TRUCKEE MEADOWS WATER AUTHORITY
Board of Directors

AGENDA

NEW DAY& TIME: Thursday, May 19, 2022 at 9:30 a.m.
Sparks Council Chambers, 745 4th Street, Sparks, NV

Board Members

Chair Vaughn Hartung
Member Neoma Jardon
Member Jenny Brekhus
Member Paul Anderson
Vice Chair Kristopher Dahir
Member Alexis Hill
Member Naomi Duerr

NOTES:

1.The announcement of this meeting has been posted at the following locations: Truckee Meadows Water Authority (1355 Capital Blvd., Reno), at http://www.tmwa.com, and State of Nevada Public Notice Website, https://notice.nv.gov/.

2. In accordance with NRS 241.020, this agenda closes three working days prior to the meeting. We are pleased to make reasonable accommodations for persons who are disabled and wish to attend meetings. If you require special arrangements for the meeting, please call (775) 834-8002 at least 24 hours before the meeting date.

3. Staff reports and supporting material for the meeting are available at TMWA and on the TMWA website at http://www.tmwa.com/meeting/. Supporting material is made available to the general public in accordance with NRS 241.020(6).

4. The Board may elect to combine agenda items, consider agenda items out of order, remove agenda items, or delay discussion on agenda items. Arrive at the meeting at the posted time to hear item(s) of interest.

5. Asterisks (*) denote non-action items.

6. Public comment is limited to three minutes and is allowed during the public comment periods. The public may sign-up to speak during the public comment period or on a specific agenda item by completing a "Request to Speak" card and submitting it to the clerk. In addition to the public comment periods, the Chairman has the discretion to allow public comment on any agenda item, including any item on which action is to be taken.

7. In the event the Chairman and Vice-Chairman are absent, the remaining Board members may elect a temporary presiding officer to preside over the meeting until the Chairman or Vice-Chairman are present (**Standing Item of Possible Action**).

8. Notice of possible quorum of Western Regional Water Commission: Because several members of the Truckee Meadows Water Authority Board of Directors are also Trustees of the Western Regional Water Commission, it is possible that a quorum of the Western Regional Water Commission may be present, however, such members will not deliberate or take action at this meeting in their capacity as Trustees of the Western Regional Water Commission.

1. Roll call*

2. Pledge of allegiance*

3. Public comment — limited to no more than three minutes per speaker*

4. Possible Board comments or acknowledgements*

5. Approval of the agenda **(For Possible Action)**

6. Approval of the minutes of the April 20, 2022 meeting of the TMWA Board of Directors **(For Possible Action)**

[1.] The Board may adjourn from the public meeting at any time during the agenda to receive information and conduct labor-oriented discussions in accordance with NRS 288.220 or receive information from legal counsel regarding potential or existing litigation and to deliberate toward a decision on such matters related to litigation or potential litigation.

* Attorney-client conference (Board will receive information in closed session) — Lucas Foletta*

7. Presentation of fiscal year 2022 Q3 year to date financial results — Matt Bowman*

8. PUBLIC HEARING ON ADOPTION OF BUDGET

   A. Discussion, and action on request for adoption of Resolution No. 304: A resolution to adopt the final budget for the Fiscal Year ending June 30, 2023 and the 2023-2027 Five-Year Capital Improvement Plan — Matt Bowman and Sandra Tozi **(For Possible Action)**

   B. Public comment — limited to no more than three minutes per speaker*

   CLOSE PUBLIC HEARING

9. Discussion and possible action regarding Palomino Farms Feasibility Study and request for Board direction — John Enloe and Stefanie Morris **(For Possible Action)**

10. General Manager's Report*

11. Public comment — limited to no more than three minutes per speaker*

12. Board comments and requests for future agenda items*

13. Adjournment **(For Possible Action)**

[1.] The Board may adjourn from the public meeting at any time during the agenda to receive information and conduct labor-oriented discussions in accordance with NRS 288.220 or receive information from legal counsel regarding potential or existing litigation and to deliberate toward a decision on such matters related to litigation or potential litigation.

TRUCKEE MEADOWS WATER AUTHORITY
DRAFT MINUTES OF THE APRIL 20, 2022
MEETING OF THE BOARD OF DIRECTORS

The Board of Directors met on Wednesday, April 20, 2022, at Sparks Council Chambers. Chair Hartung called the meeting to order at 10:00 a.m.

1. ROLL CALL

Directors Present: Paul Anderson, Kristopher Dahir, Naomi Duerr, Vaughn Hartung, *Alexis Hill, and **Neoma Jardon.

Director Absent: Jenny Brekhus

A quorum was present.

Director Hill attended virtually between 11:04 a.m. thru 11:16 a.m. and 12:30 p.m. thru 12:45 p.m.

*****Director Jardon attended virtually between 11:32 a.m. thru 11:50 a.m.***

2. PLEDGE OF ALLEGIANCE

The pledge of allegiance was led by Director Jardon.

3. PUBLIC COMMENT

There was no public comment.

4. POSSIBLE BOARD COMMENTS OR ACKNOWLEDGEMENTS

There were no Board comments.

5. APPROVAL OF THE AGENDA

Upon motion by Director Dahir, second by Director Duerr, which motion duly carried by unanimous consent of the Directors present, the Board approved the agenda.

6. APPROVAL OF THE MINUTES OF THE MARCH 16, 2022 MEETING

Upon motion by Director Jardon, second by Director Hill, which motion duly carried by unanimous consent of the Directors present, the Board approved the March 16, 2022 minutes.

*ATTORNEY-CLIENT CONFERENCE (BOARD WILL RECEIVE INFORMATION IN CLOSED SESSION)

Chair Hartung recessed at 10:04 a.m.

Chair Hartung reconvened the meeting at 11:04 a.m.

7. PRESENTATION OF RESULTS OF THE ANONYMOUS SURVEY ASKING ALL EMPLOYEES TO IDENTIFY THE KEY ATTRIBUTES AND/OR EXPERIENCE THEY WOULD LIKE TO SEE THEIR NEXT GENERAL MANAGER POSSESS

Jessica Atkinson, TMWA Human Resources Manager, presented the staff report and the open-ended survey went live on March 22 and ended on Apr 6.

The Board appreciated Ms. Atkinson's efforts and were impressed by the number of responses (81 out of 230 employees, about 30%) and personal comments(especially about preserving the TMWA culture) provided by employees, which were mostly positive (considering there has been a decline in overall satisfaction in the workplace the last two years) and will be utilized in the search process, the qualifications (leadership, interpersonal skills, strategy, team building, etc.) staff is looking for in a leader are realistic for new management, and for staff to understand the Board is paying attention to their comments.

8. DISCUSSION AND POSSIBLE DIRECTION FROM THE BOARD REGARDING EMPLOYEE CLIMATE SURVEY

Ms. Atkinson presented the staff report.

After a lengthy discussion whereby the Board thanked staff, addressed their concerns and questions, the Board determined the best course of action, and decided to wait until after the new general manager is selected prior to conducting the climate study.

Upon motion by Director Hill, second by Director Duerr, which motion duly carried by unanimous consent of the Directors present, the Board approved conducting an employee climate study after the new general manager is hired.

9. UPDATE ON GENERAL MANAGER RECRUITMENT AND DIRECTION TO STAFF REGARDING GENERAL MANAGER INTERVIEW PROCESS AND DATE

Ms. Atkinson reported that staff has engaged with a third party vendor to conduct the background checks, one candidate withdrew their application due to accepting another position and a second had expressed concerns due to the discussion that transpired at the March Board meeting and ultimately withdrew their application. This leaves three candidates, two in northern Nevada and one from the east coast.

Director Hill said the presentation was great and is interested in the interview guide and questions, and inquired whether the Board needed to submit questions they wish to ask. Ms. Atkinson said no, so long as they fall in line with the guidelines and are asked of each candidate.

The Board discussed when to hold the general manager interviews and determined the best date to be the normal Board meeting on June 15th. Additionally, the Board agreed to extend the duration for that meeting .

Upon motion by Director Dahir, second by Director Hill, which motion duly carried by unanimous consent of the Directors present, the Board approved the general manager interview process and June 15, 2022 as the interview date.

10. DISCUSSION AND POSSIBLE ACTION ON ADOPTION OF RESOLUTION NO. 303: A RESOLUTION OF THE TRUCKEE MEADOWS WATER AUTHORITY APPROVING THE U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION WATERSMART: TITLE XVI WATER RECLAMATION AND REUSE PROJECTS UNDER THE WIIN ACT GRANT APPLICATION IN FY 2022

Stefanie Morris, TMWA Water Resources Manager, presented the staff report.

Members of the Board thanked staff for moving forward with applying for grant opportunities, inquired if there is flexibility in the amount requested (no, the Board committed to $103M), and commented that the project is cutting edge and the first in the region.

Upon motion by Director Hill, second by Director Duerr, which motion duly carried by unanimous consent of the Directors present, the Board adoption Resolution No. 303: A resolution of the Truckee Meadows Water Authority approving the U.S. Department of the Interior Bureau of Reclamation WaterSmart: Title XVI Water Reclamation and Reuse Projects under the WIIN Act grant application in FY 2022.

11. RECOGNITION OF TMWA FOR RECEIVING THE AMERICAN WATER WORKS ASSOCIATION (AWWA): EXEMPLARY SOURCE WATER PROTECTION AWARD

Kara Steeland, TMWA Hydrologist, and Christian Kropf, TMWA Senior Hydrogeologist, reported that AWWA is awarding TMWA its Exemplary Source Water Protection Award for TMWA's Source Water Protection Program, which would not have been possible without regional and state collaboration.

Chair Hartung congratulated staff.

Chair Hartung opened agenda items 12 and 13 simultaneously.

12. WATER SUPPLY UPDATE

Bill Hauck, TMWA Water Supply Supervisor, presented the water supply update: Lake Tahoe is approximately one foot above the rim; January-March 2022 ended up being the driest 3-month period on record; snowpack in the Truckee Basin is currently about 53% of normal; latest model runs are projecting normal Truckee River flows through September and possibly into October (beyond TMWA's peak demand season); TMWA's drought storage is 57k acre feet (AF) and project it to be about 67k AF at its peak; and no drought storage will be required to meet customer demands.

Director Duerr inquired about storage in Stampede Reservoir, stated she has received significantly more questions related to water than in the past few years, and asked if staff has different messaging this year. Mr. Hauck replied Lake Tahoe will go below the rim and staff is moving water into Stampede prior to that happening; TMWA manages its water independently but does coordinate with other parties. He added the messaging will be addressed in the communication plan.

13. PRESENTATION ON PROPOSED CONSERVATION, COMMUNICATIONS AND OUTREACH PLAN FOR 2022, DISCUSSION AND POSSIBLE DIRECTION TO STAFF

Andy Gebhardt, TMWA Director of Distribution, Maintenance & Generation, presented the 2022 Communications and Outreach Plan ("Plan") and acknowledged the communication team and Cammy LoRe, GoodStanding, for the report. The focus of the Plan is to inform our customers, despite the news reporting the worst drought on record, TMWA's water supply is in good condition, ramp up messaging this year even though we are in a better position with our drought storage (Mr. Hauck will be presenting to the media and stakeholders on Apr 22), and anticipate normal conservation measures this year.

The Board thanked staff for their efforts on the Plan and had a lengthy discussion regarding utilizing the weatherman to provide water supply updates, much like the air quality updates, to keep the conservation messaging at the forefront, TMWA's water supply will not exceed demands (WC-3 concept), and approved the Conservation Hero campaign.

Upon motion by Director Duerr, second by Director Anderson, which motion duly carried by unanimous consent of the Directors present, the Board accepted the proposed Conservation, Communications and Outreach Plan for 2022.

14. INFORMATIONAL REPORT REGARDING FISH SPRINGS RANCH AGREEMENTS AND STATUS

John Zimmerman, TMWA Assistant General Manager, presented the staff report and updated the Board regarding Vidler Water Resources Inc. ownership of Vidler Water Co. which holds Fish Springs Ranch LLC. Fish Springs Ranch LLC owns the groundwater rights associated with TMWA's Fish Springs importation project, which are subject to the water banking and infrastructure agreements. The parent company has entered into a purchase agreement with D.R. Horton. Mr. Zimmerman added that Fish Springs Ranch, LLC has notified TMWA that it will continue to sell the beneficial interest in the water rights to developers for will-serve commitments and would proceed as they have in the past.

Chair Hartung confirmed DR Horton is a homebuilder and asked whether it was a conflict of interest for it to own and control water rights other homebuilders want to purchase. Mr. Zimmerman replied the Fish Springs Ranch, LLC is subject to the water banking agreement and infrastructure agreement that relates to capacity and reiterated that Fish Springs Ranch, LLC said that it will continue to sell water rights and capacity in the Fish Springs pipeline and provide water without preferential treatment to DR Horton.

Vice Chair asked if it is our responsibility to ensure this remains true and inquired if any regulations were in place. Mr. Zimmerman replied no, there are no regulations in place, but water rights must be dedicated pursuant to TMWA Rules and banking agreement; staff can update the Board if they hear otherwise but will monitor it since TMWA owns the infrastructure. Mr. Zimmerman added both agreements require Fish Springs Ranch LLC to make the water rights available in TMWA's service area.

Director Duerr said she would like to speak with Mr. Foree to get more information after the meeting.

15. GENERAL MANAGER'S REPORT

Mr. Foree added to Mr. Hauck's prediction, by the time he retires, there will be a small amount of water above the rim in Lake Tahoe with the most amount of upstream storage 67,000 AF in TMWA history.

16. PUBLIC COMMENT

There was no public comment.

17. BOARD COMMENTS AND REQUESTS FOR FUTURE AGENDA ITEMS

Vice Chair Dahir requested Chair Hartung to take care of his landscaping.

18. ADJOURNMENT

With no further discussion, Chair Hartung adjourned the meeting at 12:54 p.m.

Approved by the TMWA Board of Directors in session on _______________.

Sonia Folsom, Board Clerk.

*****Director Jardon was present for agenda items 1 thru 8 only.***

TRUCKEE MEADOWS WATER AUTHORITY

TO: Board of Directors
THRU: Mark Foree, General Manager
FROM: Matt Bowman, Chief Financial Officer
DATE: May 10, 2022
SUBJECT: **Presentation of Fiscal Year 2022 Q3 Financial Results**

Summary

Please refer to Attachments A-1 and A-2 for full Statements of Revenues, Expenses and Changes in Net Position for both actual to budget and year-over-year comparisons as discussed in the report below.

Budget to Actual

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
CHANGE IN NET POSITION	$ 33,223,095	$ 27,276,301	$ 5,946,794	22 %

Change in net position was $5.9m or 22% higher than budget through Q3 2022. This was driven by higher capital contributions, higher operating income, offset by higher nonoperating expenses.

Year over Year

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
CHANGE IN NET POSITION	$ 33,223,095	$ 36,781,209	$ (3,558,114)	(10)%

Change in net position was $3.6m or 10% lower than the prior year. This was due to higher capital contributions offset by lower operating income and higher nonoperating expenses.

Revenue

Budget to Actual

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
OPERATING REVENUES				
Charges for Water Sales	80,898,449	81,719,762	(821,313)	(1)%
Hydroelectric Sales	1,459,283	733,888	725,395	99 %
Other Operating Sales	3,022,322	1,657,647	1,364,675	82 %
Total Operating Revenues	85,380,054	84,111,297	1,268,757	2 %

Operating revenue was $1.3m (2%) higher than budget through Q3 2022. Other operating revenue was higher by $1.4m while water sales and hydroelectric sales were lower by $96 thousand, combined. Other operating sales are trending higher than budget in FY 2022 due to higher than expected new business inspection fees, late fees on past due accounts and customer service call out charges. Each of these items had been impacted by the pandemic in both FY 2020 and FY 2021 and the recovery of these amounts in FY 2022 was underestimated in the budget.

Year over Year

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
OPERATING REVENUES				
Charges for Water Sales	80,898,449	80,496,525	401,924	— %
Hydroelectric Sales	1,459,283	1,883,044	(423,761)	(23)%
Other Operating Sales	3,022,322	1,867,036	1,155,286	62 %
Total Operating Revenues	85,380,054	84,246,605	1,133,449	1 %

Total operating revenues were $1.1m higher through Q3 2022 than the prior year. Water sales was within 1% of the prior year due to lower consumption offset by the 2.5% rate increase in June 2021. Hydroelectric sales were lower by $0.4m due to low river flows in the late summer months in FY 2022 which forced the plants to be taken offline. Lastly, other operating sales were higher by $1.2m due to the reasons stated above.

Operating Expenses

Budget to Actual

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
OPERATING EXPENSES				
Salaries and Wages	18,745,725	20,196,361	(1,450,636)	(7)%
Employee Benefits	8,102,628	9,096,980	(994,352)	(11)%
Services and Supplies	22,917,541	24,141,520	(1,223,979)	(5)%
Total Operating Expenses Before Depreciation	49,765,894	53,434,861	(3,668,967)	(7)%
Depreciation	24,998,305	25,675,589	(677,284)	(3)%
Total Operating Expenses	74,764,199	79,110,450	(4,346,251)	(5)%

Total operating expenses were $4.3m lower (5%) than budget through Q3 2022. Salaries and wages and employee benefits are both lower due primarily to position vacancies. Services and supplies are 5% lower than budget. Even with increased pricing and contracts, there has yet to be a substantial impact on TMWA's services and supplies expenses in FY 2022. TMWA's leading expenses are power and treatment chemicals, which, combined, are only $150 thousand over budget through the third quarter.

Year over Year

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
OPERATING EXPENSES				
Salaries and Wages	18,745,725	16,593,615	2,152,110	13 %
Employee Benefits	8,102,628	7,280,979	821,649	11 %
Services and Supplies	22,917,541	20,562,487	2,355,054	11 %
Total Operating Expenses Before Depreciation	49,765,894	44,437,081	5,328,813	12 %
Depreciation	24,998,305	24,809,848	188,457	1 %
Total Operating Expenses	74,764,199	69,246,929	5,517,270	8 %

Year over year operating expenses were $5.5m higher (8%) than the prior year through Q3. Salaries and benefits are higher than prior year due to Labor Market Index (LMI) increases in July 2021, step increases and increases to headcount. Services and supplies are increased from the prior year due to several items, but primarily more spending (budgeted) on expensed projects and higher electric power costs, due to both rate increases and higher consumption.

Non-Operating Expenses

Budget to Actual

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
NONOPERATING REVENUES (EXPENSES)				
Investment Earnings	1,498,165	1,937,916	(439,751)	(23)%
Net Increase (Decrease) in FV of Investments	(8,489,292)	—	(8,489,292)	— %
Gain (Loss) on Disposal of Assets	83,284	(562,500)	645,784	(115)%
Amortization of Bond/note Issuance Costs	801	(99,750)	100,551	(101)%
Interest Expense	(8,958,464)	(8,910,458)	(48,006)	1 %
Total Nonoperating Revenues (Expenses)	(15,865,506)	(7,634,792)	(8,230,714)	108 %

Nonoperating expenses were $8.2m higher (108%) than budget through Q3 2022. This is primarily due to a net decrease in fair value of investments of $8.5m. Five and ten year treasury yields have increased significantly since July 2021. Five year treasury yield rate was 0.89% on July 1, 2021 and 2.42% on March 31, 2022. Investment earnings are also lower than budget due the amortization of investment premiums which have not been historically considered in the investment income budget.

Year over Year

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
NONOPERATING REVENUES (EXPENSES)				
Investment Earnings	1,498,165	2,006,748	(508,583)	(25)%
Net Increase (Decrease) in FV of Investments	(8,489,292)	(2,147,338)	(6,341,954)	295 %
Gain (Loss) on Disposal of Assets	83,284	—	83,284	— %
Amortization of Bond/note Issuance Costs	801	(107,136)	107,937	(101)%
Interest Expense	(8,958,464)	(9,192,031)	233,567	(3)%
Total Nonoperating Revenues (Expenses)	(15,865,506)	(9,439,757)	(6,425,749)	68 %

Nonoperating expenses were higher by $6.4m or 68% through the third quarter of the fiscal year. This is due primarily to reasons discussed above.

Capital Contributions

Budget to Actual

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
CAPITAL CONTRIBUTIONS				
Grants	2,013,271	1,012,500	1,000,771	99 %
Water Resource Sustainability Program	1,246,506	455,376	791,130	174 %
Developer Infrastructure Contributions	11,982,399	13,633,110	(1,650,711)	(12)%
Developer Will-serve Contributions (Net of Refunds)	3,553,678	2,163,036	1,390,642	64 %
Developer Capital Contributions - Other	8,930,905	7,020,225	1,910,680	27 %
Developer Facility Charges (Net of Refunds)	10,450,248	5,475,999	4,974,249	91 %
Contributions from Others	—	—	—	— %
Net Capital Contributions	38,472,746	29,910,246	8,562,500	29 %

Capital contributions were $8.6m (29%) higher than budget through the third quarter of FY 2022. One of the large variances is grant revenue. In Q2 FY 2022, TMWA received the FEMA award for the Glendale diversion rebuild following the 2017 flood event. The remaining line items in this category reflect new business/growth related collections and the budget overage is reflective of both larger projects and also continued high volume of projects being processed through TMWA. These amounts are consistent with the prior year as shown below.

Year over Year

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
CAPITAL CONTRIBUTIONS				
Grants	2,013,271	—	2,013,271	— %
Water Resource Sustainability Program	1,246,506	1,190,845	55,661	5 %
Developer Infrastructure Contributions	11,982,399	8,657,287	3,325,112	38 %
Developer Will-serve Contributions (Net of Refunds)	3,553,678	3,823,411	(269,733)	(7)%
Developer Capital Contributions - Other	8,930,905	7,835,082	1,095,823	14 %
Developer Facility Charges (Net of Refunds)	10,450,248	9,681,865	768,383	8 %
Contributions from Others	295,739	—	295,739	— %
Net Capital Contributions	38,472,746	31,221,290	7,251,456	23 %

Year over year, capital contributions are $7.3m or 23% higher through the first three quarters of the year. This is driven mostly by developer infrastructure contributions and grants which were higher by $2.0m and $3.3m, respectively. Developer infrastructure contributions, which don't impact cash flow, can vary quarter to quarter depending on the ability to close out projects. There was no grant revenue recognized in all of FY 2021. Developer contributions continue to trend higher than the prior year which is expected.

Capital Spending

Cash spent on capital outlays and construction projects during the first three quarters of the year was approximately $24.5m. Total budgeted capital spend for fiscal year 2022 is $60.1m. Spending on the top three projects for the first two quarters is below -

Disk Drive BPS	$4.5m
Prater Tank Rehabilitation	$2.0m
Humboldt-S. Monroe Main Replacement	$1.7m

Cash Position

At March 31, 2022 total cash on hand was $228.5m or $1.9m lower than at the beginning of the fiscal year. Of the total cash on hand, $185.4m was unrestricted to be used to meet upcoming and future operating & maintenance expenses, principal & interest payments and construction project payments. The remaining $43.1m was restricted to pay for scheduled bond principal and interest payments as well as maintaining required reserves as stipulated in our bond covenants.

Attachment A-1

Truckee Meadows Water Authority

Comparative Statements of Revenues, Expenses and Changes in Net Position
For the nine months ended March 31, 2022

	Actual YTD 2022	Budget YTD 2022	Variance $	Variance %
OPERATING REVENUES				
Charges for Water Sales	$ 80,898,449	$ 81,719,762	$ (821,313)	(1)%
Hydroelectric Sales	1,459,283	733,888	725,395	99 %
Other Operating Sales	3,022,322	1,657,647	1,364,675	82 %
Total Operating Revenues	85,380,054	84,111,297	1,268,757	2 %
OPERATING EXPENSES				
Salaries and Wages	18,745,725	20,196,361	(1,450,636)	(7)%
Employee Benefits	8,102,628	9,096,980	(994,352)	(11)%
Services and Supplies	22,917,541	24,141,520	(1,223,979)	(5)%
Total Operating Expenses Before Depreciation	49,765,894	53,434,861	(3,668,967)	(7)%
Depreciation	24,998,305	25,675,589	(677,284)	(3)%
Total Operating Expenses	74,764,199	79,110,450	(4,346,251)	(5)%
OPERATING INCOME	**10,615,855**	**5,000,847**	**5,615,008**	**112 %**
NONOPERATING REVENUES (EXPENSES)				
Investment Earnings	1,498,165	1,937,916	(439,751)	(23)%
Net Increase (Decrease) in FV of Investments	(8,489,292)	—	(8,489,292)	— %
Gain (Loss) on Disposal of Assets	83,284	(562,500)	645,784	(115)%
Amortization of Bond/note Issuance Costs	801	(99,750)	100,551	(101)%
Interest Expense	(8,958,464)	(8,910,458)	(48,006)	1 %
Total Nonoperating Revenues (Expenses)	(15,865,506)	(7,634,792)	(8,230,714)	108 %
Gain (Loss) Before Capital Contributions	(5,249,651)	(2,633,945)	(2,615,706)	99 %
CAPITAL CONTRIBUTIONS				
Grants	2,013,271	1,012,500	1,000,771	99 %
Water Resource Sustainability Program	1,246,506	455,376	791,130	174 %
Developer Infrastructure Contributions	11,982,399	13,633,110	(1,650,711)	(12)%
Developer Will-serve Contributions (Net of Refunds)	3,553,678	2,163,036	1,390,642	64 %
Developer Capital Contributions - Other	8,930,905	7,020,225	1,910,680	27 %
Developer Facility Charges (Net of Refunds)	10,450,248	5,475,999	4,974,249	91 %
Contributions from Others	295,739	150,000	145,739	97 %
Net Capital Contributions	38,472,746	29,910,246	8,562,500	29 %
CHANGE IN NET POSITION	**$ 33,223,095**	**$ 27,276,301**	**$ 5,946,794**	**22 %**

Attachment A-2

Truckee Meadows Water Authority

Comparative Statements of Revenues, Expenses and Changes in Net Position
For the nine months ended March 31, 2022

	Actual YTD 2022	Actual YTD 2021	Variance $	Variance %
OPERATING REVENUES				
Charges for Water Sales	$ 80,898,449	$ 80,496,525	$ 401,924	— %
Hydroelectric Sales	1,459,283	1,883,044	(423,761)	(23)%
Other Operating Sales	3,022,322	1,867,036	1,155,286	62 %
Total Operating Revenues	85,380,054	84,246,605	1,133,449	1 %
OPERATING EXPENSES				
Salaries and Wages	18,745,725	16,593,615	2,152,110	13 %
Employee Benefits	8,102,628	7,280,979	821,649	11 %
Services and Supplies	22,917,541	20,562,487	2,355,054	11 %
Total Operating Expenses Before Depreciation	49,765,894	44,437,081	5,328,813	12 %
Depreciation	24,998,305	24,809,848	188,457	1 %
Total Operating Expenses	74,764,199	69,246,929	5,517,270	8 %
OPERATING INCOME	**10,615,855**	**14,999,676**	**(4,383,821)**	**(29)%**
NONOPERATING REVENUES (EXPENSES)				
Investment Earnings	1,498,165	2,006,748	(508,583)	(25)%
Net Increase (Decrease) in FV of Investments	(8,489,292)	(2,147,338)	(6,341,954)	295 %
Gain (Loss) on Disposal of Assets	83,284	—	83,284	— %
Amortization of Bond/note Issuance Costs	801	(107,136)	107,937	(101)%
Interest Expense	(8,958,464)	(9,192,031)	233,567	(3)%
Total Nonoperating Revenues (Expenses)	(15,865,506)	(9,439,757)	(6,425,749)	68 %
Gain (Loss) Before Capital Contributions	(5,249,651)	5,559,919	(10,809,570)	(194)%
CAPITAL CONTRIBUTIONS				
Grants	2,013,271	—	2,013,271	— %
Water Resource Sustainability Program	1,246,506	1,190,845	55,661	5 %
Developer Infrastructure Contributions	11,982,399	8,657,287	3,325,112	38 %
Developer Will-serve Contributions (Net of Refunds)	3,553,678	3,823,411	(269,733)	(7)%
Developer Capital Contributions - Other	8,930,905	7,835,082	1,095,823	14 %
Developer Facility Charges (Net of Refunds)	10,450,248	9,681,865	768,383	8 %
Contributions from Others	295,739	—	295,739	— %
Net Capital Contributions	38,472,746	31,221,290	7,251,456	23 %
CHANGE IN NET POSITION	**$ 33,223,095**	**$ 36,781,209**	**$ (3,558,114)**	**(10)%**

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STAFF REPORT

TO: TMWA Board of Directors
THRU: Mark Foree, General Manager
FROM: Matt Bowman, Chief Financial Officer/Treasurer
Sandra Tozi, Senior Financial Analyst
DATE: May 10, 2022
SUBJECT: **Discussion, and action on request for adoption of Resolution No. 304: A resolution to adopt the final budget for the Fiscal Year ending June 30, 2023 and the 2023-2027 Five-Year Capital Improvement Plan**

Recommendation

Staff recommends the TMWA Board approve the proposed Final Budget for the fiscal year ending June 30, 2023 and direct staff to file the adopted Final Budget and related 2023-2027 Capital Improvement Plan (CIP) with the State of Nevada Department of Taxation as required by statute.

Summary

TMWA has prepared the proposed Final Budget for consideration and approval by the TMWA Board. Changes to the tentative budget presented originally at the March 16, 2022 board meeting result in an increase to change in net position of $2.0m due to higher grant revenue offset by lower hydroelectric revenue and higher salaries and wages and employee benefits expenses. Capital spending for 2023-2027 increased $27m for a five-year total of $393.2m.

Discussion

A comparison of the proposed Final Budget to the original approved Tentative Budget is accompanying this report in ***Attachments A and B***. Changes to the operating budget include the following –

- Increase in grant revenue - $3m. This is due to TMWA receiving a $3m grant as part of the Federal FY2022 Omnibus Appropriations bill. The grant is earmarked to fund the Advanced Purified Water Facility at American Flat, included in the 2023-2027 CIP.
- Decrease in hydroelectric revenue - $0.8m. Due to lower-than-expected precipitation in the spring of 2022, Truckee River flows are expected to drop below the required flows for operation of the hydro plants in early fall 2022.
- Increase in salaries and wages and employee benefits expense - $0.2m. Following updated results from TMWA's third-party Labor Market Index study, staff recommends an increase to MPAT wages of 3.55% beginning on or around July 1, 2022.

The primary increase to the five-year CIP came in the Raw Water category for the Advanced Purified Water Facility at American Flat at $17.0m. An additional $8.4m increase to Treatment Plant Improvements included an increase of $5.3m to Orr Ditch Pump Station Rehab and Hydro Facility as well as $2.3m to Longley Plant HV3 and HV4 Treatment improvements both based on updated construction cost estimates.

The increase of in the five-year CIP resulted in an increase of $10.2m in customer rate funded projects largely due to increases in updated pricing on various projects.

Two projects within this year's CIP that are not as reliant on internal staffing are the APW Facility at American Flat and the AMI project. The table below shows the impact of these projects on the total CIP. With these projects removed, the total CIP each year is in line with previous years' CIP.

	FY2023	FY2024	FY2025	FY2026	FY2027	Five Year CIP Total
Total Spend by FY	$ 83,875	$ 120,970	$ 88,620	$ 52,430	$ 47,300	$ 393,195
APW Facility at American Flat	(20,000)	(55,000)	(37,000)	(5,000)	-	(117,000)
Automated Meter Infrastructure (AMI)	(2,300)	(5,000)	(6,000)	(6,200)	-	(19,500)
Total Adjusted Spend by FY	$ 61,575	$ 60,970	$ 45,620	$ 41,230	$ 47,300	$ 256,695

These changes in CIP affected the budgeted statement of cash flows for FY 2023. See ***Attachment B.***

TRUCKEE MEADOWS WATER AUTHORITY
(TMWA)

RESOLUTION NO. 304

A RESOLUTION ADOPTING THE FINAL BUDGET FOR THE FISCAL YEAR ENDING JUNE 30, 2023 AND
THE 2023-2027 CAPITAL IMPROVEMENT PLAN FOR THE
TRUCKEE MEADOWS WATER AUTHORITY AFTER PUBLIC HEARING

WHEREAS, pursuant to NRS 354.596, TMWA is required to hold a public hearing on its tentative budget to allow interested persons to be heard; and

WHEREAS, pursuant to NRS 354.596, TMWA scheduled and held a public hearing on the tentative budget and Capital Improvement Plan as prescribed on May 19, 2022, the third Thursday in May; and

WHEREAS, the tentative budget and Capital Improvement Plan have been presented to the interested public and the Board; and

WHEREAS, the Board has considered and approved the revisions to the tentative budget and Capital Improvement Plan and has heard and considered comments from the public.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Truckee Meadows Water Authority to adopt the tentative budget as the final budget for the fiscal year ending June 30, 2023 and adopt the 2023-2027 Capital Improvement Plan and to direct staff to submit the final budget and Capital Improvement Plan to the State of Nevada Department of Taxation.

Upon motion of _______, seconded by _______, the foregoing Resolution was passed and adopted on May 19, 2022 by the following vote of the Board:

Ayes:____

Nays:____

Abstain: ___________________________ Absent: _____________________________

Approved: May 19, 2022

____
Vaughn Hartung, Chairman

TRUCKEE MEADOWS WATER AUTHORITY

Comparative Statements of Revenues, Expenses and Changes in Net Position

Proposed Final Budget

	Final Budget FY 2023	Tent. Budget FY 2023	Change Final v Tent.	Final Budget FY 2022
OPERATING REVENUES				
Charges for Water Sales	$ 113,142,185	$ 113,142,185	$ -	$ 108,503,854
Hydroelectric Sales	2,407,214	3,177,557	(770,343)	1,837,239
Other Operating Sales	3,861,065	3,861,065	-	2,219,679
Total Operating Revenues	119,410,464	120,180,807	(770,343)	112,560,772
OPERATING EXPENSES				
Salaries and Wages	29,656,188	29,479,887	176,301	26,634,314
Employee Benefits	12,842,853	12,787,228	55,625	11,622,696
Services and Supplies	33,719,064	33,719,064	-	32,188,000
Total Operating Expenses Before Depreciation	76,218,105	75,986,179	231,926	70,445,010
Depreciation	34,628,346	34,628,346	-	34,234,118
Total Operating Expenses	110,846,451	110,614,525	231,926	104,679,128
OPERATING INCOME	8,564,013	9,566,282	(1,002,269)	7,881,644
NONOPERATING REVENUES (EXPENSES)				
Investment Earnings	3,064,024	3,064,024	-	2,583,886
Loss on Disposal of Assets	(1,700,000)	(1,700,000)	-	(750,000)
Debt Issuance Costs	-	-	-	(133,000)
Interest Expense	(11,499,699)	(11,499,699)	-	(11,880,610)
Total Nonoperating Revenues (Expenses)	(10,135,675)	(10,135,675)	-	(10,179,724)
Gain (Loss) Before Capital Contributions	(1,571,662)	(569,393)	(1,002,269)	(2,298,080)
CAPITAL CONTRIBUTIONS				
Grants	3,585,635	585,635	3,000,000	1,350,000
Water Resource Sustainability Program	2,840,000	2,840,000	-	607,168
Developer Infrastructure Contributions	21,903,168	21,903,168	-	18,177,481
Developer Will-serve Contributions (Net of Refunds)	7,245,700	7,245,700	-	2,884,048
Developer Capital Contributions - Other	11,044,199	11,044,199	-	9,360,299
Developer Facility Charges (Net of Refunds)	13,186,258	13,186,258	-	7,301,331
Contributions from Others	94,924	94,924	-	-
Contributions from Other Governments	21,100,000	21,100,000	-	200,000
Net Capital Contributions	80,999,884	77,999,884	3,000,000	39,880,327
CHANGE IN NET POSITION	79,428,222	77,430,491	1,997,731	37,582,247
NET POSITION, BEGINNING PERIOD	848,515,140	848,515,140		
NET POSITION, END OF PERIOD	$ 927,943,362	$ 925,945,631		

TRUCKEE MEADOWS WATER AUTHORITY

Statements of Cash Flows

Proposed Final Budget

	Final Budget FY 2023	Tent. Budget FY 2023	Change Final v Tent.	Final Budget FY 2022
OPERATING ACTIVITIES				
Cash Received From Customers	$ 119,410,464	$ 120,180,807	$ (770,343)	$ 112,560,772
Cash Paid to Employees	(42,499,041)	(42,267,115)	(231,926)	(38,257,010)
Cash Paid to Suppliers	(33,719,064)	(33,719,064)	-	(32,188,000)
Net Cash From Operating Activities	43,192,359	44,194,628	(1,002,269)	42,115,762
CAPITAL AND RELATED FINANCING ACTIVITIES				
Acquisition & Construction of Capital Assets	(83,875,000)	(92,500,000)	8,625,000	(60,125,000)
Interest Paid on Financing	(15,829,559)	(15,829,559)	-	(16,391,528)
Principal Paid on Financing	(16,494,081)	(16,494,081)	-	(13,599,193)
Redemptions of Commercial Paper Notes	-	-	-	(5,500,000)
Grants	3,669,308	669,308	3,000,000	1,900,000
Contributions for Water Resource Sustainability Program	2,840,000	2,840,000	-	607,168
Contributions From Developers-Will-Serve Letters	7,245,700	7,245,700	-	2,884,048
Contributions from Developers - Other	11,044,199	11,044,199	-	9,360,299
Contributions from Developers - Facility Charges	13,186,258	13,186,258	-	7,301,331
Contributions from Others	94,924	94,924	-	-
Contributions from Other Governments	21,100,000	21,100,000	-	200,000
Bond/Note Issuance Costs	-	-	-	(133,000)
Net Cash Used For Capital & Relating Financing Activities	(57,018,251)	(68,643,251)	11,625,000	(73,495,875)
INVESTING ACTIVITIES				
Interest Received	3,064,024	3,064,024	-	2,583,886
Net Cash From Investing Activities	3,064,024	3,064,024	-	2,583,886
NET CHANGE IN CASH AND CASH EQUIVALENTS	(10,761,868)	(21,384,599)	10,622,731	(28,796,227)
CASH AND CASH EQUIVALENTS, BEGINNING PERIOD	216,227,461	216,227,461	-	211,972,331
CASH AND CASH EQUIVALENTS, END OF PERIOD	$ 205,465,593	$ 194,842,862	$ 10,622,731	$ 183,176,104

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Photo: Recharge Feasibility Drilling
Photo By: Christian Kropf, Senior Hydrogeologist

Five Year Capital Improvement Plan

Fiscal Year 2023 - 2027

Truckee Meadows Water Authority is a not-for-profit, community-owned water utility, overseen by elected officials and citizens from Reno, Sparks and Washoe County

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INTRODUCTION

The Truckee Meadows Water Authority's (TMWA's) Five-Year Capital Improvement Plan 2023-2027 (CIP), describes all infrastructure construction and major capital outlays that will take place between July 1, 2022 and June 30, 2027. Guidance for identifying and scheduling projects in the CIP is provided by TMWA's 2015-2035 Water Facility Plan (WFP) and the 2020-2040 Water Resource Plan (WRP).

TMWA is a joint powers authority formed in November 2000, pursuant to a Cooperative Agreement (as amended and restated as of February 3, 2010, the "Cooperative Agreement") among the City of Reno, Nevada ("Reno"), the City of Sparks, Nevada ("Sparks") and Washoe County, Nevada (the "County"). The Authority owns and operates a water system (the "Water System") and develops, manages and maintains supplies of water for the benefit of the Truckee Meadows communities. On January 1, 2015, TMWA, the Washoe County Water Utility (WCWU) and South Truckee Meadows General Improvement District (STMGID) consolidated to create a regional water system under TMWA. TMWA has a total of 162 square miles of service area, which includes the cities of Reno and Sparks and other surrounding populated areas of the County (except certain areas in the vicinity of Lake Tahoe and other small areas bordering California). TMWA has no authority to provide water service outside of its service area; however, may provide service in the future to developments that are annexed into its service area.

The CIP incorporates a comprehensive compilation of water system improvements for TMWA. A major feature of the CIP is the construction of several projects that will expand the conjunctive use of the region's water resources. The philosophy behind conjunctive use of local water resources is to maximize the use of surface water while preserving the integrity of groundwater resources which are drawn upon during periods of persistently dry weather. Another aspect of the CIP is to expand the Aquifer Storage and Recovery Program (ASR Program) which is the recharge of groundwater basins with treated surface water, and explore the possibilities related to Advanced Purified Water (APW). In addition, this CIP includes several major projects to extend full conjunctive use water service to the Verdi area, made possible by approved development and cost effective oversizing. The estimated costs of the new backbone water facilities is $20.0 million and is being borne largely by regional developments in the area.

The CIP constitutes an essential component in TMWA's system of planning, monitoring and managing the activities of purveying water and generating hydroelectric power. The CIP is incorporated into a broader, constantly-updated Five-Year Funding Plan ("Funding Plan") for a comparable period. This Funding Plan will determine adequate levels and sources of funding for projects contained in the CIP.

The 2022-2026 Funding Plan indicates a nominal funding gap in each year, however, due to adequate treasury and ongoing revenues from various sources, TMWA can fund the CIP.

Water Conservation TMWA is a steward of the region's water resources and promotes the efficient use of water in drought and non-drought years. Due to TMWA's ongoing conservation programs, among other factors, municipal residential per capita demand has decreased by 30% since the early 2000s, helping to offset total water use as TMWA's customer base has grown by approximately 30%. Capital spending represents a key aspect of TMWA's conservation program. Projects such as meter replacements, conjunctive use and recently the Advanced Purified Water Facility at American Flat represent projects which help to ensure TMWA has the appropriate infrastructure in place to allow for efficient water use. Specifically, projects included in the CIP having significant conservation impacts are as follows: Advanced Purified Water Facility at American Flat ($117.0 million), Automated Meter Infrastructure ($19.5 million), Well Head TTHM Mitigation ($2.1 million), STMGID Conjunctive Use Facilities (Arrowcreek BPS) ($3.5 million), and Lazy 5 Pump Station ($2.0 million).

The CIP includes total spending of $393.2 million with approximately 53.0% or $208.2 million dedicated to upgrades or replacement of existing infrastructure, and approximately 39.9% or $156.9 million allocated to construction of new water system capacity projects, conjunctive use construction projects, retrofit of remaining unmetered services, and potential opportunistic acquisition of water rights. Construction and capital outlays paid for out of STMGID reserve funds are estimated to be approximately 0.9% or $3.5 million of total spending over fiscal years 2023-2027. Of the total projected spending over the next five years 5.3% or $20.8 million is considered contingency spending which is dependent on certain events occurring to trigger spending. The $393.2 million in projected spending is grouped into broad categories of improvements and spending outlays. These categories are described below with detailed project descriptions to be found in the Project Description Section.

Raw Water Supply Improvements contains 33.0% or approximately $129.9 million of total spending in the CIP. Comprising nearly all of the spending in this category is the construction of an Advanced Purified Water (APW) Facility at American Flat which will be built as a follow up to the OneWater NV advanced purified water feasibility study, and will be a joint effort with other agencies. Through an interlocal agreement, TMWA has partnered with City of Reno who will reimburse TMWA for 70% of the construction costs. There will be immediate benefit to City of Reno resulting from increased capacity at the Reno Stead Water Reclamation Facility. Other projects in this category include improvements to the Highland Canal/Siphon raw water conveyance infrastructure, upstream storage improvements for Donner Lakes where TMWA stores Privately-Owned Stored Water (POSW) and expenses associated with the storage and implementation of the Truckee River Operating Agreement (TROA).

Ground Water Supply Improvements contains 4.6% or approximately $18.2 million of total spending in the CIP. These projects focus on preserving existing well capacities, drilling and equipping of new wells and at times complete replacement of existing wells.

Treatment Plant Improvements contains 11.9% or approximately $46.9 million of total spending in the CIP. The Orr Ditch pump station/Hyrdo Facilty project will increase redundancy and reliability by enhancing the Truckee River source of supply to the Chalk Bluff Water

Treatment Plant and directly offset power costs. Other spending in this category targets fix and finish projects with the primary focus on the Chalk Bluff and Glendale Surface Water Treatment Plants located on the Truckee River. Other improvements include installation of a new disinfection process at two wells historically treated by the Longley Lane ground water treatment plant and a complete upgrade of the Supervisory Control and Data Acquisition (SCADA) system which provides centralized automated system control and data storage for the distribution system and treatment plants.

Distribution System Pressure Improvements contains 11.1% or approximately $43.5 million of total spending. This spending primarily includes pump and pressure regulating station rebuilds and new construction, correction of pressure or fire flow deficiencies, as well as reconstruction of pressure regulating valves.

Water Main Distribution & Service Line Improvements contains 15.0% or approximately $58.8 million of total spending in the CIP. These improvements include replacement of aged water mains reaching end of service life, installation of new mains for new and expanded service, water main oversizing and extensions, off-river supply improvements, and conjunctive use projects to extend surface water supplies to the areas that rely heavily on year round groundwater pumping. This last set of projects furthers the conjunctive use philosophy of water resource management and includes the Boomtown water system improvements.

Potable Water Storage Improvements contains 10.4% or approximately $41.0 million of total spending in the CIP. These projects are comprised mainly of new treated water storage tank to increase system redundancy and reliability (Sun Valley #2 Tank and Caughlin 2 Tanks) and construction to serve new and expanded service (STMGID Tank East Zone 11 Tank), some replacement of existing treated water tank capacity as well as systematic recoating of treated water tank interiors and exteriors to extend service life of these facilities.

Hydroelectric Improvements contains 1.9% or approximately $7.5 million of total spending in the CIP. These improvement center on the three run-of-river hydroelectric facilities currently owned by TMWA. Efforts on these facilities focus primarily on flume, forebay, diversion and canal improvements as well as equipment upgrades.

Customer Service Outlays contains 5.6% or approximately $22.0 million of total spending in the CIP. The majority of spending in this category is for Automated Meter Infrastructure (AMI) meter replacements, providing more accurate and real time usage information which can be leveraged for billing, conservation and cost efficiencies. Also, in this category is a spending provision for new business meters which is funded by development.

Administrative Outlays contains 2.4% or approximately $9.5 million of total spending in the CIP. These outlays are primarily for the purchase of heavy and light vehicles, excavation equipment and fleet upgrades. Other spending in this category are for asphalt rehabilitation and replacement at various locations. Also, in this category is spending for security improvements such as fencing, intrusion detection, security cameras, lighting.

Special Programs Funded by Development include outlays for opportunistic water rights purchases. They are separated from a presentation standpoint because in the case of water right acquisitions, spending is currently driven by pricing opportunity. This comprises 3.2% or approximately $12.5 million of total spending in the CIP.

Former STMGID System Improvements are separated from a presentation standpoint because projects in this category are funded by the STMGID reserve, which TMWA acquired through the acquisition of former STMGID. It contains 0.9% or approximately $3.5 million of total spending in the CIP. Improvements in this category focus on conjunctive use facilities. This reserve fund is expected to be depleted by the end of the five year plan.

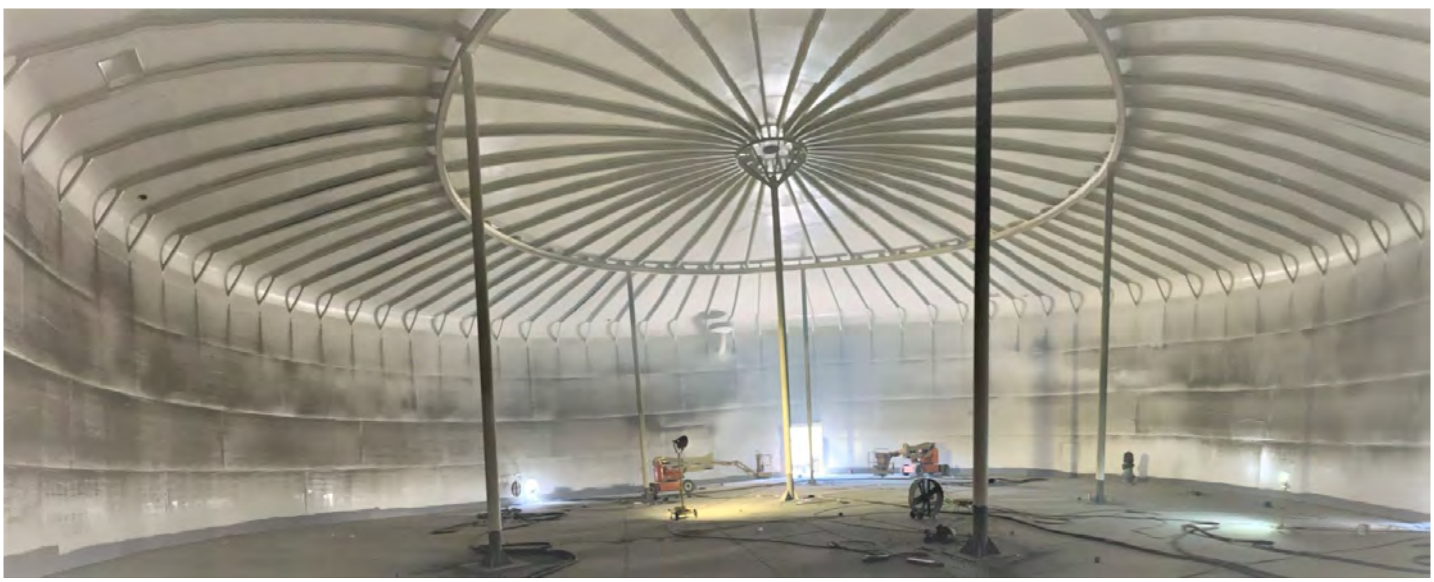


Photo: Pyramid Tank Rehab Project

Photo By: Karen Meyer, Construction Manager Coordinator

DEFINITIONS

Capital Improvement Program Definitions

The Five-Year CIP is a planning and budgeting tool, which provides information about TMWA's infrastructure needs for a five-year time frame. Each year, the list of projects is reviewed for cost and priority. New projects may be added and other projects delayed or deleted entirely. Since most projects are mandatory or necessary, deletion of a project would be rare with the exception of contingency spending. However, capital spending plans must remain flexible, and it is often necessary to take revisions to the approved fiscal year's CIP back to the TMWA Board for approval. If construction or outlays can be deferred, TMWA will defer spending in order to preserve cash reserves, regardless whether or not there are difficult economic times. These decisions are made on a case by case basis.

Generally, capital improvements/outlays are defined as physical assets, constructed or purchased, that have a useful life greater than one year and a cost of $5,000 or more.

Definition of Capital Outlays

"Capital Outlays," which are in TMWA's capital budget, include construction projects that improve the life of current TMWA infrastructure, or are new additions to TMWA infrastructure, as well as computer equipment and software, vehicles, and heavy equipment needed to support TMWA's operations. These items are generally found in the Administrative category of projects. For the Customer Service category, these outlays involve meter installations and related infrastructure, and acquiring meter reading equipment.

PRIORITIZATION OF PROJECTS/OUTLAYS

TMWA may not have sufficient funding to meet all its capital needs each year or may divert funding to meet unexpected capital improvements. If such conditions arise, projects are prioritized based on the effect each project has on TMWA's ability to meet customer demand and maintain water system reliability. TMWA’s Five-Year Funding Plan is used to analyze total spending, identify various funding alternatives, and determine whether or not water rate adjustments will be required.

The priority categories represent a relative degree of need for any particular project and are described below.

* **PRIORITY 1 MANDATORY:** These are considered absolutely required, and are the highest priority of all capital projects. Mandatory projects include those in final design or already under construction, or those required by legislation or regulation for protection of public health and safety. These projects are generally found in the first fiscal year of the CIP. Water demands or infrastructure conditions are such that if the project is not completed TMWA runs the risk of eventually being unable to reliably provide water service to its existing customers and/or new and expanded service, or incur extended outages.

* **PRIORITY 2 NECESSARY:** A project that is important for providing water service to customers, yet timing of construction or spending outlay is not as critical as a mandatory project. These projects are required and are generally found in the last four years of the CIP. External factors such as the pace of new development or the condition of existing infrastructure may delay or accelerate the timing of project construction.

* **PRIORITY 3 CONTINGENCY:** These projects or capital outlays are not immediately critical to the operation of the water system. Expenditures in this category generally require a business case study or specific criteria to be met before spending can occur. If such criteria are not met, then spending may or may not be justified. Also, some projects are deferrable if spending is required in an area of higher priority. Even though these projects and outlays are in the CIP the likelihood that spending will occur may be remote and is based upon future conditions that are difficult to predict.

FUNDING OF CAPITAL SPENDING

Funding Sources

The CIP will rely on various funding sources to pay for capital projects/capital outlays. TMWA relies heavily on revenues generated from water sales, hydroelectric, and other operating sales to fund the majority of projects. Developer contributions have historically been an important funding source for certain construction projects for new and expanded water system capacity. Investment income is also available to augment other revenue sources but is minor in relation to other funding sources. Funding from developer contributions can vary year to year and dependent on the local economy and pace of new construction in TMWA's service territory. For this reason, TMWA does not rely on these fees to fund operations or fund annual principal and interest payments on TMWA’s outstanding debt. TMWA may rely on the issuance of debt to fund large levels of capital spending in a particular period. Although, historically, TMWA has funded certain capital projects through the issuance of debt, there is no plan to issue debt to fund any portion of this CIP.

Developer Contributions

TMWA looks to the development community for developer contributions in the form of system development charges or direct reimbursements to fund capital expenditures related to new or expanded water service, including pump station construction or expansions and feeder main extension projects. In June 2003, the TMWA Board adopted facility charges to pay for new treatment/supply capacity projects and new storage capacity projects. TMWA began collecting these facility charges in January 2004. Under TMWA’s Rule 5 these proceeds are used to support new capacity construction. Rule 7 governs the purchase of water rights and reimbursement by developers for issuance of will-serve commitments for water service. However, because of the timing of certain growth driven capital projects, additional financial resources may be called upon as needed. The most recent update to the water system facility charges, which updated area fees, supply and treatment fees, as well as storage unit costs was approved by the TMWA Board in August, 2019 with an effective date of January, 2022. These fees are subject to periodic review for funding adequacy.

Financing Background

Revenue bond issuance has been an integral part of funding construction spending. TMWA has also taken advantage of lower rate, subordinated debt financing obtained through the Drinking Water State Revolving Loan Fund (DWSRF) and a tax-exempt commercial paper program (TECP) due to lower cost of capital and repayment subordination features of these funding vehicles. Federal and State Grants and loan forgiveness programs have also been identified in the past to fund projects. In the event customer water sales and developer funding is not sufficient to cover immediate infrastructure needs, TMWA maintains the ability to access the credit market and issue debt. However, TMWA has no intent to issue debt to fund any portion of this CIP.

TMWA has been able to reduce debt by over $117.1 million, and 23% during the last 5 years, and currently has no plan to increase debt to fund projects in this plan.

Rule 5 and Rule 7 Fees

These fees are collected from the development community. Rule 5 fees are paid by developers to TMWA for the construction of new water feeder mains, new treatment/supply capacity, new storage capacity, and for new or rebuilt pump stations to meet demand resulting from new and expanded service. Rule 7 Fees are derived from will-serve sales to development. TMWA historically purchased water rights on the open market and reserves these rights for will-serve letters to be sold to development. TMWA also recovers the applicable administrative and financing costs with the sale of each will-serve. The title to water rights are retained by and dedicated to TMWA. TMWA has sufficient inventory of water rights to meet the demands for new and expanded service for the foreseeable future.

Water Meter Retrofit Fees

Pursuant to Resolution 272 passed by the Board of Directors on January 16, 2019, the Water Meter Retrofit Fee was replaced by the Water Resource Sustainability Fee. The remaining balance of $5.7 million will be allocated entirely to the Automated Meter Infrastructure project.

Water Resource Sustainability Fund Fees

Resolution 272, passed by the Board of Directors on January 16, 2019, broadened the purpose of the Water Meter Retrofit Fee to support projects such as expanded conjunctive use, aquifer storage and recovery, demonstration and validation of advanced purified water treatment processes, future water resource identification and acquisition, and other projects that enhance water resource sustainability and drought resiliency. The fee has been reduced from $1,830 to $1,600 for each acre-foot of demand when will-serve commitments based on surface water right dedications are issued for new or expanded service.

Capital Contributions from Other Governments

TMWA is a water wholesaler to the Sun Valley General Improvement District (SVGID). From time to time, new infrastructure must be constructed to service this retail water-service provider. There are no expectations of any need for reimbursement from this source in the CIP although historically SVGID has made contributions to TMWA.

Reserves from the Water Utility Consolidation

TMWA, the WCWU and STMGID consolidated on January 1, 2015. As a result of the consolidation, the respective treasuries of the WCWU and STMGID were transferred to TMWA.

The WCWU treasury that was transferred to TMWA amounted to approximately $43.4 million while the STMGID treasury transferred to TMWA was approximately $15.7 million of which $2.7 million remains. These cash and investment reserves will continue to be used to make necessary improvements in the former water utility service areas including conjunctive use enhancements.

Other Resources

One method of generating additional funds for capital improvements is to increase existing fees/ charges or to add new fees/charges. However, future increases are expected to be nominal if TMWA is able to meet revenue requirements and maintain bond coverage ratios that will suffice to maintain strong investment-grade credit ratings. TMWA has obtained many benefits of Aa2 from Moodys, AA+ from S&P, and in March, 2022 upgraded to AAA from Fitch. The Board approved a five-year customer water rate plan in early 2017 which included a water rate increase of 3.0% in May of 2017 and 2018. TMWA Board deferred the 2.5% rate increases scheduled for 2019 through 2021 to 2020 through 2022, effectively delaying the rate increase plan by one year. Due to the pandemic, the Board again deferred the 2.5% water rate increases scheduled for 2020 through 2022 to 2021 through 2023. Water rate increases are essential for TMWA to maintain sound credit ratings and to preserve access to opportunities in the capital markets.

FISCAL YEAR 2023 CAPITAL SPENDING-THE CAPITAL BUDGET

TMWA expects to spend $83.9 million in fiscal year 2023, the first year of the FY 2023-2027 CIP. Of this total, $42.8 million will be funded by customer rates for water system rehabilitation, hydroelectric improvements, pressure system improvements, water main distribution service line improvements, and administrative and customer service outlays. Another $28.8 million will be funded by developer fees for water system expansion, limited opportunistic acquisition of water rights. The water meter retrofit fund will pay for $2.5 million for meter replacements, and the sustainability fund will pay for $2.1 million in projects. Insurance settlements will pay for $5.0 million in hydroelectric improvements, and STMGID reserves account for $2.7 million of improvements in the STMGID area.

SUMMARY OF PROJECTS FOR THE FISCAL YEAR 2023 BUDGET

TMWA has established the following projects for the capital budget in fiscal year 2023 (Amounts presented in thousands of dollars):

Summary of Projects for FY 2023	Amount
Raw Water Supply Improvements	
Highland Canal-Upgrades-Downstream	225
Highland Canal-Upgrades-Diversion to Chalk Bluff	500
TROA Drought Storage / Implementation	150
Donner Lake Outlet Improvements Phase 2	150
Advanced Purified Water Facility at American Flat	20,000
Washoe Lake System Improvements	100
Total Raw Water Supply	**21,125**
Ground Water Supply Improvements	
Well Rehabilitation Improvements	200
Double Diamond #5 and Equipping	50
Well Fix & Finish	350
Brush Well and Spring Creek 5	1,000
Well Head TTHM Mitigation	100
Spring Creek Well #10 - Donovan	150
Geothermal Fluid Monitoring Well	100
Spring Creek Well 9 (Spring Creek 4 Replacement)	760
Spring Creek Wells PH Adjustment	750
STMGID Well #1 Re Drill and Equipping	200
Total Ground Water Supply	**3,660**
Treatment Plant Improvements	
Chalk Bluff Treatment Plant Improvements	550
Glendale Treatment Plant Improvements	200
Mt Rose Treatment Plant Efficiency Improvements	500

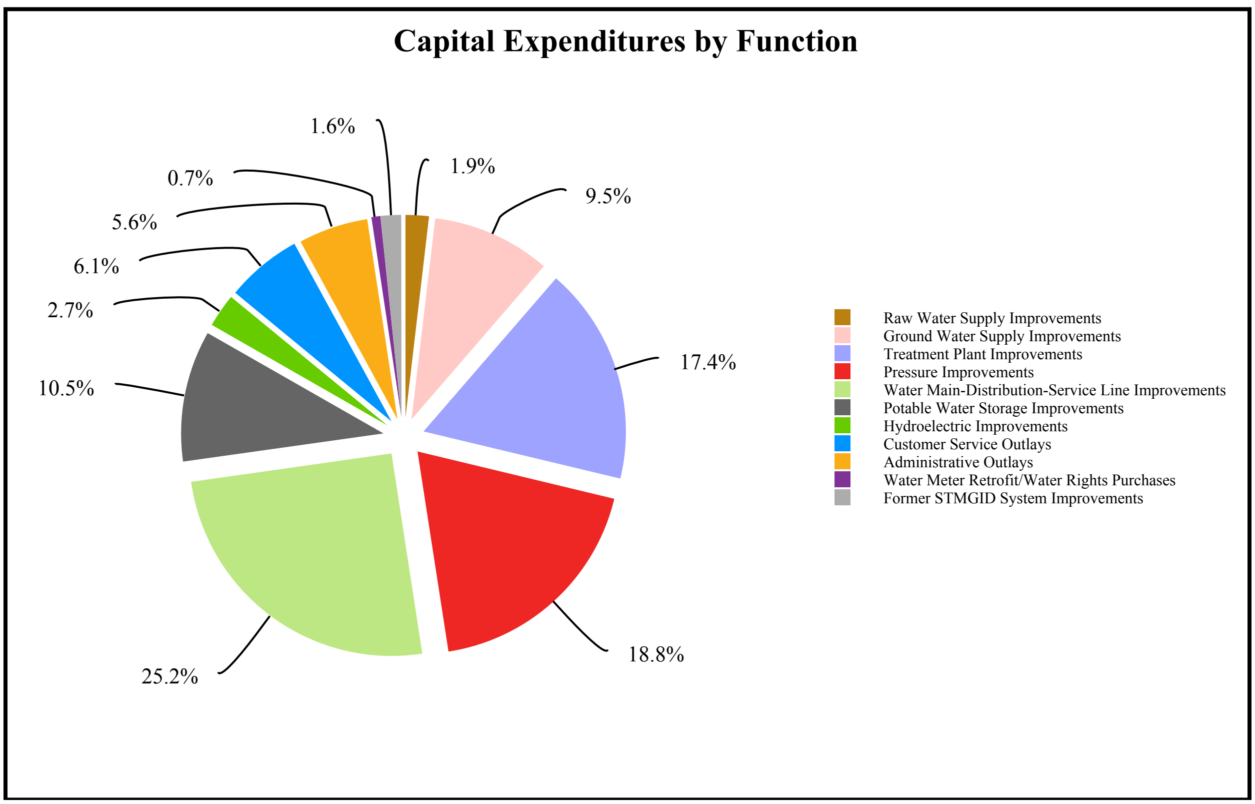
Summary of Projects for FY 2023 (continued)	
Chalk Bluff Filter Underdrains	800
Glendale Lighting Upgrade	250
Orr Ditch Pump Station Rehab and Hydro Facility	15,000
Truckee Canyon Water Treatment Improvements	100
Lightning W Treatment Improvements	20
SCADA Rehab / Plant Operating Software	1,000
Longley Plant HV 3 and HV 4 Treatment Improvements	695
Longley Plant Retrofit	250
Spanish Springs Nitrate Treatment Facility	250
Chalk Bluff Electrical System Upgrades	150
Total Treatment Plant	**19,765**
Pressure Improvements	
Pressure Regulators Rehabilitation	1,000
Land Acquisitions	250
Pump Station Oversizing	100
Pump Station Rebuilds, Rehabilitations	50
Standby Generator Improvements	50
PSOM Standby Generator Additions	100
Idlewild Booster Pump Station Improvements	100
Spanish Springs #1 Pump Zone Intertie	600
STMGID Tank #4 Booster Pump Station/Transmission Line	100
Lazy 5 Low Head Pump Station and Mains	1,000
Common (Stonegate) Booster Pump Station	1,100
Caughlin 5C Pump and Motor Replacement	150
7th Street High and Low BPS Replacements	1,300
STMGID NAC Deficiencies - Upper Toll	500
Verdi 1 BPS	1,750
Santerra Quillici 1 BPS	1,150
Silver Hills BPS	200
Upper Markridge 1 Pressure Improvements	150
Orrcrest PRS	150
Total Pressure Improvements	**9,800**
Water Main-Distribution-Service Line Improvements	
Street & Highway Main Replacements	4,200
5th, 6th & 7th St Water Main Replacements	1,170
Wright Way, E St, 5th, 6th & 7th Replacements	1,820
Oddie Wells Main Replacement	1,560
Spring Creek South Zone Conversion	600
Booth, Sharon Way, Monroe 24" Main Replacements	500
Mount Rose 5 Distribution/Pressure Improvements	50
Goldenrod Main	50
Boomtown Water System Improvements	500
Lemmon Valley Sand Yard	530

Project Summary for FY 2023 (continued)	Amount
South Truckee Meadows Capacity Improvements	200
Rock & Capital Main Tie	200
Total	**11,380**
Potable Water Storage Improvements	
Storage Tank Recoats, Access, Drainage Improvements	3,500
Highland Reservoir Tank	1,000
US 40 Tank and Feeder Main	2,150
Lemmon Valley Tank #1 Replacement and Patrician PRS	250
Hidden Valley Tank #4 Outage Improvements	250
Total Potable Water Storage	**7,150**
Hydroelectric Improvements	
Forebay, Diversion, and Canal Improvements	100
Washoe Plant_Turbine Rebuild and Rebuild/Replacement Unit 1	250
Washoe Plant_Turbine Rebuild and Rebuild/Replacement Unit 2	250
Total Hydroelectric	**600**
Customer Service Outlays	
New Business Meters	100
Mueller Pit Replacements former Washoe County	125
Galvanized / Poly Service Line Replacements	250
AMI Automated Meter Infrastructure	2,300
Total Customer Service Outlays	**2,775**
Administrative Outlays	
GIS/GPS System Mapping Equipment	45
IT Server Hardware	45
IT Network Security Upgrades	70
IT Physical Access Security Upgrades	60
Crew Trucks / Vehicles	900
Emergency Management Projects	150
System Wide Asphalt Rehabilitation	200
Physical Access Control System Upgrade	200
Total Administrative Outlays	**1,670**
Special Projects Funded by Development	
Water Right Purchases	2,500
Total Special Projects	**2,500**
Former STMGID System Improvements	
STMGID Conjunctive Use Facilities - Arrowcreek BPS	3,450
Total STMGID System Improvements	**3,450**
Total Capital Spend for FY 2023	**83,875**

Detailed project descriptions are provided for all projects in the CIP. These descriptions cover the fiscal year 2023 capital budget as well as the four additional years from 2024-2027.

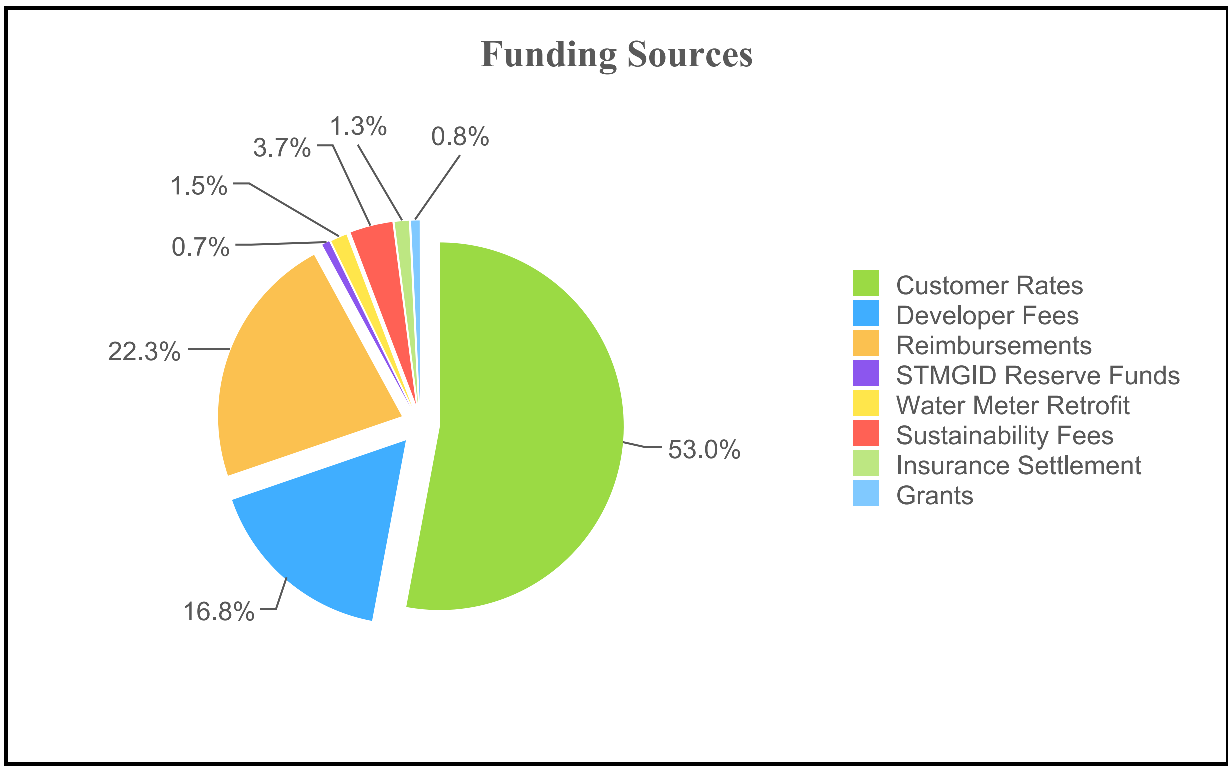
CAPITAL EXPENDITURES BY FUNCTION
(Amounts in thousands of dollars)

Summary of Capital Expenditures by Function	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
Raw Water Supply Improvements	21,125	56,125	40,325	8,675	3,675	129,925
Ground Water Supply Improvements	3,660	4,370	3,190	2,610	4,350	18,180
Treatment Plant Improvements	19,765	11,485	3,705	2,195	9,700	46,850
Distribution System Pressure Improvements	9,800	10,520	9,260	7,930	6,010	43,520
Water Main Distribution Service Line Improvements	11,380	12,120	12,245	11,590	11,500	58,835
Potable Water Storage Improvements	7,150	10,180	9,120	7,155	7,440	41,045
Hydroelectric Improvements	600	6,250	250	250	100	7,450
Customer Service Outlays	2,775	5,550	6,475	6,675	475	21,950
Administrative Outlays	1,670	1,870	1,550	2,850	1,550	9,490
Water Meter Retrofit / Water Rights Purchases	2,500	2,500	2,500	2,500	2,500	12,500
Sub-Total TMWA Construction Spending & Outlays	**80,425**	**120,970**	**88,620**	**52,430**	**47,300**	**389,745**
Former STMGID System Improvements	3,450	—	—	—	—	3,450
Total Projected Capital Spending	**83,875**	**120,970**	**88,620**	**52,430**	**47,300**	**393,195**



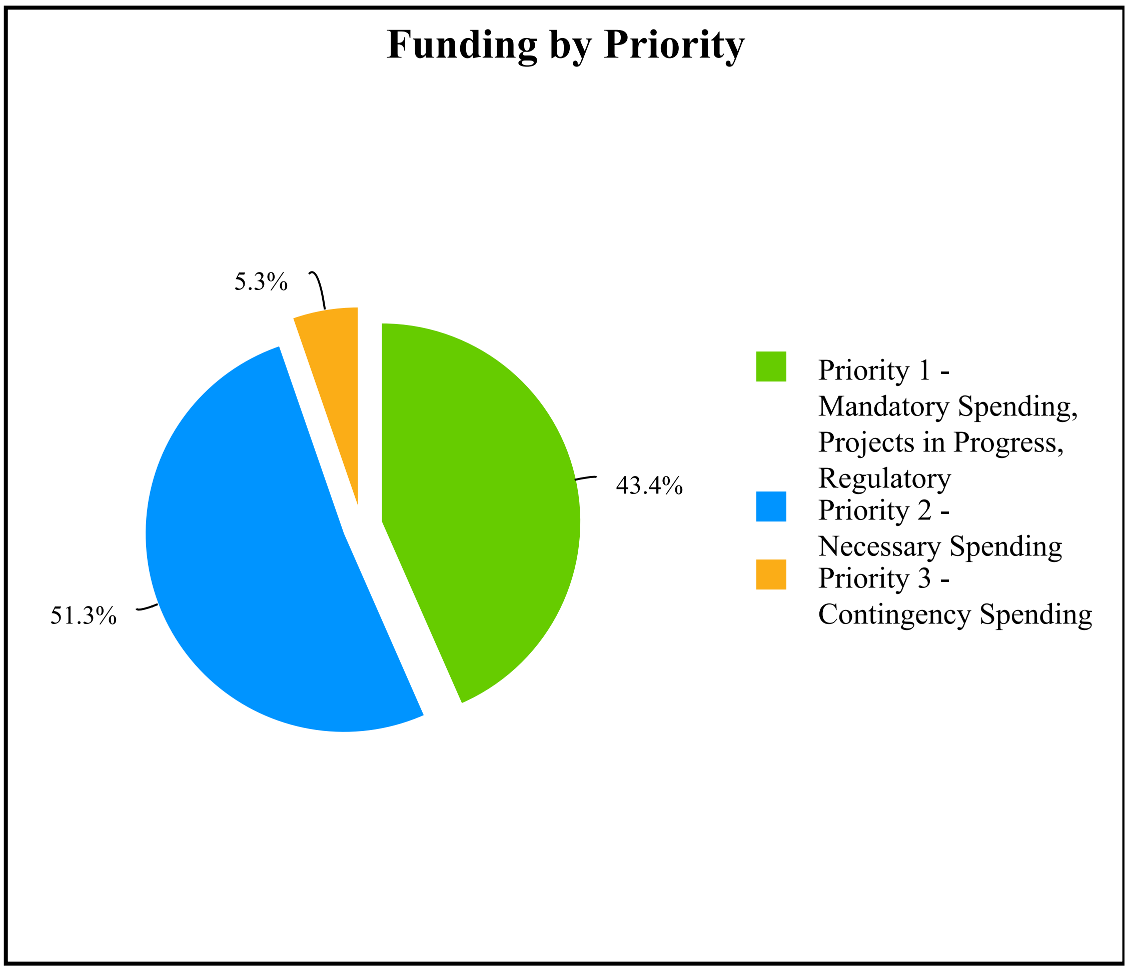
PRELIMINARY FUNDING PLAN
FUNDING SOURCES
(Amounts in thousands of dollars)

Summary of Funding Sources	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
Customer Rates	42,785	46,293	40,651	42,854	35,616	208,199
Developer Fees	9,700	22,816	16,879	5,226	11,434	66,055
Reimbursements	16,100	41,800	26,400	3,500	—	87,800
STMGID Reserves	2,700	—	—	—	—	2,700
Water Meter Retrofit / Water Rights Purchases	2,500	3,211	—	—	—	5,711
Sustainability Fees	2,090	6,850	4,690	850	250	14,730
Insurance Settlement - Applied to Orr Ditch Hydro	5,000	—	—	—	—	5,000
Grants	3,000	—	—	—	—	3,000
Total Projected Capital Spending	**83,875**	**120,970**	**88,620**	**52,430**	**47,300**	**393,195**



FUNDING BY PRIORITY
(Amounts in thousands of dollars)

Summary of Funding by Priority	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
Priority 1 - Mandatory Spending, Projects in Progress, Regulatory	37,955	41,400	33,420	33,365	24,575	170,715
Priority 2 - Necessary Spending	41,895	74,770	51,225	15,040	18,750	201,680
Priority 3 - Contingency Spending	4,025	4,800	3,975	4,025	3,975	20,800
Total Projected Capital Spending	**83,875**	**120,970**	**88,620**	**52,430**	**47,300**	**393,195**



PROJECT FUNCTIONS AND DESCRIPTIONS
RAW WATER SUPPLY IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Highland Canal-Upgrades-Downstream	225	225	225	225	225	1,125
1	Customer Rates	Highland Canal-Upgrades-Diversion to Chalk Bluff	500	500	2,500	100	100	3,700
1	Customer Rates	TROA Drought Storage / Implementation	150	100	100	100	100	550
2	Customer Rates	Donner Lake Outlet Improvements Phase 2	150	150	250	3,000	3,000	6,550
2	Developer Fees / Sustainability Fees / Grants/ Reimbursements	Advanced Purified Water Facility at American Flat	20,000	55,000	37,000	5,000	—	117,000
1	Customer Rates	Washoe Lake System Improvements	100	150	250	250	250	1,000
Subtotal Raw Water Supply			**21,125**	**56,125**	**40,325**	**8,675**	**3,675**	**129,925**

Project Locations: Map of all *Raw Water Supply Improvements* projects are highlighted in the following map.


ADVANCED PURIFIED WATER FACILITY AT AMERICAN FLAT
HIGHLAND CANAL UPGRADES
HIGHLAND CANAL DIVERSION
TROA DROUGHT STORAGE/IMPLEMENTATION
DONNER LAKE OUTLET IMPROVEMENTS PHASE 2
WASHOE LAKE SYSTEM IMPROVEMENTS
TRUCKEE RIVER
Sun Valley
Sparks
Reno
Truckee
Kings Beach
Dayton
Carson City
Minden
TRUCKEE MEADOWS WATER AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
RAW WATER SUPPLY IMPROVEMENTS SUMMARY
DATE 3/30/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 8 miles
NORTH
NAD 83 NEVADA STATE PLANE WEST FEET

Raw Water Supply Improvements
Highland Canal-Upgrades-Downstream

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Highland Canal-Upgrades-Downstream	225	225	225	225	225	1,125

PROJECT DESCRIPTION: The improvements reflected in this capital project item are for betterments along the canal downstream of the Chalk Bluff Water Treatment Plant to the Rancho San Rafael Park. Approximately 2,000 feet of "smart ditch" (a molded plastic trapezoidal channel section) has been installed downstream of Chalk Bluff in recent years. This product reduces leakage and maintenance and it is planned to continue to extend the installation in the future. Other efforts are rehabilitative in nature and may address access and security concerns.

SCHEDULE: Projects are identified and prioritized on an annual basis.

Raw Water Supply Improvements
Highland Canal – Upgrades – Diversion to Chalk Bluff

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Highland Canal-Upgrades-Diversion to Chalk Bluff	500	500	2,500	100	100	3,700

PROJECT DESCRIPTION: These improvements are for the stretch of canal between the diversion on the Truckee River and Chalk Bluff Water Treatment Plant. The proposed spending is to secure the canal from trespass to enhance public safety and prevent encroachment on TMWA property. TMWA will also complete fencing along the canal for public safety, install security cameras and access barriers. The proposed FY 2023 budget is for replacement of the existing 54-inch siphon pipe under the Truckee River just downstream of the diversion installed in 1954.

SCHEDULE: Projects are identified and prioritized on an annual basis.

Raw Water Supply Improvements
TROA Drought Storage/Implementation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	TROA Drought Storage / Implementation	150	100	100	100	100	550

PROJECT DESCRIPTION: TROA became effective and TMWA began implementation officially on December 1, 2015.

SCHEDULE: Ongoing budget under TROA implementation is for additional stream gauges in new locations as required, as well as improving the monitoring capabilities of existing gauges as needed on an annual basis. Other smaller capital improvements are related to the operation of reservoir sites.

Raw Water Supply Improvements
Donner Lake Outlet Improvements Phase 2

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Donner Lake Outlet Improvements Phase 2	150	150	250	3,000	3,000	6,550

PROJECT DESCRIPTION: Dredging of a portion of the Donner Lake outlet channel was completed in FY2019. The project was scaled back to fit within the California Environmental Quality Act emergency permitting requirements. Additional work is required to extend and improve the outlet channel further into the lake, including possible bank stabilization improvements to minimize future dredging requirements.

SCHEDULE: Permitting and preliminary design will be conducted over the next three years. Construction of improvements is scheduled to begin in FY 2026.

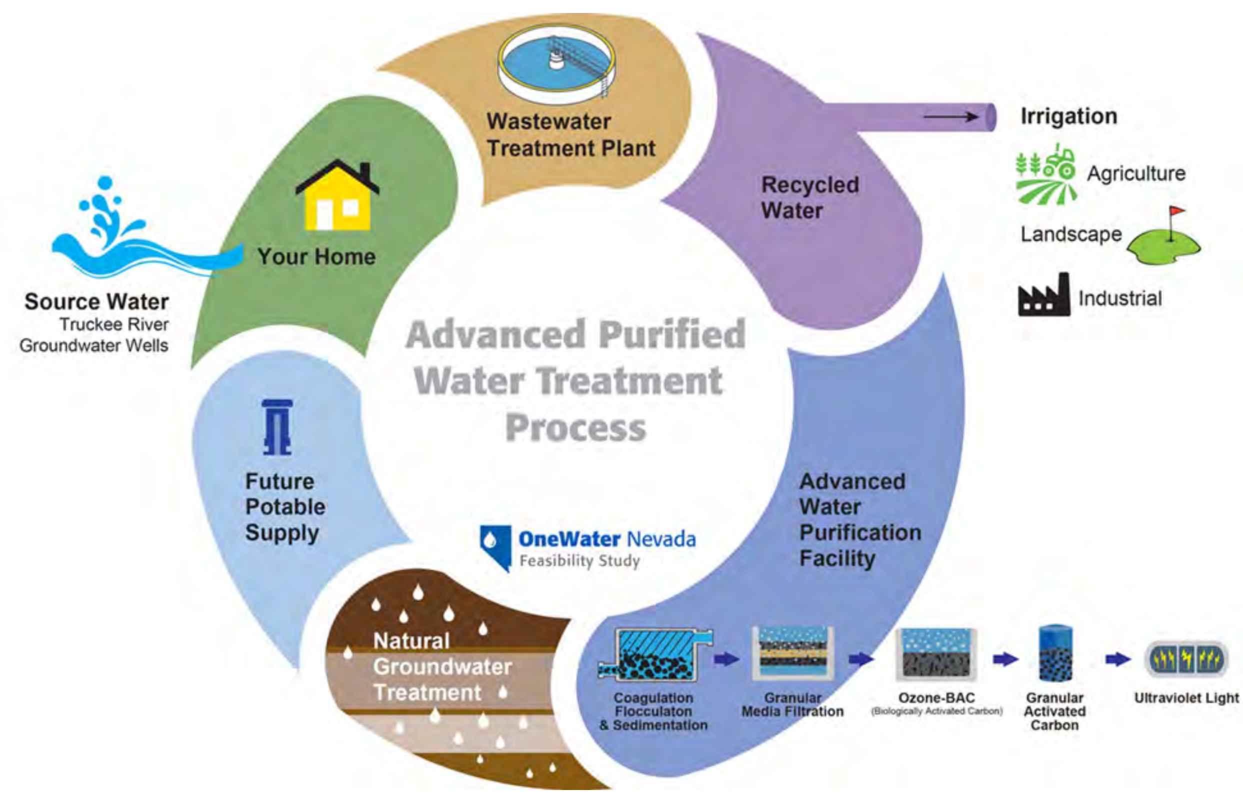
Raw Water Supply Improvements
Advanced Purified Water Facility at American Flat

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees / Sustainability Fees / Grants/ Reimbursements	Advanced Purified Water Facility at American Flat	20,000	55,000	37,000	5,000	—	117,000

PROJECT DESCRIPTION: The Advanced Purified Water Facility at American Flat will be Nevada's first Advanced Purified Water project achieving category A+ reclaimed water quality. Category A+ reclaimed water is suitable for all Nevada water recycling practices, including augmenting groundwater aquifers. The Project's core element is a 2 million gallons per day (MGD) advanced purified water facility (APWF) producing 2,000 acre-feet (AF) of water annually for groundwater augmentation to provide a sustainable regional drought proof supply and crucially enhance the region's water supply resiliency to help address future climate change impacts. TMWA is partnering with City of Reno who will be reimbursing TMWA for 70% of the total construction costs of the project.

SCHEDULE: Construction for this project will begin in FY 2023.



Raw Water Supply Improvements
Washoe Lake System Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Washoe Lake System Improvements	100	150	250	250	250	1,000

PROJECT DESCRIPTION: Improvements as necessary to Washoe Lake Dam and related infrastructure to monitor, capture, store and deliver raw water as necessary to meet regional water supply objectives.

SCHEDULE: Projects are identified and prioritized on an annual basis.

GROUND WATER SUPPLY IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Well Rehabilitation Improvements	200	200	200	200	200	1,000
2	Developer Fees	Double Diamond #5 and Equipping	50	450	—	—	60	560
2	Developer Fees	Callamont Well South Equipping	—	60	1,140	—	—	1,200
2	Customer Rates	Air Guard Well Replacement Equipping	—	—	—	—	1,100	1,100
1	Customer Rates	Lemmon Valley Well #8 Replacement	—	250	1,000	—	—	1,250
1	Customer Rates	Well Fix & Finish	350	350	350	350	350	1,750
1	Customer Rates	Brush Well Replacement and Spring Creek 8	1,000	—	—	1,500	—	2,500
1	Customer Rates / Sustainability Fees	Well Head TTHM Mitigation	100	500	500	500	500	2,100
2	Developer Fees	Callamont Well North Equipping	—	—	—	60	1,140	1,200
1	Developer Fees	Spring Creek Well #10 - Donovan	150	1,060	—	—	—	1,210
1	Customer Rates	Fish Springs Ranch TDS Monitoring Wells	—	250	—	—	—	250
1	Customer Rates	Geothermal Fluid Monitoring Well	100	—	—	—	—	100
1	Customer Rates	Spring Creek Well 9 (Spring Creek 4 Replacement)	760	1,000	—	—	—	1,760
1	Customer Rates	Spring Creek Wells pH Adjustment	750	250	—	—	—	1,000
2	Customer Rates	STMGID Well #1 Re-Drill and Equipping	200	—	—	—	1,000	1,200
Subtotal Ground Water Supply			**3,660**	**4,370**	**3,190**	**2,610**	**4,350**	**18,180**

Project Locations: Map of all *Ground Water Supply Improvements* projects are highlighted in the following map.


FISH SPRINGS RANCH TDS
MONITORING WELLS
SPRING CREEK
WELLS PH ADJUSTMENT
ARMY AIR
GUARD WELL
LEMMON VALLEY
8 WELL
SPRING CREEK 10 WELL - DONOVAN
SPRING CREEK
5 WELL
SPRING CREEK
9 WELL (SC 4 REPLACEMENT)
WELL REHABILITATION
IMPROVEMENTS
WELL HEAD TTHM
MITIGATION
Reno
Sparks
DOUBLE DIAMOND
5 WELL
THOMAS CREEK WELL
STMGID 1 WELL
STMGID 6 WELL
GENERATOR
GEOTHERMAL FLUID
MONITORING WELL
CALLAMONT
WELL NORTH
CALLAMONT
WELL SOUTH
TRUCKEE MEADOWS WATER
AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
GROUND WATER SUPPLY IMPROVEMENTS
SUMMARY
DATE 3/30/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 7 miles
NORTH
NAD 83 NEVADA STATE
PLANE WEST FEET

Ground Water Supply Improvements
Well Rehabilitation Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Well Rehabilitation Improvements	200	200	200	200	200	1,000

PROJECT DESCRIPTION: Funds are budgeted to rehabilitate TMWA production wells as required. Typically for subgrade rehabilitation efforts, five to six wells are inspected, tested and evaluated every year to determine if rehabilitation is required. Typical subgrade rehab activities include but are not limited to pump and pump column pipe replacements; rehabilitation of well casing and screen; and other enhancements to maintain well function and capacities. Spending in fiscal years 2023-2027 will include improvements at several wells to provide general above grade well equipment and building and/or electrical upgrades. Some of the spending will go towards converting an oil lubed shaft vertical turbine to water lubed and eliminate any standing oil in the well. TMWA has over 90 production wells operating throughout the water system. TMWA relies on these wells to provide drought and emergency supply and as a supplemental source to meet peak demands on the water system.

SCHEDULE: Wells targeted for rehabilitation improvements in FY 2023 include Lakeside Well, STMGID 5 Well, Lightning W Well 3 and Boomtown 12.

Ground Water Supply Improvements
Double Diamond #5 and Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Double Diamond #5 and Equipping	50	450	—	—	60	560

PROJECT DESCRIPTION: Construct pumping facilities for the existing Double Diamond Well #5 including the pump house building, electrical power, pump/motor and valves and piping to provide an additional 1,200 gallons per minute of peak period supply to the Double Diamond area. The project also includes construction of a blending main between Double Diamond Wells #4 & #5.

SCHEDULE: Based on current growth rates, it is anticipated that the additional capacity from the new well will be needed in the summer of FY 2028.

Ground Water Supply Improvements
Callamont Well South Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Callamont Well South Equipping	—	60	1,140	—	—	1,200

PROJECT DESCRIPTION: Construct pumping facilities for one of the existing Callamont wells in the Mt. Rose system including the pump house building, electrical power, pump/motor and valves and piping to provide an additional 500 gallons per minute of peak period supply to the area.

SCHEDULE: This project is currently scheduled for construction in FY 2025, but may be constructed sooner (or later) depending on the actual schedule for the proposed 210 unit Callamont residential development.

Ground Water Supply Improvements
Air Guard Well Replacement Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Air Guard Well Replacement Equipping	—	—	—	—	1,100	1,100

PROJECT DESCRIPTION: Replacement of the Air Guard Well in Stead was necessary to reduce sanding and provide additional capacity to the Stead system. The new/replacement well was drilled and constructed in FY 2016. Test pumping indicates the new well will have a capacity of about 2,500 gallons per minute which is twice the capacity of the old well. The budget for FY 2027 is for constructing the pumping facilities including the well building, pump and motor, valves and piping, electrical and controls, etc.

SCHEDULE: The pumping facilities are scheduled for construction in FY 2027.

Ground Water Supply Improvements
Lemmon Valley Well #8 Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Lemmon Valley Well #8 Replacement	—	250	1,000	—	—	1,250

PROJECT DESCRIPTION: The existing Lemmon Valley 8 Well has been in service since 1974, making it one of the older wells in the East Lemmon Valley system. The existing well casing and screens show signs of significant corrosion. With the potential for a well casing failure, TMWA intends to drill and equip a replacement well on the existing well property. In addition, the replacement well is expected to have similar construction while producing at least 20 percent more capacity than the original Lemmon Valley 8 Well. The additional capacity will provide supply to support base load supplied from the Fish Springs groundwater system.

SCHEDULE: Well drilling will occur in FY 2024 and well equipping in FY 2025.

Ground Water Supply Improvements
Well Fix & Finish

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Well Fix & Finish	350	350	350	350	350	1,750

PROJECT DESCRIPTION: Equipment improvements are expected to bring existing wells up to modern standards, including antiquated equipment replacements and improvements for water quality purposes. This project includes improvements to sodium hypochlorite rooms, pump to waste lines and drainage improvements. It also includes well retrofit for recharge where needed.

SCHEDULE: Projects are identified and prioritized on an annual basis.

Ground Water Supply Improvements
Brush Well & Spring Creek 8 Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Brush Well Replacement and Spring Creek 8	1,000	—	—	1,500	—	2,500

PROJECT DESCRIPTION: The Brush and Spring Creek 8 production wells were both replaced in FY 2019. Each well will require new infrastructure prior to use. Allocated funds will be utilized for engineering and construction activities required to bring the wells online.

SCHEDULE: This project requires new well infrastructure in FY 2023 and well equipping in FY 2026.

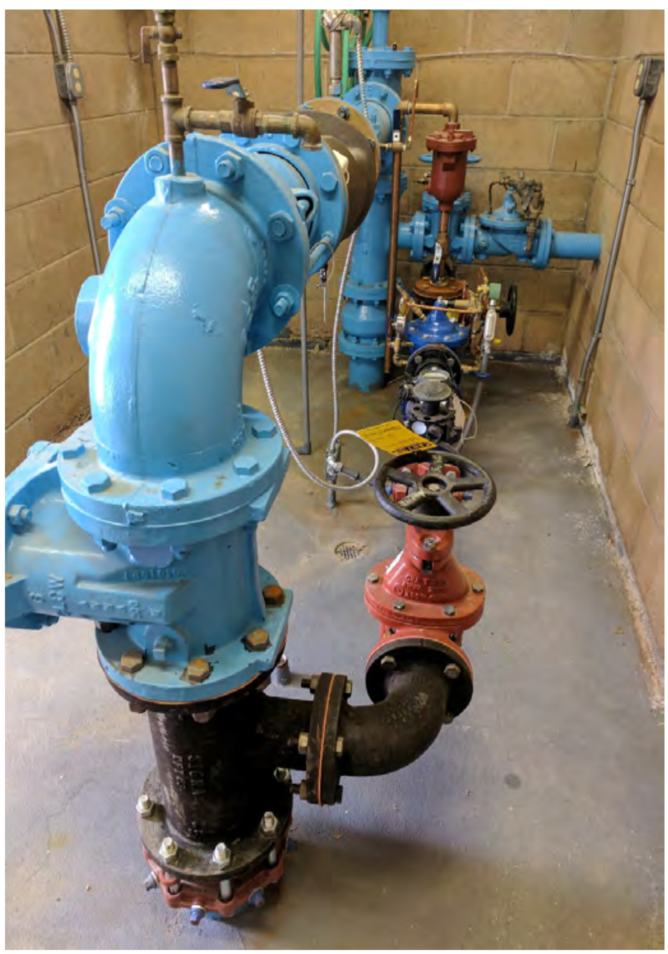
Ground Water Supply Improvements
Well Head TTHM Mitigation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Sustainability Fees	Well Head TTHM Mitigation	100	500	500	500	500	2,100

PROJECT DESCRIPTION: Planning, permitting and implementation of tank mixers and ventilation equipment technologies to reduce disinfection by product (DBP) formation in recharged water and receiving groundwater.

SCHEDULE: Planning and design began in FY 2018 and is ongoing. Construction of tank mixers and ventilation equipment at Zolezzi and Verdi Business Park tanks were completed in FY 2019 . Other technologies will be implemented at key recharge well sites in subsequent years based on priority.



Ground Water Supply Improvements
Callamont Well North Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Callamont Well North Equipping	—	—	—	60	1,140	1,200

PROJECT DESCRIPTION: Construct pumping facilities for the remaining existing Callamont well in the Mt. Rose system including the pump house building, electrical power, pump/motor and valves and piping to provide an additional 500 gallons per minute of peak period supply to the area.

SCHEDULE: This project is currently scheduled for construction in FY 2027, but may be constructed sooner (or later) depending on the actual schedule for the proposed 210 unit Callamont residential development.

Ground Water Supply Improvements
Spring Creek Well #10 - Donovan

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Spring Creek Well #10 - Donovan	150	1,060	—	—	—	1,210

PROJECT DESCRIPTION: The project involves construction and equipping of a new production well located just south of Indian Sage Court in Spanish Springs Valley. TMWA owns a 6,000 square feet parcel at this location where a test well was previously constructed but will need access and pipeline/utility easements. It is anticipated that the new well will produce up to 500 gallons per minute of new supply for the area.

SCHEDULE: This project schedule assumes the new well is drilled and constructed in FY 2023 and the pumping facilities are constructed in FY 2024.

Ground Water Supply Improvements
Fish Springs Ranch TDS Monitoring Wells

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Fish Springs Ranch TDS Monitoring Wells	—	250	—	—	—	250

PROJECT DESCRIPTION: This project involves installing a network of wells that will monitor TDS concentrations and vertical gradients near the Fish Springs Ranch production wellfield in Honey Lake Valley. These monitoring locations will provide critical water quality information associated with increased groundwater production at Fish Springs Ranch. Allocated funds will be utilized to drill and construct three nested monitoring wells completed to approximately 450-feet below land surface.

SCHEDULE: Design and construction for the project is scheduled to be completed in FY 2024.

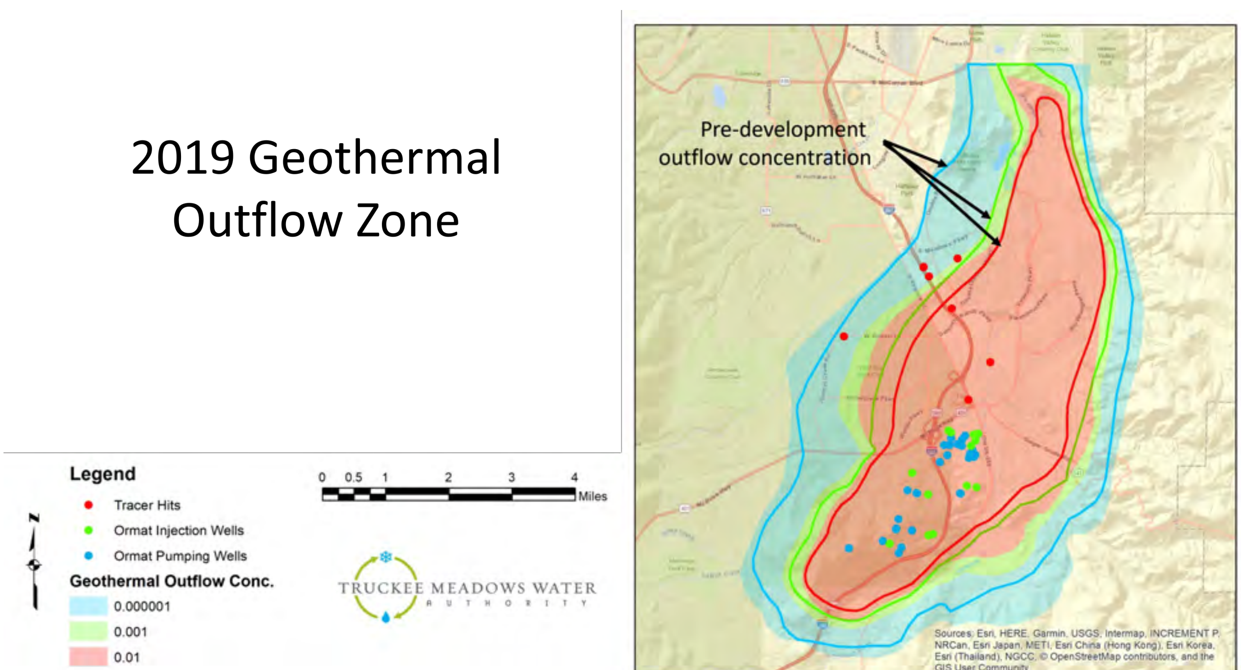
Ground Water Supply Improvements
Geothermal Fluid Monitoring Well

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Geothermal Fluid Monitoring Well	100	—	—	—	—	100

PROJECT DESCRIPTION: This project involves drilling and constructing a new well that will monitor fluid flux on the boundary of the Steamboat Hills geothermal outflow zone in South Truckee Meadows. The well will be installed to monitor water quality changes that may eventually impact down gradient municipal supply wells. Allocated funds will be utilized to drill, construct and test a four- to six-inch monitoring well completed to approximately 600-feet below land surface.

SCHEDULE: New monitoring well drilling and construction will occur in FY 2023.



Similar migration results with temperature adjusted injection rates

Ground Water Supply Improvements
Spring Creek 9 (Spring Creek 4 Replacement)

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Spring Creek Well 9 (Spring Creek 4 Replacement)	760	1,000	—	—	—	1,760

PROJECT DESCRIPTION: The project involves construction and equipping of a new production well in Spanish Springs Valley, located north of the intersection of La Posada Dr. and La Posada Ct (pending land approvals). The well will be a dual purpose ASR/Production Well and it is anticipated that the new well will produce up to 1,500 gpm or 500 gallons per minute of new supply for the area.

SCHEDULE: Drilling and installation will being in FY2023 and equipping in FY2024.

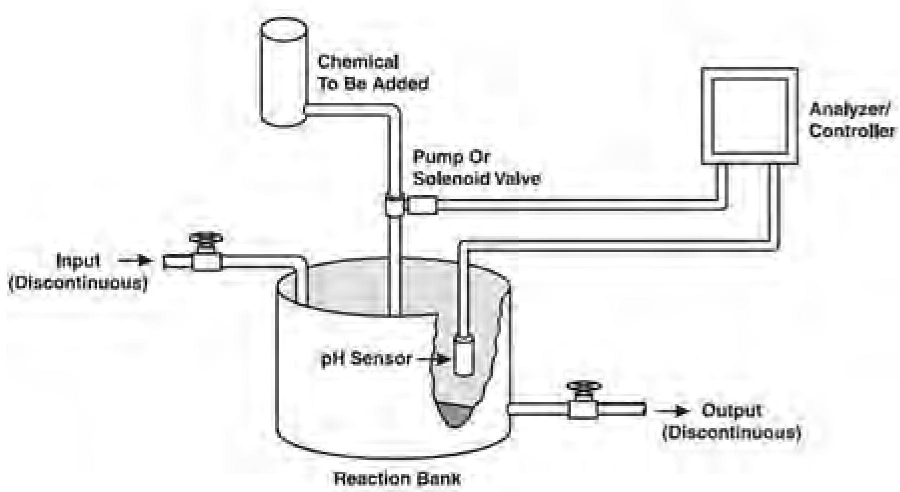
Ground Water Supply Improvements
Spring Creek Wells pH Adjustment

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Spring Creek Wells pH Adjustment	750	250	—	—	—	1,000

PROJECT DESCRIPTION: This project involves design, permit, and construct pH control systems at Spring Creek 6 & Spring Creek 7 wells.

SCHEDULE: The project is scheduled to begin in FY 2023.



Ground Water Supply Improvements
STMGID Well #1 Re-Drill and Equipping

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	STMGID Well #1 Re-Drill and Equipping	200	—	—	—	1,000	1,200

PROJECT DESCRIPTION: This project involves the complete replacement of STMGID 1. Recent rehabilitation work on the production well indicated the screens have deteriorated enough to allow sediment and gravel pack to pass through. The well is a critical groundwater supply asset as it currently accounts for ~24% of the max day demand in STMGID Tank Zone 1.

SCHEDULE: The well is estimated to be drilled in FY 2023 and constructed in FY2027.

TREATMENT PLANT IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Chalk Bluff Treatment Plant Improvements	550	365	360	350	525	2,150
1	Customer Rates	Glendale Treatment Plant Improvements	200	1,000	375	325	405	2,305
1	Customer Rates	Mt Rose Treatment Plant Efficiency Improvements	500	—	—	—	—	500
1	Customer Rates	Chalk Bluff Filter Underdrains	800	800	800	—	—	2,400
1	Customer Rates	Glendale Filter Underdrains	—	500	500	500	500	2,000
3	Customer Rates	Chalk Bluff Lighting Upgrade	—	350	—	—	—	350
3	Customer Rates	Glendale Lighting Upgrade	250	—	—	—	—	250
2	Customer Rates / Insurance Settlement	Orr Ditch Pump Station Rehab and Hydro Facility	15,000	4,000	—	—	—	19,000
1	Customer Rates	Truckee Canyon Water Treatment Improvements	100	100	20	10	10	240
1	Customer Rates	Lightning W Treatment Improvements	20	20	150	10	10	210
1	Customer Rates	SCADA Rehab / Plant Operating Software	1,000	1,000	1,000	1,000	750	4,750
2	Customer Rates	Longley Plant HV 3 and HV 4 Treatment Improvements	695	3,100	—	—	—	3,795
2	Customer Rates	Longley Water Treatment Plant Retrofit	250	—	—	—	—	250
2	Customer Rates	Spanish Springs Nitrate Treatment Facility	250	250	500	—	7,500	8,500
1	Customer Rates	Chalk Bluff Electrical System Upgrades	150	—	—	—	—	150
Subtotal Treatment Improvements			**19,765**	**11,485**	**3,705**	**2,195**	**9,700**	**46,850**

Project Locations: Map of all *Treatment Plant Improvements* projects are highlighted in the following map.

TRUCKEE MEADOWS WATER AUTHORITY

Quality. Delivered.

FY 2023-2027 CIP
TREATMENT PLANT IMPROVEMENTS
SUMMARY

DATE	3/30/2022
MAP BY:	JK
REQUESTED BY:	ST
SCALE:	1 in = 4 miles

NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

Treatment Plant Improvements
Chalk Bluff Treatment Plant Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Chalk Bluff Treatment Plant Improvements	550	365	360	350	525	2,150

PROJECT DESCRIPTION: The Chalk Bluff Water Treatment Plant is 24 years old and requires rehabilitation work to remain operational 24/7/365. This spending is classified as necessary due to the criticality of maintaining plant operations during rehabilitation work. Plant improvements include, but are not limited to, plate settlers inspections, valve and instrument replacement, filter media replacement, UPS upgrades, Trac Vac/sludge removal improvements, treatment train isolation valves, flow meter improvements and safety improvements.

SCHEDULE: Major projects and timelines include: ice fighting improvements to maintain raw water supply via the Highland Canal will continue in FY 2023, instrumentation upgrades will continue within the next five years as obsolete instruments are no longer supported by suppliers. Work to isolate sections of the treatment plant influent trains began in FY 2019. Filter media replacement will occur when yearly filter media evaluation indicates that replacement will soon be necessary.

