site Work	1	LS	$1,745,000	$1,745,000
Pump-to-Waste and Stormwater Detention Pond	1	LS	$100,000	$100,000
Mobilization	1	LS	10%	$424,000
Contingency and Allowances	1	LS	30%	$1,398,000
Construction Subtotal (rounded)				**$6,058,000**
Engineering and CMS	1	LS	25%	$1,514,000
Legal and Admin	1	LS	5%	$302,900
Permitting – ASR Well	1	LS	$65,000	$65,000
Permitting – Site Development	1	LS	$30,000	$30,000
Total Project Cost (rounded)				**$8,490,400**

Notes

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Keller Associates and/or GSI has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates and/or GSI cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

5. Conclusions

The findings from this preliminary evaluation of hydrogeologic and technical feasibility indicate that development of ASR appears feasible in the Silverton area utilizing a storage aquifer in the CRBG. The CRBG aquifers underlying the City and defined Study Area support highly productive wells with specific capacities ranging between 4 and 12 gpm/ft, or possibly higher, based on recent aquifer testing results of nearby wells. Groundwater levels in this highly productive aquifer will allow target rates of recharge and recovery, and a large capacity for ASR storage with minimal potential for creative excessive groundwater level changes in other wells. Aquifer characteristics in the CBRG in the northern and western portions of the City are most favorable for ASR.

Potential injection rates for a new ASR well could be on the order of 300 (0.4 MGD) to 694 gpm (1 MGD), or significantly greater if the future system is designed to inject under pressure. Achievable recovery rates are estimated to meet or exceed the assumed target demands for recovery of 1 MGD assuming a suitable aquifer is identified at the selected location for an ASR system.

Based on existing water availability, surface water rights, and water system capacities, there appears to be capacity to support a new ASR system in the Silverton area. Based on existing infrastructure and water system capacities, approximately 1.3 MGD is currently available for recharge source water in the low demand month. Recovery from an ASR well could also be used to meet future system peak demand shortcomings during summer peak demand periods.

6. Next Steps

An ASR system would be adaptable to the City's existing infrastructure, including existing water sources. An ASR system would provide the City a redundant source of water and would increase the overall system resiliency combined with the City's existing surface water supply sources. Infrastructure requirements would include a new ASR well, connectivity to the sanitary sewer conveyance for pump to waste, conveyance piping from the water treatment plant to the well, as well as direct connectivity to the City's distribution system. Should the City decide to explore the feasibility of developing an ASR system as a redundant source, the next steps typically includes the following:

1. **Final feasibility Study/Proof-of-Concept**

   This step involves a field investigation to verify findings from this initial feasibility evaluation and develop final system design parameters and costs that include:

- Drill an exploratory borehole on one or more select sites
- Conduct hydraulic testing to evaluate storage aquifer parameters including design storage volume, and injection and recovery rates
- Collect samples of native groundwater and complete an equilibrium geochemical compatibility modeling to evaluate potential reactions between source water, native groundwater, and the aquifer matrix.
- Develop preliminary system design
- Refine initial evaluation cost estimates to site and construct an ASR well
- Make go/no-go decision
- Apply for water supply development grant funding

2. **System Construction and Permitting**

- Apply for an ASR limited license and other permits
- Design, drill and complete a full-scale ASR well
- Complete design and construction of ASR wellhead, controls, electrical, distribution, and disinfection improvements
- Complete short-duration shakedown and cycle testing to verify system performance

Complete full-scale injection, storage, and recovery testing, including delivering recovered water to customers

3. Apply for ASR Permit

- Obtain permanent ASR system when full system is developed and tested

The ASR permitting process is relatively straight forward and familiar to the regulatory agencies involved, including OWRD, Oregon Department of Environmental Quality (ODEQ) and OHA-DWP. ASR operational pilot testing is authorized under the ASR Limited License issues by OWRD. A Class V underground injection control (UIC) permit from ODEQ and new source plan review approval from OHA-DWP are required for construction of an ASR Well. Based on GSI's experience in permitting and operating several CRBG-hosted systems in the Willamette Valley, significant permitting hurdles for an ASR system in Silverton are not anticipated. OWRD is likely to look favorably on development of an ASR system in the CRBG within the Silverton area.

7. References

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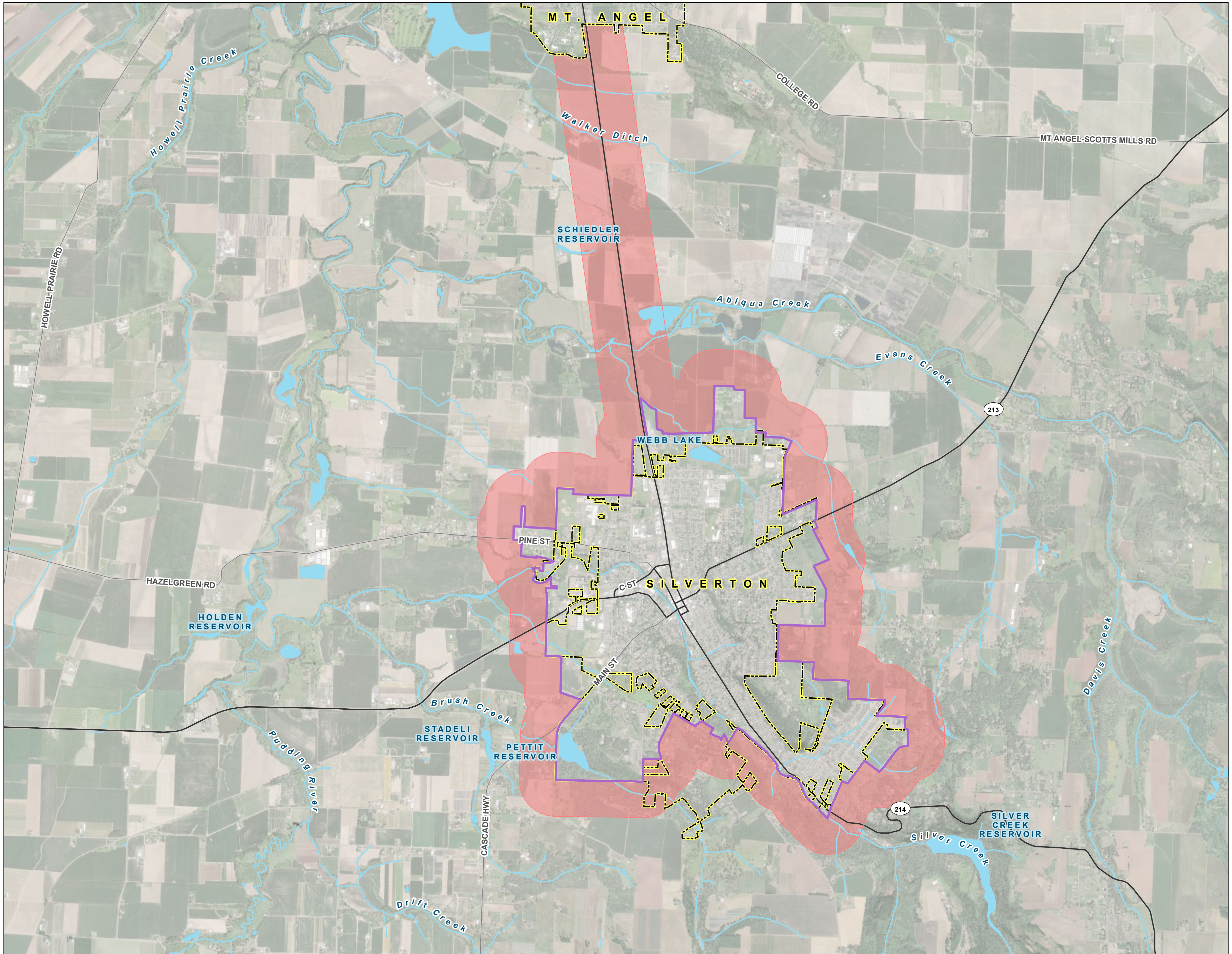

FIGURE 1-1
Overview Map
Silverton, Oregon

LEGEND

- Study Area
- City Boundary
- Urban Growth Boundary
- Major Road
- Watercourse
- Waterbody