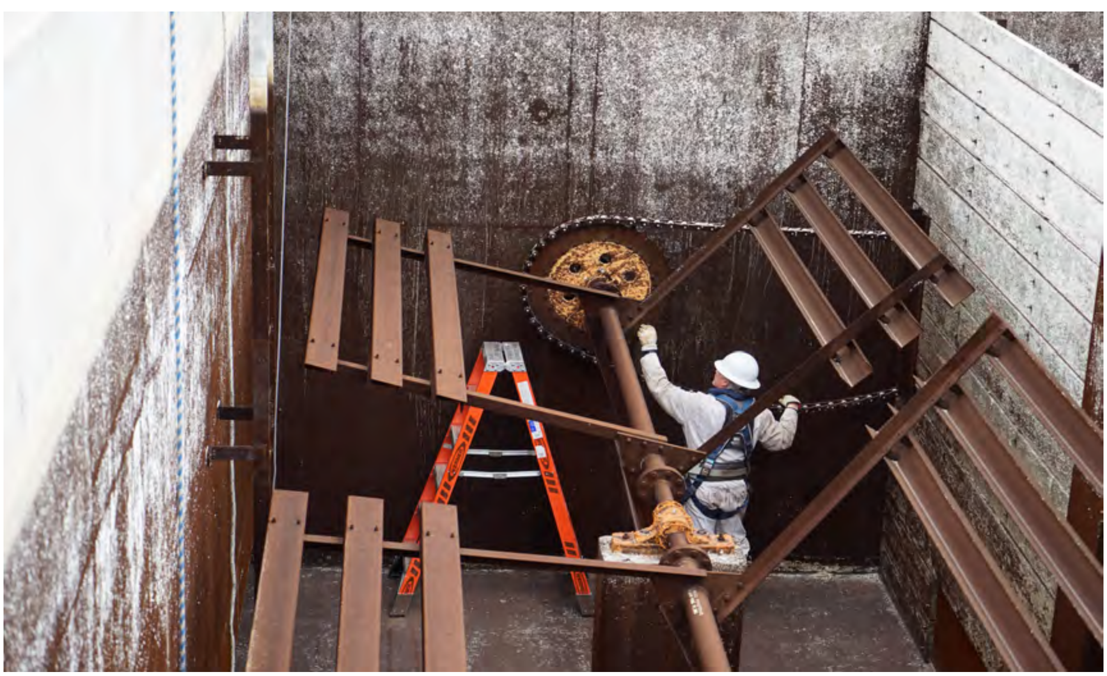
Treatment Plant Improvements
Glendale Treatment Plant Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Glendale Treatment Plant Improvements	200	1,000	375	325	405	2,305

PROJECT DESCRIPTION: The Glendale Water Treatment Plant is 40 years old and remains a significant piece of the water supply portfolio by operating 24/7 typically during the months of April through October. Glendale plays an important role due to its availability to treat off-river water supplies, such as groundwater wells that cannot pump straight to the distribution system. This spending is classified as necessary due to the criticality of maintaining plant operations. Plant improvements include, but are not limited to, plate settler inspections, valve and instrument replacement, Trac Vac improvements, flow meter improvements, treatment chemical upgrades and maintenance storage/shop upgrades.

SCHEDULE: The treatment plant maintenance shop and storage improvements are currently scheduled in FY 2024. Instrumentation upgrades will continue within the next five years as obsolete instruments are no longer supported by suppliers. Filter media replacement will occur when yearly filter media evaluation indicates that replacement will soon be necessary. Since the Glendale plant is used seasonally, most work will continue over the course of the five-year CIP and during the periods that the plant is not operating.



Treatment Plant Improvements
Mt Rose Treatment Plant Efficiency Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Mt Rose Treatment Plant Efficiency Improvements	500	—	—	—	—	500

PROJECT DESCRIPTION: This project contains several efficiency and remote operations improvements identifying during startup and testing of the Mt. Rose Water Treatment Plant (MRWTP). One larger task is adding a permanent air compressor to the creek diversion backwash cycle to support remote operations, use less power and disturb less wildlife by using air for scour instead of pumping water through the screens for backwash. The other improvements include various flow measurement and process control improvements to make remote operations more feasible by reducing on site operations labor hours and reducing downtime.

SCHEDULE: Procurement and install of the equipment and controls is planned to take place in summer/fall of 2022 pending supply chain procurement timing.

Treatment Plant Improvements
Chalk Bluff Filter Underdrains

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Chalk Bluff Filter Underdrains	800	800	800	—	—	2,400

PROJECT DESCRIPTION: The dual media filters at Chalk Bluff are nearing 28 years old and maintenance and/or repairs are needed on filters that have experienced recent underdrain performance issues. An engineering evaluation of the filters has been completed and an entire replacement of one or more filter underdrains is recommended.

SCHEDULE: Due to cost and operational complexities associated with taking a filter out of service, this will be a multi-year effort beginning with design and bidding in FY 2022 and construction taking place in at least FY's 2023-2025.

Treatment Plant Improvements
Glendale Filter Underdrains

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Glendale Filter Underdrains	—	500	500	500	500	2,000

PROJECT DESCRIPTION: The dual media filters at Glendale are nearing 25 years old and maintenance and/or repairs are needed on filters that have experienced recent underdrain performance issues. An engineering evaluation of the filters has been completed and an entire replacement of one or more filter underdrains is recommended.

SCHEDULE: Due to cost and operational complexities associated with taking a filter out of service, this will be a multi-year effort beginning with design and bidding in FY 2024 and construction taking place in FY's 2024-2027.

Treatment Plant Improvements
Chalk Bluff Lighting Upgrade

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Chalk Bluff Lighting Upgrade	—	350	—	—	—	350

PROJECT DESCRIPTION: Upgrade lighting at the Chalk Bluff Water Treatment Plant. Work will include all areas and buildings outside of the most recent remodel areas as well as upgrades to outside area lighting.

SCHEDULE: Lighting upgrade is scheduled to begin in FY 2024.

Treatment Plant Improvements
Glendale Lighting Upgrade

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Glendale Lighting Upgrade	250	—	—	—	—	250

PROJECT DESCRIPTION: Upgrade lighting at the Glendale Water Treatment Plant. Work will include all areas and buildings outside of the most recent remodel areas as well as upgrades to outside area lighting.

SCHEDULE: Lighting upgrade is scheduled to begin in FY 2023.

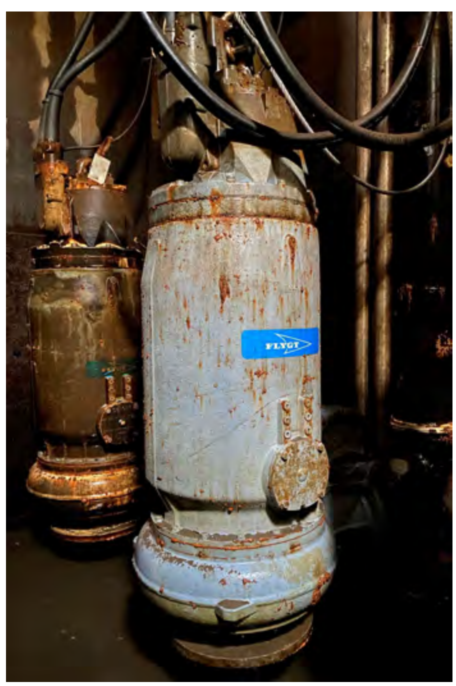
Treatment Plant Improvements
Orr Ditch Pump Station Rehabilitation and Hydro Facility

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Insurance Settlement	Orr Ditch Pump Station Rehab and Hydro Facility	15,000	4,000	—	—	—	19,000

PROJECT DESCRIPTION: This project will increase redundancy and reliability by enhancing the Truckee River source of supply to the Chalk Bluff Water Treatment Plant. Currently, there are very limited options to facilitate repairs or conduct preventative maintenance due to the location and arrangement of the intake structure and wet well. The project design will include modifying the existing proprietary wet well submersible pump design into a pedestal-style vertical turbine pump arrangement with non-submerged motors, the construction of a building over the top of the wet well to increase security and allow a safer means of performing maintenance activities, and incorporate a system to eliminate silting issues within the intake structure. During periods of low demand, the Highland Canal has available capacity to bring water to the Chalk Bluff Facility. An existing pipeline brings water from the river via the Orr Ditch Pump Station up to Chalk Bluff. A feasibility and financial study will be completed to analyze the possibility of using existing infrastructure with the addition of power generation equipment to produce power for direct use at the Chalk Bluff Water Treatment Facility.

SCHEDULE: Construction will commence in FY's 2023-2024 and scheduled to be completed in FY 2024.



Treatment Plant Improvements
Truckee Canyon Water Treatment Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Truckee Canyon Water Treatment Improvements	100	100	20	10	10	240

PROJECT DESCRIPTION: The current treatment system which removes arsenic, iron, and manganese consists of a greensand filter system and an evaporation pond for backwash water with a total capacity of about 100 gallons per minute. Scheduled improvements may include the addition of a polymer feed system to improve filter performance, fine tuning of the treatment process to reflect chemical changes in the raw water and replacement of miscellaneous components and control upgrades.

SCHEDULE: Expenditures in FY's 2023-2027 are contingent spending related to treatment efficiency and for chemical changes in the raw water.

Treatment Plant Improvements
Lightning W Treatment Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Lightning W Treatment Improvements	20	20	150	10	10	210

PROJECT DESCRIPTION: The existing treatment process consists of two ion exchange resin pressure vessels to remove uranium. Previous work included change out/replacement of the filter media, disposal of the spent media. The remaining work includes miscellaneous improvements to the building that houses the treatment equipment.

SCHEDULE: The FY 2023 work includes miscellaneous building improvements.

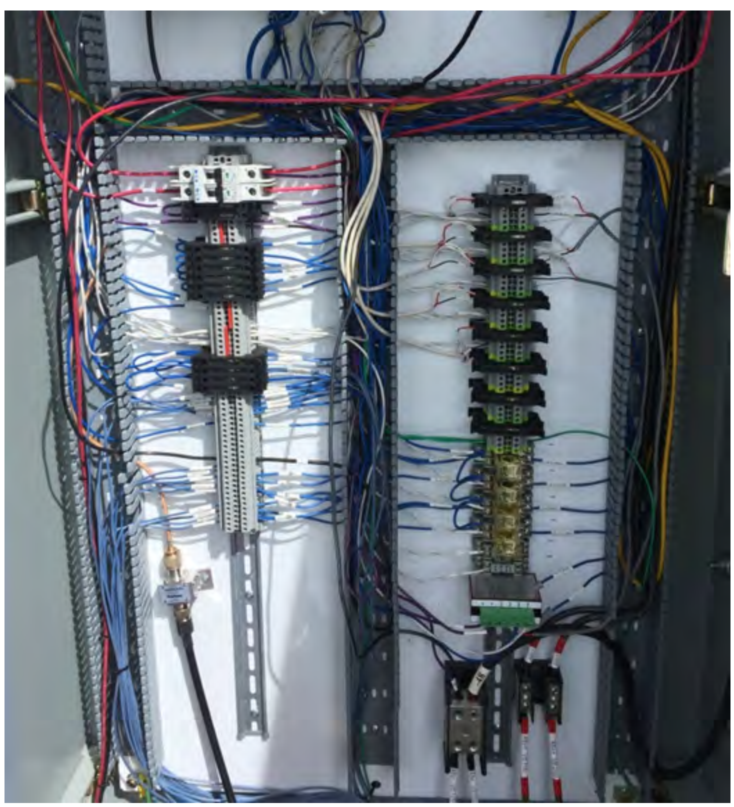
Treatment Plant Improvements
SCADA Rehab/Plant Operating Software

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	SCADA Rehab / Plant Operating Software	1,000	1,000	1,000	1,000	750	4,750

PROJECT DESCRIPTION: SCADA (Supervisory Control and Data Acquisition) is the system by which TMWA monitors, records and controls the water system inputs, outputs, flows and pressures. Data acquired by these system controls are primarily monitored at the treatment plants, but the system equipment and technology are spread throughout the water system infrastructure. Much of the technology is approaching obsolescence and needs to be replaced with emphasis on standardization of programmable logic controllers (PLC) and other equipment. Therefore, TMWA decided on a systematic approach to updating the equipment and operating software starting in fiscal year 2015 with telemetry improvement in the ensuing four years to convert to wireless transmission of data feeds where possible.

SCHEDULE: The improvements and replacements of the equipment and operating software will continue through FY 2027.



Treatment Plant Improvements
Longley Lane HV 3 and HV 4 Treatment Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Longley Plant HV 3 and HV 4 Treatment Improvements	695	3,100	—	—	—	3,795

PROJECT DESCRIPTION: TMWA completed planning and preliminary design of an innovative UV disinfection / Arsenic blending water treatment process to treat the HV 3 and HV 4 groundwater wells that are out of service due to surface water influence and elevated arsenic. These wells were formerly treated at the Longley Lane WTP which is currently not being utilized as a treatment facility due to needed safety improvements on the chemical feed, membrane clean-in-place and the solids handling piping systems. An assessment of the plant was completed, and short-term improvements identified to modify the facility to serve as a booster pump station using either surface water or groundwater supply sources.

SCHEDULE: Planning and permitting to be completed in FY 2022. Design and construction to be performed in FY's 2023-2024.

Treatment Plant Improvements
Longley Water Treatment Plant Retrofit

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Longley Water Treatment Plant Retrofit	250	—	—	—	—	250

PROJECT DESCRIPTION: Conduct a planning study to determine what improvements and costs would be needed to convert the existing Longley Lane WTP from a micro filtration process to a greensand arsenic/iron/manganese treatment process.

SCHEDULE: Planning and permitting to be completed in FY 2022. Design and construction to be performed in FY 2023.

Treatment Plant Improvements
Spanish Springs Nitrate Treatment Facility

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Spanish Springs Nitrate Treatment Facility	250	250	500	—	7,500	8,500

PROJECT DESCRIPTION: Initiation of planning, permitting, site acquisition and design for a 3 MGD biological water treatment process to treat several groundwater wells in Spanish Springs that are out of service due to elevated nitrate and arsenic. Treatment is required to maintain and restore the service capacity of the wells.

TMWA completed the operation and testing of a 5 GPM pilot treatment plant in 2018. Biological treatment of nitrate in potable water is currently not permitted in Nevada. TMWA, working with Carollo Engineers, UNR and WaterStart, has evaluated this innovative technology and determined it to be a cost-effective treatment solution compared to traditional, high cost alternatives such as ion exchange.

SCHEDULE: Planning, permitting, site acquisition and design to be conducted in FY's 2023-2025 with construction scheduled to begin in FY2027.

Treatment Plant Improvements
Chalk Bluff Electrical System Upgrades

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Chalk Bluff Electrical System Upgrades	150	—	—	—	—	150

PROJECT DESCRIPTION: Evaluation of the existing electrical system at the Chalk Bluff Treatment Plant to identify the cause of main breaker power disruption when electrical faults occur in auxiliary plant equipment.

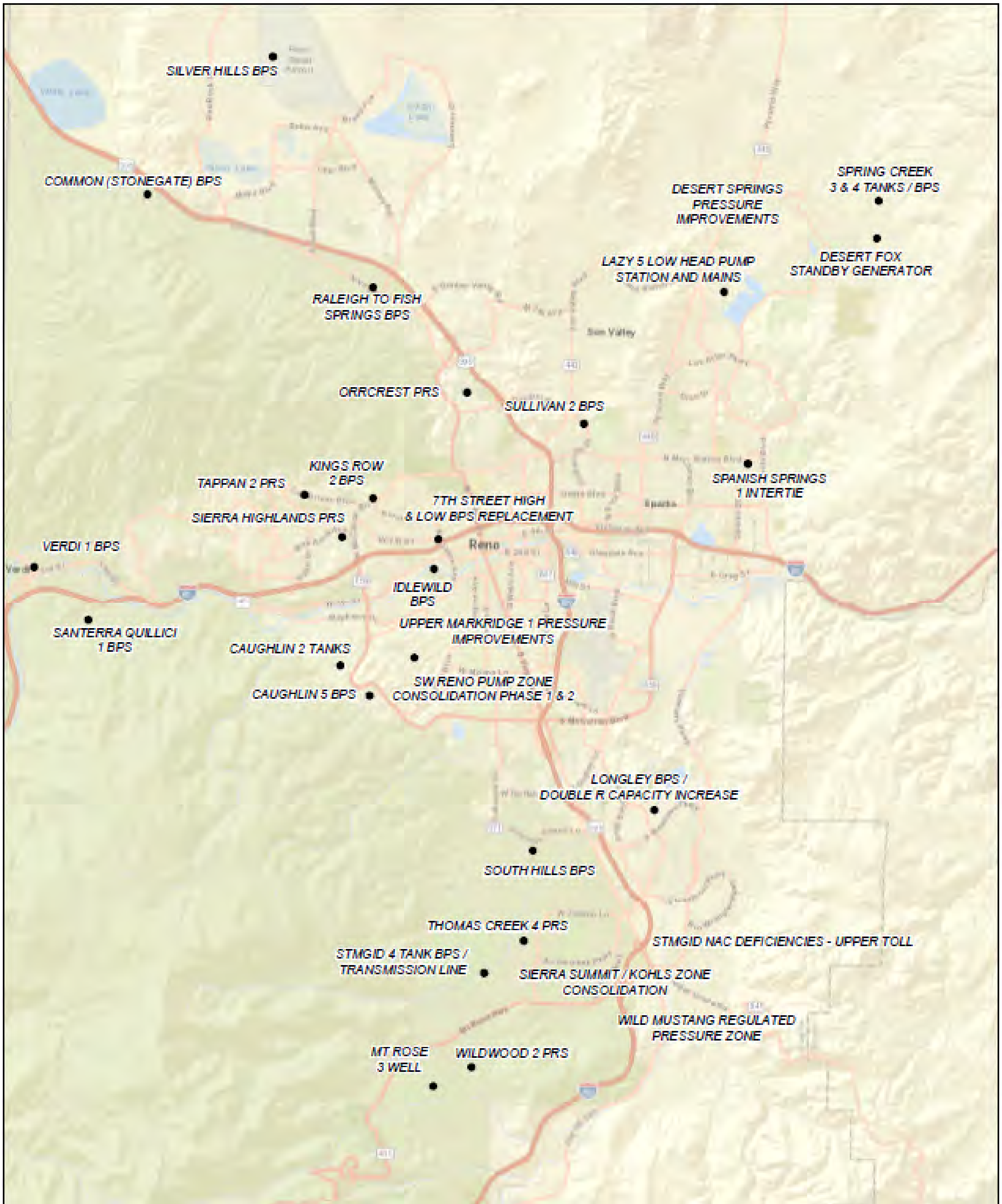
SCHEDULE: Electrical System upgrades are scheduled to be completed in FY 2023.

DISTRIBUTION SYSTEM PRESSURE IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Pressure Regulators Rehabilitation	1,000	500	500	500	500	3,000
2	Customer Rates	Land Acquisitions	150	150	150	150	150	750
2	Customer Rates	Desert Fox Standby Generator	—	150	—	—	—	150
1	Developer Fees	Longley Booster Pump Station / Double R Capacity Increase	—	250	1,000	—	—	1,250
3	Customer Rates	Pump Station Oversizing	100	100	100	100	100	500
1	Customer Rates	Pump Station Rebuilds, Rehabilitations	150	150	150	150	150	750
2	Customer Rates / Developer Fees	Sullivan #2 Booster Pump Station Replacement	—	—	—	—	80	80
2	Customer Rates	Mount Rose Well #3 Pump Station Improvements	—	250	—	—	—	250
3	Customer Rates	Standby Generator Improvements	50	50	50	50	50	250
1	Customer Rates	PSOM Standby Generator Additions	100	—	2,100	2,100	—	4,300
1	Customer Rates	Idlewild Booster Pump Station Improvements	100	1,200	—	—	—	1,300
2	Developer Fees	Raleigh to Fish Springs Booster Pump Station	—	—	—	—	300	300
2	Customer Rates / Developer Fees	South-West Pump Zone Consolidation Phase 1	—	—	—	—	330	330
2	Customer Rates	Spanish Springs #1 Pump Zone Intertie	600	—	—	—	—	600
2	Developer Fees	STMGID Tank #4 Booster Pump Station / Transmission Line	100	300	1,000	—	250	1,650
2	Developer Fees	Wildwood 2 Pressure Regulating Station SCADA Control	—	100	—	—	—	100
2	Customer Rates / Developer Fees	South-West Pump Zone Consolidation Phase 2	—	—	—	—	50	50
2	Customer Rates	Sierra Summit-Kohl's Zone Consolidation	—	—	380	400	—	780
2	Customer Rates	Wild Mustang Regulated Pressure Zone	—	—	50	380	—	430

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Thomas Creek #4 PRS	—	170	—	—	—	170
2	Customer Rates	Kings Row 2 Booster Pump Station	—	—	—	150	150	300
2	Developer Fees	Spring Creek Tanks #3&4 Booster Pump Station Modifications	—	—	—	200	900	1,100
1	Developer Fees	Lazy 5 Low Head Pump Station & Mains	1,000	1,000	—	—	—	2,000
1	Reimbursements	Common (Stonegate) Booster Pump Station	1,100	1,100	—	—	—	2,200
2	Customer Rates	Caughlin 5C Pump and Motor Replacement	150	—	—	—	—	150
1	Customer Rates	South Hills BPS Replacement	—	—	70	2,750	1,500	4,320
2	Customer Rates	Sierra Highlands PRS	—	—	210	—	—	210
1	Customer Rates	Caughlin 2 Tanks	—	—	500	1,000	1,500	3,000
1	Customer Rates	7th Street High & Low BPS Replacement	1,300	2,000	—	—	—	3,300
1	Customer Rates	STMGID NAC Deficiencies - Upper Toll	500	600	2,500	—	—	3,600
1	Reimbursements	Verdi 1 BPS	1,750	750	—	—	—	2,500
1	Reimbursements	Santerra Quilici 1 BPS	1,150	450	—	—	—	1,600
1	Reimbursements	Silver Hills BPS	200	1,000	500	—	—	1,700
2	Customer Rates	Upper Markridge 1 Pressure Improvements	150	—	—	—	—	150
2	Customer Rates	Orrcrest PRS	150	—	—	—	—	150
2	Customer Rates	Tappan 2 PRS	—	250	—	—	—	250
Sub-Total Pressure Improvements			**9,800**	**10,520**	**9,260**	**7,930**	**6,010**	**43,520**

Project Locations: Map of all *Distribution System Pressure Improvements* projects are highlighted in the following map.



TRUCKEE MEADOWS WATER AUTHORITY

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FY 2023-2027 CIP
DISTRIBUTION SYSTEM IMPROVEMENTS - PRESSURE IMPROVEMENTS SUMMARY

DATE	3/31/2022
MAP BY:	JK
REQUESTED BY:	ST
SCALE:	1 in = 3 miles

NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

Distribution System Pressure Improvements
Pressure Regulators Rehabilitation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Pressure Regulators Rehabilitation	1,000	500	500	500	500	3,000

PROJECT DESCRIPTION: Provision is made in the annual budget for major rehabilitation or complete reconstruction of several pressure regulators in the distribution system. TMWA has evaluated nearly 130 pressure regulator stations currently in service and has identified a number of pressure regulator stations requiring a certain amount of rehabilitation on an annual basis.

SCHEDULE: This is an ongoing rehabilitation project with about 130 individual stations identified as requiring rehabilitation or replacement over the next fifteen years.

Distribution System Pressure Improvements
Land Acquisitions

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Land Acquisitions	150	150	150	150	150	750

PROJECT DESCRIPTION: TMWA has over 120 pump stations in service. Many of these pump stations have 480 volt electrical services and are underground (below grade) in locations that allows for water infiltration. Many underground pump stations will be reaching the end of their service life, which will require replacement of the underground vault. Rather than replace the stations in place TMWA is planning to acquire other sites so these stations can be rebuilt above grade improving access and safety. Acquisition of sites may be time consuming and may not be purchased in a particular year.

SCHEDULE: This is an ongoing project with funding to allow purchase of 3-4 sites per year depending on location and market conditions.

Distribution System Pressure Improvements
Desert Fox Standby Generator

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Desert Fox Standby Generator	—	150	—	—	—	150

PROJECT DESCRIPTION: This project involves furnishing and installing a new standby generator and ATS to power one 50 Hp pump at the existing Desert Fox booster pump station. This alternative pumping capacity is needed when the existing 0.5 MG Spring Creek #5A Tank is out of service for recoating or other maintenance or if an extended power outage occurs in the area.

SCHEDULE: The installation of the generator is scheduled in FY 2024.

Distribution System Pressure Improvements
Longley Booster Pump Station/Double R Capacity Increase

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Longley Booster Pump Station / Double R Capacity Increase	—	250	1,000	—	—	1,250

PROJECT DESCRIPTION: Increase pumping capacity at the existing Longley Lane Booster Pump Station and make improvements at the Double R Intertie to provide additional peak supply to the Double Diamond area. The improvements at the Longley pump station will consist of replacing one of the existing pumps/motors with a new higher capacity unit along with electrical and motor starter upgrades. Certain components of the Double R Intertie will be replaced to provide the additional capacity without excessive friction losses.

SCHEDULE: The improvements are scheduled for FY's 2024-2025. The improvements are necessary when supply through the Double R Intertie must exceed 5,400 gallons per minute.

Distribution System Pressure Improvements
Pump Station Oversizing

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Pump Station Oversizing	100	100	100	100	100	500

PROJECT DESCRIPTION: The project may consist of cash contributions towards construction of a new above ground booster pump stations. From time to time, TMWA may provide oversizing to certain booster stations that are development driven. Each is reviewed on a case by case basis.

SCHEDULE: The improvements are ongoing, but the schedule is subject to change based on development & operational needs.

Distribution System Pressure Improvements
Pump Station Rebuilds, Rehabilitations

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Pump Station Rebuilds, Rehabilitations	150	150	150	150	150	750

PROJECT DESCRIPTION: TMWA has over 120 pump stations in service. An amount is budgeted annually for rehabilitation of TMWA's older pump stations. Other pump stations may require pump, motor, and electrical upgrades. Budget for future years will allow TMWA to complete up to one above ground replacement project per year if suitable sites can be acquired. Otherwise, normal rehabilitation work will be performed per the priorities established by the study at a lower overall annual cost.

SCHEDULE: In FY 2023, TMWA is preparing to reconstruct a number of booster stations above ground. Depending on land acquisition timing and priorities of rehabilitation, it could be the Scottsdale BPS, Kings Row #2 Pump Station or the South Hills BPS.

Distribution System Pressure Improvements
Sullivan #2 Booster Pump Station Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	Sullivan #2 Booster Pump Station Replacement	—	—	—	—	80	80

PROJECT DESCRIPTION: The project involves construction of a new above grade pump station at the site of the existing Sullivan Tank on El Rancho. The new pump station will pump to the proposed Sun Valley #2 Tank tentatively located off of Dandini Drive near the TMCC/ DRI complex. Completion of these facilities should allow the retirement of the existing Sun Valley #1 pump station.

SCHEDULE: Construction is scheduled to begin in FY 2028 to reflect delays in obtaining a tank site due to unknowns with the US 395 Connector Project.

Distribution System Pressure Improvements
Mt. Rose Well #3 Pump Station Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Mount Rose Well #3 Pump Station Improvements	—	250	—	—	—	250

PROJECT DESCRIPTION: The project involves rehab of the building, removal of pipe and valves that will no longer be necessary following completion of the Mt. Rose Well #3 improvements and upgrades to electrical and control systems.

SCHEDULE: Construction is scheduled in FY 2024.

Distribution System Pressure Improvements
Standby Generator Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Standby Generator Improvements	50	50	50	50	50	250

PROJECT DESCRIPTION: A number of TMWA pumps stations have backup generation in case of power failures. TMWA incorporates a contingency for replacement of a generator in case of failure or if the Washoe County Health District requires backup generation at a particular site. No spending will occur unless necessary. This spending does not include backup generation for new pump stations required by and paid for by growth.

SCHEDULE: No single project has been identified for the current 5-year CIP and no funds will be expended unless necessary.

Distribution System Pressure Improvements
PSOM Standby Generator Additions

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	PSOM Standby Generator Additions	100	—	2,100	2,100	—	4,300

PROJECT DESCRIPTION: In 2021, NV Energy began their efforts to de-risk their infrastructure during periods of high fire risk (high winds, low humidity). Those efforts culminated in the "Public Safety Outage Management" or "PSOM" events where NV Energy proactively de-energizes their grid for up to 72 hours per event. TMWA has initially responded by renting several large trailer mounted generators and modified various facilities to accept the electrical connections from these generators. This project will procure and install permanent generators for these sites: Caughlin 2 BPS, Caughlin 3 BPS, Caughlin 4 BPS, Mt. Rose 5 BPS and Well, US 40 BPS, Mae Anne 1 BPS, Mt. Rose Tank 1 BPS.

SCHEDULE: TMWA will prioritize the Caughlin pump systems and US 40 BPS in FY 2025 and the balance of the stations in FY 2026. A review of the financial viability of continuing to rent the trailer mounted generators will occur prior to procurement.

Distribution System Pressure Improvements
Idlewild Booster Pump Station Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Idlewild Booster Pump Station Improvements	100	1,200	—	—	—	1,300

PROJECT DESCRIPTION: The project will replace existing pumps and motors at the Idlewild BPS Transfer Station to insure adequate and reliable emergency capacity. It is the only booster station that is capable of transferring water from the Highland Reservoir Zone to the Hunter Creek Reservoir Zone. The station was originally constructed as part of the Idlewild WTP, and was never designed specifically for the purpose that it is used for today. Improvements identified in the project include: Properly sizing new pumps and motors for today's application, upgrading antiquated electrical systems and HVAC systems and bringing building up to modern construction codes. Evaluations by TMWA indicated this was the most cost effective alternative to provide a redundant supply for the zone and allowed retirement of the old 24-inch transmission pipeline on Plumb Lane all the way to the Hunter Creek Reservoir.

SCHEDULE: Design is scheduled for FY 2023 and construction should begin in FY 2024. This schedule may be moved based on system needs.

Distribution System Pressure Improvements
Raleigh to Fish Springs Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Raleigh to Fish Springs Booster Pump Station	—	—	—	—	300	300

PROJECT DESCRIPTION: The project involves construction of a new pump station to pump water from the Raleigh Heights zone to the Fish Springs terminal tank when the Fish Springs Wells are off-line or if a main break occurs on the Fish Springs transmission line. In the future, there will be a number of customers served directly from the Fish Springs terminal tank; therefore, it is necessary to provide a secondary supply to maintain continuous water service.

SCHEDULE: Implementation will begin in FY 2027 and construction in FY 2028.

Distribution System Pressure Improvements
South-West Reno Pump Zone Consolidation Phase 1

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	South-West Pump Zone Consolidation Phase 1	—	—	—	—	330	330

PROJECT DESCRIPTION: The project includes a new high head booster pump station located on Lakeridge golf course property adjacent to Plumas; a new 12-inch suction pipeline from Lakeside Dr.; a high pressure transmission pipeline from the pump station across golf course property to Greensboro and McCarran Blvd.; and another 12-inch pipeline tie to the Ridgeview #1 pump zone. The completion of Phase 1 will allow the retirement of four existing below ground pump stations (Lakeside, Lakeridge, Plumas, Ridgeview #1).

SCHEDULE: Design of the improvements is scheduled to begin in FY 2027. Construction is scheduled for FY 2028.

Distribution System Pressure Improvements
Spanish Springs #1 Pressure Zone Intertie

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Spanish Springs #1 Pump Zone Intertie	600	—	—	—	—	600

PROJECT DESCRIPTION: The project consists of about 1,600 feet of 8-inch main from Rio Alayne Ct to Martini Rd. paralleling the Orr Ditch and a new pressure regulating station. Completion of the facilities will allow the retirement of the existing underground Spanish Springs #1 pump station.

SCHEDULE: The project is scheduled for FY 2023.

Distribution System Pressure Improvements
STMGID Tank #4 Booster Pump Station / Transmission Line

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	STMGID Tank #4 Booster Pump Station / Transmission Line	100	300	1,000	—	250	1,650

PROJECT DESCRIPTION: The project includes a new booster pump station located near the STMGID Tank 4/5 site and approximately 6,000 feet of 12-inch discharge main to the Mt Rose WTP. The facilities will provide a supplemental source to the Mt Rose WTP that will back up plant production on the maximum day during drought and will also provide another source of supply for implementing conjunctive use in the area.

SCHEDULE: Design of the pipeline and pressure regulating station will begin in FY 2023 and construction will begin in FY 2024. The design and construction of the pump station will begin in FY 2026 with construction following in FY 2027. The need for the pump station may elevate based on an extended drought and source supply to the Mt. Rose WTP.

Distribution System Pressure Improvements
Wildwood Pressure Regulating Station/SCADA Control

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Wildwood 2 Pressure Regulating Station SCADA Control	—	100	—	—	—	100

PROJECT DESCRIPTION: The project involves retrofitting an existing pressure regulating station to SCADA (remote) control to provide additional transfer capacity into the Mt Rose Tank #2 zone. It will be necessary to obtain electrical service to the existing vault; install a new PLC; and to equip the existing pressure regulating valve with solenoid control to allow the valve to be remotely operated from the Glendale control room.

SCHEDULE: The project is scheduled for FY 2024 but may be delayed or accelerated depending on the timing of growth and the need for the additional tank fill capacity.

Distribution System Pressure Improvements
South-West Reno Pump Zone Consolidation Phase #2

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	South-West Pump Zone Consolidation Phase 2	—	—	—	—	50	50

PROJECT DESCRIPTION: The project is a continuation of Phase 1 and involves construction of additional water main to further integrate the new South-West Reno pump station and allow the retirement of one more existing underground pump station plus provide backup to two other pump zones.

SCHEDULE: Design of the facilities is scheduled to begin in FY 2027. Construction is scheduled to start in FY 2028.

Distribution System Pressure Improvements
Sierra Summit-Kohl's Zone Consolidation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Sierra Summit-Kohl's Zone Consolidation	—	—	380	400	—	780

PROJECT DESCRIPTION: The project involves construction of a new pressure regulating station (PRS) at Old Virginia and Sutherland; a short main tie between the former STMGID Well #9 site and the distribution system; and about 950 feet of 8-inch main in Sutherland from the PRS to Sage Hill Road. The improvements will convert an area with very high distribution system pressures to the existing Kohl’s Regulated Zone and would expand the regulated zone by consolidating the Kohl’s, Walmart and Old Virginia #2 regulated pressure zones.

SCHEDULE: The project is scheduled for construction in FY 2025.

Distribution System Pressure Improvements
Wild Mustang Regulated Pressure Zone

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Wild Mustang Regulated Pressure Zone	—	—	50	380	—	430

PROJECT DESCRIPTION: The project involves construction of a new pressure regulator station and approximately 750 LF of water main to create a new pressure zone in the Geiger Grade area of the South Truckee Meadows to reduce distribution system pressures in the area.

SCHEDULE: Design of the construction is scheduled to begin in FY 2025. Construction is scheduled to start in FY 2026.

Distribution System Pressure Improvements
Thomas Creek #4 PRS

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Thomas Creek #4 PRS	—	170	—	—	—	170

PROJECT DESCRIPTION: The project involves construction of a new PRS and approximately 160 LF of water main to increase capacity to the Moonrise pressure zone. The increase in capacity will help with replenishing storage in the STMGID Tank and increase fire flow within the zone.

SCHEDULE: The project is scheduled for FY 2024.

Distribution System Pressure Improvements
Kings Row 2 Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Kings Row 2 Booster Pump Station	—	—	—	150	150	300

PROJECT DESCRIPTION: This project will replace the existing underground Kings Row #1 pump station with a new above ground pump station on TMWA property. The project is part of annual booster pump station rehabilitation/replacement program focused on reconstructing existing pump stations above grade.

SCHEDULE: Planning and design will occur in FY's 2026-2027 with construction scheduled in FY 2028.

Distribution System Pressure Improvements
Spring Creek Tanks #3&4 Booster Pump Station Modifications

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Spring Creek Tanks #3&4 Booster Pump Station Modifications	—	—	—	200	900	1,100

PROJECT DESCRIPTION: This project will replace an existing 200 GPM pump with a new pump/motor rated for 1800 GPM at the existing Spring Creek 3/4 Tanks site in Spanish Springs Valley. The existing regulated bypass will also be equipped for SCADA control. The improvements will provide redundant supply to the Desert Springs 3 and Spring Creek 6 tank zones.

SCHEDULE: Planning and design will occur in FY 2026 with construction scheduled in FY 2027.

Distribution System Pressure Improvements
Lazy 5 Low Head Pump Station & Mains

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Lazy 5 Low Head Pump Station & Mains	1,000	1,000	—	—	—	2,000

PROJECT DESCRIPTION: The project involves construction of a new low head pump station located near the existing Lazy 5 Intertie in NE Sparks/Spanish Springs Valley along with suction and discharge mains. TMWA will need to acquire a parcel of land and pipeline easements out to the Pyramid Hwy. The project will increase TMWA's ability to transfer surface water to the Spanish Springs Valley and may defer more costly groundwater treatment options to increase capacity for growth.

SCHEDULE: Planning and design will occur in FY 2023 with construction scheduled to end in FY 2024.

Distribution System Pressure Improvements
Common (Stonegate) Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reimbursements	Common (Stonegate) Booster Pump Station	1,100	1,100	—	—	—	2,200

PROJECT DESCRIPTION: The project consists of design and construction of a new booster pump station to deliver the water supply for the proposed Stonegate development in Cold Springs. Suction and discharge pipelines on North Virginia and terminal storage facilities in Cold Springs will be constructed by Stonegate as applicant-installed projects. The pump station will be located on a parcel on North Virginia that has already been acquired by Stonegate. Stonegate is responsible for 100 percent of the project costs.

SCHEDULE: Design was initiated in FY 2020 with construction scheduled in FY 2023.

Distribution System Pressure Improvements
Caughlin 5C Pump and Motor Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Caughlin 5C Pump and Motor Replacement	150	—	—	—	—	150

PROJECT DESCRIPTION: The project involves replacement of the existing Caughlin #5 pump station "C" Pump with a higher capacity unit and construction of a main tie near Foxcreek Trail and Village Green Parkway to avoid a 300+ customer outage when Caughlin #5 Pump Station is off-line.

SCHEDULE: The project will be designed and built in FY 2023.

Distribution System Pressure Improvements
South Hills BPS Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	South Hills BPS Replacement	—	—	70	2,750	1,500	4,320

PROJECT DESCRIPTION: The project involves construction of a new, above grade BPS with genset; 3,700 feet of l6-inch main, 250 feet of l4-inch main and 2,300 feet of l2-inch main on Broken Hills Rd, Foothill Rd and Broili; a new Caribou PRS; and 9 each individual PRV'S on customer service lines.

SCHEDULE: Planning and design is scheduled to begin in FY 2025 and construction is scheduled to begin in FY 2026 with the project completing in FY 2027.

Distribution System Pressure Improvements
Sierra Highlands Pressure Regulator System

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Sierra Highlands PRS	—	—	210	—	—	210

PROJECT DESCRIPTION: The project involves construction of a new PRS located near the intersection of Sierra Highlands Drive and North McCarran Blvd. to provide a secondary/ supplemental supply from the Mae Anne-McCarran zone to the Chalk Bluff zone.

SCHEDULE: Construction for the project is scheduled for FY 2025.

Distribution System Pressure Improvements
Caughlin 2 Tanks

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Caughlin 2 Tanks	—	—	500	1,000	1,500	3,000

PROJECT DESCRIPTION: The project involves the proposed Caughlin 2 tanks that will provide redundancy for an existing continuous pumping zone and will expand emergency storage for the entire southwest area. The tanks will also provide a greater level of redundancy to a fire prone area by relying less on pumping and power, and more on elevated storage.

SCHEDULE: Construction for the project is scheduled to begin in FY 2025.

Distribution System Pressure Improvements
7th Street High & Low Booster Pump Station Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	7th Street High & Low BPS Replacement	1,300	2,000	—	—	—	3,300

PROJECT DESCRIPTION: The project will replace 2 underground pump stations in the intersection of Keystone Avenue and 7th Street in Northwest Reno. The pump stations need rehabilitation and accessing them for maintenance is unsafe and requires major traffic control in the highly traveled intersection. TMWA has been in discussions with NDOT for purchasing a remnant parcel on 7th street east of Keystone Avenue and West of Vine Street.

SCHEDULE: Construction for the project is scheduled for FY's 2023-2024.

Distribution System Pressure Improvements
STMGID NAC Deficiencies - Upper Toll

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	STMGID NAC Deficiencies - Upper Toll	500	600	2,500	—	—	3,600

PROJECT DESCRIPTION: The project consists of main ties, hydrant installations and individual booster pump systems to be constructed in multiple locations in former STMGID service areas to correct NAC pressure and fire flow deficiencies. In order to correct deficiencies in the upper Toll Road area, it will be necessary to create a new higher pressure zone by constructing a new tank, booster pump station and approximately 6,300 linear feet of 12-inch main.

SCHEDULE: The new pressure zone on upper Toll Road will be constructed in FY 2025 subject to acquisition of the tank site property which may be private or on BLM property.

Distribution System Pressure Improvements
Verdi 1 Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reimbursements	Verdi 1 BPS	1,750	750	—	—	—	2,500

PROJECT DESCRIPTION: This pump station is part of the ‘backbone facilities’ necessary to bring more surface water to the Verdi area and meet planned/approved growth via various housing projects underway. The planned capacity is 3,500 gpm.

SCHEDULE: Design will begin in FY 2023 and construction will occur in FY's 2023-2024.

Distribution System Pressure Improvements
Santerra Quillici 1 Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reimbursements	Santerra Quilici 1 BPS	1,150	450	—	—	—	1,600

PROJECT DESCRIPTION: This pump station will be located next to the Boomtown Tanks to provide service to the portions of Santerra Quillici project located higher in elevation than can be served by existing infrastructure. The planned capacity is 1,000 gpm.

SCHEDULE: Design will begin in FY 2023 and construction will occur in FY's 2023-2024

Distribution System Pressure Improvements
Silver Hills Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reimbursements	Silver Hills BPS	200	1,000	500	—	—	1,700

PROJECT DESCRIPTION: The pump station will be located next to the Army Air well at the Reno Stead Airport to provide service to the Silver Hills project located to the west of the Airport and on either side of Red Rock Road. The planned capacity is 2,000 gpm.

SCHEDULE: Design will begin in FY 2023 and construction will occur in FY's 2023-2024.

Distribution System Pressure Improvements
Upper Markridge 1 Pressure Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Upper Markridge 1 Pressure Improvements	150	—	—	—	—	150

PROJECT DESCRIPTION: This project will make pressure zone improvements to the Markridge 1 Pressure zone as well as convert up to 11 customers to the Markridge 2 pressure zone and increase their service pressures. A main extension will be required on Belford Rd. between Sunnyvale Ave and Marthiam Ave. Private plumbing modifications may be required.

SCHEDULE: Design and construction planned in FY 2023.

Distribution System Pressure Improvements
Orrcrest Pressure Regulator System

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Orrcrest PRS	150	—	—	—	—	150

PROJECT DESCRIPTION: This project consists of adding a secondary supply to the Tenaya Regulated Zone. Currently the zone is only supplied by a second pressure reducing station. This will bring the zone into compliance with NAC and TMWA standards.

SCHEDULE: Design and construction planned in FY 2023.

Distribution System Pressure Improvements
Tappan 2 Pressure Regulator System

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Tappan 2 PRS	—	250	—	—	—	250

PROJECT DESCRIPTION: The project will provide the Tappan Reg zone with more redundancy and a second source of supply. The location is approximate and subject to easement acquisition and timing.

SCHEDULE: Planned for design/construction in FY 2024 if land acquisition timing allows.

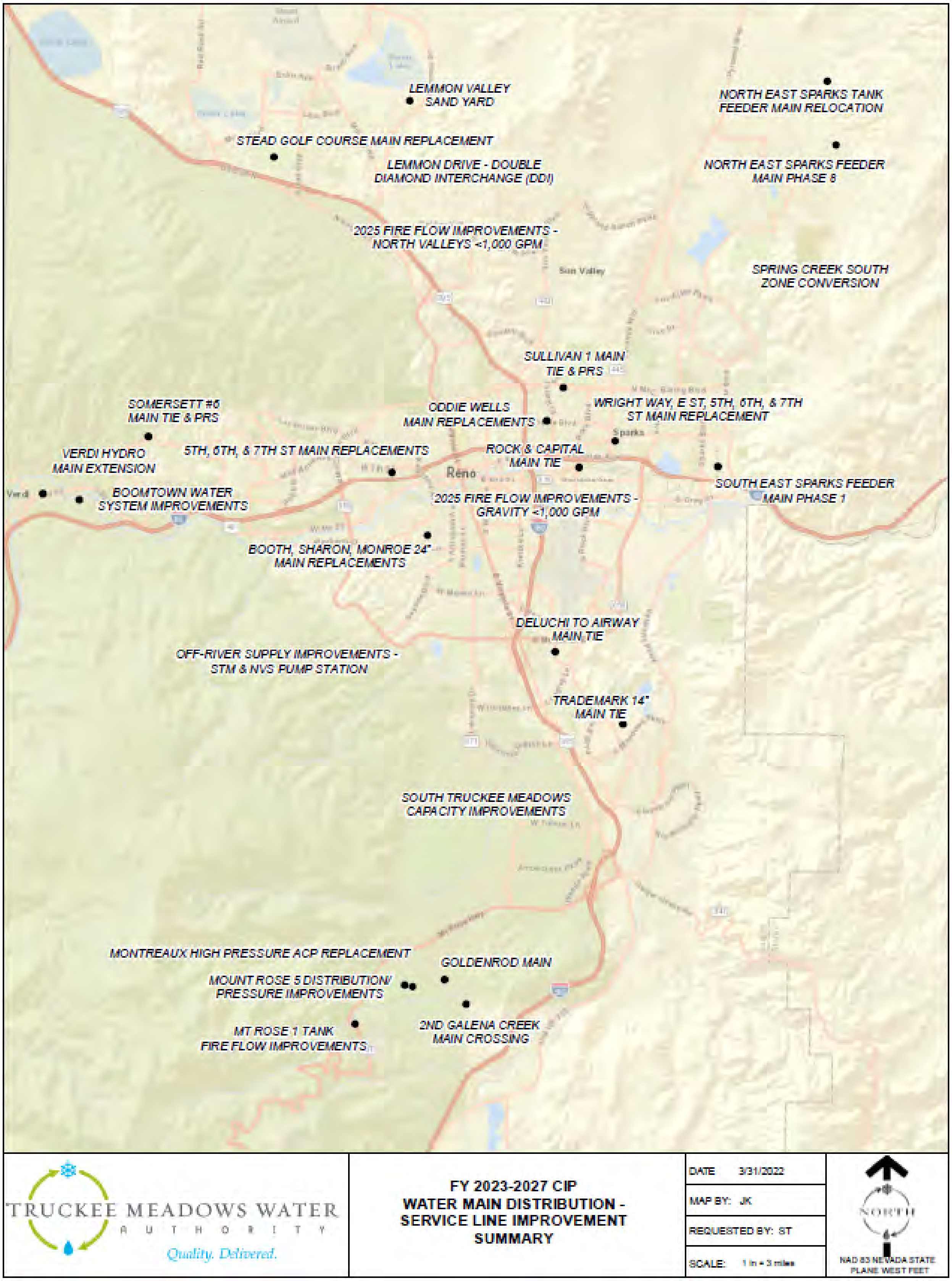
WATER MAIN DISTRIBUTION & SERVICE LINE IMPROVEMENTS

Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Street & Highway Main Replacements	4,200	5,000	5,000	5,000	5,000	24,200
1	Customer Rates	5th, 6th & 7th St. Water Main Replacements	1,170	—	—	—	—	1,170
1	Customer Rates	Wright Way, E St, 5th, 6th & 7th Replacements	1,820	—	—	—	—	1,820
1	Developer Fees	Oddie Wells Main Replacement	1,560	—	—	—	—	1,560
2	Customer Rates	Spring Creek South Zone Conversion	600	200	—	—	—	800
2	Customer Rates	Booth, Sharon Way, Monroe 24" Main Replacements	500	2,000	2,000	1,000	—	5,500
2	Developer Fees	North-East Sparks Tank Feeder Main Relocation	—	—	975	—	—	975
2	Developer Fees	Trademark 14" Main Tie	—	—	—	—	350	350
2	Customer Rates	Mount Rose Tank 1 Fire Flow Improvements	—	400	570	—	—	970
2	Customer Rates / Developer Fees	Stead Golf Course Main Replacement	—	—	170	2,400	—	2,570
1	Developer Fees	North-East Sparks Feeder Main Ph. 8	—	50	2,050	—	—	2,100
1	Developer Fees	Mount Rose 5 Distribution / Pressure Improvements	50	400	—	—	—	450
2	Developer Fees	Goldenrod Main	50	1,200	—	—	—	1,250
1	Developer Fees	Boomtown Water System Improvements	500	1,750	—	—	—	2,250
2	Customer Rates	Lemmon Valley Sand Yard	530	—	—	—	—	530
2	Customer Rates / Developer Fees	Sullivan #1 Main Tie & PRS	—	—	—	100	650	750
2	Customer Rates	Montreux High Pressure ACP Replacement	—	—	520	1,060	—	1,580
2	Customer Rates	2nd Galena Creek Main Crossing	—	40	560	—	—	600
2	Customer Rates	Off-River Supply Improvements - South Truckee Meadows	—	—	—	50	1,050	1,100
2	Customer Rates	Off-River Supply Improvements - North Virginia-Stead Pump Station	—	—	400	—	—	400

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Somersett #6 Main Tie & PRS	—	280	—	—	—	280
1	Customer Rates	2025 Fire Flow Improvements - Gravity <1,000 GPM	—	—	—	550	—	550
1	Customer Rates	2025 Fire Flow Improvements - North Valleys <1,000 GPM	—	—	—	940	—	940
2	Developer Fees	Deluchi to Airway Main Tie	—	—	—	440	—	440
1	Developer Fees	South-East Sparks Feeder Main Phase 1	—	—	—	50	4,450	4,500
1	Developer Fees	South Truckee Meadows Capacity Improvements	200	800	—	—	—	1,000
2	Customer Rates	Rock & Capital Main Tie	200	—	—	—	—	200
Subtotal Water Main Distribution Improvements			**11,380**	**12,120**	**12,245**	**11,590**	**11,500**	**58,835**

Project Locations: Map of all *Water Main Distribution Service Line Improvements* projects are highlighted in the following map.


LEMMON VALLEY SAND YARD
NORTH EAST SPARKS TANK FEEDER MAIN RELOCATION
STEAD GOLF COURSE MAIN REPLACEMENT
LEMMON DRIVE - DOUBLE DIAMOND INTERCHANGE (DDI)
NORTH EAST SPARKS FEEDER MAIN PHASE 8
2025 FIRE FLOW IMPROVEMENTS - NORTH VALLEYS <1,000 GPM
SPRING CREEK SOUTH ZONE CONVERSION
SULLIVAN 1 MAIN TIE & PRS
SOMERSETT #6 MAIN TIE & PRS
ODDIE WELLS MAIN REPLACEMENTS
WRIGHT WAY, E ST, 5TH, 6TH, & 7TH ST MAIN REPLACEMENT
VERDI HYDRO MAIN EXTENSION
5TH, 6TH, & 7TH ST MAIN REPLACEMENTS
ROCK & CAPITAL MAIN TIE
SOUTH EAST SPARKS FEEDER MAIN PHASE 1
BOOMTOWN WATER SYSTEM IMPROVEMENTS
2025 FIRE FLOW IMPROVEMENTS - GRAVITY <1,000 GPM
BOOTH, SHARON, MONROE 24" MAIN REPLACEMENTS
DELUCHI TO AIRWAY MAIN TIE
OFF-RIVER SUPPLY IMPROVEMENTS - STM & NVS PUMP STATION
TRADEMARK 14" MAIN TIE
SOUTH TRUCKEE MEADOWS CAPACITY IMPROVEMENTS
MONTREAUX HIGH PRESSURE ACP REPLACEMENT
GOLDENROD MAIN
MOUNT ROSE 5 DISTRIBUTION/ PRESSURE IMPROVEMENTS
2ND GALENA CREEK MAIN CROSSING
MT ROSE 1 TANK FIRE FLOW IMPROVEMENTS
Reno
Sparks
Sun Valley
Verdi
TRUCKEE MEADOWS WATER AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
WATER MAIN DISTRIBUTION - SERVICE LINE IMPROVEMENT SUMMARY
DATE 3/31/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 3 miles
NORTH
NAD 83 NEVADA STATE PLANE WEST FEET

Water Main-Distribution Service Line Improvements
Street & Highway Main Replacements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Street & Highway Main Replacements	4,200	5,000	5,000	5,000	5,000	24,200

PROJECT DESCRIPTION: Provision is made each year for water main replacements in conjunction with repaving efforts by the City of Reno, City of Sparks, Washoe County and RTC. In addition to repaving projects, TMWA coordinates water main replacements with sewer main replacements in areas where TMWA also has older water lines. TMWA plans for approximately $5.0 million annually for these efforts, so that TMWA can capitalize on repaving projects planned by other entities. Anticipated spending in the out years is reflective of historical activity. Levels of spending can vary year to year and are difficult to predict. These efforts by far are the largest expenditure in the water system rehabilitation category.

SCHEDULE: Projects are identified and prioritized on an annual basis.

Water Main-Distribution Service Line Improvements
5th, 6th & 7th St. Water Main Replacements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	5th, 6th & 7th St. Water Main Replacements	1,170	—	—	—	—	1,170

PROJECT DESCRIPTION: Replace approximately 1,600' of 4" and 6" cast iron main on 5th, 6th and 7th Streets between G and H Street. Work to be completed prior to City of Sparks road reconstruct on same same streets scheduled for summer 2022.

SCHEDULE: Construction is scheduled for FY 2023.

Water Main-Distribution Service Line Improvements
Wright Way, E St, 5th, 6th & 7th Replacements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Wright Way, E St, 5th, 6th & 7th Replacements	1,820	—	—	—	—	1,820

PROJECT DESCRIPTION: Replace approximately 5,800' of 4" and 6" cast iron and transite water main with ductile iron. Perform tie overs, service connections and replacements as needed.

SCHEDULE: Construction is scheduled for FY 2023.

Water Main-Distribution Service Line Improvements
Oddie Wells Main Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Oddie Wells Main Replacement	1,560	—	—	—	—	1,560

PROJECT DESCRIPTION: The project involves replacing approximately 3,500’ of cast iron water main. Existing water main to be grouted in place.

SCHEDULE: Construction is scheduled for FY 2023.

Water Main-Distribution Service Line Improvements
Spring Creek South Zone Conversion

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Spring Creek South Zone Conversion	600	200	—	—	—	800

PROJECT DESCRIPTION: The project involves construction of approximately 2,800 linear feed of various size water mains, several interties, retirement of several mains and facilities including the existing Spring Creek Tanks. New water mains include 2060 linear feet of 12-inch on Pyramid Highway and 300 linear feet of 8-inch main across Pyramid Highway at Spring Ridge.

SCHEDULE: Implementation and construction will be completed by FY 2024.

Water Main-Distribution Service Line Improvements
Booth, Sharon Way, Monroe 24" Main Replacements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Booth, Sharon Way, Monroe 24" Main Replacements	500	2,000	2,000	1,000	—	5,500

PROJECT DESCRIPTION: This project is a continuation of the previously constructed California-Marsh Intertie to provide reliable emergency capacity to the Hunter Creek gravity zone. The project consists of about 6,900 feet of 24-inch main on Booth, Sharon to Plumb Lane and on Monroe between Sharon and Nixon to supply the Nixon-Monroe regulator.

SCHEDULE: Construction is scheduled for FY's 2024-2026. TMWA will attempt to coordinate construction with other municipal infrastructure projects if possible, but the existing pipes will be 74-years old by the proposed construction date.

Water Main-Distribution Service Line Improvements
North-East Sparks Tank Feeder Main Relocation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	North-East Sparks Tank Feeder Main Relocation	—	—	975	—	—	975

PROJECT DESCRIPTION: The North-East Sparks Tank Feeder Main was constructed in 1988 within private easements several years prior to the construction of South Los Altos Parkway. The final alignment selected for South Los Altos Parkway does not follow the alignment of the tank feeder main. As a result, the tank feeder main now runs through developed properties next to buildings, under parking areas and at considerable depth in some locations. This situation presents potential problems for access to the pipe for maintenance and repair of the critical pipeline. This project will relocate approximately 3,000 feet of the 18-inch tank feeder main out into the public right-of-way in South Los Altos Parkway.

SCHEDULE: Design and the improvements are scheduled for FY 2025.

Water Main-Distribution Service Line Improvements
Trademark 14" Main Tie

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Trademark 14" Main Tie	—	—	—	—	350	350

PROJECT DESCRIPTION: This project involves construction of approximately 350 LF of 14” water main from Trademark to South Meadows Parkway, including crossing of an existing major drainage channel. The project will increase transmission capacity in the Double Diamond system to meet the needs of growth.

SCHEDULE: Construction is scheduled to be completed in FY 2027.

Water Main-Distribution Service Line Improvements
Mount Rose Tank 1 Fire Flow Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Mount Rose Tank 1 Fire Flow Improvements	—	400	570	—	—	970

PROJECT DESCRIPTION: The project involves reconstruction of an existing PRS at Mt. Rose Tank #1, a new PRS on Blue Spruce and approximately 3100 linear feet of 10-inch water main on Blue Spruce and Douglas Fir to increase system pressure and fire flow capacity to existing customers in Galena Forest Estates. Existing fire flows are currently less than 1,000 GPM in the area.

SCHEDULE: Planning and design will be completed in FY 2024. Construction will occur in FY's 2024-2025.

Water Main-Distribution Service Line Improvements
Stead Golf Course Main Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	Stead Golf Course Main Replacement	—	—	170	2,400	—	2,570

PROJECT DESCRIPTION: The project consists of replacement of about 10,000 feet of 14-inch steel pipe installed around 1945. The pipe provides an important hydraulic tie between the Stead tanks and the northeast extremities of the Stead distribution system. The pipeline may also be useful to alleviate an existing bottleneck between the Stead wells and the distribution system.

SCHEDULE: The project is scheduled for construction in FY 2026.

Water Main-Distribution Service Line Improvements
North-East Sparks Feeder Main Ph. 8

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	North-East Sparks Feeder Main Ph. 8	—	50	2,050	—	—	2,100

PROJECT DESCRIPTION: The project involves construction of approximately 6,400 linear feet of 14-inch water main on Satellite Drive from Vista Blvd to Sparks Blvd to increase capacity for growth in Spanish Springs and maintain adequate suction pressure at the Satellite Hills booster pump station.

SCHEDULE: Design is scheduled for FY 2024 and the improvements will be constructed in FY 2025.

Water Main-Distribution Service Line Improvements
Mount Rose 5 Distribution / Pressure Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Mount Rose 5 Distribution / Pressure Improvements	50	400	—	—	—	450

PROJECT DESCRIPTION: Improvements are intended to provide off-peak conjunctive use supply. The proposed improvements are intended to be consistent with future improvements to improve peaking supply to the Mt. Rose system and will reduce pressure in the high pressure pipeline downhill of Mt. Rose Well 5. It will also increase the off-peak pumping capacity of surface water into the Mt. Rose 1 and 4 tanks to 650 gpm from 400 gpm. Future phases are intended to increase system redundancy and further reduce high pressures in the system.

SCHEDULE: Construction is scheduled for FY 2024.

Water Main-Distribution Service Line Improvements
Goldenrod Main

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Goldenrod Main	50	1,200	—	—	—	1,250

PROJECT DESCRIPTION: The project involves construction of approximately 4,500 LF of 12" water main from the Tessa West Well to the intersection of Goldenrod and Mountain Meadows Lane. This project will provide additional capacity between the Arrowcreek and Mt. Rose systems for Mt. Rose 2 tank fills and for on-peak supply from the Mt. Rose Water Treatment Plant.

SCHEDULE: Design is planned in FY 2023 and construction is planned in FY 2024.

Water Main-Distribution Service Line Improvements
Boomtown Water System Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	Boomtown Water System Improvements	500	1,750	—	—	—	2,250

PROJECT DESCRIPTION: The Boomtown system requires several high priority improvements to bring the system into compliance with NAC 445A regulations and TMWA standards and to allow efficient operation and maintenance of the water facilities. The improvements consist of upgrades to three existing wells (pump to waste facilities, SCADA, new pumps, new motors, new starters and arc flash analyses), tank site improvements (grading, drainage, overflow, fencing, paving, sampling vault, SCADA) and tank access improvements.

SCHEDULE: The improvements will be designed and constructed in FY's 2023-2024.

Water Main-Distribution Service Line Improvements
Lemmon Valley Sand Yard

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Lemmon Valley Sand Yard	530	—	—	—	—	530

PROJECT DESCRIPTION: With continued growth in the area including the acquisition of the Lemmon Valley water system formerly owned by Washoe County, it is very inefficient for TMWA crews to respond to a main break or other major issue in the North Valleys and have to either return to the Truckee Meadows or call out a second crew to transport materials to the site to complete the repairs. To increase the efficiency of maintenance operations in the North Valleys, TMWA plans to improve the balance of the 1.25 acre lot surrounding Lemmon Valley Well #6 (near the intersection of Lemmon Drive and Arkansas Drive) to store the common materials such as sand and base rock normally used in water system maintenance. The improvements consist of import, grading, fencing, drainage, material storage bins, lighting and landscaping. The project has been designed and the building permit has been acquired.

SCHEDULE: Planned for construction in FY 2023 pending zoning compliance.

Water Main-Distribution Service Line Improvements
Sullivan #1 Main Tie & PRS

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	Sullivan #1 Main Tie & PRS	—	—	—	100	650	750

PROJECT DESCRIPTION: The project involves construction of about 1,300 LF of 10" main on El Rancho and a new PRS to supply the Sullivan #1 zone. The project timeline assumes that the proposed Sun Valley #2 Tank and Sullivan #2 pump station are in service.

SCHEDULE: Planning and design is scheduled to begin in FY 2026 with construction scheduled in FY 2027.

Water Main-Distribution Service Line Improvements
Montreux High Pressure ACP Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Montreux High Pressure ACP Replacement	—	—	520	1,060	—	1,580

PROJECT DESCRIPTION: The project involves replacement of approximately 6,500 linear feet of existing 10-inch transite water main between Mt Rose Well #5 and Joy Lake Road. The existing ACP pipe installed in the 1970's is currently operated at pressures between 120-250 psi.

SCHEDULE: Planning and design will occur in FY 2025 with construction to be completed in FY 2026.

Water Main-Distribution Service Line Improvements
2nd Galena Creek Main Crossing

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	2nd Galena Creek Main Crossing	—	40	560	—	—	600

PROJECT DESCRIPTION: The project involves construction of approximately 2,200 linear feet of 10-inch ductile iron water main between Breithorn Cir. and Piney Creek Parklet including a crossing of Galena Creek. The existing 10" ACP pipe that crosses Galena Creek is currently the only tie between well sources and storage tanks.

SCHEDULE: Design will occur in FY 2024 with construction to be completed in FY 2025.

Water Main-Distribution Service Line Improvements
Off-River Supply Improvements - South Truckee Meadows

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Off-River Supply Improvements - South Truckee Meadows	—	—	—	50	1,050	1,100

PROJECT DESCRIPTION: The project involves construction of four SCADA controlled, pressure reducing bypass stations in strategic locations in the South Truckee Meadows to allow excess well capacity and excess Mt. Rose Water Treatment Plant capacity to be provided to the Highland gravity zone in case of loss supply from the Truckee River. Two additional bypasses (Arrowcreek BPS & future Veteran's BPS) will be constructed separately under the budget for those facilities.

SCHEDULE: Planning and design will occur in FY 2026 with construction to be completed in FY 2027.

Water Main-Distribution Service Line Improvements
Off-River Supply Improvements - North Virginia-Stead Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Off-River Supply Improvements - North Virginia-Stead Pump Station	—	—	400	—	—	400

PROJECT DESCRIPTION: The project involves construction of a SCADA controlled, pressure reducing bypass station at the North Virginia-Stead booster pump station to allow excess Fish Springs well capacity to be provided to the Highland gravity zone in case of loss supply from the Truckee River.

SCHEDULE: Project implementation and construction will occur in FY 2025.

Water Main-Distribution Service Line Improvements
Somersett #6 Main Tie & PRS

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Somersett #6 Main Tie & PRS	—	280	—	—	—	280

PROJECT DESCRIPTION: The project involves construction of about 600 linear feet of 10-inch main within improved paved pathway and a new pressure regulator station to provide a secondary source to Somersett Village 6.

SCHEDULE: Project implementation and construction will occur in FY 2024.

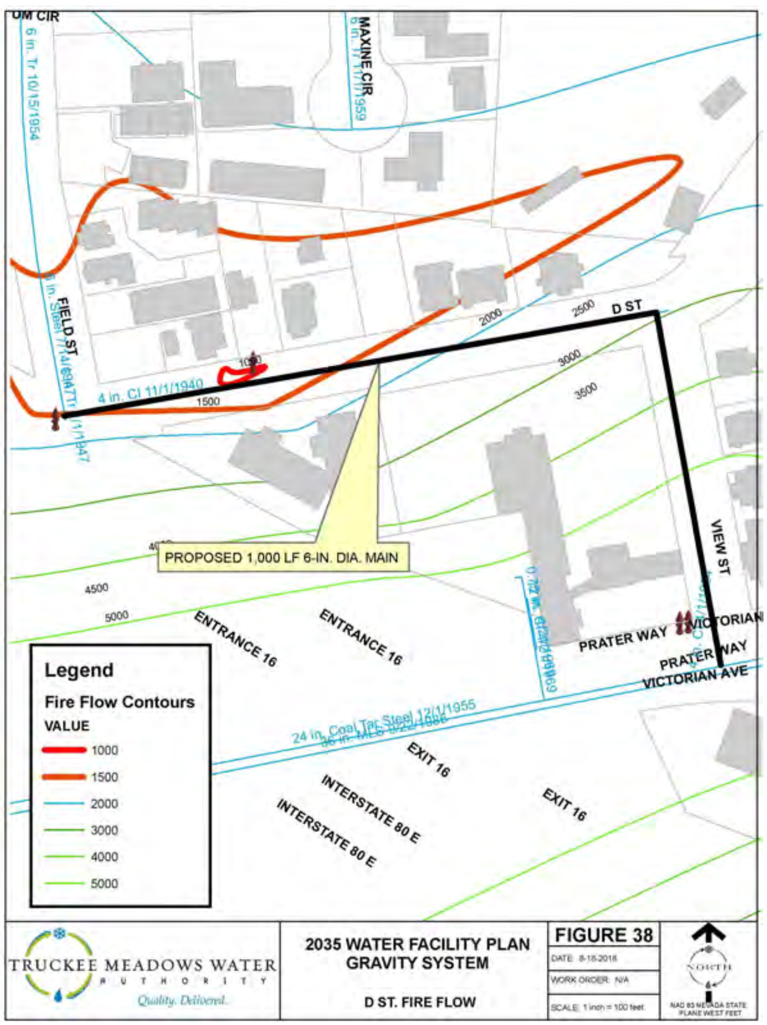
Water Main-Distribution Service Line Improvements
2025 Fire Flow Improvements - Gravity <1,000 GPM

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	2025 Fire Flow Improvements - Gravity <1,000 GPM	—	—	—	550	—	550

PROJECT DESCRIPTION: The project involves improvements at 5 separate locations in the gravity zone that have an available fire flow of less than 1000 GPM. Reference Pages 20-22 of the 2035 WFP – Items 14,18,20,25,31 (also Figures 38,42,44,49,55). Construction consists of approximately 1,900 linear feet of new 6-inch & 8-inch main including new hydrant taps and laterals.

SCHEDULE: The improvements are scheduled for construction in FY 2026.



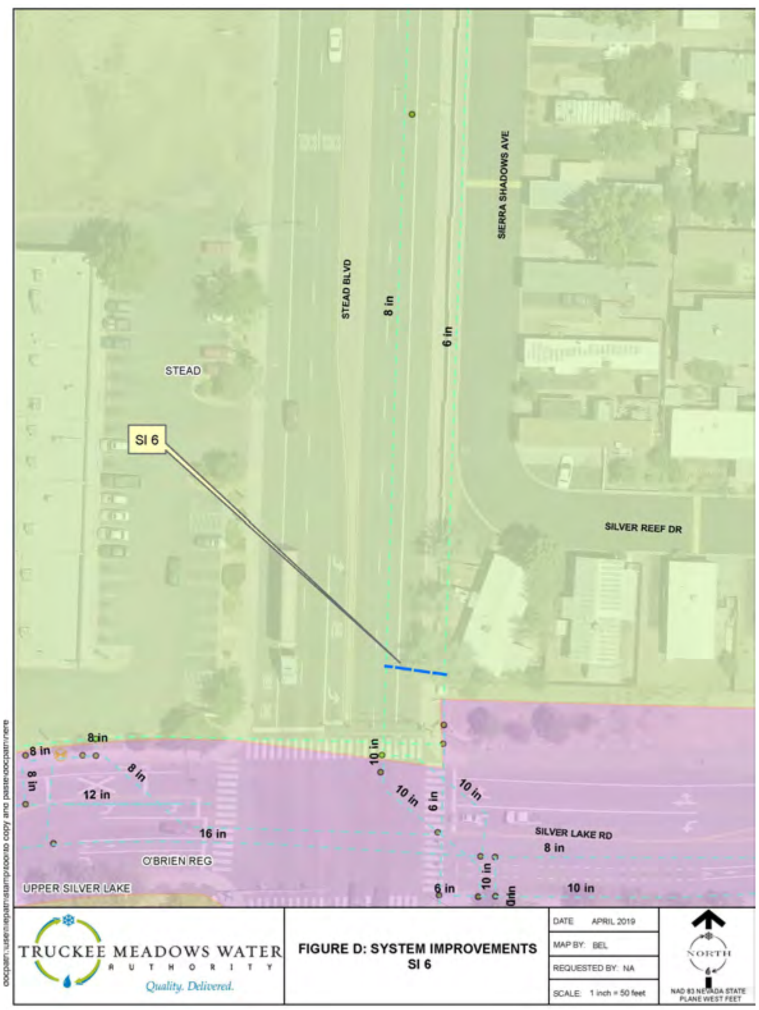
Water Main-Distribution Service Line Improvements
2025 Fire Flow Improvements - North Valleys <1,000 GPM

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	2025 Fire Flow Improvements - North Valleys <1,000 GPM	—	—	—	940	—	940

PROJECT DESCRIPTION: This project involves improvements at two separate locations that have an available fire flow of less than 1,000 GPM. Reference Items SI6 and SI7 on pages 6-7 of the North Valleys section of the 2035 Water Facilities Plan (also Figures D and E). Construction of approximately 3,500 linear feet of new 6-inch and 8-inch main and new high pressure Regulating Station.

SCHEDULE: The improvements are scheduled for construction in FY 2026.



Water Main-Distribution Service Line Improvements
Deluchi to Airway Main Tie

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Deluchi to Airway Main Tie	—	—	—	440	—	440

PROJECT DESCRIPTION: The project involves construction of approximately 1,200 linear feet of l4-inch main from Deluchi to Airway including crossing a major storm drainage channel. The project promotes looping of the distribution system and provides additional North to South peak period capacity.

SCHEDULE: The project is scheduled for construction in FY 2026.

Water Main-Distribution Service Line Improvements
South-East Sparks Feeder Main Phase 1

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	South-East Sparks Feeder Main Phase 1	—	—	—	50	4,450	4,500

PROJECT DESCRIPTION: The project involves construction of approximately 9,700 linear feet of 24-inch main on Greg Street between 21st Street and Stanford to provide additional capacity for future growth and to lower peak period pressure in the area.

SCHEDULE: Planning and design are scheduled to begin in FY 2026 and construction is scheduled to begin in FY 2027.

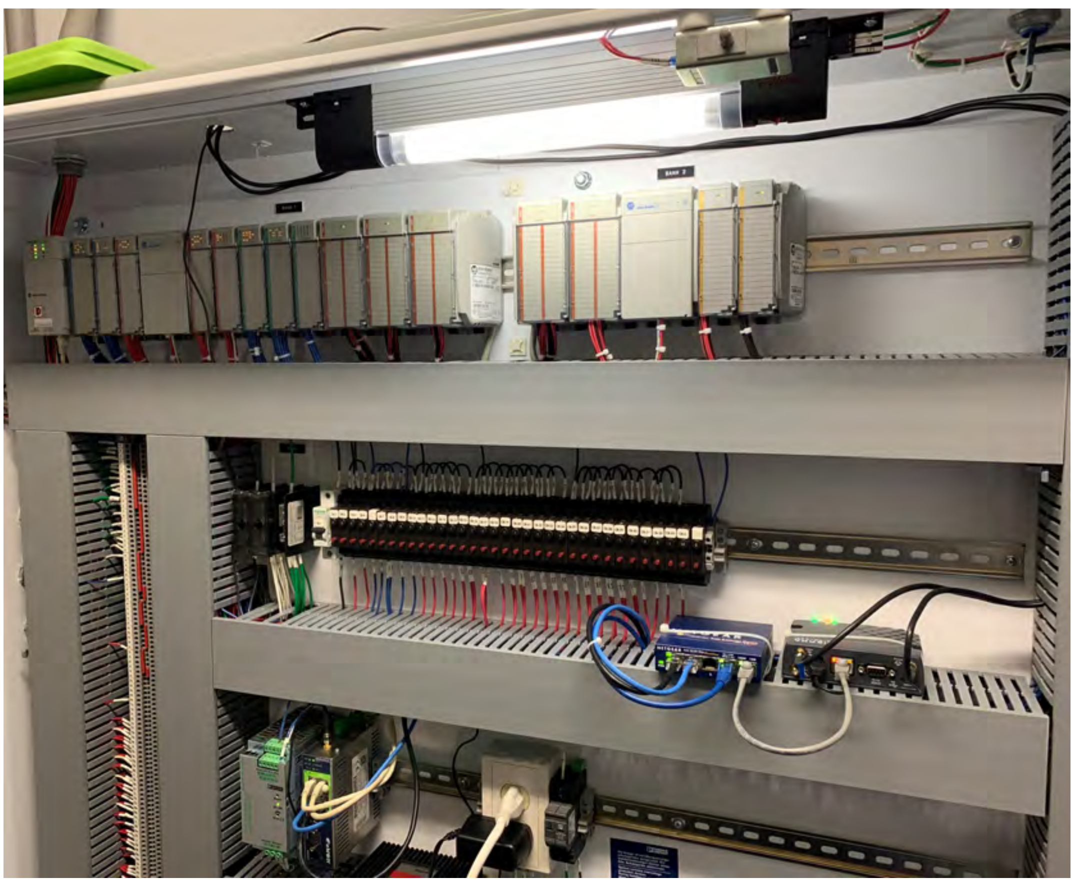
Water Main-Distribution Service Line Improvements
South Truckee Meadows Capacity Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Developer Fees	South Truckee Meadows Capacity Improvements	200	800	—	—	—	1,000

PROJECT DESCRIPTION: The project involves construction of approximately 1,500 linear feet of l4-inch main on Offenhauser and Gateway with a SCADA controlled valve installed in an underground vault to provide an intertie between the Longley and Double Diamond systems. Also included is a short 8-inch main tie at Bluestone and Portman.The improvements increase capacity to the South Truckee Meadows system.

SCHEDULE: Design for the project is scheduled to begin in FY 2023 and construction is scheduled for FY 2024.



Water Main-Distribution Service Line Improvements
Rock & Capital Main Tie

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Rock & Capital Main Tie	200	—	—	—	—	200

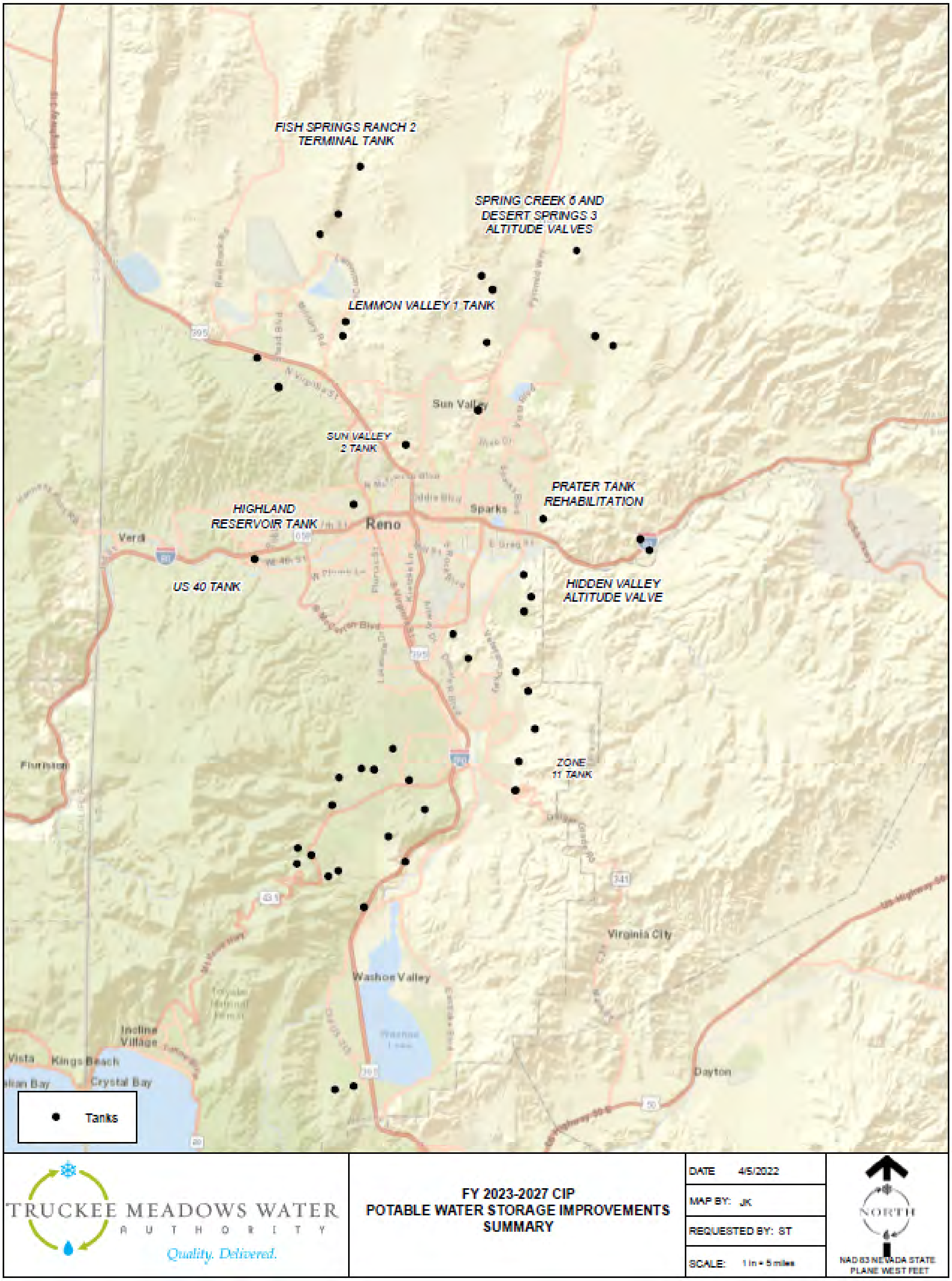
PROJECT DESCRIPTION: This project adds redundancy to the industrial area of Mill/Rock/Capital Blvd. It includes 700 linear feet of 12" main in Rock between Edison and Capital to reduce an outage of entire industrial area during a main shutdown due to leak repair.

SCHEDULE: Design and Construction planned in FY 2023.

POTABLE WATER STORAGE IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Developer Fees	Sun Valley #2 Tank	—	—	420	2,980	—	3,400
2	Developer Fees	Fish Springs Terminal Tank #2	—	—	—	—	40	40
1	Customer Rates	Storage Tank Recoats; Access; Drainage Improvements	3,500	4,000	4,000	4,000	4,500	20,000
2	Customer Rates / Developer Fees	Highland Reservoir Tank	1,000	2,000	4,700	—	—	7,700
1	Customer Rates / Developer Fees	STMGID Tank East Zone 11 Tank	—	—	—	175	2,900	3,075
1	Customer Rates / Reimbursements / Developer Fees	US 40 Tank & Feeder Main	2,150	2,530	—	—	—	4,680
2	Customer Rates / Developer Fees	Spanish Springs Altitude Valves (SC6 & DS3)	—	300	—	—	—	300
2	Customer Rates	Hidden Valley Tank Altitude Valve	—	350	—	—	—	350
1	Customer Rates	Lemmon Valley Tank #1 Replacement and Patrician PRS	250	750	—	—	—	1,000
1	Customer Rates	Hidden Valley Tank #4 Outage Improvements	250	250	—	—	—	500
Subtotal Storage Improvements			**7,150**	**10,180**	**9,120**	**7,155**	**7,440**	**41,045**

Project Locations: Map of all *Potable Water Storage Improvements* projects are highlighted in the following map.


FISH SPRINGS RANCH 2
TERMINAL TANK
SPRING CREEK 6 AND
DESERT SPRINGS 3
ALTITUDE VALVES
LEMMON VALLEY 1 TANK
Sun Valley
SUN VALLEY
2 TANK
PRATER TANK
REHABILITATION
HIGHLAND
RESERVOIR TANK
Reno
Sparks
Verdi
US 40 TANK
HIDDEN VALLEY
ALTITUDE VALVE
ZONE
11 TANK
Virginia City
Washoe Valley
Incline
Village
Kings Beach
Crystal Bay
Dayton
Tanks
TRUCKEE MEADOWS WATER
AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
POTABLE WATER STORAGE IMPROVEMENTS
SUMMARY
DATE 4/5/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 5 miles
NORTH
NAD 83 NEVADA STATE
PLANE WEST FEET

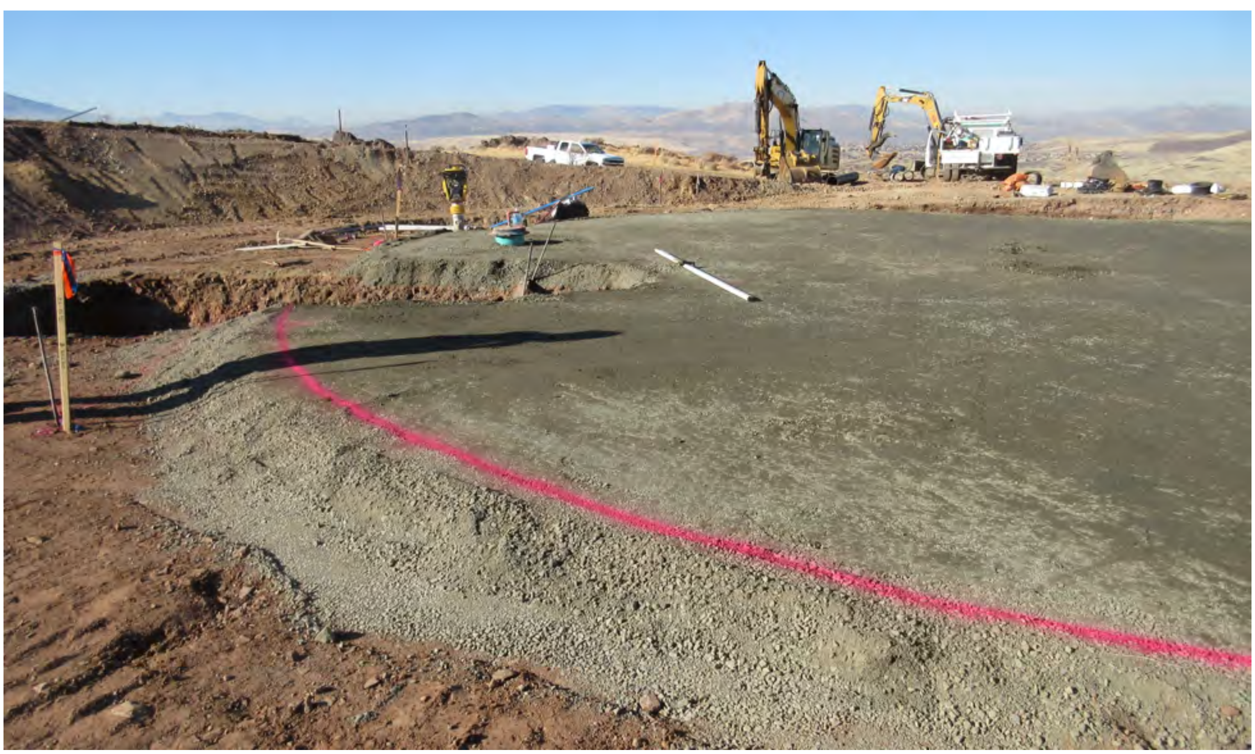
Potable Water Storage Improvements
Sun Valley #2 Tank

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Developer Fees	Sun Valley #2 Tank	—	—	420	2,980	—	3,400

PROJECT DESCRIPTION: TMWA continues to analyze opportunities to consolidate pump zones to eliminate future pump station replacement costs and to increase reliability to continuous pumping zones. Several years ago, TMWA consolidated the Sutro #1 pump zone with the Sun Valley/Sullivan pump zone, placing additional capacity requirements on the Sun Valley zone. This tank is needed to provide the required emergency storage capacity to the expanded zone and will also provide the capacity for the Sun Valley zone to reach build-out.

SCHEDULE: The project is scheduled for construction in FY 2026 subject to successful acquisition of a suitable tank site which is elevation sensitive and is complicated by the US 395 Connector project alignment.



Potable Water Storage Improvements
Fish Springs Terminal Tank #2

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	Fish Springs Terminal Tank #2	—	—	—	—	40	40

PROJECT DESCRIPTION: Ultimately, a second 2.5 MG storage tank is needed at the terminus of the Fish Springs pipeline at the north end of Lemmon Valley to equalize demand and supply during peak use periods.

SCHEDULE: The project is currently scheduled for design in FY 2027 with construction to follow in FY 2028. The actual schedule will be dependent upon the rate of growth in the North Valleys.

Potable Water Storage Improvements
Storage Tank Recoats; Access; Drainage Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Storage Tank Recoats; Access; Drainage Improvements	3,500	4,000	4,000	4,000	4,500	20,000

PROJECT DESCRIPTION: TMWA has a very proactive tank reservoir maintenance program where 20% of all tanks are inspected annually on a rotating basis. Based on these inspection observations, a determination is made as to whether interior tank coatings (for steel tanks) or other fix and finish work is required. TMWA has 95 storage tanks in service, with combined storage of approximately 121 million gallons. Interior coating/liners are generally replaced every 20 years resulting in the need to recoat several tanks per year to maintain the rehabilitation cycle. The budget and plan also includes exterior painting of steel tanks and any replacement of any interior components that may be corroded.

SCHEDULE: This is an ongoing annual project. It is anticipated that several tanks will need to be recoated every year.

Potable Water Storage Improvements
Highland Reservoir Tank

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	Highland Reservoir Tank	1,000	2,000	4,700	—	—	7,700

PROJECT DESCRIPTION: TMWA has two large finished water storage reservoirs, one at Hunter Creek and one at the Highland site just west of the intersection of Washington and College Drive. These reservoirs are lined and covered with flexible polyethylene or hypalon membranes. As such, they are more maintenance intensive and susceptible to damage than a conventional steel or concrete tank. To provide reliability during repairs or during extended outages for inspection and cleaning, it is proposed to construct a conventional 4 million gallon water storage tank at the reservoir site. Due to topography and proximity to residential areas the tank may need to be a buried pre-stressed concrete tank, which is reflected in the project budget. The tank will also provide additional storage capacity to meet future system requirements as required by the NAC regulations.

SCHEDULE: The tank is scheduled for construction in FY's 2023-2025.

Potable Water Storage Improvements
STMGID Tank East (Zone 11 Tank)

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Developer Fees	STMGID Tank East Zone 11 Tank	—	—	—	175	2,900	3,075

PROJECT DESCRIPTION: The project involves construction of a 3.7 MG above ground welded steel storage tank in the South Truckee Meadows area off of Geiger Grade formerly owned by STMGID. Due to growth in the area over the last several years, additional storage is required to meet the requirements of the NAC 445A regulations and TMWA standards. The tank will replace an existing 0.75 MG tank providing a net increase in storage of about 3 MG.

SCHEDULE: The project is currently scheduled for construction in FY 2027, subject to acquisition of the Special Use Permit and Bureau of Land Management (BLM) permitting.

Potable Water Storage Improvements
US 40 Tank & Feeder Main

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Reimbursements / Developer Fees	US 40 Tank & Feeder Main	2,150	2,530	—	—	—	4,680

PROJECT DESCRIPTION: The project involves construction of two 800,000 gallon steel tanks with site improvements, utilities, drain line and access road including about 2,100 LF of 20" feeder main. The project will improve reliability and hydraulic performance in the zone which experiences a lot of surge issues due to cycling of the Mae Anne pump train and the closed system on the Mogul end. This situation is only expected to worsen when pumping to Verdi begins.

SCHEDULE: The project is currently scheduled for design in FY's 2023-2024 and construction in FY 2024.

Potable Water Storage Improvements
Spanish Springs Altitude Valves

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates / Developer Fees	Spanish Springs Altitude Valves (SC6 & DS3)	—	300	—	—	—	300

PROJECT DESCRIPTION: The project involves the construction of altitude valves in underground vaults at the Desert Springs Tank #3 and at Spring Creek Tank #6. The altitude valves will keep the existing tanks from overflowing when well recharge operations are conducted in Spanish Springs Valley.

SCHEDULE: Implementation and construction will occur in FY 2024.

Potable Water Storage Improvements
Hidden Valley Tank Altitude Valve

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Hidden Valley Tank Altitude Valve	—	350	—	—	—	350

PROJECT DESCRIPTION: The project involves installation of a new altitude valve in a vault on the Hidden Valley Tank #l in/out line. Requires cutting into and rerouting existing piping, addition of new valves, etc.

SCHEDULE: The project is schedule for construction in FY 2024.

Potable Water Storage Improvements
Lemmon Valley Tank #1 Replacement and Patrician PRS

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Lemmon Valley Tank #1 Replacement and Patrician PRS	250	750	—	—	—	1,000

PROJECT DESCRIPTION: Lemmon Valley Tank 1 is at the end of it’s useful life and needs to be replaced. The tank can’t be taken out of service without improvements to the system. The Patrician PRS would provide supply with the tank out of service and allow the existing tank to be demolished and the new tank to be constructed.

SCHEDULE: Design will occur in FY 2023. Construction is scheduled in FY 2024.

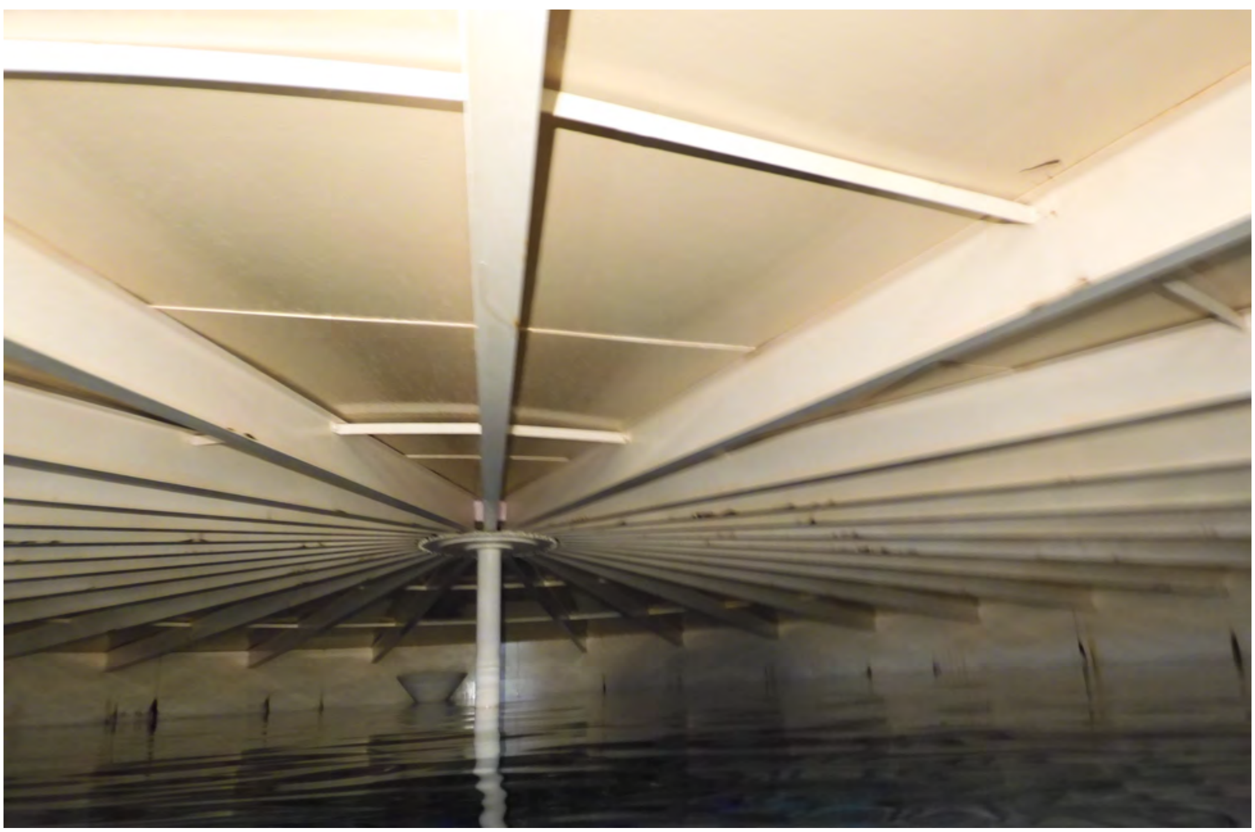
Potable Water Storage Improvements
Hidden Valley Tank #4 Outage Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Hidden Valley Tank #4 Outage Improvements	250	250	—	—	—	500

PROJECT DESCRIPTION: Hidden Valley Tank #4 is due for rehabilitation and recoating in the next year. The tank cannot be taken out of service and meet all NAC requirements including fire flow. This project will improve redundancy and supply to the zone with the tank out of service.

SCHEDULE: Design will occur in FY 2023. Construction is scheduled in FY 2024.



HYDROELECTRIC IMPROVEMENTS

Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Forebay, Diversion, and Canal Improvements	100	100	100	100	100	500
3	Customer Rates	Flume Rehabilitation	—	—	150	150	—	300
3	Customer Rates	Hydro Plant Generator Rewinds	—	650	—	—	—	650
1	Customer Rates	Washoe Plant_Turbine Rebuild and Rebuild/ Replacement Unit 1	250	2,750	—	—	—	3,000
2	Customer Rates	Washoe Plant_Turbine Rebuild and Rebuild/ Replacement Unit 2	250	2,750	—	—	—	3,000
Subtotal Hydroelectric Improvements			**600**	**6,250**	**250**	**250**	**100**	**7,450**

Project Locations: Map of all *Hydroelectric Improvements* projects are highlighted in the following map.

VERDI POWER HOUSE
FOREBAY, DIVERSION, AND CANAL IMPROVEMENTS
FLUME REHABILITATION AND RECONSTRUCTION
WASHOE POWER HOUSE
ORR DITCH HYDRO FACILITY
FLEISH POWER HOUSE
Verdi
Somersett Golf & Country Club
Las Brisas Blvd
Mae Anne Ave
Sharlands Ave
W 4th St
Mayberry
N McCarran Blvd
TRUCKEE MEADOWS WATER AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
HYDROELECTRIC IMPROVEMENTS
SUMMARY
DATE 4/5/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 1 miles
NORTH
NAD 83 NEVADA STATE PLANE WEST FEET

Hydroelectric Improvements
Forebay, Diversion, and Canal Improvements

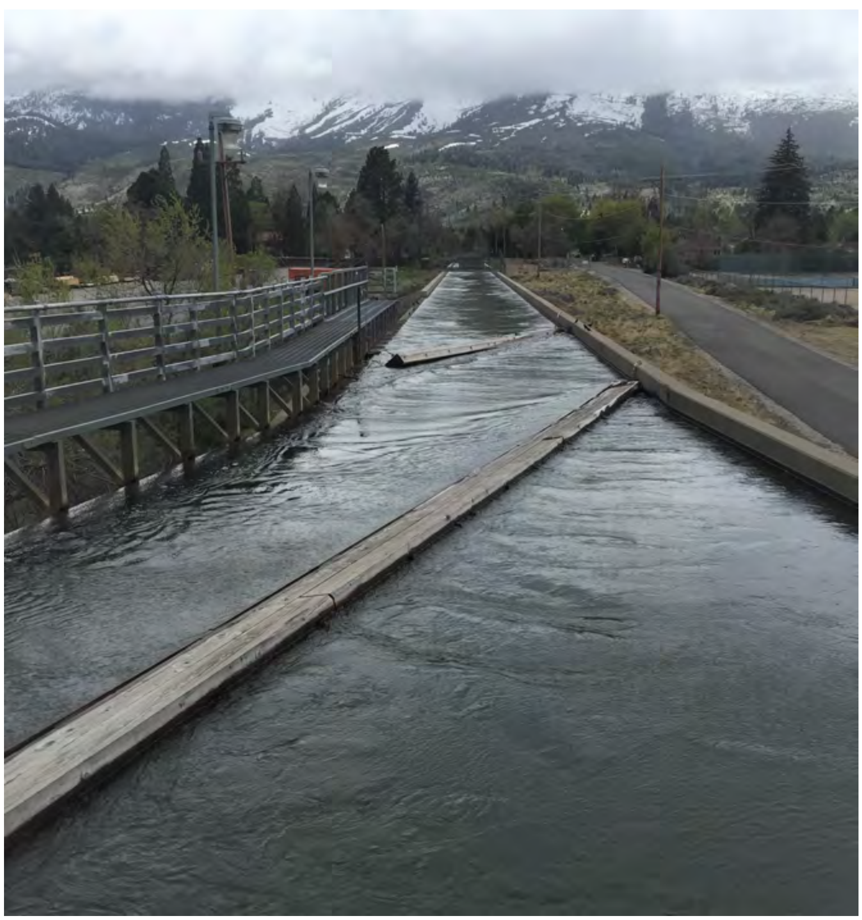
FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Forebay, Diversion, and Canal Improvements	100	100	100	100	100	500

PROJECT DESCRIPTION:

Provision is made each year for hydroelectric flume reconstruction to mitigate damage from unexpected rock falls, landslides and/or flooding events. Diversion structures including gates, canals, flumes, forebays and all hydro-plant water conveyance structures are monitored and evaluated for reliable and safe operation.

SCHEDULE: Ongoing annual evaluation and prioritization of forebay and canal conditions in the early spring (winter weather can change priorities) to identify projects for fall construction when historically, river flows are lower.



Hydroelectric Improvements
Flume Rehabilitation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Flume Rehabilitation	—	—	150	150	—	300

PROJECT DESCRIPTION: TMWA's three operating hydroelectric facilities have nearly 12,150 feet of flume. The average service life for flume structures is 35 years using treated timbers, at an average replacement cost of approximately $1,000 per lineal foot of flume. The present cost to replace a linear foot of flume depends on the location and height of the flume structure.

SCHEDULE: Ongoing annual evaluation and prioritization of flume condition in the early spring (winter weather can change priorities) to identify projects for fall construction when historically, river flows are lower.

Hydroelectric Improvements
Hydro Plant Generator Rewinds

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Hydro Plant Generator Rewinds	—	650	—	—	—	650

PROJECT DESCRIPTION:
The Fleish generator was last rewound in 1958 and is still operational. The typical in-service life of this type of generator is about 50 years.

SCHEDULE: This schedule is assessed as needed and may be adjusted depending on river flows and generator condition evaluation.

Hydroelectric Improvements
Washoe Plant Turbine Rebuild and Rebuild/Replacement of Unit 1

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Washoe Plant_Turbine Rebuild and Rebuild/ Replacement Unit 1	250	2,750	—	—	—	3,000

PROJECT DESCRIPTION: The project involves replacing the No. 1 Hydroelectric Turbine, complete a rewind of the Unit 1 Generator. To expedite completion of the project and minimize the plant outage time, procurement of the new No. 1 Turbine as well as fabrication of the two new Tailraces will be completed first as a separate project. Replace the No. 1 Plant Turbine and rewind the associated generator. The turbine will be dismantled with the pressure case and Turbine appurtenances removed from the building. Work for rewinding the No. 1 Generator will commence as soon as the plant is taken off line for the project. The new No. 1 Turbine will be installed and the associated rewound generator re-installed.

SCHEDULE: Construction is scheduled for FY 2024.

Hydroelectric Improvements
Washoe Plant Turbine Rebuild and Rebuild/Replacement of Unit 2

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Washoe Plant_Turbine Rebuild and Rebuild/ Replacement Unit 2	250	2,750	—	—	—	3,000

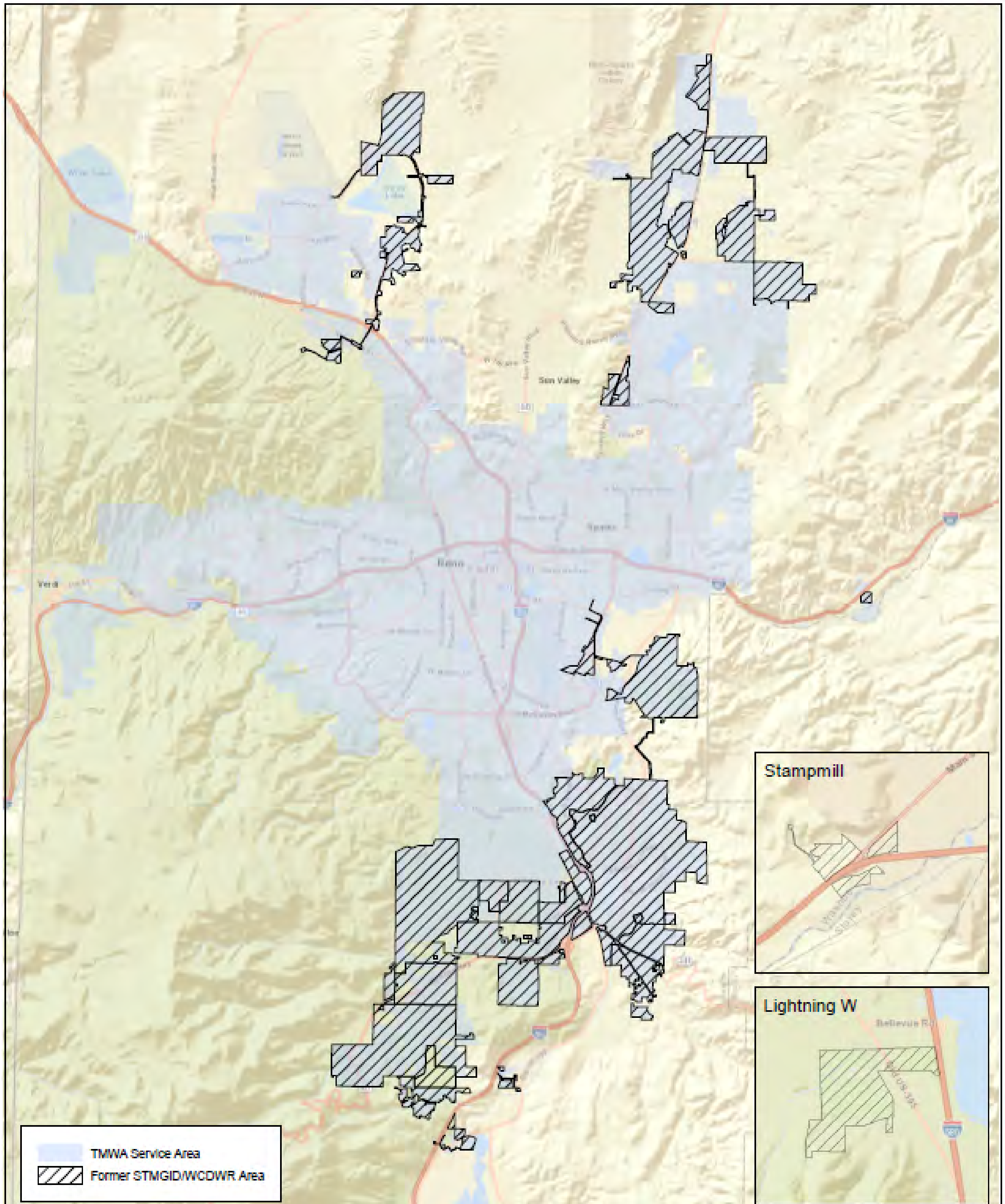
PROJECT DESCRIPTION: This project will replace the No. 2 Hydroelectric Turbine and complete a rewind of the Unit 2 Generator. To expedite completion of the project and minimize the unit outage time, the No. 2 Turbine will be procured before work begins. Once equipment is procured, work will begin for completing the Unit 2 Generator rewind and dismantling of the No. 2 Turbine pressure cases and appurtenances. The new No. 2 Turbine will be installed and the rewound generator re-installed.

SCHEDULE: Construction is scheduled for FY 2024.

CUSTOMER SERVICE OUTLAYS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Meter Reading Equipment	—	75	—	—	—	75
2	Developer Fees	New Business Meters	100	100	100	100	100	500
1	Customer Rates	Mueller Pit Replacements former Washoe County	125	125	125	125	125	625
2	Customer Rates	Galvanized / Poly Service Line Replacements	250	250	250	250	250	1,250
1	Customer Rates / Meter Retrofit Fees	Automated Meter Infrastructure (AMI)	2,300	5,000	6,000	6,200	—	19,500
Subtotal Customer Service			**2,775**	**5,550**	**6,475**	**6,675**	**475**	**21,950**

Project Locations: Map of all *Customer Service Outlays* projects are highlighted in the following map.