N

0 1,750 3,500
Feet

Date: February 3, 2022
Data Sources: BLM, ESRI, ODOT, USGS, Maxar Imagery (2021)

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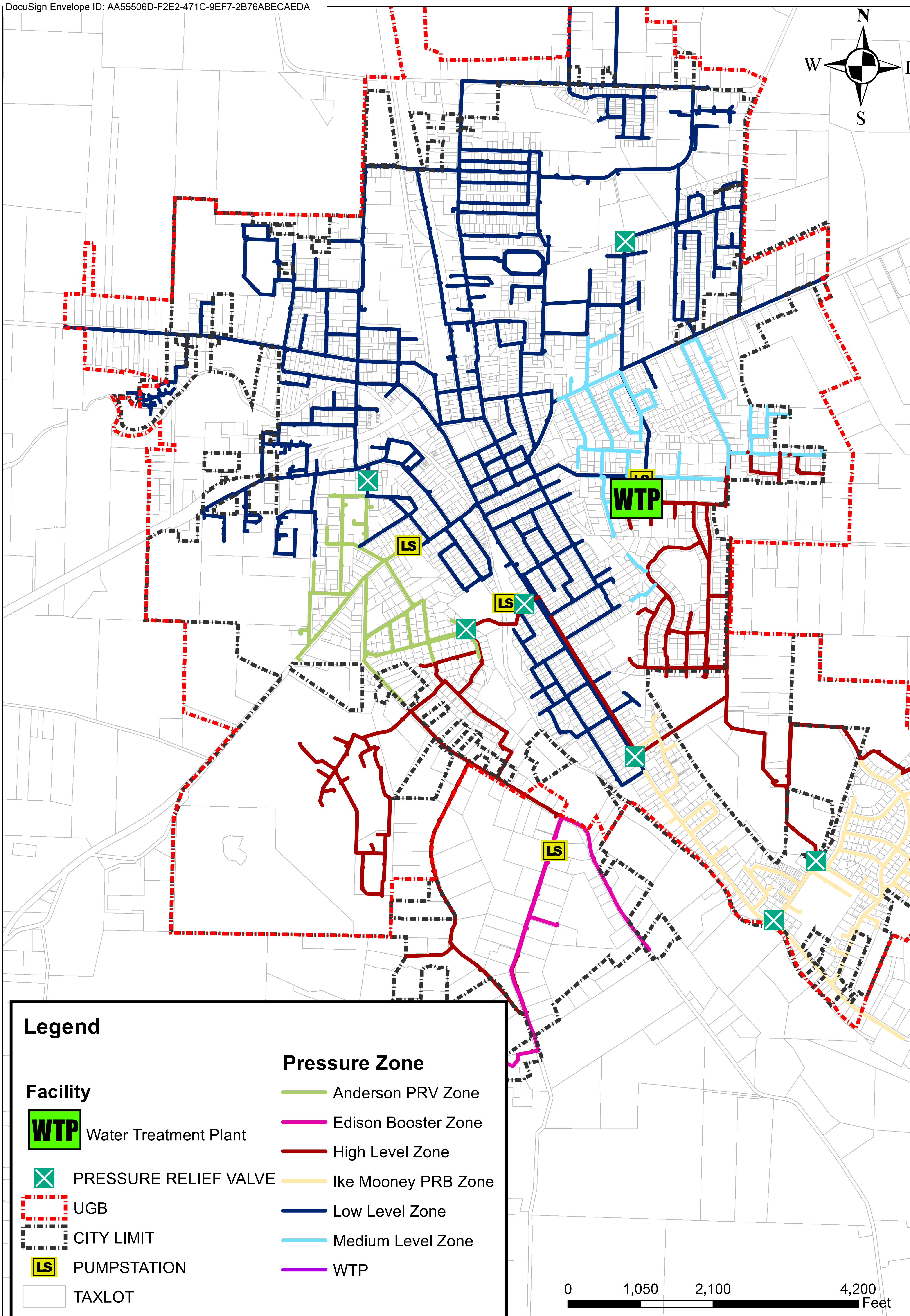