TRUCKEE MEADOWS WATER AUTHORITY

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FY 2023-2027 CIP
CUSTOMER SERVICE OUTLAYS
SUMMARY

DATE	4/5/2022
MAP BY:	JK
REQUESTED BY:	ST
SCALE:	1 in = 3 miles

NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

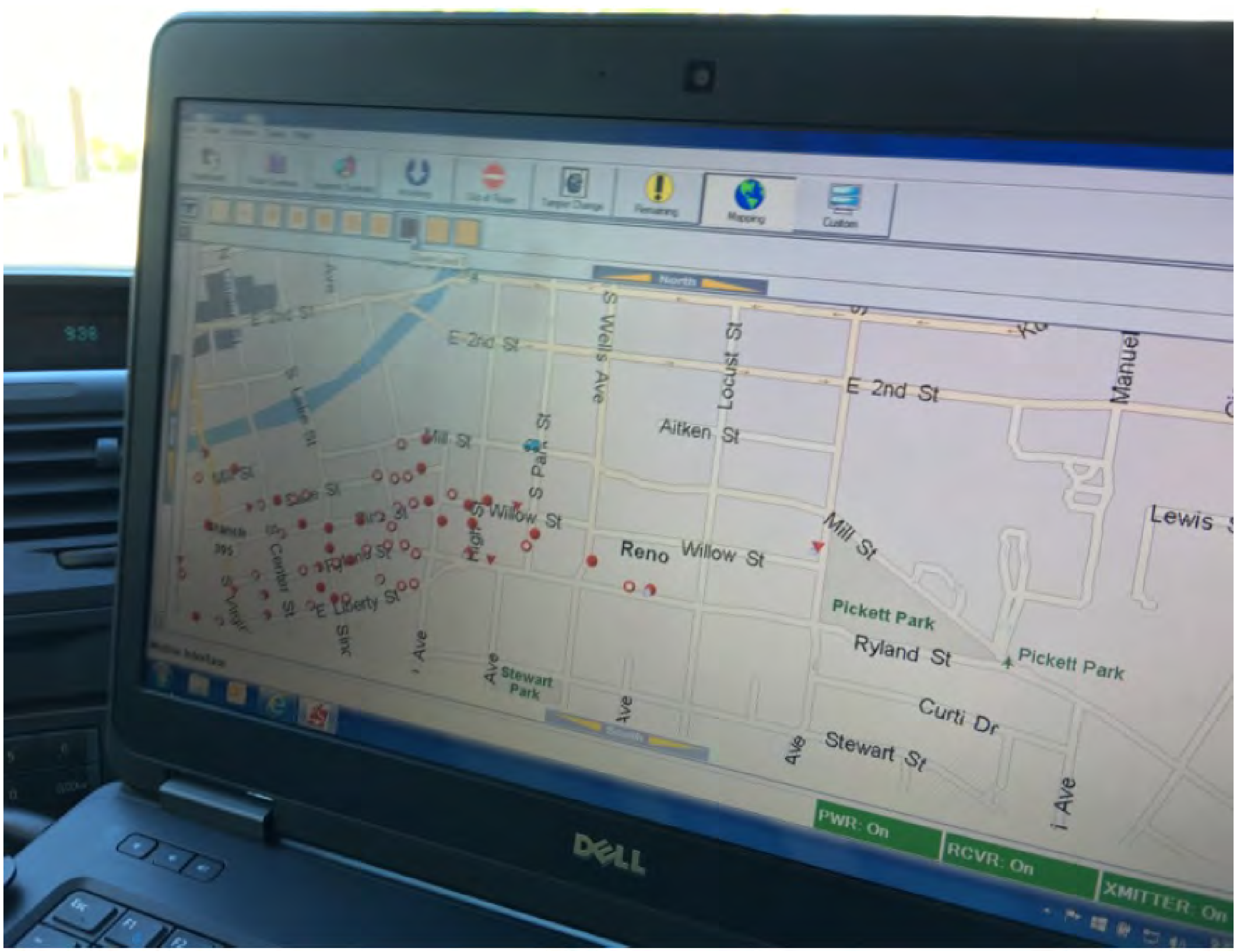
Customer Service Outlays
Meter Reading Equipment

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Meter Reading Equipment	—	75	—	—	—	75

PROJECT DESCRIPTION: TMWA utilizes a multiple meter reading systems in which the transmitters attached to the meters send a signal out to be collected by data collectors. These collectors are mounted in the meter reading vehicles or on various mountain peaks surrounding the valley. TMWA is anticipating replacing units that have degraded.

SCHEDULE: Will need to purchase equipment on an as needed basis.



Customer Service Outlays
New Business Meters

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Developer Fees	New Business Meters	100	100	100	100	100	500

PROJECT DESCRIPTION: All new water services are required to be metered. Meters are purchased by TMWA and installed for new development. New business fees pay for these installations.

SCHEDULE: As development picks up, more meters will need to be purchased.

Customer Service Outlays
Mueller Pit Replacements Former Washoe County

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Mueller Pit Replacements former Washoe County	125	125	125	125	125	625

PROJECT DESCRIPTION: The Mueller metering pits are a very high maintenance metering facility and are prone to leaks and failures. TMWA plans to replace these facilities in response to leaks and or subsidence of these facilities.

SCHEDULE: Equipment and employee needs are evaluated and updated annually**.**

Customer Service Outlays
Galvanized / Poly Service Line Replacements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Galvanized / Poly Service Line Replacements	250	250	250	250	250	1,250

PROJECT DESCRIPTION: TMWA has shifted from just repairing service lines from the street main to the curb valve or meter box to completely replacing service lines that are galvanized steel or polybutylene. These two materials are responsible for many after-hours call outs which escalate overtime expenses to repair leaks in the street because the galvanized lines are corroded, and polybutylene once thought very durable, becomes brittle and cracks or splits very easily. Just repairing these lines does not prevent them from leaking in the near future, escalating repair costs while further damaging city streets. Complete replacement provides a permanent repair in a cost effective manner and prevents further water system losses.

SCHEDULE: This is an ongoing annual project budget. Service lines will be replaced as they are identified.

Customer Service Outlays
AMI Automated Meter Infrastructure

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates / Meter Retrofit Fees	Automated Meter Infrastructure (AMI)	2,300	5,000	6,000	6,200	—	19,500

PROJECT DESCRIPTION: TMWA utilizes multiple meter reading systems in which the transmitters attached to the meters send a signal out to be collected by data collectors. Over the next four years, TMWA will be installing new meters or retrofitting existing meters with technology that will allow for remote readings. This is expected to assist in quickly identifying leaks for customers, more accurate billing, and long-term cost savings.

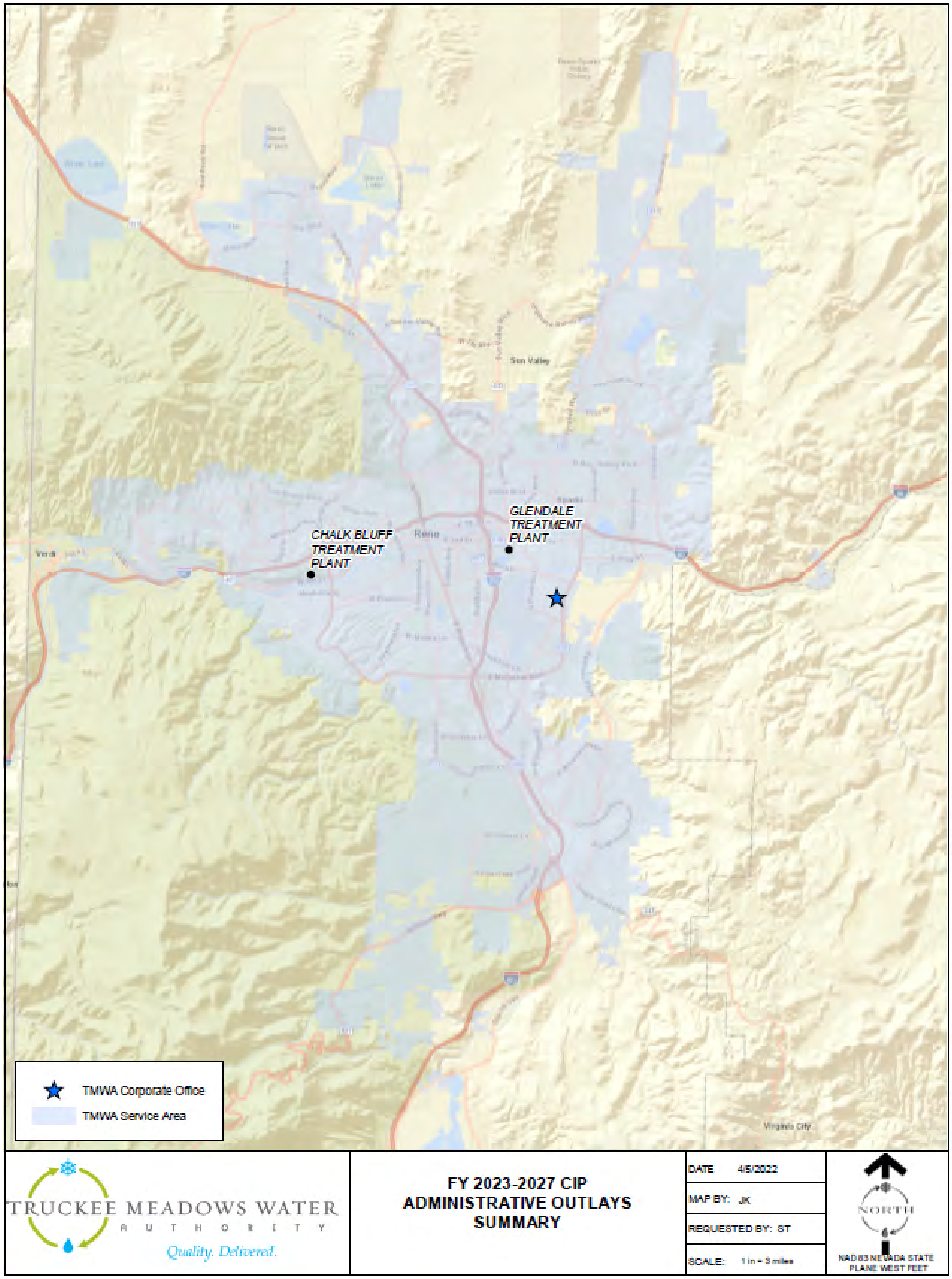
SCHEDULE: This project has begun as of July 1, 2022 and is expected to be completed in FY 2026.

ADMINISTRATIVE OUTLAYS

Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	GIS / GPS System Mapping Equipment	45	20	—	—	—	65
2	Customer Rates	IT Server Hardware	45	30	—	—	—	75
2	Customer Rates	IT Network Security Upgrades	70	10	—	—	—	80
2	Customer Rates	IT Physical Access Security Upgrades	60	60	—	—	—	120
2	Customer Rates	Printer / Scanner Replacement	—	100	—	—	—	100
3	Customer Rates	Crew Trucks / Vehicles	900	850	950	1,000	1,100	4,800
1	Customer Rates	Emergency Management Projects	150	150	150	150	150	750
1	Customer Rates	Emergency Operations Annex Design / Construction	—	250	250	1,500	—	2,000
2	Customer Rates	System Wide Asphalt Rehabilitation	200	200	200	200	200	1,000
1	Customer Rates	Physical Site Security Improvements	200	200	—	—	100	500
Subtotal Administrative Outlays			**1,670**	**1,870**	**1,550**	**2,850**	**1,550**	**9,490**

Project Locations: Map of all *Administrative Outlays* projects are highlighted in the following map.


GLENDALE
TREATMENT
PLANT
CHALK BLUFF
TREATMENT
PLANT
Reno
Sun Valley
Verdi
TMWA Corporate Office
TMWA Service Area
TRUCKEE MEADOWS WATER
AUTHORITY
Quality. Delivered.
FY 2023-2027 CIP
ADMINISTRATIVE OUTLAYS
SUMMARY
DATE 4/5/2022
MAP BY: JK
REQUESTED BY: ST
SCALE: 1 in = 3 miles
NORTH
NAD 83 NEVADA STATE
PLANE WEST FEET

Administrative Outlays
GIS/GPS System Mapping Equipment

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	GIS / GPS System Mapping Equipment	45	20	—	—	—	65

PROJECT DESCRIPTION: TMWA will have to update mapping equipment on a periodic basis to keep up with changes in technology; and to replace existing equipment as it reaches obsolescence.

SCHEDULE: Equipment is replaced and/or purchased as needed.

Administrative Outlays
IT Server Hardware

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	IT Server Hardware	45	30	—	—	—	75

PROJECT DESCRIPTION: TMWA currently has over 50 physical servers and 130 virtual servers, hosting a variety of enterprise software applications that support TMWA's daily business operations. All physical servers are typically purchased with a three year warranty, with the expectation that they will reach the end of their system life cycle in a three to five year time frame, requiring a replacement. TMWA annually reviews its server platforms and can option a strategy of warranty extension, if cost effective, rather than outright hardware replacement. All servers require an Operating System Software license to run. Operating System Software is upgraded only when the current release is obsolete or a newer version offers a significant advantage over the current iteration.

SCHEDULE: Spending would be determined on an as needed basis.

Administrative Outlays
IT Network Security Upgrades

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	IT Network Security Upgrades	70	10	—	—	—	80

PROJECT DESCRIPTION: As a leading water purveyor for a major metropolitan area, TMWA is reliant on the internet for employee productivity enhancement and providing valuable customer information and outreach. Such dependency on the internet also carries a significant degree of risk, as it makes TMWA a major target for external security threats looming within globalized networks. To offset this risk and combat network threats, a variety of security specific hardware and software solutions are used, weaving them into a layered deployment strategy called Defense in Depth. In order to continually evolve and reinforce this Defense in Depth strategy and effectively fight new unforeseen threats, TMWA must continually acquire new security platforms that adapt to the continually changing security landscape.

SCHEDULE: Spending occurs only on an as needed basis**.**

Administrative Outlays
IT Physical Security Upgrades

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	IT Physical Access Security Upgrades	60	60	—	—	—	120

PROJECT DESCRIPTION: Security measures that are designed to deny unauthorized access to facilities, equipment and resources to protect personnel from damage or harm such as theft or attacks. Physical security involves the use of multiple layers of interdependent systems which can include surveillance, security guards, protective barriers, locks and other techniques.

SCHEDULE: Equipment is replaced and/or purchased as needed.

Administrative Outlays
Printer / Scanner Replacement

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	Printer / Scanner Replacement	—	100	—	—	—	100

PROJECT DESCRIPTION: TMWA currently has variety of printers and scanners that support TMWA's daily business operations. All printers are typically purchased with a three-year warranty, with the expectation that they will reach the end of their system life cycle in a three to five year time frame, requiring a replacement. TMWA annually reviews its printer/scanner performance and business needs and can option a strategy of warranty extension, if cost effective, rather than outright replacement.

SCHEDULE: Equipment is replaced and/or purchased as needed.

Administrative Outlays
Crew Trucks/Vehicles

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
3	Customer Rates	Crew Trucks / Vehicles	900	850	950	1,000	1,100	4,800

PROJECT DESCRIPTION: TMWA's service fleet consists of light duty and heavy duty crew trucks. TMWA plans to cycle the light crew fleet over a period of seven to ten years. Spending is determined annually depending on vehicle availabilities and other factors. Spending only occurs if justified. TMWA's fleet cycles older vehicles to the treatment plants or other less demanding activities prior to disposal at auction. TMWA has scaled back spending on light vehicles for the past several years and a number of vehicles will be in excess of ten years old and greater than 120,000 miles of duty.

SCHEDULE: Equipment and employee needs are evaluated and updated annually.

Administrative Outlays
Emergency Management Projects

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Emergency Management Projects	150	150	150	150	150	750

PROJECT DESCRIPTION: Various ongoing improvements to security infrastructure are required to protect TMWA facilities. TMWA has performed vulnerability assessment studies in the past and reviews the applicability of the findings to continually improve physical security as needed. In addition, TMWA is preparing a new disaster recovery plan with procedures to recover and protect water system operations.

SCHEDULE: Upgrades to security projects is ongoing and completed on a review of priorities each year.

PROJECT LOCATION: Various locations at treatment plants, at well sites, storage area for water fill station manifolds.

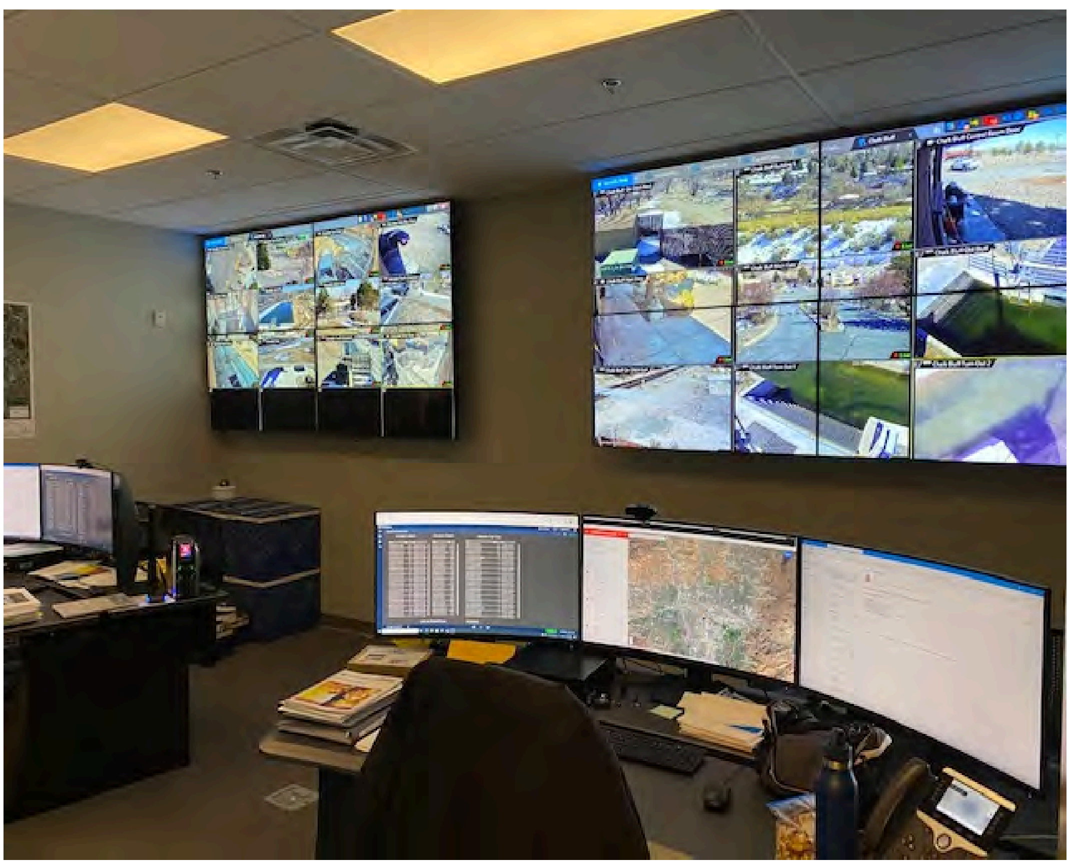
Administrative Outlays
Emergency Operations Annex-Design / Construction

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Emergency Operations Annex Design / Construction	—	250	250	1,500	—	2,000

PROJECT DESCRIPTION: TMWA is currently in the planning and conceptual design phase for a Primary Emergency Operations Center (EOC) including Disaster Recovery (DR) capacity. TMWA's EOC will relocate from the current location at the corporate office to the Chalk Bluff Water Treatment Plant. Which includes scope review, design, and contract bid packages, bid and award, construction, and testing. Potential emergency operations would include responding to earthquakes, floods, or other emergency related events.

SCHEDULE: Construction of water fill stations at four tank sites, standby power retrofits at four existing wells and ten portable water fill manifold stations to be completed in FY's 2024-2026.



Administrative Outlays
System Wide Asphalt Rehabilitation

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
2	Customer Rates	System Wide Asphalt Rehabilitation	200	200	200	200	200	1,000

PROJECT DESCRIPTION: TMWA has 96 tanks, 100 wells, 116 pump stations, 2 storage reservoirs and 5 treatment plants, most of which have some asphalt pavement. It is much more economical to extend the life of existing pavement with routine maintenance such as repairing cracks and applying slurry seals than it is to prematurely replace the pavement.

SCHEDULE: This is a new reoccurring maintenance item. It is originally assumed that up to 15 sites per year will receive some sort of rehabilitation that may include patching, crack repair, slurry seal and/or partial replacement.

Administrative Outlays
Physical Site Security Improvements

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Customer Rates	Physical Site Security Improvements	200	200	—	—	100	500

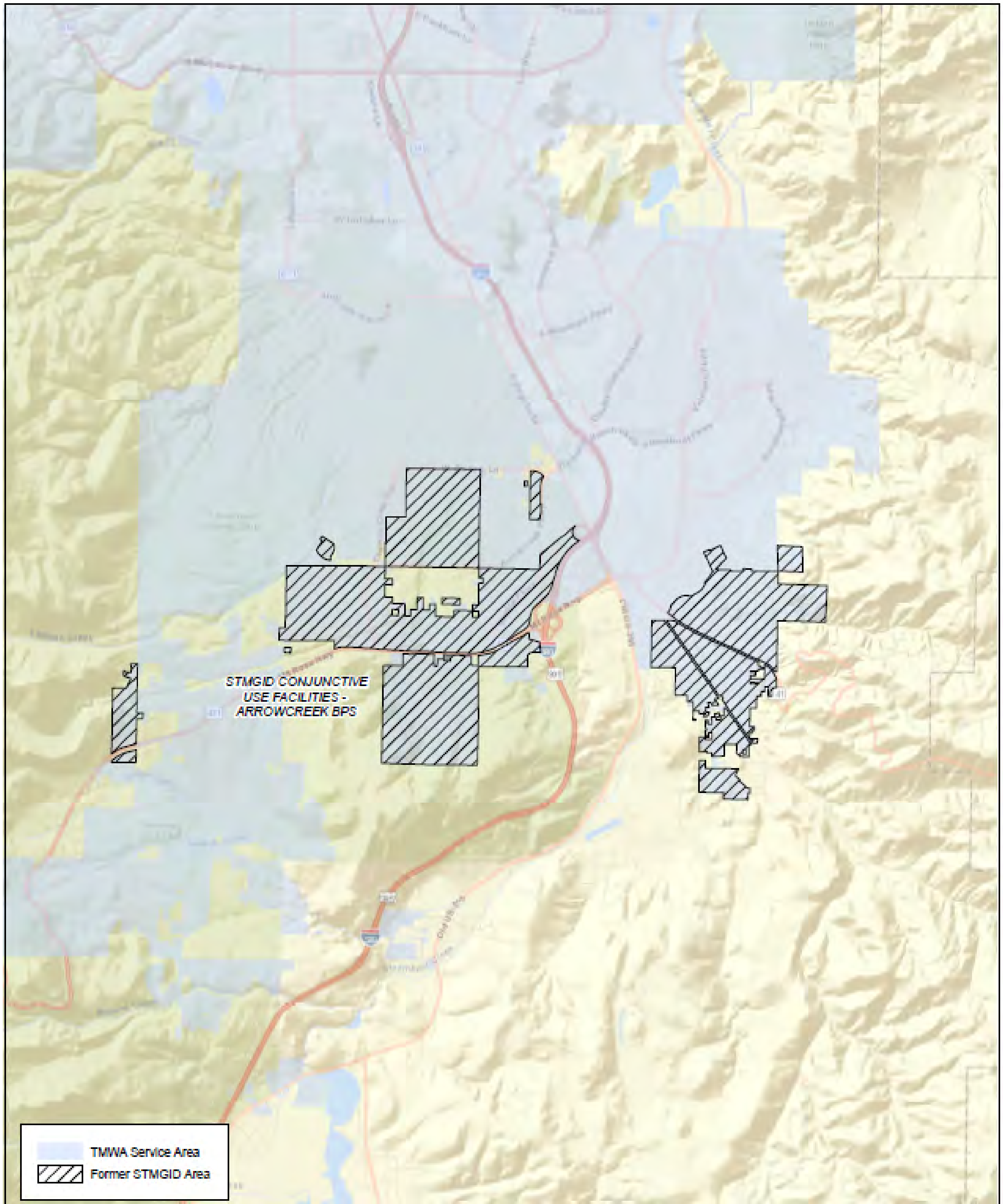
PROJECT DESCRIPTION: Physical site security improvements for Chalk Bluff, Glendale and Corporate sites are based on Department of Homeland Security (DHS) Vulnerability Assessments. Recommended priorities included bringing site perimeter fencing up to DHS minimum standards, expanding our security camera network for better site perimeter coverage, general exterior lighting improvement throughout both treatment plants and the use of intrusion detection systems. Landscaping improvements were also noted to help prevent unauthorized access, improve overall visibility, and protect TMWA personnel and buildings.

SCHEDULE: The project began in FY 2021 and will continue through FY 2024 and begin again in FY 2027.

FORMER STMGID SYSTEM IMPROVEMENTS
Summary

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reserve	STMGID Conjunctive Use Facilities - Arrowcreek BPS	3,450	—	—	—	—	3,450
Subtotal STMGID System Improvements			**3,450**	**—**	**—**	**—**	**—**	**3,450**

Project Locations: Map of all *Former STMGID System Improvements* projects are highlighted in the following map.



TRUCKEE MEADOWS WATER AUTHORITY *Quality. Delivered.*	FY 2023-2027 CIP FORMER STMGID SYSTEM IMPROVEMENTS SUMMARY	DATE 4/5/2022 MAP BY: JK REQUESTED BY: ST SCALE: 1 in = 1 miles

NORTH
NAD 83 NEVADA STATE PLANE WEST FEET

Water Main-Distribution & Service Line Improvements
STMGID Conjunctive Use Facilities - Arrowcreek Booster Pump Station

FUNDING TIMELINE:

Priority	Funding Source	Description	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	CIP Total
1	Reserve	STMGID Conjunctive Use Facilities - Arrowcreek BPS	3,450	—	—	—	—	3,450

PROJECT DESCRIPTION: The project involves construction of a new booster pump station on the reclaim water reservoir site on Arrowcreek Parkway and approximately 8,100 feet of 14-inch discharge pipe on Arrowcreek Parkway to the STMGID Tank 4/5 pressure zone. Approximately $0.5 million of the $2.7 million will be used for pipeline oversizing which will be allocated to new development. The facilities will provide off-peak supply which will allow TMWA to implement conjunctive use in the STMGID West system.

SCHEDULE: Construction of the pipeline was completed in FY 2019 and the booster station design/construction is scheduled to begin in FY 2023.

Photo: Fleish Hydro Forebay Spill
Photo By: Chris Hires, Hydro/Diesel Generation, HVAC, & Property Maintenance Supervisor

STAFF REPORT

TO: Board of Directors
THRU: Mark Foree, General Manager
FROM: John Enloe, Director, Natural Resources
Stefanie Morris, Manager, Water Resources
DATE: May 19, 2022
SUBJECT: **Discussion and possible action regarding Palomino Farms Feasibility Study and request for Board direction on negotiation of agreements**

Recommendation

Contingent upon Reno City Council, Sparks City Council and/or Washoe County Board of County Commissioners approval to continue to pursue the Palomino Farms Sustainable Water Resource Project, authorize staff to explore potential future agreement(s) for continued implementation, including an option/purchase agreement with Palomino Farms LLC and LW Land Company, LLC (Palomino-LW), and a cost sharing agreement with the City of Reno, City of Sparks and/or Washoe County for the coordinated use of surface water, groundwater, and recycled water to help meet regional water resource management needs.

Summary

The City of Reno, City of Sparks, Washoe County, and TMWA entered an Interlocal Agreement to conduct the Palomino Farms Resource Sustainability Feasibility Study ("Feasibility Study"). This Agreement facilitated collaborative efforts to complete a Feasibility Study to better inform the Project's viability and future benefits of a regional water and treated effluent management concept. The Project concept includes using treated effluent as recycled water for irrigation purposes at the Palomino-LW site, building separate pipelines to convey recycled and potable water to and from the Palomino-LW site, recharging and storing potable water on a long-term basis, developing a water banking site and securing and developing additional water supplies for drought protection and operational flexibility.

The Feasibility Study is complete and the report is attached. The information presented in the report demonstrates that technically, bringing both potable water and recycled water to the Palomino Farms area as part of a long-term sustainable water management plan is a viable regional water management project. Palomino Farms could be irrigated with recycled water rather than groundwater, allowing the groundwater basin to recover, and the aquifer can be utilized to conserve and store large quantities of potable water for drought protection and to assist meeting peak summer-use demands. As identified in the report, there are additional areas that require further investigation. If directed by the Board, staff will continue to obtain additional information.

The estimated Project cost is considerable, and includes the following components:

• Purchase of land, water rights and underground storage:	$34 million
• 2,400 AF recycled water irrigation site, required infrastructure:	$36.8 million
• 1,200 AF sustainable groundwater rights, required infrastructure:	$43.9 million
• 45,000 AF drought storage, required infrastructure oversizing:	$18.2 million
Total:	$132.9 million

The Project is a regional solution to wastewater management and drought resiliency/climate change preparedness. Several significant regional water management benefits could be realized by the Project, including controlling a large recycled water irrigation site for the Truckee Meadows Water Reclamation Facility ("TMWRF"), and acquiring a large water banking site that could yield 3,000 AFA of off river drought storage, providing the community with enhanced water supply resiliency and climate change preparedness. Additionally, in exchange for the purchase price for the land, water rights and underground storage, Palomino-LW would relinquish its large-scale development zoning, helping preserve the valley's rural characteristics.

Although the cost is significant, both TMWA and TMWRF would realize sizeable cost savings by deferring and/or reducing in size planned capital improvement projects and their associated operating expenses. Preliminary financial analyses indicate that Project costs can be substantially, if not fully mitigated by the deferral and reduction in size of the planned capital improvement projects. This is discussed in the report. Additional benefits may also be available to Washoe County and the South Truckee Meadows Water Reclamation Facility ("STMWRF") facility by connecting the TMWRF and STMWRF recycled water distribution systems and operating the systems under a coordinated recycled water management plan.

Western Turf holds approximately 912 acre-feet of water rights and 294 acres of land in the Project area. Western Turf, although not specifically included in the Feasibility Study, willingly cooperated and provided access to their property and irrigation wells for the hydrogeologic investigation. Western Turf has expressed an interest in further discussing the Project and generally supports the concept.

Next Steps

Permitting requirements, public education and outreach, and financial considerations outlined in the study will take additional time to work through to gain confidence that the Project can be successfully implemented.

Several additional steps are necessary to determine if the investment of resources and capital in the Palomino Farms regional water management project makes sense. Based on the positive Feasibility Study results and potential regional benefits identified, the following is a summary of the next steps that would be undertaken to provide a specific Project proposal for future Board consideration.

1. Prepare detailed cost / benefit analyses for each agency partner.
2. Further evaluate the permitting requirements, specifically the State Engineer interbasin transfer matter, return flow considerations, and Warm Springs Area Plan conformance.
3. Negotiate a proposed cost sharing and operating agreement between the agency partners.
4. Finalize the proposed option / purchase agreement with Palomino-LW.
5. Evaluate the opportunity of adding the Western Turf commercial operations, land and water rights into the overall regional water management concept.
6. Other matters as may be identified.

Assuming the Board continues to support staff's efforts and gives direction to explore potential future agreement(s) with the City of Reno, City of Sparks and/or Washoe County, and an option / purchase agreement with Palomino-LW, and the City of Reno, City of Sparks and/or Washoe County provides similar direction, staff's intention is to bring back more-detailed information regarding the above-described next steps and a definitive agreement or agreements to the Board for future consideration.

Fiscal Impact

None currently. Future financial considerations will be identified in a subsequent definitive agreement or agreements.

Attachment: Feasibility Study Report

PALOMINO VALLEY FEASIBILITY REPORT

Truckee Meadows Water Authority

TRUCKEE MEADOWS WATER AUTHORITY

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PROJECT CONCEPT

OneWater Nevada's Palomino Farms Sustainable Water Resource Feasibility Study (Study) is part of a regional effort to manage, optimize and expand local water resources. The purpose of the Study is to explore the coordinated use of surface water, groundwater, and recycled water (known as conjunctive use) to help meet our regional water resource management needs.

Reno and Sparks operate a regional water reclamation facility known as the Truckee Meadows Water Reclamation Facility (TMWRF), and Reno and Washoe County operate other regional water reclamation facilities in their jurisdictions. As regional water reclamation facility operators, Reno, Sparks and Washoe County are interested in exploring long-term opportunities to provide treated effluent as recycled water for agricultural irrigation or other beneficial uses to maximize the use of recycled water, in addition to discharging it into the Truckee River. TMWA is interested in locating sites where it may bank water through active and passive groundwater recharge, and in developing groundwater resources to provide an additional source of water for drought protection, water resource sustainability, and operational flexibility. Palomino Farms LLC and LW Land Company, LLC (collectively, Palomino-LW) own approximately 1,484 acres of farmland as shown in Figure 1, and 2,580 acre-feet (AF) of groundwater rights in Warm Springs Valley, Nevada. Palomino-LW are interested in selling their land and water rights to allow for project implementation.

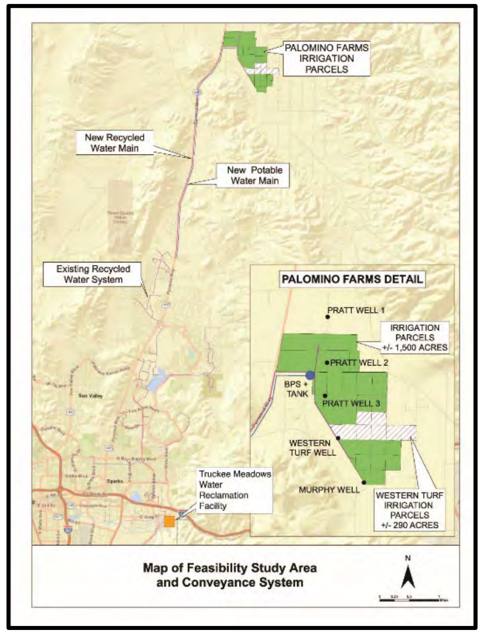

Figure 1

Specifically, the Study is focused on evaluating the viability of bringing both potable water and recycled water to Palomino-LW's farmland as part of a long-term sustainable water management plan. The desired outcome is to irrigate the farm with recycled water rather than groundwater, allowing the groundwater basin to recover, and utilizing the aquifer to conserve and store up to 45,000 AF of potable water for drought protection and to help meet Spanish Springs area demand during the peak summer-use season.

To implement the project concept, recycled "purple pipe" water would be piped to the farm from northern Spanish Springs for use in agricultural irrigation. This would dramatically reduce the need for agricultural groundwater pumping currently supplying this area. Potable water from TMWA would also be sent through a separate pipeline to Palomino-LW's farm in the winter, when there is less use of Truckee River water and TMWA customer demands are lower, and recharged into the aquifer via injection wells. The recharged water would then be withdrawn to meet peak summer demands and during droughts. Under the sustainable water management plan, more water would remain in storage than withdrawn for peak summer use or drought reserves, allowing water levels within the groundwater basin to recover. There is also the additional benefit to Palomino Valley residents of securing the Palomino-LW Land as farmland and open space and preserving the rural lifestyle.

ILA SUMMARY

Prior to conducting the Study, the City of Reno, City of Sparks, Washoe County and TMWA entered an Interlocal Agreement for the Study (Appendix A). The purpose of this Agreement was to facilitate unified and cooperative efforts to complete a study to inform those entities on the viability and future benefits of developing options for regional treated effluent management, reducing the volume of treated effluent being discharged into the Truckee River to facilitate TMWRF NPDES permit compliance, using treated effluent as recycled water for irrigation purposes, recharging and storing potable water on a long-term basis, developing water banking sites and securing and developing additional water supplies for drought protection and operational flexibility. Further, the Study investigated the availability and suitability of existing potable and recycled water infrastructure necessary to convey water to the Palomino-LW Land, as well as necessary rights-of-way, easements, and/or pipeline corridors. Approximately $1.6 million of work was conducted, predominantly hydrogeologic and engineering investigations, the cost of which was shared equally by the four parties.

To facilitate the Study, TMWA also entered a Feasibility Study Agreement with Palomino-LW (Appendix B) which granted TMWA physical access to the Palomino-LW Land to conduct the Study and access to data and information related to irrigation operations, the land, wells and water rights.

Alfalfa Fields

PALOMINO-LW OPTION AGREEMENT

TMWA staff and Palomino-LW have been negotiating the agreement terms for over a year. The current concept is for TMWA to purchase an option from Palomino-LW that grants TMWA the right to purchase their land (roughly 1,484 acres) water rights (roughly 2,580 acre-feet) and storage rights for a total price of $34M. The option would be for five years, and option payments would be applied to the purchase price. Under the most-recent Palomino-LW proposal, the first option payment of $5M would be due upon signing. Subsequent annual option payments for years 2-4 would be $2.5M and year 5 would be $21.5M. During the option period TMWA and its partners would continue to conduct due diligence and seek to obtain all necessary project permits.

Before the option agreement is finalized between TMWA and Palomino-LW, TMWA will obtain input from Reno, Sparks, and Washoe County and may bring back changes for Palomino-LW to consider. Additionally, the option agreement will not be effective unless TMWA and some or all of TMWA's regional partners (Reno, Sparks, and Washoe County) have entered an interlocal agreement governing each organization's respective rights and obligations for the project and defining their respective cost sharing and responsibilities. Therefore, the ILA is a condition precedent to the option agreement becoming effective.

PUBLIC OUTREACH - COMMUNITY ENGAGEMENT REPORT

Outreach focused on two primary objectives: (1) educate community members about the potential benefits of the projects being contemplated by the Study; and (2) encouraging residents to participate by allowing their wells to be tested. To achieve these objectives, outreach focused on fostering direct engagement with individuals—addressing their questions and concerns in person whenever possible. This engagement was achieved through several public meetings, email updates and direct correspondence and conversations. These efforts are supported by a dedicated project website (palomino-farms.com) and various printed materials.

Public meetings in Warm Springs, as summarized below, have been well attended (30 to 50 people each) and email correspondence has been conducted with numerous community members. The website has received several thousand pageviews and over a thousand unique visitors. The tone and substance of interactions, though rigorous at times, has been constructive and productive.

- **Public Meeting – February 26, 2022**: Open house. In attendance were representatives from Truckee Meadows Water Authority, Washoe County, The City of Sparks, The City of Reno, Truckee Meadows Regional Planning Agency, Western Regional Water Commission, and the Nevada State Engineer.
- **Public Meeting - November 10, 2021**: Representatives from Truckee Meadows Water Authority/OneWater Nevada attend Warm Springs Advisory Board meeting to both discuss the Palomino Farms Feasibility Study and answer questions from the public.
- **Public Meeting - July 20, 2021**: Warm Springs Community Alliance hosted an informational meeting regarding the Palomino Farms Feasibility Study.
- **Public Meeting - May 20, 2021**: TMWA Board of Directors Meeting
- **Palimino-Farms.com informational website goes Live – April 21, 2021**
- **Public Meeting – April 21, 2021**: TMWA Board of Directors Meeting

HYDROGEOLOGIC INVESTIGATION

The Study included an extensive hydrogeologic investigation including: 1) reviewing previous hydrogeologic investigations; 2) collecting additional data on lithology, aquifer hydraulic parameters, borehole geophysics, water quality and geochemistry; 3) development of a hydrogeologic conceptual model for Warm Springs Valley; 4) development of a numerical groundwater flow and transport model; and 5) development of a geochemical model to evaluate the compatibility of potable and recycled water mixing with ambient groundwater.

Sonic Borings Drill

The hydrogeologic investigation's purpose was to collect data necessary to evaluate the proposed aquifer storage and recovery project. A variety of field activities were completed including drilling eight test wells, soil cores collected at ten locations, lithologic analysis and borehole geophysics, evaluation of previously collected airborne geophysical data, aquifer testing, water quality analysis, an evaluation of the geochemical compatibility of the existing groundwater with recycled and potable water, and groundwater modeling. Results from the hydrogeologic investigation are summarized below. The full report is presented in the Palomino Farms Sustainable Water Resource Feasibility Study, March 2022 (Appendix C).

The Study developed a Warm Springs Valley hydrogeologic conceptual model. The key components of the conceptual model include: 1) northwest-southeast oriented high permeability (1 – 100 feet per day) aquifer in the central portion of the valley; 2) groundwater recharge from infiltration of precipitation (2,600 acre-feet annually (AFA)); 3) groundwater discharge as evapotranspiration (2,500 AFA under predevelopment conditions), pumping (as much as 5,000 AFA), and small amounts of interbasin flow through Mullen Pass and to Spanish Springs; 4) elevated concentrations of nitrate in groundwater from naturally occurring soil nitrogen; and 5) elevated concentrations of arsenic due to geothermal outflow and potentially desorption from aquifer sediments following potable water injection.

Aquifer Pumping Test Set-Up

Pumping at high-capacity irrigation wells caused groundwater levels to decline over 125 feet since the 1960s. The drawdown trough as defined by the 25-foot contour is eight miles long and two miles wide.

A significant amount of residual nitrate mass occurs in the vadose zone beneath previously irrigated fields. Total nitrate mass beneath all previously irrigated fields is estimated to be 4.9 million pounds.

Nitrogen and oxygen isotopes of nitrate were used to identify the source of nitrogen in groundwater. The nitrate source was found to be naturally occurring soil nitrate derived from long-term accumulation of precipitation in the vadose zone.

Nitrate concentrations have exceeded the Environmental Protection Agency's Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L) throughout large portions of the agricultural area. After initial agricultural development in the 1960s, nitrate concentrations increased significantly and by the mid-1980s nearly 1,500 acres beneath the agricultural area had concentrations above the MCL because of nitrate flushing beneath irrigated fields. By 2021, the area with concentrations exceeding the MCL reduced to less than 200 acres. The decrease in nitrate concentrations was likely due to a combination of factors including: 1) decrease in agricultural irrigation around 2010 and associated nitrate flushing beneath these fields, 2) lowering of the water table due to decades of irrigation pumping thereby trapping some of the nitrate in the vadose zone, and 3) northward migration of high nitrate groundwater ultimately discharging and concentrating beneath the playa.

Arsenic concentrations exceed the MCL (10 ug/L) along the west and southern portions of Warm Springs Valley and are attributed to geothermal outflow zones with highest arsenic concentrations being located near Ironwood Road along the western margin of the valley.

Leaching and column experiments with aquifer sediments and geochemical modeling indicate that arsenic concentrations may increase following injection of potable water. Arsenic concentrations may increase from between 3 to 4 ug/L due to dissolution of arsenic bound to soil particles.

From a hydraulic perspective, the project area is a viable site for an Aquifer Storage and Recovery (ASR) project. The hydraulic conductivity in the alluvial aquifer is large enough for direct injection of 1,300 AFA in three wells for a total storage of 45,000 acre-feet. Undesirable shallow groundwater conditions are not predicted in the next 50 years if withdrawal of stored water for municipal use is a least equal to 1,300 AFA.

The sustainable net municipal pumping rate of Warm Springs groundwater from the Palomino-LW project area is 1,200 AFA. This is in addition to continued basin-wide pumping of 871 AFA of pumping for agricultural irrigation, domestic, stock, recreational, and quasi-municipal uses.

A groundwater nitrate transport model predicts elevated nitrate concentrations in the project area as groundwater levels rise and encroach on residual nitrate in the vadose zone. Peak nitrate concentrations in proposed municipal wells will likely exceed the MCL and could exceed 20 mg/L. Nitrate issues could be mitigated with treatment and/or shallow groundwater pumping which could be used for agricultural irrigation in conjunction with reduced fertilizer application.

Elevated arsenic concentrations could become an issue for the project under higher pumping rates (constant 2,500 AFA) and/or mobilization due to geochemical reactions induced by low total dissolved solids (TDS) potable water injection. Additional research is needed to determine the arsenic mobilization potential and potential mitigation options.

ENGINEERING EVALUATIONS

Planning level engineering investigations reviewed available capacity in the potable and recycled water distribution systems, irrigation requirements, infrastructure improvements and estimated costs. Several permitting and administrative matters were also investigated, including State Engineer permitting and interbasin transfer considerations, Washoe County Area Plan conformance and Special Use Permit requirements, return flow management, land ownership versus lease considerations, rights-of-way, including NDOT lands, and potential flood risk.

RECYCLED WATER IRRIGATION, INFRASTRUCTURE REQUIREMENTS

A preliminary planning study and hydraulic modeling evaluation was performed to help identify recycled water distribution system improvements required to supply recycled water from the current northern terminus of the Sparks recycled water system to the Warm Springs Valley area (Appendix D). This evaluation developed estimated flows to satisfy the existing peak irrigation demands at the existing Palomino-LW properties. Potential demands from the Western Turf property were also included.

The existing Palomino- LW wells generally pump to irrigation ponds that are then used as the irrigation water source. Based on this information, the peak design capacity for the proposed facility should provide approximately 5,400 to 5,900 gpm during the irrigation season, which is roughly seven months. This corresponds to an annual irrigation demand of approximately 2,400 AF. Irrigating Palomino Farms with recycled water rather than groundwater would dramatically reduce the need for groundwater pumping and would allow the groundwater basin to recover.

Based on the desired capacity and the limitations of the existing recycled water distribution system, the proposed improvements include the following elements, as shown in Figure 2:

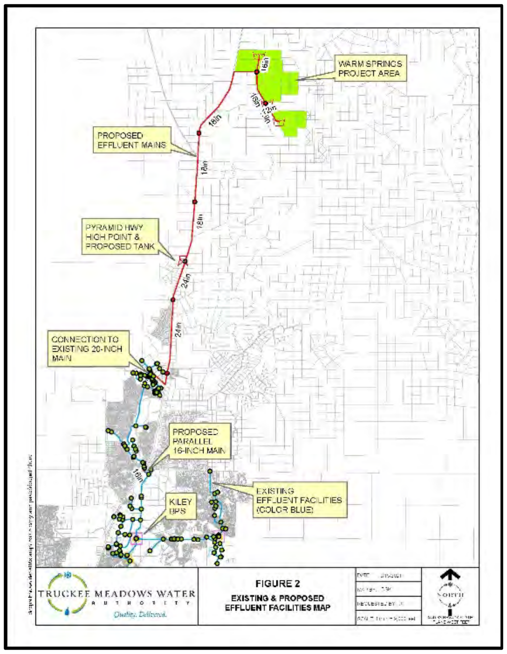

Figure 2

- 1,800 feet of 16-inch main parallel to existing effluent reuse main near the Pyramid Hwy and La Posada intersection.
- 22,900 feet of 24-inch main from a connection point in Sha Neva Road to a proposed tank.
- Installation of a proposed tank with an approximate pad elevation of 4,720 feet.
- 34,800 feet of 18-inch gravity flow main from the tank north to Palomino Farms property.
- Approximately 11,500 feet of 16-inch distribution main in the vicinity of the Palomino, LW and Western Turf irrigation ponds.

The proposed improvements have an estimated supply capacity of 5,250 gpm, which is slightly less than the existing irrigation demands (5,400 to 5,900 gpm)[1]. Flexibility in operation, pond storage and some minor local groundwater pumping would help to meet projected irrigation demands. The estimated cost of the proposed improvements is $36.8 million.

Care must be taken to limit recycled water irrigation rates to minimize infiltration and potential nitrate mobilization from the vadose zone. By limiting irrigation to the net irrigation water requirement, little if any seepage beneath the root zone will occur. Groundwater recharge beneath the irrigated areas will be minimal and not impact the hydraulics or water quality within the aquifer.

Category A recycled water[2] is suitable for use in agricultural settings, including irrigation of food crops, and Category B recycled water is suitable for non-food crops like turfgrass, garden crops, and animal feed. Years of testing and analysis have established that the safety of recycled water for use on food crops is comparable to other water sources. Recycled water in food production is treated to meet all applicable state and federal regulations, delivering water that is safe for humans, animals, and the environment.

[1] Existing infrastructure, specifically the Kiley booster pump limitation, caps the capacity at 5,250 gpm.

[2] As defined by Nevada Administrative Code section 445A.2762.

Furthermore, the TDS of recycled water is less than or equal to the existing groundwater, so crops will not be negatively affected.

Recycled water use is a beneficial use and reduces TMWRF capital and operating expenses, while at the same time benefiting Truckee River water quality. Water that is recycled and not discharged into the Truckee River has a direct and positive impact on all three of TMWRF's Total Maximum Daily Load (TMDL) discharge permit limitations. For instance, every 1 million gallons per day (MGD) of recycled water use represents 14.2 lbs. of Total Nitrogen (TN), 3100 lbs. of TDS and 3.5 lbs. of Total Phosphorus (TP) not discharged into the Truckee River.

The proposed Palomino Valley recycled water flow is estimated to be 2,400 AFA or an average flow of approximately 3.5 MGD over a seven-month irrigation season[3]. The potential reduction in discharge to the Truckee River beneficially impacts TMWRF in the following ways:

- Extends TMDL initiated Capital Improvements Projects into the future. Expenses could potentially be deferred 15 or more years, based on Consensus Forecast residential development projections within the TMWRF service area. These deferred facilities include both the Dissolved Organic Nitrogen (DON) removal system and the Advanced Treatment Facility. (Appendix E - TMWRF Facility Plan Technical Memorandum No. 11: Revised CIP Recommendations)
- Lowers the required size of the advanced treatment facility from approximately 6 to 2.5 MGD and reduces both capital and operating expenses.

As discussed later, under the Truckee River Operating Agreement, most recycled water use that does not return to the Truckee River must satisfy the return flow obligations to downstream users by providing substitute water sources to return to the river.

WATER AVAILABILITY, ASR POTENTIAL, WATER INFRASTRUCTURE REQUIREMENTS

Palomino-LW land is in the Warm Springs hydrographic basin (Basin 84). The Nevada Division of Water Resources (NDWR) sets the perennial yield, which is described by NDWR as the amount of groundwater that can be withdrawn from a basin annually on a long-term basis without exceeding the annual recharge of the basin. For the Warm Springs basin, the perennial yield is set at 3,000 AFA. There are currently over 6,500 AFA of committed groundwater rights in the basin, a majority being irrigation rights.

Based on groundwater modeling completed by TMWA, the estimated perennial yield is 2,600 AFA for the entire Warm Springs Basin. The sustainable net pumping rate for the project area is 1,200 AFA, this includes other agricultural pumping in the Project area, such as Western Turf. The current estimated basin-wide pumping outside of the project area is 871 AFA. This includes pumping for agricultural irrigation, domestic, stock, recreational, and quasi-municipal uses throughout the Warm Springs Basin. Groundwater extraction for environmental uses (Rocketdyne) continues, but this use is non-consumptive. Therefore, approximately 529 acre-feet of the estimated 2,600 AFA perennial yield could potentially be pumped from areas beyond the Project area.

Based on the perennial yield it appears that curtailment would not occur to water rights prior to 1969. Palomino Farms-LW has some of the most senior water rights in the Warm Springs Basin. Approximately

[3] For purposes of comparison, 3.5 MGD of recycled water use is equivalent to approximately 20,000 residential units.

900 AFA have a priority prior to 1969. Another approximately 1,070 AFA have a 1969 priority. The other large groundwater user in the Warm Springs Basin is Western Turf. Western Turf has approximately 272 AFA of pre 1969 water rights and 592 AFA of 1969 priority water rights. Based on the water rights priorities for the 1,200 AFA pumping within the project area, Palomino Farms-LW pre-1969 rights are a significant portion of the 1,200 AFA, roughly 900 AFA.

Moving up to 1,200 AFA to north Spanish Springs would only be feasible by irrigating Palomino Farms with recycled water rather than groundwater. Meaning, TMWA and its partners would provide recycled water for irrigation in lieu of pumping groundwater. Effectively this would provide a new source of water to substitute for the prior groundwater pumping.

The Palomino-LW project area is also a viable site for an ASR project. The hydraulic conductivity in the alluvial aquifer is large enough for direct injection of 1,300 AFA, which corresponds to the available winter-time supply capacity from TMWA's distribution system in north Spanish Springs. A total storage capacity of 45,000 AF is available without creating undesirable shallow groundwater conditions north of Pyramid Highway.

A preliminary planning study and hydraulic modeling evaluation (Appendix F) was performed to help identify potable water distribution system improvements required to supply water from the existing TMWA facilities in the northern Spanish Springs Area to the Palomino Farms area for aquifer recharge. These facilities also provide the ability to supply groundwater and/or stored water from Palomino-LW back to the existing TMWA potable water system in Spanish Springs. The intent of the proposed potable water infrastructure is to supply water to Warm Springs during winter months for aquifer storage, which can then be recovered during peak summer months to meet TMWA customer potable water demands in the Spanish Springs area.

The hydraulic model was developed based on the following two potable water distribution system alternatives and design criteria:

- Alternative 1: Maximum day supply from Palomino-LW farm to Spanish Springs (summer) = 4,000 gpm
- Alternative 2: Maximum day plus drought supply from Palomino-LW farm to Spanish Springs (summer) = 7,000 gpm
- Recharge supply from Spanish Springs to Palomino-LW farm (winter) = 2,600 gpm, incorporated into both alternatives

Alternative 1 assumes a return design flow of 4,000 gpm during peak demand periods, limiting annual withdrawals to 1,200 AF.

Alternative 2 assumes a return design flow of up to 7,000 gpm. The additional 3,000 gpm of supply capacity would provide supplemental drought capacity on top of the 4,000 gpm maximum day capacity. The additional supply capacity is equivalent to 3,000 AF of supplemental drought storage. It should be emphasized that the additional 3,000 AF of drought storage would not be relied upon every year. Like other TMWA drought operations evaluations, for purposes of this analysis, the additional drought capacity is assumed to be utilized a maximum of 3 out of every 10 years, if necessary.

This pumping scenario (Scenario 4) is depicted in Figure 3, which is Figure 118 of the Palomino Farms Sustainable Water Resource Feasibility Study, Groundwater Investigation Report. With 1,300 AFA of recharge and 2,400 AFA of recycled water used for irrigation, groundwater levels continue to increase modestly over time under pumping Scenario 4.

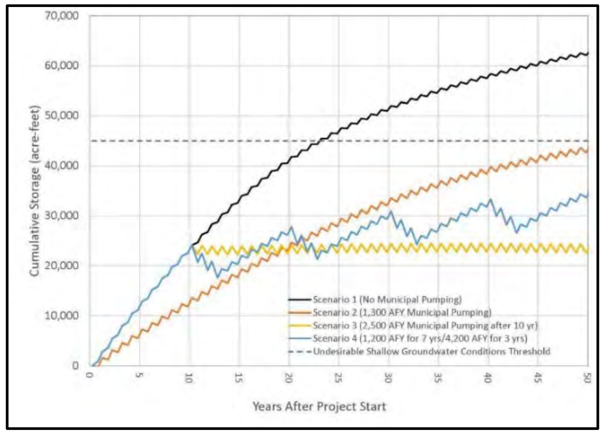

Figure 3

Facility requirements and estimated costs were developed for the two water supply alternatives described above. It should be noted that the facilities required to recharge 1,300 AFA are incorporated in both water supply alternatives. The recommended facilities consist of the following infrastructure, as shown in Table 1 and Figure 4:

Table 1 – Water Infrastructure Requirements

	Alternative 1	Alternative 2
Wells	4	7
Wellfield Piping	12,000 Ft 12-inch	15,000 Ft 12-inch
Wellfield Tanks	2-250,000 Gal	2-250,000 Gal
Booster Pump Station	4,000 GPM	7,000 GPM
Transmission Main	52,500 Ft 18-inch	52,500 Ft 24-inch
Estimated Cost	**$43.9M**	**$62.1M**

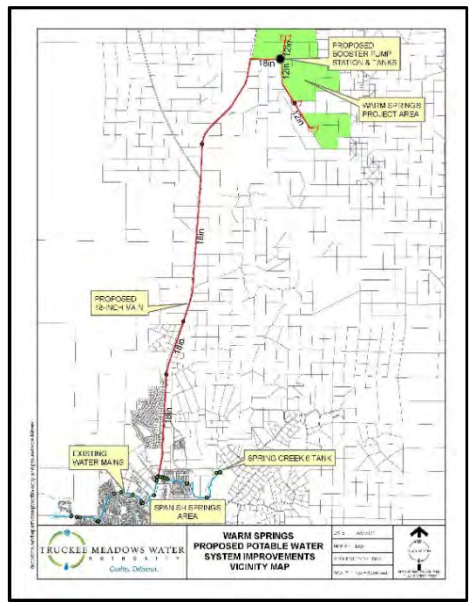

Figure 4

The incremental cost to upsize the facilities to provide the additional 3,000 AF of drought storage capacity is $18.2 million.

Several financial benefits would accrue to TMWA from this proposed project. First, 1,200 AFA of water rights would be available to support future development in Spanish Springs. Second, the project would allow TMWA to reduce significant capital expenditures, primarily the deferral and downsizing of the planned $87 million Sparks I Street groundwater treatment plant. Placing a value on the 3,000 AF of drought storage is more qualitative. For comparison, TMWA paid $17.5 million for the 4,750 AF TCID portion of Donner Lake storage rights in 2016.[4]

[4] The actual yield due to capacity constraints is less than 4,750 AFA. Additionally, there were other considerations for reaching this valuation.

FLOODING RISK

A planning-level evaluation was conducted of potential flood impacts and mitigation measures at proposed Palomino Farms water and recycled facility locations being considered in the vicinity of Pyramid Highway and Whiskey Springs Road. A copy of the evaluation is provided in Appendix G. Portions of the existing and proposed facilities are located within a FEMA Special Flood Hazard Area. A summary of the findings is provided below:

- Flooding in the overbanks is relatively shallow across most of the overbank areas (1.5 feet or less in a 100-year storm).
- Increased sediment loading from potential flood flows should be expected but is not a serious maintenance problem.
- Well and pump station pads should be elevated above the base flood elevation to reduce flooding/sediment issues.
- Elevating the well and pump station pads should not impact the overall floodplain depths or flow patterns significantly.

The evaluation did not address potential flooding impacts to the balance of undeveloped irrigated land. Flooding and sediment deposition should be expected and will require periodic maintenance. Historically, sediment deposited on the farm property was plowed into the field, with the excess being pushed to the edges and along the creek.

PERMITTING EVALUATIONS

State Engineer Permitting

TMWA will need permits from the Nevada State Engineer for each part of the project (irrigation with recycled water in Palomino Valley, storage of potable water in Palomino Valley, and importation of Palomino/Warm Springs groundwater to TMWA's service area). The following is a summary of that process for each part of the project.

Recycled Water Permitting Requirements

Under NRS 533.440, treated effluent discharged from TMWRF is subject to appropriation for beneficial use. Recycled water from TMWRF is divided into different components based on the sources of potable water supplied to its customers that return through the sanitary sewer system to be treated at TMWRF. The surface water component is from potable Truckee River usage, the groundwater component is from potable groundwater usage, and the Privately Owned Stored Water (POSW) and TROA Credit Water components are from potable POSW or Credit Water usage. Each component is calculated by the Federal Water Master based on its percentage of TMWA's overall daily potable water supplies.

A portion of recycled water produced from TMWRF are currently appropriated by the Cities of Reno and Sparks through State Engineer permit 29973, which is a reservoir or so-called "primary" permit. To use water appropriated under a primary permit, TMWRF must obtain "secondary" permits for specific uses. These secondary permits allow TMWRF to use the surface/groundwater component of recycled water for specific uses within its reclaimed water system and for instream flow purposes to Pyramid Lake.

To use the surface water and groundwater components of recycled water for irrigation in Palomino Valley, Reno and Sparks will need to obtain additional secondary permits from the State Engineer. Under NRS

533.440(1), The State Engineer is not required to, and typically does not, follow the statutory public notice process as is required for other permit applications. The State Engineer may decide to publish notice of these secondary applications because of the unique characteristics of this project and public interest. Secondary applications may be protested by any interested person or organization. The amount of time necessary to obtain State Engineer approval of a secondary application varies but is likely six months or longer depending on backlog of other pending applications and whether the applications are protested. Regardless of whether an application is protested, the State Engineer may, but is not required to, hold a hearing on the application.

If an A+ advanced potable water treatment facility is constructed in the future and used to deliver A+ water to Palomino for direct injection or infiltration through rapid infiltration basins, then TMWA would also be required to obtain a recharge permit (described below).

Lastly, under the Truckee River Decree, any use of recycled water that does not return to the Truckee River must satisfy applicable return flow obligations to downstream users by providing substitute water sources to return to the River. This obligation will require TMWA to permit other water rights for instream flow purposes.

Potable Water Storage Permitting Requirements

To store water underground in Palomino Valley, TMWA must obtain a recharge permit from the State Engineer under NRS 534.250. Under the statute, TMWA must prove that: (1) it has the technical and financial capability to construct and operate the project, (2) it has the right to use the water to be recharged, (3) the project is hydrologically feasible, and (4) the project will not cause harm to users of land and water within the area. The State Engineer must conduct an initial review of the application within 45 days of filing and, if the application is determined to be complete, publish notice of the application within 30 days of the determination. The notice must be published one time a week for two weeks. Under NRS 534.270(3)(d), a protest of a recharge application is limited to the above-described criteria. Regardless of whether an application is protested, the State Engineer may, but is not required to, hold a hearing on the application. For this project, TMWA's source of water and water rights would be the Truckee River. The diversion to and storage of Truckee River water in Palomino Valley and subsequent use in TMWA's service area is not an interbasin transfer because the water returns to the Truckee Meadows. Additionally, under NRS 534.007, an interbasin transfer applies to groundwater only.

Palomino Groundwater Importation Permitting Requirements

TMWA will need to obtain permits from the State Engineer to change Palomino Farms and LW Land Company's existing irrigation water rights to municipal use within its service area. Under NRS 533.370(1)(c), TMWA must show that it has the good faith intent to construct the project and financial ability and reasonable expectation to construct the project and put the water to beneficial use with reasonable diligence. The State Engineer must also consider whether the proposed use of groundwater conflicts with existing rights or protectable interests in existing domestic wells or threatens to prove detrimental to the public interest. NRS 533.370(2). Lastly, diverting groundwater from Palomino to TMWA's service area would be an interbasin transfer of groundwater under NRS 534.007 because the point of diversion would be in a different basin than the place of use. As described below, this is really more like a substitute source of supply since more water would remain in storage than would be withdrawn. The State Engineer must consider the following under NRS 533.370(3) because it would be an interbasin transfer:

1. Whether the applicant has justified the need to import the water from another basin;
2. If the State Engineer determines that a plan for conservation of water is advisable for the basin into which the water is to be imported, whether the applicant has demonstrated that such a plan has been adopted and is being effectively carried out;
3. Whether the proposed action is environmentally sound as it relates to the basin from which the water is exported;
4. Whether the proposed action is an appropriate long-term use which will not unduly limit the future growth and development in the basin from which the water is exported; and
5. Any other factor the State Engineer determines to be relevant.

The interbasin transfer statute was enacted in 1999 out of concerns that large urban water utilities could appropriate all water resources in rural areas and negatively impact future growth and the environment of those areas. The intent of the interbasin transfer statute was not to prevent this type of project where recycled water will be used as a substitute source of supply for the existing irrigation operations and only a sustainable amount of groundwater will be diverted as described above and staff believe that the interbasin transfer criteria will be met by the project. Lastly, under NRS 533.364, the State Engineer must conduct, or require the applicant to conduct, an inventory of water rights and resources in the basin of origin (i.e. Warm Springs Valley). The inventory must include:

1. The total amount of surface water and groundwater appropriated in accordance with a decreed, certified or permitted right;
2. An estimate of the amount and location of all surface water and groundwater that is available for appropriation in the basin; and
3. The name of each owner of record set forth in the records of the Office of the State Engineer for each decreed, certified or permitted right in the basin.

TMWA would need to obtain a special use permit and amendment to the Warm Springs Area Plan to import Palomino Valley groundwater to its service area. Under the plan, which was adopted in 2012, Washoe County adopted a policy stating that it "shall not approve transfers of groundwater from the Warm Springs Valley Hydrographic Basin." Like the interbasin statute, the Area Plan prohibition was not intended to prevent this type of project from moving forward. Rather it was intended to protect an export only situation. The Area Plan also includes another policy/action, which states that the County should investigate the possibility of importing surface water from another basin to supplement water resources in Warm Springs Valley, which is exactly what this project would accomplish.

TMWA would work with Washoe County to narrowly tailor the special use permit and amendment to be specific to this project because it is a regional solution to wastewater management and drought resiliency/climate change preparedness and will improve the groundwater basin. The project would also help preserve the rural characteristics of the valley by keeping the farm in operation and reducing the amount of existing irrigation water rights that can be converted to municipal use for development in the valley.

Land Purchase or Lease

TMWA staff has evaluated whether purchasing or leasing the Palomino Farms-LW land would further the Project's goals. Key project elements include the ability to use recycled water, the ability to recharge potable water for banking, and protecting water quality in the groundwater basin. To use the recycled water, it is important that the timing and application of water be precise. It is also critical that water be applied in a manner that does not impact the water quality in the groundwater basin, including controlling farming practices. This amounts to several constraints for how the farming, water application, and timing of the water application must occur.

The project will require constructing significant infrastructure. This infrastructure will have a longer life than any lease agreement that would be available to TMWA. Additionally, to protect the investment of banked water, TMWA would need long term access to the property. Leasing the property would also provide less control over the farming operations on the property. Weighing these considerations, staff believes the Project goals are better accomplished through land ownership.

Pipeline Alignment Rights-of-Way

TMWA staff have identified the optimal transmission pipeline alignment for the proposed Palomino Project as an alignment within State Route 445 (Pyramid Highway). TMWA staff are completing due diligence research regarding the requirements to secure highway permits to place the potable and non-potable pipeline alignments within Nevada Department of Transportation (NDOT) Right of Way for Pyramid Highway. NDOT Records indicate a significant portion of Pyramid Highway alignment from Sha Neva Road to Whiskey Springs Road is utilized by NDOT as a surface easement interest dating back to 1935. NDOT requires Permittee's who wish to utilize the highway to indemnify NDOT during the permitting process. It is the responsibility of the permittee to conduct the due diligence to locate current owners of the easement areas and obtain permissions from them to utilize the underlying fee areas of the highway.

TMWA staff have been conducting due diligence to trace title for the easement areas to assess the risks and obtain the necessary underlying fee owner permissions. TMWA will continue to work with NDOT to attempt to eliminate or minimize the risks by clearing up the underlying ownership issue. TMWA staff has established that there are two owners currently tied to the existing rights of way and, those owners and NDOT have been contacted and are willing to cooperate with clearing up the title issue.

TMWA is currently working in-house and with an independent land specialist to produce title research/abstracts to provide to all parties as proof of ownership for the various sections of right of way. Additionally, TMWA will be working with a land surveyor to produce legal descriptions that describe the highway areas that exist today. After completing this work, NDOT will own the easement areas on Pyramid Highway, which will allow TMWA to obtain highway permits, mitigating the risk of third-party legal action. TMWA staff has compiled a draft pipeline alignment and is preparing to coordinate with NDOT through a pre-application meeting to present and request review of the preferred pipeline alignment.

SUMMARY

The Study presents the viability of bringing both potable and recycled water to the Palomino Farms-LW land as part of a long-term sustainable water management plan. Palomino Farms-LW land would be irrigated with recycled water rather than groundwater, allowing the groundwater basin to recover. The aquifer could be utilized to conserve and store large quantities of potable water for drought protection and to help meet peak water demands in the Spanish Springs area.

The total estimated cost of the proposed project is considerable, and includes the following cost components:

Purchase of land, water rights and underground storage	$34 million
2,400 AF recycled water irrigation site, required infrastructure	$36.8 million
1,200 AF sustainable groundwater rights, required infrastructure	$43.9 million
45,000 AF drought storage, required infrastructure oversizing	$18.2 million
Total	**$132.9 million**

Several significant regional water management benefits could be realized by the project. First the project would provide total control of a large recycled water irrigation site for TMWRF. Second, the project would allow acquisition of a large water banking site ultimately capable of yielding 3,000 AF of off river drought storage, providing the community with enhanced water supply resiliency and climate change preparedness.

Although the proposed project cost is substantial, both TMWA and TMWRF would realize substantial cost savings by deferring and/or eliminating planned capital improvement projects and their associated operating expenses. Based on initial high-level financial analyses, results indicate that the project cost can be substantially, if not fully, mitigated by the deferral and reduction in size of the planned capital improvement projects described previously. Additional benefits may also be available to Washoe County and the STMWRF facility by connecting the TMWRF and STMWRF recycled water distribution systems, providing STMWRF access to existing and/or future TMWRF recycled water customers, and operating the systems under a coordinated recycled water management plan.

Financial/permitting uncertainties:

Several financial and permitting uncertainties still exist and will require additional investigation. They are described below.

Arsenic water quality mitigation – Elevated arsenic concentrations may become an issue under high pumping rates and/or mobilization due geochemical reactions from potable water recharge. More research is underway to determine the arsenic mobilization potential and potential mitigation options, such as potable water quality conditioning.

Nitrate water quality mitigation – Nitrate issues can likely be mitigated by closely managing irrigation rates, recharge quantities and municipal pumping locations, and by pumping shallow groundwater with high Nitrates which could augment agricultural irrigation.

State Engineer Interbasin transfer – TMWA will need to obtain permits from the State Engineer to change Palomino-LW's existing irrigation water rights to municipal use within its service area. Diverting groundwater from Palomino to TMWA's service area would be an interbasin transfer of groundwater. The intent of the interbasin transfer statute was not to prevent this type of project where recycled water will be used as a substitute source of supply for the existing irrigation operations. Only a sustainable amount of groundwater will be diverted. Staff believe that the interbasin transfer criteria will be met by the project.

Return flow considerations – Under the Truckee River Decree, some recycled water uses that do not return to the Truckee River must satisfy the return flow obligations to downstream users by providing substitute water sources to return to the river. Staff believe that a permanent return flow solution can be implemented, consistent with TROA and Pyramid Lake Paiute Tribe objectives.

Warm Springs Area Plan conformance – The project is a regional solution to wastewater management and drought resiliency/climate change preparedness. TMWA would need to obtain a special use permit and amendment to the Warm Springs Area Plan to import Palomino Valley groundwater to its service area. TMWA would work with Washoe County to narrowly tailor the special use permit and amendment to be specific to this project. In turn, the project would relinquish its large-scale development zoning, helping preserve the rural characteristics of the valley.

Next steps

The information presented in the Study demonstrates that from a technical perspective delivering both potable water and recycled water to the Palomino Farms area as part of a long-term sustainable water management plan is a viable regional water management concept. Palomino Farms could be irrigated with recycled water rather than groundwater, allowing the groundwater basin to recover. Additionally, the aquifer can be utilized to conserve and store large quantities of potable water for drought protection and to help meet peak demand during the summer- season.

Permitting requirements, public education and outreach, and financial considerations outlined above will take additional time and information to gain more confidence that the Project can be successfully implemented.

Several additional steps are necessary to determine if the investment in the Palomino Farms regional project is a good water management investment. The positive feasibility study results and potential regional benefits support moving forward. If the agency partners desire to continue to evaluate the Project's technical, financial, managerial, and environmental merits, the following outline the next steps to obtain necessary information and a specific project proposal for Board consideration.

1. Prepare detailed cost / benefit analyses for each agency partner.
2. Further evaluate the permitting uncertainties, specifically the State Engineer interbasin transfer requirements, return flow considerations, and conformance with the County's Warm Springs Area Plan.
3. Negotiate a proposed cost sharing and operating agreement with agency partners.
4. Finalize the proposed option / purchase agreement with Palomino-LW.
5. Evaluate the opportunity to add the Western Turf commercial operations, land and water rights into the overall regional water management concept.

The Feasibility Study Agreement with Palomino-LW expired in April, which means they could develop or sell the land and water rights. Palomino-LW have stated that they strongly support the project, but they intend to maximize the return on their investment. Since the existing agreement has expired, there is no legal mechanism to stop Palomino-LW from moving forward with other options for the property. Until a new agreement is entered into to secure the option to purchase the land, there is no guarantee that the Palomino-LW land will remain available for this Project.

FIGURES

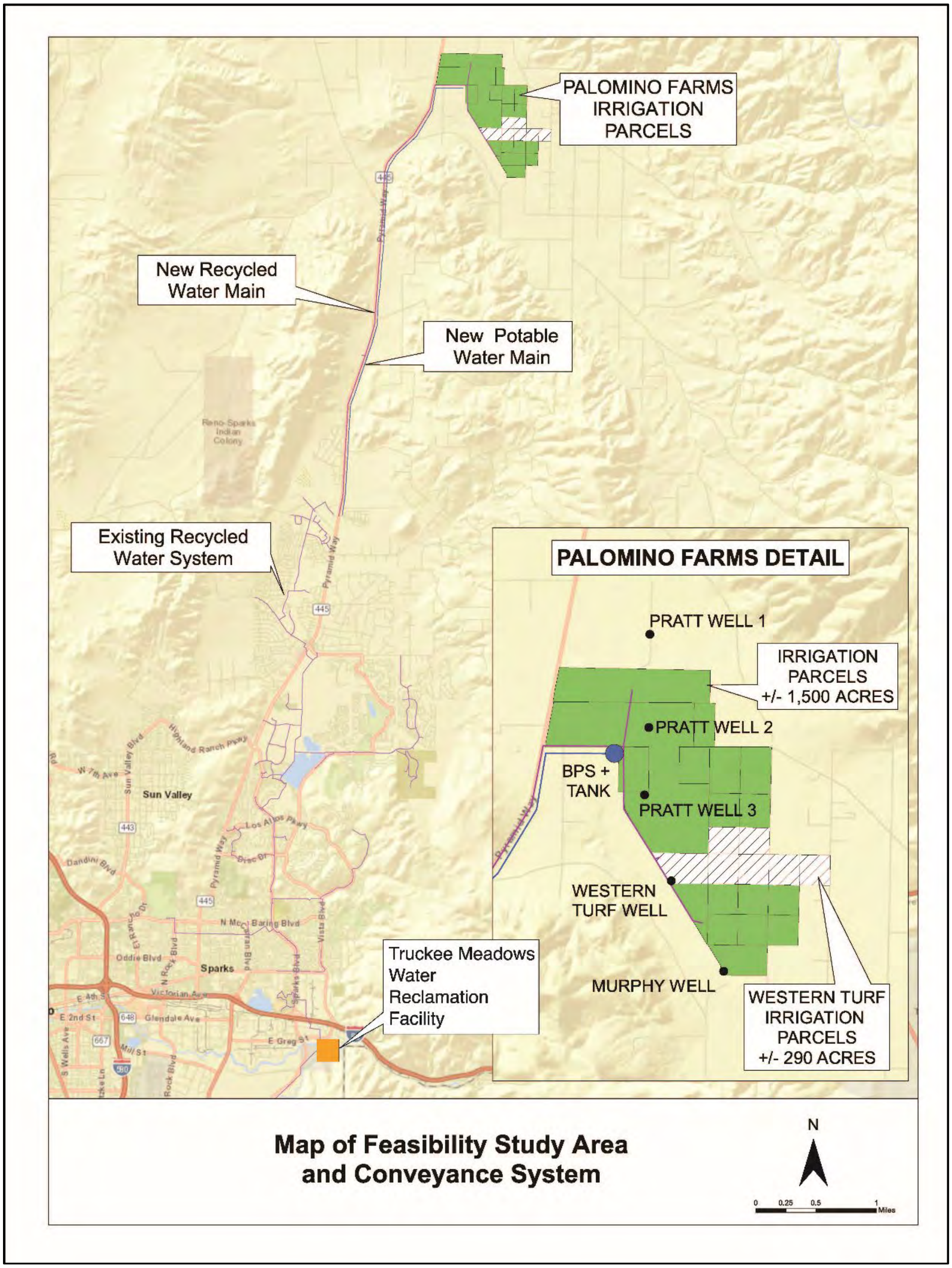

Figure 1 – Palomino Farms Map

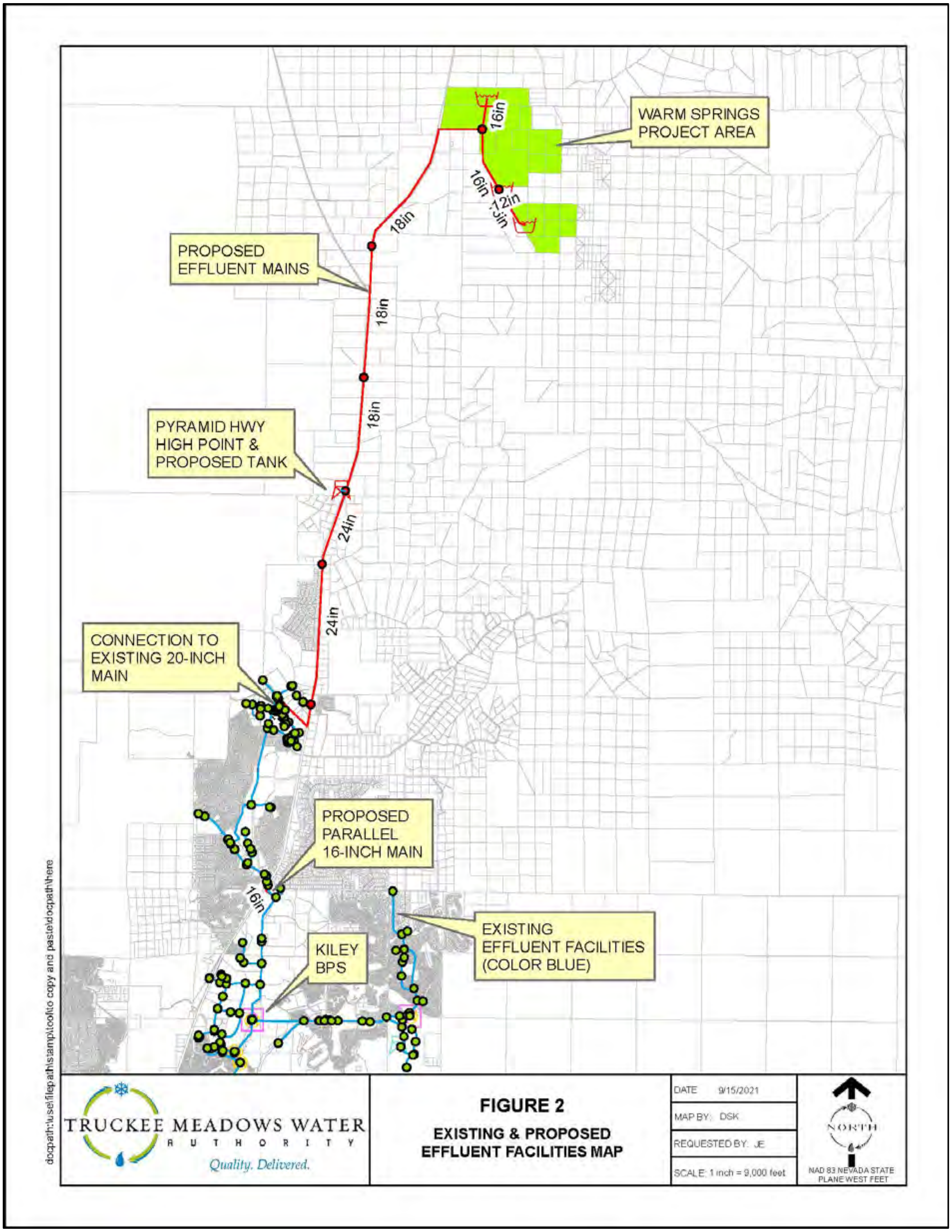

Figure 2 – Warm Springs Effluent Map

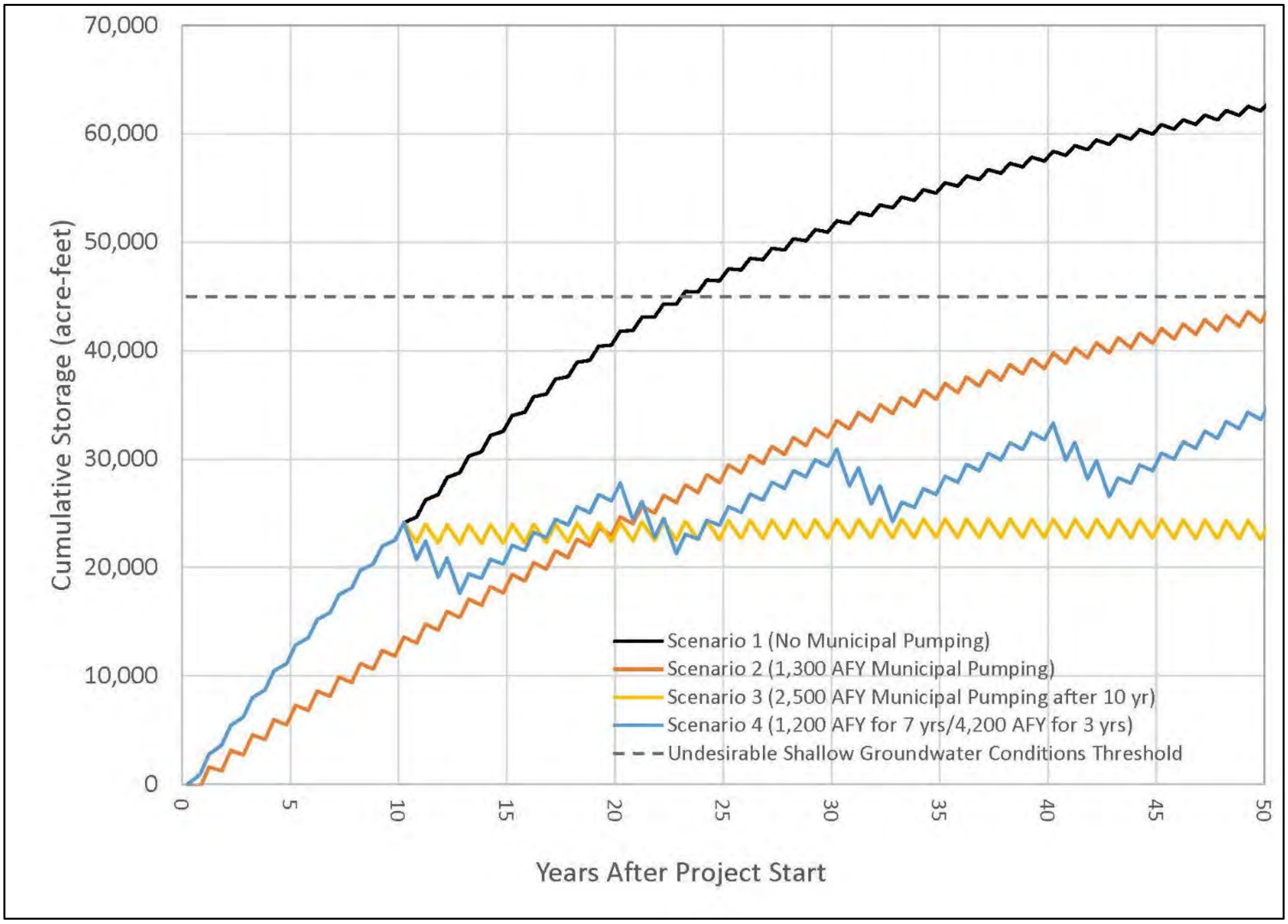

Figure 3 – Groundwater Study

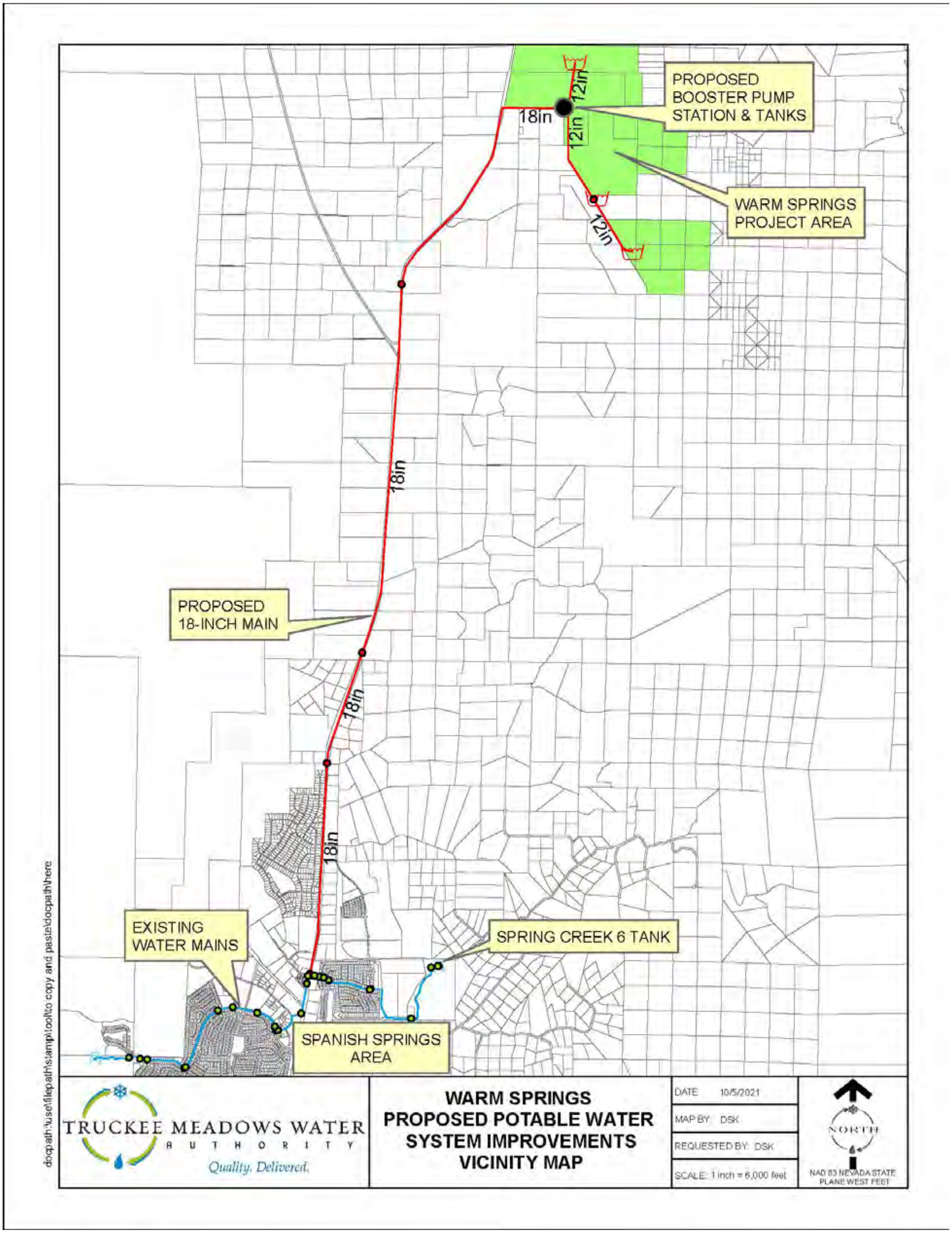

Figure 4 – Warm Springs Proposed Potable Water Map

INTERLOCAL AGREEMENT FOR THE
PALOMINO FARMS RESOURCE SUSTAINABILITY FEASIBILITY STUDY

This Interlocal Agreement dated as of the last date executed by the Parties below (Effective Date) is between the Truckee Meadows Water Authority, a joint powers authority under the laws of the State of Nevada (TMWA), the City of Reno, a municipal corporation (Reno), City of Sparks, a municipal corporation (Sparks), and Washoe County, a political subdivision of the State of Nevada (Washoe County). TMWA, Reno, Sparks, and Washoe County may be referred to under this Agreement individually as a Party or collectively as the Parties.

RECITALS

A. NRS 277.180 provides that any one or more public agencies may contract with any one or more other public agencies to perform any governmental service, activity, or undertaking which any public agency, entering into the contract, is authorized to perform.

B. TMWA is a public purveyor of water service within Reno, Sparks, and portions of Washoe County, Nevada and is interested in locating sites where it may bank water through active and passive groundwater recharge, and in developing groundwater resources to provide an additional source of water for drought protection, water resource sustainability, and operational flexibility.

C. Reno and Sparks operate a regional water reclamation facility known as the Truckee Meadows Water Reclamation Facility (TMWRF), and Reno and Washoe County operate other regional water reclamation facilities in their jurisdictions. As operators of regional water reclamation facilities, Reno, Sparks and Washoe County are interested in exploring long-term opportunities to provide treated effluent as recycled water for agricultural irrigation or other beneficial uses rather than discharging it to surface waters, like the Truckee River.

D. Palomino Farms LLC and LW Land Company, LLC (collectively, Palomino-LW) own approximately 1,484 acres of farmland and 2,580 acre-feet (AF) of groundwater rights in Warm Springs Valley, Nevada, which land (Palomino-LW Land) and water rights (Palomino-LW Water Rights) are more-specifically described on the attached Exhibits A and B.

E. Under the auspices of OneWater Nevada, a collaboration between TMWA, Reno, Sparks, Washoe County, the University of Nevada, Reno and other local government entities, with the cooperation of Palomino-LW, a feasibility study is proposed to evaluate the long-term feasibility of using recycled water from TMWRF and other regional water reclamation sources to irrigate the Palomino-LW Land in lieu of using their existing groundwater rights (the Feasibility Study).

F. The Feasibility Study will evaluate the feasibility and direct and indirect benefits of, among other things: (i) providing another option for regional treated effluent management, (ii) reducing the volume of treated effluent being discharged into the Truckee River, (iii) the long-term delivery of treated effluent as recycled water for permanent use for irrigation, land application or other beneficial uses on the Palomino-LW Land, (iv) increasing the sustainability of the Warm Springs groundwater basin by resting current irrigation wells, (v) recharging and storing on a long-term basis potable water and potentially advanced purified water in the Warm Springs groundwater basin using rapid infiltration basins or injection wells on Palomino-LW Land, and (vi) providing TMWA with a water banking site and an additional source of water for drought protection, water resource sustainability, and operational flexibility; (vii) availability and suitability of existing conveyance pipelines and appurtenances, and (viii) right-of-way corridors for water system facilities.

G. Depending on the results of the Feasibility Study, there may also be benefits to Palomino Valley from leaving the Palomino-LW Land as farmland and open space, augmenting the water supply in the Warm Springs groundwater basin, improving area groundwater levels and water quality, and preserving existing farmland and a rural lifestyle. The intent includes determining whether water resources can be improved and sustainably managed improving the overall regional water supply.

H. To facilitate the Feasibility Study, TMWA has entered or will enter concurrently herewith a Feasibility Study Agreement with Palomino-LW (the Palomino Farms Agreement) pursuant to which Palomino-LW will grant TMWA physical access to the Palomino-LW Land to conduct the Feasibility Study for a ten month period and will grant TMWA access to data and information related to irrigation operations, the land, wells and water rights as necessary to allow TMWA to conduct the Feasibility Study, as well as options for TMWA to secure rights and interests for implementing permanent treated effluent solutions on the Palomino-LW Land if determined sustainable under the Feasibility Study.

I. The Parties desire to enter this Agreement for purposes of outlining each of their respective obligations and responsibilities regarding the Feasibility Study and their desire to work together and cooperatively on all public outreach, engagement, and education regarding the intent and scope of the Feasibility Study and the direct and indirect benefits to the region.

AGREEMENT

NOW THEREFORE, in consideration of the forgoing recitals, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties agree as follows:

1. PURPOSEAND INTENT

The purpose of this Agreement is to facilitate unified and cooperative efforts to complete a study to inform the Parties on the viability and future benefits of developing alternate options for regional treated effluent management, reducing the volume of treated effluent being discharged into the Truckee River, using treated effluent as recycled water for irrigation purposes, recharging and storing on a long-term basis potable water and advanced purified water, developing water banking sites and securing and developing additional water supplies for drought protection and operational flexibility, and potential roles and responsibilities on related water management projects in the future. Further, the Feasibility Study will investigate the availability and suitability of both existing water infrastructure necessary to convey water to the Palomino-LW Land as well as existing or necessary rights-of-way, easements, and/or pipeline corridors.

2. PERFORMANCE OF FEASIBILITY STUDY

2.1 Palomino Farms Agreement. TMWA will endeavor in good faith to negotiate and enter the Palomino Farms Agreement with Palomino-LW for the purpose of securing access to the Palomino-LW Land to conduct the Feasibility Study, on terms and conditions reasonably agreeable to TMWA in its discretion. The Palomino Farms Agreement is anticipated to include the following elements: (i) physical access to the Palomino-LW Land to conduct the Feasibility Study, including permission for physical tests; (ii) rights to discuss permitting requirements with all regulatory agencies with respect to irrigation and land application with recycled water on the Palomino-LW Land, and recharging and storing potable water and potentially, advanced purified water; (iii) mechanisms for exploring TMWA's potential purchase, lease or other acquisition of the Palomino-LW Land (for irrigation using recycled water and recharge and recovery of potable water and potentially, advanced purified water) and Palomino-LW Water Rights (for possible importation into TMWA's system).

2.2 Agreement to Perform Study. Conditional on securing the Palomino Farms Agreement, TMWA will provide and perform or cause to be performed the services set forth in the scope of work attached hereto as Exhibit "C" as necessary to complete the Feasibility Study. TMWA will perform or contract for all services required to complete the Feasibility Study and shall perform the services diligently, in a timely and professional manner, and to the best of its ability, and in such a manner as is customarily performed by a person who is in the business of providing such services in similar circumstances.

2.3 Delivery of Study Results. TMWA shall provide the Parties with updates on the Feasibility Study as work progresses and upon completion of the Feasibility Study shall prepare and provide a report to each of the Parties setting forth information on the data collected and any conclusions drawn from the completion of the Feasibility Study.

3. REIMBURSEMENT OF COSTS

3.1 Allocation of Cost Share. Each Party shall be responsible for twenty five percent (25%) of the actual costs incurred by TMWA to perform and complete the Feasibility Study (TMWA staff time shall be excluded from costs); provided, unless agreed otherwise in writing the cost responsibility of Reno, Sparks and Washoe County shall not exceed $400,000 each. Unless otherwise agreed by the Parties, TMWA shall be responsible for any costs in excess of $1,600,000, but TMWA shall have the discretion to modify the scope of work or elements of the Feasibility Study as necessary to avoid cost overruns in excess of $1,600,000. Should TMWA desire to modify the scope of work or elements of the Feasibility Study for any other purpose, then TMWA shall notify and receive prior approval from the Parties.

3.2 Payment of Invoices. TMWA shall submit invoices to the Parties on a monthly or other regular basis for activities completed and payment of the Party's share of reimbursable costs. Each Party shall promptly review the invoice, request any further information or documentation required, and process the invoice for payment to TMWA within thirty (30) days following receipt.

3.3 Backup Information. TMWA shall, through its designated representative or Contract Administrator, provide to the Parties any information requested relating to any invoice submitted for payment. TMWA shall set up a separate account for the Feasibility Study, if not already existing, so that check numbers along with copies of cancelled checks for all expenditures can be submitted, as well as an exact itemization of Feasibility Study expenditures, copies of itemized invoices, and properly documented timesheets.

4. COOPERATION.

Reno, Sparks and Washoe County shall work cooperatively and collaboratively with TMWA to facilitate the Feasibility Study, including sharing data reasonably relevant to the Feasibility Study, working cooperatively on all public outreach, engagement, and education regarding the intent and scope of the Feasibility Study and the direct and indirect benefits to the region, Reno, Sparks, and Washoe County, communications with regulatory agencies (including the Nevada Division of Environmental Protection, Nevada Department of Transportation and Nevada Division of Water Resources), applications for grant or other funding available to support the Feasibility Study, and providing survey and right of way assistance and engineering support (including phasing, cost estimating, pipeline sizing, cost options) for potential future implementation of projects related to the Feasibility Study.

5. INDEMNIFICATION.

Subject to the limitations of Chapter 41 of the Nevada Revised Statutes, each party agrees to indemnify, defend and hold harmless the other party from and against any liability including, but not limited to, property damage and personal injury or death, proximately caused by the negligent acts or omissions of its officers, agents and employers arising out of the performance of this Agreement. Contract liability of the Parties shall not be subject to punitive damages. Liquidated damages shall not apply unless otherwise specified in this Agreement or any incorporated attachments. Damages for any breach by Reno, Sparks or Washoe County shall never exceed the amount of funds appropriated for payment under this Agreement, but not yet paid to TMWA, for the fiscal year budget in existence at the time of the breach.

6. MISCELLANEOUS PROVISIONS

6.1 This Agreement is binding upon and inures to the benefit of the Parties and their respective heirs, estates, personal representatives, successors and assigns.

6.2 This Agreement is made in, and shall be governed, enforced and construed under the laws of the State of Nevada

6.3 This Agreement constitutes the entire understanding and agreement of the Parties with respect to the subject matter hereof, and supersedes and replaces all prior understandings and agreements, whether verbal or in writing, with respect to the subject matter hereof. This Agreement shall not be construed to provide any person or entity not a party to this Agreement with any benefits or cause of action arising from the performance of this Agreement.

6.4 This Agreement may not be modified or amended in any respect, except pursuant to an instrument in writing duly executed by the Parties.

6.5 Each Party shall endeavor to include funding for this Feasibility Study in its FY 2022 budget. In the event any Party fails to appropriate or budget funds for the purposes as specified in this Agreement, each Party hereby consents to the termination of this Agreement as to such Party. In such event, the terminating Party shall notify the other Parties in writing and the Agreement will terminate as to such Party on the date specified in the notice. The Parties understand that this funding out provision is required under NRS 354.626.

6.6 No delay or omission by any Party in exercising any right or power under this Agreement shall impair any such right or power or be construed to be a waiver thereof, unless this Agreement specifies a time limit for the exercise of such right or power or unless such waiver is set forth in a written instrument duly executed by the person granting such waiver. A waiver of any person of any of the covenants, conditions, or agreements hereof to be performed by any other Party shall not be construed as a waiver of any succeeding breach of the same or any other covenants, agreement, restrictions or conditions hereof.

6.7 This Agreement may be executed in separate and multiple counterparts, each of which is deemed an original, but all of which taken together constitute one and the same instrument.

6.8 All notices, demands or other communications required or permitted to be given in connection with this Agreement shall be in writing, and shall be deemed delivered when personally delivered to a Party; when sent to a Party by electronic mail and same day U.S. regular mail with U.S. Postal Service Certificate of Mailing; or, if only mailed, three (3) business days after deposit in the United States mail, postage prepaid, certified or registered mail, addressed to the Parties as follows:

To TMWA: Truckee Meadows Water Authority
Attn: John Enloe
Director of Natural Resources Planning & Management
1355 Corporate Blvd.
Reno, Nevada 89502
jenloe@tmwa.com

To County: Dwayne E. Smith
Director, Engineering and Capital Projects

1001 Ninth St.,
Reno, NV 89512
desmith@washoecounty.us

To Reno: John Flansberg
Director of Public Works
City of Reno
P.O. Box 1900
Reno, Nevada 89501
flansbergj@reno.gov

To Sparks: John A. Martini
Assistant City Manager
City of Sparks
P.O. Box 857
Sparks, Nevada 89432-0857
jmartini@cityofsparks.us

6.9 This Agreement is effective on the latest date executed by the last Party to sign this Agreement below (Effective Date).

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed by their authorized officers the day and year written below.

TRUCKEE MEADOWS WATER AUTHORITY

Mark Foree

Mark Foree, General Manager

Date: MAY 27, 2021

APPROVED AS TO FORM:

Michael Pagni, General Counsel

[*Additional Signature Pages Follow*]

CITY OF RENO

By: ______________________________
Hillary L. Schieve, Mayor

Date: 6/28, 2021

APPROVED AS TO FORM:

____
Susan Ball Rothe, Deputy City Attorney

ATTEST:

____
Ashley D. Turney, Reno City Clerk

[*Additional Signature Pages Follow*]

CITY OF SPARKS

DocuSigned by:

By Ed Lawson

2FF0422E72AA4D1...

Ed Lawson, Mayor

Date: June 14, 2021

ATTEST:

DocuSigned by:

8EE531DAF649409...

Sparks City Clerk
Lisa Hunderman

APPROVED AS TO FORM:

DocuSigned by:

Chet Adams

C89FEF96A9C4416...

Chester H. Adams
City Attorney

[*Additional Signature Pages Follow*]

WASHOE COUNTY

By: ______________________
Robert Lucey, Chair

Date: JUNE 8, 2021

ATTEST:

Jan Galassini
County Clerk

APPROVED AS TO FORM:

____
Deputy Attorney

EXHIBIT A
PALOMINO FARMS, LLC Land

No.	APN	Address	Acreage
1	077-090-03	5555 Sage Flat Road	60.18 acres
2	077-090-07	0 Youngs Road	48.96 acres
3	077-090-13	0 Whiskey Springs Road	539.53 acres
4	077-090-14	0 Sage Flat Road	204.45 acres
5	077-090-15	5800 Whiskey Springs Road	40.97 acres
6	077-340-04	0 Whiskey Springs Road	63.57 acres
7	077-340-05	0 Whiskey Springs Road	64.27 acres
8	077-340-44	0 Youngs Road	46.73 acres
9	077-340-45	0 Unspecified	46.54 acres

PALOMINO FARMS, LLC Groundwater Rights

Permit No.	Cert. No.	Acre-Feet
23888	8283	53.08
53304	12898	4.59
53306	12900	20.40
53307	12901	32.12
53308	12902	127.88
	Subtotal	238.07
57085	14078	92.52
57086	14032	112.40
57087	14033	102.49
57088	14034	9.08
57089	14035	9.08
57095	14041	127.60
58507	14042	8.96
58508	14043	52.00
58509	14044	2.60
75473	18348	114.80
	Subtotal	519.96*
57084	14031	409.48
57090	14036	57.32
57091	14037	57.32
57092	14038	68.80
57093	14039	86.00
57094	14040	150.60
	Subtotal	772.20**
	Total	**1,530.23**

*The permit terms state that the total combined duty of permits 57085-57089, 57095, 58507-58509, and 75473 is limited to 519.96 acre-feet.
**The permit terms state that the total combined duty of permits 57090-57092, 57093, and 57094 is limited to 772.20 acre-feet.

EXHIBIT A, CONT'D

PALOMINO FARMS, LLC Surface Water Rights

Permit No.	Cert. No.	Acre-Feet
V02333	NA	540
11653	3663	327
11654	3664	360
15326	5055	590
15327	5007	68.64
	Total	**2,155.64**

EXHIBIT B
LW LAND COMPANY, LLC Land

No.	APN	Address	Acreage
1	077-100-01	0 Youngs Road	40.27 acres
2	077-100-02	0 Youngs Road	40.39 acres
3	077-100-07	0 Grass Valley Road	40.35 acres
4	077-100-08	0 Grass Valley Road	40.24 acres
5	077-100-09	0 Grass Valley Road	40.2 acres
6	077-100-10	0 Grass Valley Road	40.32 acres
7	077-130-23	0 Grass Valley Road	67.6 acres
8	077-200-05	5855 Youngs Road	49.2 acres

LW LAND COMPANY, LLC Water Rights

Permit No.	Cert. No.	Acre-Feet
55603	14068	164.32
55604	14069	23.36
55605	14070	7.40
55606	14071	304.68
55607	14072	47.60
	Total	**524***

* The permit terms state that the total combined duty of permits 55603-55607 is limited to 524 acre-feet

EXHIBIT C

Palomino Farms Sustainable Water Resource Feasibility Study

Feasibility Study Budget Summary

Task		Cost Estimate
Well Videos and Contractor-Assisted Well Sampling		$60,000
Existing Production Well Flow and Quality Profiles (4)		$120,000
Deep Sonic Core Boring and 2" Monitoring Wells (2)		$150,000
Deep Mud Rotary 6" Monitoring Wells (6) to 600'		$510,000
6" Monitoring Well Flow and Quality Profiles (5)		$175,000
Water Quality Analyses		$15,000
Soil Lab Analyses		$10,000
Geochemistry Assessment		$200,000
	Subtotal	$1,240,000
Engineering, Surveying, and R/W Research		$160,000
	Contingency	$200,000
	TOTAL	**$1,600,000**

FEASIBILITY STUDY AGREEMENT

This Feasibility Study Agreement is entered into as of May __, 2021 between TRUCKEE MEADOWS WATER AUTHORITY, a Joint Powers Authority entity created pursuant to a cooperative agreement among the cities of Reno, Nevada, Sparks, Nevada and Washoe County, Nevada, pursuant to NRS Ch. 277 (TMWA) and PALOMINO FARMS, LLC, a Nevada limited liability company (Palomino Farms), and LW LAND COMPANY, LLC, a Nevada limited liability company (LW Land) (collectively, Palomino-LW). TMWA, Palomino Farms, and LW Land may be referred to under this Agreement individually as a Party or collectively as the Parties.

RECITALS

A. TMWA is a public purveyor of water service within Reno, Sparks, and portions of Washoe County, Nevada.

B. Palomino-LW collectively own approximately 1,484 acres of farmland and 2,580 acre-feet (AF) of groundwater rights in Warm Springs Valley, Nevada, which land and water rights are more-specifically described on the attached <u>Exhibits A and B</u>, which land is hereinafter referred to as the Palomino-LW Land, and which water rights are hereinafter referred to as the Palomino-LW Water Rights.

C. A portion of the Palomino-LW Land and all of the Palomino-LW Water Rights are under lease for irrigation purposes through two separate farm lease agreements (collectively, the Leases).

D. As operators of wastewater reclamation facilities in Reno and Sparks, with respect to the Truckee Meadows Wastewater Reclamation Facility (TMWRF), and Washoe County with respect to the South Truckee Meadows Wastewater Reclamation Facility (STMWRF), Reno, Sparks, and Washoe County are interested in exploring long-term opportunities to use recycled water for agricultural irrigation rather than discharging it to surface waters, such as the Truckee River.

E. TMWA, as the purveyor of potable water service in Reno, Sparks and portions of Washoe County, is interested in locating sites where it may bank water through active and passive groundwater recharge, and also groundwater resources, to provide an additional source of water for drought protection, water resource sustainability, and operational flexibility.

F. Under the auspices of OneWater Nevada, a collaboration between TMWA, Reno, Sparks, Washoe County, the University of Nevada, Reno and other local government entities, with the cooperation of Palomino-LW, a study is proposed to evaluate the long-term feasibility of using recycled water from TMWRF and STMWRF to irrigate the Palomino-LW Land in lieu of the Palomino-LW Water Rights (the “Feasibility Study”).

G. The Feasibility Study will evaluate the feasibility and direct and indirect benefits of (i) providing another option for regional effluent management, (ii) reducing the volume of treated effluent being discharged into the Truckee River, (iii) the long-term delivery of recycled water for permanent use for irrigation or other beneficial uses on the Palomino-LW Land, (iv) increasing the sustainability of the Warm Springs groundwater basin by resting current irrigation wells, (v) recharging and storing on a long-term basis potable water and potentially advanced purified water in the Warm Springs groundwater basin using rapid infiltration basins or injection wells on Palomino-LW Land, and (vi) providing TMWA with a water banking site and an additional source of water for drought protection, water resource sustainability, and operational flexibility (collectively, the "Project").

H. Depending on the results of the Feasibility Study, there may also be benefits to Palomino Valley from leaving the Palomino-LW Land as farmland and open space, augmenting the water supply in the Warm Springs groundwater basin, improving area groundwater levels and water quality, and preserving existing farmland and a rural lifestyle. TMWA intends to improve and sustainably manage the water resources for the overall benefit of the regional water supply.

I. TMWA, in collaboration with Reno, Sparks, and Washoe County, intends to perform and pay for all work required to complete the Feasibility Study pursuant to an Interlocal Agreement (ILA) outlining each of their respective obligations and responsibilities regarding the Feasibility Study and the Project, which ILA is attached hereto as Exhibit C. Under the ILA, TMWA, Reno, Sparks, and Washoe County will work together and cooperatively on all public outreach, engagement, and education regarding the intent and scope of the Feasibility Study and the direct and indirect benefits to the region.

J. When this Agreement enters into effect and even prior to the completion of the Feasibility Study, TMWA and Palomino-LW will in good faith attempt to negotiate a five-year option agreement granting TMWA the right to purchase (1) all necessary rights and interests in the Palomino-LW Land and (2) the Palomino-LW Water Rights sufficient to allow TMWA and Reno, Sparks and Washoe County, subject to obtaining necessary permits, the right to implement the following: (i) delivery for permanent use of recycled water for irrigation or other beneficial uses on Palomino-LW Land, (ii) recharge and recover potable water and potentially advanced purified water, and (iii) importation of a sustainable volume of groundwater from the Palomino-LW Water Rights to TMWA's service area.

K. During the option period, TMWA intends to work collaboratively with Reno, Sparks, and Washoe County to determine each of their respective rights and obligations regarding (i) the delivery and use of recycled water on Palomino-LW Land, (ii) recharging and recovering potable water and potentially advanced purified water, (iii) importing a sustainable volume of water from Palomino-LW Water Rights to TMWA's service area, and (iv) the regulatory and financial feasibility of the same.

Accordingly, for good and valuable consideration, the receipt and sufficiency of which is acknowledged, TMWA and Palomino-LW agree as follows:

1. Recitals. The Recitals are incorporated as part of this Agreement as if specifically set forth herein.

2. Effective Date and Term. This Agreement shall not enter into effect until (i) it is approved by the TMWA Board and (ii) the ILA is approved by the TMWA Board and the respective governing boards of Reno, Sparks, and Washoe County (Effective Date). The term of this Agreement is ten (10) months from the Effective Date (Term).

3. <u>Agreement to Perform Study</u>. Subject to and in accordance with the terms of the ILA, TMWA agrees to perform or cause to be performed all of the work needed for the Feasibility Study, at its cost.

4. <u>Grant of Feasibility Study Rights</u>. Palomino Farms and LW Land, each as to their own interest, grant TMWA, and its employees, agents, contractors, and assigns, the following rights:

a. Physical access to the Palomino-LW Land needed to conduct the Feasibility Study during the Term, including permission to perform all physical tests thereon necessary for the Feasibility Study, so long as such access does not interfere with the rights granted by Palomino-LW under the Leases. TMWA shall regularly communicate with, and provide reasonable notice to, Palomino-LW regarding activities on the Palomino-LW Land. A list of TMWA's anticipated activities on the Palomino-LW Land during the course of the Feasibility Study is attached hereto as Exhibit D;

b. To discuss permitting requirements with all regulatory agencies that have or may have jurisdiction over implementation of all or any element of the Project, including, but not limited to, Nevada State Engineer, Washoe County, Nevada Department of Transportation, and Nevada Division of Environmental Protection;

c. Access to all data and information in Palomino-LW's possession or control or obtained during the Term related to the land, wells, and water rights; and

d. Access to information regarding the timing, location, and extent of Palomino-LW's groundwater pumping during the irrigation season as necessary to allow TMWA to conduct the Feasibility Study. Subject to the terms of the Leases, Palomino-LW shall cooperate with TMWA to operate the wells in such a manner as needed by TMWA to conduct the Feasibility Study, provided, however, Palomino-LW shall have sole discretion to control the operation of their wells.

5. <u>Palomino Development Rights, Prohibited Transfers, Memorandum of Agreement</u>. During the Term, Palomino-LW may pursue all entitlements necessary for the development of their properties so long as such activities do not impede TMWA's rights under this Agreement, interfere with the Feasibility Study, impair the ability to obtain permits necessary to implement the Feasibility Study or the Project or any element of the Feasibility Study or Project, or encumber the Palomino-LW Land or Palomino-LW Water Rights. The Parties acknowledge and agree that the existing farming practices will not impede or impair TMWA's rights under this Agreement, interfere with the Feasibility Study, impair the ability to obtain permits necessary to implement the Feasibility Study or the Project or any element of the Feasibility Study or Project. If TMWA believes that Palomino-LW's pursuit of any entitlements will impede or impair the Feasibility Study or Project as described above, then the Parties shall meet and attempt to resolve the potential conflict. Other than the Leases, Palomino-LW shall not transfer, pledge, or otherwise encumber any interest in Palomino-LW Land or Palomino-LW Water Rights during the Term. Palomino-LW consent to TMWA recording a memorandum of this Agreement with the Washoe County Recorder.

6. <u>Cooperation; Further Assurances</u>. Palomino-LW must cooperate with TMWA in good faith and provide all necessary approvals required by regulatory agencies to conduct the Feasibility Study. During the course of the Feasibility Study, and any applicable option period, TMWA shall regularly provide to Palomino-LW all data, results, reports and conclusions derived from the Feasibility Study and will provide Palomino-LW with any final report issued pursuant to the Feasibility Study. If the Parties do not enter into an option agreement, then within 30 days after the end of the Term, TMWA must provide Palomino-LW with any data, results, reports and conclusions derived from the Feasibility Study that were not provided during the Term. Palomino-LW and TMWA agree to do such further acts and to execute and deliver to the other such additional documents and instruments as the other may reasonably require or deem advisable in order to carry into effect the purposes of this Agreement.

7. <u>Study Cost; Hold Harmless</u>. TMWA shall be responsible for all work and costs related to completing the Feasibility Study and must indemnify, defend and hold Palomino-LW harmless from any liability caused by TMWA, or its agents, contractors, and assignees, in carrying out any work on Palomino-LW's Land related to the Feasibility Study, as further specified in Section 14.

8. <u>Good-Faith Negotiation of Option Agreement</u>.

a. During the term of this Agreement, the Parties shall in good faith negotiate and attempt to execute a five-year option agreement granting TMWA the right to purchase (1) all necessary rights and interests in the Palomino-LW Land and (2) the Palomino-LW Water Rights sufficient to allow TMWA and Reno, Sparks and Washoe County, subject to obtaining necessary permits, the right to implement the following: (i) delivery of recycled water for permanent use for irrigation or other beneficial uses on Palomino-LW Land, (ii) recharge and recover potable water and potentially advanced purified water, and (iii) importation of a sustainable volume of groundwater from the Palomino-LW Water Rights to TMWA's service area. These interests include, but are not limited to, an easement or other real property interest for the construction and operation of a future advanced purified water treatment facility, injection wells, production wells, pump stations, and associated pipelines and other water facilities necessary to implement the Project.

b. The Parties agree that the total purchase price for the above-described interests in the Palomino-LW Land and Palomino-LW Water Rights under the option shall be $27,000,000 and any option payments shall be applied toward the purchase price. The option must reserve to Palomino-LW the right to use the Palomino-LW Land for any activity so long as such activity does not adversely impact and is consistent with the Project. Such activities may take place directly by Palomino-LW, through an agreement or lease with a third party, by encumbering the Palomino-LW Land with a conservation easement, or such other activity that does not adversely impact and is consistent with the Project.

9. <u>Remediation; No Liens or Encumbrances</u>. TMWA shall restore the Palomino-LW Land disturbed by any work related to the Feasibility Study to its original condition before such disturbance, except for ordinary wear and tear. TMWA shall keep the Palomino-LW Land free and clear of any materialmen's liens arising from any work done by TMWA's third-party contractors. If a workman's or materialman's lien is imposed upon the Palomino-LW Land because of a claim which TMWA is contesting, within sixty (60) days of the filing of such lien, TMWA will take such measures as provided by law to cause the discharge of the lien, including obtaining a bond therefor. TMWA shall plug and abandon, at its cost and in accordance with all State Engineer requirements, all exploratory wells drilled on Palomino-LW Land unless the individual owner of the land on which the well is located (either Palomino Farms or LW Land) requests that the well remain unplugged for its future use and provided TMWA is legally authorized to comply with such request without violating any laws or regulations related to such well. As to any well left unplugged at Palomino Farms or LW Land's request, the owner of the land on which the well is located shall indemnify, hold harmless, and defend TMWA against any claims related to such well from the date the owner requests such well to remain unplugged.

10. <u>Representations and Warranties of Palomino Farms</u>. As a material inducement to TMWA to enter into this Agreement, Palomino Farms represents and warrants to TMWA as follows:

a. <u>Organization and Power</u>. It is a duly organized, validly existing, and authorized to conduct business under the laws of the State of Nevada and has full power and authority to enter into and perform its obligations under this Agreement. This Agreement and all other documents delivered by Palomino Farms to TMWA, have been or will be duly executed and delivered by it and are or will be legal, valid, and binding obligations of Palomino Farms, and are enforceable in accordance with their respective terms, subject to applicable bankruptcy, insolvency and similar laws affecting the rights of creditors generally, and general principles of equity. Each of the persons signing this Agreement and other instruments required under this Agreement on behalf of Palomino Farms is or will be authorized to so sign; and the execution, consent or acknowledgment of no other person, entity, court or governmental authority is necessary in order to validate the execution and performance of this Agreement by Palomino Farms.

b. <u>Property, Title and Related Matters</u>. Palomino Farms owns all right, title, and interest in the land and water rights described on Exhibits A and B as being owned by Palomino Farms and other than the Leases, such land and water rights are free and clear of all security interests, mortgages, liens, pledges, charges, claims, or encumbrances of any kind or character and Palomino Farms has not, and will not sell, encumber, pledge, assign, convey or transfer any interest in such land and water rights during the Term.

c. <u>Transferability</u>. Palomino Farms has no knowledge of any condition or fact related to its land and water rights, which would prevent or impede the Feasibility Study.

d. <u>No Litigation</u>. There are no pending or to the best of Palomino Farms' knowledge threatened actions which would materially and adversely affect its land and water rights or the Feasibility Study.

e. No Misstatement. No representation, statement or warranty by Palomino Farms contained in this Agreement or in any exhibit hereto contains or will contain any untrue statements or omits, or will omit, any material fact necessary to make the statement of fact recited not misleading.

f. No Agreements. Neither the execution and delivery of this Agreement by Palomino Farms nor the consummation of the transactions contemplated hereby will result in any breach or violation of or default under any judgment, decree, order, mortgage, lease, agreement, indenture or other instrument to which Palomino Farms is a party or to which it is bound.

11. Representations and Warranties of LW Land. As a material inducement to TMWA to enter into this Agreement, LW Land represents and warrants to TMWA as follows:

a. Organization and Power. It is a duly organized, validly existing, and authorized to conduct business under the laws of the State of Nevada and has full power and authority to enter into and perform its obligations under this Agreement. This Agreement and all other documents delivered by LW Land to TMWA, have been or will be duly executed and delivered by it and are or will be legal, valid, and binding obligations of LW Land, and are enforceable in accordance with their respective terms, subject to applicable bankruptcy, insolvency and similar laws affecting the rights of creditors generally and general principles of equity. Each of the persons signing this Agreement and other instruments required under this Agreement on behalf of LW Land is or will be authorized to so sign; and the execution, consent or acknowledgment of no other person, entity, court or governmental authority is necessary in order to validate the execution and performance of this Agreement by LW Land.

b. Property, Title and Related Matters. LW Land owns all right, title, and interest in the land and water rights described on Exhibits A and B as being owned by LW Land and other than the Leases, such land and water rights are free and clear of all security interests, mortgages, liens, pledges, charges, claims, or encumbrances of any kind or character and LW Land has not, and will not sell, encumber, pledge, assign, convey or transfer any interest in such land and water rights during the Term.

c. Transferability. LW Land has no knowledge of any condition or fact related to its land and water rights, which would prevent or impede the Feasibility Study.

d. No Litigation. There are no pending or to the best of LW Land's knowledge threatened actions which would materially and adversely affect its land and water rights or the Feasibility Study.

e. No Misstatement. No representation, statement or warranty by LW Land contained in this Agreement or in any exhibit hereto contains or will contain any untrue statements or omits, or will omit, any material fact necessary to make the statement of fact recited not misleading.

f. No Agreements. Neither the execution and delivery of this Agreement by Palomino Farms nor the consummation of the transactions contemplated hereby will result in any breach or violation of or default under any judgment, decree, order, mortgage, lease, agreement, indenture or other instrument to which Palomino Farms is a party or to which it is bound.

12. <u>TMWA Representations and Warranties</u>. As a material inducement to Palomino Farms and LW Land to enter into this Agreement, TMWA represents and warrants to the Palomino Farms and LW Land as follows:

a. <u>Organization and Power</u>. TMWA is duly organized, validly existing and authorized to conduct business under the laws of the State of Nevada and has full power and authority to enter into and perform its obligations under this Agreement. This Agreement and all other documents delivered by TMWA, have been or will be duly executed and delivered by TMWA and are or will be legal, valid and binding obligations of TMWA, and are enforceable in accordance with their respective terms, subject to applicable bankruptcy, insolvency and similar laws affecting the rights of creditors generally and general principles of equity. Each of the persons signing this Agreement and other instruments required under this Agreement on behalf of TMWA is or will be authorized to so sign; and the execution, consent or acknowledgment of no other person, entity, court or governmental authority is necessary in order to validate the execution and performance of this Agreement by TMWA.

b. <u>No Misstatement</u>. No representation, statement or warranty by TMWA contained in this Agreement or in any exhibit hereto contains or will contain any untrue statements or omits, or will omit, any material fact necessary to make the statement of fact recited not misleading.

c. <u>No Agreements</u>. Neither the execution and delivery of this Agreement by TMWA nor the consummation of the transactions contemplated hereby will result in any breach or violation of or default under any judgment, decree, order, mortgage, lease, agreement, indenture or other instrument to which TMWA is a party, or to which it is bound.

13. <u>Insurance</u>. During the Term, TMWA must maintain a commercial general liability (CGL) insurance policy as provided in this Section to cover it and its third-party contractors' access and use of Palomino-LW's land for the Feasibility Study. The commercial general liability insurance policy and, if necessary commercial excess or umbrella insurance, shall have a limit of liability of not less than $1,000,000 each occurrence and must name Palomino-LW as additional insureds.

14. <u>Indemnification</u>.

a. TMWA shall indemnify, defend and hold harmless Palomino-LW and their owners, parents, subsidiaries and affiliates, together with each of their respective officers, directors, shareholders, agents, representatives, employees, licensees, successors and assigns (collectively, the Palomino-LW Parties) from and against any and all demands, suits, causes of action, liabilities, notices of alleged regulatory violations issued by any Federal, state, or local government agency, judgments, damages, costs and expenses (including reasonable attorneys' fees and court costs) (collectively, Damages) incurred in connection with any claim asserted by a third party against any of the Palomino-LW Parties arising out of, resulting from or in any way related to (i) the actual or alleged breach by the TMWA Parties (as defined below) of any representation, warranty or covenant under this Agreement; (ii) the actual or alleged negligence or willful misconduct of the TMWA Parties and their contractors and vendors, and (iii) notices of alleged regulatory violations by Federal, state, or local government agency. The Parties agree, however, that TMWA will not be obligated to indemnify any Palomino-LW Party from or against any Damages to the extent resulting from (A) the negligence or willful misconduct of the Palomino-LW Party seeking to be indemnified, (B) a breach of the Agreement by Palomino-LW, (C) any pre-existing or latent condition at the Palomino-LW Land, or due to TMWA's compliance with any instructions from Palomino-LW, or (D) any condition at the Palomino-LW Land not created or caused by any of the TMWA Parties or their contractors and vendors.

b. Palomino-LW shall indemnify, defend and hold harmless TMWA and its officers, directors, agents, representatives, employees, licensees, successors and assigns (collectively, TMWA Parties) from and against any and all Damages incurred in connection with any claim asserted by a third party against any of the TMWA Parties arising out of, resulting from or in any way related to: (i) the Palomino-LW business activities and any condition at the Palomino-LW Land not created or caused by any of the TMWA Parties; (ii) the actual or alleged breach by Palomino-LW of any representation, warranty or covenant under this Agreement; or (iii) the actual or alleged negligence or willful conduct of the Palomino-LW Parties and their contractors and vendors. The Parties agree, however, that Palomino-LW will not be obligated to indemnify any TMWA Party from or against any Damages to the extent resulting from (A) the negligence or willful misconduct of the TMWA Party seeking to be indemnified, (B) a breach of this Agreement by TMWA, or (C) compliance with reasonable written instructions provided by any authorized TMWA Party.

c. Each party will provide the other with notice of any Damages promptly upon gaining knowledge of the related third-party claim, provided that the indemnified party's failure to do so will not relieve the indemnifying party of its obligations hereunder except to the extent it is materially prejudiced thereby. The indemnifying party will solely control the defense of any such claim, but will consult with, the indemnified party regarding such defense provided that (i) the indemnified party will reasonably cooperate in such defense at the indemnifying party's request and sole cost and expense, (ii) subject to the foregoing, the indemnified party may participate in the defense of any such claim with its own counsel at the indemnified party's sole cost and expense. Neither party will settle any claim for which it is providing indemnification to the other party without the prior written consent of the indemnified party, such consent not to be unreasonably withheld, conditioned or delayed; provided that it is not unreasonable to withhold consent to any proposed settlement that would require the indemnified party to admit fault or liability and/or pay any monetary settlement. The indemnification and insurance provisions contained in this Agreement will survive the expiration or earlier termination of the Agreement.

15. <u>Compliance with Laws</u>. All work by or on behalf of TMWA on the Palomino-LW Land must be conducted in compliance with all applicable Federal, state and local laws, rules, regulations, and ordinances, including but not limited to all rules, regulations and procedures of the applicable utility and local government with jurisdiction over such work. TMWA shall be solely responsible for any penalties, fines or other liabilities associated with notices of alleged regulatory violations issued by any Federal, state, or local government agency to the extent created or caused by TMWA or its agents.

16. Default, Opportunity to Cure. If any Party defaults on their obligations under this Agreement, then the other Party shall send written notice of such default, which notice must clearly describe the default and the steps to take to cure it. If the defaulting Party (i) fails to cure the default within 15 days of receiving the notice of default or (ii), for defaults that cannot reasonably be cured within 15 days, fails to take all necessary steps to cure the default within 15 days of receiving notice and diligently work to cure the default within a reasonable time period, then the non-defaulting Party may, at its option, terminate this Agreement.

17. MISCELLANEOUS.

a. Assignment. The Parties shall not assign their interest under this Agreement without all Parties' advance written consent, which may be withheld in any Party's sole discretion.

b. Notices. Any notice, demand, request, consent, approval, or communication that either party desires or is required to give to the other shall be sent by email as follows and shall be deemed to have been given on receipt of the email:

To TMWA: John Enloe
jenloe@tmwa.com
(775) 834-8250

To Palomino: Michael Benjamin
mikebenjamin@mac.com
(702) 499-7404

c. Severability; Modification; No Third-Party Beneficiaries. If any term, provision, covenant, condition, or restriction of this Agreement is held by a court of competent jurisdiction to be unlawful, invalid, void, unenforceable, or not effective, the remainder of this Agreement shall remain in full force and effect and shall in no way be affected, impaired, or invalidated. This Agreement constitutes the entire contract between the Parties and shall not be modified unless in writing and signed by the parties. This Agreement shall not be construed to provide any person or entity not a party to this Agreement with any benefits or cause of action arising from the performance of this Agreement.

d. Time. Time is of the essence in the performance of all obligations under this Agreement.

e. Nevada Law. The validity, interpretation and performance of this Agreement shall be controlled and governed by and construed under the laws of the State of Nevada, without regard to its conflicts of law principles.

f. Counterparts. This Agreement may be executed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument. Legible executed counterparts of this Agreement may be delivered by facsimile, PDF e-mail attachment, or any other electronic means.

g. Inurement. This Agreement shall be binding on and shall inure to the benefit of the parties hereto and their respective heirs, legal representatives, successors and/or assigns.

h. Entire Agreement. This Agreement contains the sole and only agreement between the parties hereto relating to their agreement regarding the subject matters and correctly sets forth the rights, duties and obligations of each to the other as of this date. Any prior agreements, promises, negotiations or representations not expressly set forth in this Agreement are of no force and effect.

The Parties have executed this Agreement as of the date first above written.

TRUCKEE MEADOWS WATER AUTHORITY, a Joint Powers Authority

By: Mark Foree
Mark Foree, General Manager

Dated: May 20, 2021

Palomino Farms, LLC, a Nevada limited liability company

By: ______________________________
Michael Benjamin, Manager

Dated: ______________________________

LW Land Company, LLC, a Nevada limited liability company

By: ______________________________
Brian Murphy, Manager

Dated: ______________________________

one and the same instrument. Legible executed counterparts of this Agreement may be delivered by facsimile, PDF e-mail attachment, or any other electronic means.

g. Inurement. This Agreement shall be binding on and shall inure to the benefit of the parties hereto and their respective heirs, legal representatives, successors and/or assigns.

h. Entire Agreement. This Agreement contains the sole and only agreement between the parties hereto relating to their agreement regarding the subject matters and correctly sets forth the rights, duties and obligations of each to the other as of this date. Any prior agreements, promises, negotiations or representations not expressly set forth in this Agreement are of no force and effect.

The Parties have executed this Agreement as of the date first above written.

TRUCKEE MEADOWS WATER AUTHORITY, a Joint Powers Authority

By: Mark Foree
Mark Foree, General Manager

Dated: May 20, 2021

Palomino Farms, LLC, a Nevada limited liability company

By: mB
Michael Benjamin, Manager

Dated: July 21, 2021

LW Land Company, LLC, a Nevada limited liability company

By: Brian Murphy
Brian Murphy, Manager

Dated: July 21, 2021

EXHIBIT A
PALOMINO FARMS, LLC Land

No.	APN	Address	Acreage
1	077-090-03	5555 Sage Flat Road	60.18 acres
2	077-090-07	0 Youngs Road	48.96 acres
3	077-090-13	0 Whiskey Springs Road	539.53 acres
4	077-090-14	0 Sage Flat Road	204.45 acres
5	077-090-15	5800 Whiskey Springs Road	40.97 acres
6	077-340-04	0 Whiskey Springs Road	63.57 acres
7	077-340-05	0 Whiskey Springs Road	64.27 acres
8	077-340-44	0 Youngs Road	46.73 acres
9	077-340-45	0 Unspecified	46.54 acres

PALOMINO FARMS, LLC Groundwater Rights

Permit No.	Cert. No.	Acre-Feet
23888	8283	53.08
53304	12898	4.59
53306	12900	20.40
53307	12901	32.12
53308	12902	127.88
	Subtotal	238.07
57085	14078	92.52
57086	14032	112.40
57087	14033	102.49
57088	14034	9.08
57089	14035	9.08
57095	14041	127.60
58507	14042	8.96
58508	14043	52.00
58509	14044	2.60
75473	18348	114.80
	Subtotal	519.96*
57084	14031	409.48
57090	14036	57.32
57091	14037	57.32
57092	14038	68.80
57093	14039	86.00
57094	14040	150.60
	Subtotal	772.20**
	Total	**1,530.23**

*The permit terms state that the total combined duty of permits 57085-57089, 57095, 58507-58509, and 75473 is limited to 519.96 acre-feet.
**The permit terms state that the total combined duty of permits 57090-57092, 57093, and 57094 is limited to 772.20 acre-feet.

EXHIBIT A, CONT'D

PALOMINO FARMS, LLC Surface Water Rights

Permit No.	Cert. No.	Acre-Feet
V02333	NA	540
11653	3663	327
11654	3664	360
15326	5055	590
15327	5007	68.64
	Total	**2,155.64**

EXHIBIT B
LW LAND COMPANY, LLC Land

No.	APN	Address	Acreage
1	077-100-01	0 Youngs Road	40.27 acres
2	077-100-02	0 Youngs Road	40.39 acres
3	077-100-07	0 Grass Valley Road	40.35 acres
4	077-100-08	0 Grass Valley Road	40.24 acres
5	077-100-09	0 Grass Valley Road	40.2 acres
6	077-100-10	0 Grass Valley Road	40.32 acres
7	077-130-23	0 Grass Valley Road	67.6 acres
8	077-200-05	5855 Youngs Road	49.2 acres

LW LAND COMPANY, LLC Water Rights

Permit No.	Cert. No.	Acre-Feet
55603	14068	164.32
55604	14069	23.36
55605	14070	7.40
55606	14071	304.68
55607	14072	47.60
	Total	**524***

* The permit terms state that the total combined duty of permits 55603-55607 is limited to 524 acre-feet

PALOMINO FARMS SUSTAINABLE WATER RESOURCE FEASIBILITY STUDY

Prepared by:

Greg Pohll, Ph.D., Christian Kropf, Nick White, Lydia Teel Ph.D., Lauren Jones, Ben Bardet, and David Nelson

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March 2022

Executive Summary

The Palomino Farms Sustainable Water Resource Feasibility Study (Study) is part of a regional effort to optimize and expand available water resources, research resource innovations and advanced water treatment technologies, and develop innovative and integrated water solutions for regional needs.

The Study explores the coordinated use of surface water, groundwater, and recycled water (known as conjunctive use) to help meet water supply needs. The Study is focused on determining the viability of bringing water to the Palomino Farms and Warm Springs areas as part of a long-term sustainable water management plan. More specifically, the feasibility study is investigating the option of bringing recycled water to Palomino Valley for irrigation of the Palomino Farms and potentially other farmland, to significantly reduce reliance on groundwater. As an additional part of the study, potable surface water supplied by the Truckee Meadows Water Authority (TMWA) could be brought in through a separate pipeline and injected to replenish the Palomino Valley aquifer in the winter when Truckee River water is more plentiful. Stored water could be used to support Spanish Springs during peak summer demands or during droughts.

An extensive hydrogeologic investigation was conducted as part of the Study including 1) reviewing previous hydrogeologic investigations, 2) collecting additional data on lithology, aquifer hydraulic parameters, borehole geophysics, water quality and geochemistry, 3) development of a hydrogeologic conceptual model for Warm Springs Valley, 4) development of a numerical groundwater flow and transport model, 5) development of a geochemical model to evaluate the compatibility of potable and recycled water mixing with ambient groundwater.

The Study developed a hydrogeologic conceptual model of the Warm Springs Valley hydrographic area. The key components of the conceptual model include 1) northwest-southeast oriented high permeability (1 – 100 feet per day) aquifer in the central portion of the valley, 2) groundwater recharge from infiltration of precipitation (2,600 acre-feet per year), 3) groundwater discharge as evapotranspiration (2,500 acre-feet per year under predevelopment conditions), pumping (as much as 5,000 acre-feet per year), and small amounts of interbasin flow through Mullen Pass and to Spanish Springs, 4) elevated concentrations of nitrate in groundwater from naturally occurring soil nitrogen, 5) elevated concentrations of arsenic due to geothermal outflow and potentially desorption from aquifer sediments following potable water injection.

Sediment profiles indicate that the lithology is highly heterogeneous with no apparent continuous fine-grained, low permeability unit in the project area. Without a continuous confining bed, the aquifer was found to be unconfined.

Pumping at high capacity irrigation wells caused groundwater levels to decline over 125 feet since the 1960s. The drawdown trough as defined by the 25 foot contour is eight miles long and two miles wide.

A significant amount of residual nitrate mass occurs in the vadose zone beneath previously irrigated fields. Total nitrate mass beneath all previously irrigated fields is estimated to be 4.9 million pounds.

Nitrogen and oxygen isotopes of nitrate were used to identify the source of nitrogen in groundwater. The source of nitrate was found to be naturally occurring soil nitrate derived from long-term accumulation of precipitation in the vadose zone.

Nitrate concentrations have exceeded the Environmental Protection Agency's Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L) throughout large portions of the agricultural area. After initial agricultural development in the 1960s, nitrate concentrations increased significantly and by the mid-1980s nearly 1,500 acres beneath the agricultural area had concentrations above the MCL because of nitrate flushing beneath irrigated fields. By 2021, the area with concentrations exceeding the MCL reduced to less than 200 acres.

Arsenic concentrations exceed the MCL (10 ug/L) along the west and southern portions of Warm Springs Valley and are attributed to geothermal outflow zones with highest arsenic concentrations being located near Ironwood Road along the western margin of the valley.

Leaching and column experiments with aquifer sediments and geochemical modeling indicate that arsenic concentrations may increase following injection of potable water. Arsenic concentrations may increase from 3 – 4 ug/L due to dissolution of arsenic bound to soil particles.

A groundwater flow model was developed for the Warm Springs Valley aquifer system. Simulated groundwater level trends are in excellent agreement with measured values with a mean absolute error of 18 feet and a relative error of 1.4 percent.

From a hydraulic perspective, the project area is a viable site for an Aquifer Storage and Recovery (ASR) project. The hydraulic conductivity in the alluvial aquifer is large enough for direct injection of 1,300 acre-feet per year in three wells for a total storage of 45,000 acre-feet. Undesirable shallow groundwater conditions are not predicted in the next 50 years if municipal pumping is a least equal to 1,300 acre-feet per year.

The sustainable net municipal pumping rate for the project area is 1,200 acre-feet per year. This is in addition to continued pumping of 871 acre-feet per year of pumping for agricultural irrigation, domestic, stock, recreational, and quasi-municipal uses. Groundwater extraction for environmental uses continues, but this water is reinjected and not consumed.

A groundwater nitrate transport model predicts elevated nitrate concentrations in the project area as groundwater levels rise and encroach on residual nitrate in the vadose zone. Peak nitrate concentrations in proposed municipal wells will likely exceed the MCL and could exceed 20 mg/L. Nitrate issues could be mitigated with treatment and/or shallow groundwater pumping which could be used for agricultural irrigation.

Elevated arsenic concentrations may become an issue under higher pumping rates (constant 2,500 acre-feet per year) and/or mobilization due geochemical reactions induced by low total dissolved solids (TDS) potable water injection. More research is needed to determine the arsenic mobilization potential and potential mitigation options.

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Introduction

Overview

The Palomino Farms Sustainable Water Resource Feasibility Study (Study) is part of a regional effort to optimize and expand available water resources, research resource innovations and advanced water treatment technologies, and develop innovative and integrated water solutions for regional needs.

The Study is focused on determining the viability of bringing water to the Palomino Farms and Warm Springs areas as part of a long-term sustainable water management plan. Currently, groundwater pumped from the Palomino Valley aquifer is used to irrigate farmland. The groundwater basin in the Palomino Valley area (Warm Springs Valley – 084) has historically been over-used, with water levels dropping over 125 feet in some areas over the past 50 years, threatening its long-term viability.

More specifically, the feasibility study is investigating the option of bringing recycled water to Palomino Valley for irrigation of the Palomino Farms and potentially other farmland, to significantly reduce reliance on groundwater. Using imported recycled water for agricultural irrigation would reduce pumping from the groundwater basin, allowing groundwater levels to rebound. Recycled water from the local water reclamation facilities (meeting Category A and B quality) would be piped to Palomino Valley for use in agricultural irrigation. A new recycled water pipeline (“purple pipe”) would be constructed from Palomino Farms to the existing Spanish Springs recycled water distribution system, with the nearest connection point being approximately 11 miles away.

As an additional part of the study, potable surface water supplied by TMWA could be brought in through a separate pipeline and injected to replenish the Palomino Valley aquifer in the winter when Truckee River water is more plentiful. Stored water could be used to support Spanish Springs during peak summer demands or during droughts. The potable water imported to the area would be strictly for groundwater basin replenishment – not to be connected to existing domestic well users or otherwise be used as a municipal water source. The nearest connection point to the existing TMWA potable distribution system is approximately 10 miles away.

Both enhancements would improve local groundwater levels, and help preserve farmland and open space, which would assist in maintaining the rural lifestyle and character of the area. In addition to these opportunities, a long-term concept includes the possibility of treating local water reclamation facility recycled water to Category A+ advanced purified water for groundwater recharge.

Purpose/Objectives

This purpose of the Study is to evaluate the feasibility of irrigating with recycled water and injecting potable water into the local aquifer. To achieve this goal, multiple objectives have been identified including:

- Review of previous hydrogeologic investigations.
- Conducting a hydrogeologic investigation to collect additional data on lithology, aquifer hydraulic parameters, borehole geophysics, water quality and geochemistry.
- Development of a hydrogeologic conceptual model for Warm Springs Valley.
- Development of a numerical groundwater flow and transport model.

- Development of a geochemical model to evaluate the compatibility of potable and recycled water mixing with ambient groundwater.
- Use modeling tools to evaluate the feasibility of injecting and recovering potable water into/from the local aquifer.

Location

The Palomino Farms site is in the central portion of the Warm Springs Valley, Washoe County, Nevada (Figure 1). The site is in the Warm Springs Valley (WSV) hydrographic area (084) as defined by the Nevada State Engineer's office.

The project site consists of 1,806 acres of agricultural property as shown in Figure 2. These include the Palomino Farms property (1,148 acres), Western Turf (296 acres), and LW (362 acres). The Palomino Farms property currently grows alfalfa on three center pivots and a smaller rectangular plot. Western Turf grows turf grass and a small amount of pumpkins on their property and the LW property to the south which they lease. It is important to note that Western Turf was included as part of the Study but is not included in the purchase option agreement.

The proposed pipelines would be routed along Pyramid Lake Highway. The route is approximately 10 miles from Palomino Farms to TMWA's distribution system and 11 miles to Spark's recycled water system in northern Spanish Springs Valley.

Previous Investigations

Some of the earliest hydrogeologic investigations in WSV were done in support of the North American Aviation Corporation's efforts to develop a water supply for rocket engine testing. The investigations were published as an internal report (Glenn et al., 1965) and as a master's Thesis (Glenn, 1968). The key finding of these studies included an estimate of groundwater recharge from infiltration of precipitation in the amount of 4,000 acre-feet per year (AFY). A well drilling and testing program was used to locate areas where groundwater could be withdrawn from the valley's basin-fill sediments. They concluded that groundwater is generally available anywhere in the basin-fill sediments, but the central portion of the valley would result in a low specific yield.

A gravity study was conducted in WSV to determine the depth to basement rock (Gimlett, 1967). They concluded that the anomalous northwest trend of WSV is due to lateral faulting along a zone (Warm Springs Valley Fault) which extends at least 50 miles. Inversion of the gravity profiles yielded a maximum depth to bedrock of 3,400 feet just west of Pyramid Highway near Whiskey Springs Road. The sediment-filled basin follows the same northwest to southeast orientation as the valley floor.

In 1967 the U.S. Geological Survey conducted a water resource evaluation of WSV (Rush and Glancy, 1967). The study was part of a larger reconnaissance study of groundwater resources in Nevada. They estimated recharge from infiltration of precipitation of 6,000 AFY using the Maxey and Eakin, 1949 approach. They also estimated groundwater evapotranspiration (ET) of phreatophytes by mapping greasewood, rabbitbrush, and saltgrass. They mapped 6,300 acres of phreatophytes and estimated ET rates for various depth to water zones to yield 1,500 AFY of groundwater ET. Groundwater outflow through Mullen Pass was estimated at 200 AFY and groundwater pumping at that time was thought to be less than 50 AFY. Total estimated groundwater outflow was 1,750 AFY, although they appeared to round this value up to 2,000 AFY in the summary budget. They attributed the large imbalance between inflow and outflow as an overestimation of precipitation and associated recharge. They ultimately selected 3,000 AFY as the most likely estimate of perennial yield and this is the value that Nevada Division of Water Resources (NDWR) used as the basis for their perennial yield estimate.

In the early 1970s, an evaluation of groundwater resources was conducted in WSV to address water supply and demand issues for a proposed development in Palomino Valley (Sharp, Krater and Associates, 1973 and 1974). They reevaluated the hydrology of the basin and determined the perennial yield ranged between 4,400 – 4,900 AFY (Sharp, Krater and Associates, 1973). In a subsequent study they significantly revised their estimate of recharge to 11,000 AFY but did not change their estimates of perennial yield (Sharp, Krater and Associates, 1974).

Following approval of the Palomino Valley project by the Washoe County Commissioners in June 1973, additional water quality samples were taken on two of the irrigation wells located east of Pyramid Highway. The testing revealed a significant increase in nitrate concentrations (as nitrogen) from 5 milligrams per liter (mg/L) to 18 mg/L (Behnke and Sharp, 1973). The U.S. Environmental Protection Agency Maximum Contaminant Level (MCL) for nitrate (as nitrogen) is 10 mg/L. The increase in nitrate was attributed to downward leaching of naturally occurring soil nitrate beneath irrigated lands.

Guyton Associates, 1987 evaluated groundwater availability in the valley for Sierra Pacific Power Company for a potential development in the Reno/Sparks area. Beyond collecting a few water samples for water quality analysis and monitoring groundwater levels, the study mostly consisted of reviewing existing reports. Regardless, numerous conclusions were drawn from the analysis and are described briefly below.

Guyton Associates, 1987 noted three geologic formations found in the valley including consolidated rocks, semi-consolidated sedimentary rocks, and unconsolidated sediments. The unconsolidated alluvium is the major source of groundwater in the basin and deposited before, during, and after lakes (ancient Lake Lahontan) occupied the valley. They noted two clay beds in a well located east of Pyramid Highway in the primary agricultural area, each being 80 feet thick between 160 and 410 feet, which probably represent lake deposits. Another well located approximately three miles south shows very little clay to a depth of 400 feet, indicating that the thickness of clay resulting from lake deposits varies significantly.

They noted water level declines of 65 feet from 1967 to 1986 within the irrigation area and noted that declining water levels have likely intercepted the natural discharge area to the northwest.

They found that existing irrigation wells can produce 150 – 1,900 gallons per minute (gpm) with specific capacities of 4 to 40 gallons per minute per foot of drawdown (gpm/ft). These wells are completed to depths of 105 – 745 feet.

Chemical analysis of water samples screened in alluvium show total dissolved solids (TDS) concentrations ranging from 230 – 850 mg/L, with most being less than 500 mg/L. Water samples from wells at the north end of Hungry Valley show TDS concentrations ranging from 590 – 2,100 mg/L. In addition, water quality is generally better along the northeast side of the valley as compared to the southwest side. Elevated concentrations of nitrate, sulfate, arsenic, and/or fluoride above the MCL were noted at various locations in the valley. High arsenic and fluoride concentrations are likely due to upwelling of geothermal fluid along permeable fault zones. They recommended that groundwater supply wells should not be located west of Pyramid Highway.

They estimated approximately 270,000 acre-feet of water with low TDS is in storage in the alluvial aquifer east of Pyramid Highway. Groundwater could be developed in the valley by intercepting natural discharge and withdrawing water from storage. They noted that only a portion of the 2,000 AFY of natural discharge could be captured practically.

The authors noted that lowered water levels in the valley provided space for the storage of additional groundwater, but additional studies would be required to determine if surface infiltration or direct aquifer injection would be required.

Since 1989 consultants for the U.S. Environmental Protection Agency and Rockwell International Corporation (now Boeing) produced several reports to help characterize and mitigate groundwater contamination (McGinley and Associates, 2019a and 2019b; Groundwater Resource Consultants, 1991 and 1992). Trichloroethylene (TCE) is the main contaminant and it appears to be limited to consolidated rocks in the mountains surrounding the southeast portion of WSV. One area is on the west flank of the eastern Pah Rah range and the other is one the east flank of the western Pah Rah range. There is no indication that the TCE plumes pose a threat to the basin-fill aquifer.

Washoe County, 1993 conducted a drilling and water quality sampling program to determine the vertical extent of high nitrate concentrations found in previous investigations (Behnke and Sharp, 1973) and to quantify hydraulic properties in test wells located near agricultural properties east of Pyramid Highway. Highest nitrate concentrations (24 mg/L as nitrogen) were found in the shallower (120 – 140 feet depth) screen sections, then decreasing with depth to less than 1 mg/L below 400 feet below land surface. Aquifer testing yielded transmissivities ranging from 35 – 115 gpm/ft.

The results from testing the Stewart/Cochrane Well, located at the southeast end of WSV are provided in Washoe County, 1997. The aquifer test resulted in a transmissivity of 700 square feet per day and all water quality parameters were below MCLs.

Harding Lawson Associates, 1993 conducted an engineering study of the water resources of the Winnemucca Ranch and Upper Dry Valley Watershed. The study evaluated the potential methods and costs for collecting, storing, and conveying spring and surface flows by pipeline to Spanish Springs Valley and/or Lemmon Valley.

Ross, 1997 developed a groundwater flow model for the basin-fill aquifer within WSV. The model simulated the basin-fill sediments with a 500 meter (1,640 feet) horizontal grid cell resolution with three layers to a maximum depth of approximately 1,000 meters (3,280 feet).

A steady-state pre-development, transient historical (1967 – 1995), and predictive simulations (1995 – 2095) were developed. Hydraulic conductivity was calibrated using the steady-state model and storage parameters using the transient model. The predictive model was used to evaluate the effect of various pumping scenarios with net pumping rates up to 7,200 AFY.

Boundary conditions included recharge from infiltration of precipitation of 2,350 AFY, subsurface inflow from Spanish Springs Valley of 100 AFY, a head-dependent boundary to represent outflow through Mullen Pass, and groundwater ET for phreatophytes located in the central portion of the valley. The magnitude of groundwater recharge was based on a chloride mass balance estimate.

Calibration of the steady-state model yielded the largest hydraulic conductivities (3 – 16 feet per day) along the main axis of the valley from the southern end of the basin-fill sediments to about where Mullen and Cottonwood Creek exit the valley. Other basin-fill sediments along the valley margins were simulated with significantly lower hydraulic conductivity values (0.01 – 0.2 feet per day).

The transient historical model was able to correctly simulate water level declines more than 110 feet in the central portion of the valley in response to irrigation pumping. In addition, the model predicted declines in groundwater ET in 1995 to 20 percent of predevelopment levels.

Predictive simulations showed continued groundwater declines when pumping continued at rates like those in the 1980s and 90s. Simulations with net pumping rates greater than 7,000 AFY were not completed due to numerical instabilities.

Katzer, 1997 developed a groundwater budget for WSV in support of a proposed aquifer storage and recovery (ASR) project which would have provided additional water to the valleys north of Reno, Nevada. The study concluded that approximately 4,500 AFY is used by all phreatophytes in the basin (1996). They estimated the perennial yield to be 4,000 AFY of which 850 AFY is attributable to springflow. They proposed conveying springflow and streamflow from the Marshall Ranch, located at the far northwest end of the valley, to the lower ephemeral reaches of Warm Springs Creek where the water would recharge into the groundwater system.

Katzer, 1997 provided a detailed map of the phreatophyte distribution as mapped by Natural Resources Consultants in the early 1970s (Figure 3). The entire shaded area in Figure 3 represents an early 1970s interpretation of the pre-development groundwater discharge zone. Katzer, 1997 performed a second reconnaissance level survey of WSV to identify discharge zones active in 1997 (greasewood and saltgrass) and those areas type converted from a phreatophyte zone to a non-phreatophyte zone due to encroachment of agriculture and falling water levels. They noted that the highest density greasewood stands were located near the GW-02 location (see Figure 3) complex (GW-02) with 2,000 plants per acre and greasewood 30 inches high and 45 inches in diameter.

Stantec, 1998 performed water quality testing in four domestic wells surrounding the Warm Springs Ranch property (now Palomino Farms) and found that all water quality parameters were within acceptable state and Federal drinking water standards. A new well was drilled on the Warms Springs Ranch property and the nitrate (as nitrogen) concentration was found to be 0.5 mg/L.

Widmer, 2001 used aeromagnetic data from WSV to better understand fault structure in the valley. Numerous northwest trending lineaments were interpreted from the analysis, with some being collocated with previously mapped faults. High fluoride concentrations were also noted in the central area of the basin with partial correlation to fault features.

Hydrogeologic Investigation

Scope

The purpose of the hydrogeologic investigation was to collect hydrogeologic data necessary for the evaluation of the proposed aquifer storage and recovery project. A variety of field activities were undertaken including drilling of eight new wells, soil cores collected at ten locations, lithologic analysis and borehole geophysics, evaluation of previously collected airborne geophysical data, aquifer testing, water quality analysis, an evaluation of the geochemical compatibility of the existing groundwater with recycled and potable water, and groundwater modeling. The subsections below describe the results of the data collection and modeling activities.

Soil Borings/Monitoring Wells

Eight soil borings and eight monitoring wells were drilled and constructed to collect additional geological, water quality, and groundwater flow data (see Figure 4). All borings and monitoring wells were drilled and constructed with oversight and lithologic logging provided by TMWA.

Soil borings were drilled by Cascade Drilling using sonic drilling techniques. Sediment samples were collected from the nearly undisturbed soil bore.

Six monitoring wells (MW-01, MW-02, MW-04, MW-05, MW-06, and MW-07) were drilled and constructed by Stonehouse Drilling using direct circulation mud rotary drilling methods. Mud properties (i.e., viscosity, mud weight, percent sand, and filter cake) were tested and recorded by Stonehouse Drilling intermittently throughout the entire drilling process to control formation disturbance.

Two monitoring wells (MW-03 and MW-08) were drilled and constructed by Cascade Drilling using direct circulation mud rotary drilling methods. Initially, these wells were drilled using sonic methods for sediment sample collection and constructed with nominal 2-inch PVC casing; however, during air development, downhole failures occurred, and the wells were abandoned. The replacement wells were drilled adjacent to the abandoned wells and were constructed with 3-inch PVC casing.

Following construction of each monitoring well, a concentrated liquid polymer dispersant, Aqua-Clear PFD, was injected via tremie pipe into the wells prior to air development and aquifer testing to remove drilling mud and any other sediments from the formation. Air development occurred in 20-foot sections and started at the bottom and moved up. Each 20-foot section used continuous air and swabbing techniques until deemed clean by TMWA.

Lithology was logged using the Natural Resources Conservation Service (NRCS) textural classification system. The field method was modified by the NRCS from the method of Thien, 1979. Well logs were further simplified for easier viewing by combining similar textural classifications. The original 12 NRCS classifications were grouped into three categories: 1) coarse, 2) medium, and 3) fine. The coarse group includes coarse sand, loamy sand, and sandy loam. The medium group includes loam, silt loam, and silt. The fine group includes clay, sandy clay, silty clay, clay loam, sandy clay loam, and silty clay loam.

Figure 5 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-01. Lithology consists of intermittent sections of coarse and fine material throughout most of the borehole, with only limited sections of medium grained sediments. There is general agreement between the resistivity and lithology with higher resistivity values typically being associated with coarser sediments. Borehole diameters range between 12 and nearly 16 inches, and washout zones are generally associated with coarse sections. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 200 feet. A 6 inch diameter double row 0.080 inch steel mill slot screen was installed from 200 – 600 feet. The annular space was backfilled with #6 SRI gravel pack from 190 – 600 feet below land surface. A bentonite seal was installed from 180 – 190 feet, and the upper 180 feet was sealed with grout. The water table was measured at 179 feet.

Figure 6 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-02. Course sediments dominate the profile, with one fine-grained facies from 410 – 490 feet below land surface. Lowest resistivity values are associated with the fine-grained sediments from 400 – 450 feet. Borehole diameters range between 12 and 20 inches, and washout zones are generally associated with coarse sections. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 197 feet. Six inch double row 0.080 inch steel mill slot screen was installed from 197 – 797 feet. The annular space was backfilled with #6 SRI gravel pack from 187 – 820 feet below land surface. A bentonite seal was installed from 185 – 187 feet, and the upper 185 feet was sealed with grout. The water table was measured at 202 feet.

Figure 7 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-03. Lithology is highly variable over the entire borehole with intermittent sections of coarse, medium, and fine sediments. There is little correlation between the resistivity and lithology. Borehole diameters range between 8 and 14 inches. A washout zone exists from about 20 – 60 feet. The monitoring well was constructed with 3 inch diameter schedule 80 PVC blank casing from ground surface to 100 feet and 350 – 400 feet. Three inch diameter schedule 80 screen was installed from 100 – 350 feet and 400 – 600 feet. The annular space was backfilled with #6 SRI gravel pack from 98 – 352 feet and 398 – 600 feet below land surface. A bentonite seal was installed from 350 – 400 feet, and the upper 98 feet was sealed with grout. The water table was measured at 171 feet.

Figure 8 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-04. The upper 320 feet are dominated by fine-grained sediments, with smaller zones of coarse and medium-grained facies. Below 320 feet the sediments are dominated by coarse-grained sediments with smaller lenses of medium-grained sediments. There is little correlation between the resistivity and lithology. Borehole diameters range between 12 and 16 inches with two washout zones being in the upper 240 feet. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 197 feet. Six inch double row 0.080 inch steel mill slot screen was installed from 197 – 597 feet. The annular space was backfilled with #6 SRI gravel pack from 190 – 620 feet below land surface. A bentonite seal was installed from 180 – 190 feet, and the upper 180 feet was sealed with grout. The water table was measured at 206 feet.

Figure 9 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-05. The borehole is dominated by fine-grained sediments, with smaller zones of coarse and medium-grained facies. There is little correlation between the resistivity and lithology. Borehole diameters range between 12 and 20 inches with two washout zones being associated with medium and coarse-grained sediments. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 200 feet. Six inch double row 0.080 inch steel mill slot screen was installed from 200 – 600 feet. The annular space was backfilled with #6 SRI gravel pack from 190 – 600 feet below land surface. A bentonite seal was installed from 180 – 190 feet, and the upper 180 feet was sealed with grout. The water table was measured at 184 feet.

Figure 10 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-06. The borehole is dominated by coarse-grained sediments, with smaller zones of coarse and fine-grained facies below 320 feet. There is little correlation between the resistivity and lithology. Borehole diameters range between 12 and 20 inches with two washout zones being associated with medium and coarse-grained sediments. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 197 feet. Six inch double row 0.080 inch steel mill slot screen was installed from 197 – 597 feet. The annular space was backfilled with #6 SRI gravel pack from 191 – 620 feet below land surface. A bentonite seal was installed from 180 – 191 feet, and the upper 180 feet was sealed with grout. The water table was measured at 239 feet.

Figure 11 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-07. The borehole is dominated by coarse-grained sediments above 330 feet, with two fine-grained facies located in this upper zone. Below 330 feet the borehole is all fine-grained material. There is little correlation between the resistivity and lithology. Borehole diameters range between 12 and 18 inches with two washout zones generally associated with coarse-grained sediments. The monitoring well was constructed with a 6 inch diameter 0.188 inch blank steel casing from ground surface to 197 feet. Six inch double row 0.080 inch steel mill slot screen was installed from 197 – 597 feet. The annular space was backfilled with #6 SRI gravel pack from 190 – 620 feet below land surface. A bentonite seal was installed from 180 – 190 feet, and the upper 180 feet was sealed with grout. The water table was measured at 245 feet.

Figure 12 shows the lithology, electric logs (short-normal resistivity and spontaneous potential), caliper, and well construction diagram for MW-08. Lithology is dominated by coarse-grained sediments with intermittent zones of fine-grained facies above 300 feet and between 545 and 565 feet. There is little correlation between the resistivity and lithology. Borehole diameters range between 8 and 16 inches. A washout zones exists from about 40 – 60 feet. The monitoring well was constructed with 3 inch diameter schedule 80 PVC blank casing from ground surface to 100 feet. Three inch diameter schedule 80 screen was installed from 100 – 600 feet. The annular space was backfilled with #6 SRI gravel pack from 98 – 600 feet. The upper 98 feet was sealed with grout. The water table was measured at 245 feet.

Lithologic Cross Section

Nine wells were used to develop a north-south lithologic cross-section (see Figure 13). Figure 14 shows lithology from nine wells and short-normal resistivity from five wells. The sediment profile is highly heterogeneous with no apparent continuous layer throughout the section. Coarser sediments and likely higher permeability zones are found in Pratt 1, Pratt 2, MW-02, Pratt 3, below 320 feet in MW-04, MW-06 and below 320 feet in MW-08.

Airborne Geophysics

WCDWR Geophysical Surveys

During the 1990's, the Washoe County Department of Water Resources conducted multiple geophysical surveys within most of its southern management areas. The surveys were used to further refine the hydrogeologic conceptual model. Specific data collection consisted of an airborne magnetic survey and electrical resistivity surveys at 900 Hz, 7,200 Hz, and 56,000 Hz. One of the first basins examined was Warm Springs Valley. Data was interpolated and analyzed in 1995 (Hartley, 1995) and 2001 (Widmer, 2001). TMWA reviewed these datasets focusing on characteristics of the basin-fill sediment, range front faulting, and geothermal influence surrounding the study area.

Electrical Resistivity

TMWA's review of the resistivity survey focused on the 900 Hz dataset given its geo-electric penetration depth is the greatest (up to approximately 300 feet). It is important to note geo-electric penetration can be dispersed in low resistivity clay units (Widmer, 2021), so care was taken to match resistivity data with additional surface and subsurface information and assumptions. The 900 Hz resistivity survey data was interpolated and displayed focusing on values less than 300 Ohm-meters. Values above 300 Ohm-meters are representative of exposed range fronts and competent hard rock which added little to no value to the aquifer assessment.

Figure 15 depicts the 900 Hz resistivity survey interpolation and aquifer interpretations. Delineating the margins equal to approximately 300 Ohm-meters can be interpreted as the extents of basin fill sediment in WSV. This outline also correlates well with the topography of the basin and fully encompasses the modeled extent of higher hydraulic conductivity (calculated via pilot point calibration using recent pump test results). The exception to this trend is the southern margin where there appears to be a much lower resistivity signature most likely created by a geologic transition.

TMWA also reviewed lower resistivity signatures along inferred geothermal boundaries. Figure 16 depicts the 900 Hz resistivity survey interpolation and geothermal interpretations. Geothermal groundwater often has elevated levels of total dissolved solids (TDS) which makes the water chemistry more conductive, resulting in a lower resistivity value. Of importance is a lower resistivity zone that aligns with elevated levels of TDS and arsenic on the western margin of the extent of higher hydraulic conductivity. This area may represent a potential zone of geothermal influx near the study area.

Aeromagnetic

Like the resistivity dataset, the aeromagnetic survey data was interpolated and displayed. The total magnetic field values recorded during the survey ranged from 52,000 nano-Teslas to 54,000 nano-Teslas. The total magnetic field correlates well with other existing data associated with the geologic structure and orientation of the basin.

More importantly, fault lineaments determined based on the analysis of the first horizontal derivative of the total magnetic field (Hartley, 1995) were also reviewed. The first horizontal derivative of the total magnetic field provides enhanced resolution in determining the largest gradients which typically occur at the edges of horizontal bodies (e.g., faults). The potential zone of geothermal influx discussed in the Water Quality section was compared to the locations and extents of nearby fault lineaments. The zone of potential geothermal influx is generally located within a series of apparent fault interruptions or stepover zones. These fault characteristics would likely create upwelling or influx of geothermal fluid which supports the elevated levels of TDS and arsenic observed in the area. Figure 17 depicts the aeromagnetic survey interpolation and geothermal interpretations.

Aquifer Testing

TMWA conducted six, single-well aquifer tests during August 2021 to obtain hydraulic conductivity estimates. Each well was pumped for approximately eight hours at rates ranging from 95 to 500 gallons per minute (gpm). Drawdown and recovery measurements were recorded during five of the tests via pressure transducers. Manual measurements had to be recorded for one test due to transducer malfunctions.

Aquifer test results were interpreted utilizing AQTESOLV 4.5 (Duffield, 2007). Transmissivity values were calculated utilizing a best-fit line matching approach with the Theis (Theis, 1935) and Cooper-Jacob (Cooper and Jacob, 1946) analytical solutions for an unconfined aquifer. Analysis intervals for the Cooper-Jacob method were chosen utilizing derivative analysis (Bourdet et al., 1983). Derivative analysis includes plotting both drawdown data and the derivative of drawdown data with respect to the natural logarithm of time. Trends observed on the derivative plot can aid in the proper selection of slope intervals for solution matching. This is done by identifying a radial flow plateau represented by a straight-line parallel to the x-axis on the derivative plot. Radial flow plateaus are assumed to satisfy Theisian or Infinite-Acting Radial Flow conditions where drawdown is controlled by aquifer characteristics rather than interferences such as boundary conditions, aquifer heterogeneities, wellbore storage, partial penetration, discharge inconsistencies, etc.

The following summaries outline the hydraulic parameters calculated utilizing the results from each single-well aquifer test.

MW-01

MW-01 was pumped at 500 gpm for eight hours resulting in approximately 22 feet of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 8,800 square feet per day (ft^2/day) and 8,500 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 18. The simulated Cooper-Jacob solution are depicted in Figure 19. Hydraulic conductivity values calculated utilizing the submerged screen interval under static conditions for MW-01 (400 feet) were equal to 22 and 21 feet per day (ft/day), respectively.

MW-02

MW-02 was pumped at 500 gpm for eight hours resulting in approximately 19 feet of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 15,000 ft^2/day and 13,000 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 20. The simulated Cooper-Jacob solution are depicted in Figure 21. Hydraulic conductivity values calculated utilizing submerged screen interval under static conditions for MW-02 (585 feet) were equal to 25 and 23 ft/day, respectively.

MW-04

MW-04 was pumped at 452 gpm for eight hours resulting in approximately 29 feet of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 6,000 ft^2/day and 7,000 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 22. The simulated Cooper-Jacob solution are depicted in Figure 23. Hydraulic conductivity values calculated utilizing the submerged screen interval under static conditions for MW-04 (390 feet) were equal to 16 and 19 ft/day, respectively.

MW-05

MW-05 was pumped at 400 gpm for eight hours resulting in approximately 75 feet of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 560 ft^2/day and 550 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 24. The simulated Cooper-Jacob solution are depicted in Figure 25. Hydraulic conductivity values calculated utilizing the submerged screen interval under static conditions for MW-05 (400 feet) were both equal to one ft/day.

MW-06

MW-06 was pumped at 300 gpm for eight hours resulting in approximately 34 feet of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 3,000 ft^2/day and 2,100 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 26. The simulated Cooper-Jacob solution are depicted in Figure 27. Hydraulic conductivity values calculated utilizing the static submerged screen interval for MW-06 (340 feet) were equal to nine and six ft/day, respectively.

MW-07

MW-07 was pumped at 95 gpm for eight hours resulting in approximately 15 ft of drawdown. Transmissivity values calculated utilizing the Theis and Cooper-Jacob solutions were 2,500 ft^2/day and 2,600 ft^2/day, respectively. The simulated Theis solution and measured drawdown are shown in Figure 28. The simulated Cooper-Jacob solution are depicted in Figure 29. Hydraulic conductivity values calculated utilizing the submerged screen interval under static conditions for MW-07 (335 feet) were both equal to eight ft/day.

Groundwater Evapotranspiration

A groundwater ET discharge estimate was made using pre-development groundwater level distribution (Ross, 1997) and the relationship between depth to groundwater and phreatophyte evapotranspiration developed by Nichols, 1994 (see Figure 30). The pre-development groundwater levels were digitized and interpolated to a 650 foot grid and the ET rates were calculated at each grid cell using the equation shown in Figure 30. Total pre-development groundwater ET is estimated at 2,800 AFY and the resulting distribution of groundwater evapotranspiration is shown in Figure 31. Most of the groundwater evapotranspiration is discharging near the thermal springs in the western portion of the groundwater discharge zone.

Agricultural Water Use

Irrigation demand was compared to the amount of groundwater pumped at the Palomino Farms facility. This information was used to understand if more or less water was applied to the alfalfa as compared to the amount of water used by the crops.

Irrigation amounts are assumed to be equal to the amount of groundwater pumped. At Palomino Farms there are three supply wells for four alfalfa fields (see Figure 32). Well #1 (Pratt 1) provides irrigation water to Field 10, Well #2 (Pratt 2) provides water to Field 20, and Well #3 (Pratt 3) provides water to Fields 40 and 50. The area for Fields 10, 20, 40, and 50 are 198, 133, 47, and 138 acres, respectively.

The net irrigation water requirement (NIWR) was used to estimate the alfalfa water demand (Huntington and Allen, 2010). NIWR was calculated as the difference between calculated ET for alfalfa and precipitation.

NIWR was calculated daily and then integrated (summed) over the irrigation season. Daily potential ET (alfalfa reference) and precipitation were obtained from the gridMET product, which is available through Google Climate Engine. GridMET is a dataset of daily high-spatial resolution (4 kilometer) surface meteorological data covering the contiguous US from 1979-yesterday (Abatzoglou, 2013).

Potential ET is calculated using the Penman-Montieth method using primary climate data such as radiation, wind velocity, temperature, and humidity.

Actual ET for alfalfa was calculated as the product of a crop coefficient and the potential ET (alfalfa reference). The crop coefficient curve developed by the Agricultural Research Service on lysimeter plots in Kimberly, Idaho was used to estimate actual ET (Allen, et al., 1998). The curve assumed that dormancy breaks on April 1 and then increases linearly through May 31 where the peak crop coefficient peaks at 0.85. From June 1 – October 15 the crop coefficient remains at 85 percent of potential ET (alfalfa reference). NIWR was converted to a volume by multiplying the actual ET rate by the field area.

The ratio of the irrigation volume to the volumetric NIWR was used to determine if the crop was deficit irrigated or if excess water was available for deep percolation and groundwater recharge. Table 1 shows the amount of groundwater pumped for irrigation, the volumetric NIWR, and the ratio of irrigation volume to NIWR for each field.

Field 10 was deficit irrigated in three of the five years studied (2018, 2020, and 2021) and irrigation exceeded NIWR by 8 and 3 percent for 2017 and 2019, respectively. Deficit irrigation is primarily due to a lack of well capacity in Pratt 1.

Field 20 was deficit irrigated in four of the five years, with 2017 being the only year when irrigation volume exceeded crop demand. Deficit irrigation was largely due to a lack of production capacity in Pratt 2.

Irrigation rates in Fields 40 and 50 were generally larger than the NIWR with 2017 being the only year when these fields were deficit irrigated.

For additional context, the normalized difference vegetation index (NDVI) was obtained using Google Climate Engine to determine the alfalfa vigor from 2017 – 2021. NDVI quantifies vegetation vigor by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). Dense agricultural vegetation such as alfalfa will have NDVI values above 0.8.

Figure 33 shows the NDVI from 2017 – 2021 for Fields 10, 20, 40, and 50. Field 10 shows only marginal alfalfa vigor from 2017 – 2020, increasing substantially in 2021. The ratio of irrigation volume to NIWR volume for Field 10 shows a different pattern with highest values in 2017 and 2019 and only 49 percent in 2021 when the NDVI was highest. Field 10 contains a large amount of weed growth, which may be causing the discrepancy between plant vigor and the ratio of the irrigation volume to the volumetric NIWR.

Field 20 shows good alfalfa vigor throughout the period 2017 – 2020, and only slightly lower vigor in 2021. In contrast, the ratio of irrigation volume to NIWR volume for Field 20 is greater than 100 percent in 2017 and below 100 percent thereafter. This field has some pest infestation, which may cause the NIWR calculations to be invalid.

Field 40 shows good alfalfa vigor from 2019 – 2021. Plant vigor is very low in 2017, indicating there may not have been a planted crop in this field at that time. Field 50 shows strong plant vigor throughout the period 2017 – 2021. The ratio of irrigation volume to NIWR volume for Fields 40 and 50 is above 100 percent after 2018 which agrees with the NDVI data. Pratt 3 which services Fields 40 and 50 has enough production capacity to meet the plant demand.

Overall, irrigation at Palomino Farms is at or below plant demand. This suggests that groundwater recharge is minimal beneath these fields.

Water Quality

Maps showing the spatial distribution of total dissolved solids (TDS), arsenic, and nitrate concentrations within the aquifer were developed for two time periods. Maximum concentrations of the three constituents were compiled for 1) 1962 – 1986 and 2) 2020 – 2021. Water quality data from the first period were obtained from Guyton, 1987 and TMWA collected data for the second period. Most of the samples were obtained from the alluvial aquifer, with only a few from the consolidated granodiorite or volcanic aquifers. Wells where water quality samples were taken ranged in depth from 90 to 710 feet and one spring sample was taken. Guyton, 1987 collected samples from a total of 60 wells including domestic (41), irrigation (11), industrial (1), monitoring (11), and a spring (1). The recent study collected samples from 46 wells including domestic (25), monitoring (16), and irrigation (5).

Maximum measured TDS concentrations within the project area for the two time periods are shown in Figure 34. TDS concentrations range from 210 – 970 milligrams per liter (mg/L) for the first period (1962 – 1986) and 160 – 790 mg/L for the second period. During the first period, highest TDS concentrations are in northern WSV which is associated with the ET discharge area, near Pyramid Highway and Whiskey Springs Road which is associated with geothermal outflow, and in the southern portion of the valley. The Nevada Division of Environmental Protection (NDEP) defines the secondary maximum contaminant level (SMCL) for TDS as 1,000 mg/L. Secondary drinking water standards provide guidelines for regulation of contaminants that may have aesthetic considerations, such as taste, color, and odor. TDS concentrations within the project area were below the SMCL for TDS.

Maximum measured arsenic concentrations are shown for 1962 – 1986 and 2020 – 2021 are shown in Figure 35. Arsenic concentrations range from 0.2 – 240 micrograms per liter (µg/L) for the first period and 1.5 – 185 µg/L for the second period.

Arsenic concentrations are highest along the west and southern portions of WSV in both periods. High arsenic concentrations are generally associated with geothermal systems (Bundschuh, and Maity, 2015). Geothermal reservoirs release arsenic from arsenic-bearing pyrite at temperatures above 150 ^{o}C. In WSV, geothermal fluid is thought to upflow at fault structures located along the western margin of the valley as shown in Figure 35. This is supported by arsenic concentrations above 100 µg/L near the geothermal fault structures.

The EPA defines the maximum contaminant level (MCL) for arsenic as 10 µg/L. During the second period (2020 – 2021) arsenic concentrations are generally less than the MCL within the agricultural area. During the first period arsenic concentrations above the MCL encroach into the agricultural area along Whiskey Springs Road. The encroachment coincides with increased agricultural pumping from 1975 – 2009. After 2009, agricultural pumping decreased by 20 – 67 percent which resulted in less arsenic encroachment.

Maximum measured nitrate concentrations are shown for 1962 – 1986 and 2020 – 2021 in Figure 36. Nitrate concentrations (as nitrogen) range from 0.1 – 21 mg/L for the first period and 0.1 – 16 mg/L for the second period.

During the first period (1962 – 1986) highest nitrate concentrations are found beneath agricultural areas. The MCL for nitrate (as nitrogen) is 10 mg/L and nitrate concentrations exceed the MCL throughout most of the agricultural area. The high nitrate concentration beneath the agricultural properties is likely due to leaching of naturally occurring nitrate from infiltrating irrigation water. High nitrate concentrations in desert vadose zone environments are well known (Viers, 2012; Dyer, 1965; Stadler et al., 2008; Walvoord et al., 2003).

The extent of nitrate concentrations above the MCL decreased significantly during the second period (2020 – 2021). Reduced pumping and associated irrigation after 2008 may have reduced groundwater recharge occurring beneath the irrigated areas, thereby reducing the nitrate concentrations within the aquifer.

Total nitrate mass in the aquifer was estimated using water quality data from the two time periods (1962 - 1986 and 2020 – 2021). Mass was calculated by integrating the interpolated nitrate concentrations (as nitrogen) shown in Figure 36. An effective porosity was assumed to be 0.015, which is consistent with the specific yield value estimated from the groundwater flow model within the agricultural area. The aquifer thickness was assumed to be 600 feet, which represents the typical saturated thickness of the wells in 1986. Total nitrate mass (as nitrogen) was calculated to be 780,000 and 100,000 pounds for 1986 and 2021, respectively. The large decrease in nitrate mass from 1986 to 2021 indicates that most of the nitrate mass has moved away from the project area with little to no loading from the vadose zone since 1986. Some of the nitrate mass likely moved north toward the phreatophyte zone and some was pumped by the agricultural wells and applied as irrigation water and used by the plants.

Nitrate mass within the vadose zone was measured at ten boreholes (B1, B2, B3, B4, B5, B6, B7, B8, MW-03, and MW-08 – See Figure 4). For reference, Figure 37 shows the years when fields where boreholes are located were irrigated from 1985 – 2021. Irrigation schedules were determined based on Landsat imagery by calculating a NDVI. Fields with a NDVI greater than 0.5 during a particular year were assumed to be irrigated.

Soil nitrate concentrations, soil moisture, and lithology for borehole B1 are shown in Figure 38. Largest nitrate concentrations are found at 70 and 120 feet below land surface with concentrations of 4 and 6 milligrams per kilogram (mg/kg), respectively. Coarse lithology is found throughout the entire profile. The field where this borehole is located (Field 10) appears to be flushed of nitrate as evidenced by nitrate concentrations below 10 mg/kg and most of the nitrate mass below the water table. At this location nitrate mass is 600 pounds per acre (lbs/acre). This field was generally irrigated from 1985 – 2021.

Soil nitrate concentrations, soil moisture, and lithology for borehole B2 are shown in Figure 39. The largest nitrate concentration was observed at 30 feet with a concentration of 91 mg/kg. A fine-grained facies was observed from 60 – 80 feet, which may have limited downward movement of nitrate. Although this field was generally irrigated from 1985 – 2021, there is residual nitrate mass in the vadose zone at 5,000 lbs/acre.

Soil nitrate concentrations, soil moisture, and lithology for borehole B3 are shown in Figure 40. The largest nitrate concentration was observed at 100 feet with a concentration of 300 mg/kg. A medium-grained facies is also observed at this depth, which may have limited downward movement of nitrate. Three additional boreholes (B6, B7, and B8) were drilled in Field 50 to verify the large mass observed in B3. Soil concentrations from these new boreholes and B3 are shown in Figure 41.

Residual nitrate mass for this field was calculated as the average of the four boreholes (B3, B6, B7, B8). Although this field was generally irrigated from 1985 – 2021, there is a significant amount (17,000 lbs/acre) of residual nitrate mass in the vadose zone.

Soil nitrate concentrations, soil moisture, and lithology for borehole B4 are shown in Figure 42. The largest nitrate concentration was observed at 60 feet with a concentration of 17 mg/kg. A medium-grained facies is also observed at this depth, which may have limited downward movement of nitrate. Although this field was generally irrigated from 1985 – 2021, there is a moderate amount (3,400 lbs/acre) of residual nitrate mass in the vadose zone.

Soil nitrate concentrations, soil moisture, and lithology for borehole B5 are shown in Figure 43. This borehole is in a fallow field and the nitrate profile is representative of naturally occurring nitrate in a relatively undisturbed and unirrigated desert environment. The largest nitrate concentration (21 mg/kg) was observed at 5 feet in a coarse-grained facies. The mass of nitrate at this location is 400 lbs/acre.

Soil nitrate concentrations, soil moisture, and lithology for borehole MW-03 are shown in Figure 44. The largest nitrate concentration (49 mg/kg) was observed at 120 feet in a coarse-grained facies. Although this field was generally irrigated from 1985 – 2021, there is a substantial amount of residual nitrate mass in the vadose zone at 9,000 lbs/acre.

Soil nitrate concentrations, soil moisture, and lithology for borehole MW-08 are shown in Figure 45. The largest nitrate concentration (25 mg/kg) was observed at 40 feet in a coarse-grained facies. This field was irrigated in 21 of the last 37 years or 57 percent. Although the nitrate mass is only 2,700 lbs/acre at this site, it appears that the higher nitrate concentration may have moved downward to about 40 feet from the 5 – 20 feet, which is typical of unirrigated sites.

For reference, nitrate mass within unirrigated desert soil typically ranges between near zero to as much as 26,000 lbs/acre (Walvoord et al., 2003; Al-Taani and Al-Qudah, 2013). The range of nitrate mass (400 – 17,000 lbs/acre) in Warm Springs Valley falls within the range found in other desert environments.

Figure 46 shows the estimated total nitrate mass still in the vadose zone for all fields that have been irrigated in the past. The estimate of nitrate mass for fields with boreholes were calculated as the product of normalized mass (lbs/acre) and field area (acres). For those fields without boreholes, nearby boreholes were used to estimate normalized mass, and total mass was calculated as estimated normalized mass and field area. Field 50 where the four boreholes (B3, B6, B7, and B8) were drilled has by far the largest nitrate mass at 2.3 million pounds. Total mass for all previously irrigated fields is estimated to be 4.9 million pounds.

Less than one million pounds of excess nitrate was estimated to be in the aquifer beneath the irrigated areas in 1986. Thereafter, nitrate mass in the aquifer decreased to about 100,000 pounds indicating that the nitrate plume moved away from the study area and little to no nitrate loading occurred from the vadose zone. This is compared to the nearly 4.9 million pounds estimated to still be in the vadose zone. The significant amount of nitrate within the vadose zone could be remobilized as groundwater levels rise which would increase the nitrate mass and concentrations within the aquifer.

Nitrogen ($\delta^{15}N$) and oxygen ($\delta^{18}O$) isotopes of nitrate (NO_3) were used to identify the source in groundwater. There are two naturally occurring stable isotopes of nitrogen, ^{14}N and ^{15}N, and the corresponding natural abundances are 99.633% and 0.366%, respectively (Zhang et al., 2018). Oxygen is composed of three stable isotopes, ^{16}O (99.757%), ^{17}O (0.038%), and ^{18}O (0.205%). The stable isotope composition is usually expressed in delta (δ) units and a per mil (‰) notation relative to the respective international standards:

$$\delta = \left(R_{sample}/R_{standard} - 1\right) * 1000 \quad (1)$$

where the positive value and negative value of δ respectively represent the enrichment and impoverishment of heavy isotopes in test samples compared with a standard sample, respectively. The nitrogen and oxygen isotopic ratios (R) are reported as the per mil deviation from the $^{15}N/^{14}N$ or $^{18}O/^{16}O$ ratios relative to N_2 (air) and Vienna Standard Mean Ocean Water (V-SMOW).

The $\delta^{15}N$ and $\delta^{18}O$ compositions of nitrate differ in different potential sources. The $\delta^{15}N$ plays an important role in identifying nitrate from fertilizers (nitrate and ammonium based), soil nitrogen, manure, and sewage.

Figure 47 shows the $\delta^{15}N$ and $\delta^{18}O$ compositions from seven groundwater samples with elevated nitrate concentrations in WSV. Samples include the Pratt 3 production well (NO_3-N= 19 mg/L), Murphy production well (NO_3-N = 5 mg/L), Western Turf 1 production well (NO_3-N = 7 mg/L), Murphy domestic well (NO_3-N = 19 mg/L), MW-06 monitoring well (NO_3-N = 18 mg/L), and discrete vertical samples in MW-04 at 220 feet (NO_3-N = 82 mg/L) and 585 feet (NO_3-N = 6 mg/L).

The mean $\delta^{15}N$ of all seven samples is 8.0 ‰ with a range of 7.3 – 9.0. The mean of $\delta^{18}O$ is -0.7 ‰ with a range of -1.5 to -0.1. The range of $\delta^{15}N$ and $\delta^{18}O$ for each source type were taken from Zhang et al., 2019 and Kendall and McDonnell, 1998. All samples fall within the soil nitrogen, manure, and sewage zones. Although there are septic systems, and animal waste in the valley, there is not enough nitrate mass from these sources to have groundwater concentrations as large as measured. Therefore, the likely source of nitrate in this area is from naturally occurring nitrate from long-term accumulation of precipitation in the vadose zone.

Fluoride and iron exceeded EPA's SMCL in a few wells. Fluoride concentrations exceeded the SMCL of 2 mg/L in 14 percent of the wells tested. All five of the wells with fluoride concentrations above the SMCL were located near inferred geothermal upflow zones. Elevated fluoride concentrations in groundwater are known to be associated with geothermal outflow zones (Wang et al., 2021). Iron concentrations exceeded EPAs SMCL of 0.3 mg/L in 22 percent of the wells tested. There was no apparent spatial pattern associated with the elevated iron levels, but these seemed to be associated with older wells constructed with mild steel casing. A few of these wells with elevated iron concentrations were analyzed using unfiltered and filtered (0.45 micron) water samples. All the filtered samples had iron concentrations below the detection limit (0.1 mg/L) indicating that the iron is in colloidal form, likely from iron oxide coatings flaking from the casing.

Five irrigation wells (Pratt 1, Pratt 2, Pratt 3, Western Turf 1, and Murphy) were tested in 2021 for 97 pesticides and herbicides (see Table 2) including dichlorophenoxyacetic acid (i.e. 2-4, D), which was used historically on the agricultural properties. The pesticides and herbicides that were sampled for were not detected in any of the water samples.

BESST, Inc. conducted vertical profile sampling on six wells in WSV. The wells included MW-01, Truckee Meadows Fire Protection District well, MW-02, MW-04, Western Turf Test, and MW-06 as shown in Figure 48.

Vertical well profiling included several steps to calculate inflow zones, and zonal chemistry concentrations (e.g. nitrate, arsenic, chloride, fluoride, manganese, iron, and total dissolved solids) including 1) reviewing drillers logs to establish an understanding of downhole geology, 2) removing the existing pump column and pump, 3) installing and running a test pump to a single designated depth at a designated flow rate, 4) measurement of discrete inflow zones using a tracer flowmeter, and 5) collecting discrete water samples using a depth dependent sampler.

Zonal flow contributions were estimated through a series of calculations that translate tracer return times at discrete intervals into velocities and associated zonal flow rates.

Depth dependent groundwater sampling was used to collect downhole water chemistry samples that are co-located with the tracer injection depths. The flow-weighted raw laboratory values were then used to derive an estimate of the formational concentrations between each sequential pair of co-located tracer injections and depth dependent groundwater samples. These flow-weighted concentrations are named "mass balance results" and the raw chemical concentrations are named "laboratory results." The laboratory results represent an integrated concentration over a sampling zone, while the mass balance results represent a concentration at a specified inflow zone.

It is important to note that temporal and spatial variability may impact the interpreted chemical concentration results. First, significant calculation errors can be introduced to the mass balance results when the concentration gradient is large and there is very little flow contribution. Only the raw laboratory results are presented in this report.

In addition, the vertical concentration profile and composite concentration can vary according to total production rates. In some cases, the test pumping rate was less than typical production rates for a given well and the composite wellhead concentration for a particular constituent differed at these different flow rates.

Figure 49 shows the results of the BESST profiling at MW-01. Most of the inflow is coming from two zones at approximately 210 – 240 and 565 – 576 feet below land surface. A lower magnitude inflow zone occurs from 290 – 340 feet below land surface. Two pump settings (370 and 600 feet) were used for the discrete sampling and all constituents are in general agreement between the two sampling depths except for iron. Nitrate (as nitrogen) concentrations decrease with depth and all depths show concentrations well below (less than 1.6 mg/L) the MCL of 10 mg/L. Arsenic concentrations are relatively constant throughout the profile with concentrations ranging from 5 – 6 micrograms per liter (ug/L). Iron concentrations are variable throughout the profile and exceed the secondary MCL (0.3 mg/L) at the top (220 feet) and bottom of the profile for the deep pump setting and at the bottom (370 feet) of the pump setting for the shallow setting. The pH remains stable at 8.0 throughout most of the profile. Chloride decreases with depth from 55 mg/L at 220 feet to 40 mg/L at 600 feet below land surface. TDS concentrations decrease a small amount with depth with values of about 470 mg/L at 220 feet and about 400 mg/L at 600 feet.

Figure 50 shows the results of the BESST profiling at the TMFPD well. Inflow generally increases with depth, with the largest inflow at 490 – 500 feet below land surface. Temperature increased from 19^{o} C at 350 feet to above 25^{o} C at 500 feet. Arsenic concentrations were well above the MCL (10 ug/L) throughout the profile, and they generally decreased with depth. The largest arsenic concentration was 250 ug/L at 350 feet. Iron concentrations were also well above the SMCL (0.3 mg/L) and decreased with depth. Peak iron concentration was 90 mg/L at 350 feet. Chloride concentrations remained constant at 110 mg/L throughout the profile. TDS varied from 380 – 600 mg/L throughout the profile, but with no discernable trend with depth. Fluoride exceeded the MCL (4 mg/L) throughout the profile with concentrations ranging from 5.7 – 6.8 mg/L. Manganese exceeded the SMCL in the upper portion of the profile (350 – 440 feet). Elevated constituent concentrations (arsenic, iron, and manganese) are from geothermally induced groundwater and enter the borehole in the granitic formation.

Figure 51 shows the results of the BESST profiling at MW-02. Most of the inflow is coming from two zones at 245 – 620 and 760 – 780 feet below land surface. Two pump settings were used for the discrete sampling at 414 feet and 800 feet below land surface. Most of the constituent concentrations are similar between the two pump settings, except arsenic. Arsenic concentrations increase about 3 ug/L for the shallower pump setting. Nitrate (as nitrogen) concentrations decrease with depth from 18 mg/L at 245 feet to 3 mg/L from 400 – 780 feet. Arsenic concentrations are relatively constant throughout the profile with reported concentrations ranging of 5 – 8 ug/L for the deep pump set, and 8 – 10 ug/L for the shallow. Iron concentrations exceed the SMCL (0.3 mg/L) above 330 feet and at a few other depths (465, 555, 680, and 780 feet). The pH remains stable throughout most of the profile at about 8.0, then increases to 8.3 below 740 feet. Chloride concentrations are elevated (above 40 mg/L) from 245 – 300 feet then remain stable at about 35 mg/L to the bottom of the profile. TDS concentrations are also elevated above 300 feet, but decrease below that depth to a concentration of about 450 mg/L. Fluoride, manganese, and nitrite are not shown in Figure 51 as all concentrations were below detection.

Figure 52 shows the results of the BESST profiling at MW-04. Inflow occurs throughout the entire profile, but inflow rates are elevated from 360 – 380 feet below land surface. Two pump settings were used for the discrete sampling at 387 and 600 feet below land surface. The constituent concentrations are in general agreement between the two pump settings. There is no discernable trend in arsenic concentrations with depth with concentrations ranging from 3 – 7 ug/L. Iron concentrations were also above the SMCL (0.3 mg/L) from 240 – 340 feet. Chloride concentrations were elevated (30 – 108 mg/L) above 340 feet and remained constant at 28 mg/L for the remainder of the profile. In a similar fashion, TDS concentrations were elevated (above 800 mg/L) at the top of the water column and then decreased with depth to about 350 mg/L to total depth. Fluoride, nitrite, and manganese were not shown on Figure 52 because all were below detection limits throughout the entire profile.

Figure 53 shows the results of the BESST profiling at the Western Turf Test well. Inflow only occurs in the upper portion (250 – 470 feet) of the profile. Arsenic concentrations increase with depth from about 4 ug/L at 270 feet to 17 ug/L at 600 feet below land surface. Iron concentrations are generally above the SMCL (0.3 mg/L), except for a short section between 310 – 350 feet. Chloride concentrations were elevated (> 24 mg/L) from 250 – 410 feet and remained at 17 mg/L for the remainder of the profile. pH was also elevated above 440 feet at 8.1 and decreased below 8.0 to total depth. TDS concentrations decreased with depth from 340 mg/L at 280 feet to 120 mg/L at 600 feet. Nitrate concentrations were below 1.5 mg/L throughout the entire profile.

Manganese concentrations exceeded the SMCL (0.05 mg/L) below 440 feet. Fluoride and nitrite were not shown on Figure 53 because they were below detection limits throughout the entire profile.

Figure 54 shows the results of the BESST profiling at MW-06. Inflow occurs in two zones located at 260 – 420 feet and 510 – 580 feet. Arsenic concentrations are below the MCL (10 ug/L) for the entire profile. Iron concentrations are above the SMCL (0.3 mg/L) from 280 – 300 feet. Chloride concentrations are stable (40 mg/L) throughout the entire profile. The pH decreases with depth from 8.3 at 260 feet to 7.8 at 580 feet. TDS concentrations ranged from 340 – 420 mg/L) throughout the profile. Nitrate concentrations were above the MCL (10 mg/L) throughout the entire profile. Manganese, fluoride, and nitrite were not shown on Figure 54 because they were below detection limits throughout the entire profile.

Appendix A shows the water quality results from the existing and newly installed wells.

Geochemistry

The Desert Research Institute was contracted to evaluate geochemical properties of the WSV aquifer. Specifically, they evaluated the potential for arsenic to mobilize following injection of recycled and potable water.

Geochemical evaluation included a variety of tasks including 1) geochemical characterization of the aquifer sediments, 2) identification, and quantitation of potential harmful constituents, 3) determination of groundwater hydrochemical evolution by means of laboratory experiments and numerical models.

Leaching experiments and column experiments were conducted with aquifer material collected from WSV. Leaching and column experiments used recycled and potable water to determine the mobilization potential of each fluid type. For the leaching experiments different mixtures of recycled and potable water were continuously mixed with aquifer material and arsenic concentrations were quantified. Column experiments were designed by first allowing WSV groundwater to come into equilibrium with aquifer sediments, then recycled water was injected for six hours followed by another six hours of potable water injection. Six hours of injection represents approximately four pore volumes of fluid.

Results of the leaching experiments are shown in Figure 55. Experiments using 100 percent potable water produced higher arsenic concentrations which indicates more leaching. When 100 percent potable water meets aquifer sediments, arsenic concentrations increase on average 3.5 ug/L with a range of 3 – 4 ug/L. The experiment with 100 percent recycled water only increased arsenic concentrations 1 ug/L. Potable water releases more arsenic from the sediments because of the lower TDS concentration and the high and low abundance of silicates and iron silicates, respectively. The geochemical model (shown as red dashed line in Figure 55) agrees with the experimental results.

The results of the column experiments are shown in Figure 56. Column effluent concentrations begin at 6 ug/L which is the concentration of arsenic in groundwater at MW-08. After 50 minutes of recycled water flowing through the column, arsenic concentrations rise to 8 ug/L. Thereafter, arsenic concentrations decrease asymptotically to 2 ug/L at 350 minutes, which is lower than the arsenic concentration of recycled water (3.8 ug/L). After switching to potable water in the injection procedure, arsenic concentrations increased to a peak of about 12 ug/L at 650 minutes. Thereafter, arsenic concentrations decreased to 10 ug/L at 650 minutes.

The results of the column experiments are consistent with the leaching results which show that potable water reacts with the sediments. Late time arsenic concentrations reach an arsenic concentration near 10 ug/L which can be explained by the mineralogy.

Conceptual Hydrogeologic Model

Physiographic Setting

Physiographically, WSV can be divided into three regions: 1) mountains, 2) alluvial aprons, and 3) the valley floor. Figure 57 shows the topography and key geographic features within WSV. The highest elevation is in the northern portion of the basin at Tule Peak with an elevation of 8,700 feet above mean sea level (MSL). Elevations along the Pah Rah range in the southeast exceed 8,300 feet above MSL at Virginia Peak. Elevations decrease to 5,900 feet above MSL in the southwest along Hungry Mountain. Slopes are relatively steep on the alluvial fans and ultimately descend to the lowest point at Mullen Creek at 4,200 feet.

Climate

Annual precipitation is estimated to be 10 inches on the valley floor and up to 26 inches at higher elevations as shown in Figure 58 (PRISM, 2019). Washoe County, Department of Water Resources staff began installing storage type rain gauges in the valleys north of Reno in the 1990s. McEvoy and McCurdy, 2018 evaluated the Washoe County precipitation data and found that the change in precipitation with elevation was smaller than predicted with PRISM. Published reports and limited precipitation data collected by Washoe County suggest that average annual precipitation is on the order of 130,000 AFY (Klieforth et al, 1983; Ross, 1997) whereas PRISM estimates 182,000 AFY.

Hydrography

The valley has perennial, intermittent, and ephemeral streams (Figure 59). There are a limited number of perennial streams in the far north and south at higher elevations. There are two intermittent streams including Cottonwood Creek which drains the southeast portion of WSV, and Mullen Creek that drains a small subwatershed in the Painted Hills area. Neither stream reaches Mullen Pass except during periods of rapid snowmelt or heavy precipitation. Flooding may be a concern during these periods as the Cottonwood Creek channel is routed through the southernmost center pivot on the Western Turf and Palomino Farms properties. Mullen Creek, the only surface-water outlet from the basin, has a flow of less than 1 cubic foot per second for several days during the spring (Glenn et al., 1965).

Numerous springs exist throughout the valley, with most being in the higher elevations. The valley's namesake springs (Warm Springs) are hot springs located at the base of Dogskin Mountain.

Geology

There are four generalized geologic units: 1) Quaternary alluvium, which form the valley fill, 2) unconsolidated to semi-consolidated Tertiary sediments, 3) Tertiary volcanics, and 4) Mesozoic granodiorite.

Figure 60 shows the surficial geology within WSV. The Mesozoic granodiorite form the basement rock and outcrop in the Dogskin, Warm Springs, Hungry Mountains, and to a lesser extent in the Pah Rah Range. The Tertiary volcanics overlay the granodiorite and outcrop along the Pah Rah Range and in the mountains north of Winnemucca Valley. The Tertiary sediments occur in Hungry Valley and the south end of WSV and dip to the north/northwest. The Quaternary alluvium makes up the majority of WSV.

The structural basin below WSV is very deep, and few wells except at the valley margins penetrate the basement rocks (Ross, 1997). Gimlett, 1967 applied gravity-based geophysical methods to determine depth to bedrock. The estimated thickness of the basin-fill sediments is shown in Figure 61. Presumably, these sediments include the Quaternary alluvium and Tertiary sediments. At its deepest point, the basin-fill is over 3,400 feet thick. The bedrock high located in the central portion of WSV east of Pyramid Lake Highway was confirmed with five driller's logs. Logs in this area indicate depth to bedrock ranging from 200 – 290 feet.

The northwest-trending faults within WSV are part of the larger Warm Springs Valley fault system which extends 60 miles from WSV in the south to the Honey Lake Basin in the north and separates Dogskin Mountains and Fort Sage Mountains on the west from the Virginia Mountains to the east (Gold, et al., 2013). The Warm Springs Valley fault system is part of a network of closely spaced faults in the northern Walker Lane.

Soils/Vadose Zone

The soils drainage classification is shown for the agricultural parcels in Figure 62. This layer is derived from the 2019 version of the gSSURGO 30m (100 foot) rasters and is produced by the Natural Resources Conservation Service (NRCS). The value for drainage class is derived from the gSSURGO map unit aggregated attribute table field Drainage Class - Dominant Condition (drclassdcd). The agricultural area mainly consists of moderately to well-drained soil types. The well drained classification is defined as soils where water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep. Moderately well drained soils allow water to drain from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season. They commonly have a moderately low saturated hydraulic conductivity (0.1 ft/day) in a layer within the upper 3 feet.

Hydraulic Properties

Ten aquifer tests are known to have been conducted in WSV. Two tests were performed in Hungry Valley and the remainder in Warm Springs Valley (see Figure 63). Hydraulic conductivity values ranged from 1 to 100 ft/day, with a geometric mean of 10 ft/day.

The highest hydraulic conductivity (100 ft/day) was measured at a test well located to the southwest of the Pratt 2 irrigation well. (Washoe County, 1993). At this location, aquifer testing was performed at four wells in proximity but screened at various depths from 180 to 660 feet below land surface. Hydraulic conductivity decreased with depth with the highest value (100 ft/day) representing depths from 180 – 400 feet. Hydraulic conductivity decreased to 0.5 ft/day for the test well screened from 320 – 660 feet below land surface.

Another aquifer test was performed at the Stewart/Cochrane well located in the southeast portion of Warm Springs Valley. Interpretation of drawdown results yielded a hydraulic conductivity of 2 ft/day (Washoe County, 1997).

Two aquifer tests were performed in Hungry Valley (Kinder, 2012) but are not shown in Figure 63. A hydraulic conductivity of 13 ft/day was found for the well pair (7/8) located at the southwest end of Hungry Valley. A second test was performed at the southeast well pair (4/5) which yielded a hydraulic conductivity of 1 ft/day. These wells are completed in a combination of lower permeability fine-grained sediments with smaller and generally discontinuous coarse-grained units. The short term (24 hour) tests are most likely measuring the coarse-grained material and not necessarily the larger scale conductivity of the Tertiary sediments.

Six additional aquifer tests were performed as part of this study. Test results are presented above in the Hydrogeologic Investigation/Aquifer Test section.

Ross, 1997 estimated the spatial distribution of hydraulic conductivity using lithologic descriptions and specific capacity tests reported on driller's logs, interpretation of geophysical data, and the results of aquifer testing for the upper 330 feet of aquifer material. The spatial distribution of hydraulic conductivity was revised for this study based on newly acquired hydraulic conductivity data and groundwater level measurements. The resulting five hydraulic conductivity zones are shown in Figure 64. Zone 1 has the largest hydraulic conductivities (10^0-10^2 ft/day) and were interpreted along the main axis of WSV from the southern end of main agricultural to about three miles west of Pyramid Lake Highway. A less productive aquifer (10^{-1} - 10^0 ft/day) was mapped for the remainder of the alluvial sediments in WSV (Zone 3). Very low hydraulic conductivities (< 10^{-3} - 10^{-2} ft/day) were associated with the Tertiary sediments in Hungry Valley and the southeast end of WSV (Zone 2). Reworked sediments along the riparian zone in the north make up Zone 4 with a hydraulic conductivity of 10^1 ft/day. Consolidated rock units in the higher elevations have estimated hydraulic conductivities ranging between 10^{-3} to 10^{-2} ft/day (Zone 5).

Groundwater Source and Movement

Groundwater recharge within WSV is primarily derived from infiltration of precipitation and seepage from streams. Numerous investigators have estimated groundwater recharge in WSV as shown in Table 3. Recharge estimates range between 1,700 – 9,500 AFY (excluding the unverified estimate of 11,000 AFY from Sharp, Krater and Associates, 1974) with an arithmetic average of 4,400 AFY. The largest estimates are derived from empirical methods that relate precipitation to recharge (Epstein et al., 2010; Maxey and Eakin, 1949). The elevated recharge estimates may be due to overly inflated precipitation estimates because of an assumed precipitation versus elevation relationship that is quite large and generally unverified due to lack of precipitation data.

Pre-development discharge estimates of ET and interbasin flow range between 1,700 – 4,900 AFY. The relatively large range in discharge estimates is due to large uncertainty in ET rates. There are very few ET measurements for phreatophyte vegetation and small changes in ET rates lead to large changes in volumetric estimates.

The most reliable estimates of groundwater recharge are 1,700 AFY from Rush and Glancy, 1967 (ET estimate), 2,300 AFY from Ross, 1997 (chloride mass balance), and 2,800 AFY from the ET estimate produced herein. Therefore, the total range of reliable estimates is 1,700 – 2,900 AFY. The best estimate is assumed to be 2,600 AFY which more heavily weights the chloride mass balance analysis of Ross, 1997 and the ET analysis herein.

Groundwater recharge from the infiltration of precipitation and stream seepage is thought to infiltrate in the higher elevations and ultimately flow to the Quaternary alluvial aquifer.

Groundwater flows from areas of higher to areas of lower hydraulic head. The groundwater flow system is shown in Figure 65 which shows generalized groundwater levels, flow directions, geothermal upflow, and ET discharge in the Quaternary alluvial aquifer for pre-development and 2021 conditions.

Under pre-development conditions (prior to 1967) precipitation infiltrates and recharges the groundwater system in the higher elevations. Groundwater then flows into the basin fill sediments from the northwest, southwest, and southeast and moves toward the groundwater ET zone where more than 95 percent of the water discharges to the atmosphere with a minor amount flowing through Mullen Pass toward Pyramid Lake and possibly toward Spanish Springs to the south. Some of the groundwater flow moves within the fractured bedrock to sufficient depths to increase groundwater temperature and degrade water quality. The geothermal flow ultimately discharges into the alluvial sediments along a southeast to northwest geothermal outflow zone. The alluvial aquifer system is primarily unconfined as clay lenses are not continuous throughout the entire valley.

In the late 1960s agricultural production began as did groundwater pumping for irrigation water. Figure 66 shows the estimated historical pumping rates in WSV from 1965 – 2021. Estimates are based on NDWR pumping inventory data when available and extrapolated back in time based on water right initiation dates. Metered data were available for large irrigation wells from 2017 – 2021. Groundwater pumping increased rapidly from near zero in the late 1960s to 5,000 AFY in 1980s. Pumping remained relatively constant until 2010 when irrigation pumping declined by about 50 percent due to a significant decline in agriculture. Irrigation pumping makes up the majority (68 – 99 percent) of total pumping in the valley. Groundwater pumping for domestic, recreation, stock, and quasi-municipal uses steadily increased from near zero in 1965 to about 600 AFY in 2011. Pumping to mitigate TCE contamination increased from 60 to 560 AFY in 2012, bringing pumping rates from sources other than irrigation to more than 1,100 AFY. It is important to note that pumping for TCE mitigation is reinjected into the aquifer so none of this water is consumed. Pumping steadily increased from 2010 to 2019 as irrigation pumping returned with total pumping of 4,500 AFY in 2019. Thereafter, total pumping declined slightly to less than 4,000 AFY in 2021.

Irrigation pumping caused a significant change in the groundwater flow system as shown in Figure 65 for 2021. Groundwater that recharges in the higher elevations now moves toward the high capacity irrigation wells which significantly reduces groundwater ET. Pumping caused groundwater levels to decline by more than 125 feet in an elongated drawdown trough of about eight miles long and two miles wide in the direction of the main axis of the valley floor.

Water Quality

The primary water quality issues are elevated concentrations above the MCL for nitrate, arsenic, and fluoride. In addition, concentrations of iron, and manganese, do exceed the SMCL at a few well locations.

Nitrate

Nitrate concentrations have exceeded the MCL (10 mg/L) throughout large portions of the agricultural area. After initial agricultural development in the 1960s, nitrate concentrations increased significantly and by the mid-1980s nearly 1,500 acres beneath the agricultural area had concentrations above the MCL (see Figure 36). By 2021, the area with concentrations exceeding the MCL reduced to less than 200 acres.

The high nitrate concentration beneath the agricultural properties is likely due to leaching of naturally occurring nitrate from infiltrating irrigation water. Over the last thousands of years, precipitation provides a continual source of nitrate to the vadose zone, but in desert environments, the precipitation magnitude is not large enough to leach nitrate to the water table. This leaves large stores of nitrate above the water table, generally 5 – 20 feet below land surface.

Irrigating desert lands can increase the fluid flux to a point that naturally occurring nitrate will begin to migrate downward. If irrigation continues over a long enough period (usually tens of years), naturally occurring nitrate in the vadose zone can ultimately contaminant the underlying aquifer as was observed in WSV.

If irrigation is done infrequently or if fine-grained deposits exist beneath the irrigated lands, nitrate will move downward, but not all the way to the underlying aquifer. Figure 67 shows a conceptual diagram of this process. Prior to agricultural irrigation, the nitrate remains in the upper portion of the vadose zone (inset a). After intermittent irrigation or in locations with fine-grained facies that limit vertical migration of nitrate, the nitrate moves downward, but not all the way to the underlying aquifer (inset b). If fluid is injected for an ASR project, the water table rises and mobilizes nitrate previously held in the vadose zone.

Arsenic

Arsenic concentrations have exceeded the MCL (10 ug/L) along the north, west and southern portions of WSV (see Figure 35). The elevated arsenic concentrations are attributed to geothermal outflow zones. Highest arsenic concentrations (greater than 100 ug/L) are associated with upflow at fault structures located near Ironwood Road along the western margin of the valley (Figure 35). Arsenic concentrations are generally below the MCL in the agricultural area, but arsenic encroachment was observed in the mid-1980s during peak agricultural irrigation production (Figure 35).

Leaching and column experiments with WSV aquifer sediments and geochemical modeling indicate that arsenic concentrations may increase following injection of potable water. Arsenic concentrations may increase from 3 – 4 ug/L due to dissolution of arsenic bound to soil particles.

Fluoride

Fluoride concentrations exceeded EPA's SMCL (2 mg/L) in a few wells. Elevated fluoride concentrations in groundwater are known to be associated with geothermal outflow zones (Wang et al., 2021) and are associated with wells that also have high arsenic levels. Elevated fluoride concentrations are not as spatially extensive as arsenic and should remain limited to the geothermal outflow zones.

Iron

Iron concentrations exceeded EPAs SMCL of 0.3 mg/L in 8 of the 37 wells tested (22 percent). There was no apparent spatial pattern associated with the elevated iron levels, but these seemed to be associated with older wells constructed with mild steel casing. Iron contamination should not be a problem if stainless steel wells are used for municipal well production.

Manganese

Manganese concentrations more than the SMCL (0.1 mg/L) were observed in seven of the older monitoring wells. Mobilization of manganese as Mn(II) into groundwater occurs most readily in shallow groundwaters where subsurface strata possess Mn content, with enough dissolved oxygen to trigger manganese reduction (e.g., Mn(IV) to Mn(II)), while still maintaining a high enough redox status to allow manganese to remain dissolved in well water without precipitating manganese carbonate or other reduced manganese solids (Ramachandran et al., 2021). Therefore, shallow wells can yield higher concentrations of manganese when in contact with oxygen.

Elevated manganese concentrations were not observed in the deeper, high capacity wells, which would be like those used for an ASR project.

TDS

TDS concentrations in the project area do not exceed the SMCL of 1,000 mg/L as defined by the NDEP. Elevated TDS concentrations in the north are associated with the ET discharge area. The elevated concentrations on the west and south portions of WSV are associated with geothermal outflow. The SMCLs are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor.

Vadose Zone Model

Model Design

Two vadose zone models were developed to estimate the travel time for water and solutes that are applied at land surface to reach the water table. These estimates were used to verify the 10 – 20 year time frame in which naturally occurring nitrate flushed from the vadose zone leaching into the aquifer. Irrigation in Warm Springs Valley began in the later 1960s and elevated nitrate concentrations were observed in the late 1970s through the 1980s.

The HYDRUS-1D software package (Simunek, 2013) was used to simulate the movement of fluid and solutes from land surface to the water table at monitoring well locations MW-03 and MW-08 (see Figure 68). MW-03 is located at the edge of an actively irrigated alfalfa field and MW-08 is in a fallow field. Depth to the water table is approximately 190 and 240 feet for MW-03 and MW-08, respectively.

Soil hydraulic parameters were estimated based on the soil textural analysis. The laboratory classified each soil sample according to the Unified Soil Classification System (USCS). The HYDRUS-1D has a database of hydraulic parameters based on the U.S. Department of Agriculture (USDA) soil classification system so soil textures had to be converted from the USCS to the USDA system. Soil classification conversions were made using the Frankenstein, 2014 method. The soil classifications are provided in Table 4 and 5 for MW-03 and MW-08, respectively. The hydraulic parameters for each USDA soil class are provided in Table 6.

The initial condition was specified in water content for both models. Water content was measured in the soil samples taken from each borehole. Soil samples in the upper 80 feet of MW-03 were considerably drier than in the bottom 100 feet. An average water content of 0.13 was used to define the initial condition in the upper 80 feet and 0.22 from 80 – 190 feet for the MW-03 location. An average water content of 0.10 was used to define the initial condition at the MW-08 location.

The one-dimensional vertical vadose zone model grid was subdivided into 500 finite element cells for both models. Grid cell size was approximately 5 inches for MW-03 and 6 inches for MW-08.

Boundary conditions were defined at land surface and at the water table. A zero pressure head was defined at the water table. A specified flux boundary condition was defined at land surface to represent irrigated conditions. Irrigation was assumed to begin on April 1st and continue through October 15. Outside of the irrigation season a zero fluid flux was applied at land surface. Irrigation was applied at 125 percent of the net irrigation water requirement (NIWR). This is based on the maximum irrigation rate calculated for the alfalfa fields at Palomino Farms from 2017 – 2021 and then subtracting the full NIWR rate for plant ET. The NIWR for Basin 084 (Warm Springs) is 3.3 feet per year (ft/yr). Therefore, 25 percent excess is 0.8 ft/yr that can infiltrate into the soil and migrate to the water table. The 0.8 ft/yr is applied only during the irrigation season.

A unit concentration was applied to the upper boundary flux. Fluid concentrations were monitored at the water table to determine breakthrough of the excess irrigation water.

Both models simulated fluid and solute movement for a total of 30 years. Time stepping was adaptive based on the number of solver iterations required for the previous time step.

Results

Simulated solute breakthrough curve results for the MW-03 and MW-08 locations are shown in Figure 69. Initial breakthrough (relative concentration ~ 0.01) is at 10 and 19 years for MW-08 and MW-03, respectively. The coarse sediments and high permeability at MW-08 allow for more rapid migration to the water table than MW-03 which has a larger percentage of fine sediments. These results are consistent with the elevated nitrate concentrations measured in the aquifer beneath the agricultural area in the mid-1980s, which is 10 – 15 years after agricultural started in the valley.

Groundwater Flow Model

A groundwater flow and transport model were developed to verify the conceptual model and to predict groundwater levels and water quality under various management strategies. The sections below describe previous models in WSV, model development and calibration.

Previous Models

Two groundwater models have been developed within the Warm Springs Valley (Ross, 1997; Kinder, 2012).

Ross, 1997 developed a groundwater flow model for the basin-fill aquifer within Warm Springs Valley. The model simulated the basin-fill sediments with a 500 meter (1,640 feet) horizontal grid cell resolution with three layers to a maximum depth of approximately 1,000 meters (3,280 feet).

A steady-state pre-development, transient historical (1967 – 1995), and predictive models (1995 – 2095) were developed. Hydraulic conductivity was calibrated using the steady-state model and storage parameters using the transient model. The predictive model was used to evaluate the effect of various pumping scenarios with net pumping rates up to 7,200 AFY.

Boundary conditions included recharge from infiltration of precipitation of 2,350 AFY, subsurface inflow from Spanish Springs Valley of 100 AFY, a head-dependent boundary to represent outflow through Mullen Pass, and groundwater ET for phreatophytes located in the central portion of the valley.

Calibration of the steady-state model yielded largest hydraulic conductivities (3 – 16 ft/day) along the main axis of the valley from the southern end of the basin-fill sediments to about where Mullen and Cottonwood Creek exit the valley. Other basin-fill sediments along the valley margins were simulated with significantly lower hydraulic conductivity values (0.01 – 0.2 ft/day).

The transient predictive model was able to correctly simulate water level declines of more than 110 feet in the central portion of the valley in response to irrigation pumping. In addition, the model predicted declines in groundwater ET in 1995 to 20 percent of predevelopment levels.

Predictive simulations showed continued groundwater declines when pumping continued at rates like those in the 1980s and 90s. Simulations with net pumping rates greater than 7,000 AFY were not completed due to numerical instabilities.