KELLER ASSOCIATES

Pressure Zones

Initial Feasibility Evaluation of ASR

CITY OF SILVERTON EST 1854 OREGON'S GARDEN CITY

Figure 2-1

City of Silverton, OR

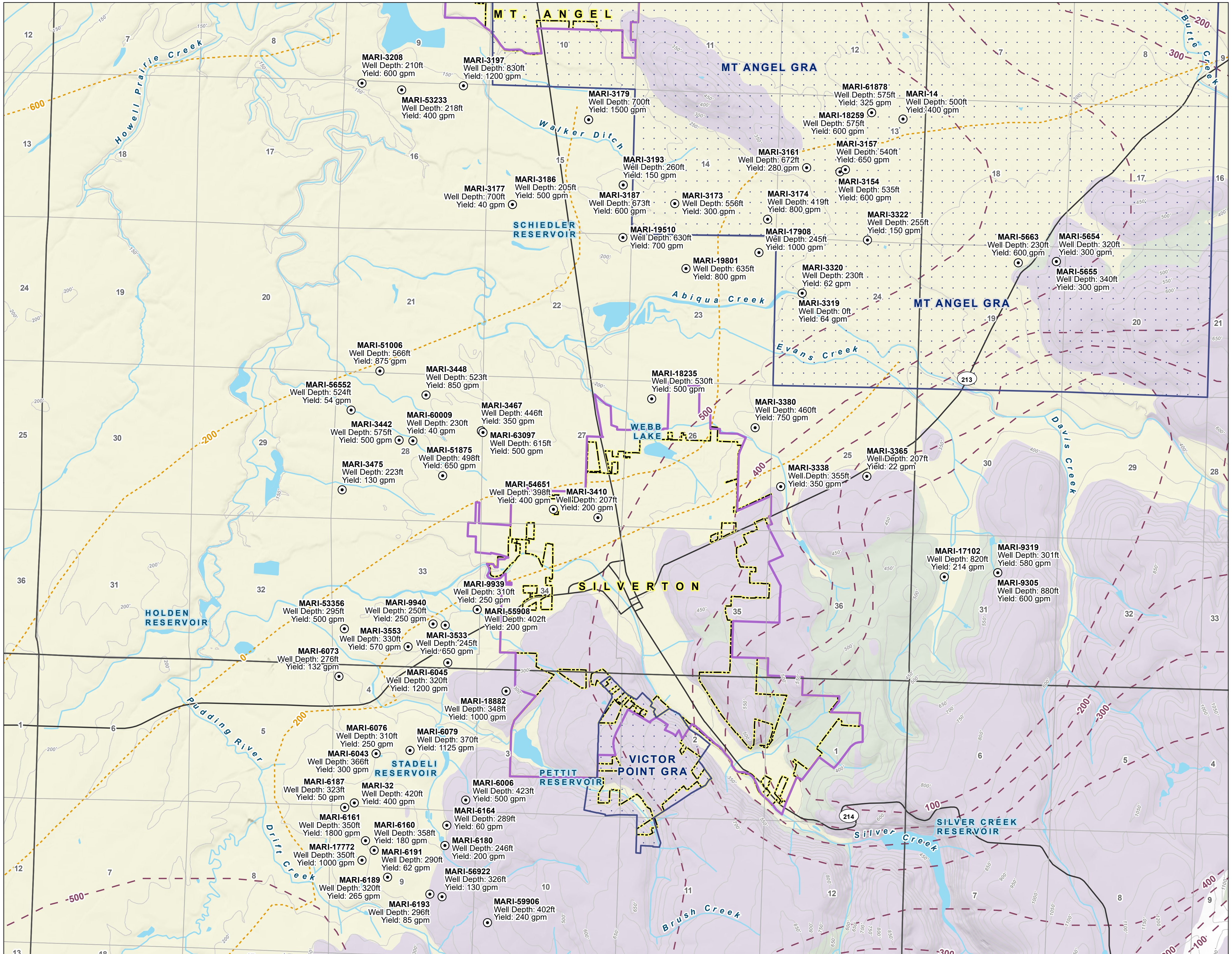

FIGURE 3-1

General Geology Map

Silverton, Oregon

LEGEND

- Irrigation Well (depth > 200ft)
- Approximate Thickness in feet of Columbia River Basalt Group[1]
- Altitude in feet of the Top of Columbia River Basalt Group[1]
- Surface Contour (feet)
- Groundwater Restrictive Area (GRA)

Generalized Geology

- Alluvium
- Columbia River Basalt Group
- Older Rocks

All Other Features

- Major Road
- City Boundary
- Urban Growth Boundary
- Watercourse
- Waterbody

NOTES

gpm: gallons per minute

[1]Isopach and contour lines adapted from a 2005 USGS-OWRD report, Figure 9 and 10.