Kinder, 2012 developed a two-layer flow model of the Hungry Valley area to optimize groundwater pumping rates while minimizing drawdown effects. The hydrogeologic system was conceptualized as a confined basin-fill aquifer consisting of low-permeability alluvial sediments consisting of clays and silts with limited sand lenses. The sands were thought to be laterally discontinuous over large areas but most likely intersect faulted bedrock along mountain front areas, as indicated by artesian conditions found at several of the test and production wells. The upper-most layer was simulated with a hydraulic conductivity of 3×10^{-4} feet per day (ft/day) representing the fine-grained Tertiary sediments. The lowermost layer was simulated with varying hydraulic conductivity ranging from 10^{-4} to 5×10^{-1} ft/day, with the higher values representing confined aquifer unit. Hydraulic conductivities developed from aquifer tests in test wells completed in the aquifer ranged from 1 – 10 ft/day. The model assumed a recharge rate of 280 AFY. Horizontal flow barriers were required to ensure simulated heads agreed with measured values. Model optimization was used to propose a pumping strategy that reduced groundwater level declines throughout Hungry Valley.

Grid Design

The active model area includes 251 square miles within the Warm Springs hydrographic area (Figure 70). The model was defined with 660 feet (200 meter) horizontal grid cell resolution over three layers. The top of the model is defined by land surface which was interpolated from a 98 feet (30 meter) digital elevation model (DEM). Layer 1 represents Quaternary alluvium, Tertiary sediments, and consolidated rock units in the higher elevations. Maximum thickness of layer 1 is 740 feet representing the higher permeability younger sediments. Layer 2 represents the older alluvium and Tertiary sediments in areas where the basin-fill exceeds 740 feet and consolidated rocks elsewhere. Layer 3 represents consolidated rocks only.

The maximum thickness (740 feet) of the higher permeability Quaternary alluvium is based on interpretations of lower permeability with depth and maximum depth of high capacity irrigation wells (Glenn, 1968; Ross, 1997; Washoe County, 1997).

The grid origin is located at 256,000 meters east and 4,390,200 meters north and the model is referenced to the Universal Transverse Mercator (UTM) projection using the NAD83 projection in Zone 11 north.

Temporal Framework

Two models were developed for this analysis. The transient historical model simulated the period 1965 – 2021 using annual time steps from 1965 – 2017 and monthly timesteps thereafter. Monthly timesteps were used after 2018 to achieve model calibration with high resolution groundwater level data that became available. The first timestep (and stress period) is simulated as steady state, representing pre-development conditions (prior to about 1965) and the remaining time steps are transient. The transient predictive model simulates the period 2022 – 2072.

Software

All groundwater flow simulations were run using MODFLOW-NWT (Niswonger et al., 2011). The program relies on the Newton solution method and unstructured, asymmetric matrix solver to calculate groundwater head (Knoll and Keyes, 2004). MODFLOW-NWT is specifically designed to work with the upstream weighted (UPW) package to solve complex unconfined groundwater flow simulations to maintain numeric stability during the wetting and drying of model cells. The UPW package replaces the traditional MODFLOW packages including the block-centered flow (BCF), the layer-property flow (LPF) and the hydrogeologic-unit flow (HUF). The UPW package differs from these previous packages by smoothing the horizontal-conductance function and storage-change function during wetting and drying to provide continuous derivatives for the solution by the Newton method, as opposed to a linear approach to their calculation. While smoothing introduces some error, the smoothing interval is defined by the user and can be made very small (e.g. $1x10^{-5}$) to limit numeric dispersion.

MODFLOW-NWT offers two matrix-solver options: the generalized-minimum-residual (GMRES) solver (Saad, 2003) and the Orthomin/stabilized conjugate-gradient (CGSTAB) solver. The GMRES is used for the WSV models. Input relies on the preset “Moderate” solution parameters for the steady-state model and the “Moderate” option for the transient models. The maximum head change between outer iterations is set at 3×10^{-4} feet and the maximum root-mean-squared error (RMSE) in flux difference for outer iterations is set equal to 140 gpm (750 m^3/day).

The model was developed within the Groundwater Modeling System (GMS) environment (version 10.5.6). GMS acts as a database for all the hydrogeologic information and provides an easy to use pre- and post-processor for MODFLOW.

Hydraulic Properties

To allow for spatial differences in hydraulic properties within the model area, the model grid was delineated into six property zones. Zone 1 represents the high permeability Quaternary alluvium in the central portion of the basin in model layer 1. Note that the layout of zone 1 is like the high permeability zone mapped in Ross, 1997, but it was extended further to the northwest. This was required to match groundwater level trends in this area that show a strong hydraulic response to irrigation well pumping east of Pyramid Highway. Zone 2 represents the low permeability Tertiary sediments in Hungry Valley and the south end of Warm Springs Valley (layer 1). Zone 3 represents moderate permeability Quaternary alluvium in model layer 1. Zone 4 represents a zone of high permeability along the riparian corridor in the northwest portion of the model domain. Zone 5 represents the consolidated rock units in all three layers. Zone 6 represents the moderate permeability alluvium in layer 2.

The pilot point method (Doherty, 2003) was used to allow a smooth spatial variation in hydraulic conductivity for zones 1 and 5 (high permeability Quaternary alluvium and consolidated rocks). Pilot points are discrete locations distributed throughout the model area that represent measured values of hydraulic conductivity and surrogate parameters from which hydraulic conductivity values are interpolated to the model grid using an interpolation process (Doherty and Hunt, 2010). Zone 1 contained 21 pilot points of which 8 are measured values obtained from aquifer tests. A total of 44 pilot points were used in zone 5, none of which were measured values.

Boundary Conditions

Recharge from Infiltration of Precipitation

Groundwater recharge from the infiltration of precipitation was simulated using the recharge package. Four recharge zones were developed to cover areas with precipitation above 10 inches per year as defined by the PRISM isohyetal map (PRISM Climate Group, 2019). The zones include the northwest (Dogskin Mountain and the range to the east of Winnemucca Valley area), southwest (Hungry Mountain and Warm Springs Mountain and portions of Hungry Valley), southeast (Pah Rah

Range), and geothermal outflow at various locations along the central axis of the valley.

The average annual recharge from infiltration of precipitation was determined to be 2,600 AFY (see Recharge/Discharge section). Recharge was partitioned to each zone based on the relative proportion of recharge as defined by the Epstein, et al., 2010 method. A small amount of recharge (37 AFY) was assigned to the geothermal upflow zones in layer 2 of the model. The fluid flux at each upflow zone was adjusted to achieve agreement between the simulated and measured spatial distribution of the geothermal outflow zone. The distribution of the average annual recharge is shown in Figure 71. The southeast portion of the basin produces 54 percent (1,400 AFY) of recharge, the northwest 27 percent (700 AFY), 18 percent (500 AFY) from the southwest, and one percent (37 AFY) from geothermal upflow. A majority (83 percent) of the geothermal upflow occurs in the two northernmost fault zones.

Recharge is scaled to precipitation for the transient historical model. The Reno airport gage was used as the basis for the annual scaling factors (Western Regional Climate Center, 2021). Figure 72 shows the resulting groundwater recharge scaling factors for 1965 – 2021. Note that 1965 had an actual scaling factor of 1.31 but was adjusted to 1.0 to represent the steady-state stress period.

Domestic Wells

Domestic wells are included at the centroid of each domestic parcel that is served by a well. Pumping for each domestic well begins in the year that well was drilled, for a total of 561 domestic wells (Figure 73). Domestic wells were placed in the first active model layer.

The domestic well rate was assumed to be 0.9 AFY which assumes total pumping of 1.1 AFY and 0.2 AFY of return flow through septic systems. These rates are 10 percent larger than estimated by the Nevada State Engineer's Office (1 AFY) in their annual groundwater pumpage inventory (Marr, 2017). The slight increase is to account for the relatively large parcel size (mean = 54 acres). Figure 74 shows the domestic well pumping rate throughout the model simulation period (1965 – 2021). Total domestic well pumping in 2021 is estimated at 540 AFY.

Other Wells

A total of 23 other active wells were identified in Warm Springs Valley (Figure 75). The other pumping categories include environmental (14), stock (1), recreational (2), and quasi-municipal (6). Pumping for stock water, recreational, and quasi-municipal wells was 104 AFY in 2021. Environmental wells are for the mitigation of TCE at the Boeing properties. Pumping for the treatment of TCE was 556 AFY in 2021, but all the water is reinjected back into the aquifer so these wells are not simulated explicitly in the model (personal communication with McGinley and Associates January 3, 2022). The stock well is for the U.S. Bureau of Land Management's wild horse adoption facility. Recreational wells include the glider and shooting facilities. Quasi-municipal wells include water supply for Hungry Valley residents and the small water company at the Palomino Valley Estates.

Well discharge was estimated for 2017 by the Nevada Division of Water Resources (Marr, 2017). The 2017 rates were used for each well back to the original permit date. Pumping for each pumping category is shown in Figure 74.

Irrigation Wells

A total of 33 active irrigation wells were identified in Warm Springs Valley. For accounting purposes, the wells were categorized into large and small producers as shown in Figure 76. Large producing wells are those will annual production rates greater than 75 AFY and are associated with Palomino Farms, Western Turf, LW, and the Duin property in the northwest.

Irrigation well discharge for the small producers were estimated from a variety of sources from 1965 – 2021. Production rates in 2017 were obtained from the NDWR (Marr, 2017) for the small producers. The 2017 rates were assumed to represent rates from 2017 – 2021 and then projected back in time to the original permit date.

Pumping rates for the large producers were estimated from metered data, NDWR, and Landsat data. Water meter data were available from 2013 – 2021 for the three Pratt wells (1 – 3), the active Western Turf well (WT-1) and the Murphy well. Total irrigation pumping estimates were available from Ross, 1997 for 1967 – 1995 and from the Nevada Division of Water Resources (NDWR) for 1996 – 2012 (Marr, 2017). Prior to 2013 total pumping from the large producers was taken as the difference between the total irrigation rate and the small irrigation rates. Partitioning amongst individual wells was based on the metered data over the period 2013 – 2021. Landsat data was used from 1984 – 2019 to estimate when the center pivot near the Duin well was in production and pumping rates were based on permitted duty and vigor of the alfalfa crop.

The resulting irrigation pumping rates are shown in Figure 77. Although irrigation pumping has varied historically, it always makes up most of the pumping in the valley. Irrigation pumping increased steadily from zero in 1965 to about 4,800 AFY in 1981. Irrigation pumping remained relatively stable through 2009 and then decreased to less than 2,000 AFY from 2010 – 2013. Thereafter, pumping increased steadily to about 3,800 AFY in 2019 and declined to 2,900 AFY in 2021.

Interbasin Flow

Interbasin flow was simulated through two general head boundaries to represent inflow from Spanish Springs Valley and outflow through Mullen Pass. The general head boundary representing flow to Mullen Pass used a head value of 4,167 feet above mean sea level (AMSL) and a conductance of 3 ft/day in model layer 1. The general head boundary representing flow to Spanish Springs Valley used a head value of 4,511 feet MSL and a conductance of 3 ft/day.

Groundwater Evapotranspiration

Groundwater ET was simulated using the ET package in Modflow. Groundwater ET was applied to the previously mapped pre-development discharge zone as shown in Figure 3 (Katzer, 1997).

The maximum ET rate for the phreatophytes was specified as 1.2 ft/yr as defined by Nichols, 1994. Extinction depth was set at 30 feet. These parameters are representative of greasewood with a 20 percent density and are the same parameters used by Ross, 1997 in the previous groundwater model. Land surface was defined by a 98 foot (30 m) Digital Elevation Model (DEM). Modflow assumes a linear relationship between depth to water and ET rate. The parameters used are a linear approximation of the Nichols, 1994 relationship shown in Figure 78.

Model Calibration

Methodology

Model calibration is the process of estimating model parameters to minimize the differences, or residuals, between observed (measured or estimated) data and simulated values. The observed data that are used in model calibration are generally referred to as calibration targets. Groundwater levels measured between 1980 – 2021 were used as calibration targets.

A manual calibration process was used to minimize the differences between the simulated and observed water levels. Parameters that were adjusted in the calibration process include the bulk hydraulic conductivity for the older alluvium, Tertiary sediments, hydraulic conductivity at multiple locations to develop a heterogeneous hydraulic conductivity field for the high permeability alluvium and consolidated rocks, fault characteristic parameter for four horizontal flow barriers, and storage parameters (specific yield and specific storage) for all six of the hydraulic property zones.

The method of pilot points (Doherty, 2003), in which hydraulic conductivity is estimated for a set of point locations within the model area, was used to estimate the horizontal hydraulic conductivity in the consolidated rock units and high permeability alluvium. The method of pilot points was used to interpolate a smooth hydraulic-conductivity field and apply the resulting spatially variable distribution of hydraulic conductivity to the model grid.

The storage parameters (specific storage and specific yield) were adjusted during the calibration with the goal of replicating observed trends in hydraulic head.

A total of 80 parameters were adjusted during model calibration. These include five bulk hydraulic conductivity values for five hydrostratigraphic zones (original five zones were further subdivided), seven specific yield values, seven specific storage values, 44 pilot points within the consolidated rock units, 13 adjustable pilot points within the high permeability alluvial unit, and four fault characteristics. Note that the eight measured hydraulic conductivity values were not adjusted during calibration.

Calibration Results

Calibration results are described through optimal parameter estimates for horizontal hydraulic conductivity, specific storage, specific yield, and fault characteristics. The model was primarily evaluated using a visual comparison between simulated and measured groundwater levels.

The final hydraulic conductivity distribution for layer 1 is shown in Figure 79 and layer 2 in Figure 80. Hydraulic conductivities within the high permeability alluvium range between 0.9 – 100 ft/day. The calibration yielded a hydraulic conductivity of 0.7 and 30 ft/day for the older alluvium and riparian corridor in the north, respectively. The hydraulic conductivity Tertiary sediments was 3×10^{-4} and 3×10^{-3} ft/day for the Hungry Valley region and southwest, respectively. The hydraulic conductivity of the consolidated rocks ranged between 3×10^{-3} - 3×10^{-1} ft/day.

The calibrated fault characteristics for the four horizontal flow barriers are shown in Figure 81. Fault characteristic values ranged between 10^{-6} – 10^{-3} day^{-1}.

The final calibrated values for specific yield are 0.015, 0.1, 0.2, 0.1, and 0.01 for the high permeability alluvium at the center of Warm Springs Valley, Tertiary sediments, older alluvium in layer 1, older alluvium in layer 2, and consolidated rock units, respectively.

The transient historical model was able to replicate the general magnitude and trends at most of the 27 wells used as calibration targets. The location of these wells is shown in Figure 82. Figure 83 - Figure 109 show the simulated and measured hydrographs for the transient simulation.

Simulated groundwater level magnitude and trends are in excellent agreement with measured values in 23 of the 27 wells. The mean absolute error (MAE) for the transient simulation is 18 feet. Simulated groundwater levels range from 4,089 to 5,368 feet or a total range of 1,279 feet. The relative error (MAE/Head Range) is 1.4 percent. Typically, models that have a relative error less than 10 percent are deemed acceptable for predictive purposes. Those models with a relative error less than 5 percent are considered excellent.

The simulated versus measured groundwater levels are shown in Figure 110. The plot does not suggest any bias with magnitude.

The spatial distribution of error (MAE) for the 27 wells where groundwater levels were used as calibration targets is shown in Figure 111. Lowest errors are found near the Palomino Farms study area.

The notable locations where groundwater trends were not simulated properly include wells 10, 15, 17, and 21. All four of these wells are located well outside of the Palomino Farms area.

Location 10 is located near the intersection of Pyramid Highway and Ironwood Road. This well is used by the Palomino Valley General Improvement District to fill water trucks for dust suppression. Pumping records were not available for this well which is why the model was not able to simulate the irregular trends.

Location 15 appears to be a domestic well where we do not have historical pumping records. Water levels in this well have increased since about 2014-2015, perhaps in response to decreased pumping at this location.

Location 17 is located at the far north end of WSV, near Winnemucca Ranch Road. The well is located next to an ephemeral stream. Seepage from this stream is not simulated explicitly and is likely causing temporal variability in groundwater levels.

Location 21 is at the Washoe County shooting facility near Pyramid Highway. Again, pumping records are not available at this site so irregular pumping rates are not simulated in the model.

Figure 112 shows the recharge and net groundwater storage into the aquifer for the transient historical model. Groundwater recharge varies linearly with local precipitation which results in a range of 2,200 – 3,200 AFY. The long term average is 2,600 AFY. Groundwater storage into the model increases as groundwater pumping increases. Groundwater storage into the model indicates decreasing groundwater levels. Groundwater storage increases rapidly to about 3,000 AFY in 1973 where it remains relatively constant until 2010 when it decreased to about 500 AFY in response to decreased pumping. Thereafter, storage into the model increased to above 1,500 AFY.

Figure 113 shows groundwater pumping, ET, and net interbasin flow for the transient historical model. Pumping increased rapidly to about 1,900 AFY in 1967 where it remained relatively constant. Pumping increased again through 1974 to about 4,000 AFY. Thereafter, it varied between 4,000 – 5,000 AFY until 2009. Pumping decreased from 2010 – 2013 to about 2,400 AFY. Pumping increased again through 2019 to about 4,400 AFY. ET gradually declines from about 2,400 AFY in 1965 to 600 AFY in 2021 due to declining water levels.

Cumulative changes in groundwater storage for the central portion of the basin-fill aquifer are shown in Figure 114. Loss in groundwater storage is linear through 2010 when pumping declines significantly. Total groundwater storage loss from 1965 – 2021 in the central portion of the basin-fill sediments is nearly 80,000 acre-feet.

The model simulated interbasin flow through Mullen Pass toward Pyramid Lake and south toward Spanish Springs. Flow through Mullen pass was simulated at 31 AFY in 1965, decreasing to 29 AFY in 2021. Flow to Spanish Springs was simulated at 119 AFY in 1965, decreasing to 110 AFY in 2021. Note that Ross, 1997 simulated inflow from Spanish Springs at 114 AFY. Flow across this basin boundary is uncertain, but not critical to simulating groundwater flow in the Palomino Farms area.

Simulated drawdown from 1965 – 2021 is shown in Figure 115. The drawdown cone (as defined by the 25 foot contour) is approximately eight miles long (along main axis of valley) and two miles wide. Groundwater levels declined more than 125 feet around the large capacity agricultural wells which pumped the largest volumes of water in the valley.

Groundwater Transport Model

A solute transport model was built using MT3D-USGS (Bedekar et al., 2016) to simulate the migration of arsenic and nitrate. The transport simulation utilized the Advection (ADV), Dispersion (DSP), Source and Sink Mixing, and Generalized Conjugate Gradient Solver (GCG) Packages.

Two time periods were simulated to test the conceptual model and determine the how nitrate and arsenic will migrate in the future under various management scenarios. Arsenic was simulated under predevelopment conditions to determine if the specified geothermal outflow zones were consistent with measured arsenic concentrations throughout WSV. Predictive simulations 50 years into the future were simulated for both arsenic and nitrate under four management scenarios.

The third-order TVD ULTIMATE solution algorithm was used to solve the advection-dispersion equation (Leonard and Niknafs, 1991). The ULTIMATE scheme is mass conservative, without excessive numerical dispersion, and essentially oscillation-free.

Longitudinal dispersivity was set to 160 ft. Dispersivity is a scale-dependent parameter and as such is typically set based on the maximum migration distance (Gelhar et al., 1992). Horizontal transverse dispersivity ratio was set to 0.1 and the vertical transverse dispersivity ratio was set to 0.01.

The arsenic mass flux for the geothermal outflow was adjusted to achieve a general agreement between simulated and measured arsenic concentrations throughout WSV. The steady-state pre-development flow model (i.e., no pumping) was used to calibrate the location and magnitude of arsenic flux within the geothermal outflow zone. The transport simulation was run until equilibrium conditions were met to reduce the sensitivity of the solution to the initial condition. The arsenic concentration of the geothermal outflow was set to 1,000 ug/L which is consistent with other geothermal reservoirs in northern Nevada, (Pohll, 2019). The fluid flux was from each geothermal fault was adjusted until the simulated aquifer arsenic concentrations matched observed values. Fluid flux ranged from 1 – 15 AFY as shown in Figure 71.

Nitrate mass was added to the aquifer to represent remobilization due to the rising water table encroaching on residual nitrate within the vadose zone. Details on the magnitude and timing of the nitrate loading for each of the predictive scenarios are provided in the next section “Aquifer Storage and Recovery Feasibility.”

The initial conditions for the predictive simulations were taken from the interpolated measurements as shown in Figure 35 and Figure 36, for arsenic and nitrate, respectively.

Aquifer Storage and Recovery Feasibility

Evaluation Criteria

ASR feasibility is evaluated through groundwater flow and transport simulations of various injection and pumping alternatives. Multiple evaluation metrics were used including: 1) depth to groundwater throughout WSV to ensure that no undesirable shallow groundwater conditions develop, 2) spatial distribution of arsenic and nitrate concentrations to ensure that migration pathways do not create undesirable conditions in WSV, and 3) nitrate and arsenic concentrations at proposed municipal well locations to ensure that water quality meets water quality standards for human consumption.

Operational Scenarios

Four scenarios were developed to evaluate the full range of conditions for the proposed aquifer storage and recovery project. In all cases, TMWA will supply 1,300 AFY of potable water to recharge the groundwater system. The four scenarios represent increasing levels of municipal well pumping:

1. No municipal well pumping.
2. Municipal pumping of 1,300 AFY starting immediately.
3. Municipal pumping of 2,500 AFY starting in year 10.
4. Municipal pumping of 1,200 AFY for seven years, followed by 4,200 AFY for three years, starting at year 10.

Scenario 1 represents a case in which potable water is stored in the WSV aquifer without extraction for municipal use over the next 50 years. Scenario 2 represents a case in which the same of amount of water (1,300 AFY) is extracted for municipal use as is injected. Two municipal wells (1 and 3) are used for this scenario as shown in Figure 116. Scenario 3 represents a case in which potable water is used to replenish groundwater storage over the next ten years, then a sustainable amount (2,500 AFY) is used thereafter. Sustainability is based on having stable groundwater storage volumes. Two municipal wells (1 and 3) are used for this scenario as shown in Figure 116. Scenario 4 represents a case in which potable water is used to replenish groundwater storage over the next ten years, municipal water is extracted according to an expected drought frequency. Under this scenario, smaller amounts (1,200 AFY) are extracted for seven years of assumed near-normal precipitation periods, followed by three years of drought conditions when larger amounts (4,200 AFY) are pumped. Three municipal wells (1, 2, and 3) are used for this scenario as shown in Figure 116. Municipal well pumping for Scenarios 2 – 4 is simulated from April – October.

It is important to note that Scenarios 3 and 4 are the most likely operational scenarios to be implemented. Scenarios 1 and 2 were simulated to quantify the maximum storage volume available within the project area.

Recycled water was assumed to be used to irrigate the existing agricultural properties, and therefore current irrigation pumping will cease (Palomino Farms, LW, and Western Turf). Irrigation will be limited to the NIWR such that little if any seepage beneath the root zone will occur. Groundwater recharge beneath the irrigated areas will be minimal and not impact the hydraulics within the aquifer. As such, the irrigation using recycled water is not simulated explicitly in the groundwater model.

The groundwater model was setup to simulate 50 years into the future. The initial hydraulic head distribution was taken from the last timestep (2021) of the transient historical model.

Groundwater pumping outside of the project area was assumed to continue at 2021 rates for the entire 50 year simulation. This includes pumping for domestic, stock, recreational, and quasi-municipal uses for a total of 800 AFY. The only agricultural pumping that continued in the future was 71 AFY at the small parcel to the east of the Palomino Farms property (i.e., Tom Pratt's agricultural well). All water used for environmental use is reinjected and not included in the future simulations. Therefore, total non-municipal pumping for all scenarios is 871 AFY.

All four scenarios assume 1,300 AFY of potable water injection in three wells (see Figure 116) over a five month period (November – March). The magnitude of the potable water injection was primarily constrained by infrastructure capacity in the Spanish Springs area.

Arsenic and nitrate transport are simulated for each of the four scenarios 50 years into the future.

Geothermal outflow is assumed to be the only arsenic source beyond arsenic already in the shallow aquifer. Total arsenic loading from the geothermal reservoir is 100 pounds per year (37 AFY at a concentration of 1,000 ug/L).

Nitrate loading is based on the position of the water table relative to the mass stored in the vadose zone. The total mass stored in the vadose zone beneath previously irrigated fields is 4.9 million pounds. The magnitude of nitrate loading is based on the simulated position of the water table relative to where the residual mass is stored in the vadose zone. Scenarios that simulate a higher water table will result in larger nitrate mass loading to the aquifer. The timing of the nitrate loading is based on the rate at which the water table encroaches on the residual nitrate in the vadose zone. Table 7 shows the magnitude and timing of the nitrate loading for the four model scenarios. Figure 46 shows the spatial distribution of nitrate mass within the vadose zone for Scenario 1. Nitrate mass for Scenarios 2 – 4 are scaled according to Table 7.

Simulated cumulative change in groundwater storage and change in groundwater levels are predicted for all for scenarios. Groundwater storage change calculations are limited to the basin-fill area where nearly all the storage change occurs from proposed simulated aquifer storage and recovery project (see Figure 117). Figure 117 also shows the location where simulated groundwater level changes (i.e., "drawup") are monitored.

Simulated cumulative groundwater storage for the four scenarios is shown in Figure 118. In Scenario 1 groundwater storage increases on the order of 2,500 AFY during the first two decades, which is about double that of the injection rate of 1,300 AFY. The rapid storage increase is due to ASR injection and a significant decrease in groundwater pumping which allows natural recharge to replenish the aquifer.

In Scenario 2, groundwater storage increases about 1,400 AFY during the first two decades. Although municipal pumping is equal to ASR injection in this scenario, groundwater storage continues to increase due to decreased pumping and natural recharge.

In Scenario 3, groundwater storage increases 2,500 AFY during the first decade because municipal pumping does not begin until after year 10. Thereafter, municipal pumping of 2,500 AFY causes groundwater storage to stabilize at approximately 23,500 acre-feet. In this scenario the pumping rate is 2,500 AFY and the injection rate is 1,300 AFY for a net difference of 1,200 AFY. This result emphasizes that the net sustainable pumping rate in the project area is 1,200 AFY.

In Scenario 4 groundwater storage increases 2,500 AFY during the first decade because municipal pumping does not begin until after year 10. Thereafter, the cycle of pumping at 1,200 AFY for seven years and 4,200 AFY for three years causes a slow increase in groundwater storage for the remaining 40 years. Cumulative groundwater storage gain from year 10 to 50 is about 10,000 acre-feet.

Simulated increases in groundwater levels near the center of the project area (see Figure 117 for monitoring point location) is shown in Figure 119. Groundwater levels increase rapidly in Scenario 1 by 120 feet over the first two decades. Thereafter, water levels asymptotically approach an increase of 140 feet.

Groundwater levels increase more slowly in Scenario 2 with an increase of about 60 feet after 10 years and approaching 120 feet after 50 years.

In Scenario 3 groundwater levels follow the same pattern as Scenario 1 for the first decade with an increase of nearly 100 feet. Thereafter, groundwater levels fall about 15 feet and achieve a new equilibrium position of 75 feet above 2021 levels.

In Scenario 4, groundwater levels follow the same pattern as Scenario 1 for the first decade with an increase of nearly 100 feet. Thereafter, groundwater levels decrease by about 50 feet following the three year high production period (4,200 AFY). During the seven year low production (1,200 AFY) period groundwater levels rise another 50 feet. This cycle repeats for the remaining three decades with a small long-term upward trend.

Undesirable shallow groundwater conditions were monitored in all the Scenarios by calculating depth to groundwater within the basin-fill aquifer. Undesirable shallow groundwater conditions are defined as a depth to groundwater of 10 feet or less. This condition was only observed in Scenario 1 after 32 years of operation and once the cumulative groundwater storage exceeded 45,000 acre-feet (see Figure 118). Figure 120 shows the maximum extent of the undesirable shallow groundwater conditions after 50 years of operation for Scenario 1. The shallow groundwater covers an area of approximately 430 acres north of Palomino Farms. There are ten developed parcels within the shallow groundwater area.

Figure 121 shows the average arsenic concentrations at municipal wells for Scenarios 2 – 4. Arsenic concentrations for Scenario 1 are not shown because there was no municipal pumping in that scenario.

Scenario 2 shows a small increase in arsenic concentrations from 4 ug/L in the first year to just above 5 ug/L after eight years. Thereafter, arsenic concentrations decline to 2 ug/L by year 50. The small increase in arsenic concentrations is due to municipal pumping (1,300 AFY) which draws some of the arsenic coming from the geothermal outflow on the west side of the valley toward the center of the valley.

Municipal pumping does not begin until after year 10 in Scenario 3. Thereafter, arsenic concentrations steadily increase from 2 ug/L to slightly above 10 ug/L in year 5. Annual arsenic concentration variations of as much as 5 ug/L occur due to seasonal pumping patterns. The gradual increase in arsenic concentrations is due to municipal pumping (2,500 AFY) which causes the geothermal outflow to move toward the center of the valley. The arsenic concentrations are larger in Scenario 3 as compared to Scenario 2 because the municipal pumping rates are larger.

Municipal pumping does not begin until after year 10 in Scenario 4. Thereafter, arsenic concentrations steadily increase from 2 ug/L to 5 ug/L in year 13 in response to the increased pumping (4,500 AFY). Arsenic concentrations decrease for the next seven years in response to decreased pumping (1,200 AFY) over this period. The cycle repeats due to the repeated 10 year pumping cycle, but peak arsenic concentrations increase nearly 1 ug/L every 10 years. Arsenic concentrations are higher in the municipal wells when pumping rates increase as this draws more geothermal water into the wells.

Figure 122 shows the average nitrate concentrations at municipal wells for Scenarios 2 – 4. Nitrate concentrations for Scenario 1 are not shown because there was no municipal pumping in that scenario. In Scenario 2 nitrate concentrations remain below 5 mg/L for the first 10 years and then begin increasing due to rising groundwater levels encroaching on residual nitrate stored in the vadose zone. Nitrate concentrations peak in year 28 at 17 mg/L and then stay below 10 mg/L by year 40. Municipal pumping does not begin until after year 10 in Scenario 3. Thereafter, nitrate concentrations steadily increase from 3 mg/L to 21 mg/L in year 15. After rising groundwater levels capture most of the nitrate mass, nitrate concentrations fall below 10 mg/L in year 24. Municipal pumping does not begin until after year 10 in Scenario 4. Thereafter, nitrate concentrations increase in a pattern that mimics the pumping rate cycle. More rapid nitrate concentration increases occur during high pumping rate periods and concentrations either increase slowly or are stable during lower pumping rate periods. The peak nitrate concentration occurs in year 12 at 18 mg/L and concentrations remain below 10 mg/L after year 24.

Figure 123 shows the simulated progression of arsenic concentrations in model layer 1 (uppermost layer) for Scenario 1. Injection at 1,300 AFY without any municipal pumping causes a slow progression of the geothermal outflow zone and associated high arsenic concentrations from a northward migration pathway to a northwestern pathway. This is caused by low arsenic concentration fluid being injected in the project area and increasing groundwater levels in the local aquifer.

Figure 124 shows the simulated progression of arsenic concentrations in model layer 1 for Scenario 2. In this scenario, municipal pumping is equal to ASR injection and the arsenic distribution changes very little over time. There is a small northwest progression of the elevated arsenic concentrations by year 50, but not as strong as was observed in Scenario 1.

Figure 125 shows the simulated progression of arsenic concentrations in model layer 1 for Scenario 3. In this scenario, municipal pumping exceeds ASR injection by 1,200 AFY which tends to draw high arsenic concentration water toward to the northern municipal well and to a lesser degree to the southern well.

Figure 126 shows the simulated progression of arsenic concentrations in model layer 1 for Scenario 4. In this scenario, municipal pumping rates vary through a 10 year cycle. Large municipal pumping rates (4,200 AFY) occur for three years and then decline (1,200 AFY) for seven years. This pumping cycle has less of an impact on the high arsenic concentration water allowing more of it to flow northward instead of into the northern municipal well.

Figure 127 shows the simulated progression of nitrate concentrations in model layer 1 for Scenario 1. Nitrate concentrations increase rapidly as groundwater levels rise and mobilize residual nitrate in the vadose zone. Most of the vadose zone mass resides near Field 50 in Palomino Farms. As this mass is mobilized it moves northwest with the regional groundwater flow. Nitrate concentrations in the project area return to below 5 mg/L after most of the mass migrated to the north. It is important to note that this Scenario was only simulated to quantify the maximum storage volume within the project area and would not be implemented. Scenarios 2 – 4 include municipal pumping that restrict northward migration of nitrate toward domestic wells.

Figure 128 shows the simulated progression of nitrate concentrations in model layer 1 for Scenario 2. Nitrate concentrations increase in a pattern like Scenario 1, but the high nitrate concentrations cover a smaller area. Groundwater levels do not increase as much in this scenario and do not capture as much nitrate mass in the vadose zone.

Figure 129 shows the simulated progression of nitrate concentrations in model layer 1 for Scenario 3. Nitrate concentrations increase more rapidly than Scenario 1, but there is much less mass and the concentrations drop below 5 mg/L more rapidly.

Figure 130 shows the simulated progression of nitrate concentrations in model layer 1 for Scenario 4. The projection of nitrate concentrations in this scenario is very similar to Scenario 3, but there is a small area with nitrate concentrations above 5 mg/L in year 50.

Evaluation of ASR Feasibility

From a hydraulic perspective, the project area is a viable site for an ASR project. The hydraulic conductivity in the alluvial aquifer is large enough for direct injection of 1,300 AFY in three wells.

Undesirable shallow groundwater conditions are not predicted during the next 50 years if at least 1,300 AFY of municipal pumping occurs. Undesirable shallow groundwater conditions (depth to water less than five feet) were predicted in year 23 if no municipal pumping occurred.

Groundwater modeling using various municipal pumping rates indicates that groundwater storage will either increase or stabilize. Groundwater storage will continue to increase with municipal pumping rates 1,300 AFY. Municipal pumping rates of 2,500 AFY after 10 years into the project will produce stable groundwater storage conditions. Alternating pumping at 1,200 AFY for seven years, followed by three years of 4,200 AFY will create a small increasing trend in groundwater storage.

Although water quality is generally good within the project area, there are areas with poor water quality. Nitrate and arsenic concentrations exceed the MCL in portions of WSV.

Elevated nitrate concentrations (> 10 mg/L) are currently centered around Field 50 on the Palomino Farms property. Nitrate transport simulations suggest that nitrate concentrations will likely increase if water is injected into the aquifer. This is caused by rising groundwater levels encroaching on residual nitrate stored in the vadose zone. Peak nitrate concentrations in proposed municipal wells will likely exceed the MCL and could exceed 20 mg/L. High nitrate concentrations could be mitigated with treatment and/or shallow groundwater pumping for irrigation of agricultural plants.

Elevated arsenic concentrations are currently limited to the western and southern portions of WSV. Arsenic transport simulations without geochemical reactions suggest that arsenic concentrations will remain below 10 ug/L for Scenarios 2 and 4 (pumping of 1,300 AFY and alternating 1,200/4,200 AFY). Arsenic concentrations are expected to increase above 10 ug/L by year 39 for Scenario 3 (2,500 AFY) as the geothermal outflow zone is drawn to the east with higher municipal pumping.

Geochemical experiments and modeling indicate that arsenic concentrations may increase following injection of potable water. Arsenic concentrations may increase from 3 – 4 ug/L due to dissolution of arsenic bound to soil particles. Increases in arsenic concentrations from desorption may cause arsenic concentrations to exceed the MCL (10 ug/L) for Scenarios 2 and 4.

Fluoride concentrations exceeded EPA's SMCL (2 mg/L) in a few wells and are associated with geothermal outflow zones. Elevated fluoride concentrations are not as spatially extensive as arsenic and should remain limited to the geothermal outflow zones.

Iron concentrations exceeded EPAs SMCL of 0.3 mg/L in 22 percent of the wells tested. There was no apparent spatial pattern associated with the elevated iron levels, but these seemed to be associated with older wells constructed with mild steel casing. Iron contamination should not be a problem if stainless steel wells are used for municipal well production.

Manganese concentrations above the SMCL (0.1 mg/L) were observed in seven of the older and typically shallower monitoring wells. Shallow wells can yield higher concentrations of manganese when in contact with oxygen. Elevated manganese concentrations were not observed in the deeper, high capacity wells which would be used for the ASR project.

TDS concentrations do not exceed NDEP's SMCL (1,000 mg/L) within the project area but elevated (above 500 mg/L) TDS concentrations are found in northern WSV, near Ironwood Road, and in the southern portion of the valley. The high TDS concentrations in the north are associated with the ET discharge area. The elevated concentrations on the west and south portions of WSV are associated with geothermal outflow.

Conclusions

The following conclusions can be drawn from this analysis:

- The Study evaluated the viability of bringing water to the Palomino Farms and Warm Springs areas as part of a long-term sustainable water management plan. The project would include bringing recycled water to Palomino Valley for irrigation of the Palomino Farms and potentially other farmland. Irrigation amounts will be limited to plant demand to ensure that little if any seepage beneath the root zone will occur. In addition, potable surface water supplied by TMWA could be brought in through a separate pipeline and injected to replenish the Palomino Valley aquifer in the winter when Truckee River water is more plentiful. Stored water could be used to support Spanish Springs during peak summer demands or during droughts.
- A high permeability (1 – 100 ft/day) unconfined aquifer exists in the central portion of WSV and is oriented northwest-southeast.
- The range of reliable recharge estimates is 1,700 – 2,900 AFY. The best estimate is assumed to be 2,600 AFY.
- Groundwater pumping increased rapidly from near zero in the late 1960s to almost 5,000 AFY in 1980s. Pumping remained relatively constant until 2010 when irrigation pumping declined by about 50 percent. Irrigation pumping makes up the majority (68 – 99 percent) of total pumping in the valley. Total pumping

generally increased from 2010 to 2021, with 2021 pumping at 3,500 AFY.

- Groundwater ET discharge was at a maximum under pre-development conditions at about 2,500 AFY in the 1960s. As groundwater levels declined in response to increased pumping rates, so did ET which declined exponentially to about 400 AFY in 2021.
- Pumping at the high capacity irrigation wells caused an elongated drawdown trough of about eight miles long and two miles wide. Groundwater declines exceed 125 feet near the large irrigation wells.
- A significant amount of residual nitrate mass (4.9 million pounds) occurs in the vadose zone beneath previously irrigated fields.
- Nitrogen and oxygen isotopes of nitrate were used to determine that the source of nitrate is from naturally occurring soil nitrate derived from long term accumulation of precipitation in the vadose zone.
- Nitrate concentrations have exceeded the MCL (10 mg/L) throughout large portions of the agricultural area. After initial agricultural development in the 1960s, nitrate concentrations increased significantly and by the mid-1980s nearly 1,500 acres beneath the agricultural area had concentrations above the MCL. By 2021, the area with concentrations exceeding the MCL reduced to less than 200 acres.
- Arsenic concentrations exceed the MCL (10 ug/L) along the west and southern portions of WSV. The elevated arsenic concentrations are attributed to geothermal outflow zones with highest arsenic concentrations being located near Ironwood Road along the western margin of the valley.
- Leaching and column experiments with WSV aquifer sediments and geochemical modeling indicate that arsenic concentrations may increase following injection of potable water. Arsenic concentrations may increase from 3 – 4 ug/L, but the exact amount is uncertain until in-situ experiments can be done.
- Other chemical constituents of potential concern include fluoride, iron, and manganese. Elevated fluoride concentrations are associated with geothermal outflow zones, but not as extensive as arsenic. Elevated iron concentrations are likely due to flaking of older steel casing. Elevated manganese concentrations were found in shallow wells and not likely to be a problem in deeper wells constructed for the ASR project.
- A groundwater flow model was developed for the WSV aquifer system. Simulated groundwater level trends are in excellent agreement with measured values with a MAE of 18 and a relative error of 1.4 percent.
- From a hydraulic perspective, the project area is a viable site for an ASR project. The hydraulic conductivity in the alluvial aquifer is large enough for direct injection of 1,300 AFY in three wells for a total storage of 45,000 acre-feet. Undesirable shallow groundwater conditions are not predicted in the next 50 years if municipal pumping is a least equal to 1,300 AFY.
- The sustainable net municipal pumping rate for the project area is 1,200 AFY. This is in addition to continued pumping of 871 AFY of pumping for agricultural irrigation, domestic, stock,

recreational, and quasi-municipal uses. Groundwater extraction for environmental uses continues, but this water is reinjected and not consumed.

- Nitrate concentrations greater than the MCL are predicted to occur in the project area as groundwater levels rise and encroach on residual nitrate in the vadose zone. Nitrate issues could be mitigated with treatment and/or shallow groundwater pumping which could be used for irrigation of the agricultural parcels.
- Municipal pumping is required in the project area to ensure that elevated nitrate concentrations do not migrate northward toward domestic wells.
- Elevated arsenic concentrations may become an issue under higher pumping rates (i.e., constant 2,500 AFY) and/or mobilization due geochemical reactions induced by low TDS potable water injection.

Data Gaps/Recommendations

An extensive amount of hydrogeologic data was collected in support of this study. This information was used to develop and update conceptual and numerical models of groundwater flow and contaminant transport. After these new data were evaluated new issues and questions developed.

The main issue that developed out of this study include the potential for nitrate and arsenic concentrations to exceed the MCL in proposed municipal wells. The severity of the water quality issues hinge on the amount of nitrate that can be mobilized in the vadose zone and the extent geochemical reactions increase arsenic concentrations after injection of low TDS potable water.

The degree to which nitrate will mobilize after groundwater levels rise into the high mass zone is uncertain. Nitrate mass located in fine-grained sediments may not migrate easily due to the low permeability of these sediments. Shallow monitoring wells should be installed to monitor the nitrate concentrations following rising water tables and mitigation strategies can be based on the results of the in-situ measurements. Additional transport modeling is needed to evaluate the effectiveness of pumping shallow groundwater for agricultural irrigation.

Arsenic concentrations are expected to increase on the order of 3 – 4 ug/L as the potable water potentially desorbs arsenic from the sediment. In-situ injection tests using potable water should be conducted to verify the amount of arsenic desorption. A push/pull type test could be conducted to evaluate the potential for arsenic concentrations to increase. Injection of 50,000 gallons would result in aquifer penetration of 20 feet. Engineering controls should also be investigated to determine if injection fluid chemistry can be adjusted to reduce the amount of arsenic mobilization.

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Figures

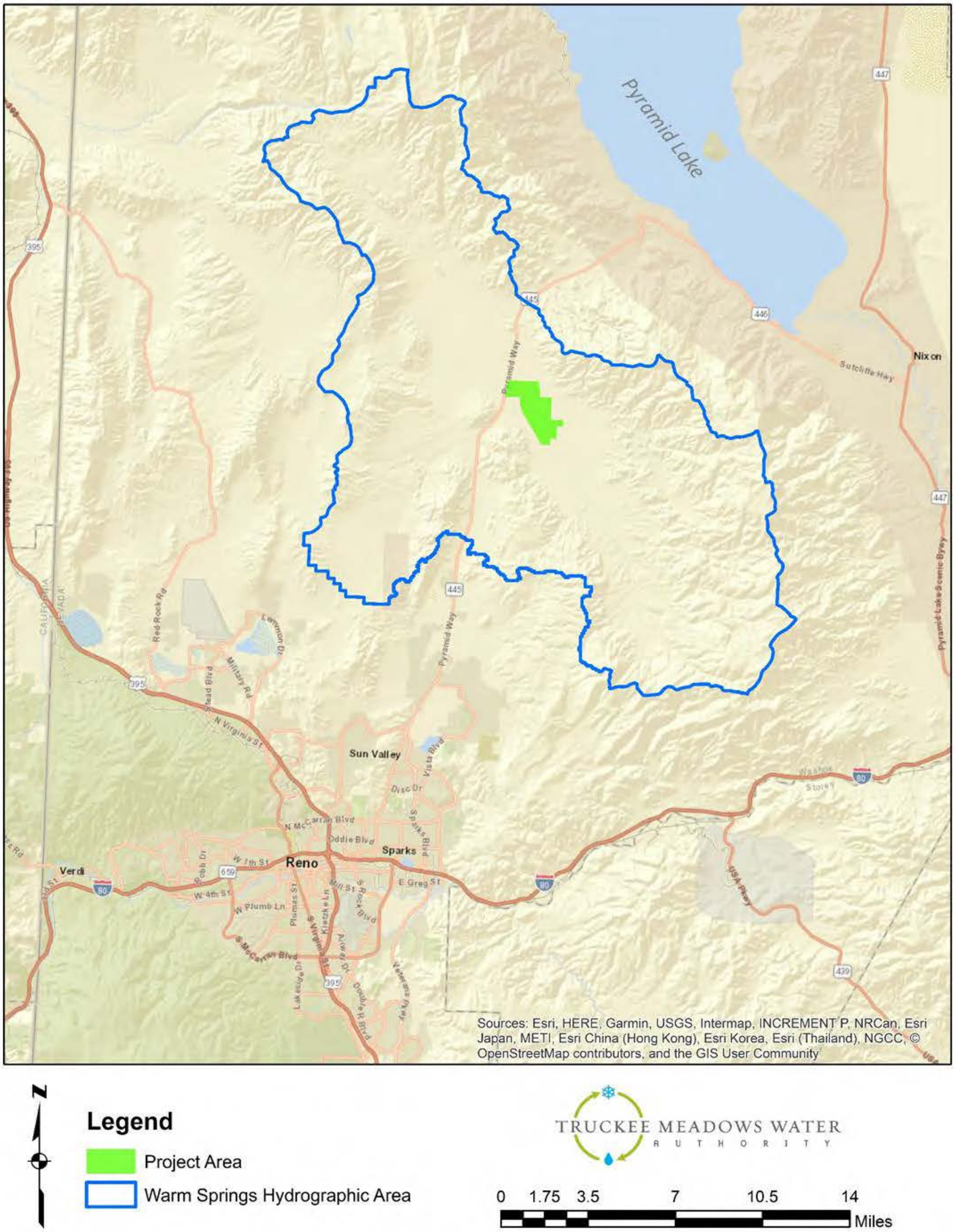

Figure 1. Proposed project area within Warm Springs Valley.

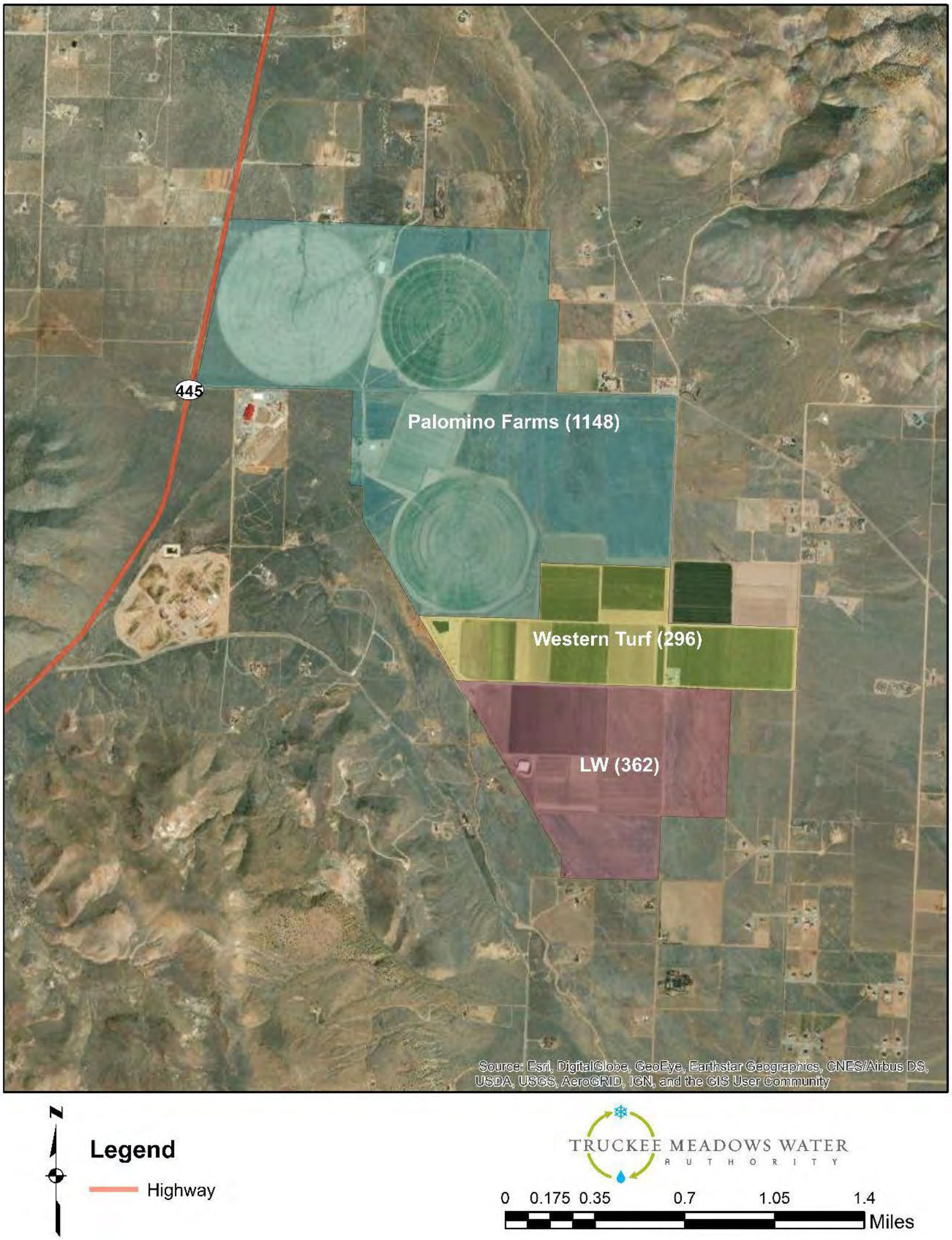

Figure 2. Location of ranches being considered for the aquifer storage and recovery project in Warm Springs Valley. Number in parenthesis represents the area of each property in acres.

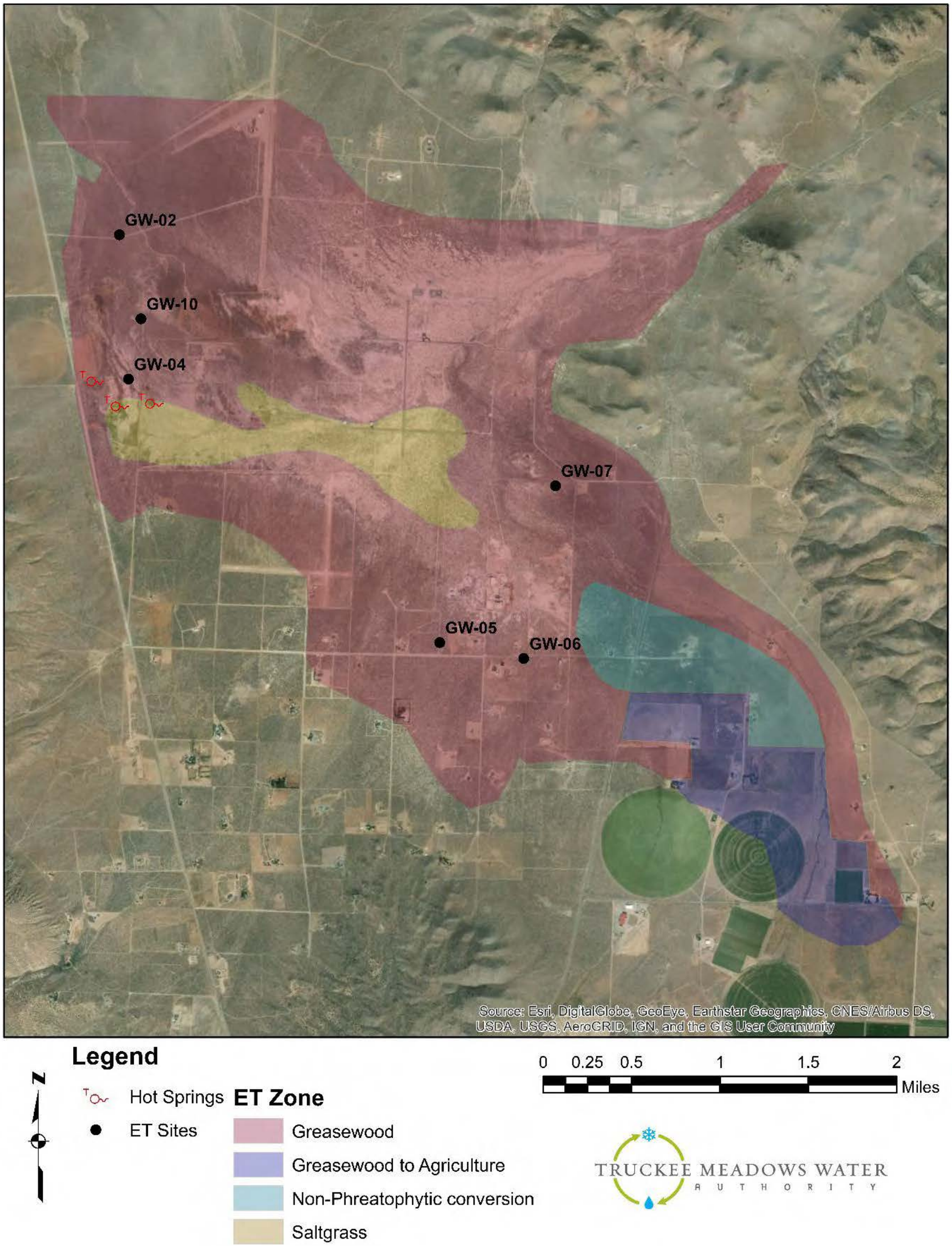

Figure 3. Phreatophyte distribution as mapped by Katzer, 1997.

Figure 4. Soil borings and monitoring wells constructed for this project.

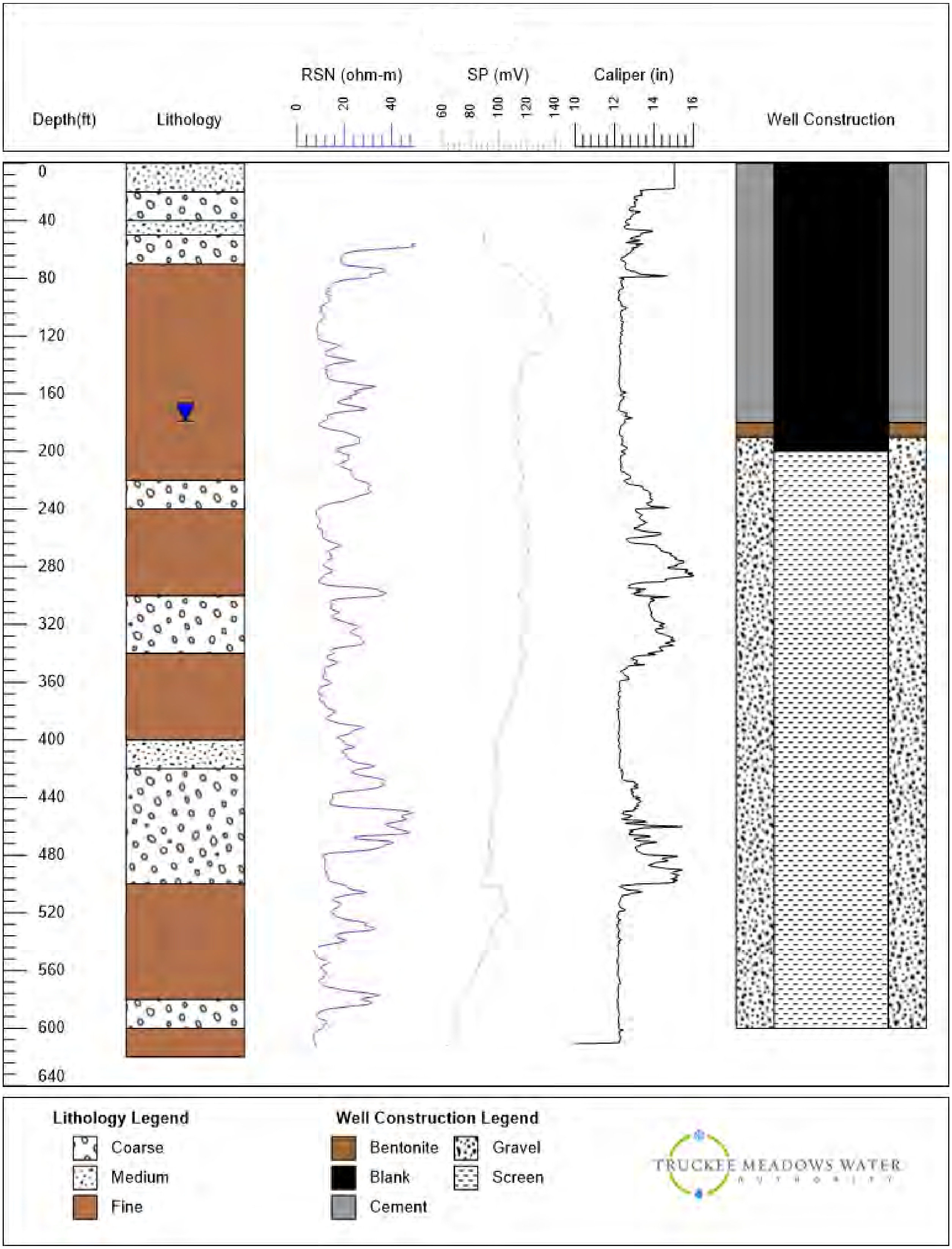

Figure 5. MW-01 lithology, Elogs, caliper, and well construction diagram.

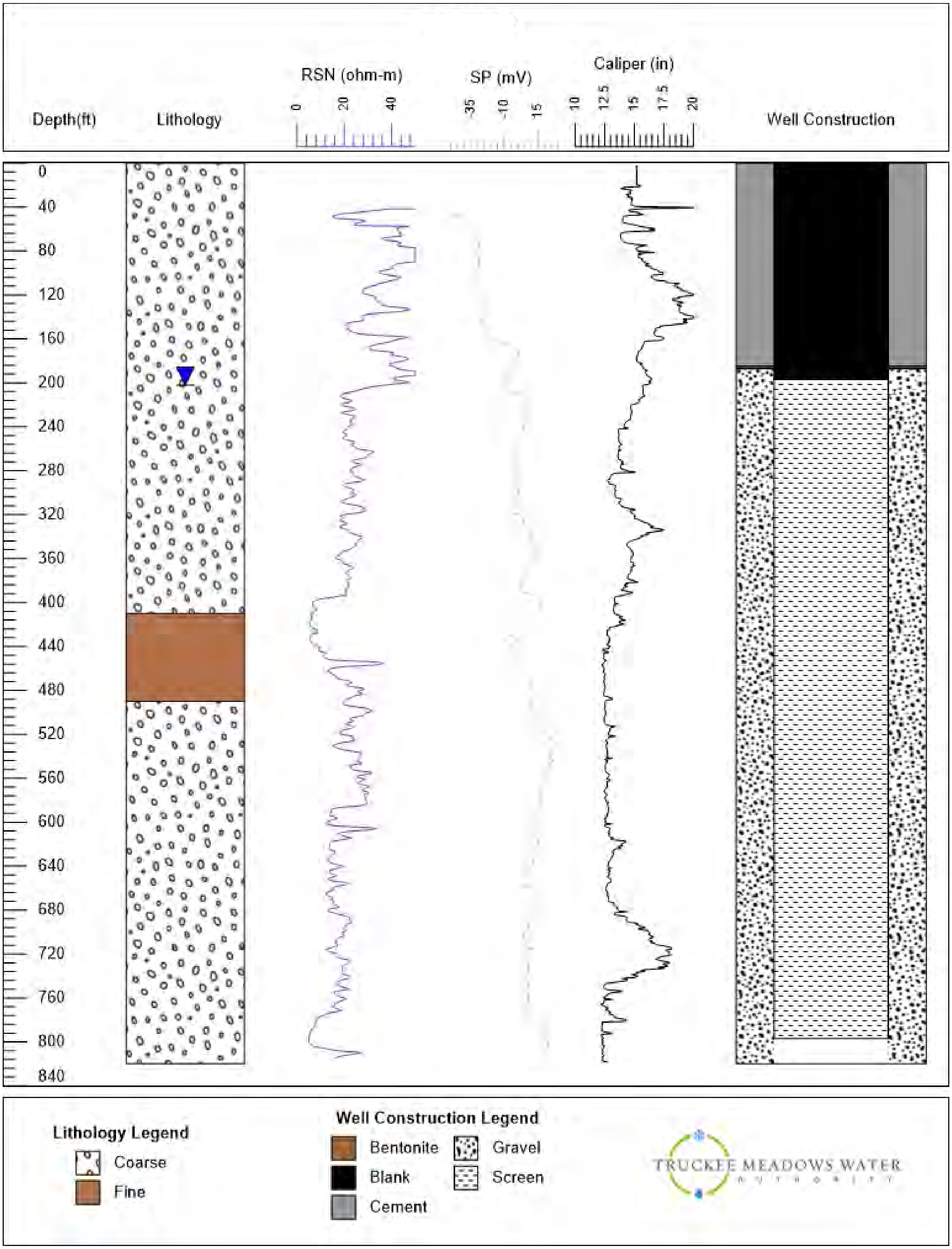

Figure 6. MW-02 lithology, Elogs, caliper, and well construction diagram.

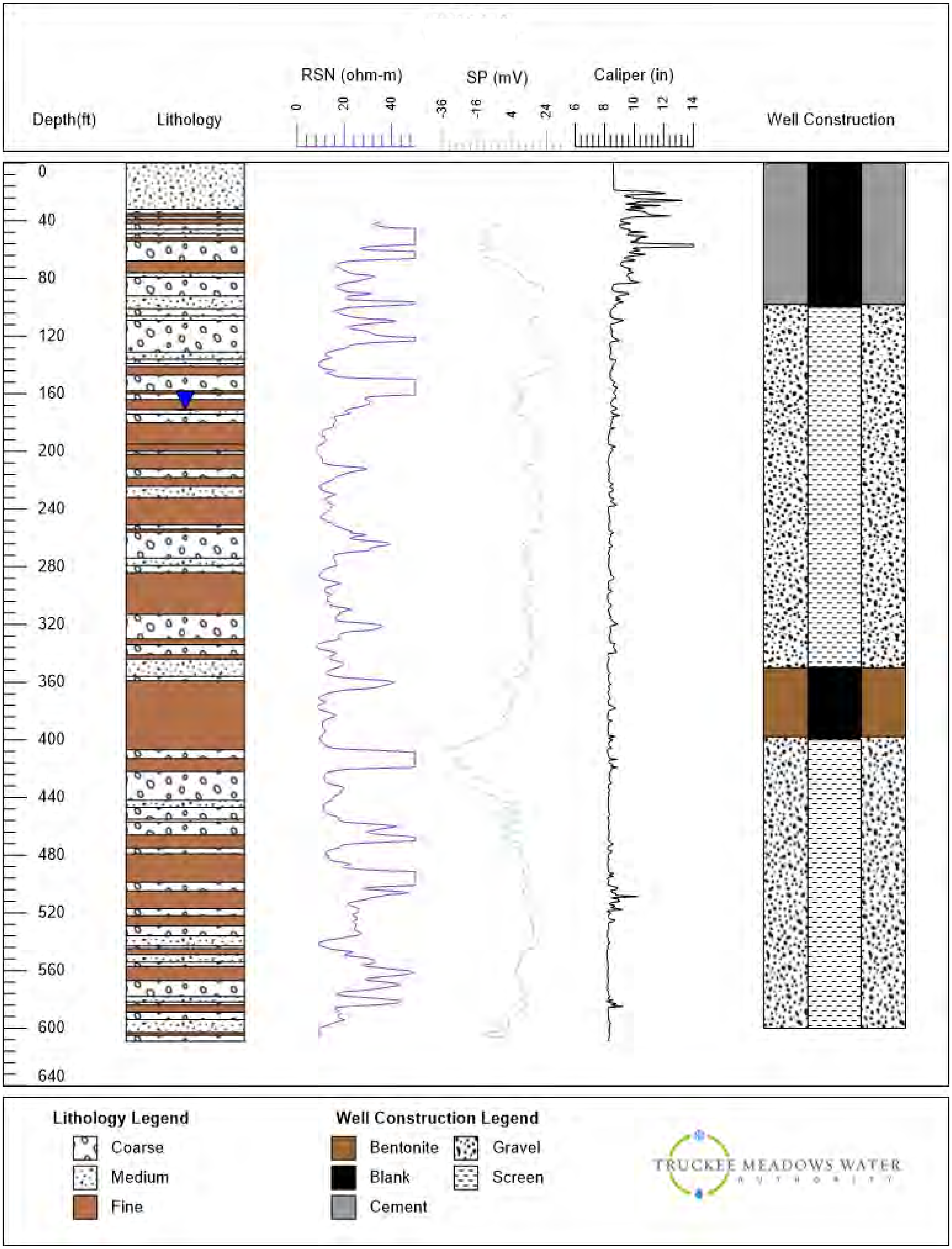

Figure 7. MW-3 lithology, Elogs, caliper, and well construction diagram.

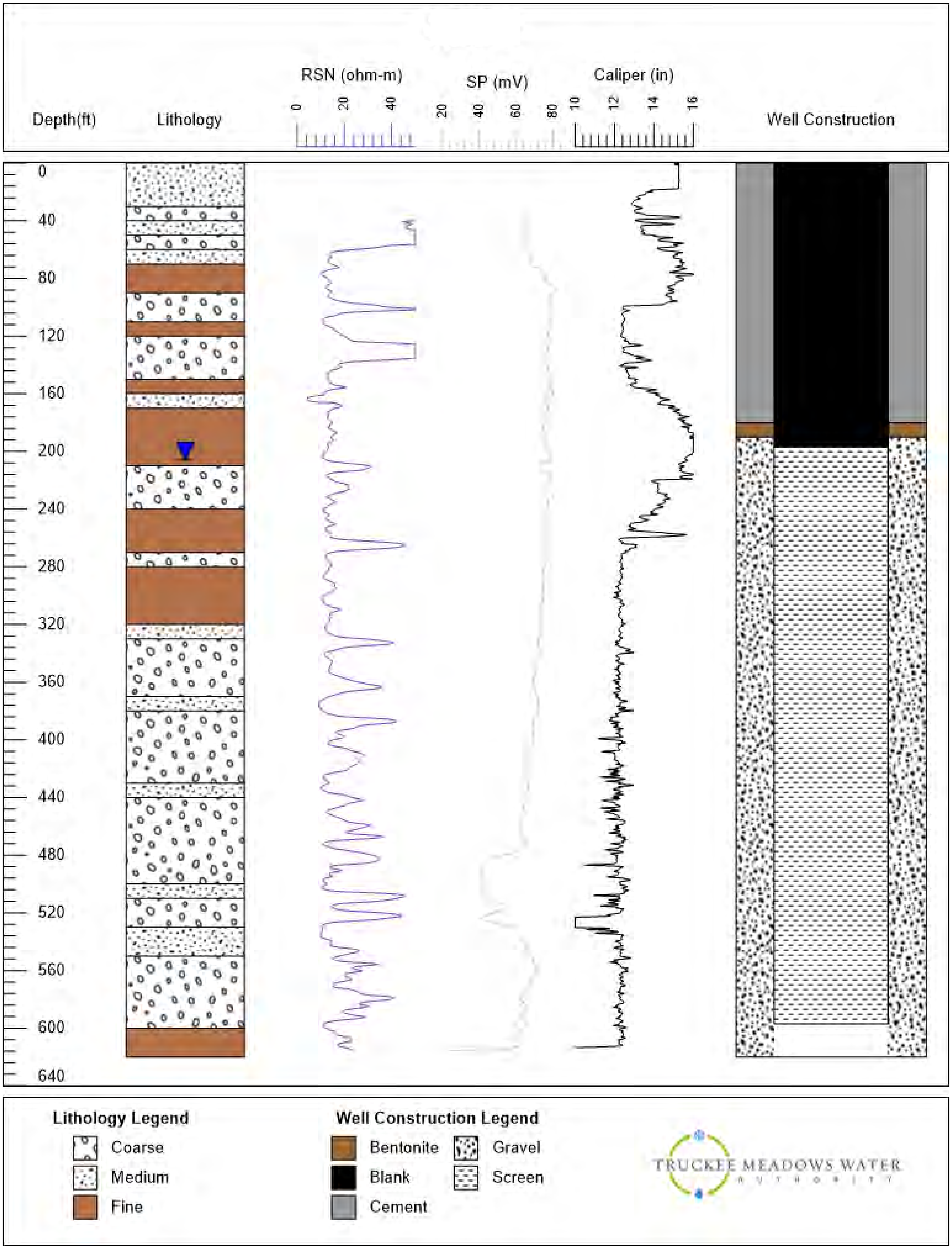

Figure 8. MW-04 lithology, Elogs, caliper, and well construction diagram.

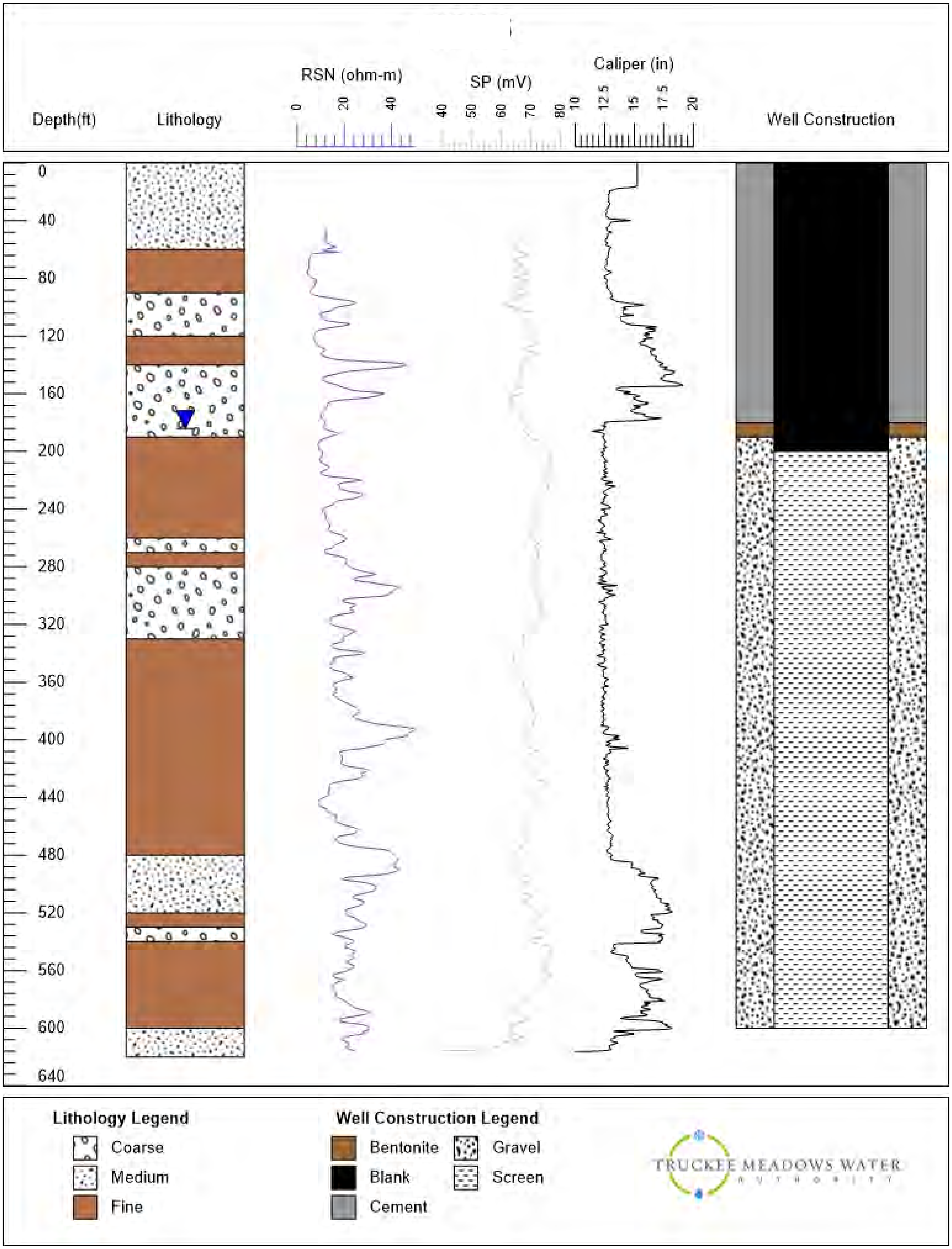

Figure 9. MW-05 lithology, Elogs, caliper, and well construction diagram.

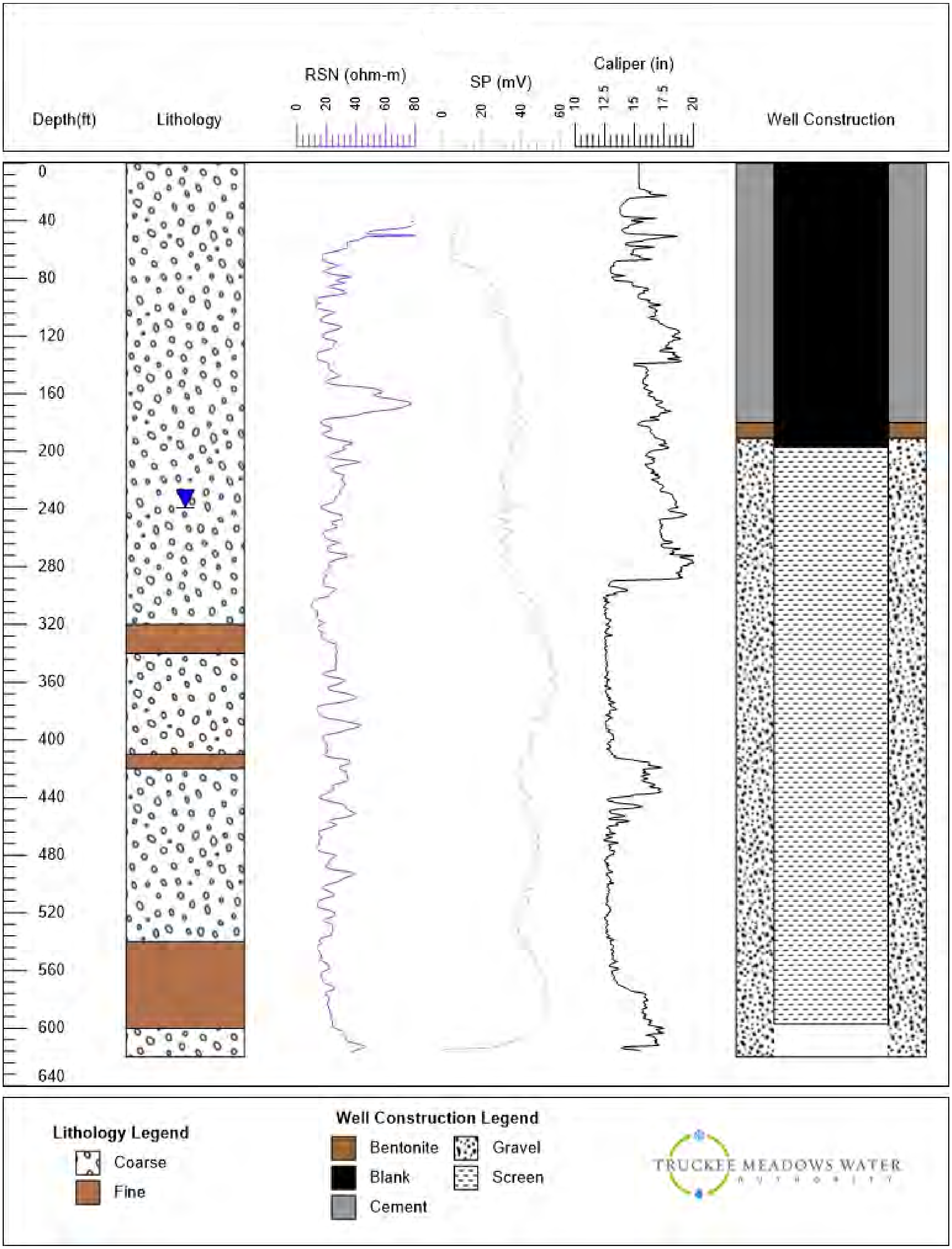

Figure 10. MW-06 lithology, Elogs, caliper, and well construction diagram.

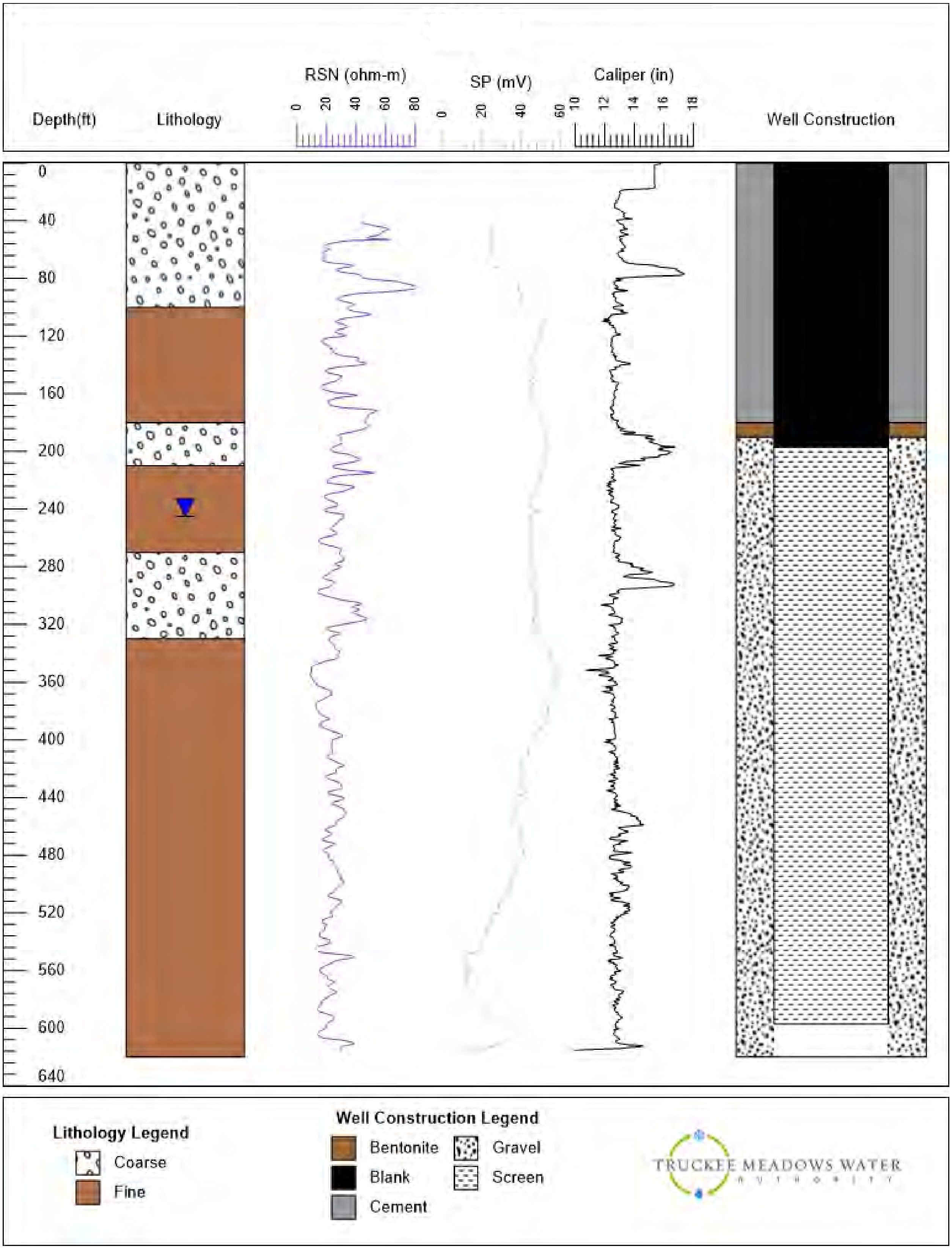

Figure 11. MW-07 lithology, Elogs, caliper, and well construction diagram.

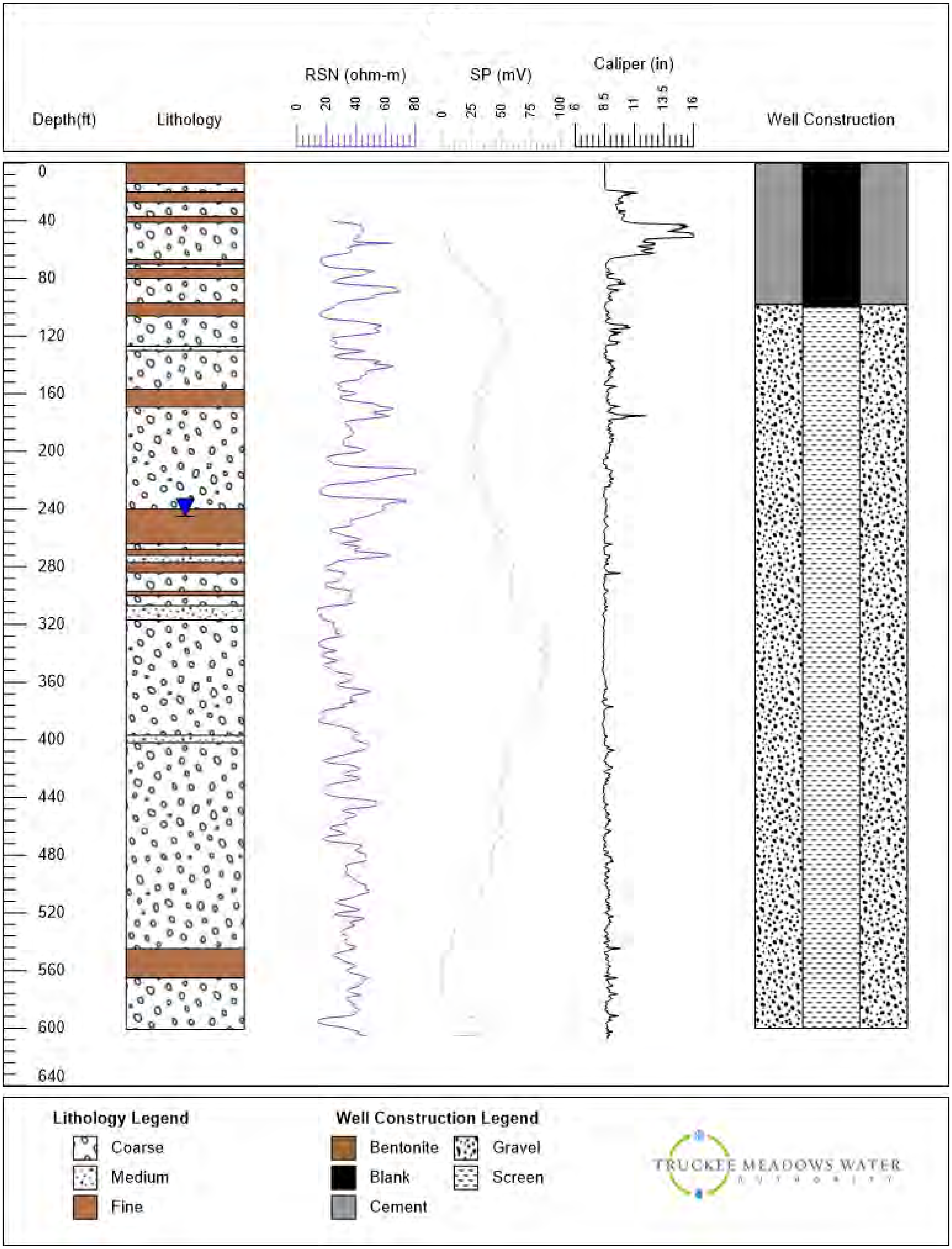

Figure 12. MW-08 lithology, Elogs, caliper, and well construction diagram.

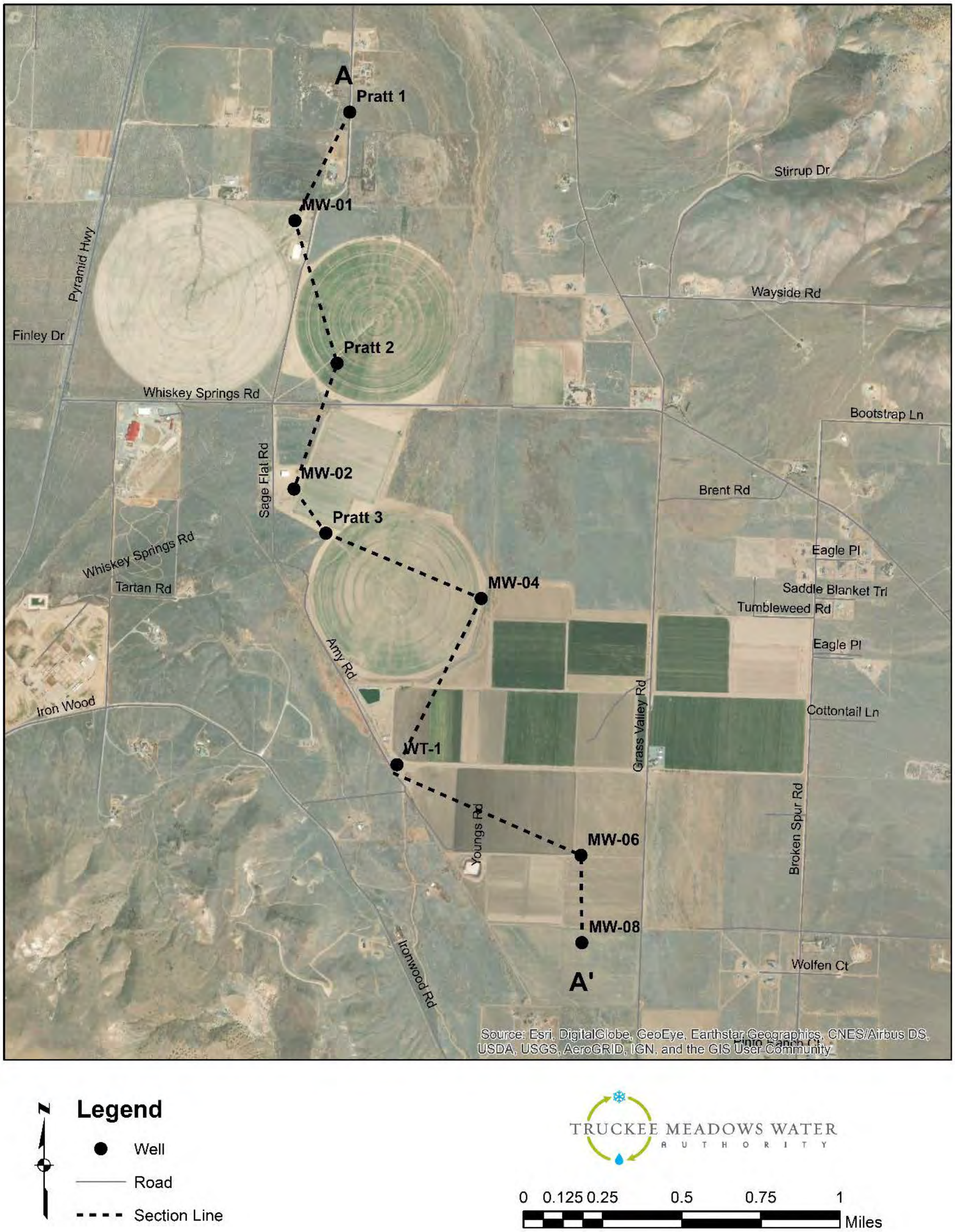

Figure 13. North-south section line (A - A') for geologic cross section.

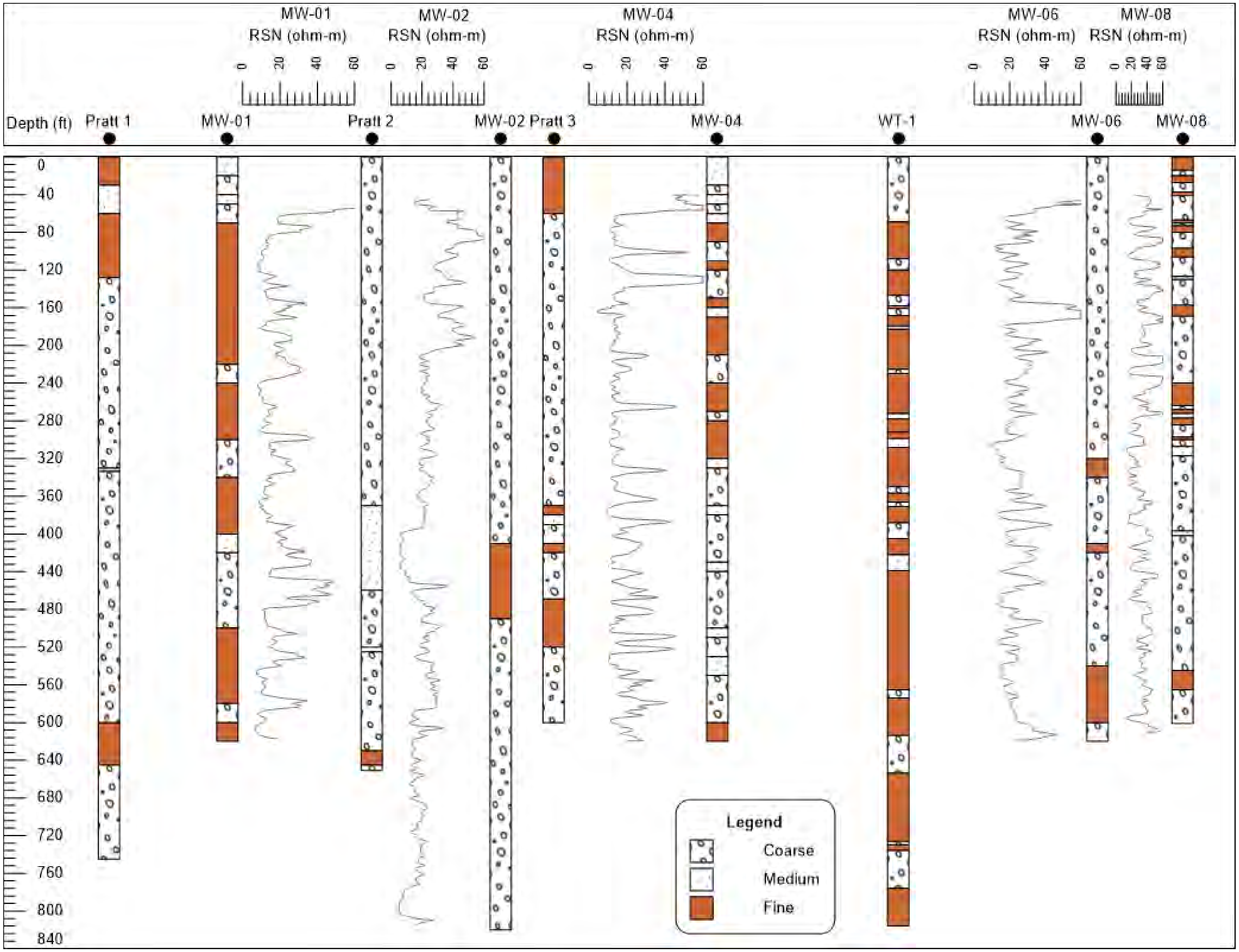

Figure 14. North-south section (A-A') showing lithology and available resistivity logs.

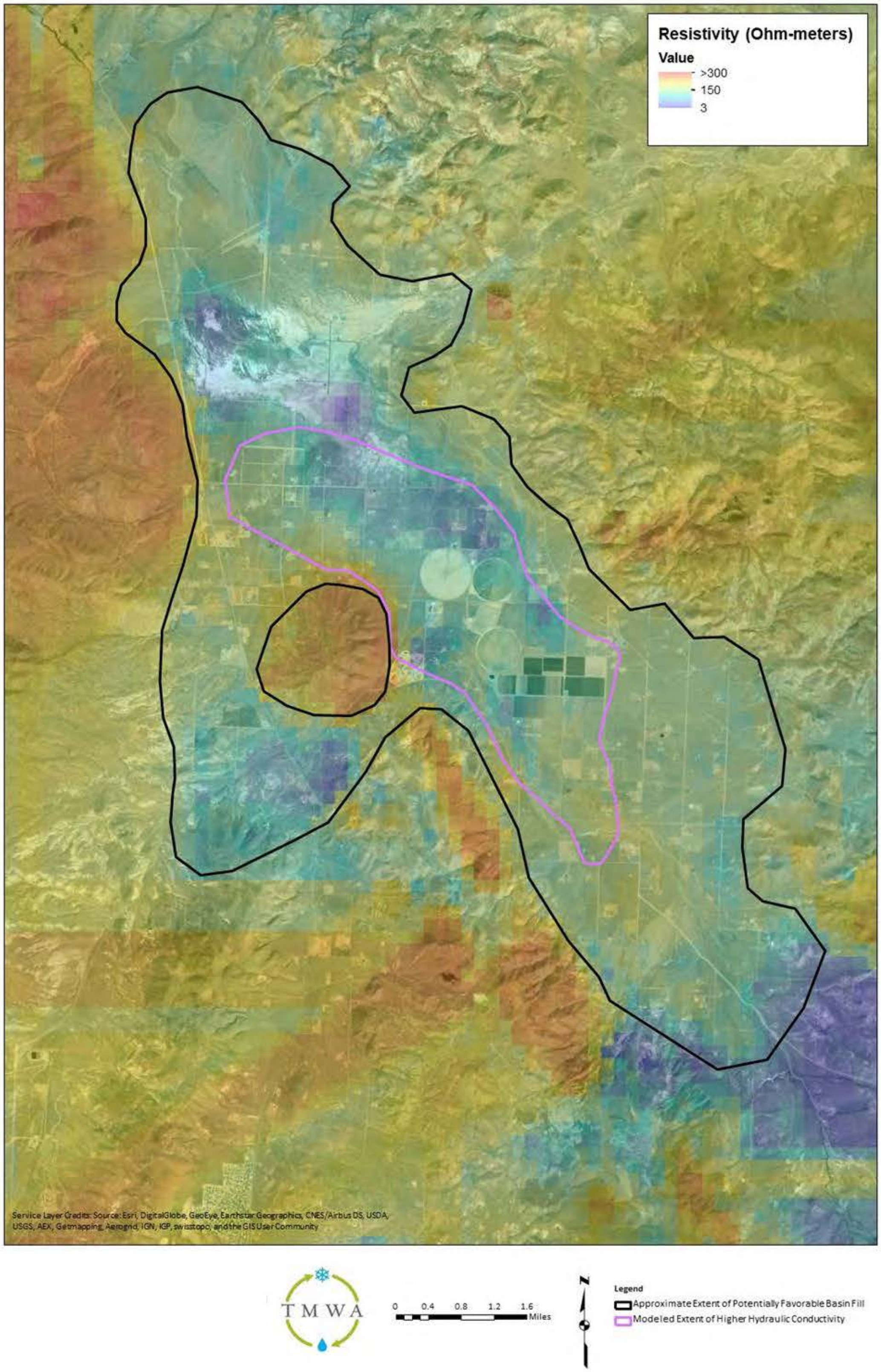

Figure 15. 900 Hz resistivity survey interpolation and aquifer interpretations.

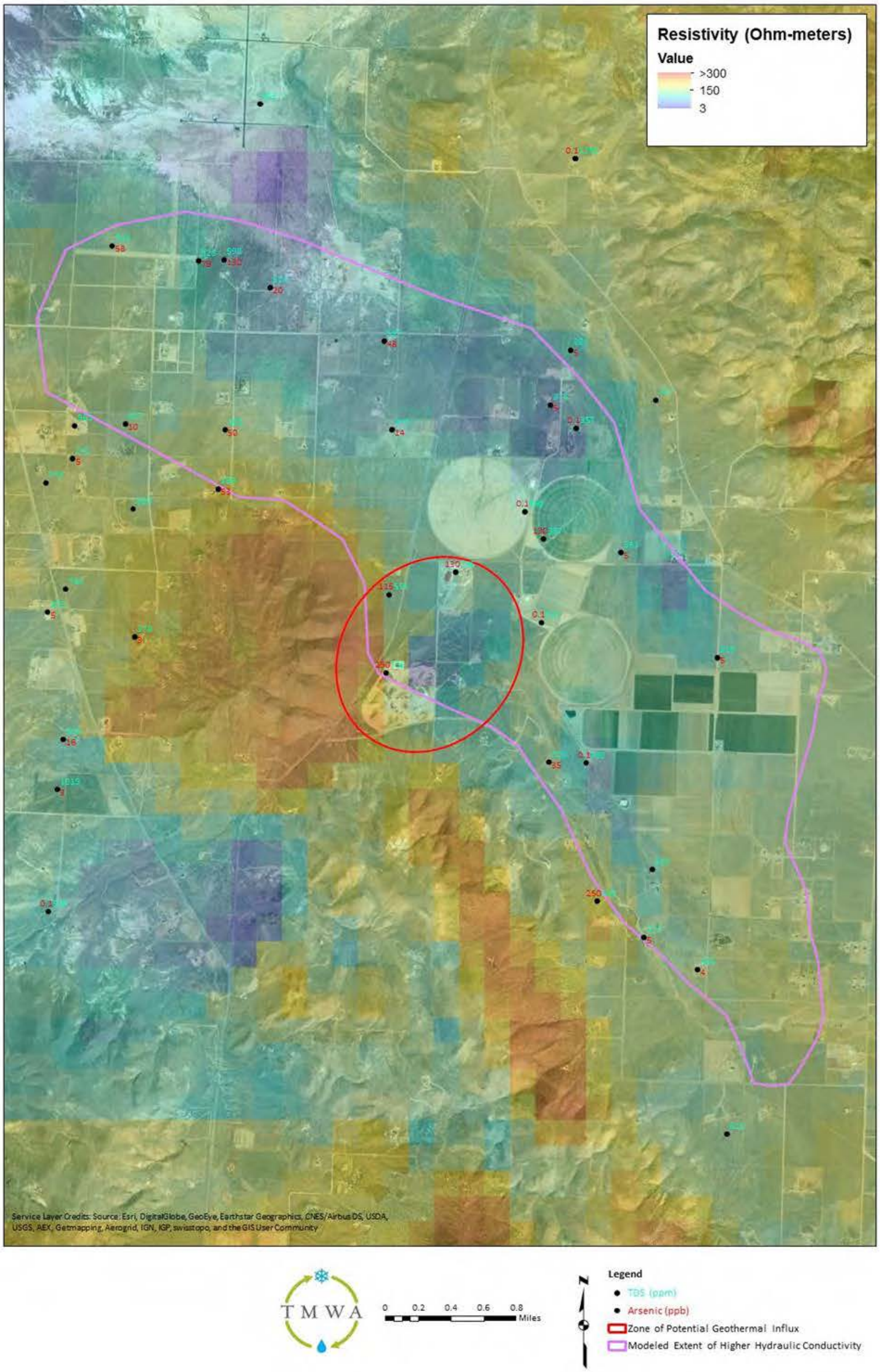

Figure 16. 900 Hz resistivity survey interpolation and geothermal interpretations.

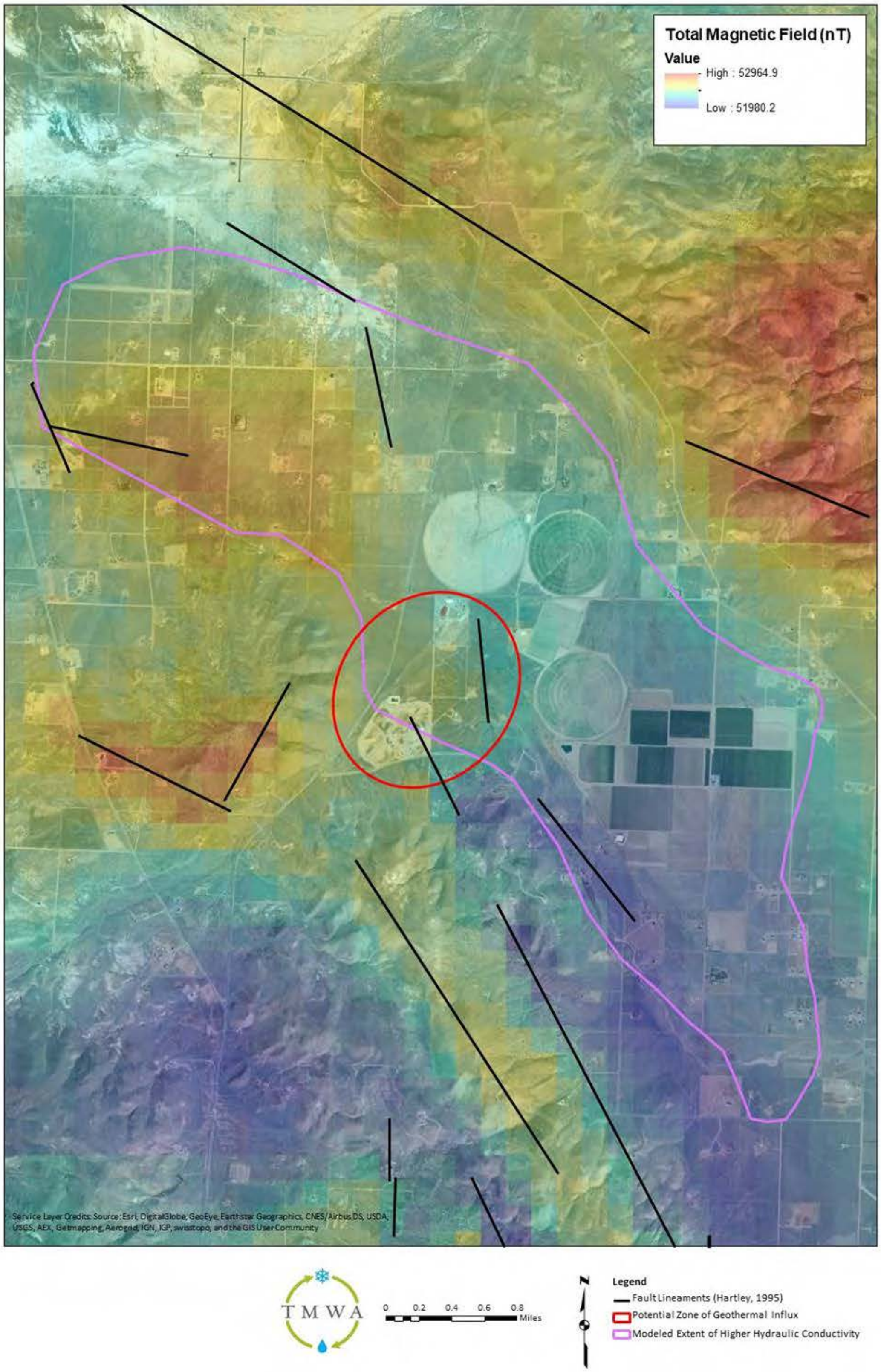

Figure 17. Aeromagnetic survey interpolation and geothermal interpretations.

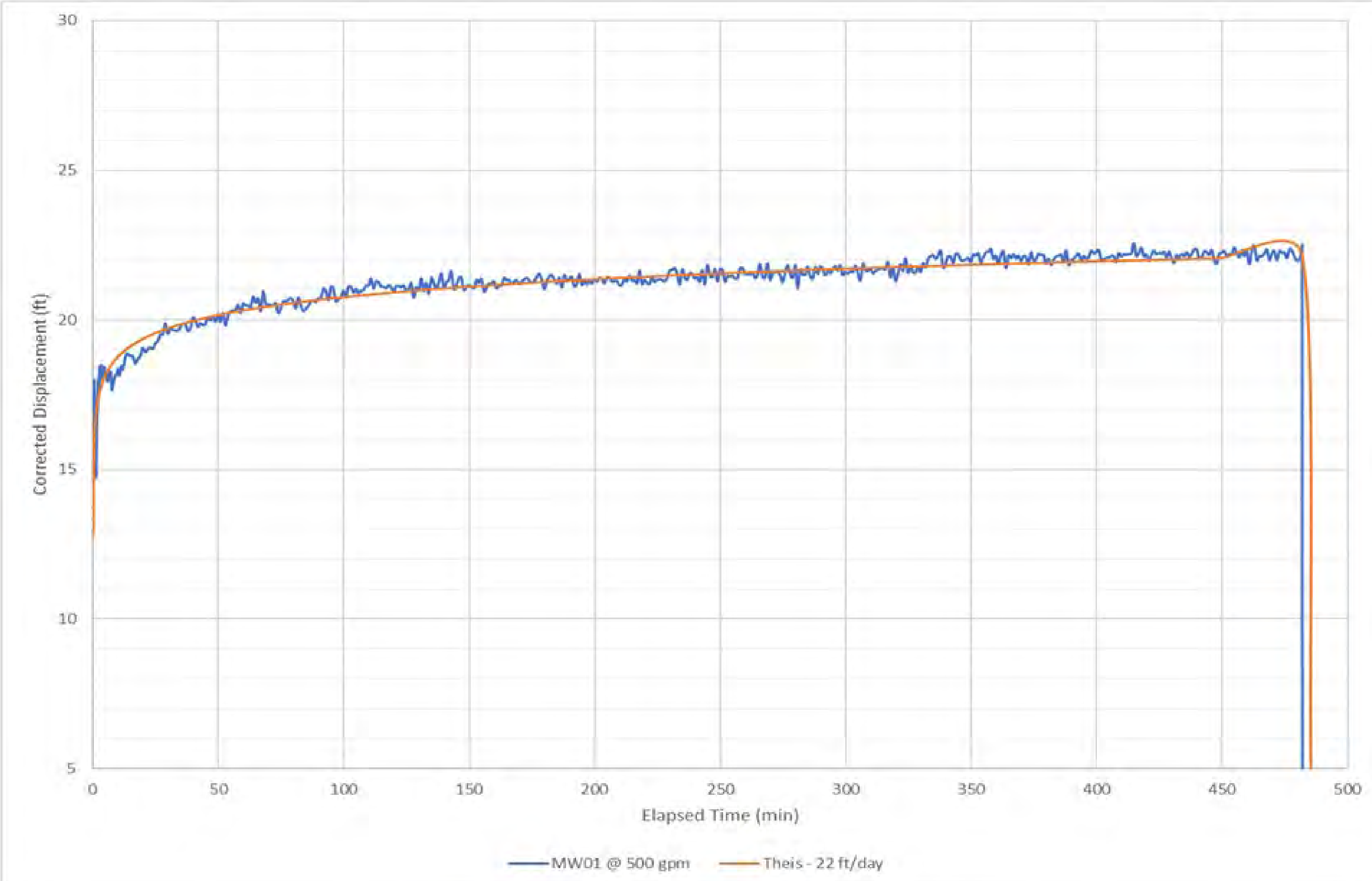

Figure 18. Simulated (Theis) and measured drawdown for the MW-01 aquifer test.

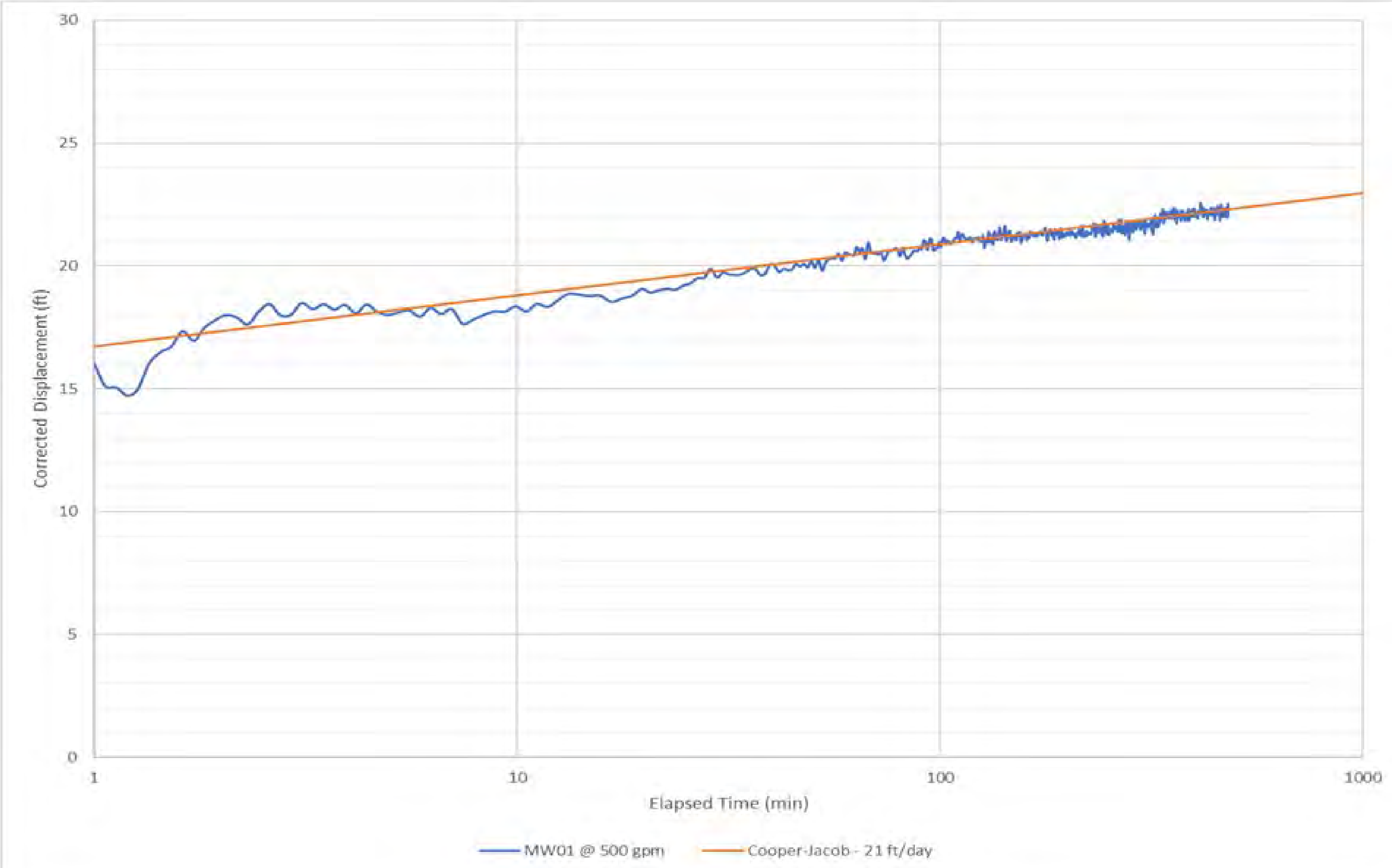

Figure 19. Simulated (Cooper-Jacob) and measured drawdown for the MW-01 aquifer test.

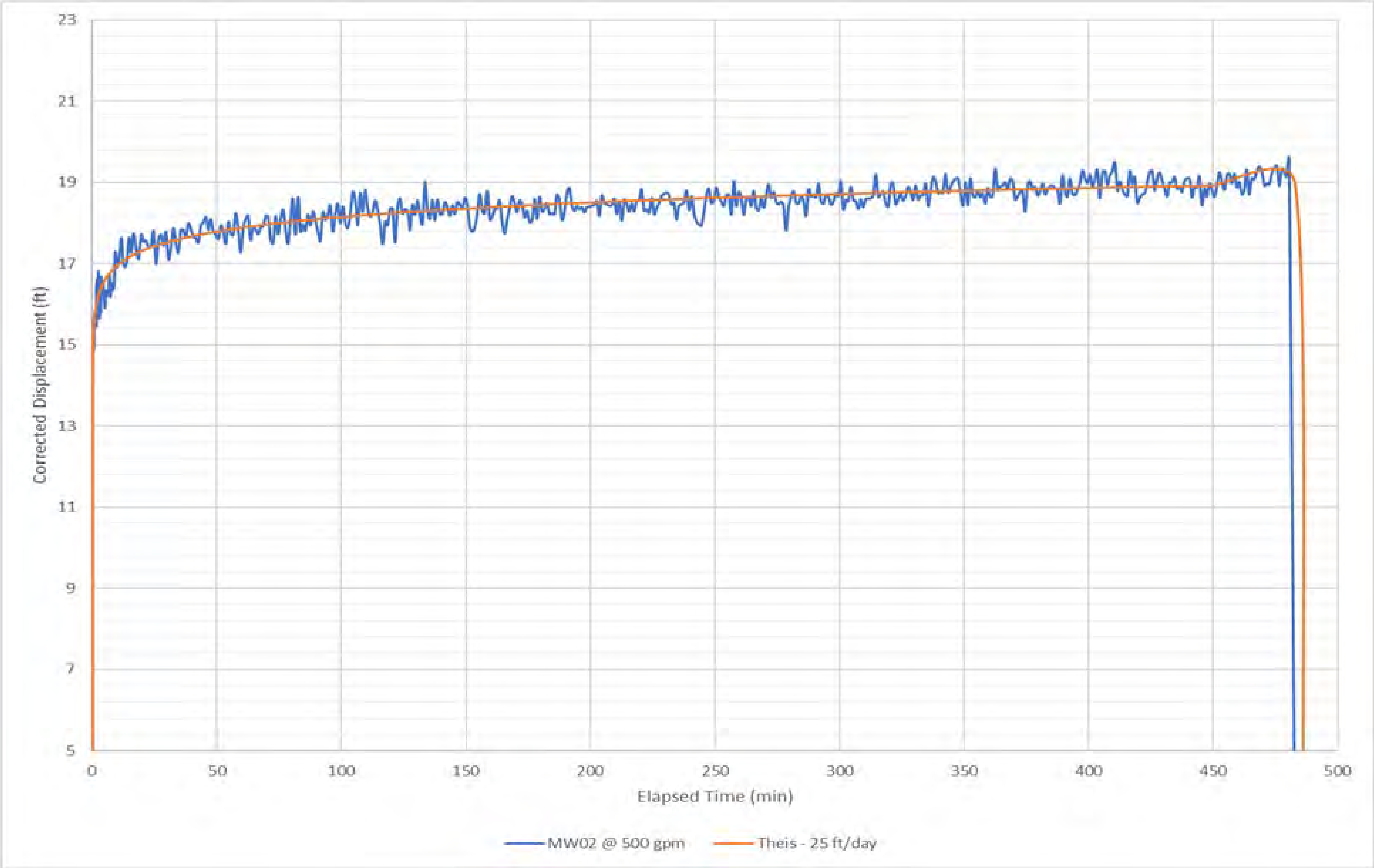

Figure 20. Simulated (Theis) and measured drawdown for the MW-02 aquifer test.

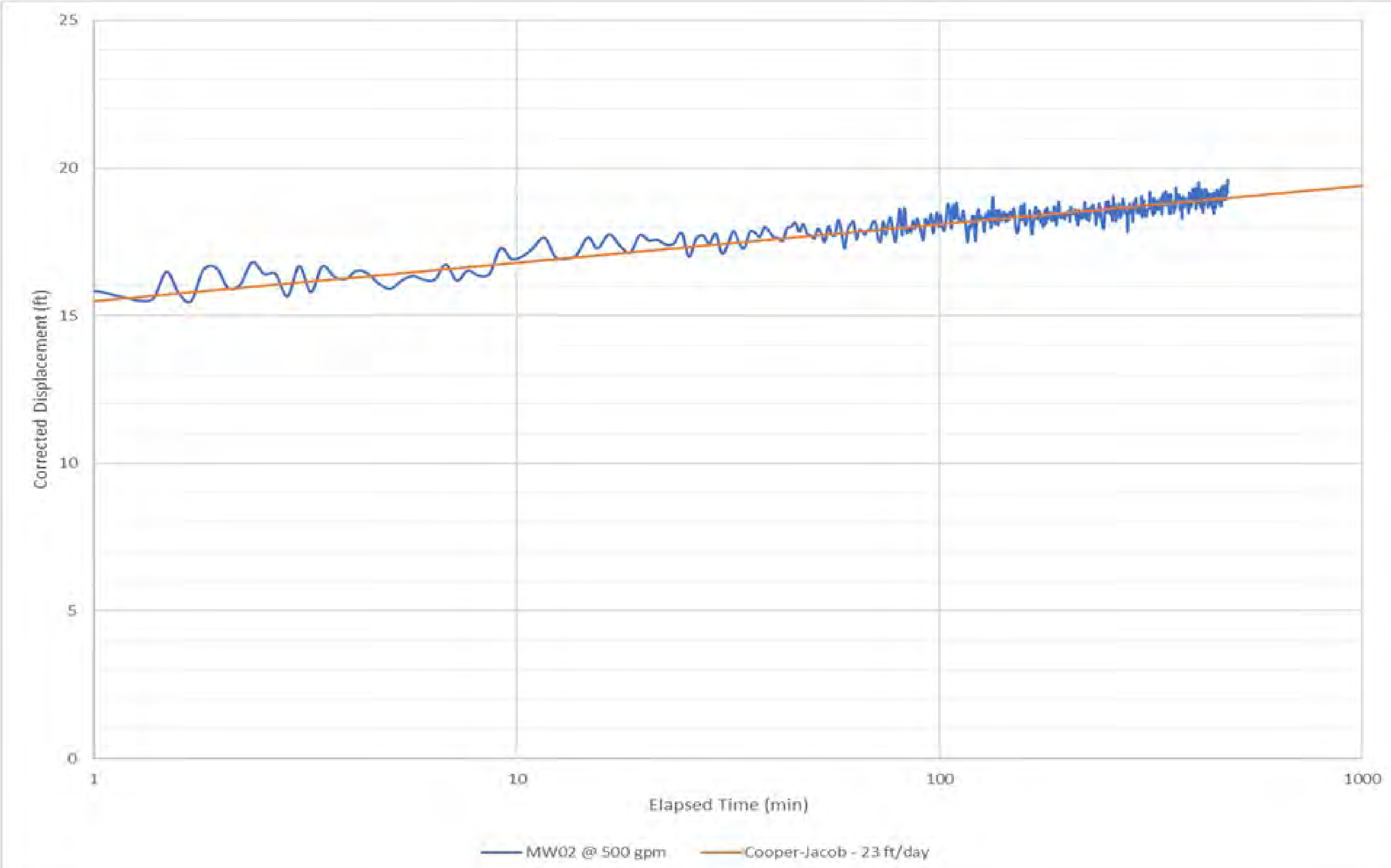

Figure 21. Simulated (Cooper-Jacob) and measured drawdown for the MW-02 aquifer test.

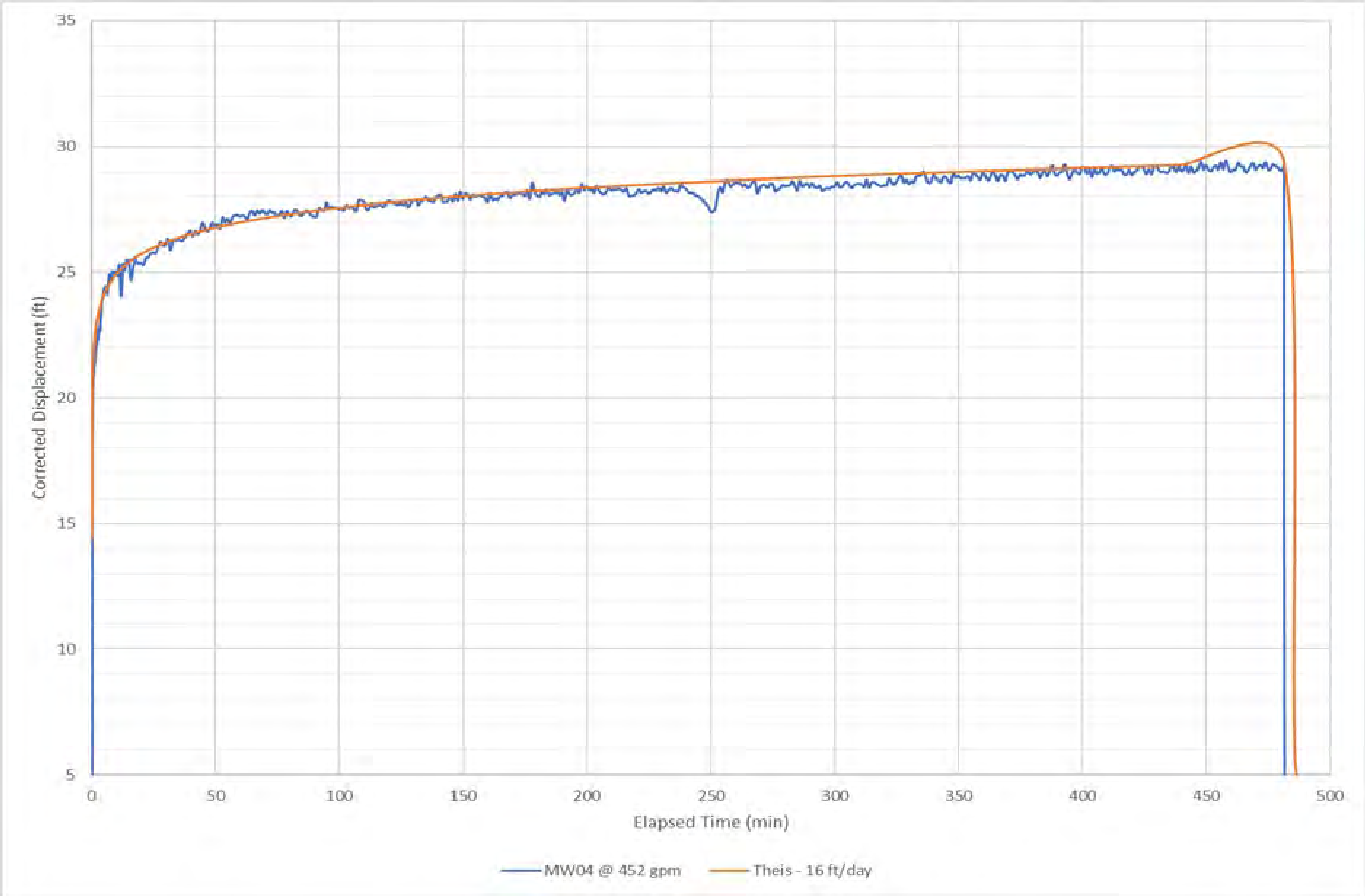

Figure 22. Simulated (Theis) and measured drawdown for the MW-04 aquifer test.

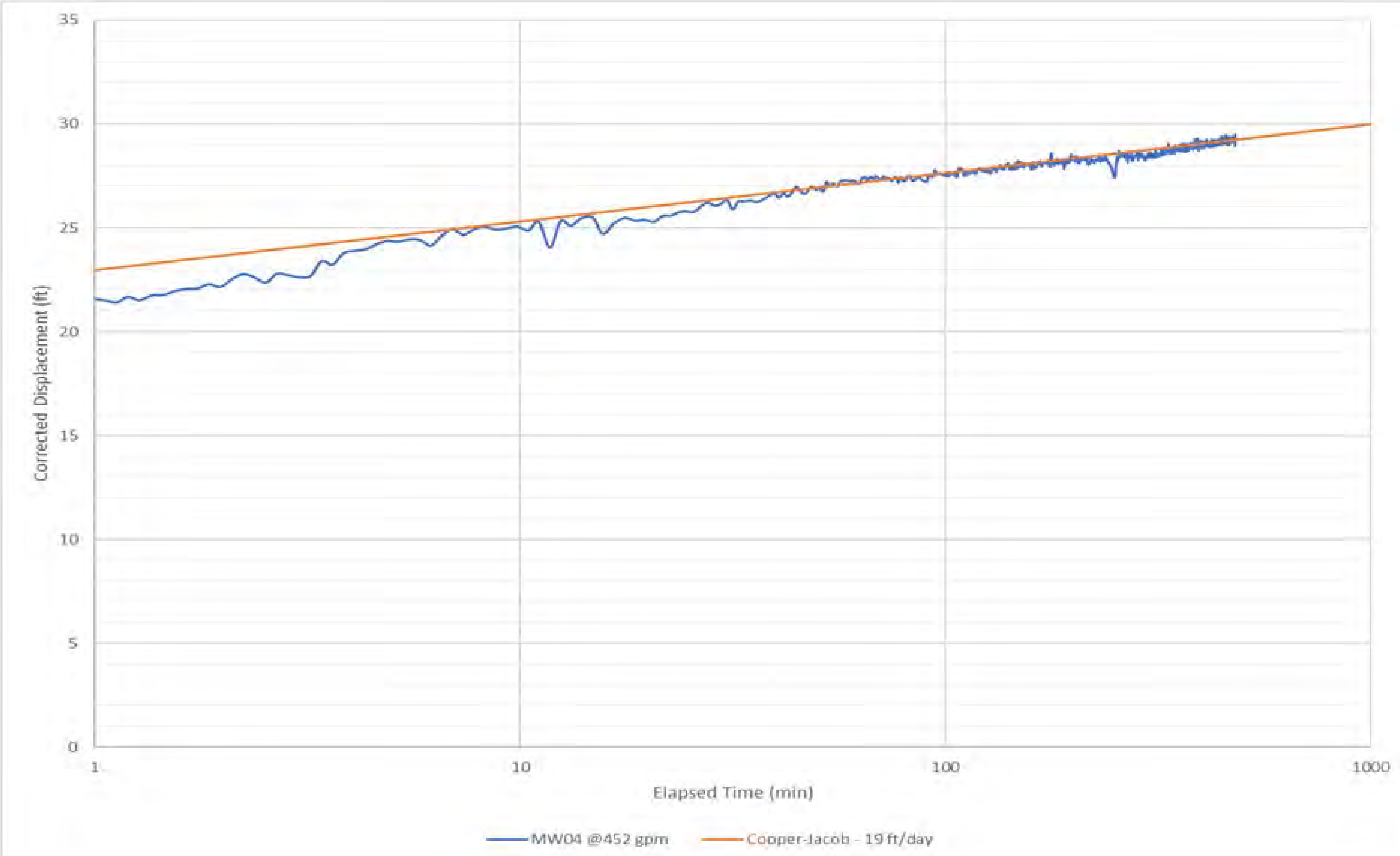

Figure 23. Simulated (Cooper-Jacob) and measured drawdown for the MW-04 aquifer test.

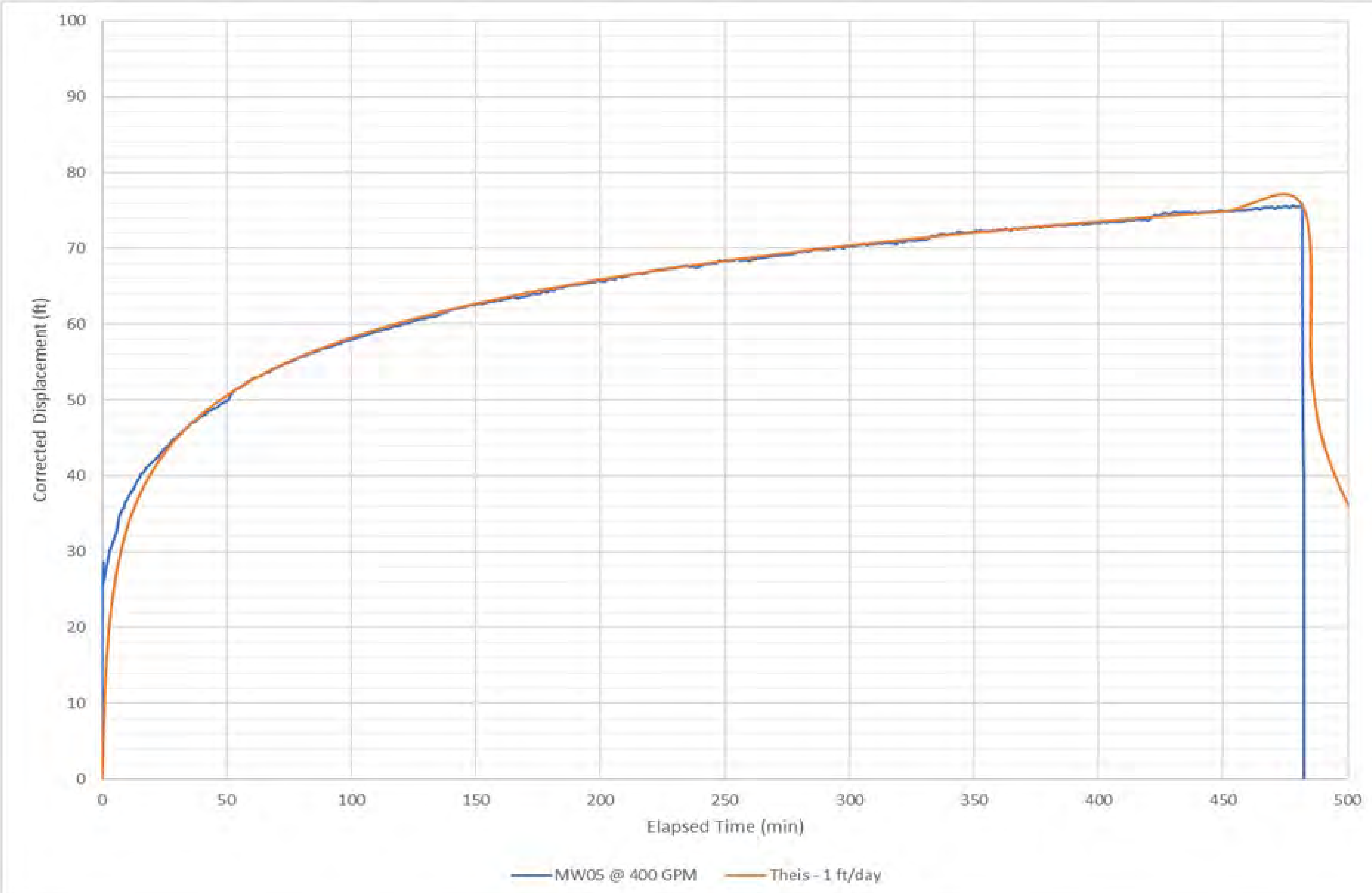

Figure 24. Simulated (Theis) and measured drawdown for the MW-05 aquifer test.

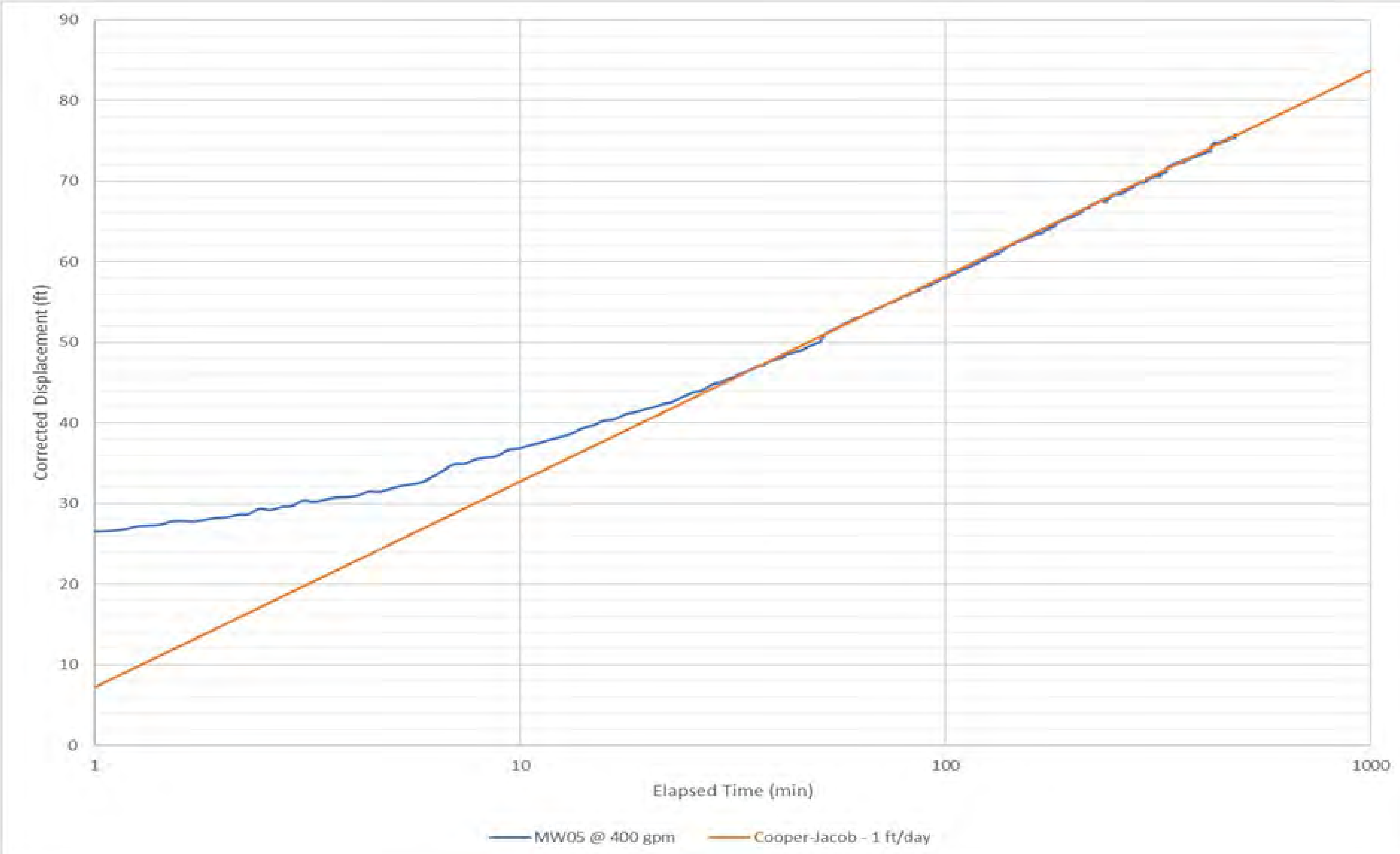

Figure 25. Simulated (Cooper-Jacob) and measured drawdown for the MW-05 aquifer test.

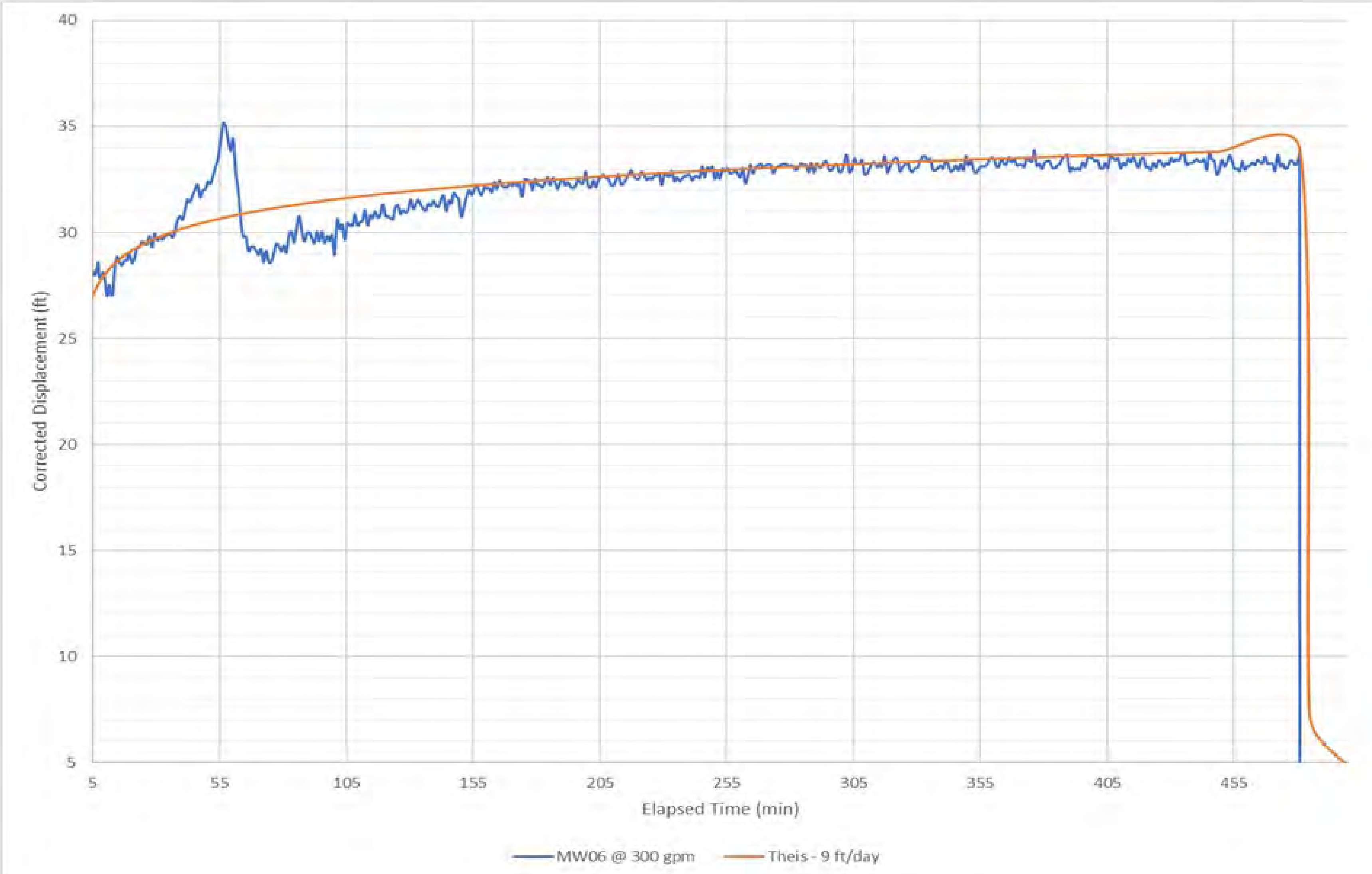

Figure 26. Simulated (Theis) and measured drawdown for the MW-06 aquifer test.

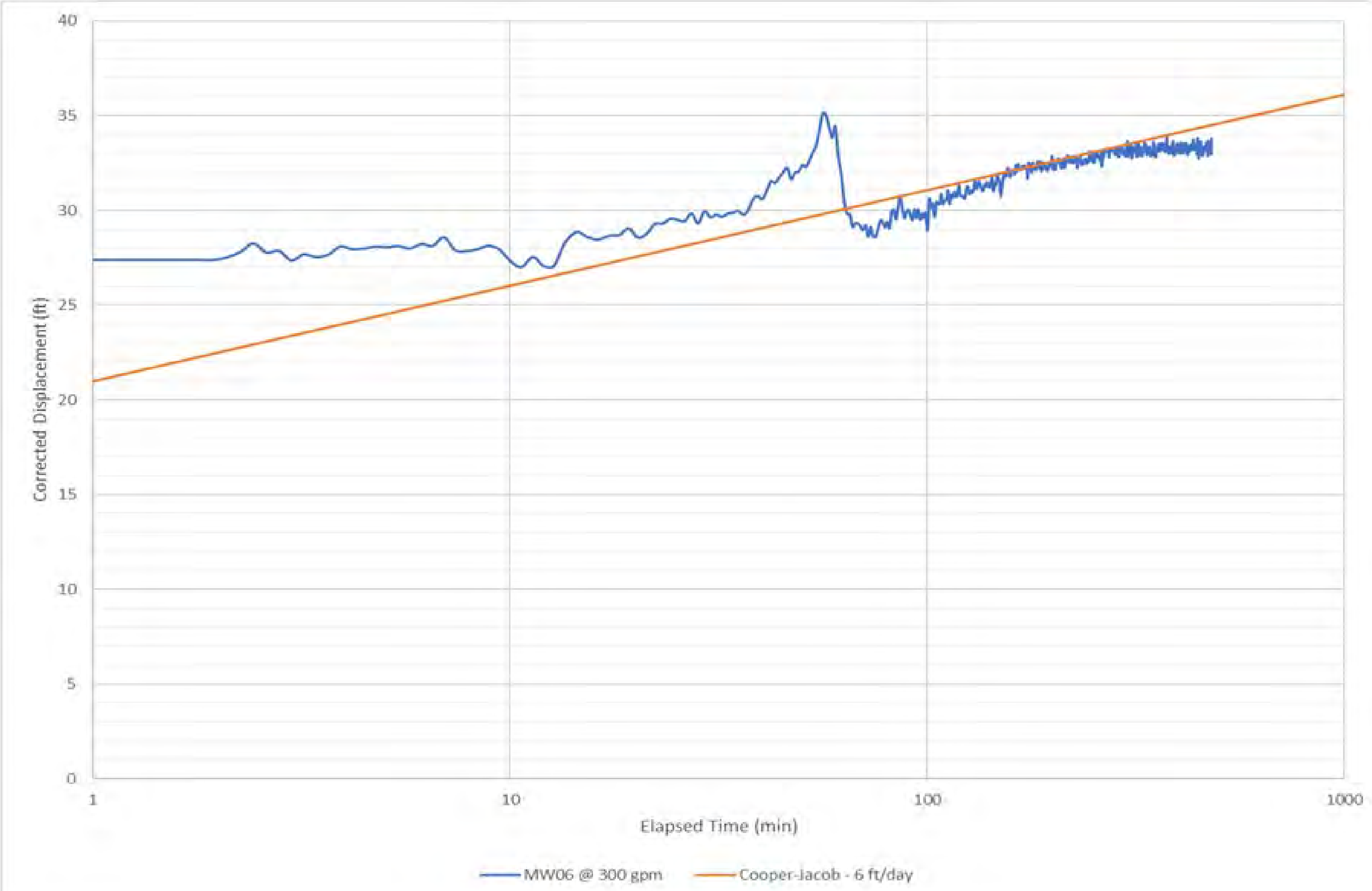

Figure 27. Simulated (Cooper-Jacob) and measured drawdown for the MW-06 aquifer test.

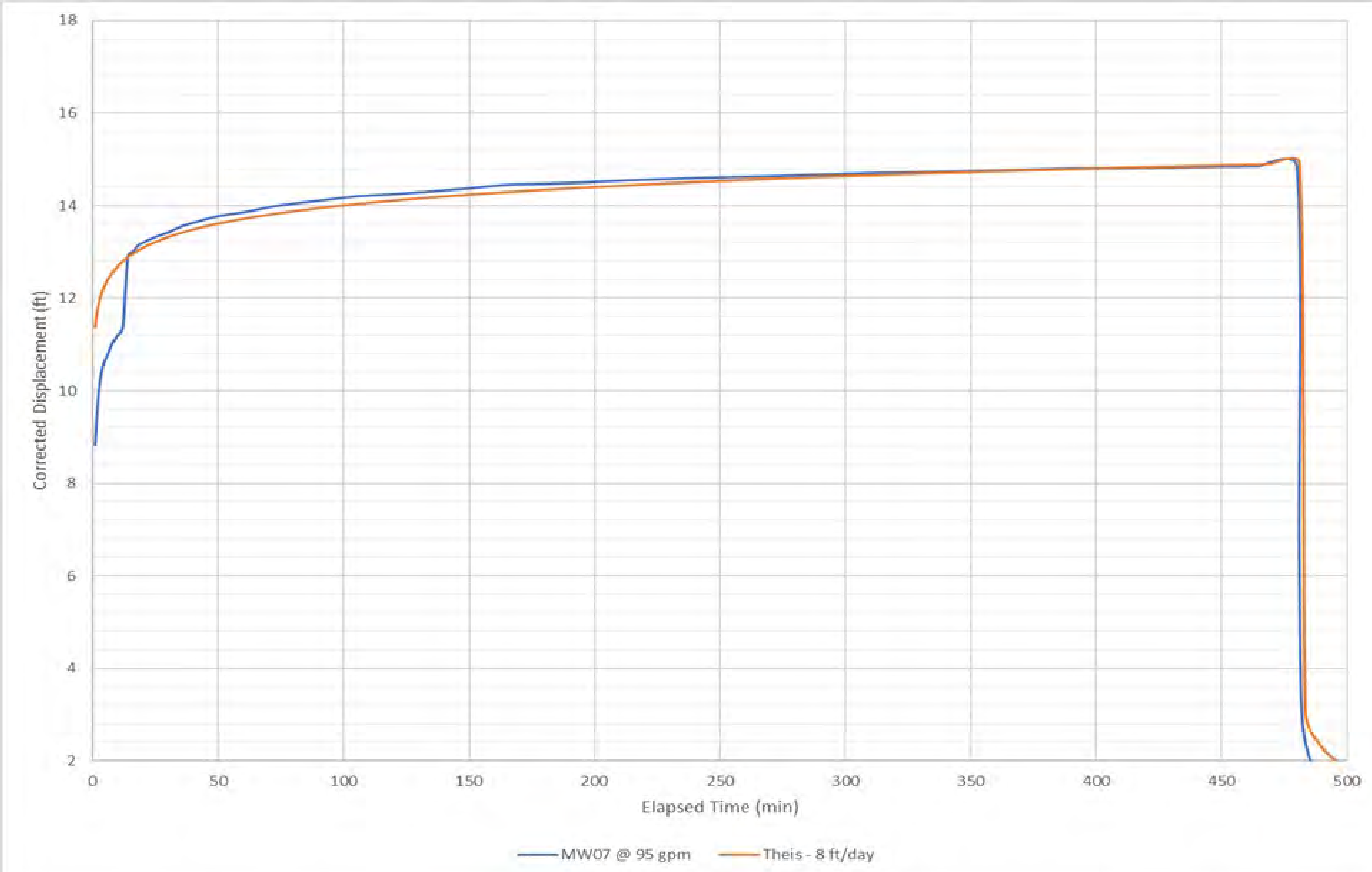

Figure 28. Simulated (Theis) and measured drawdown for the MW-07 aquifer test.

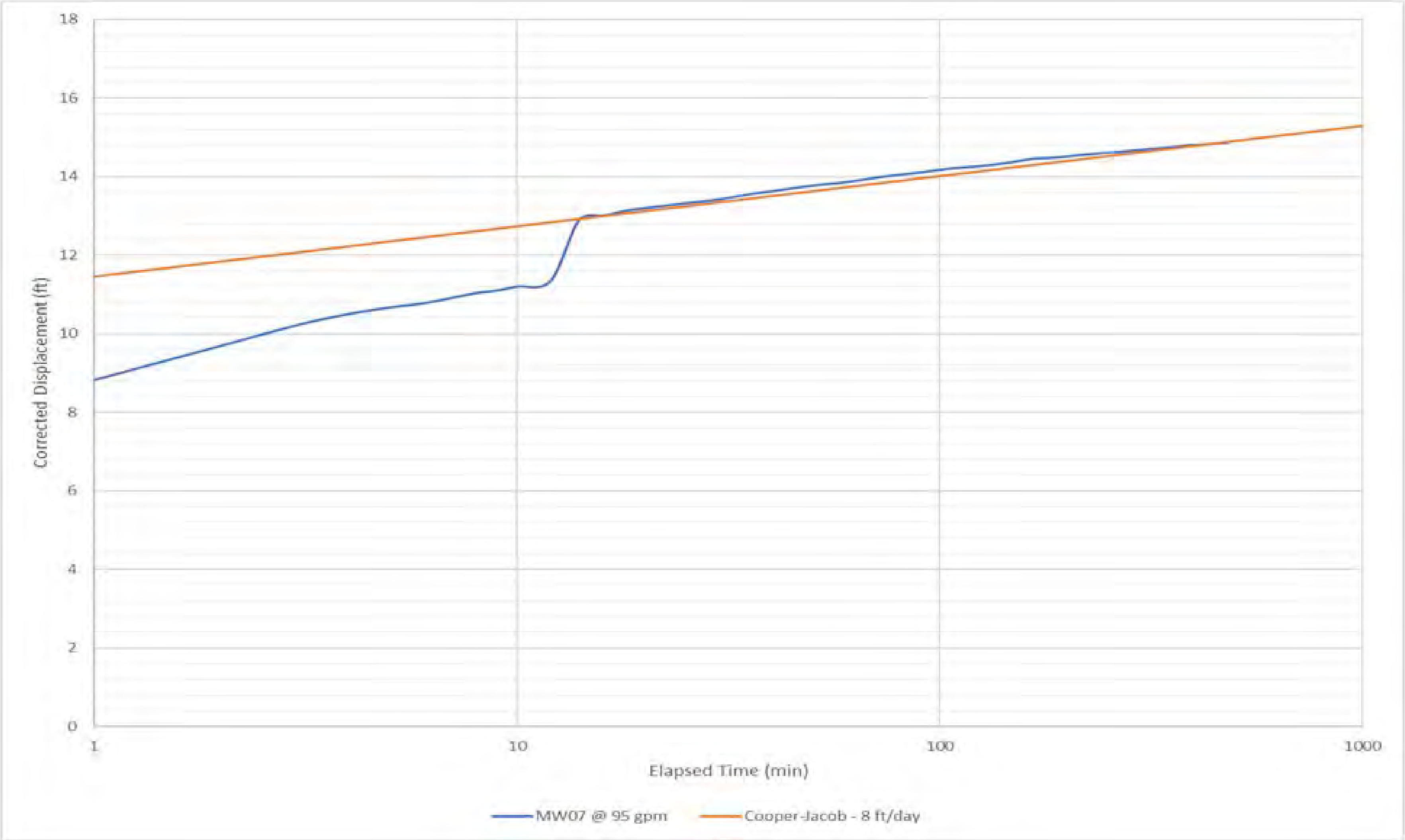

Figure 29. Simulated (Cooper-Jacob) and measured drawdown for the MW-07 aquifer test.

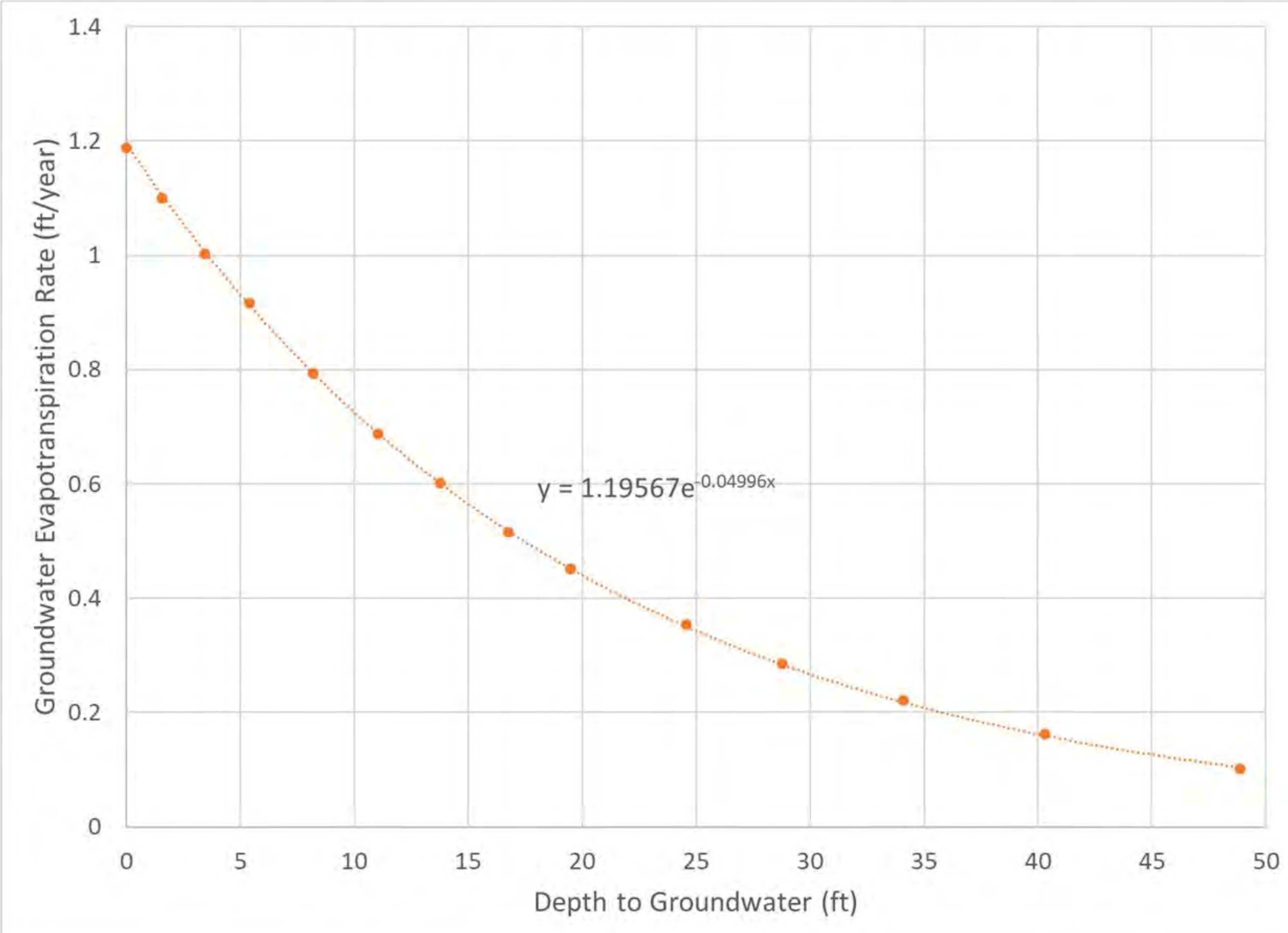

Figure 30. Depth to groundwater versus phreatophyte evapotranspiration rate (adapted from Nichols, 1994 for a plant density of 20 percent).

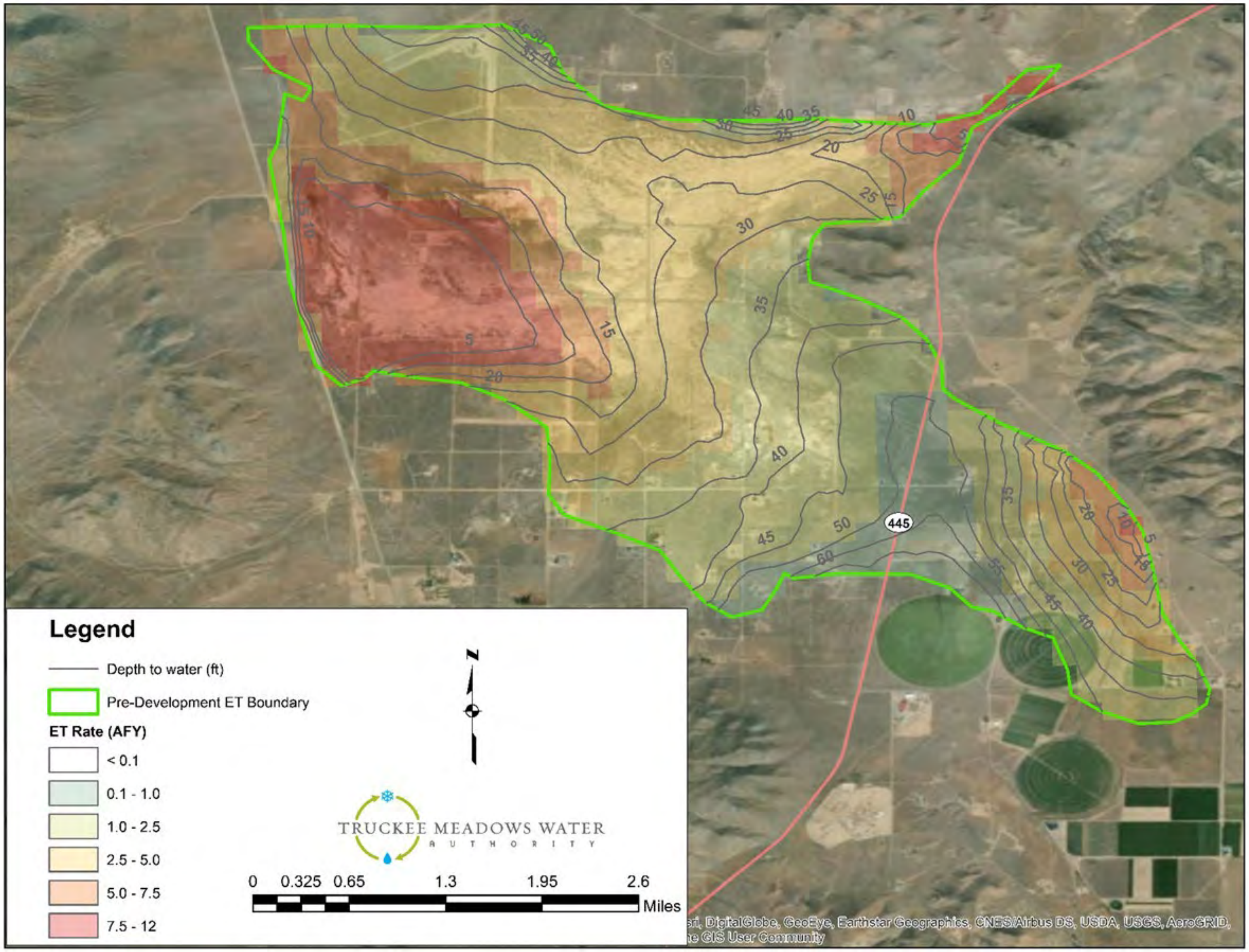

Figure 31. Calculated groundwater evapotranspiration rate and associated depth to groundwater contours.

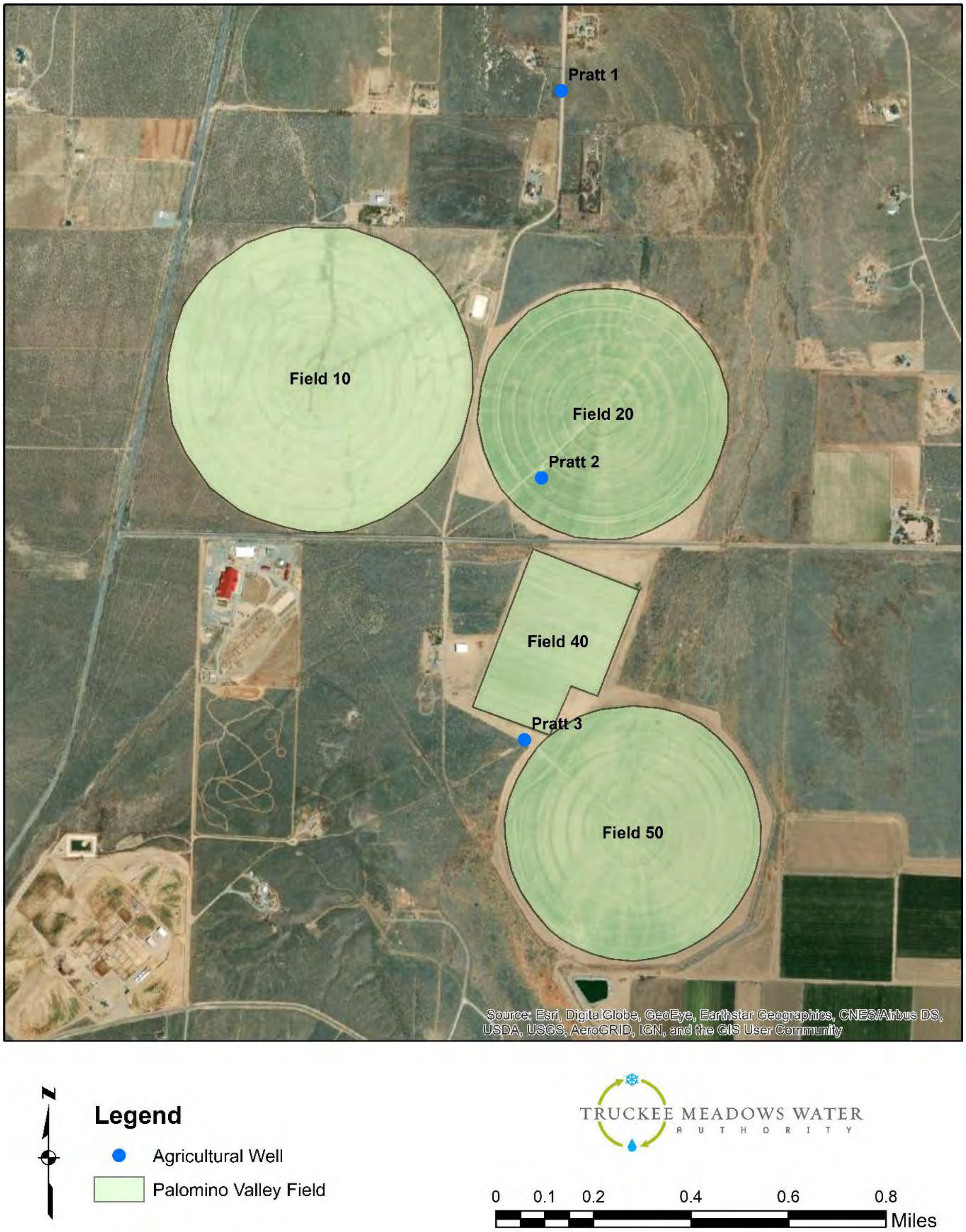

Figure 32. Agricultural wells and associated alfalfa fields at Palomino Farms.

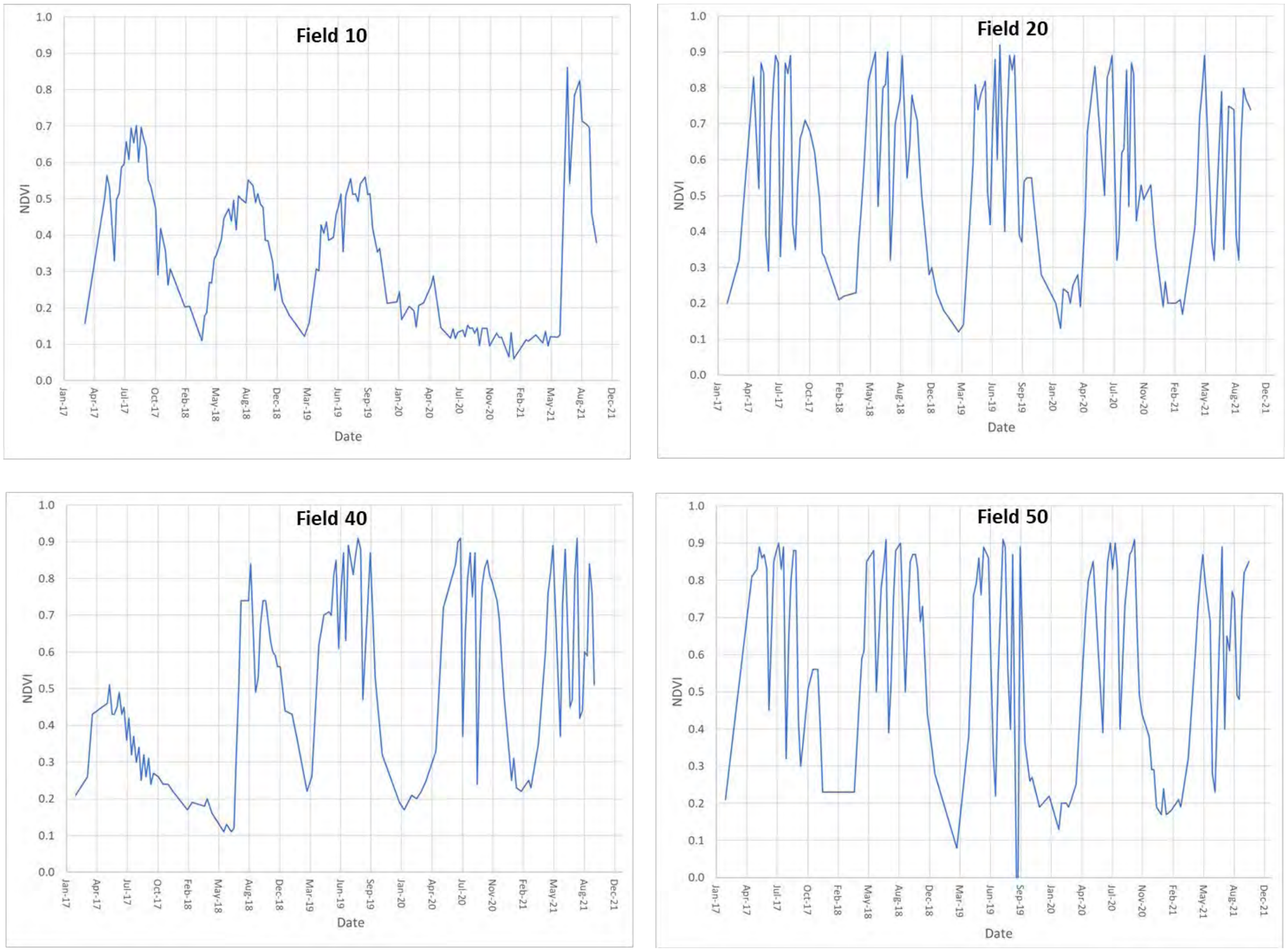

Figure 33. Normalized difference vegetation index (NDVI) for Fields 10, 20, 40, and 50 for 2017 - 2021.

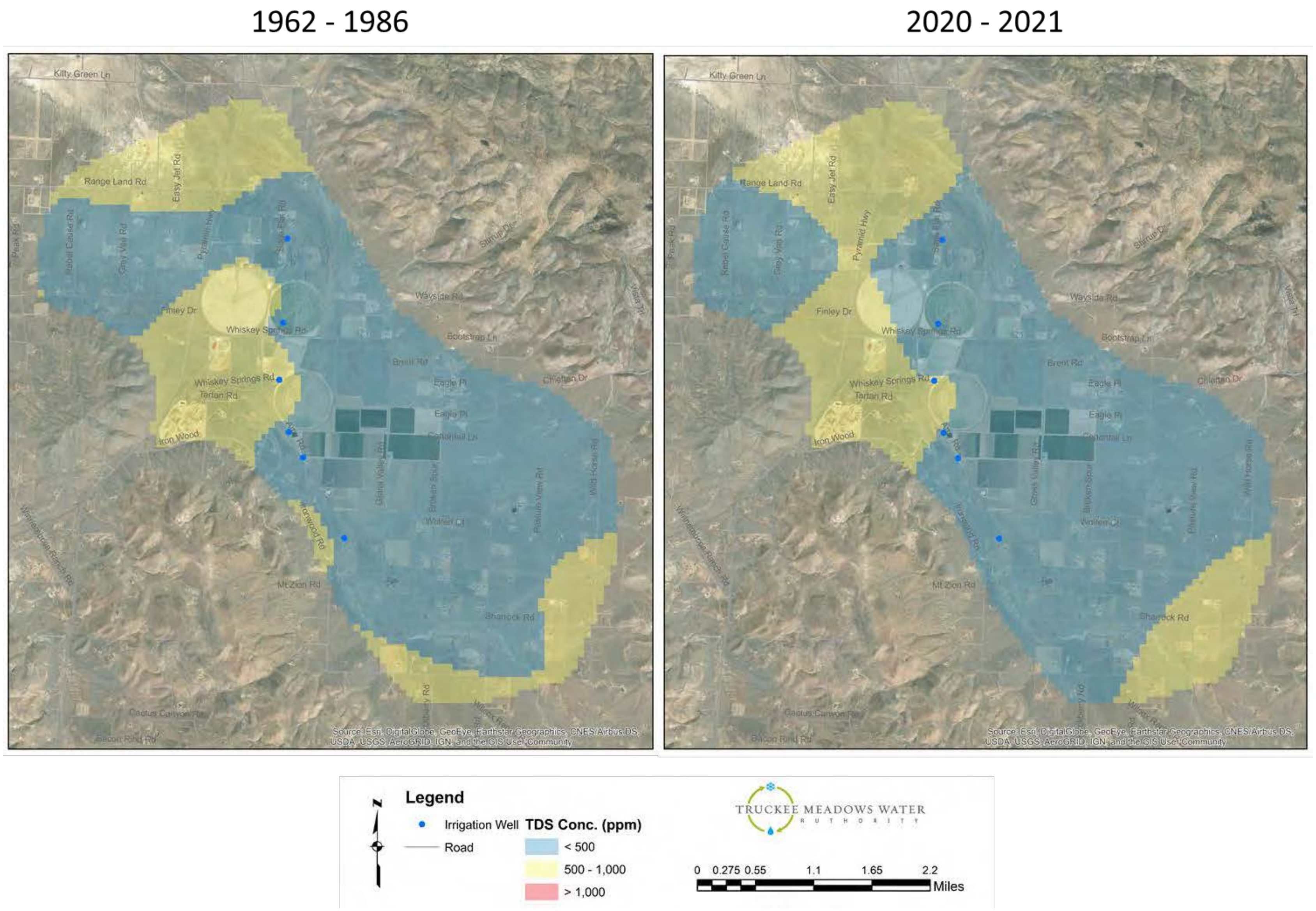

Figure 34. Spatial distribution of aquifer TDS concentration.

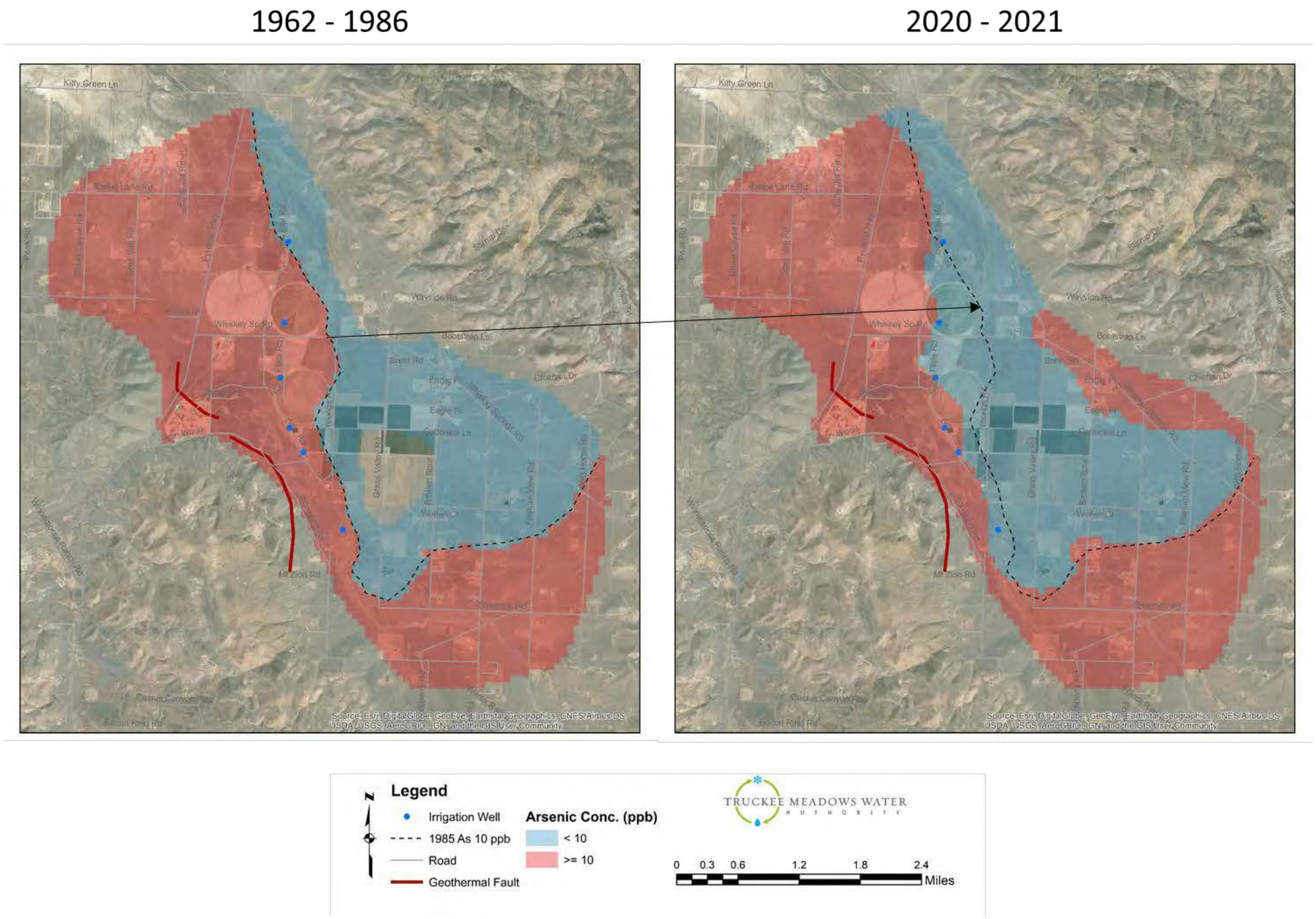

Figure 35. Spatial distribution of aquifer arsenic concentration. Dashed line represents the 10 ppb contour for the 1962 – 1986 period.

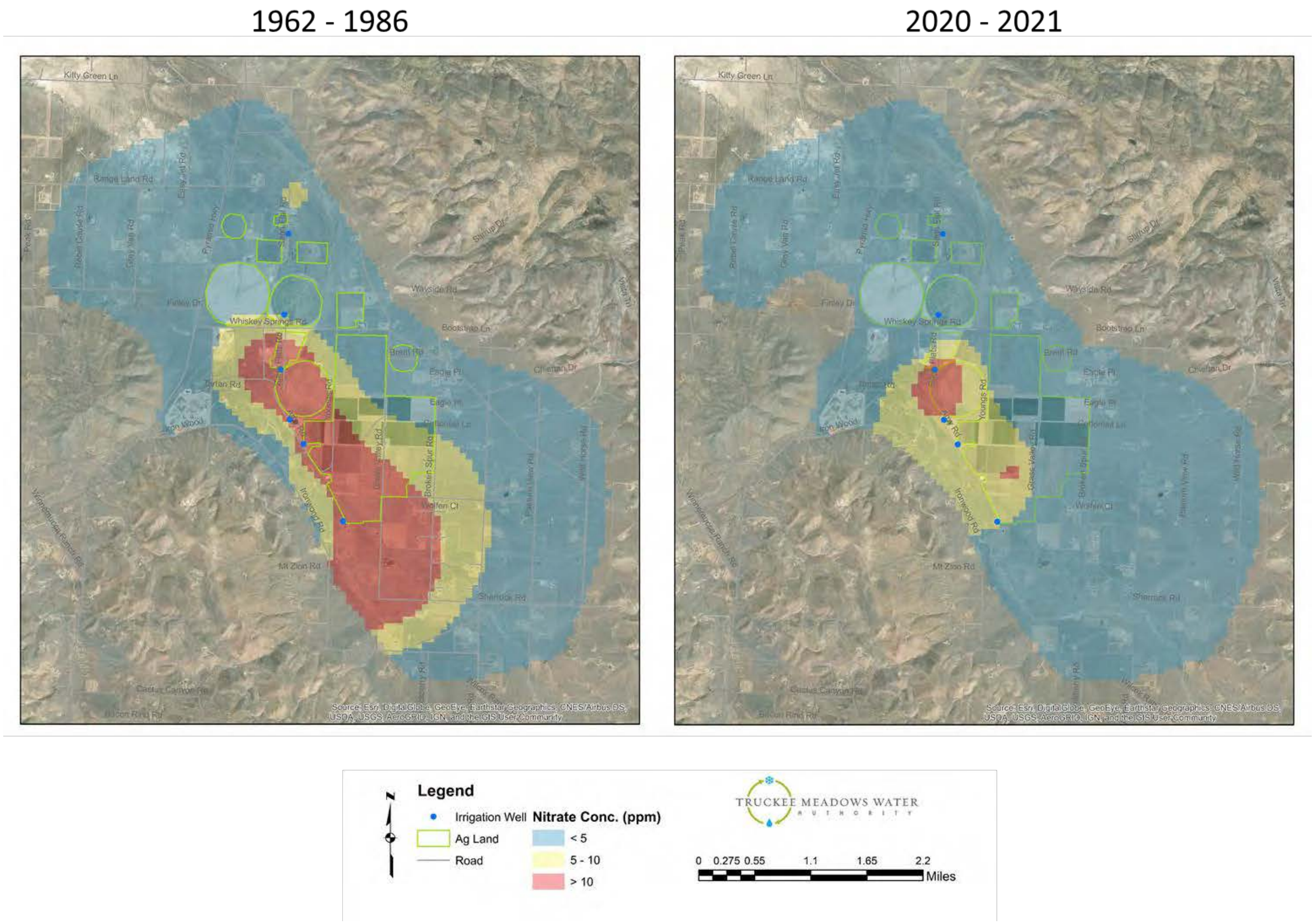

Figure 36. Spatial distribution of aquifer nitrate (as nitrogen) concentration.

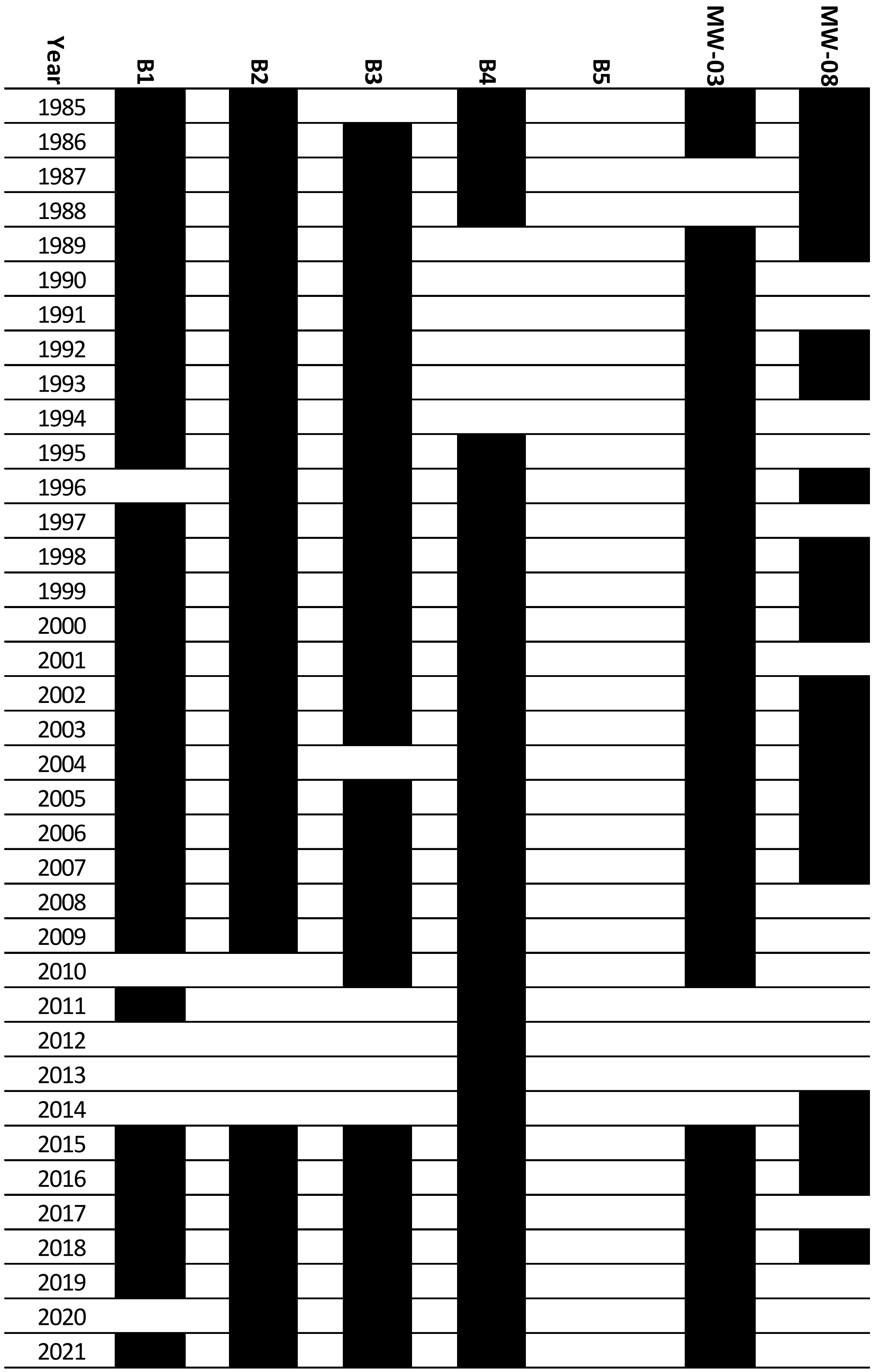

Figure 37. Irrigation by year for fields with boreholes. Years showing black formatting were irrigated in that year.

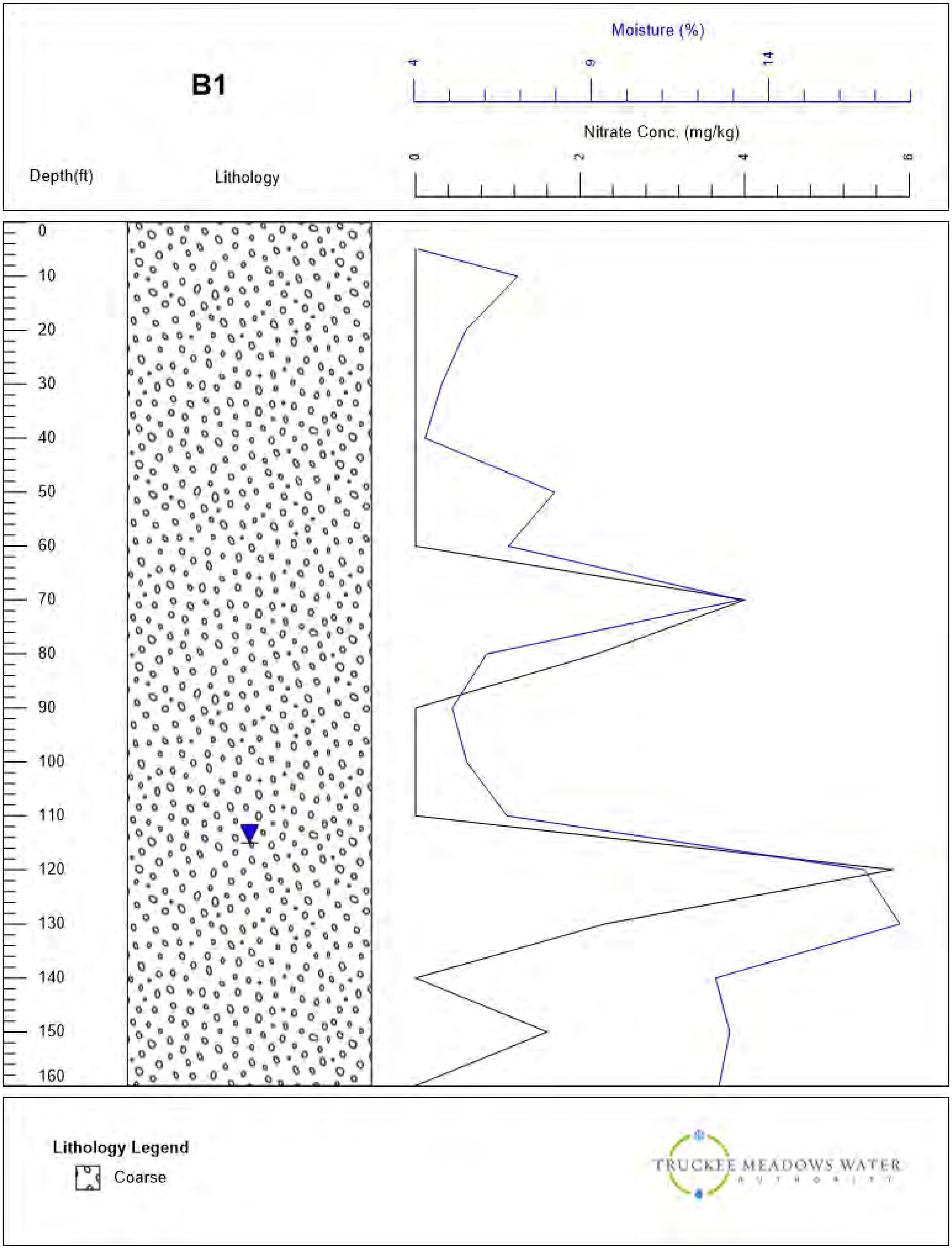

Figure 38. Vadose zone lithology, soil moisture, and nitrate concentrations for B1.

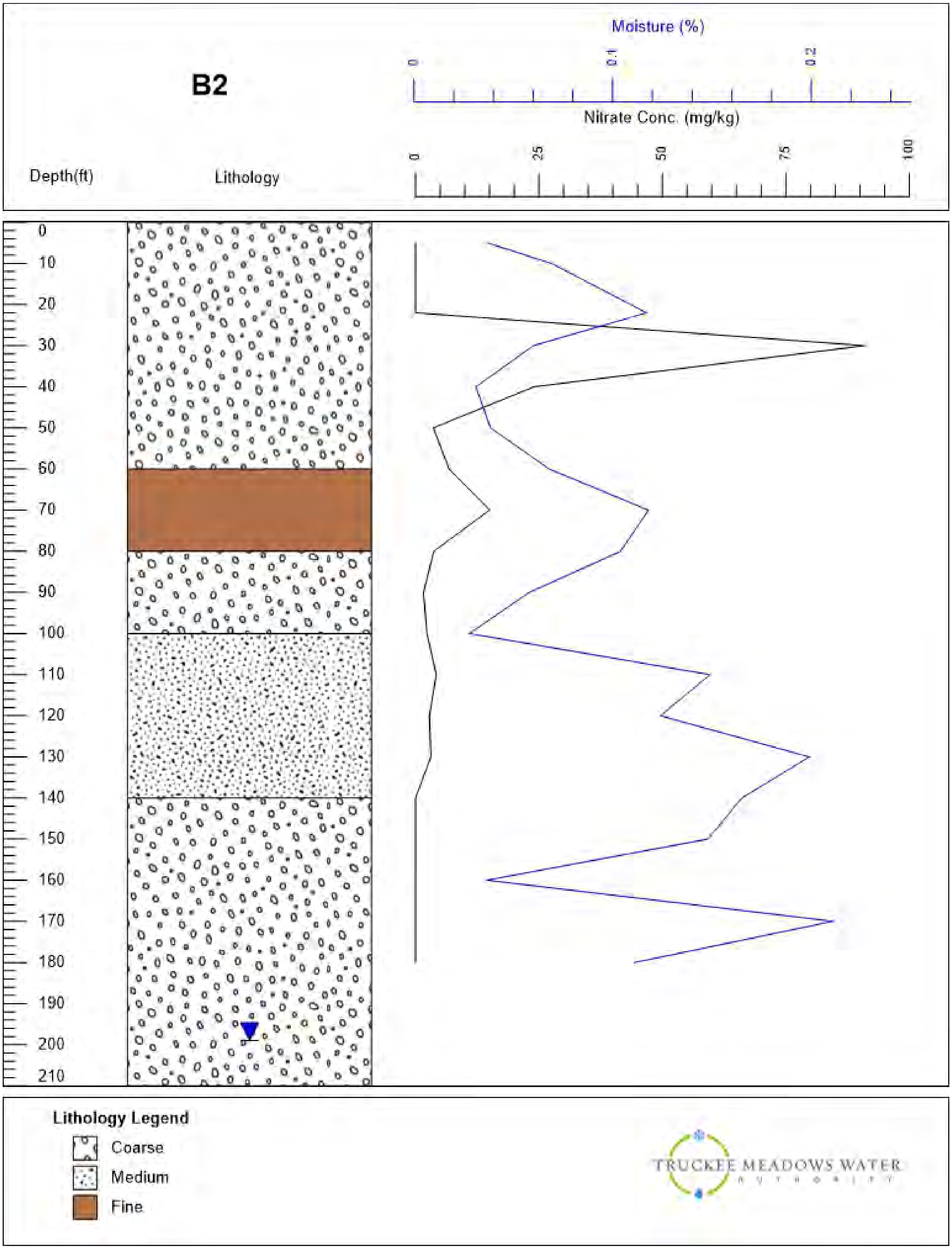

Figure 39. Vadose zone lithology, soil moisture, and nitrate concentrations for B2.

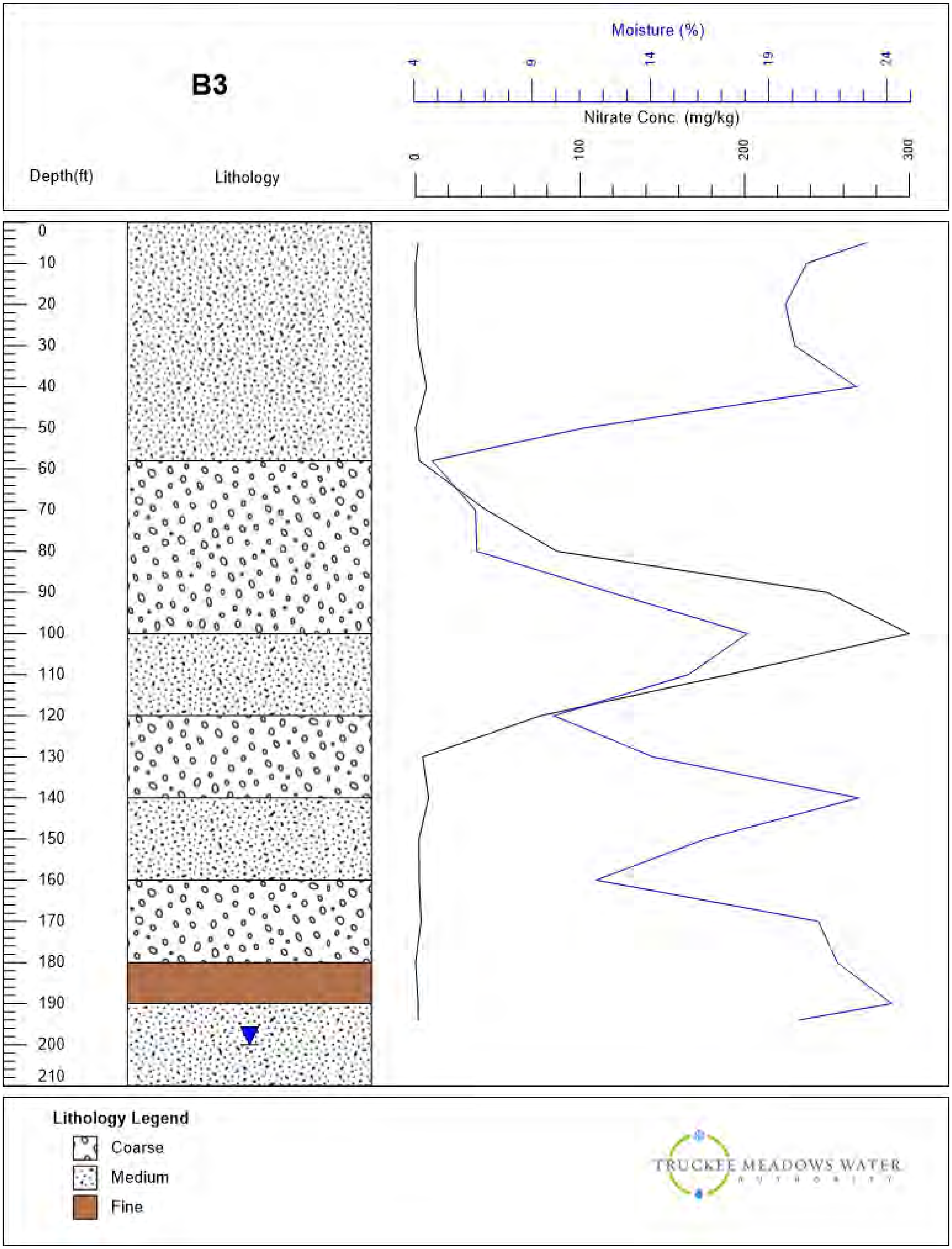

Figure 40. Vadose zone lithology, soil moisture, and nitrate concentrations for B3.

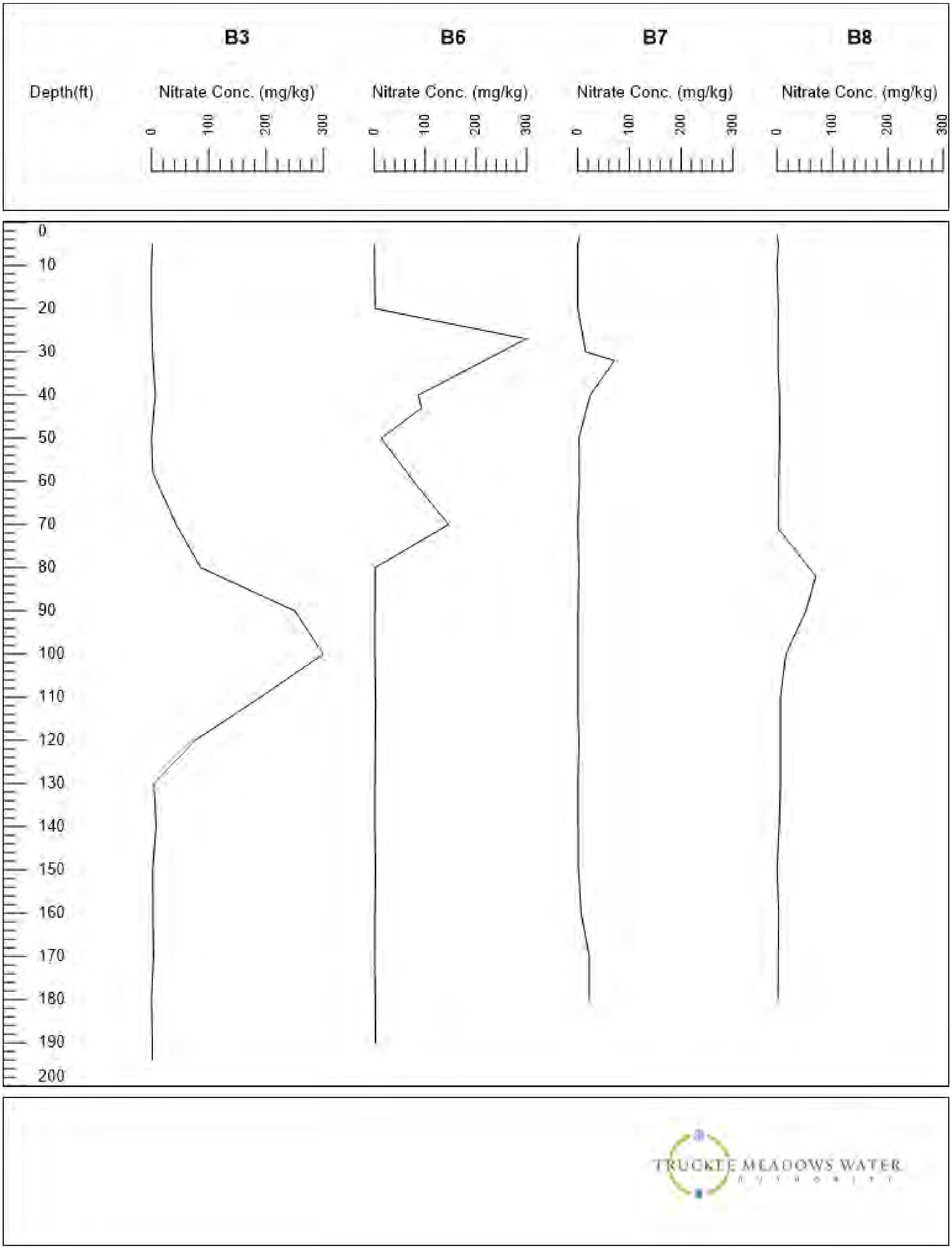

Figure 41. Soil nitrate concentrations at boreholes B3, B6, B7, and B8 in Field 50.

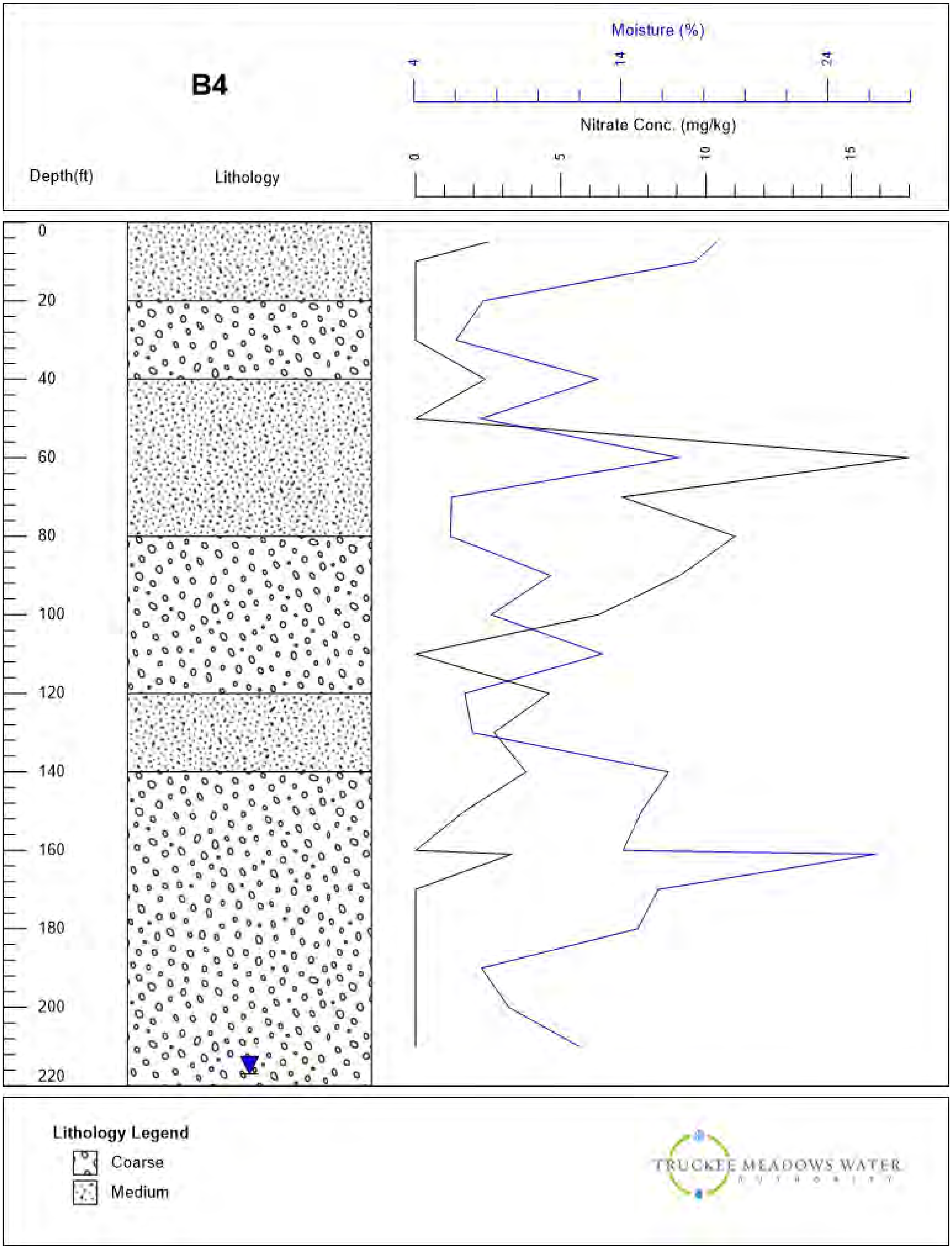

Figure 42. Vadose zone lithology, soil moisture, and nitrate concentrations for B4.

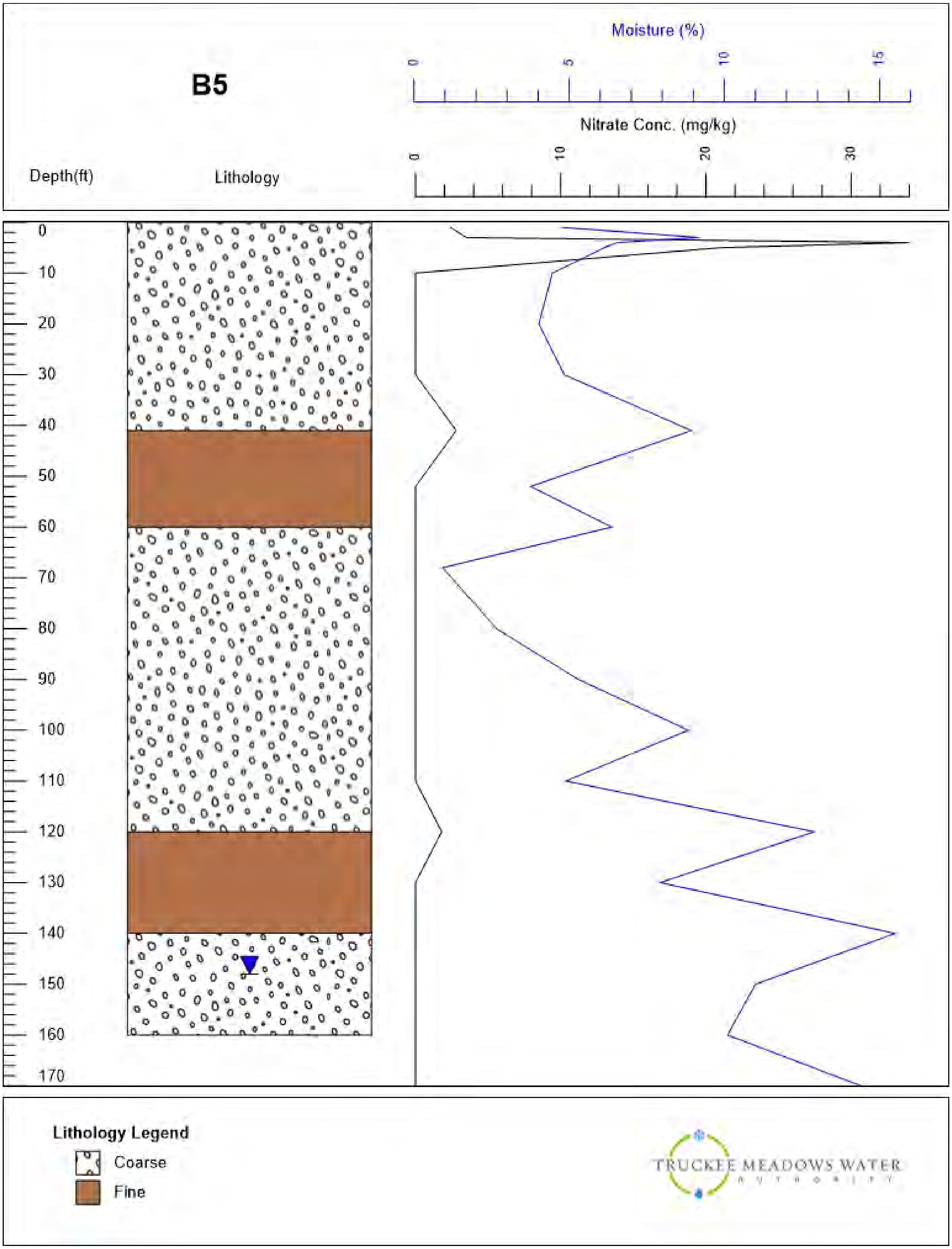

Figure 43. Vadose zone lithology, soil moisture, and nitrate concentrations for B5.

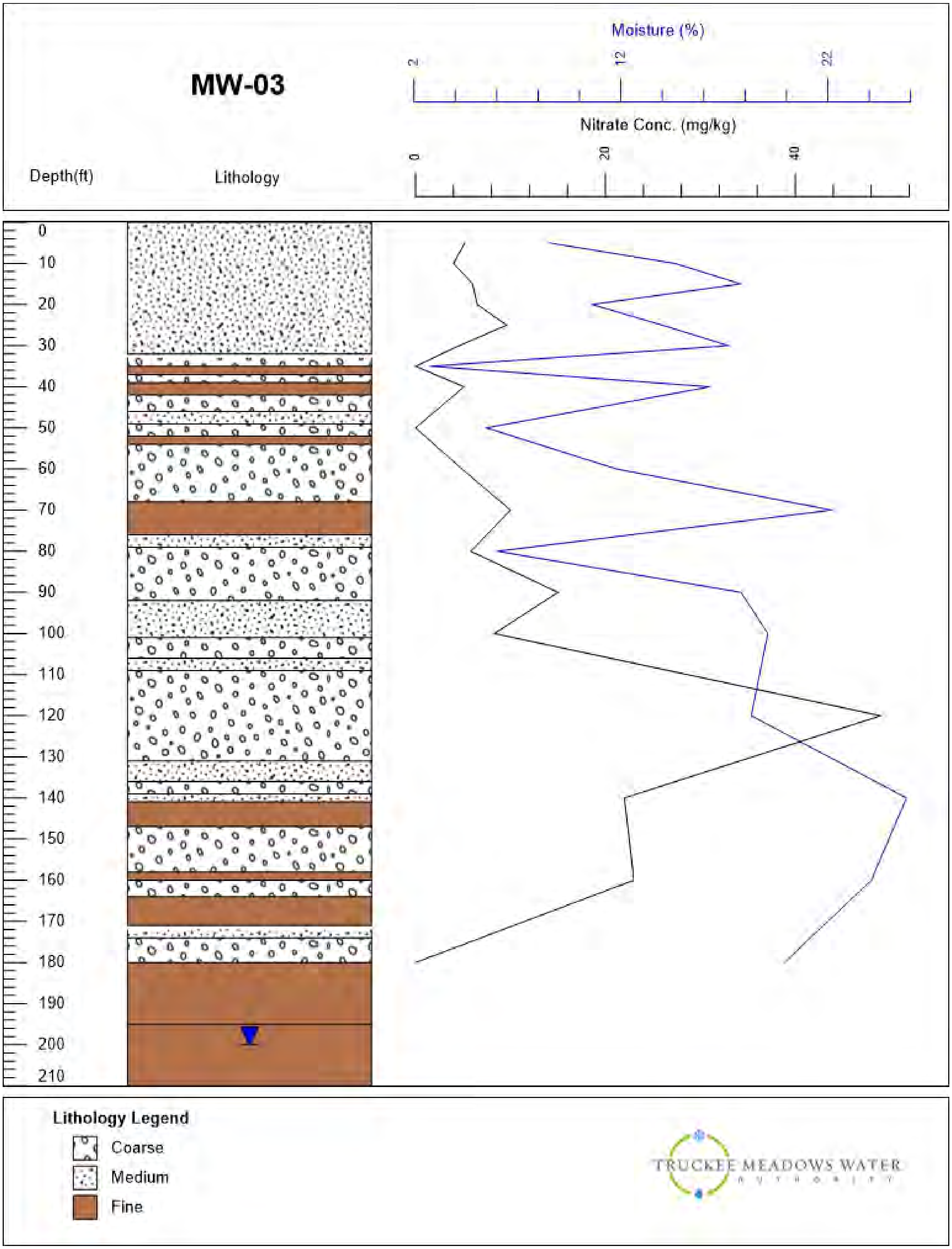

Figure 44. Vadose zone lithology, soil moisture, and nitrate concentrations for MW-03.

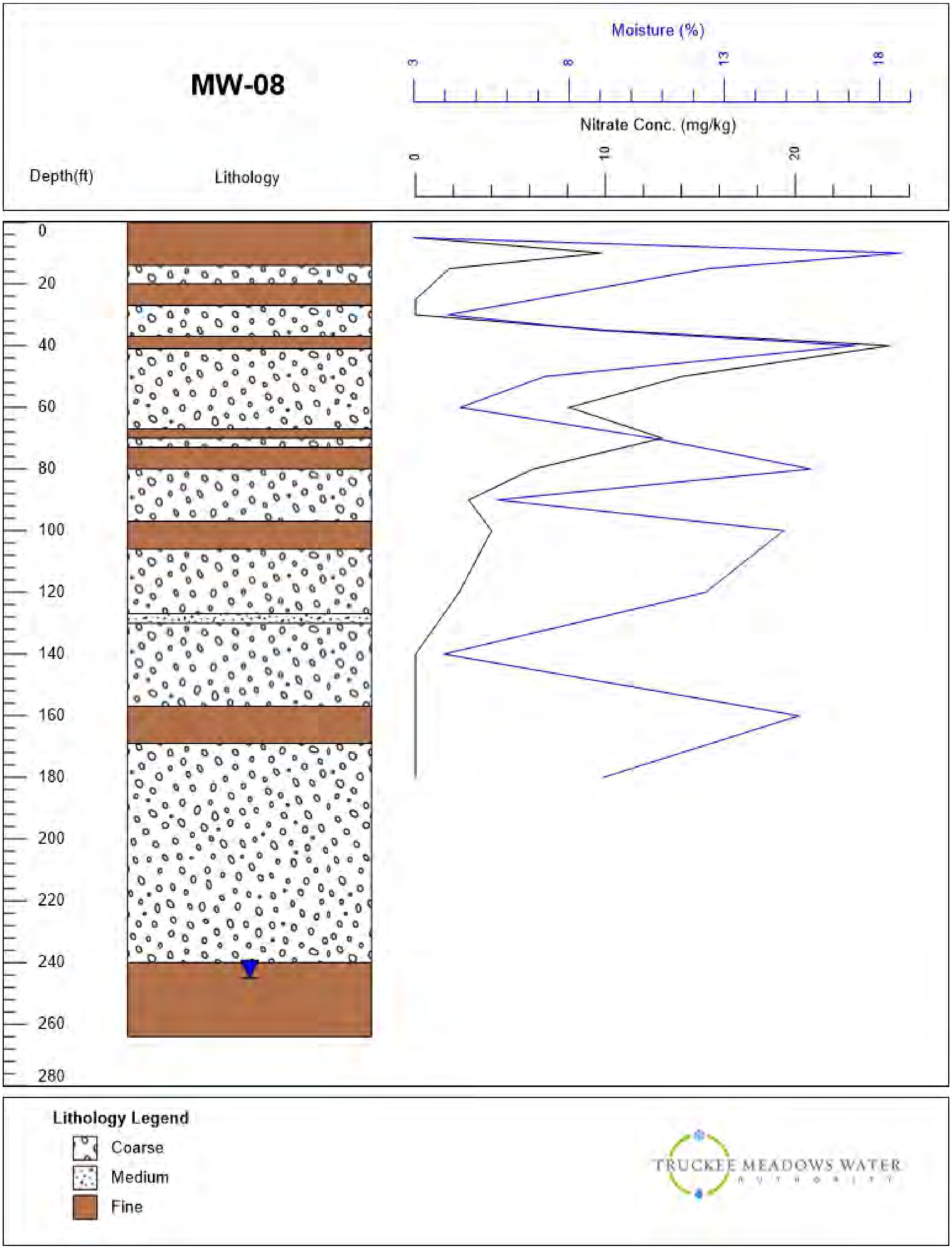

Figure 45. Vadose zone lithology, soil moisture, and nitrate concentrations for MW-08.

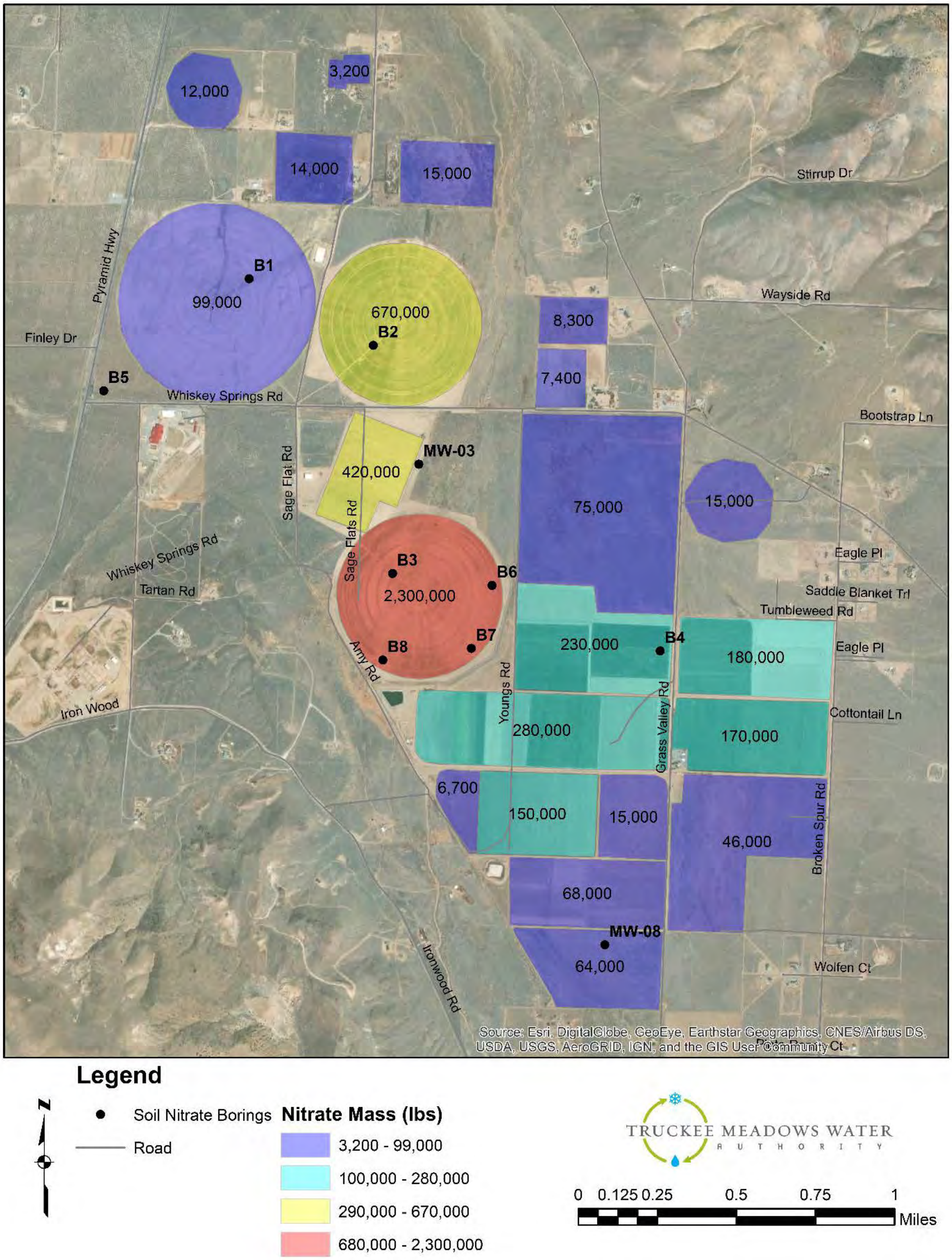

Figure 46. Estimated total soil mass for previously irrigated fields.