N

0 1,750 3,500

Feet

Date: February 3, 2022

Data Sources: BLM, ESRI, ODOT, USGS, DOGAMI

GSI Water Solutions, Inc.

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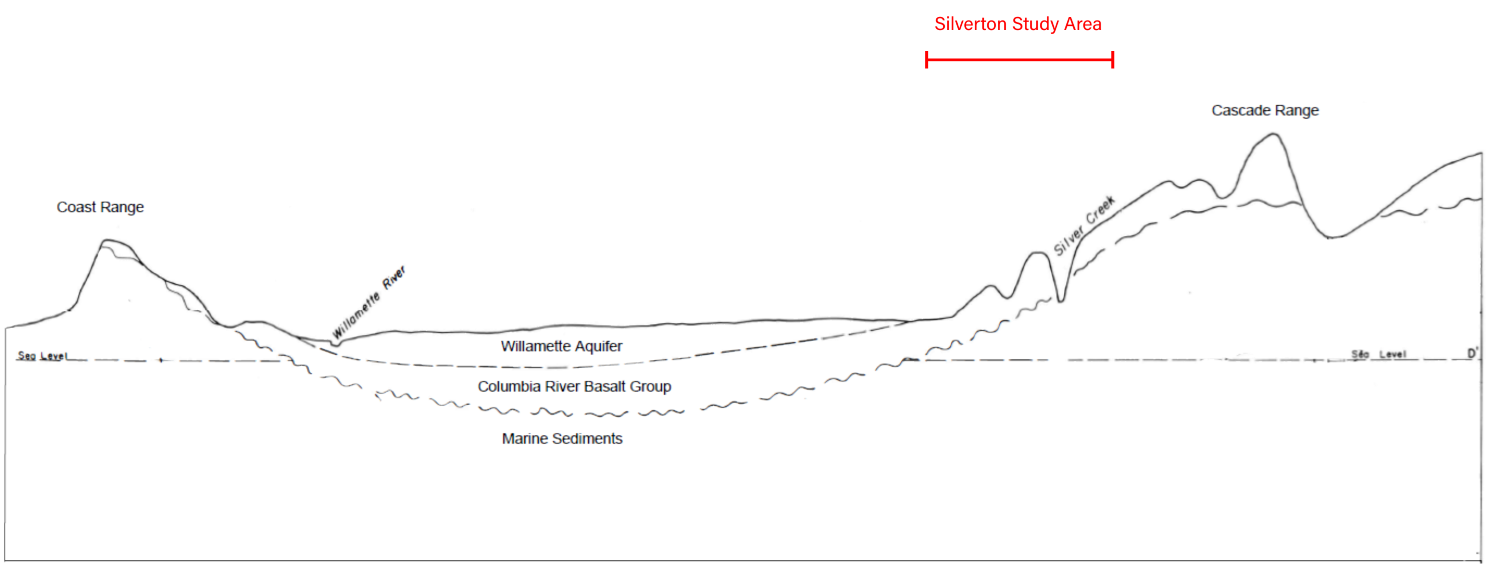

FIGURE 3-2

Conceptual Diagram of Major Hydrogeologic Units in the Central Willamette Valley

Silverton, Oregon

GSI Water Solutions, Inc.