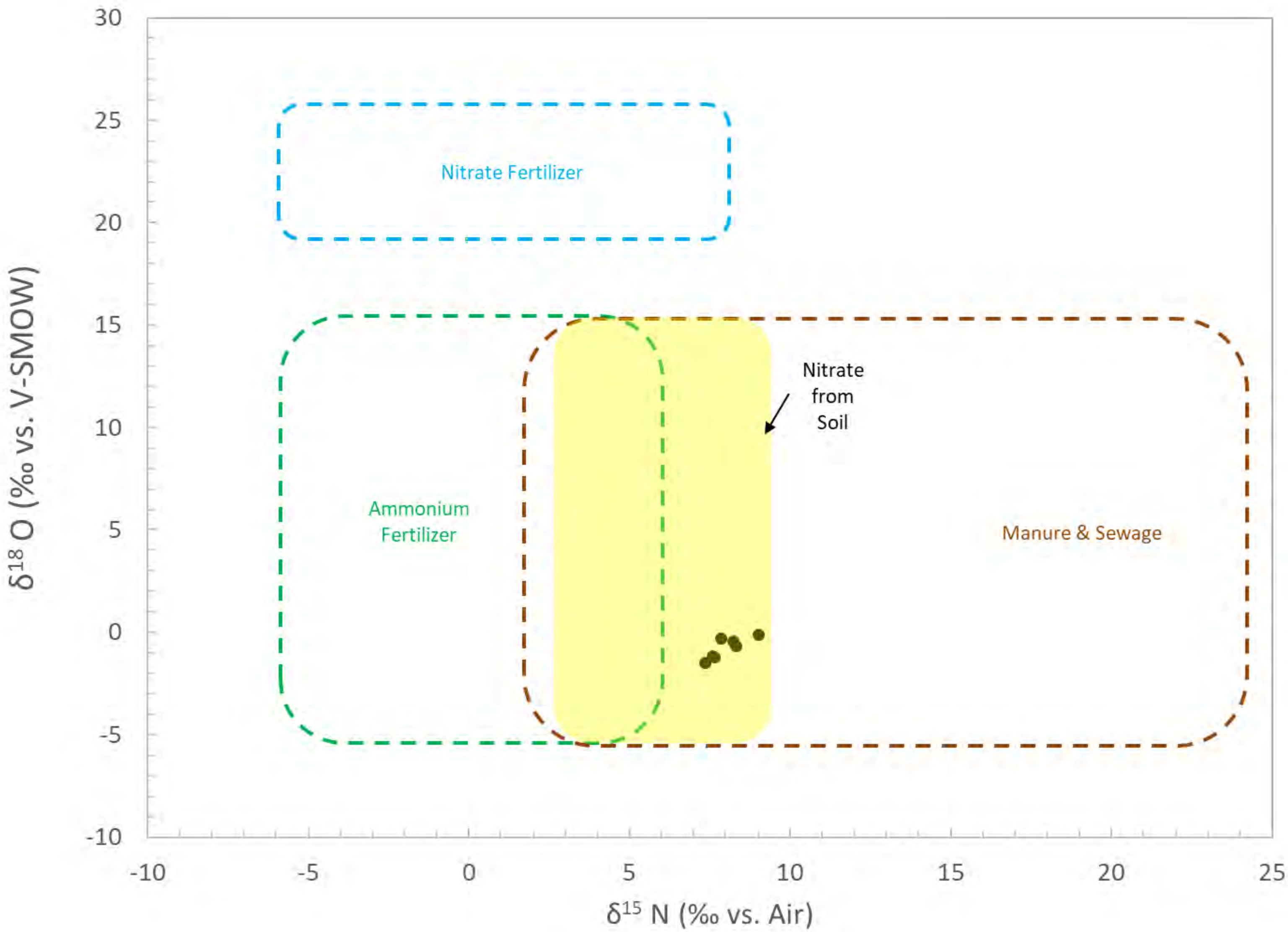

Figure 47. Plot of nitrogen-15 versus Oxygen-18 for groundwater samples in Warm Springs Valley.

Figure 48. Location of BESST well vertical profiles.

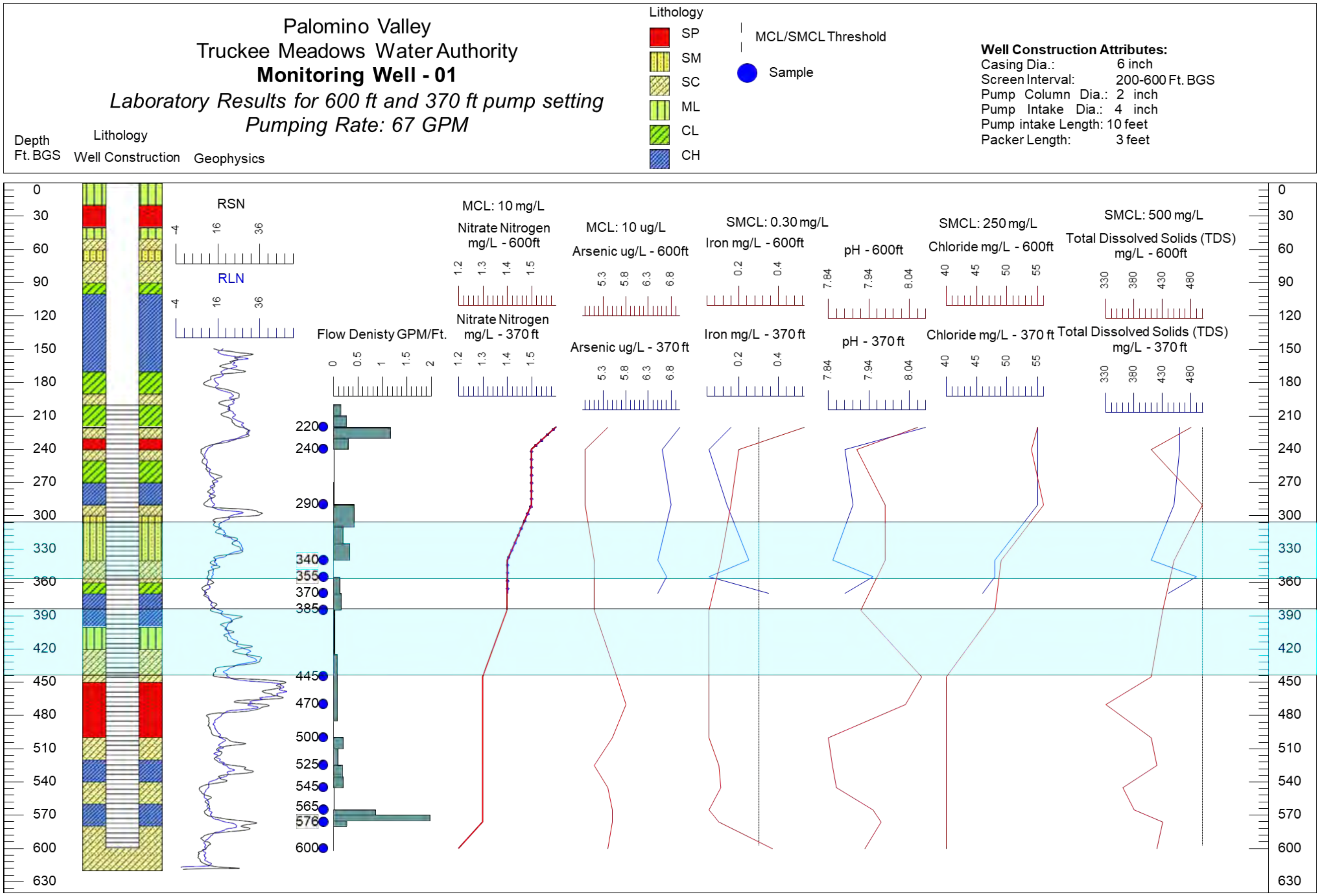

Figure 49. Results from BESST profiling at MW-01.

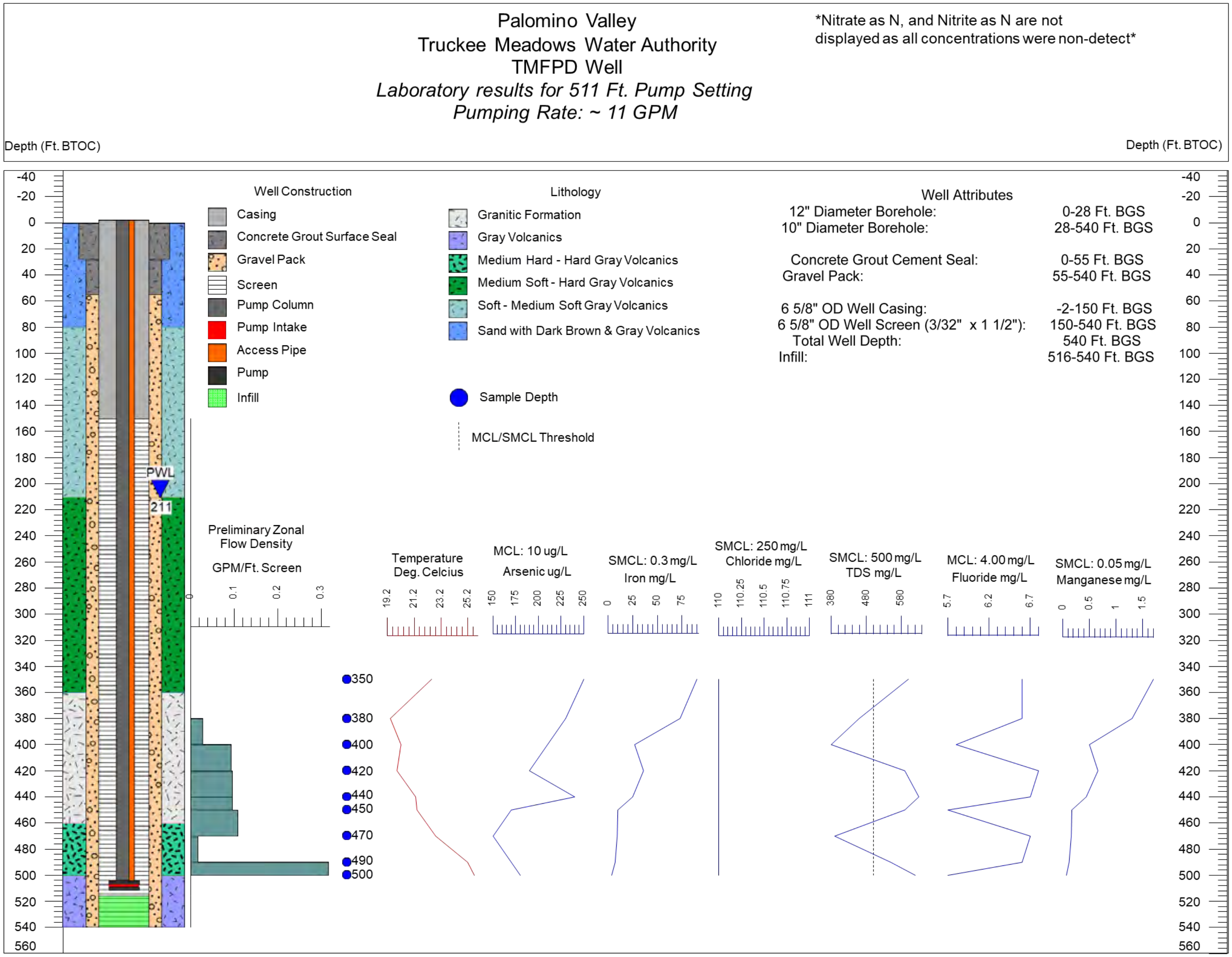

Figure 50. Results from BESST profiling at TMFPD well.

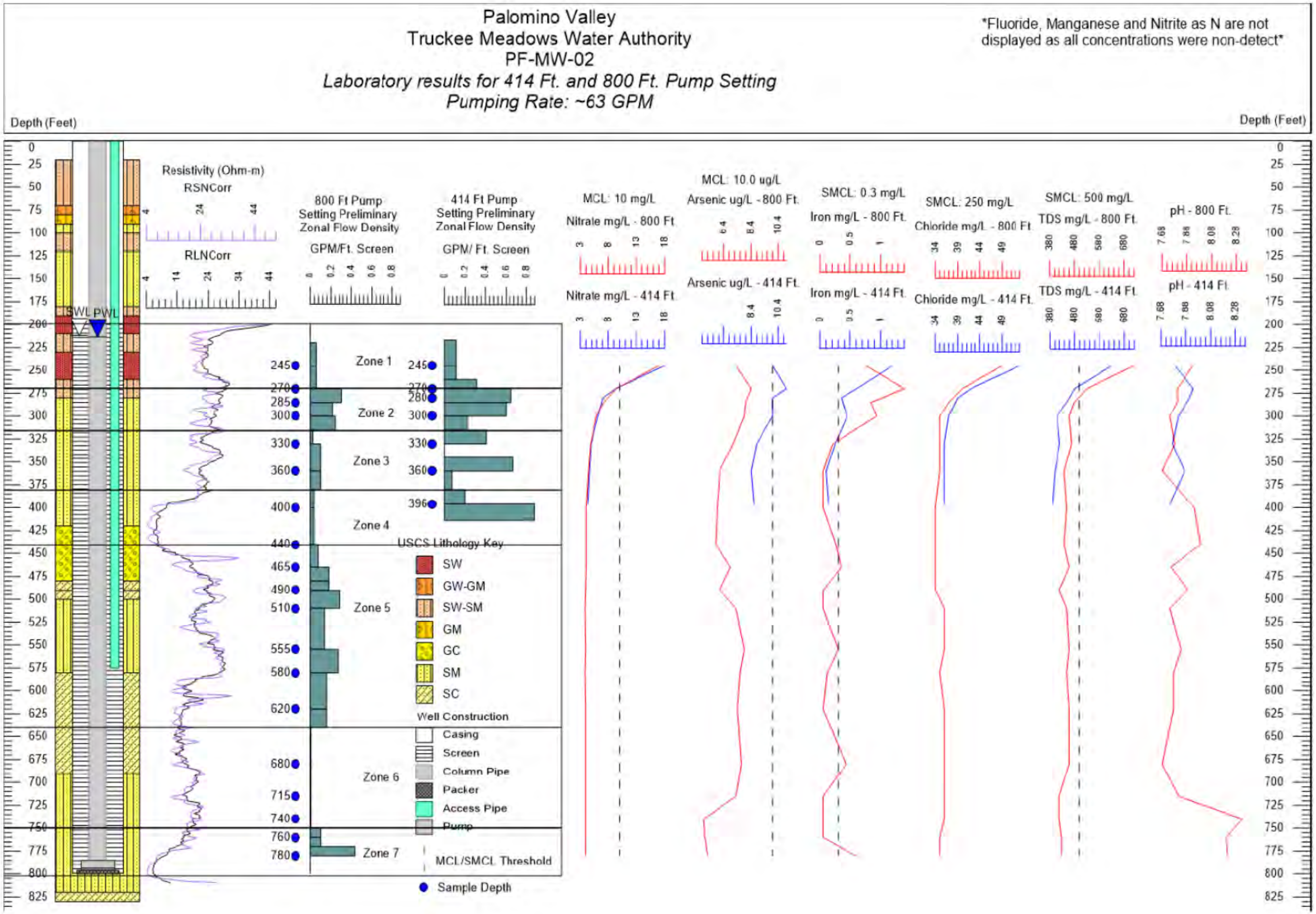

Figure 51. Results from BESST profiling at MW-02.

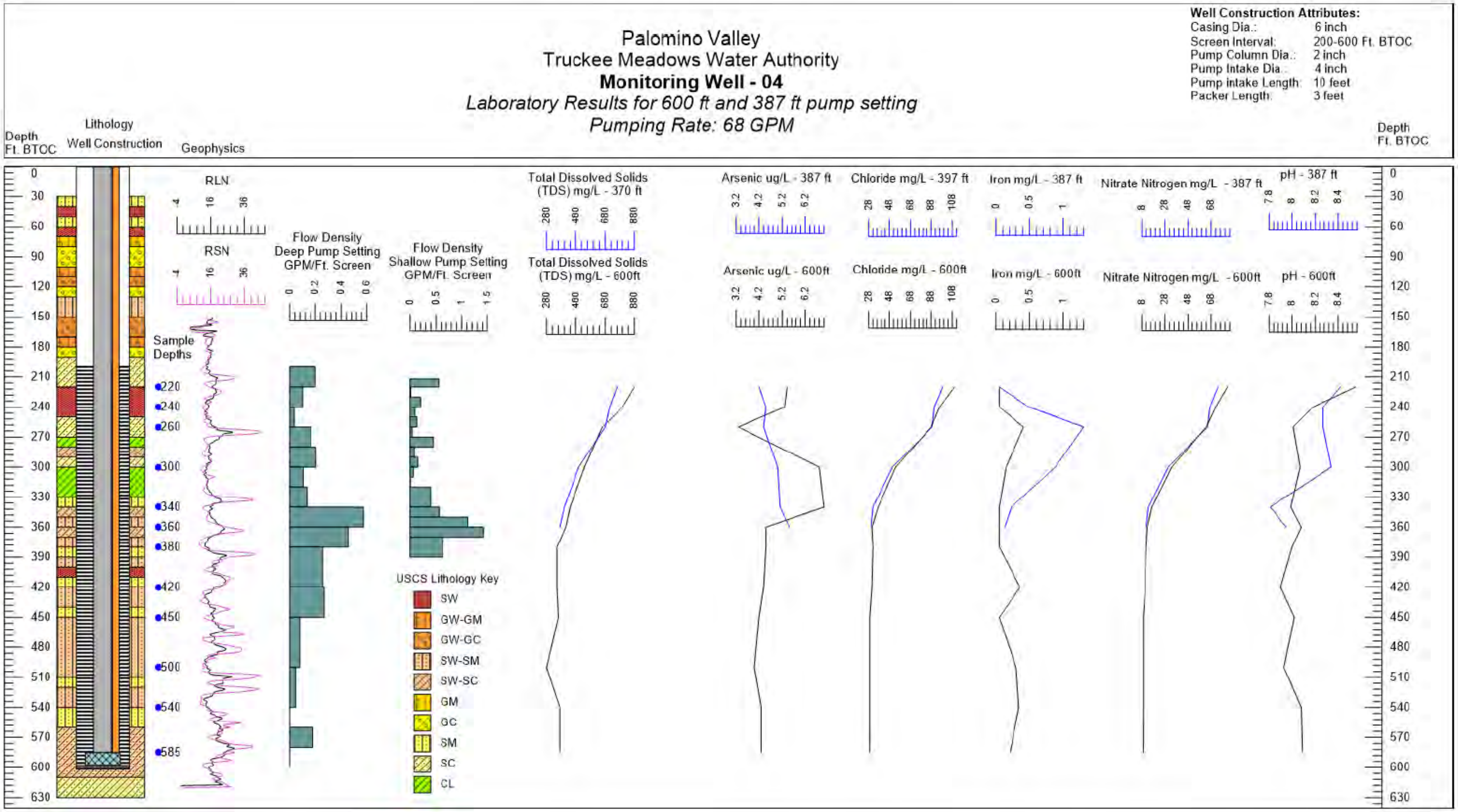

Figure 52. Results from BESST profiling at MW-04.

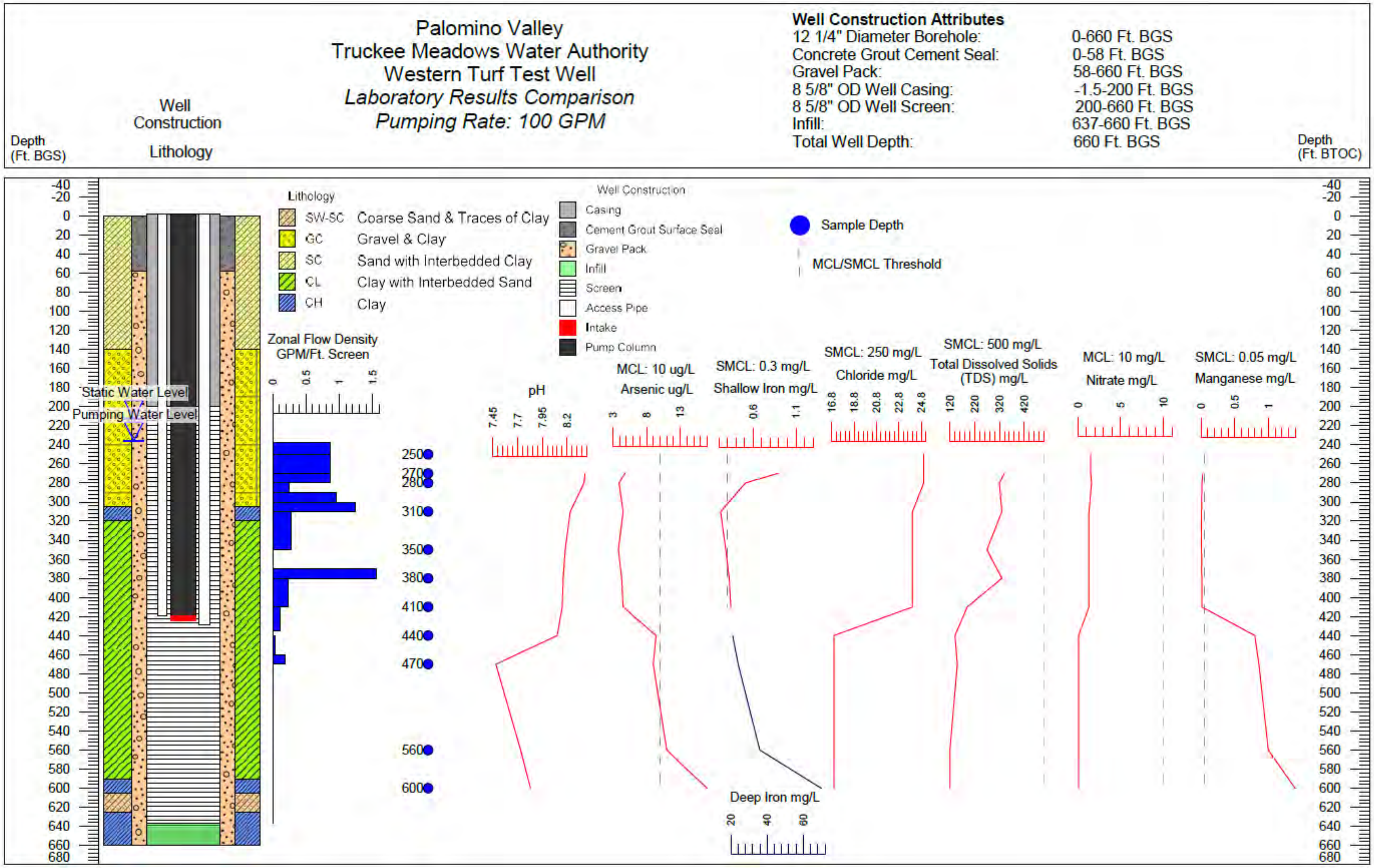

Figure 53. Results from BESST profiling at Western Turf Test well.

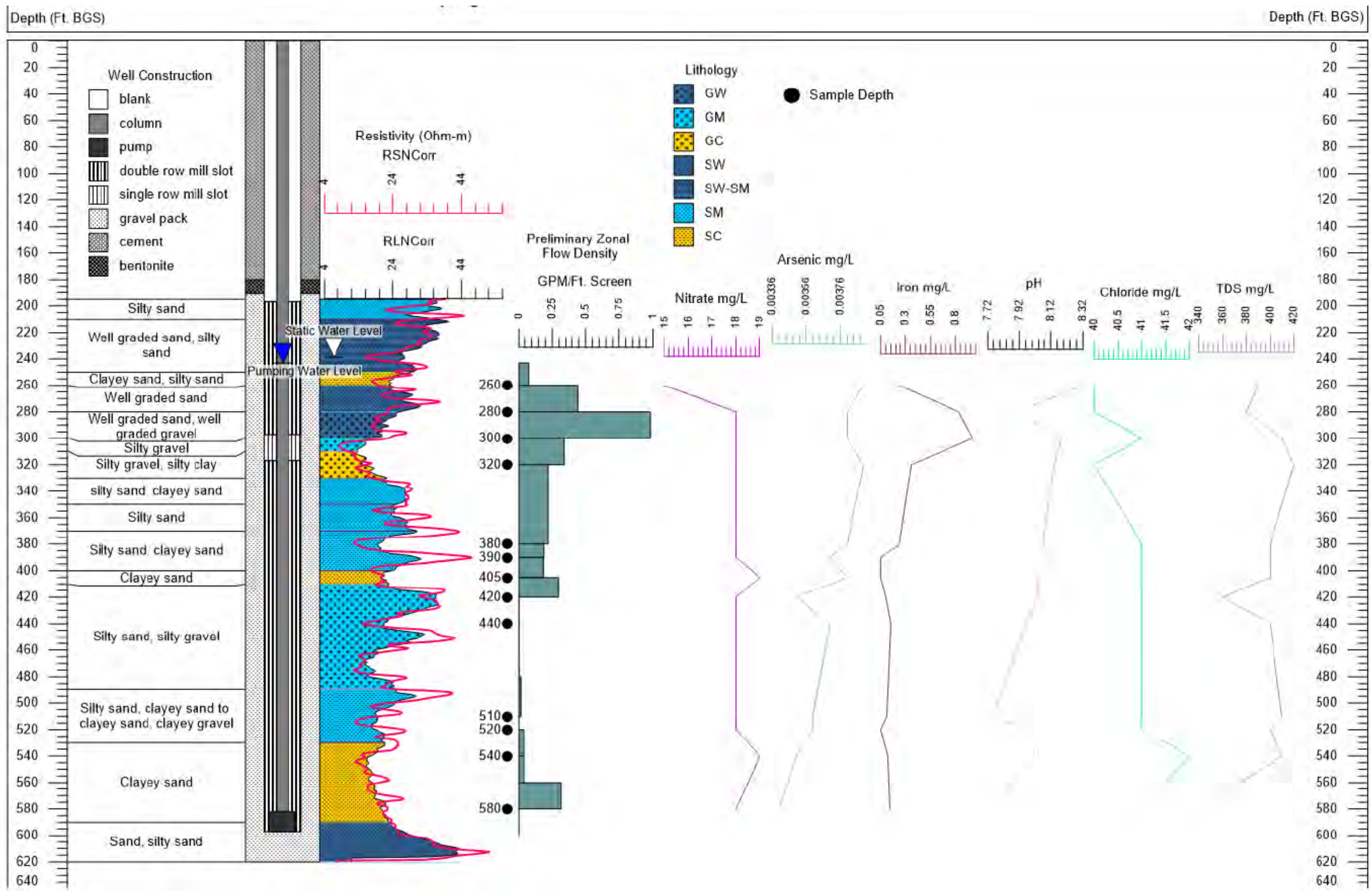

Figure 54. Results from BESST profiling at MW-06.

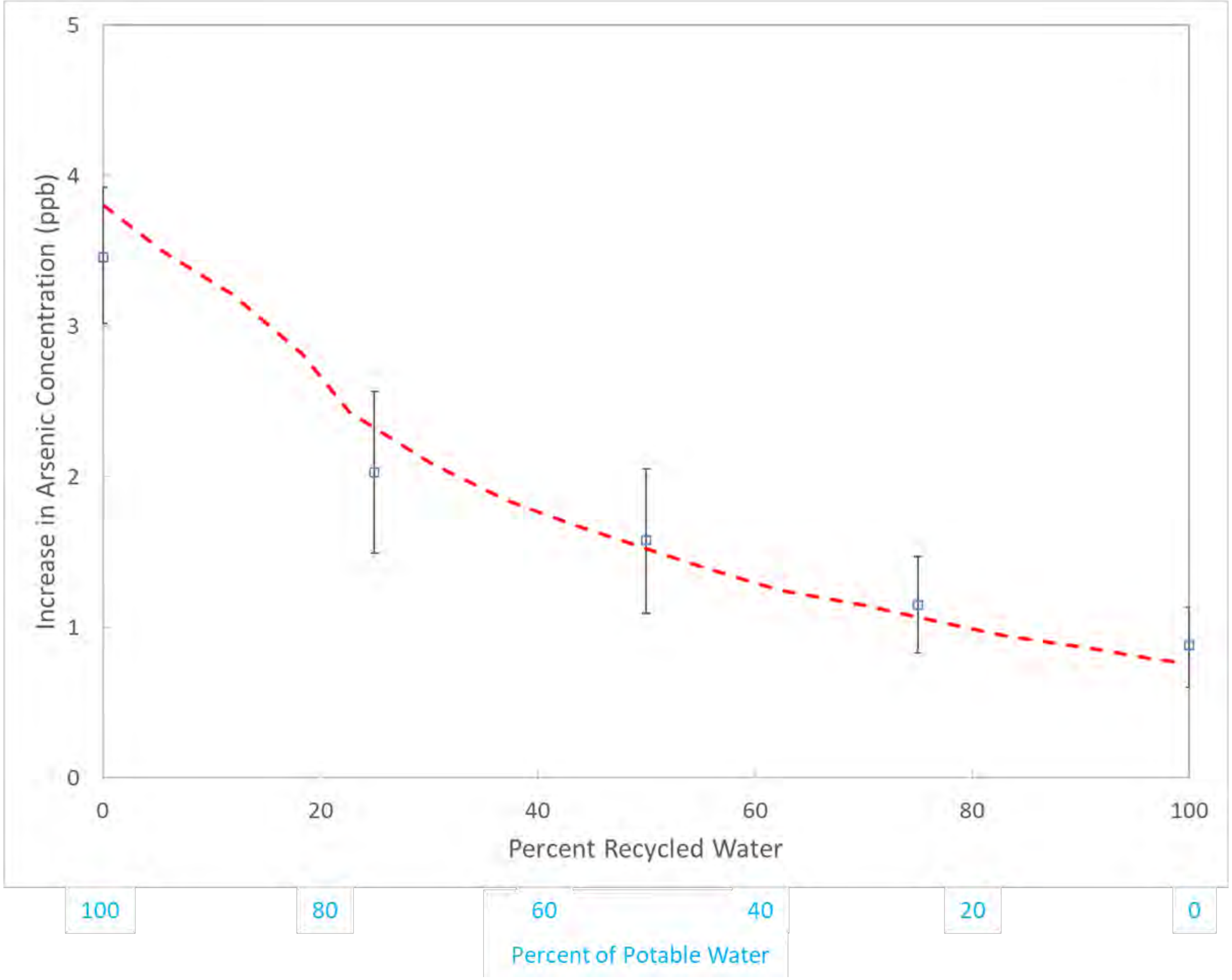

Figure 55. Arsenic concentrations at the end of the MW-08 leaching experiment for various ratios of recycled and potable water.

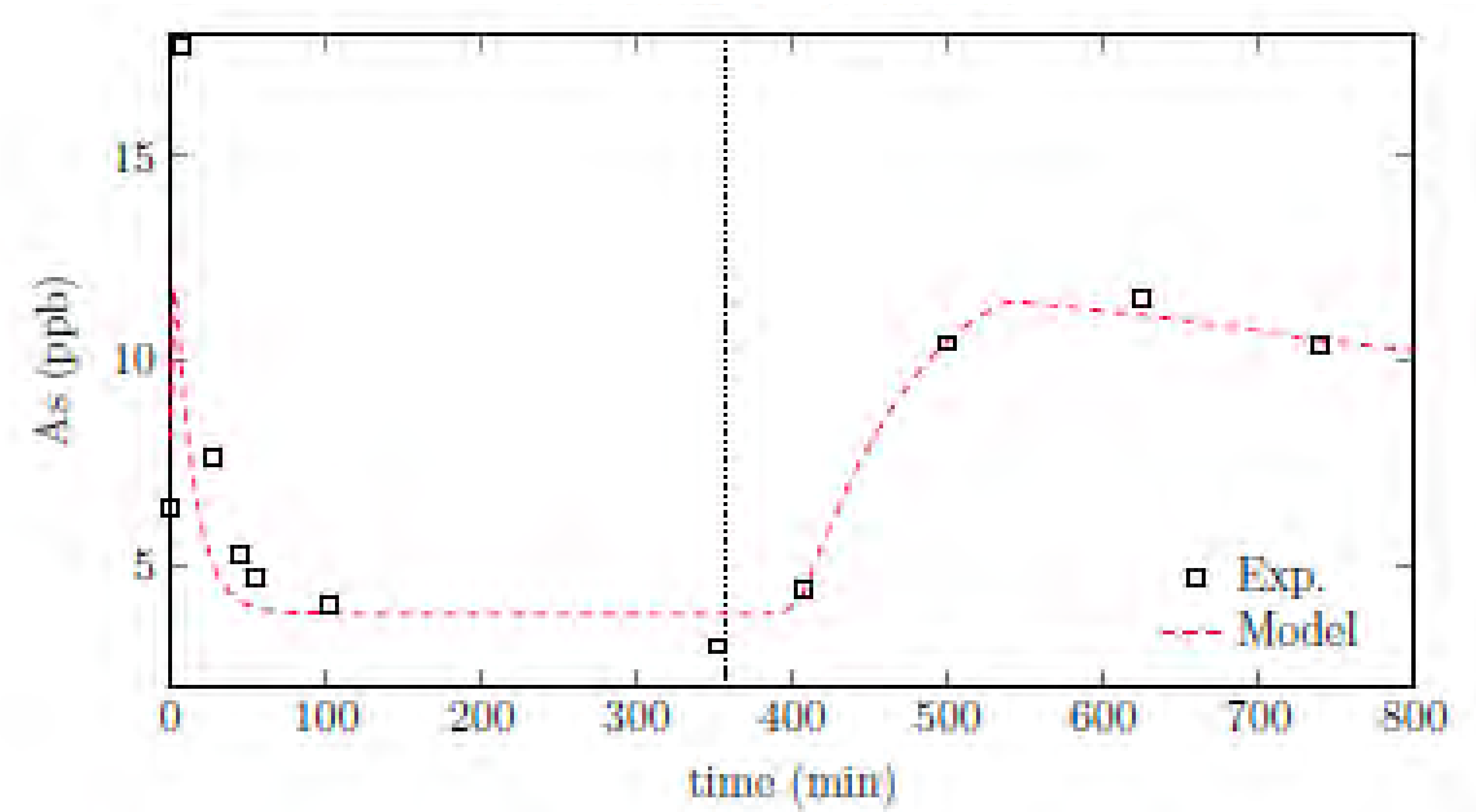

Figure 56. Arsenic concentration versus time for the column experiment.

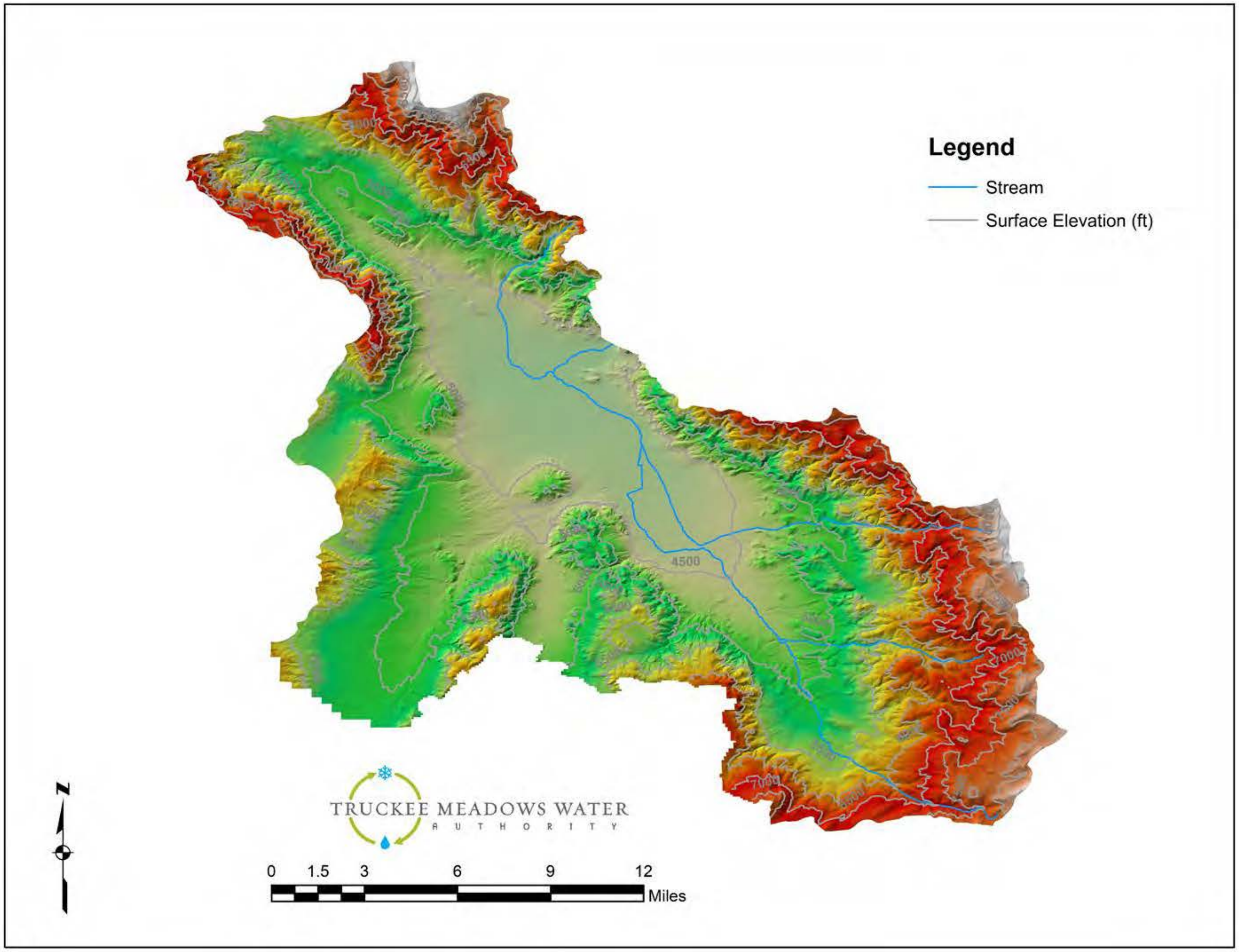

Figure 57. Topographic map of Warm Springs Valley.

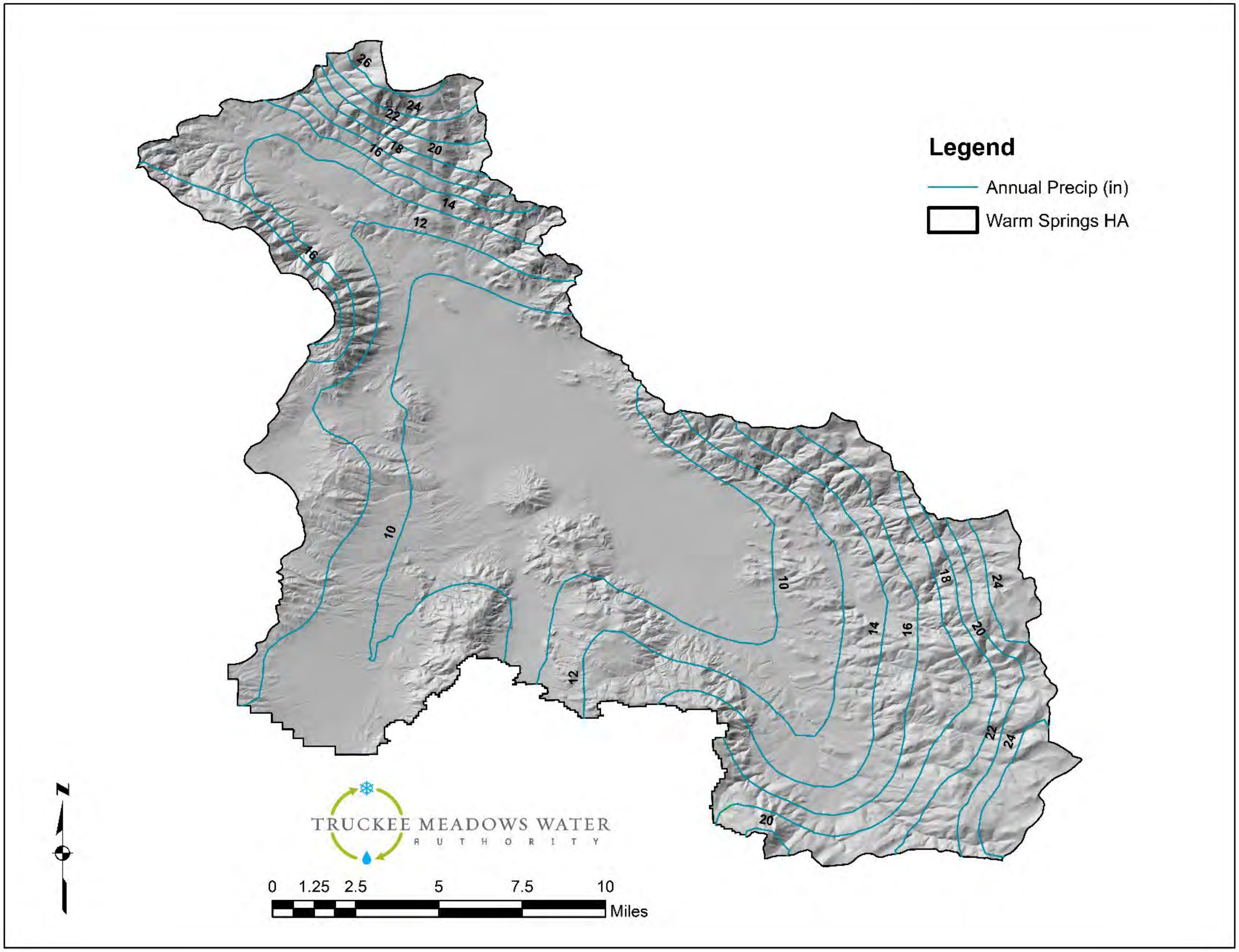

Figure 58. Isohyetal map of Warm Springs hydrographic basin (data taken from PRISM, 2019).

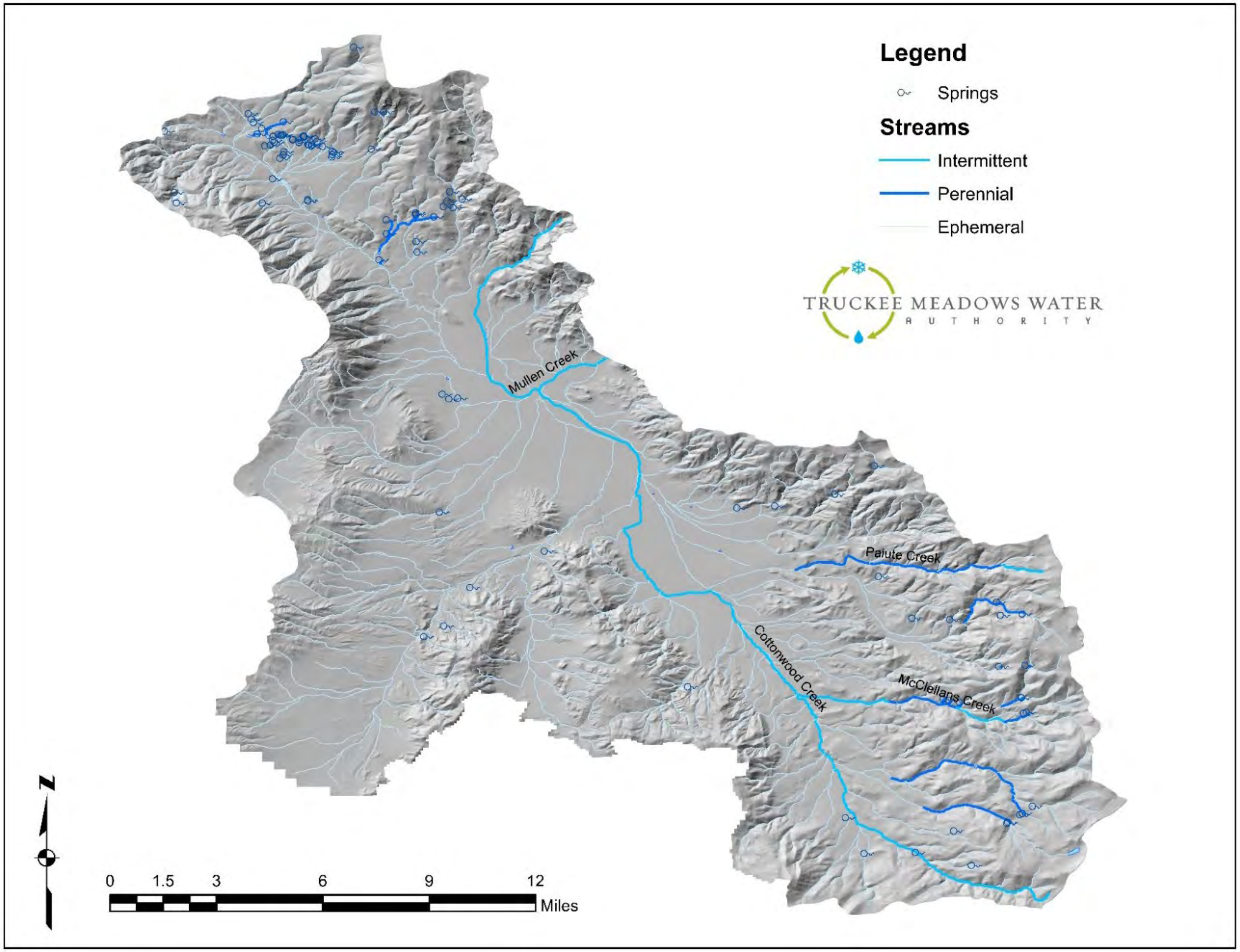

Figure 59. Hydrography within Warm Springs Valley hydrographic area.

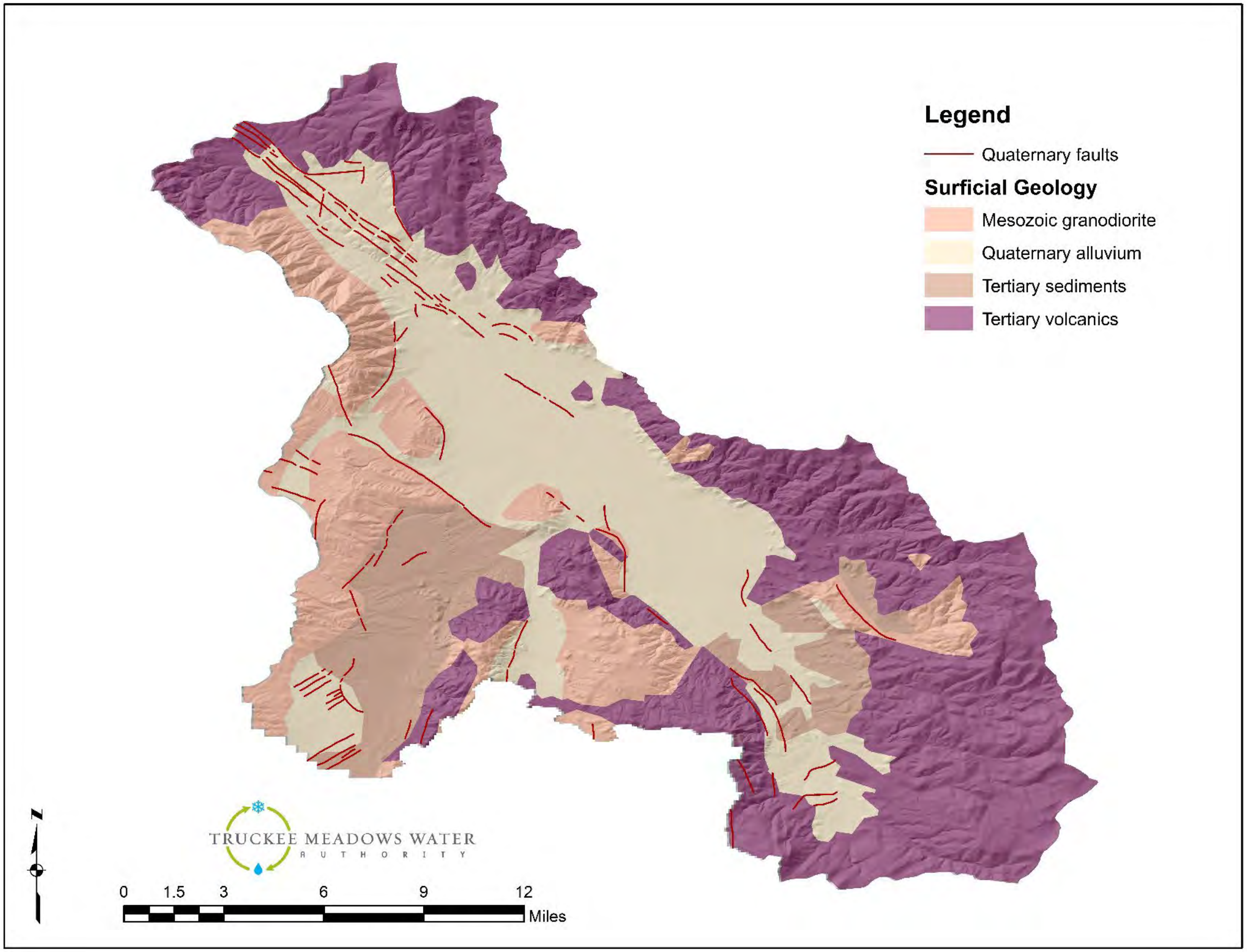

Figure 60. Surficial geology and Quaternary faults (dashed where inferred).

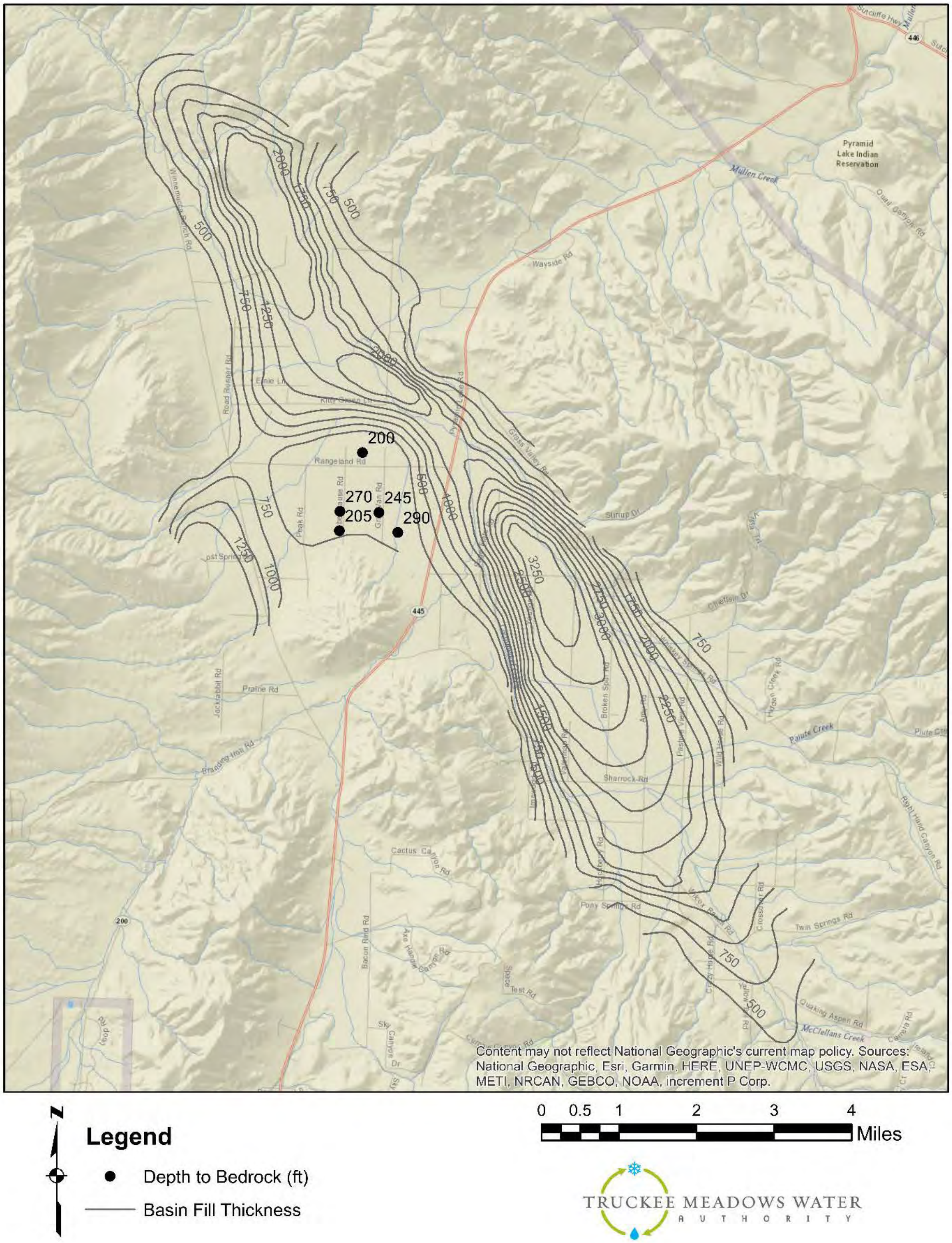

Figure 61. Basin fill thickness and wells confirming bedrock depth in the bedrock high area.

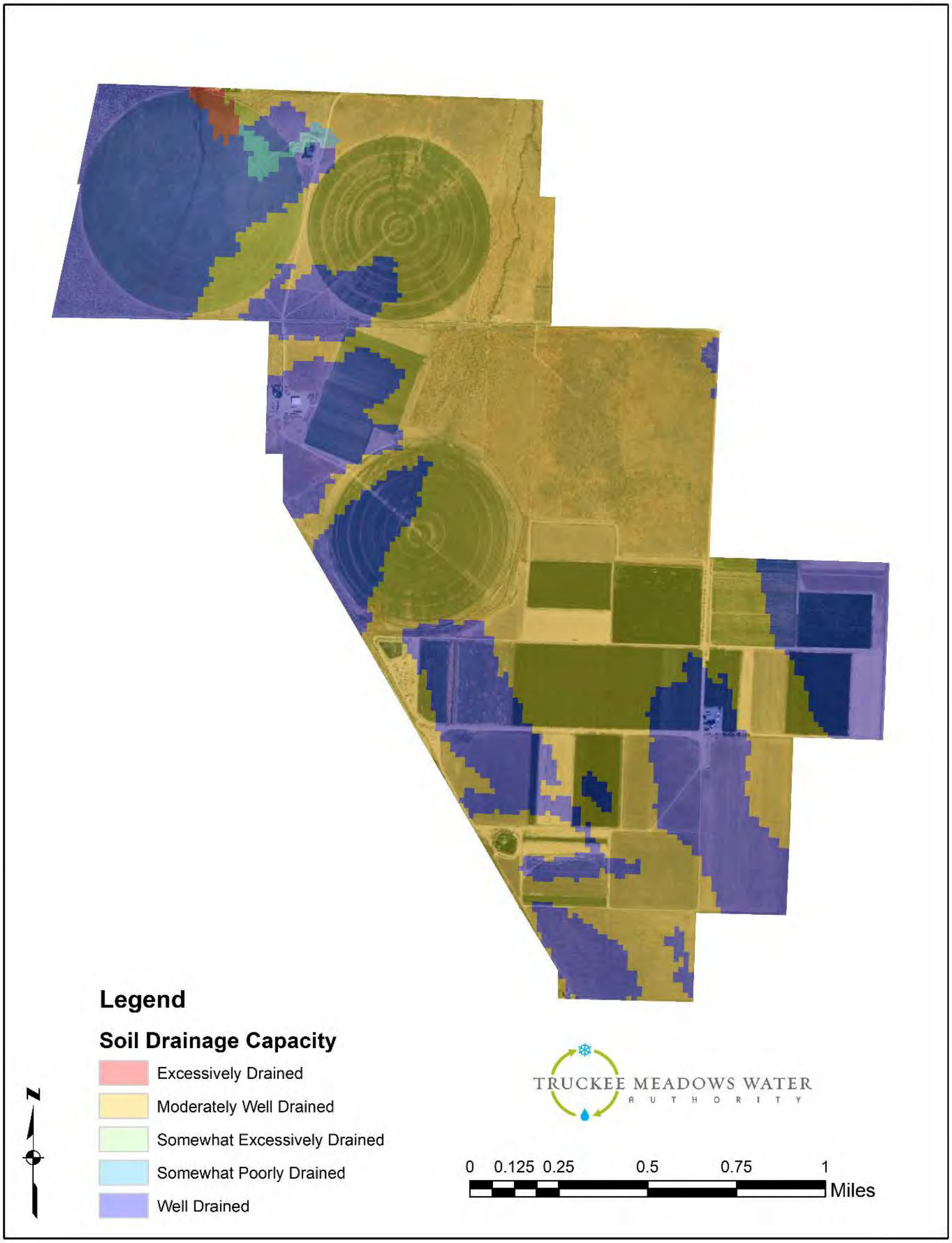

Figure 62. The soils drainage classification for the agricultural parcels. This layer is derived from the 2019 version of the gSSURGO 30m (100 foot) rasters and is produced by the Natural Resources Conservation Service.

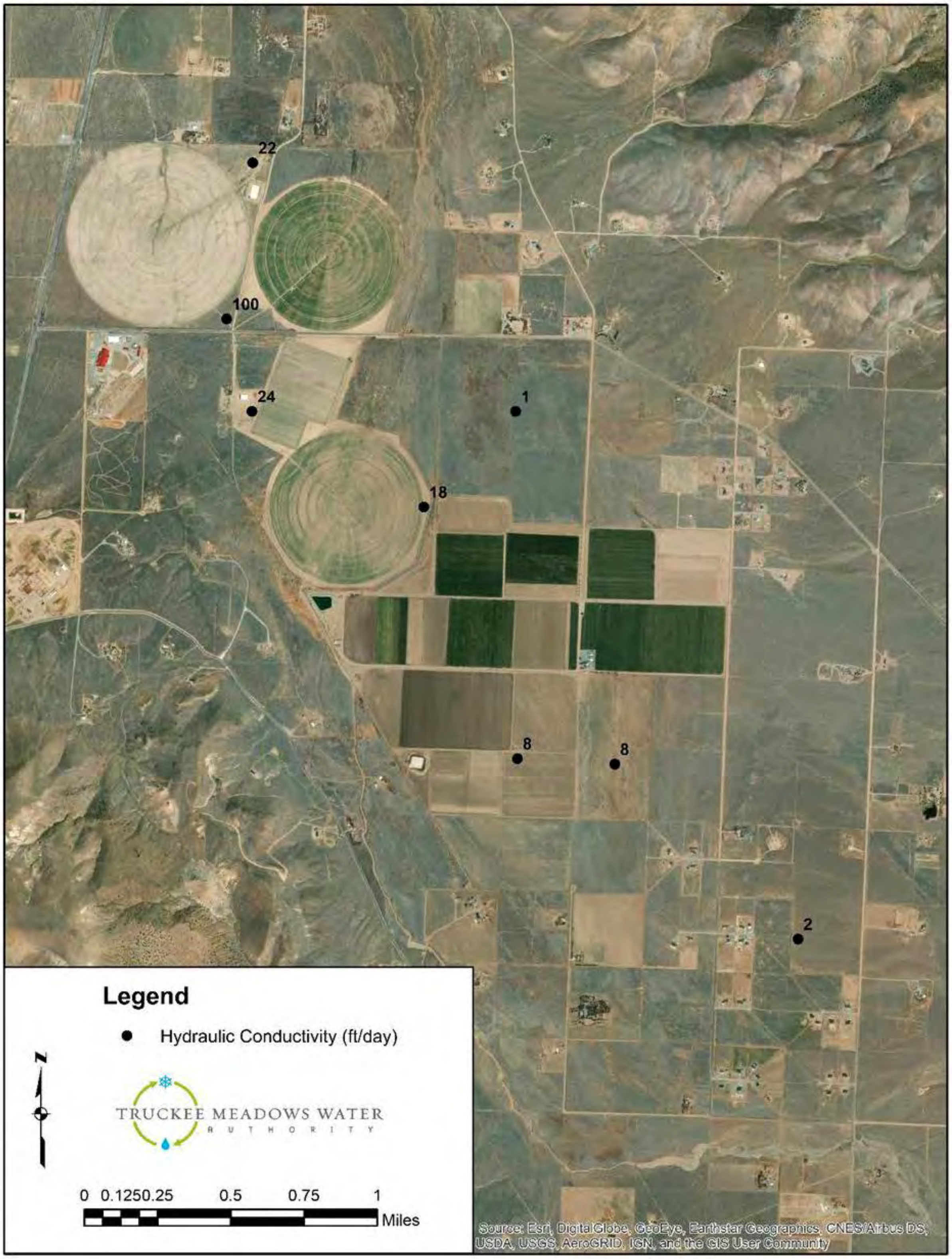

Figure 63. Measured hydraulic conductivity values.

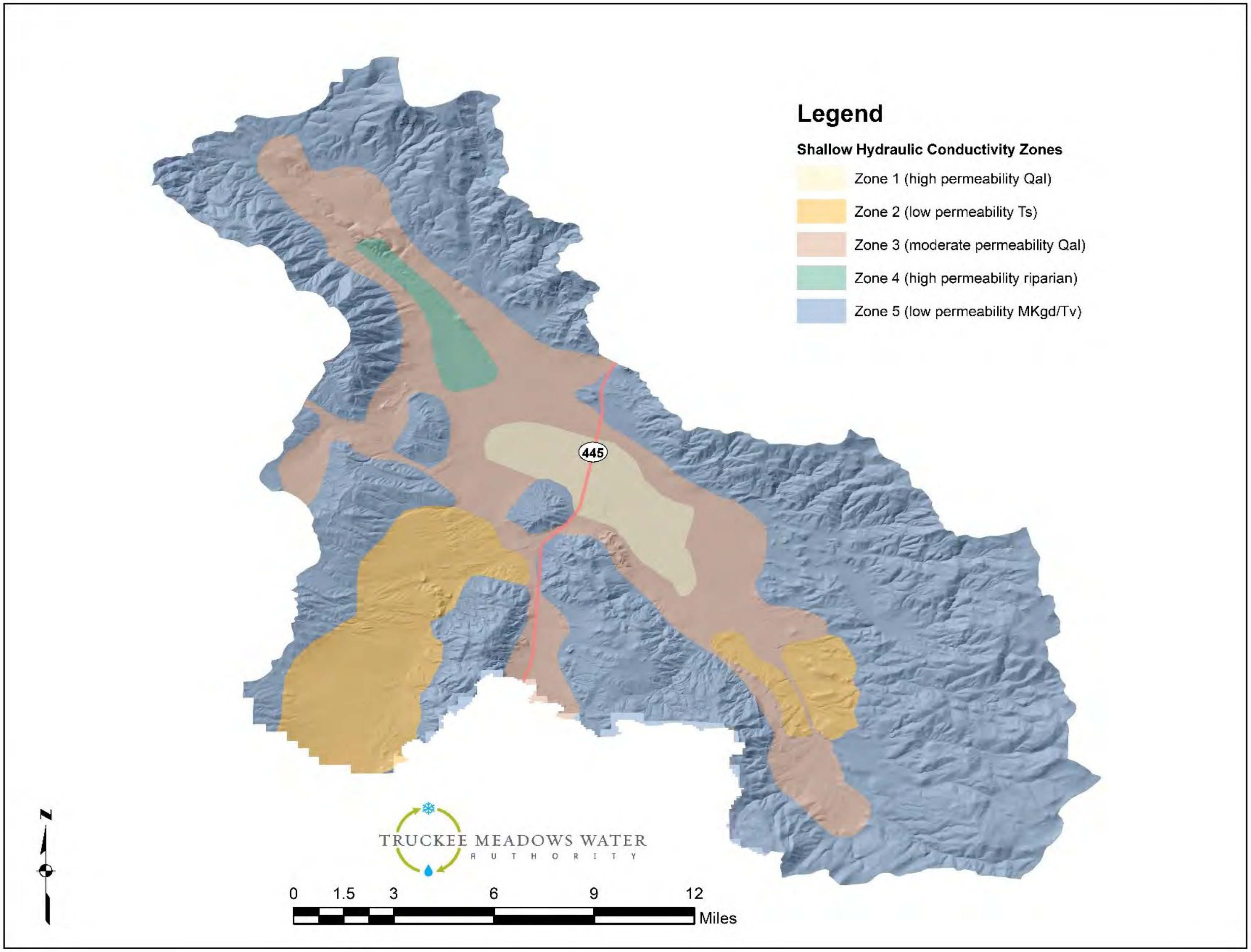

Figure 64. Hydraulic conductivity zones for the upper portion of the groundwater system in Warm Springs Valley.

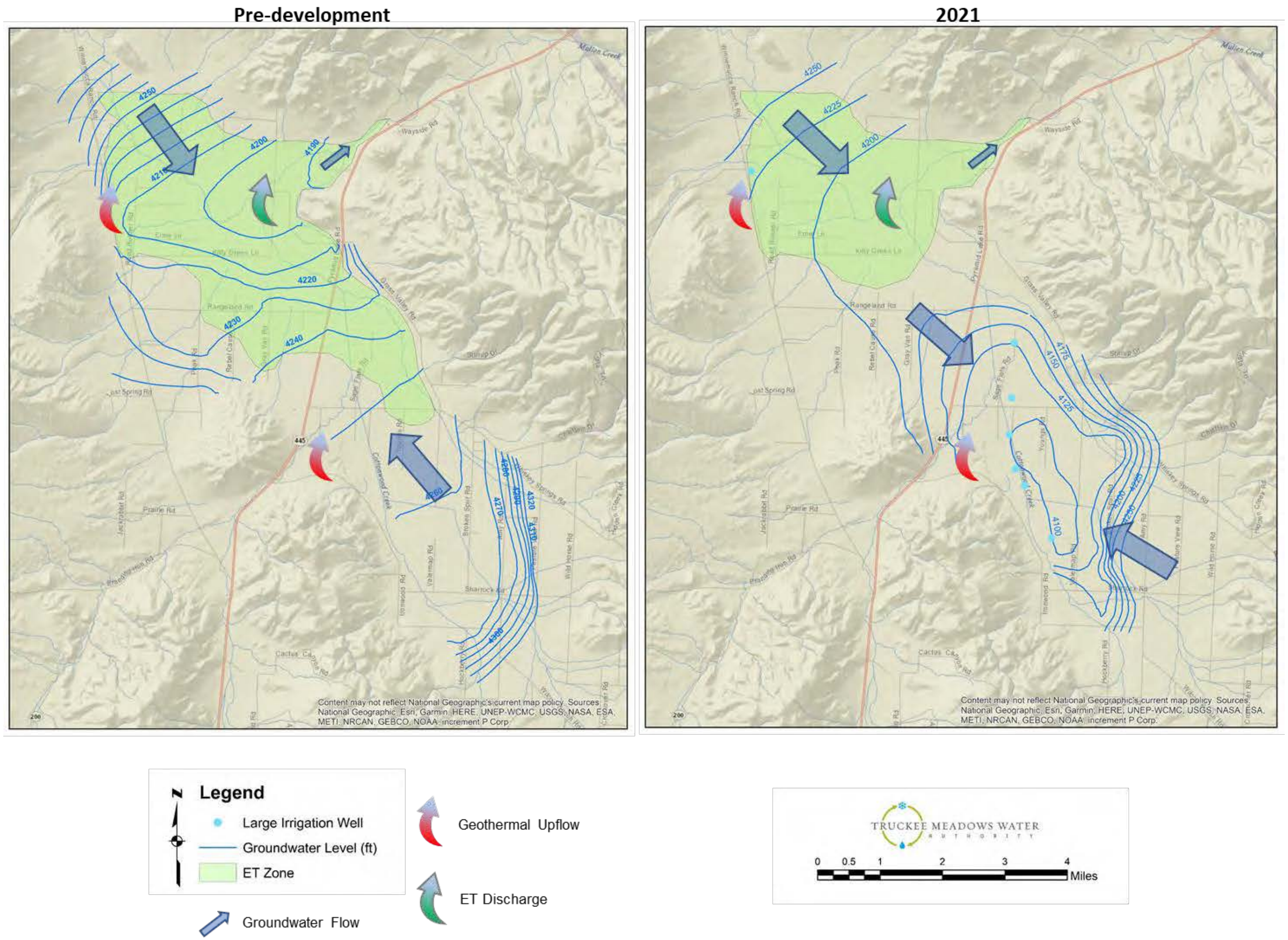

Figure 65. Generalized groundwater levels and flow direction for pre-development and 2021 conditions.

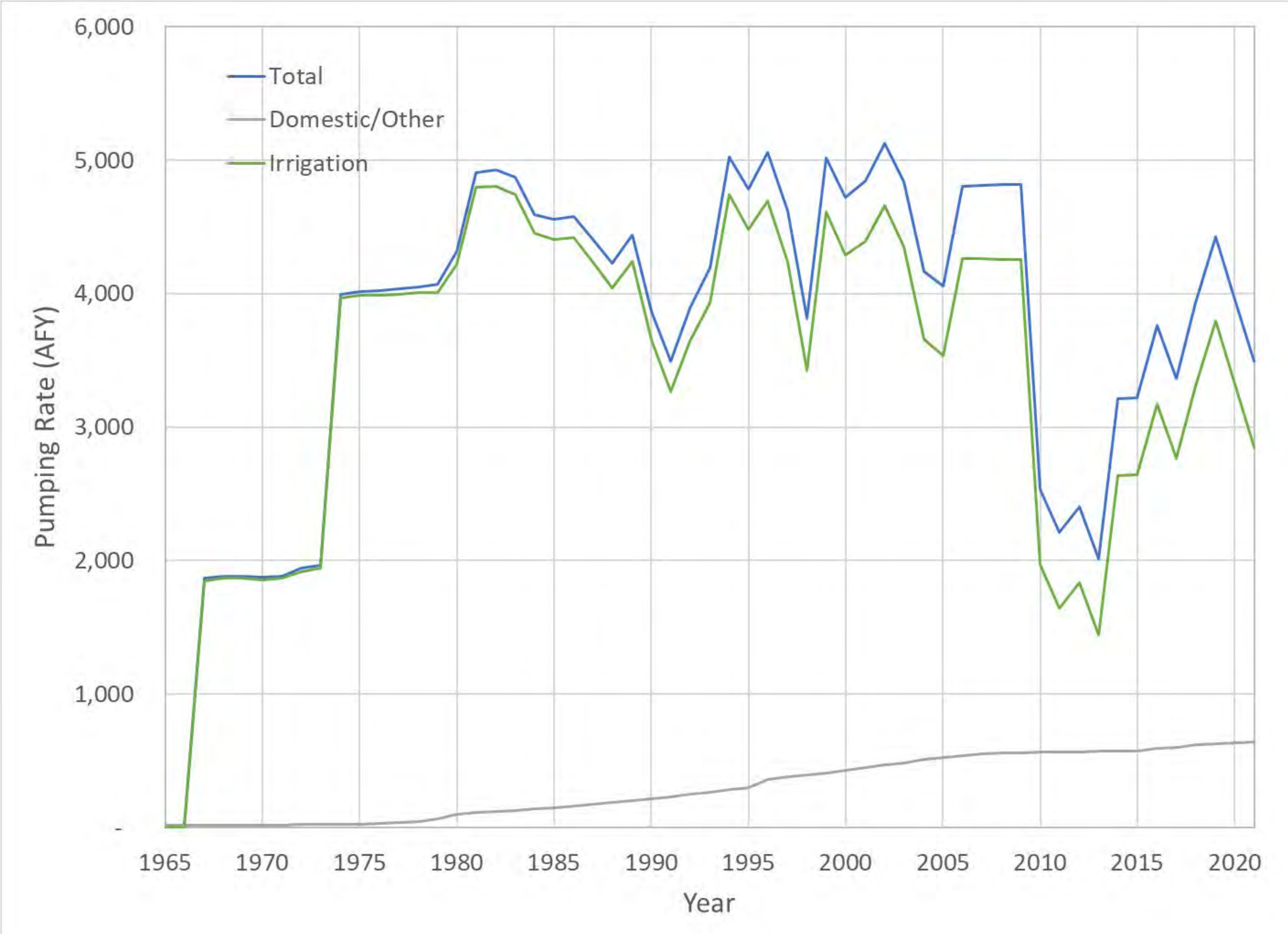

Figure 66. Estimated pumping rates for domestic wells and other pumping (environmental, recreation, stock, and quasi-municipal), irrigation wells, and total for all wells.

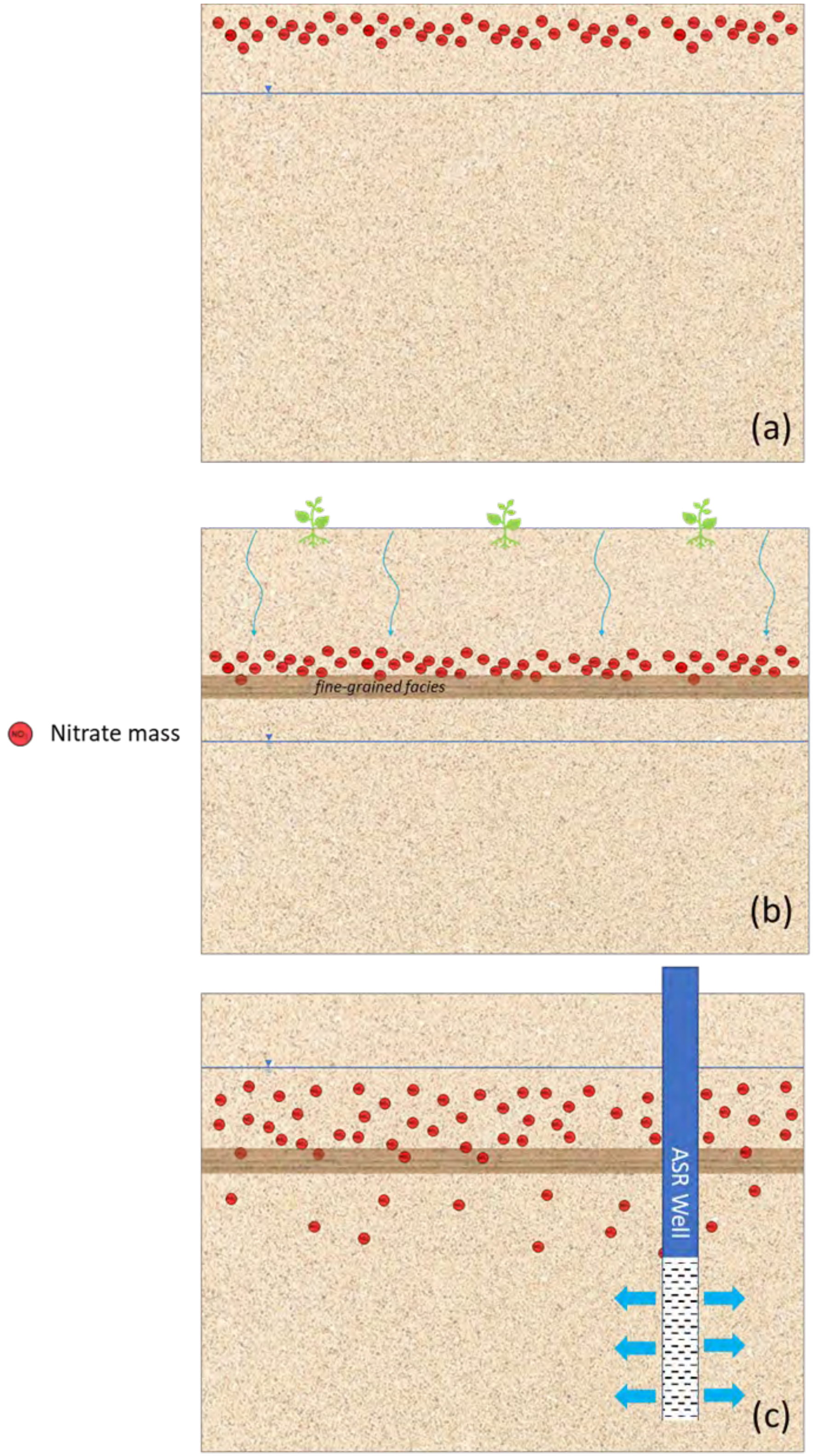

Figure 67. Conceptual diagram of nitrate migration under intermittent irrigation: a) vertical distribution of nitrate before agricultural irrigation, b) vertical distribution of nitrate after intermittent irrigation or in areas with fine-grained facies, c) vertical distribution of nitrate after aquifer storage and recovery (ASR) project.

Figure 68. Location of MW-03 and MW-08 soil borings and monitoring wells.

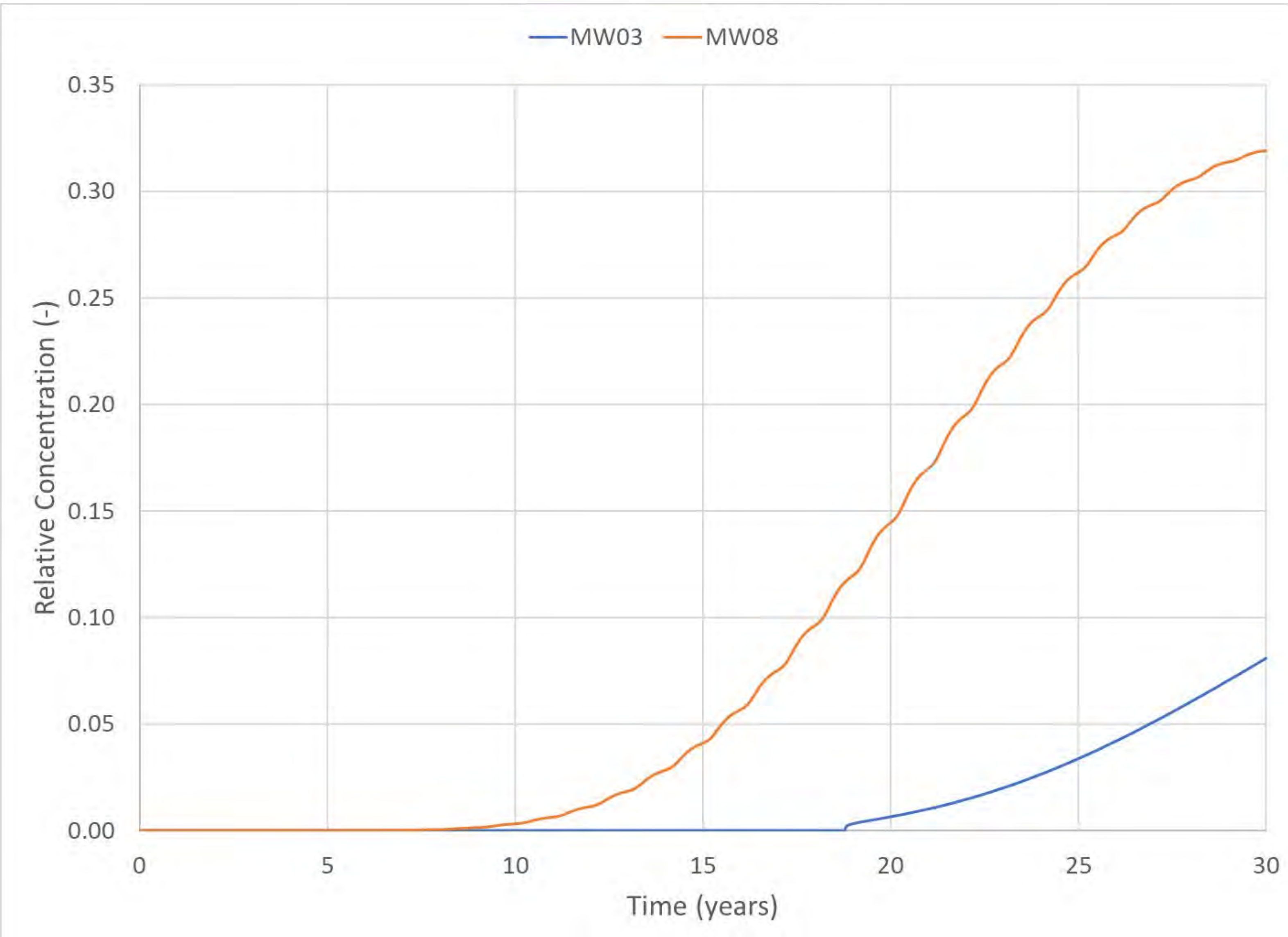

Figure 69. Simulated concentration at the water table for the MW-03 and MW-08 locations.

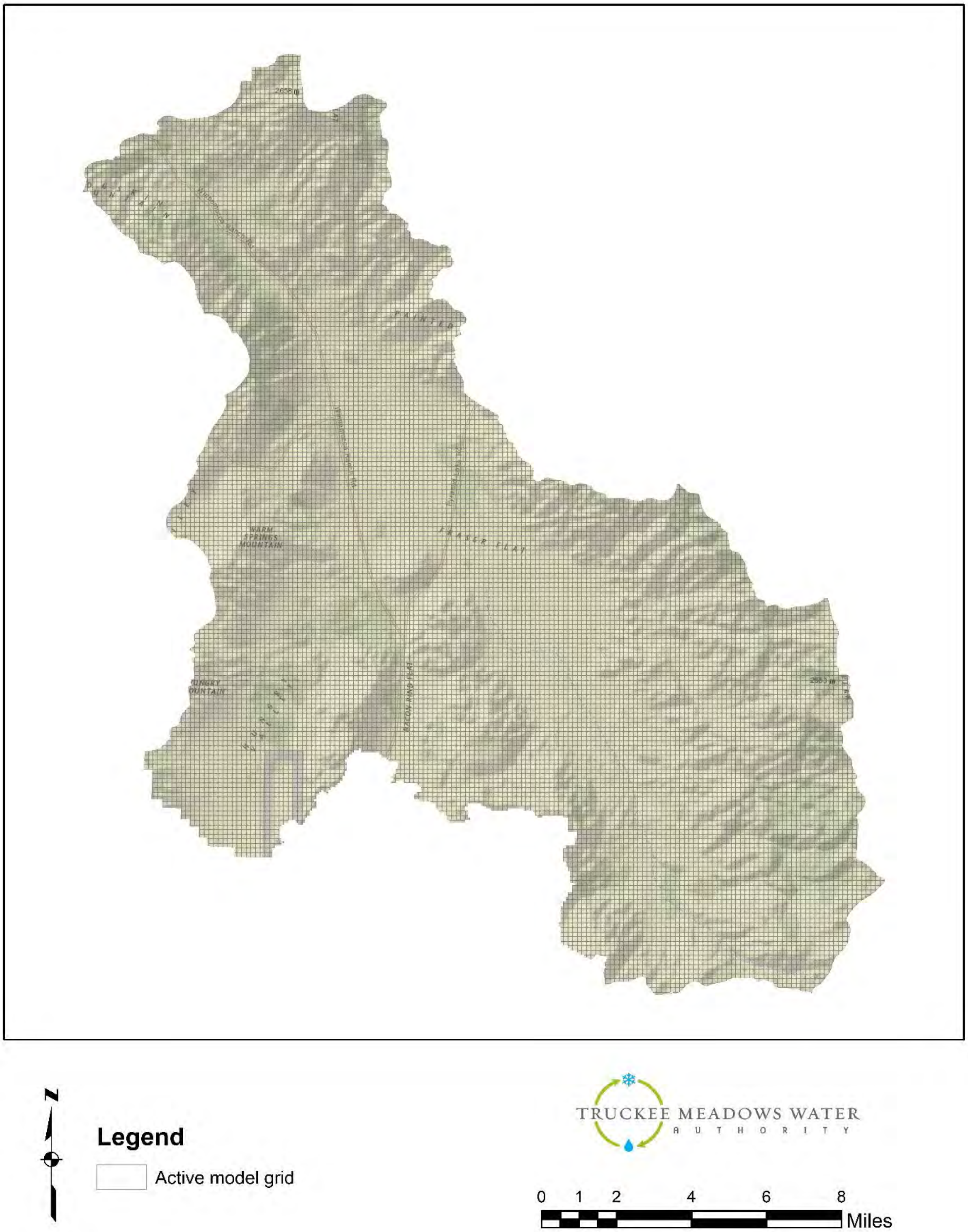

Figure 70. Active grid for groundwater model.

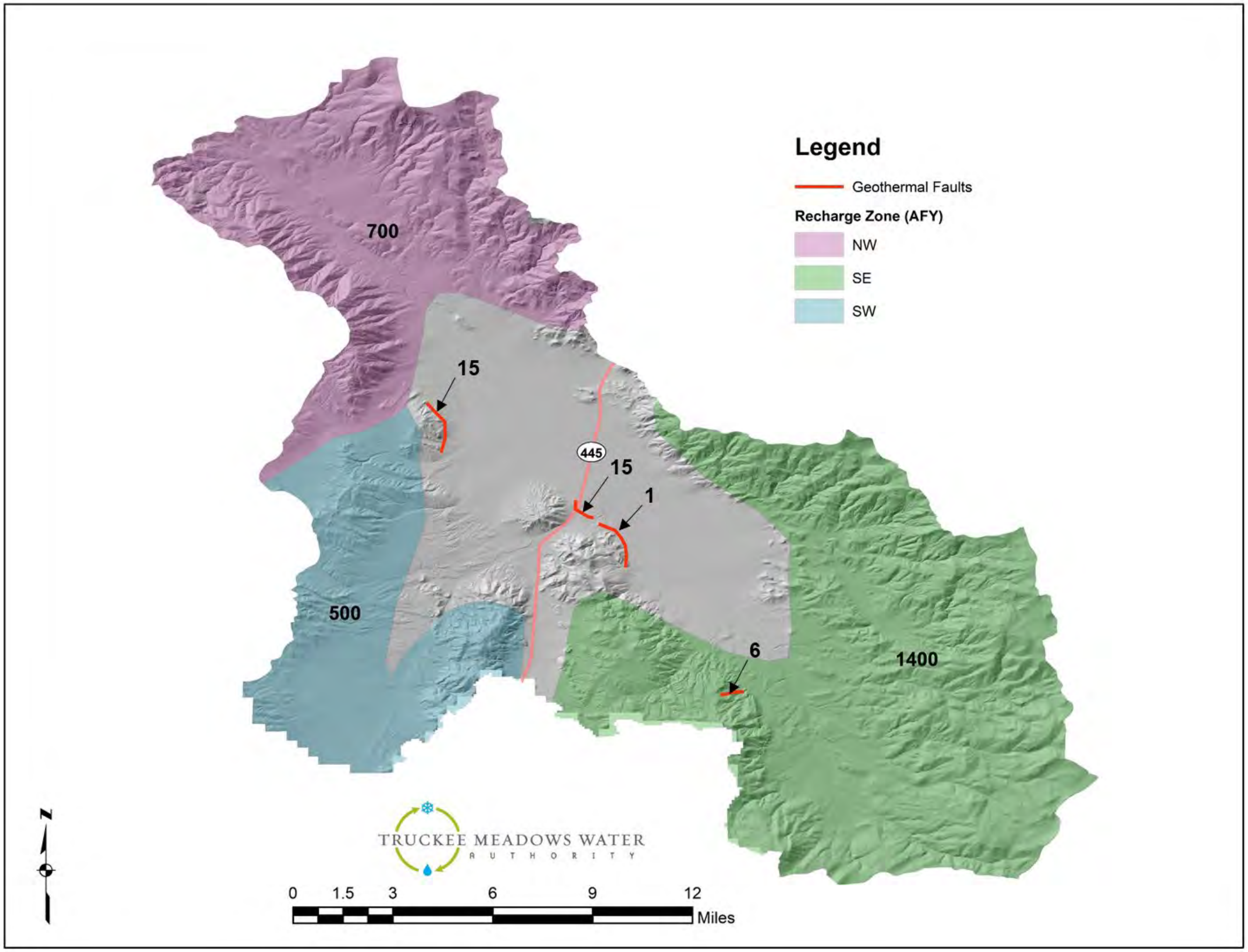

Figure 71. Spatial distribution of groundwater recharge from the infiltration of precipitation.

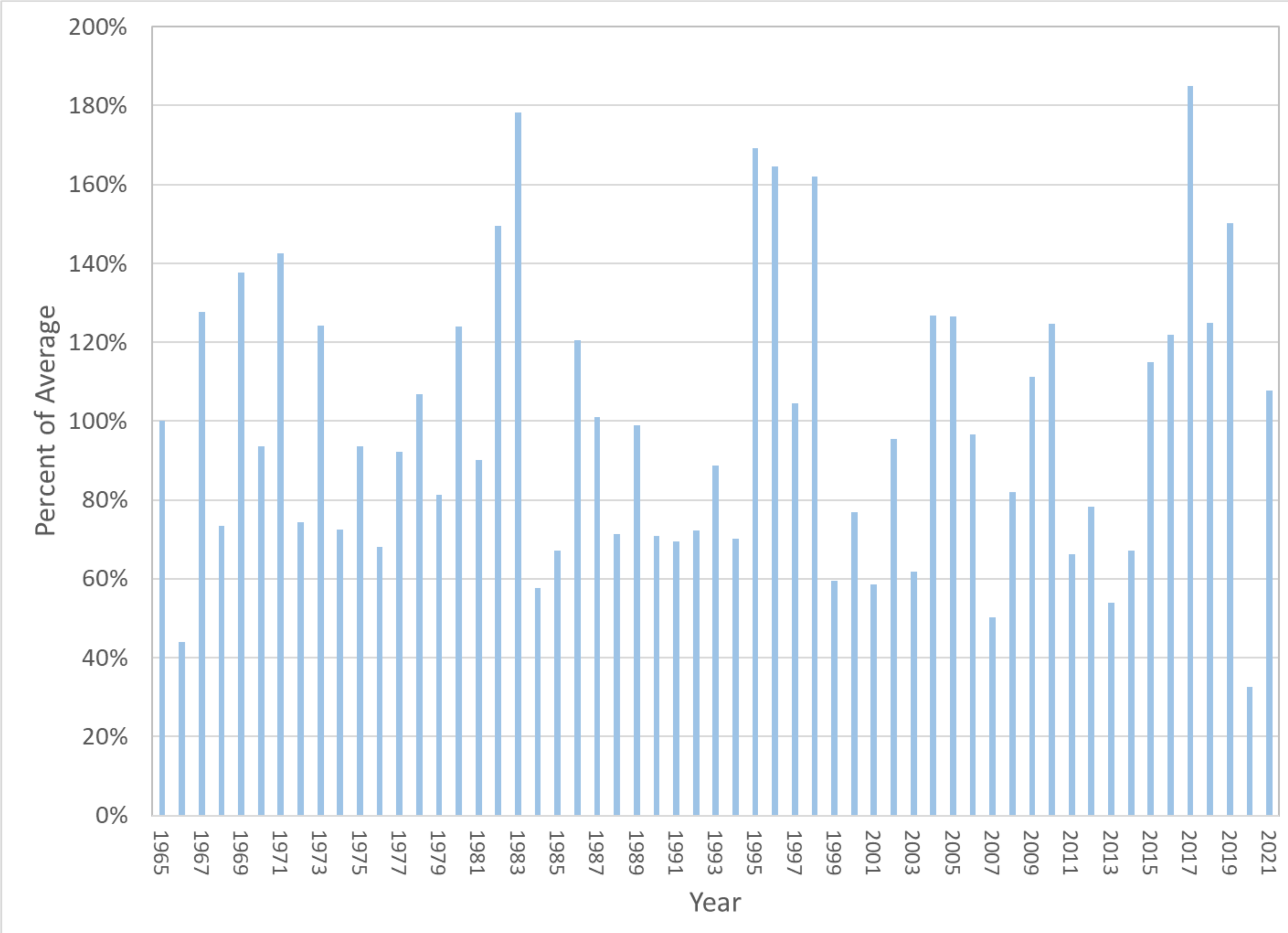

Figure 72. Annual precipitation (Reno Airport) as a percentage of the long-term average.

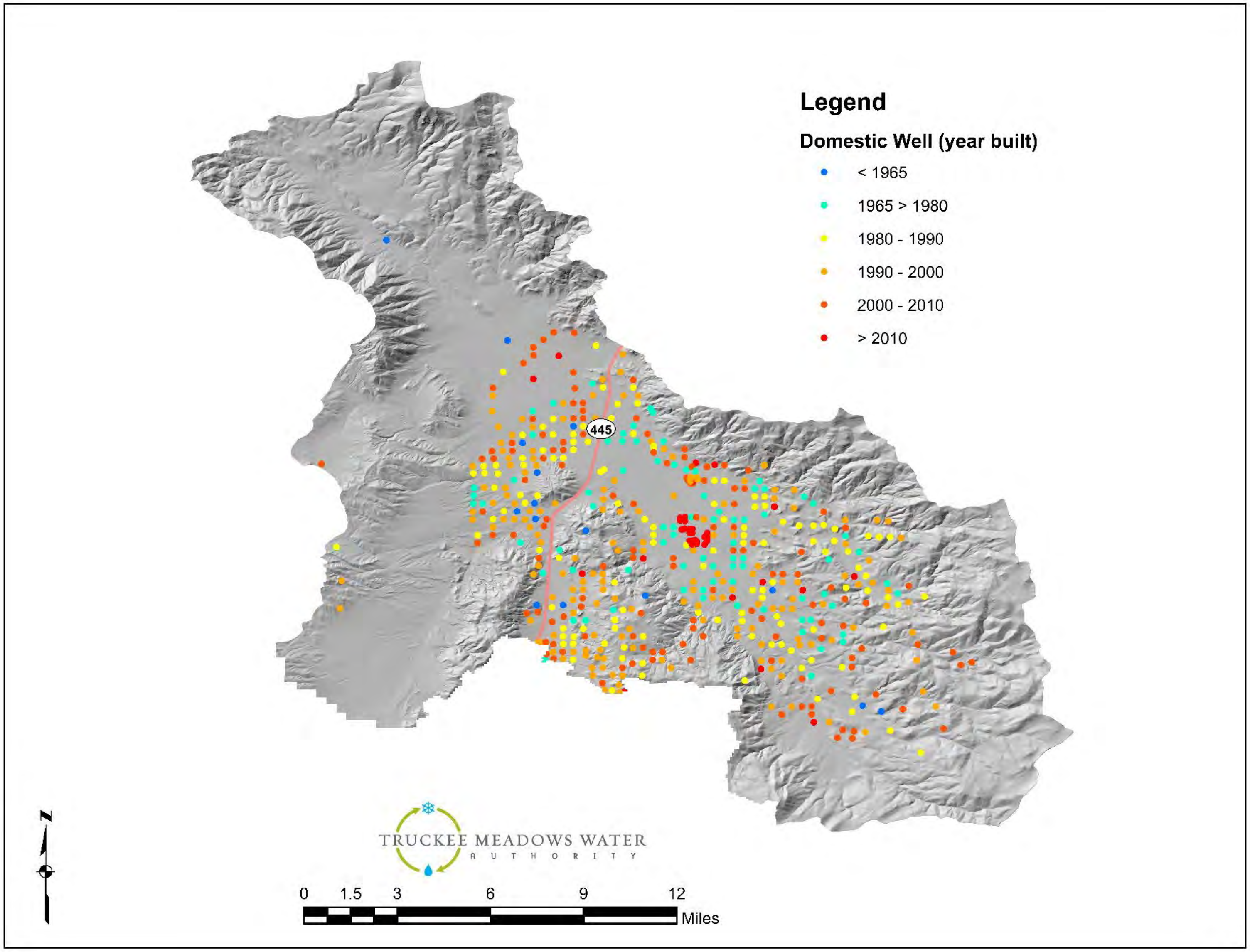

Figure 73. Location of domestic wells in Warm Springs Valley and associated build date.

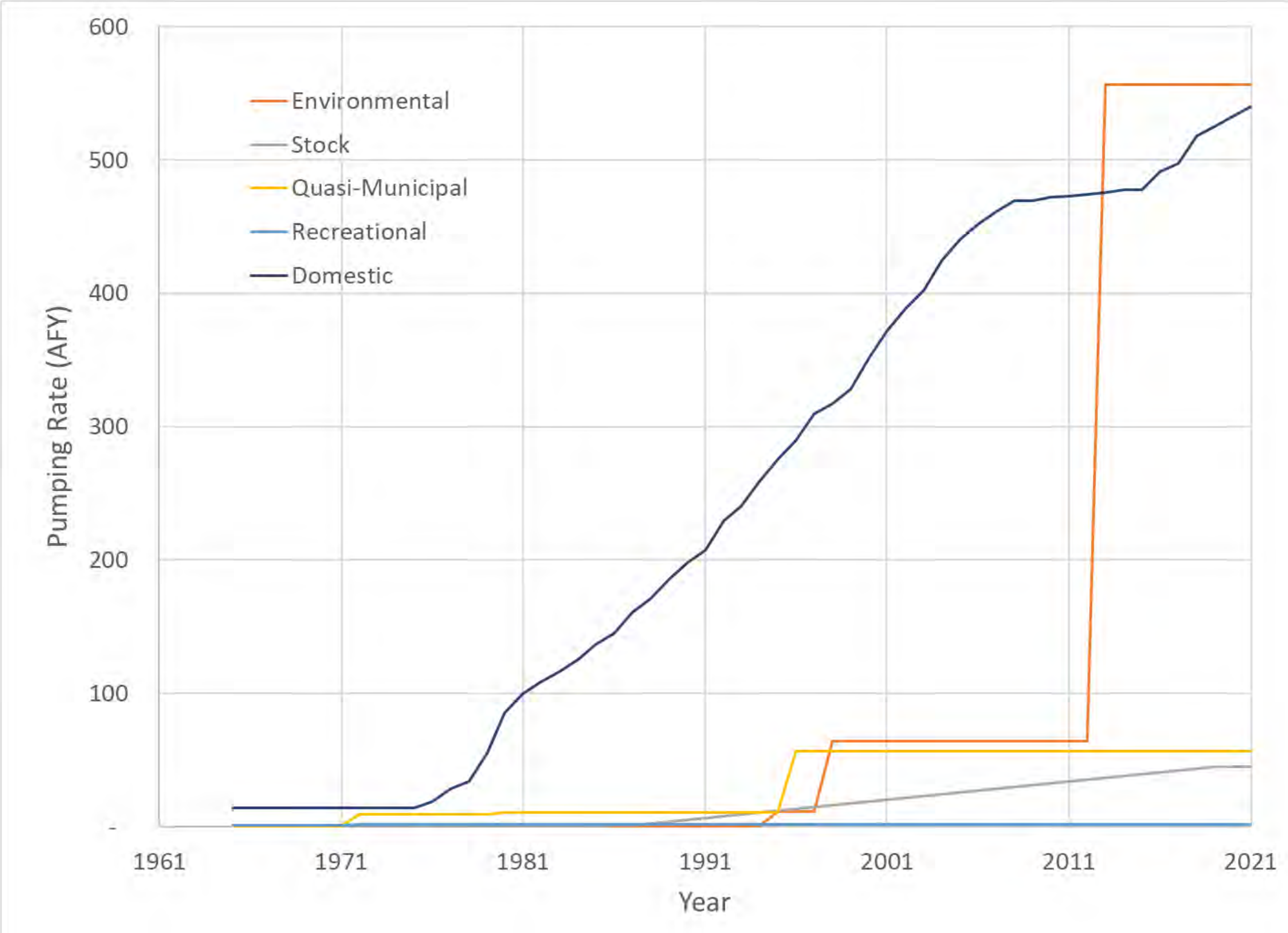

Figure 74. Estimated pumping rates for environmental, stock, quasi-municipal, recreation, and domestic wells from 1965 - 2021.

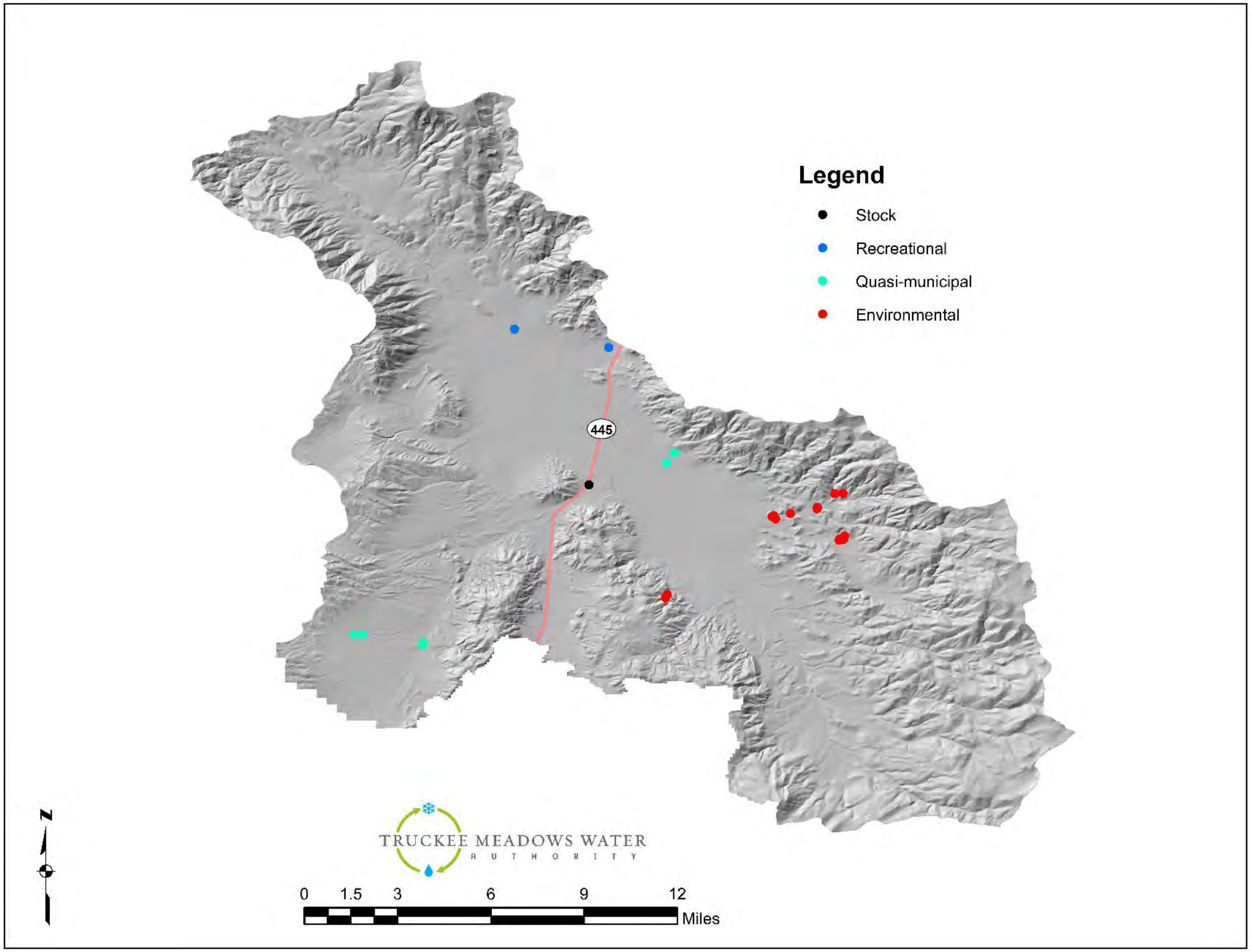

Figure 75. Location of stock, recreational, quasi-municipal, and environmental wells in Warm Springs Valley.