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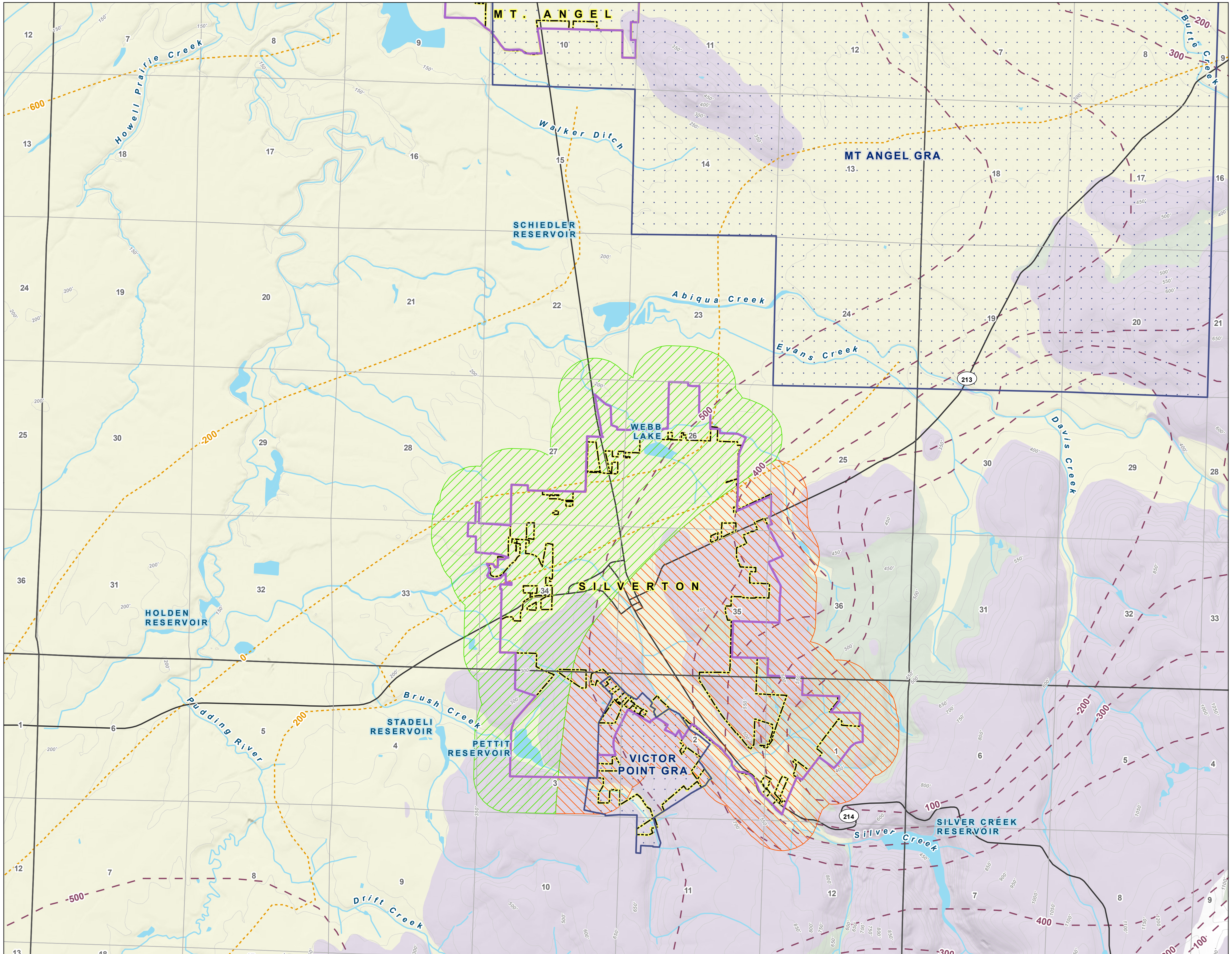

FIGURE 3-3

Preferred ASR Development Area

Silverton, Oregon

LEGEND

- Approximate Thickness in feet of Columbia River Basalt Group[1]
- Altitude in feet of the Top of Columbia River Basalt Group[1]
- Surface Contour (feet)
- Groundwater Restrictive Area (GRA)

ASR Development Area

- More Favorable ASR
- Less Favorable ASR

Generalized Geology

- Alluvium
- Columbia River Basalt Group
- Older Rocks

All Other Features

- Major Road
- City Boundary
- Urban Growth Boundary
- Watercourse
- Waterbody

NOTE

[1]Isopach and contour lines adapted from a 2005 USGS-OWRD report, Figure 9 and 10.

N

0 1,750 3,500
Feet

Date: February 3, 2022
Data Sources: BLM, ESRI, ODOT, USGS, DOGAMI

GSI Water Solutions, Inc.

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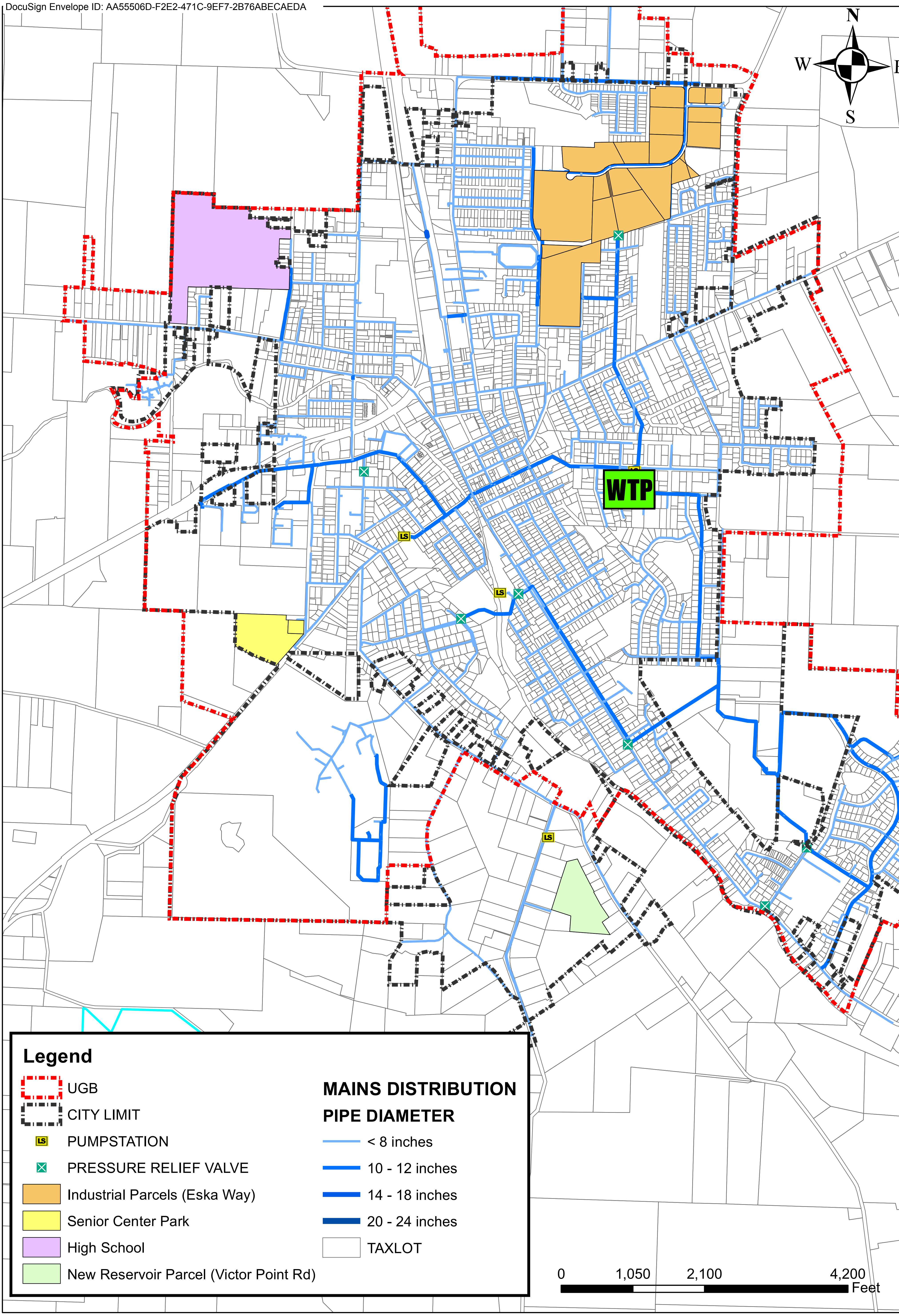

KELLER ASSOCIATES

Potential ASR Sites

Initial Feasibility Evaluation of ASR

CITY OF SILVERTON EST 1854 OREGON'S GARDEN CITY

Figure 4-1

City of Silverton, OR