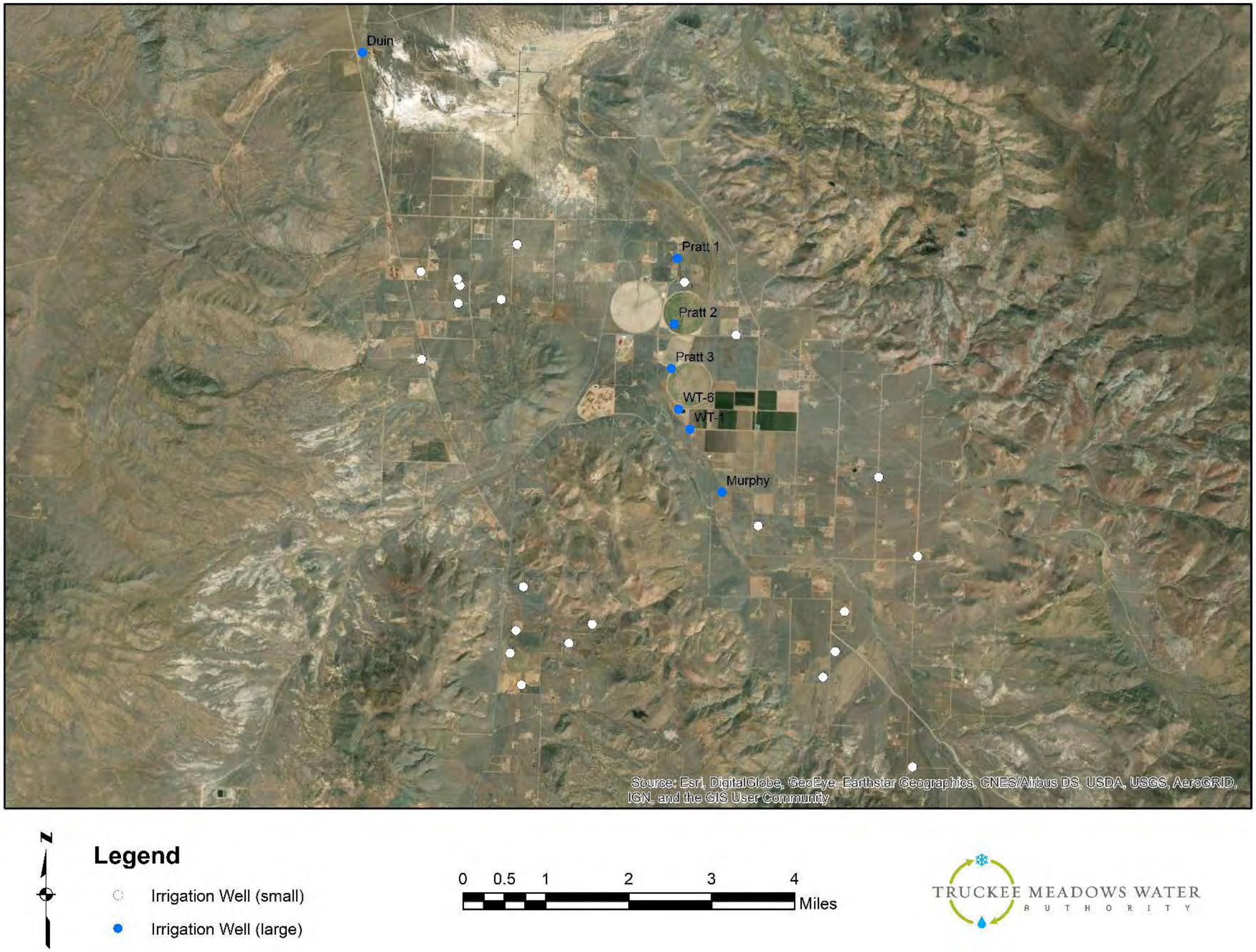

Figure 76. Location of irrigation wells in Warm Springs Valley.

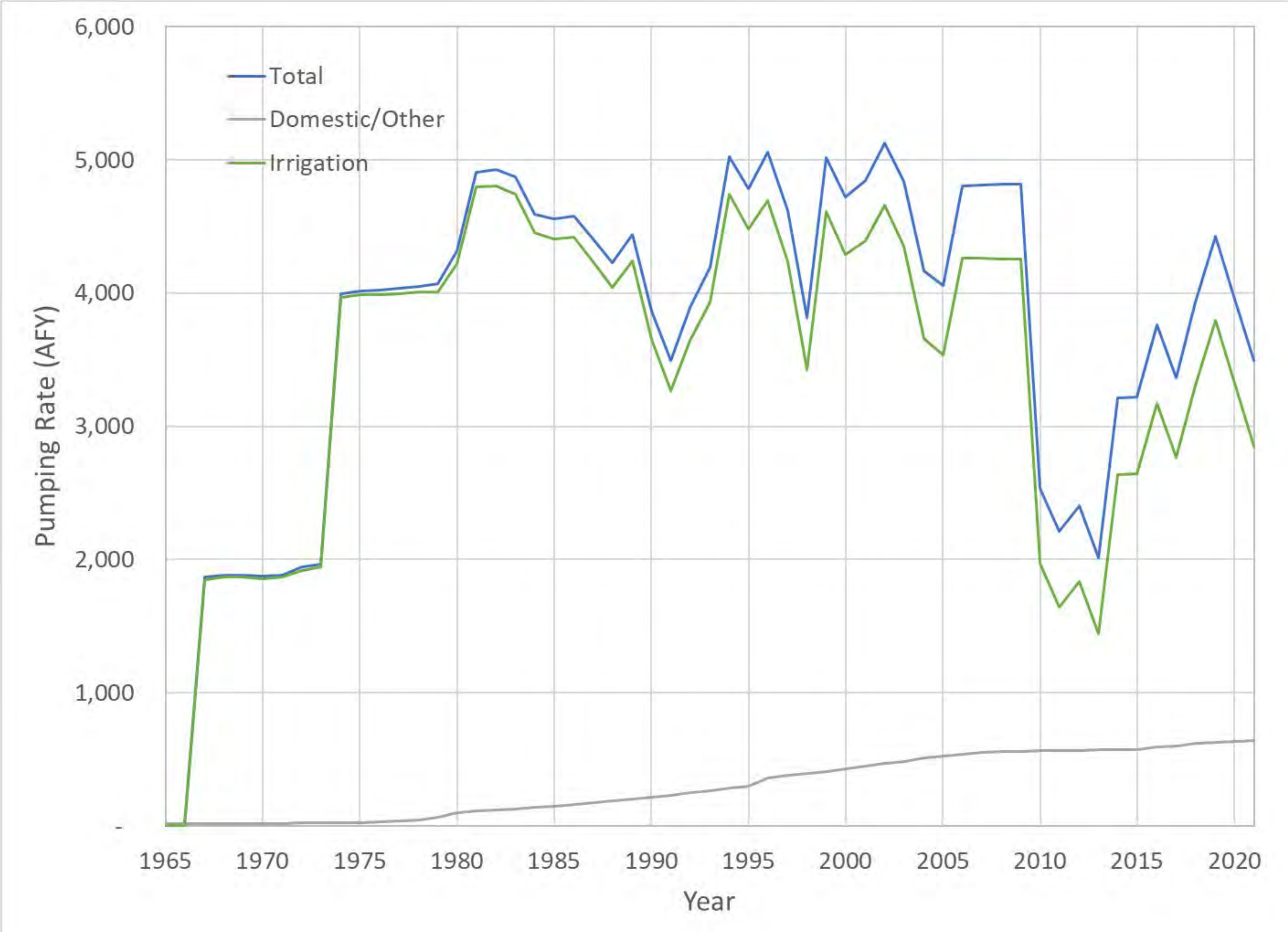

Figure 77. Irrigation and domestic/other pumping rates for Warm Springs Valley.

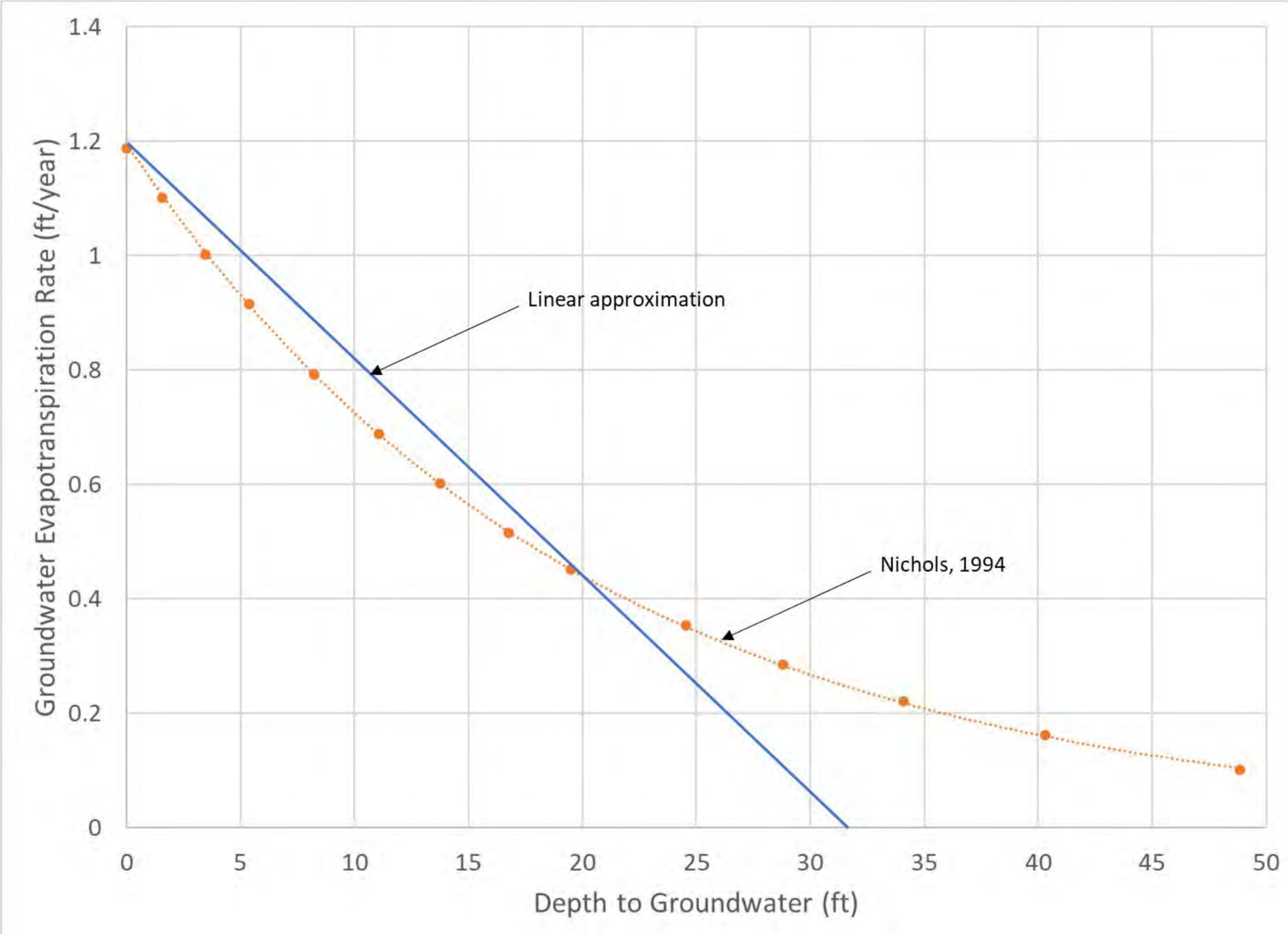

Figure 78. Depth to groundwater versus phreatophyte evapotranspiration rate developed by Nichols, 1994 (plant density of 20 percent) and linear approximation.

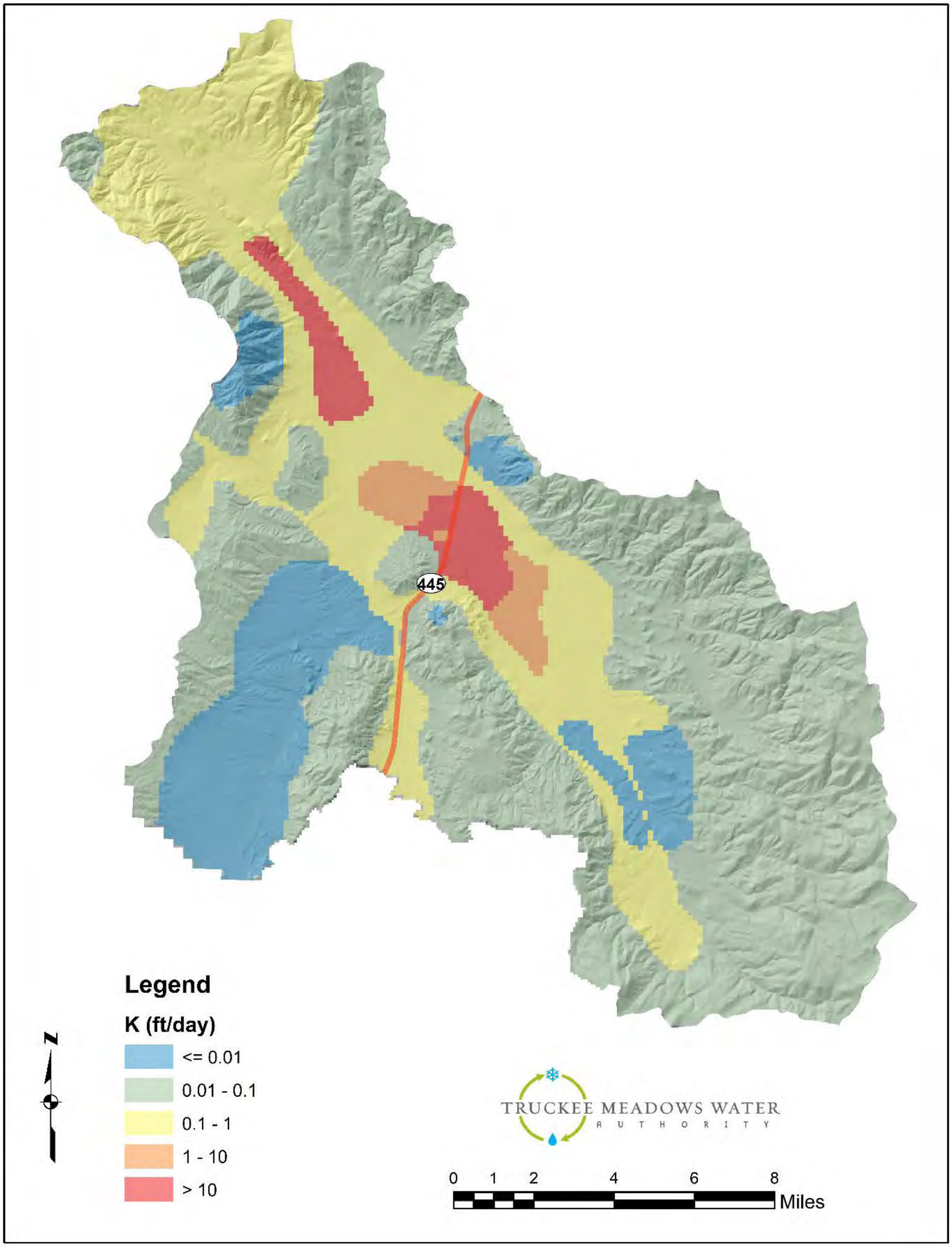

Figure 79. Hydraulic conductivity distribution for model layer 1.

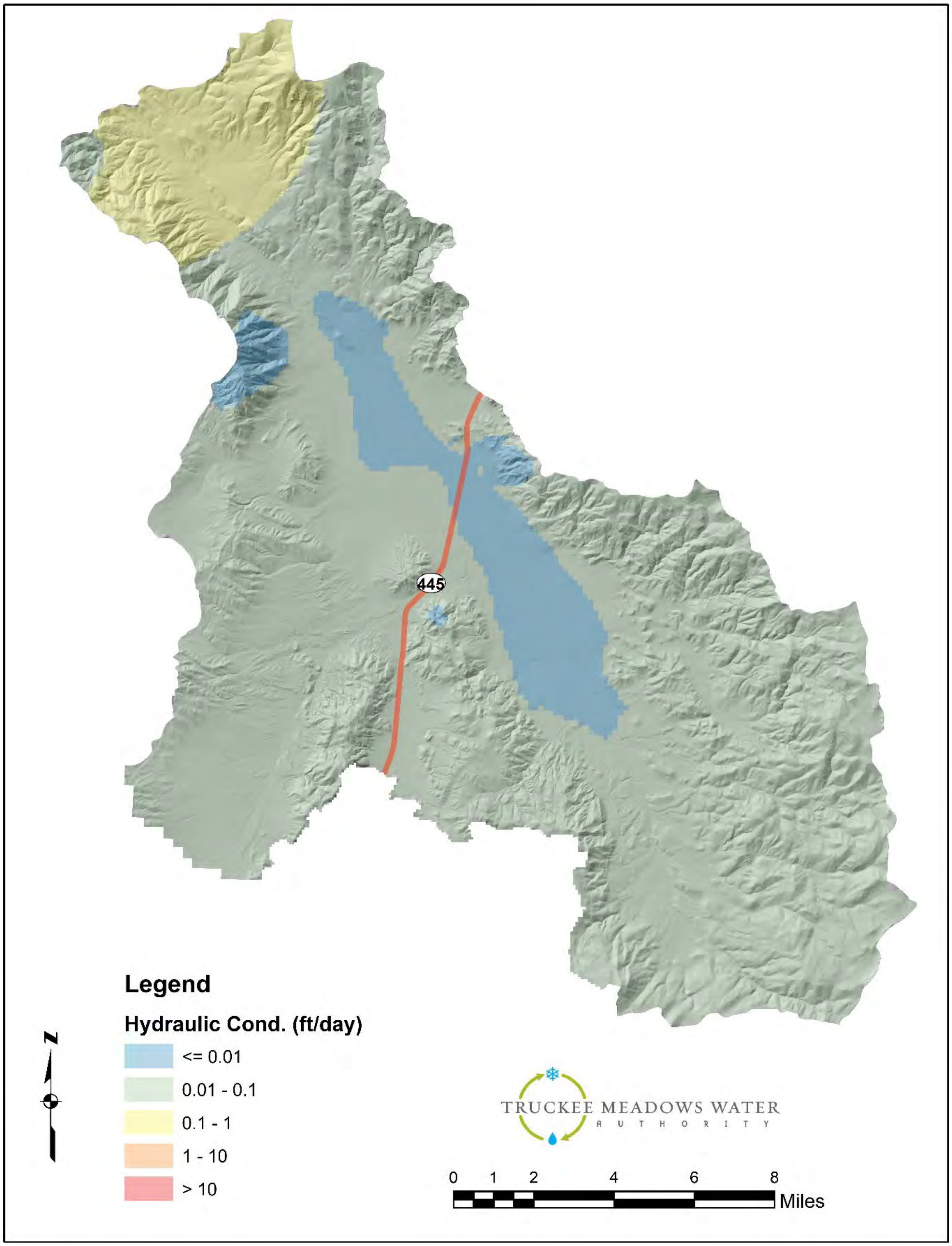

Figure 80. Hydraulic conductivity distribution for model layer 2.

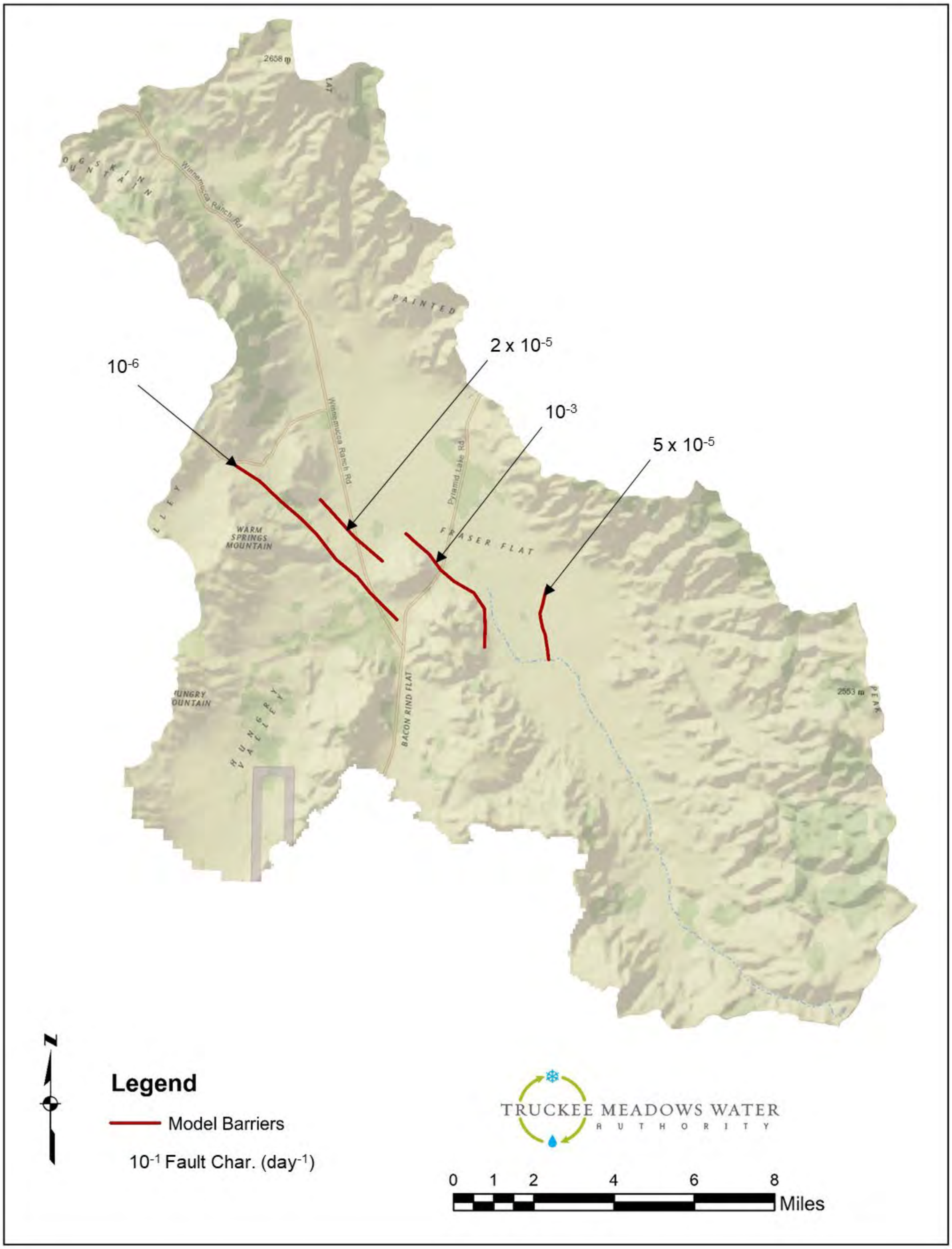

Figure 81. Horizontal flow barriers and associated fault characteristics.

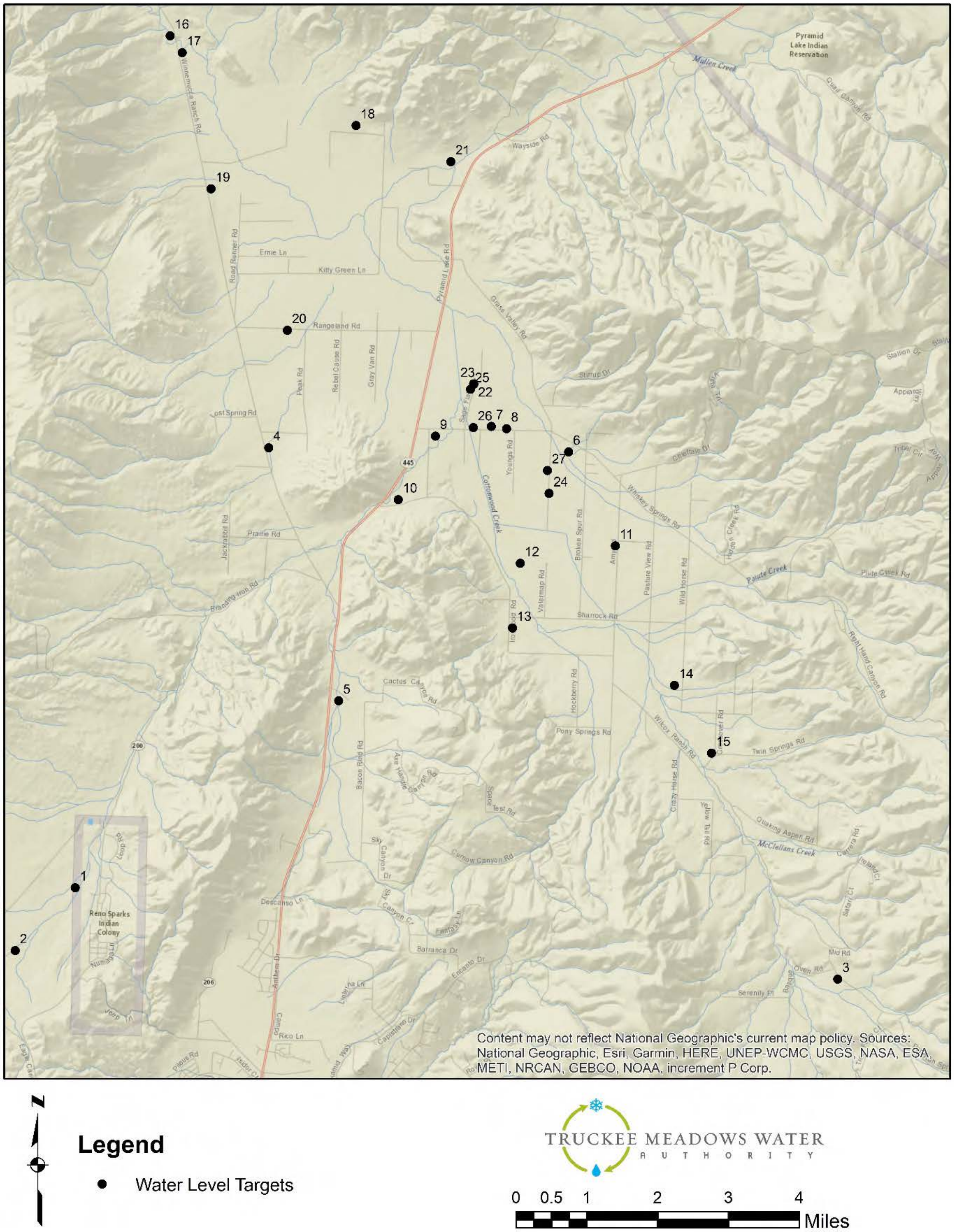

Figure 82. Water level targets used to calibrate the groundwater flow model.

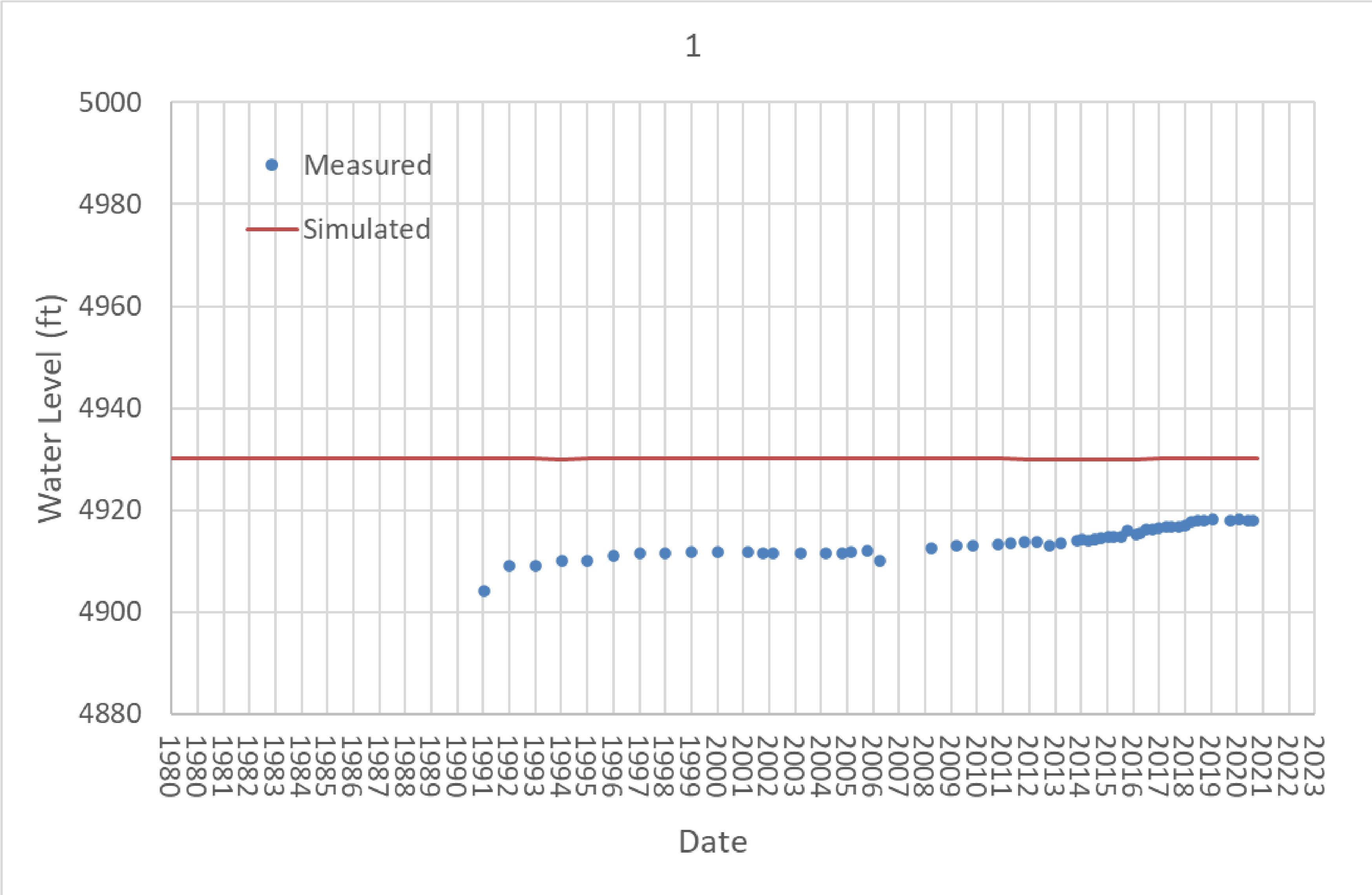

Figure 83. Measured and simulated groundwater level at point #1.

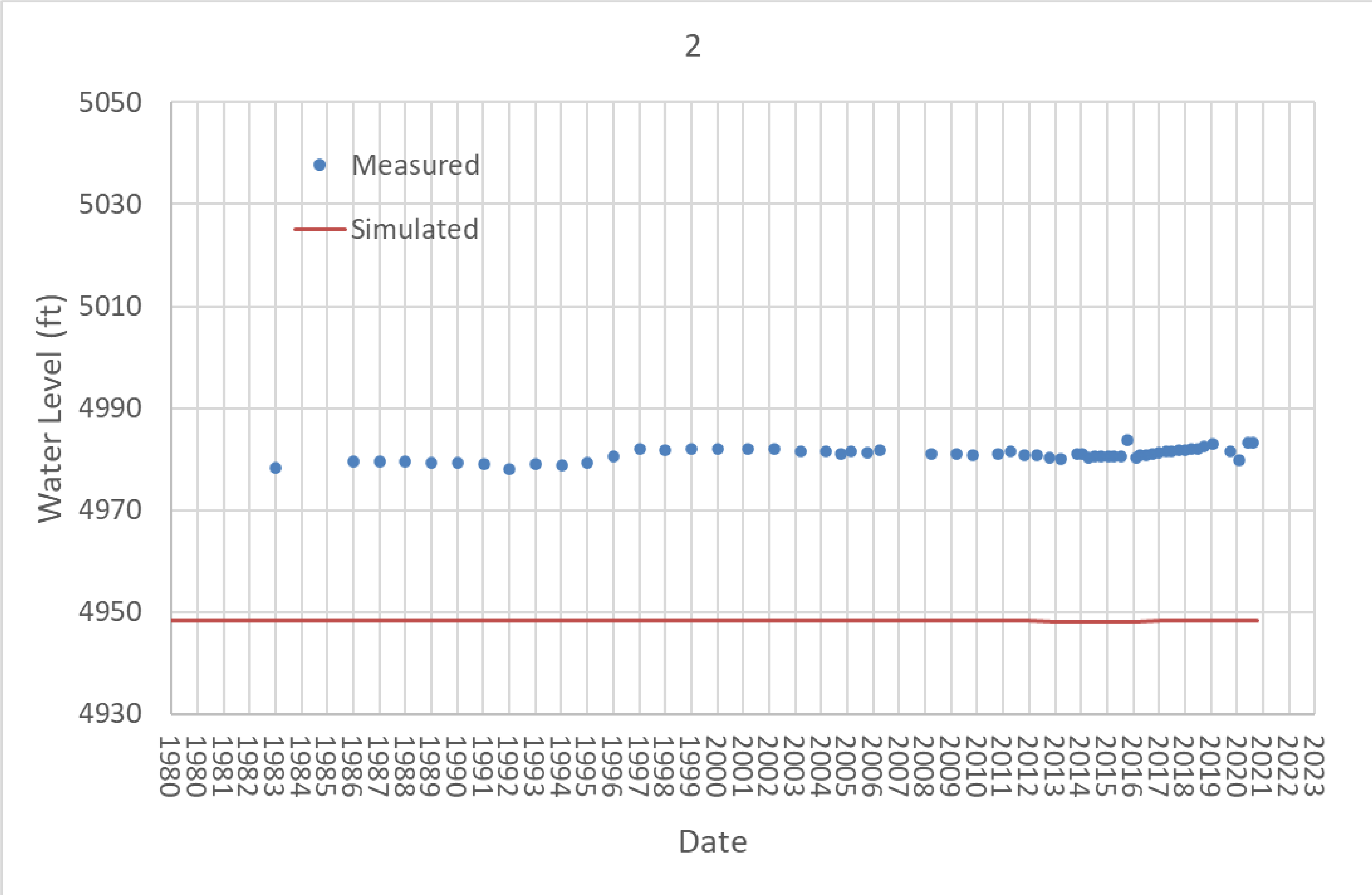

Figure 84. Measured and simulated groundwater level at point #2.

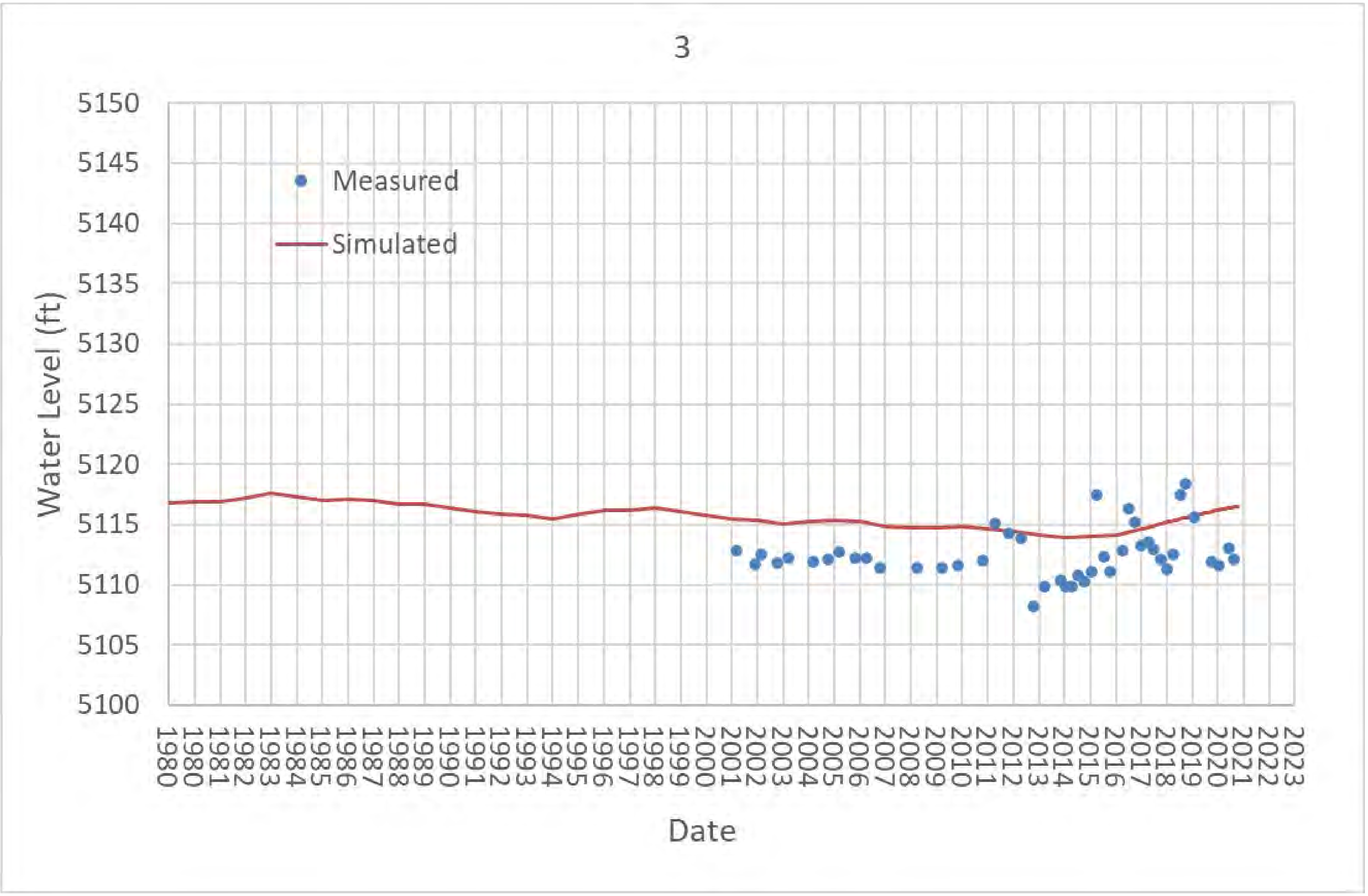

Figure 85. Measured and simulated groundwater level at point #3.

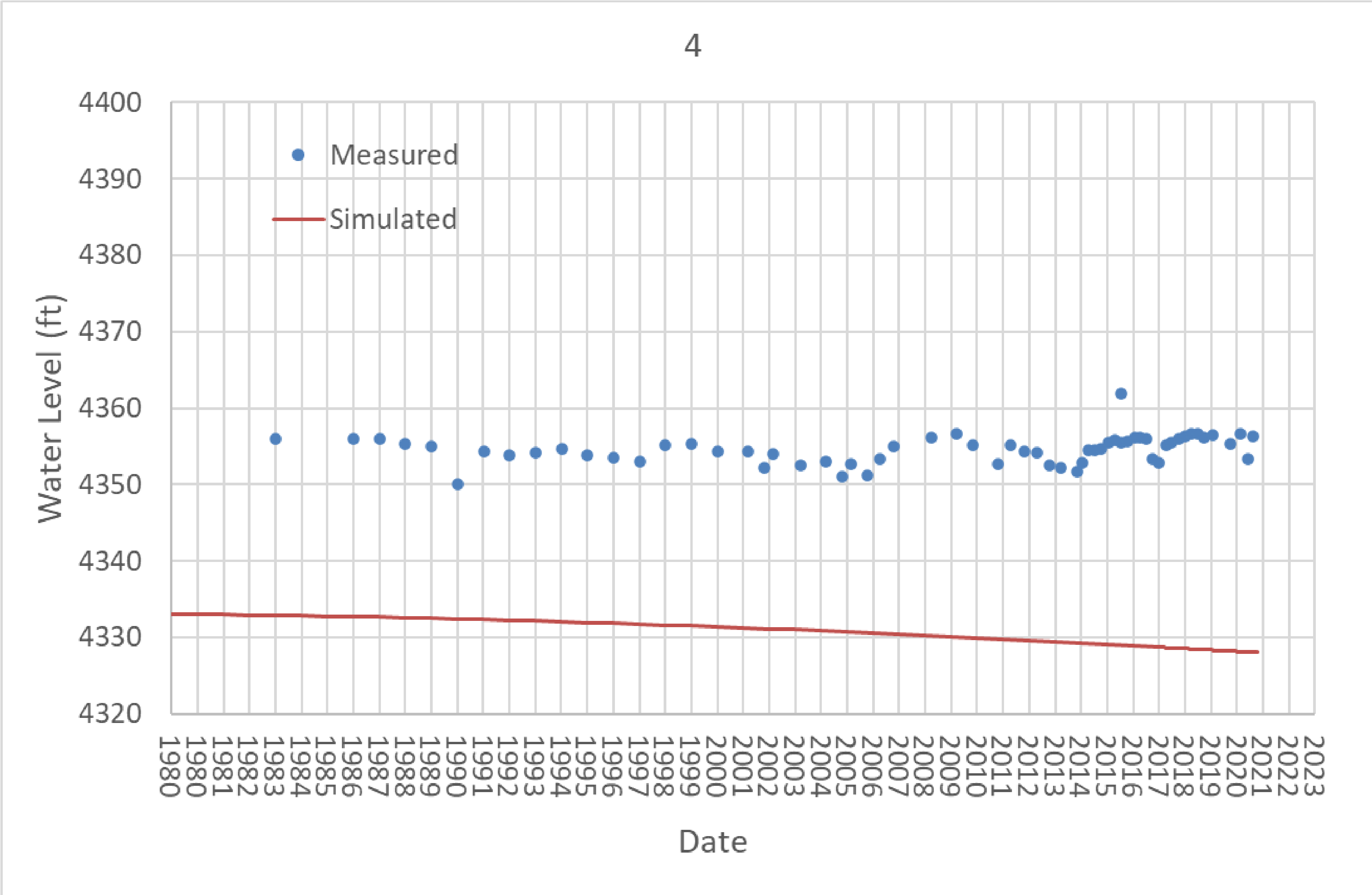

Figure 86. Measured and simulated groundwater level at point #4.

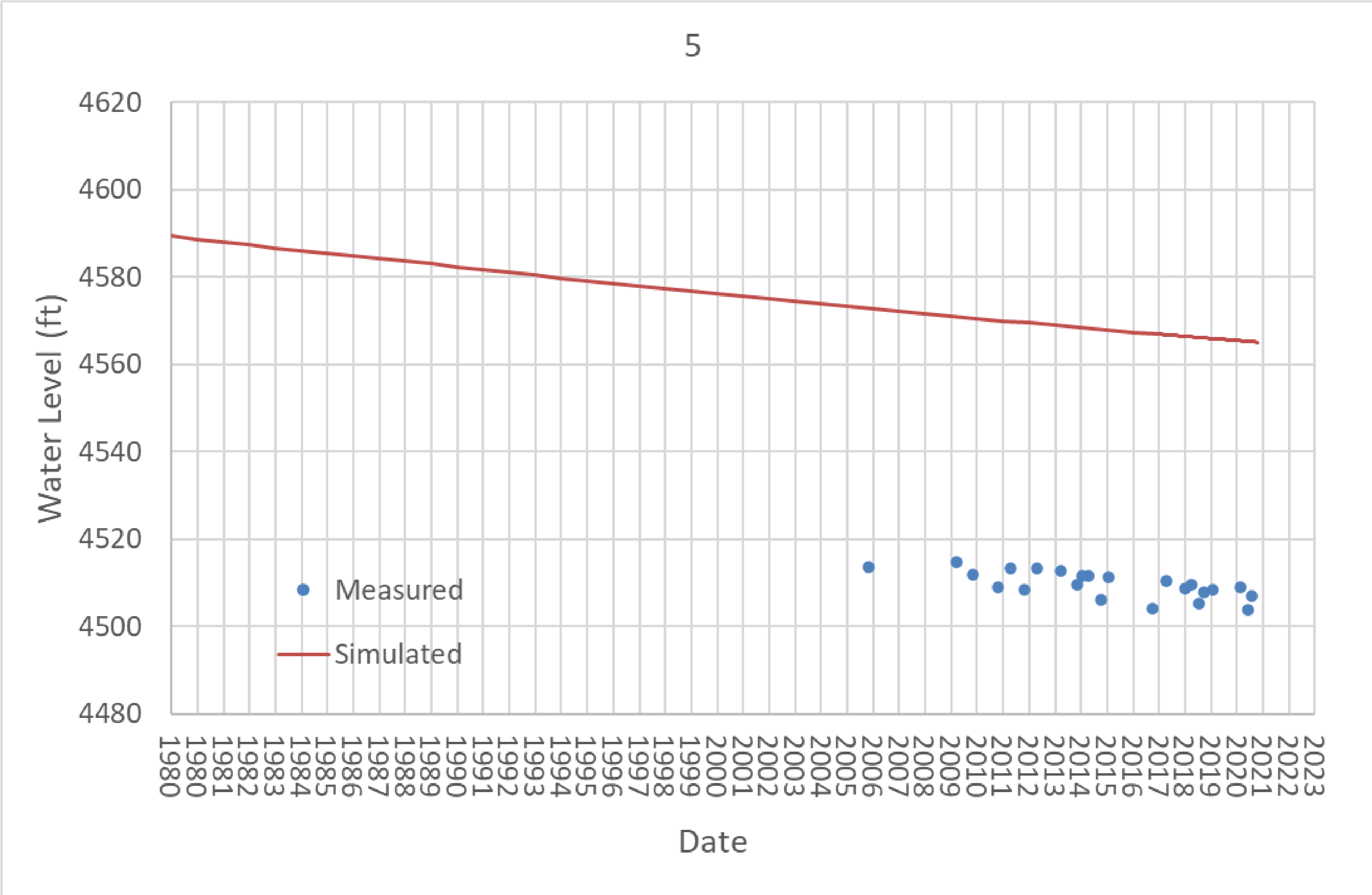

Figure 87. Measured and simulated groundwater level at point #5.

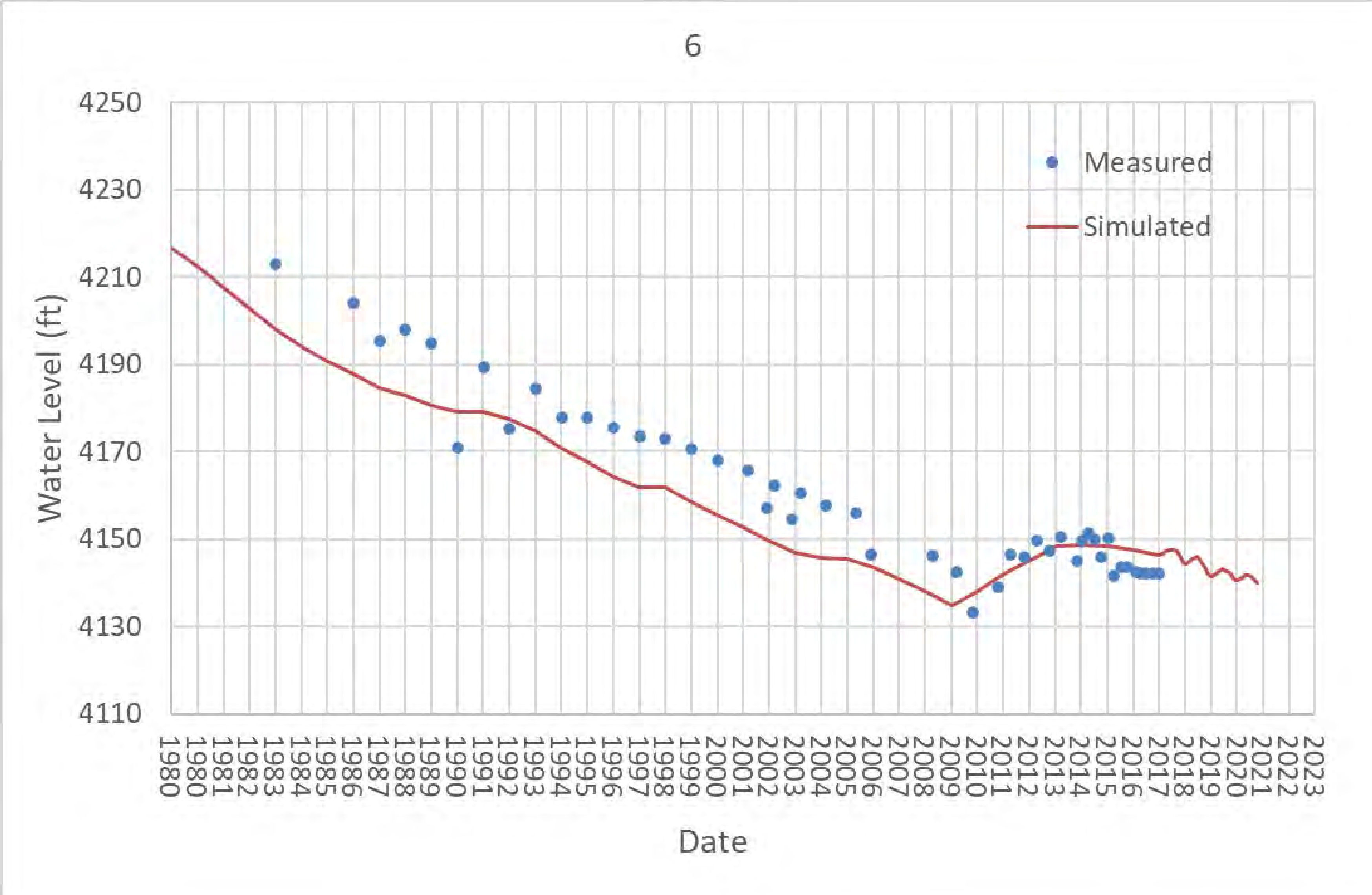

Figure 88. Measured and simulated groundwater level at point #6.

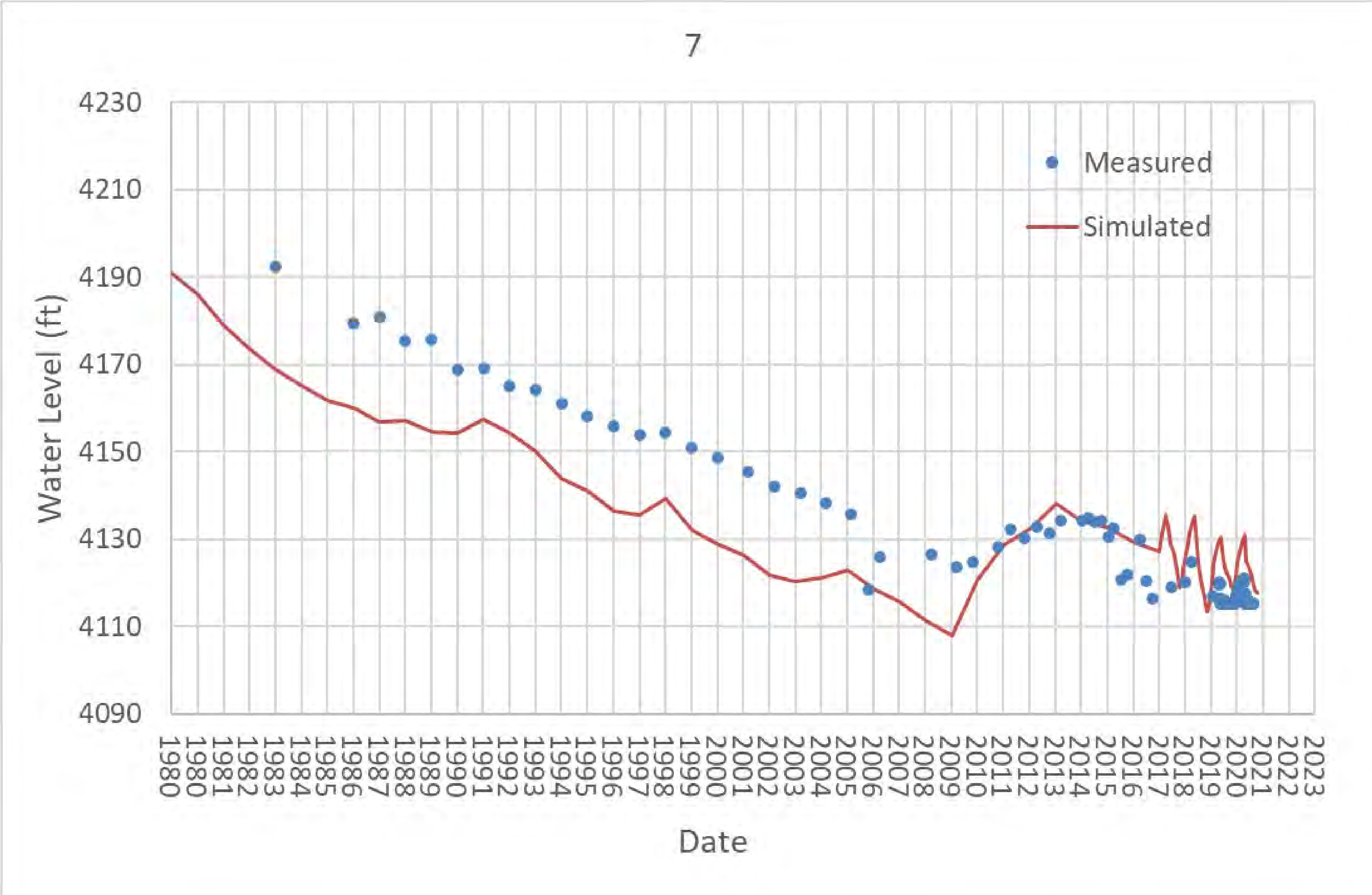

Figure 89. Measured and simulated groundwater level at point #7.

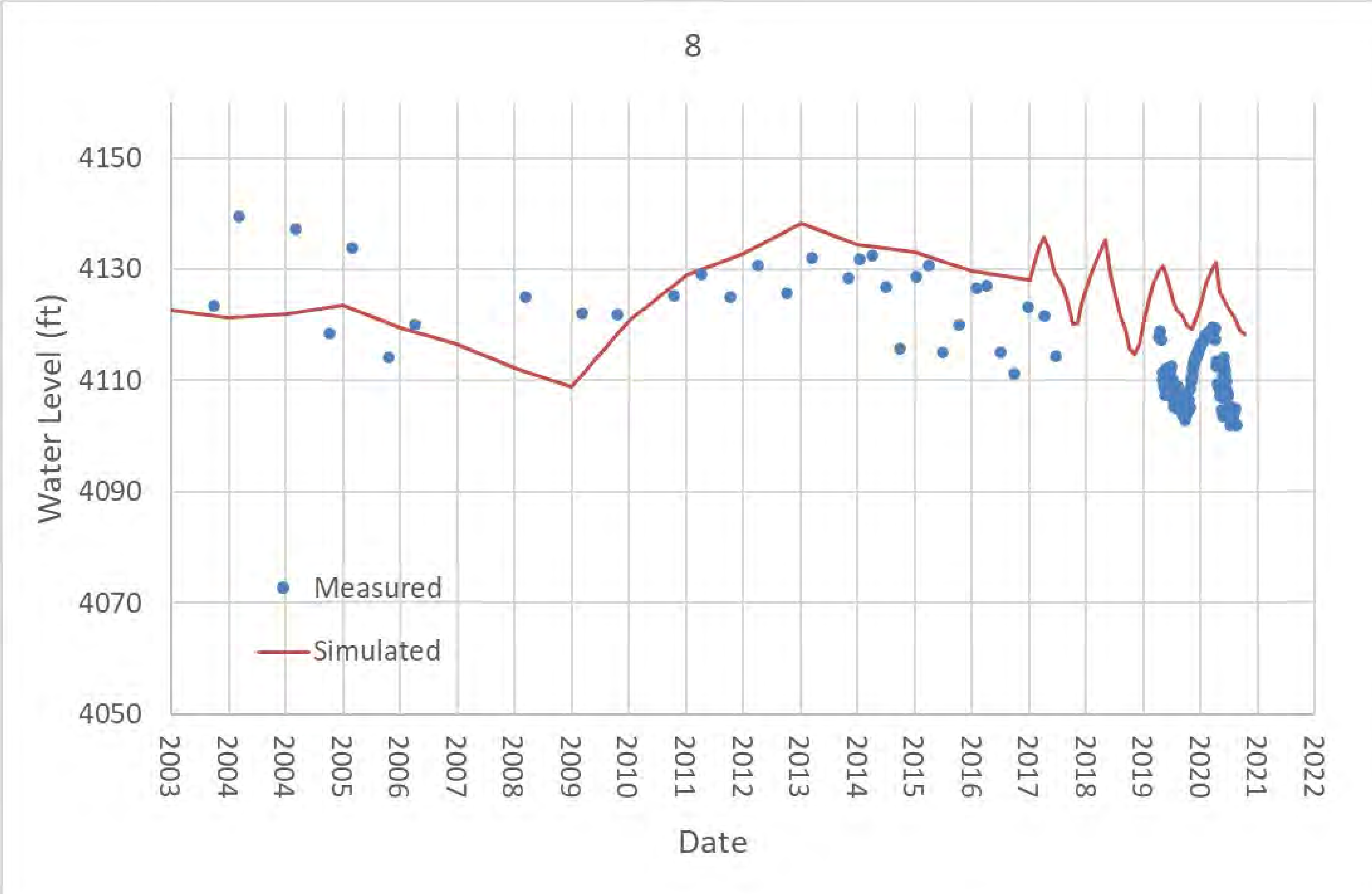

Figure 90. Measured and simulated groundwater level at point #8.

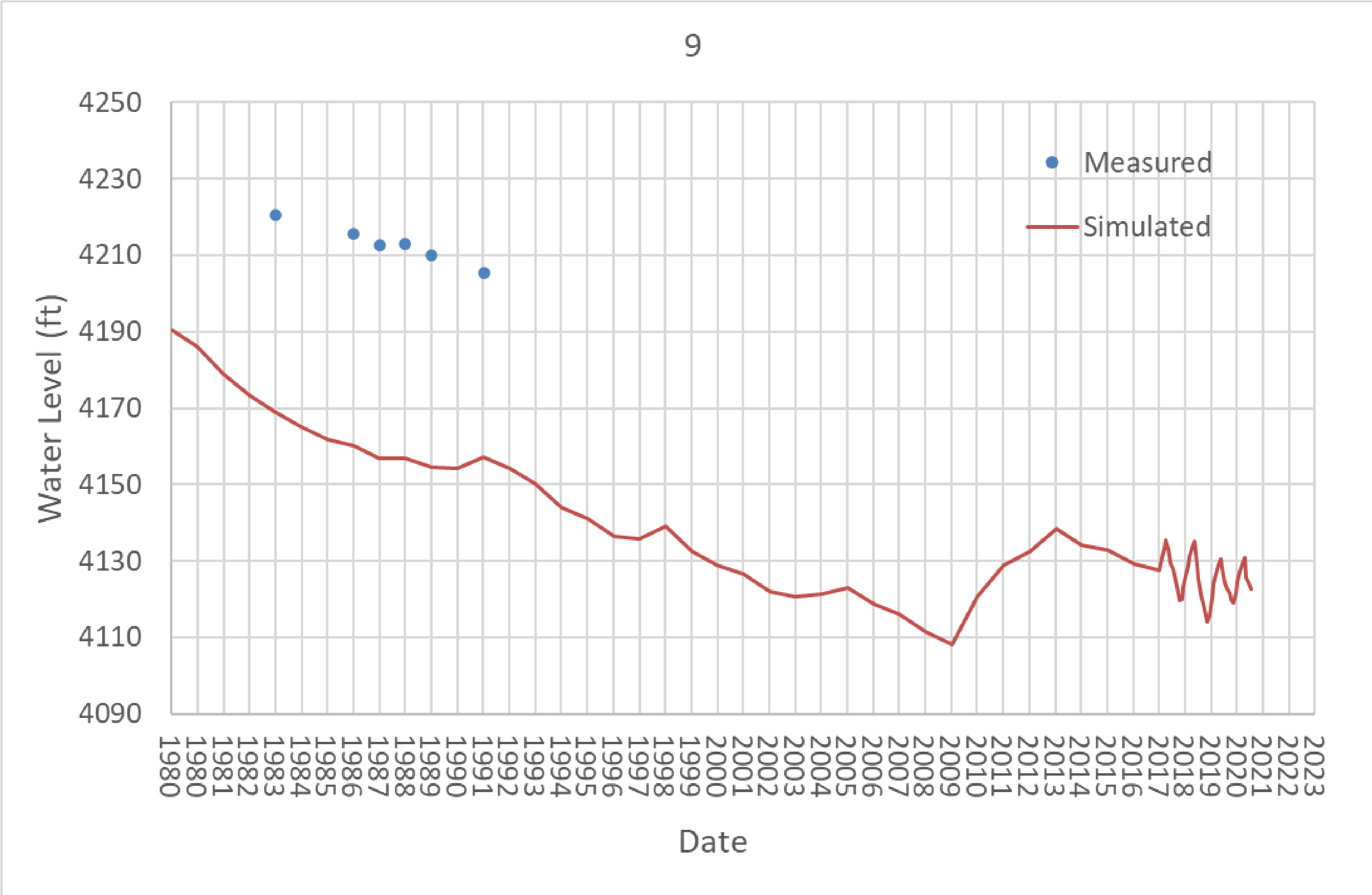

Figure 91. Measured and simulated groundwater level at point #9.

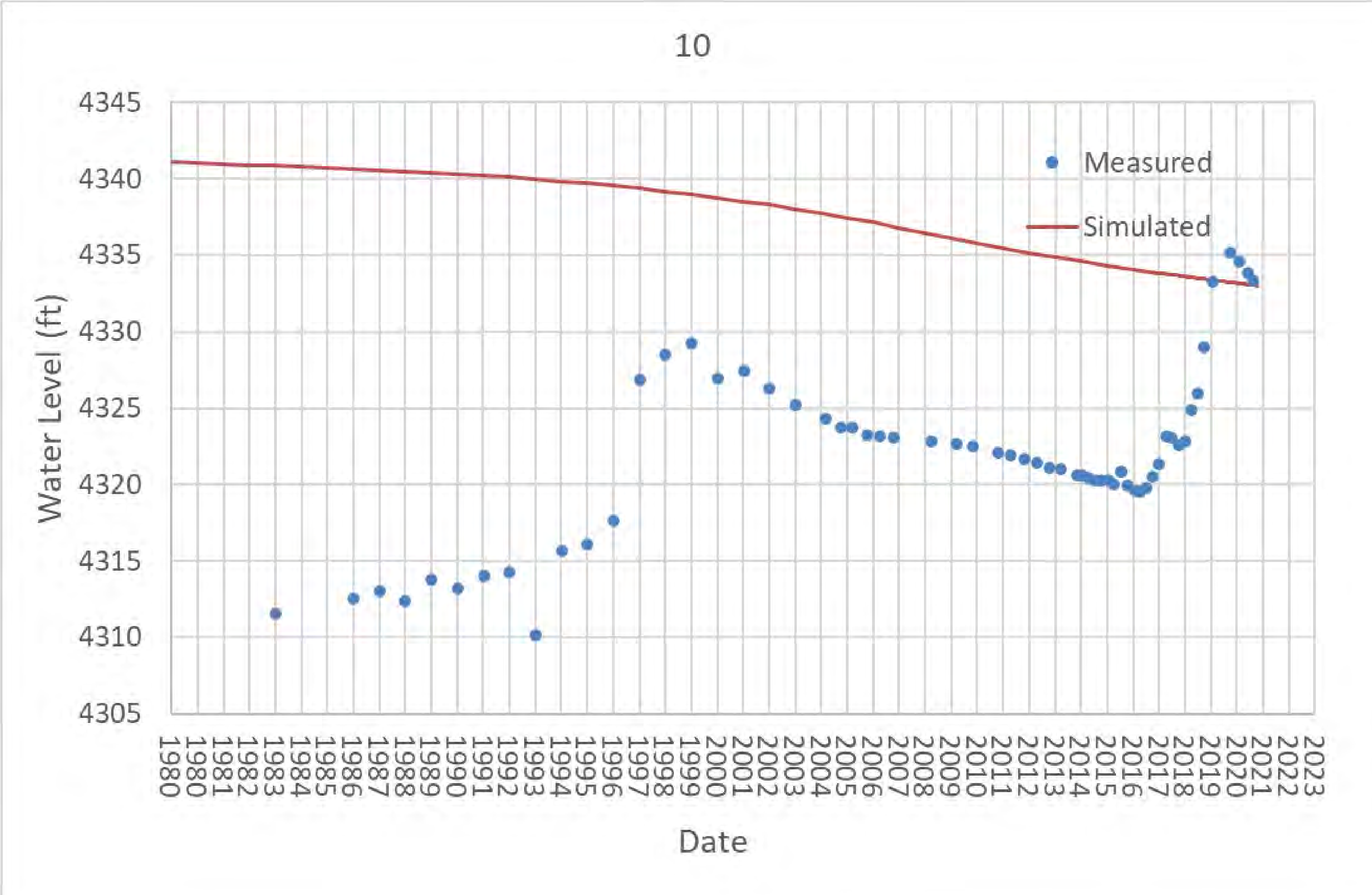

Figure 92. Measured and simulated groundwater level at point #10.

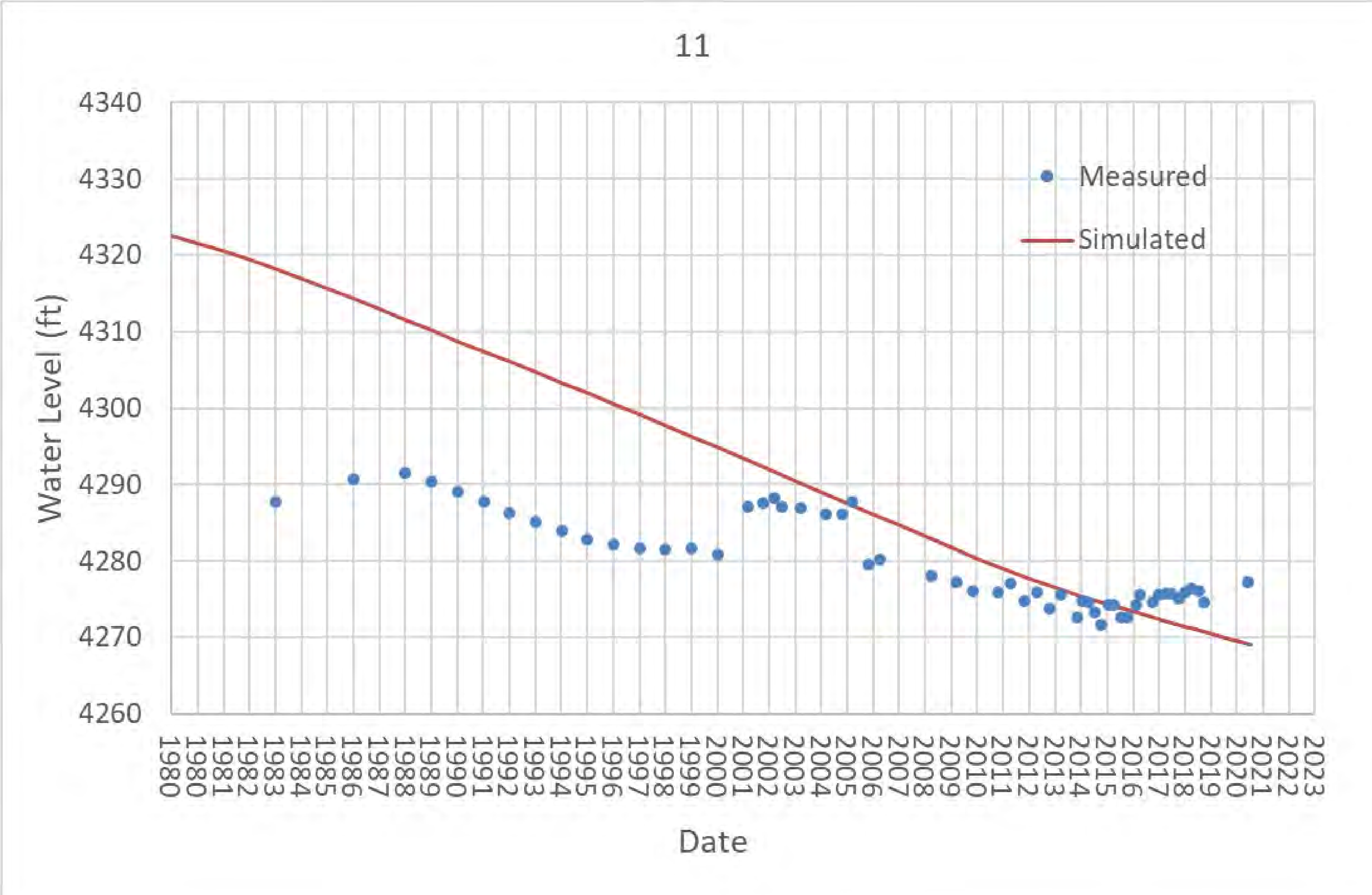

Figure 93. Measured and simulated groundwater level at point #11.

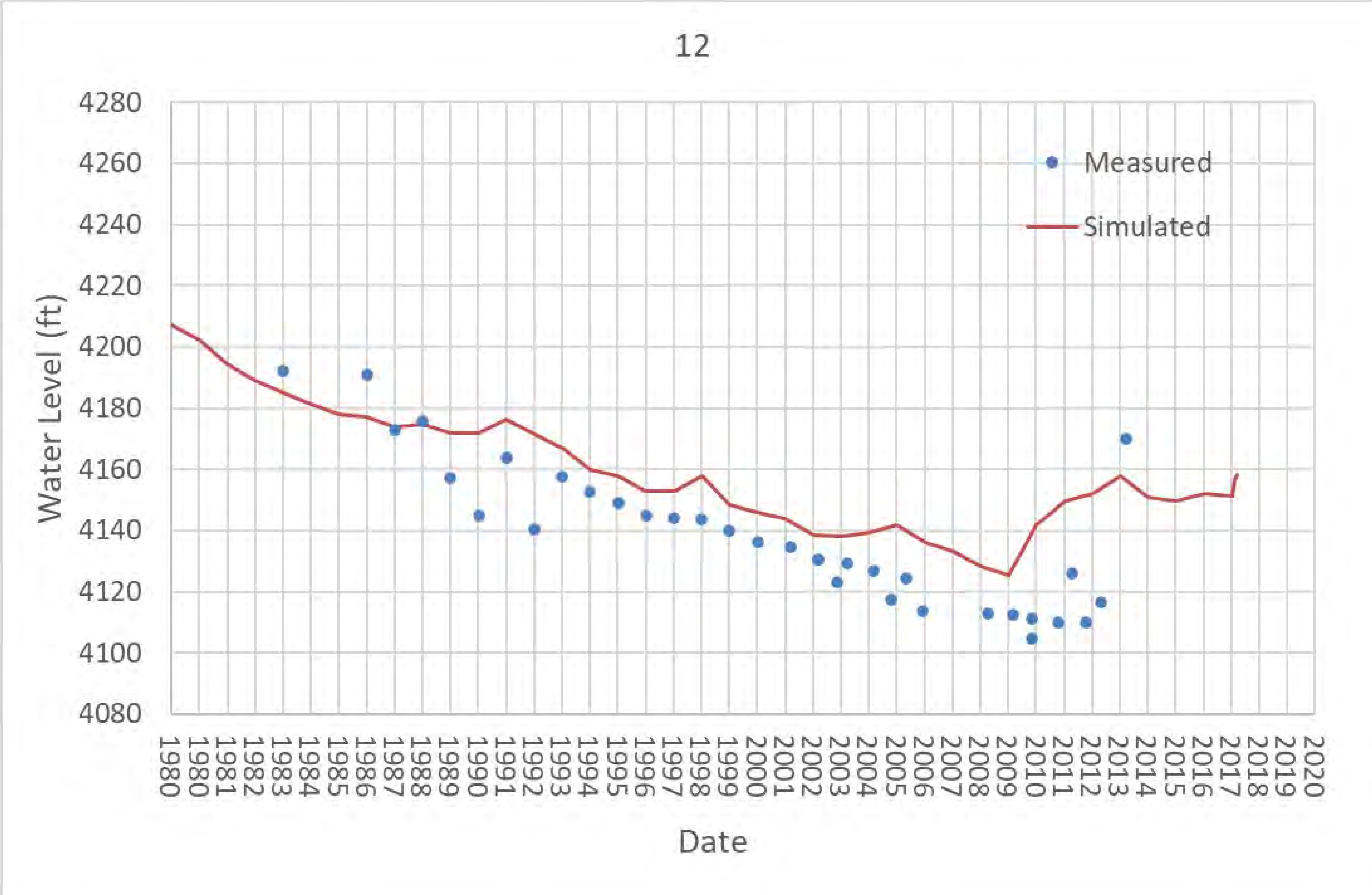

Figure 94. Measured and simulated groundwater level at point #12.

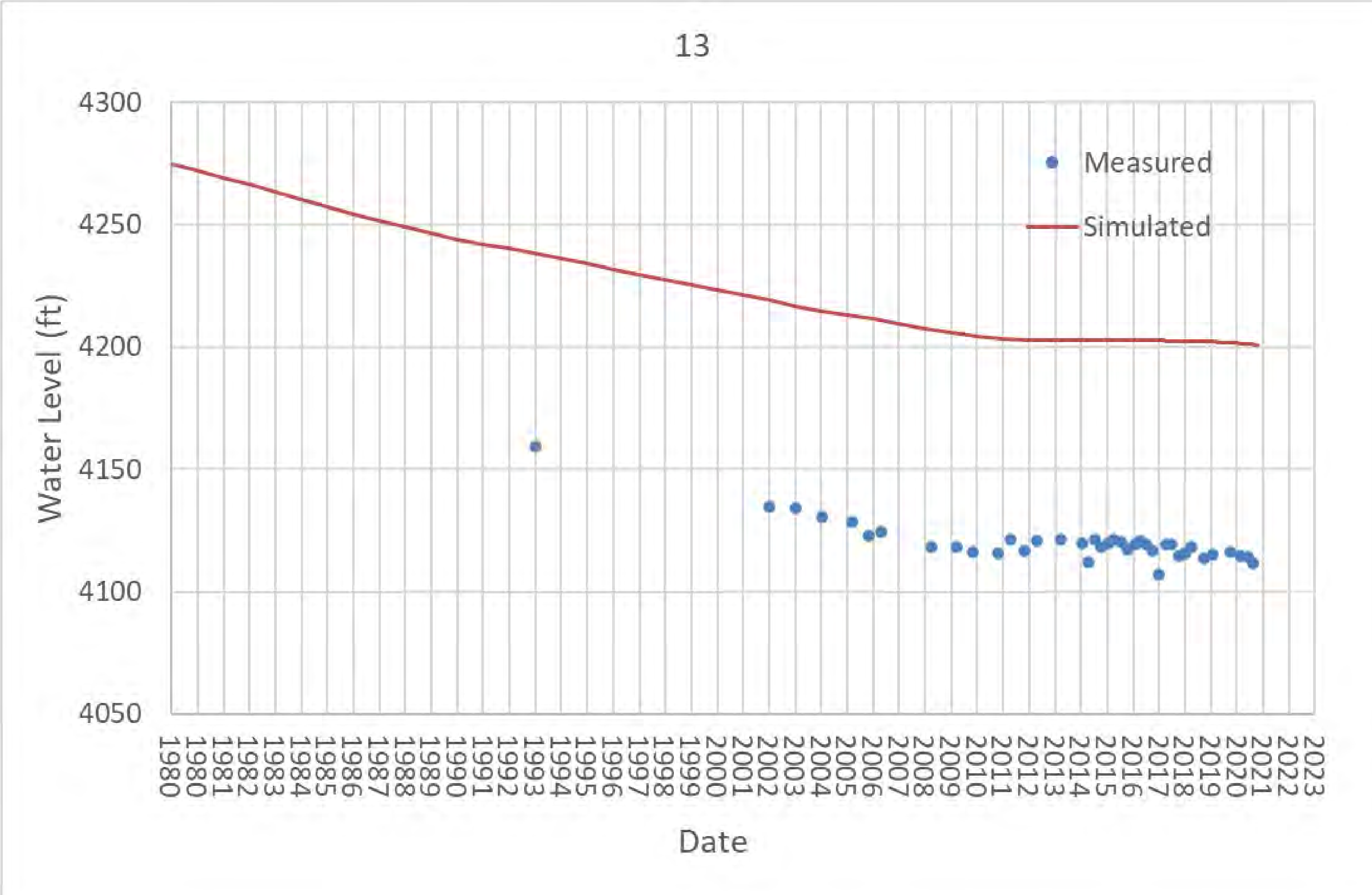

Figure 95. Measured and simulated groundwater level at point #13.

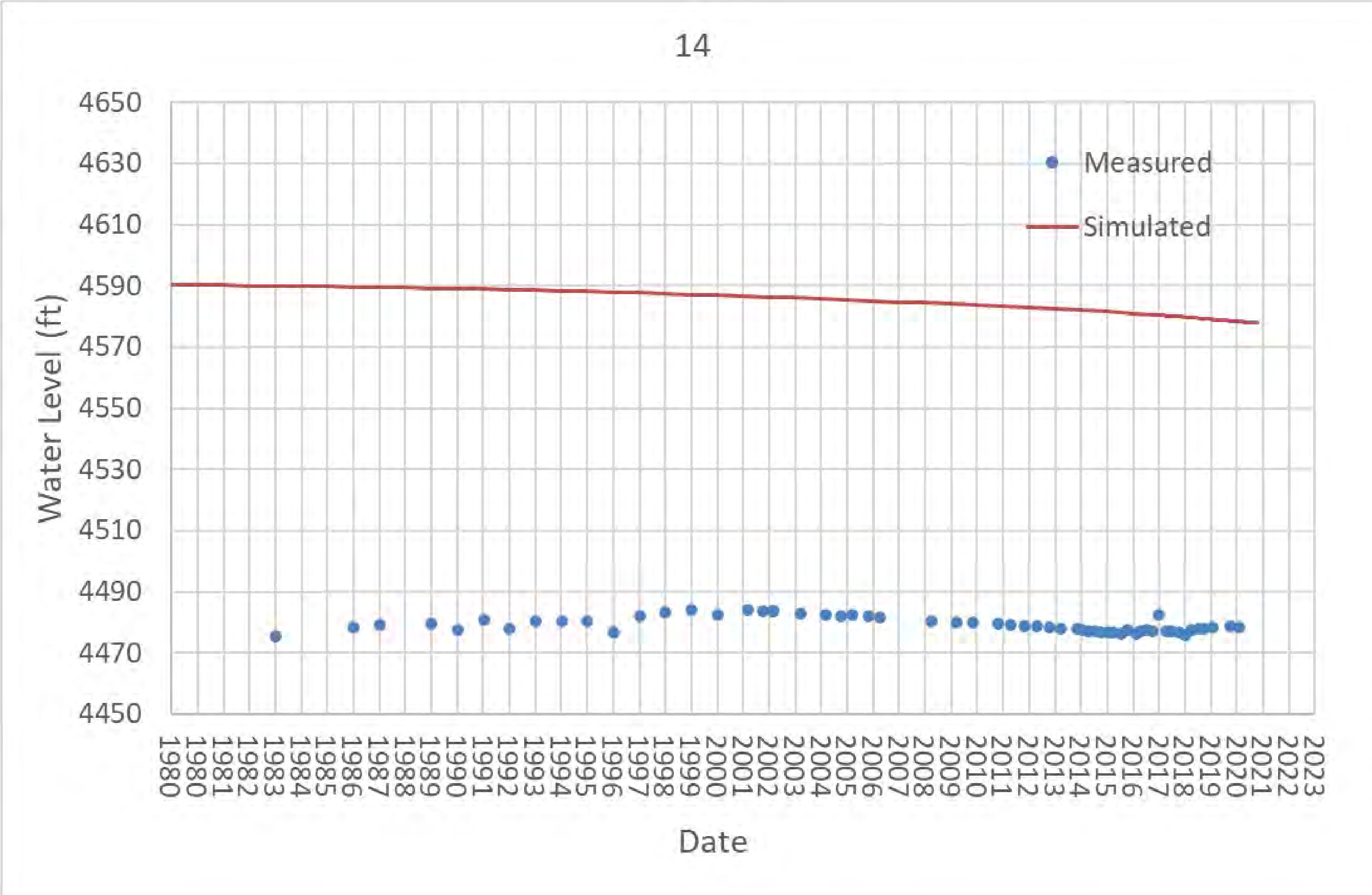

Figure 96. Measured and simulated groundwater level at point #14.

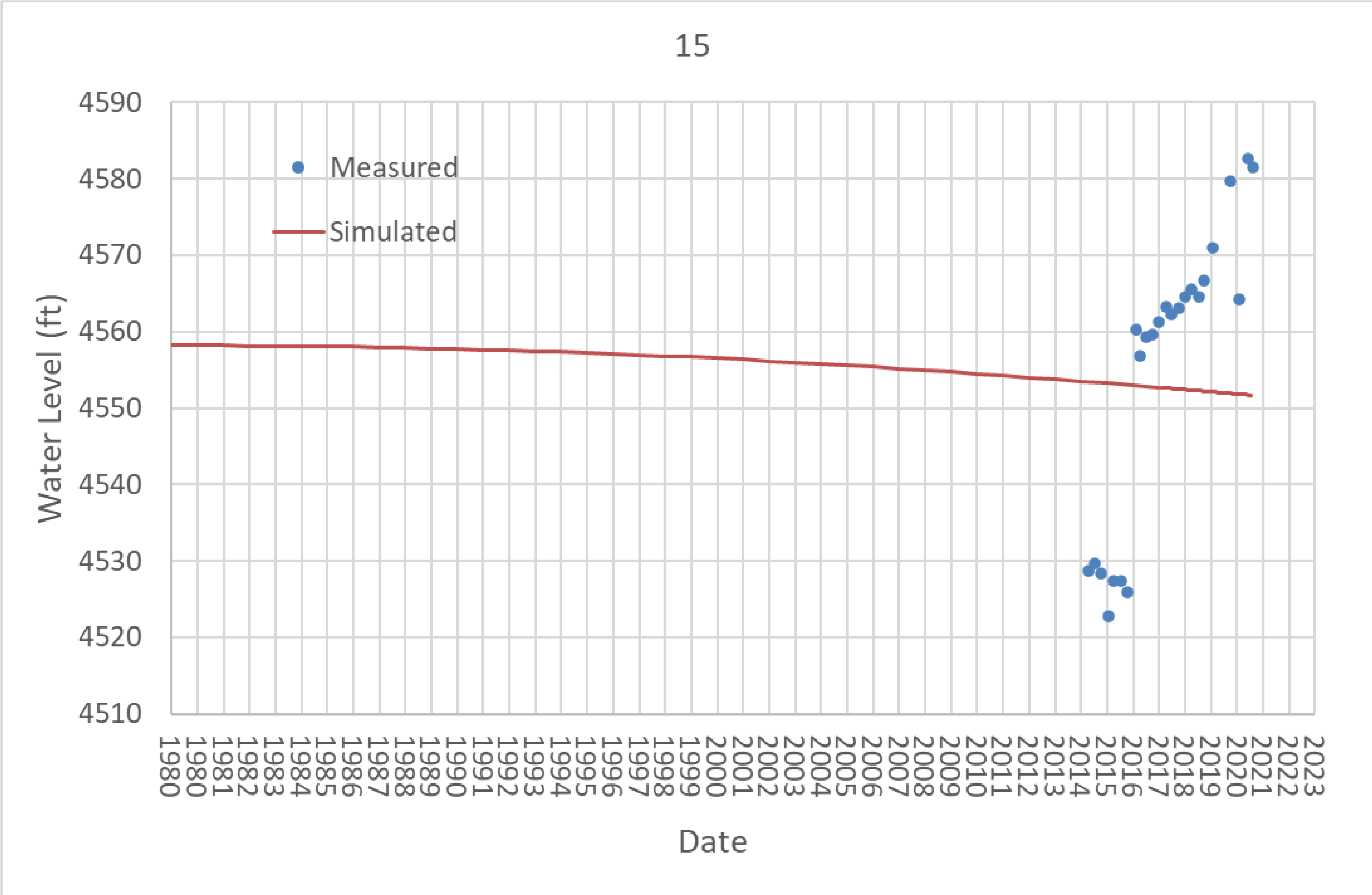

Figure 97. Measured and simulated groundwater level at point #15.

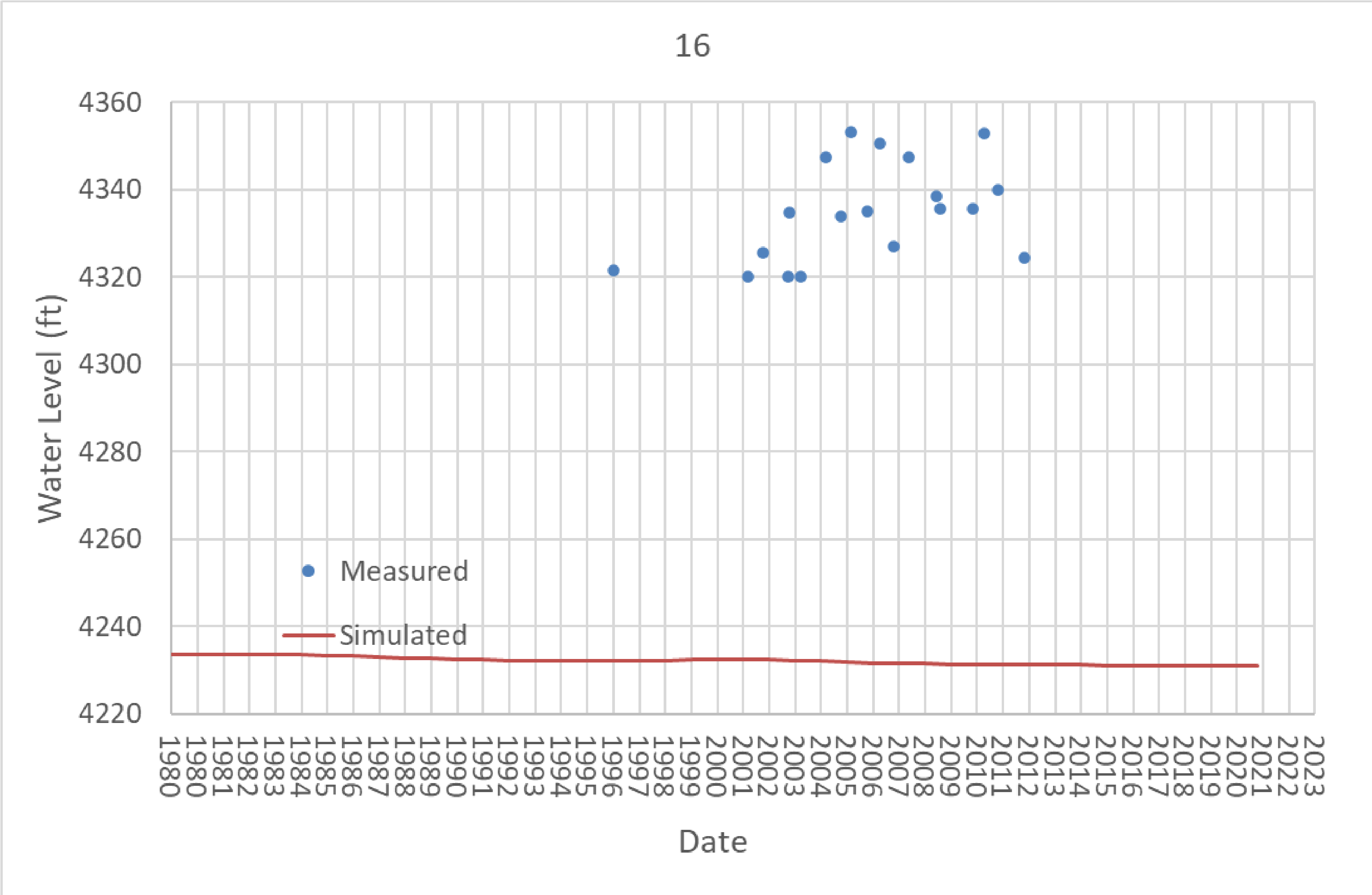

Figure 98. Measured and simulated groundwater level at point #16.

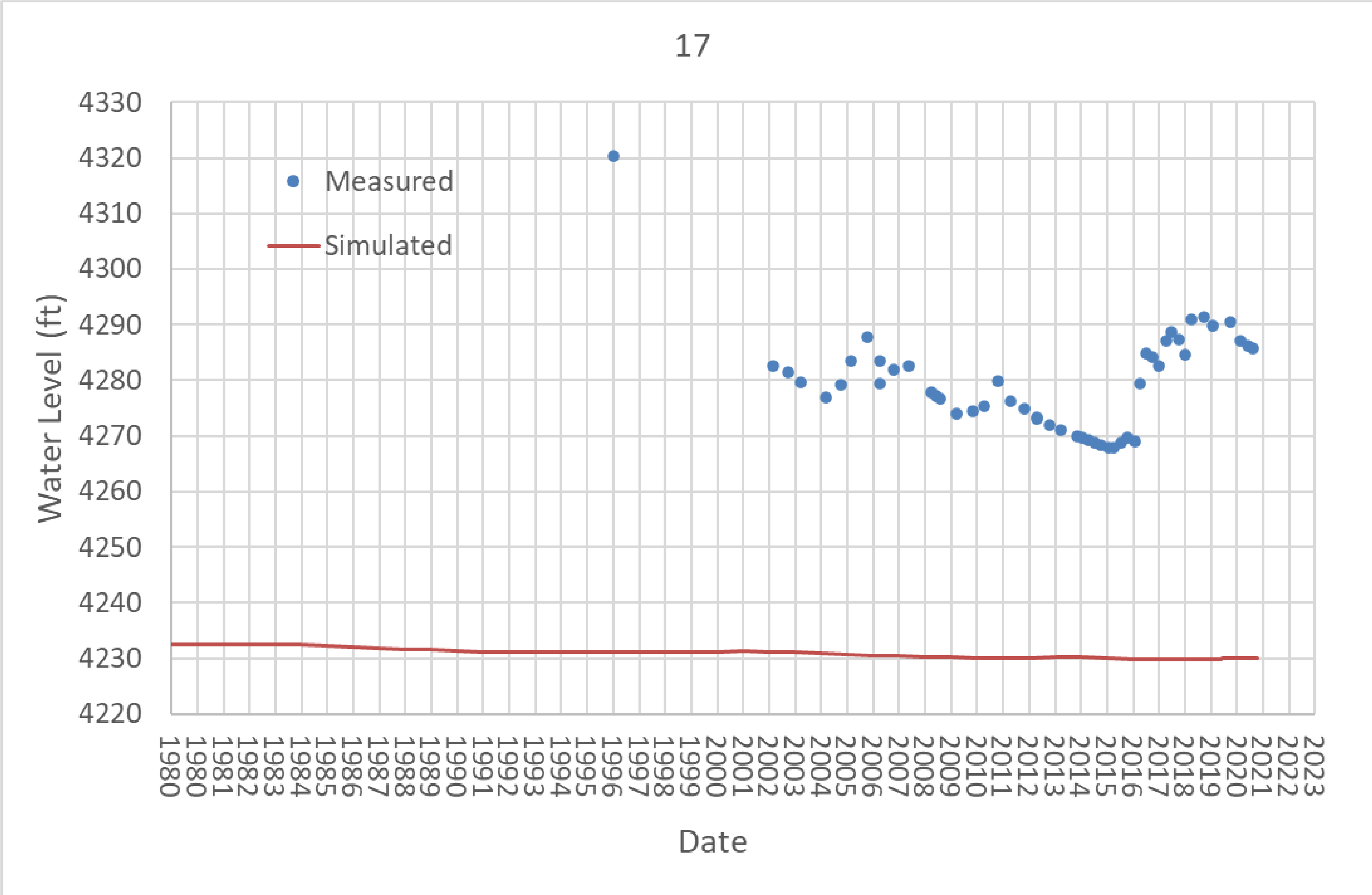

Figure 99. Measured and simulated groundwater level at point #17.

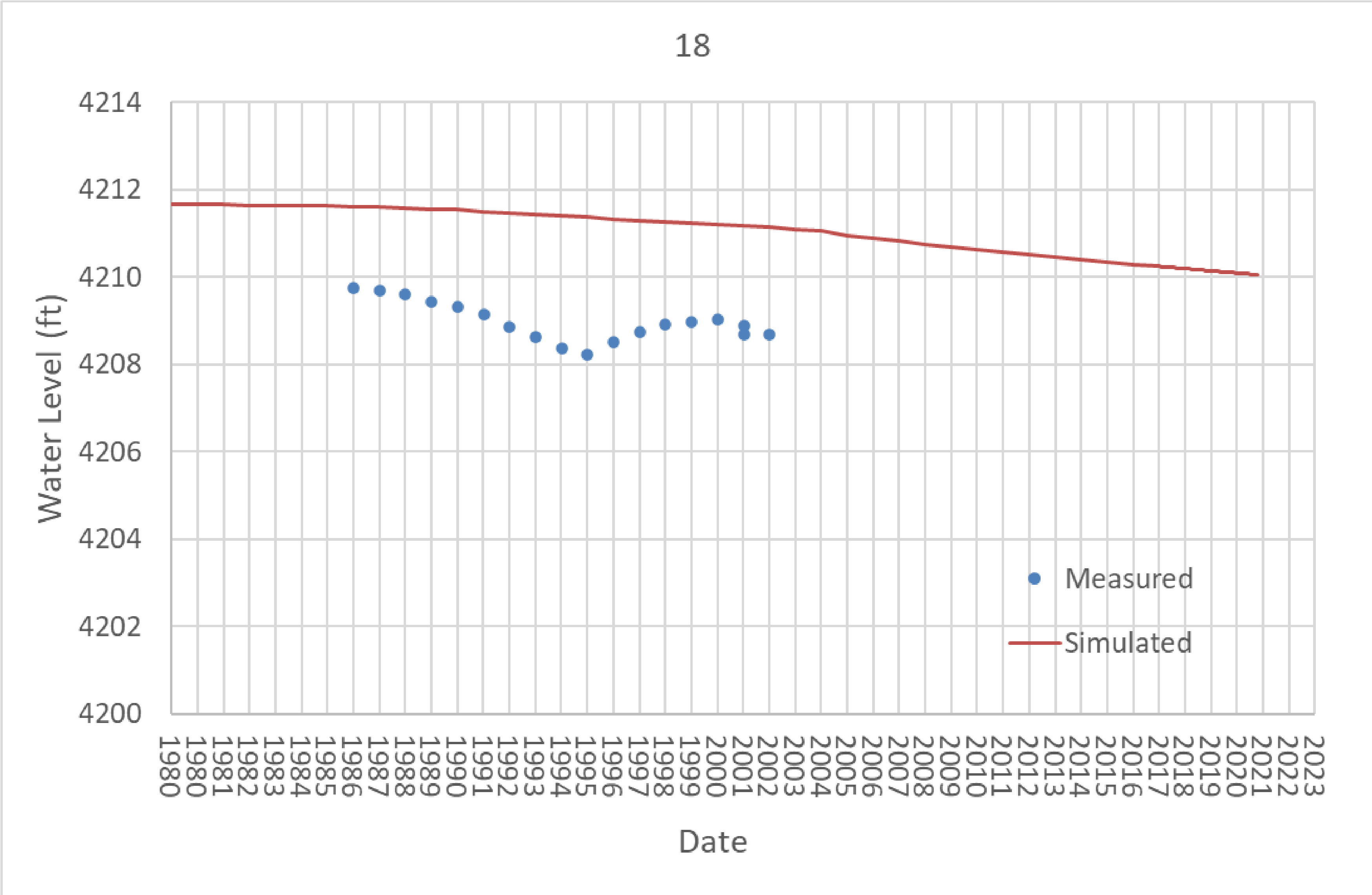

Figure 100. Measured and simulated groundwater level at point #18.

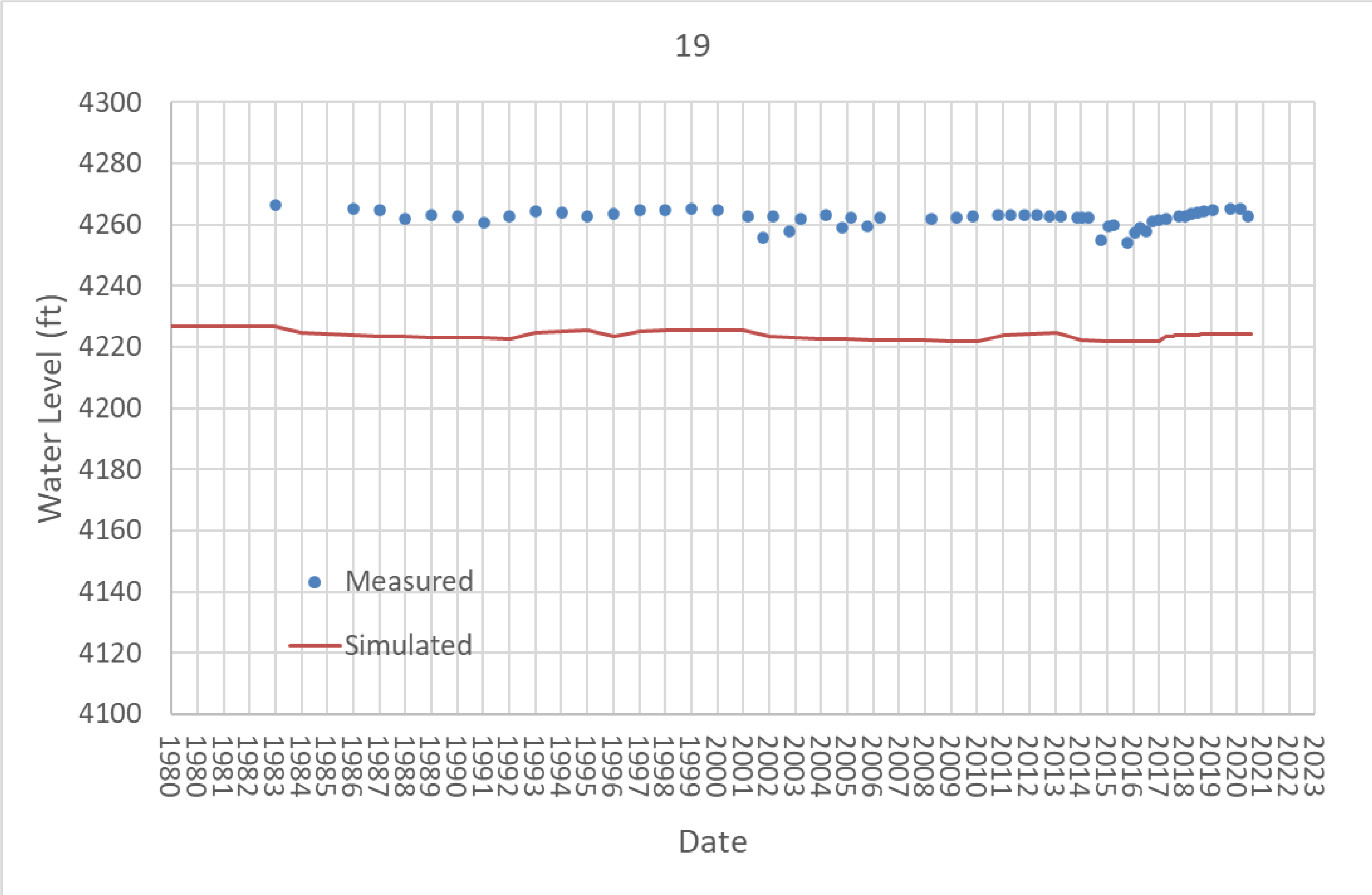

Figure 101. Measured and simulated groundwater level at point #19.

Figure 102. Measured and simulated groundwater level at point #20.

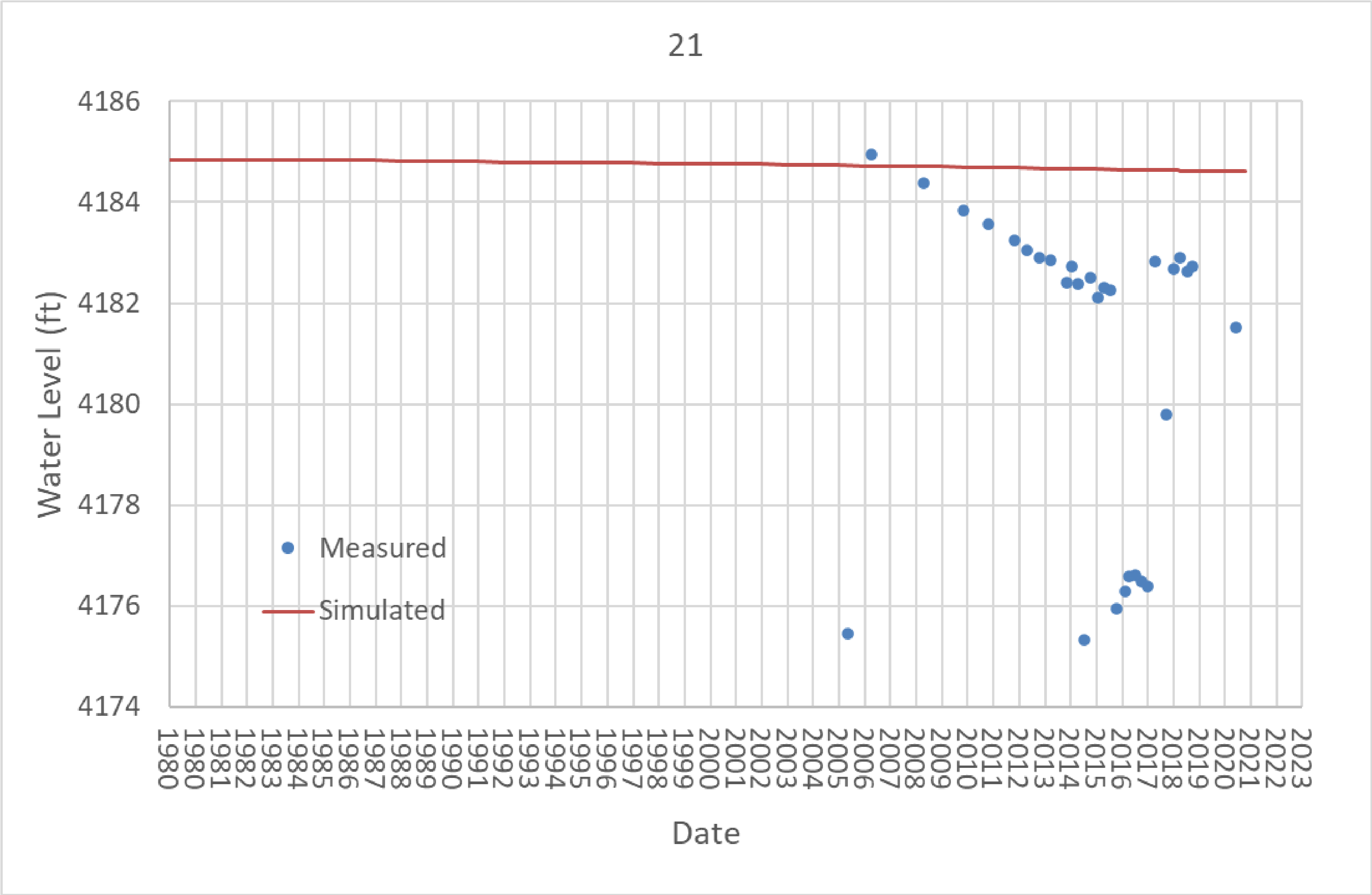

Figure 103. Measured and simulated groundwater level at point #21.

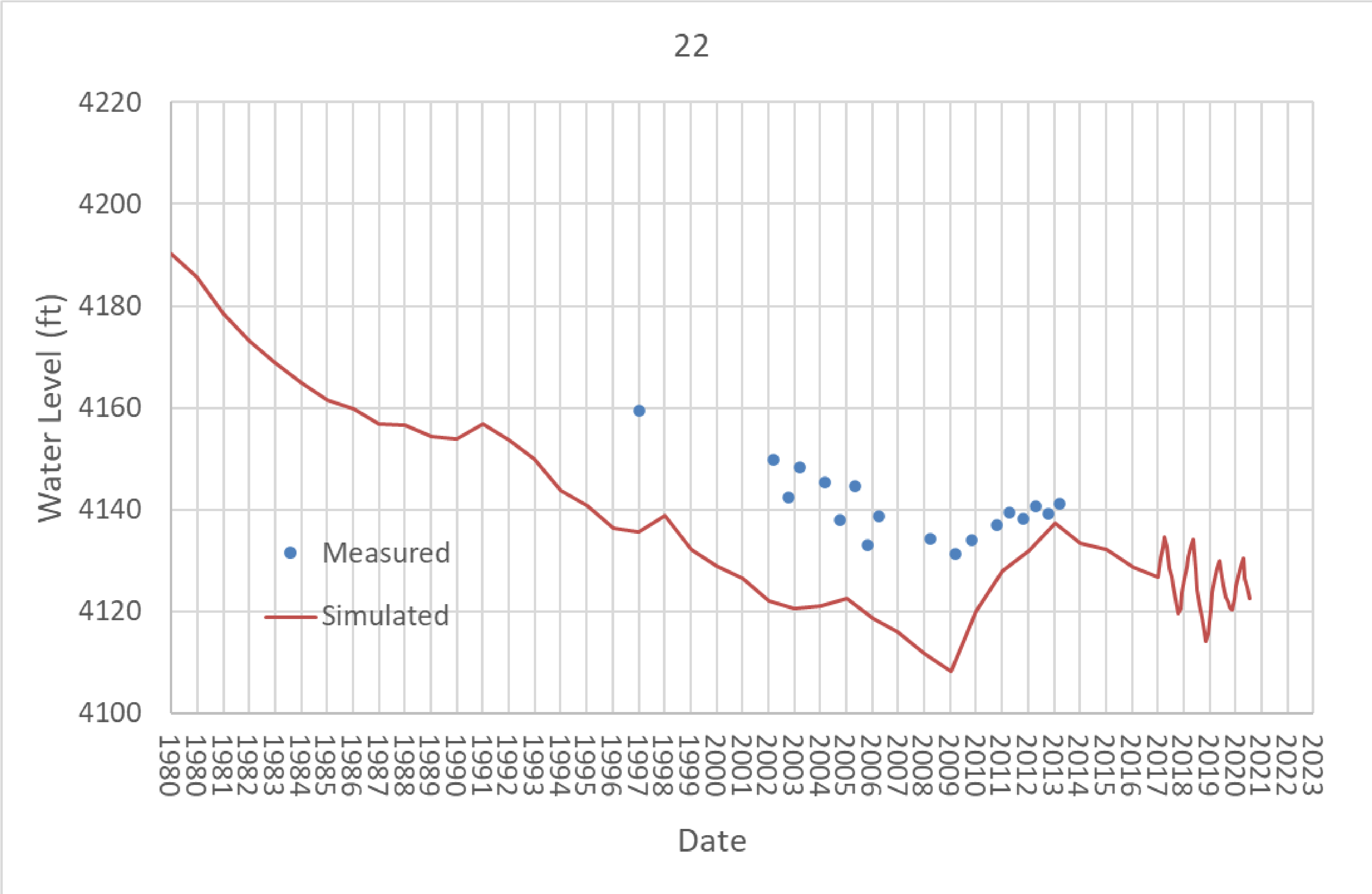

Figure 104. Measured and simulated groundwater level at point #22.

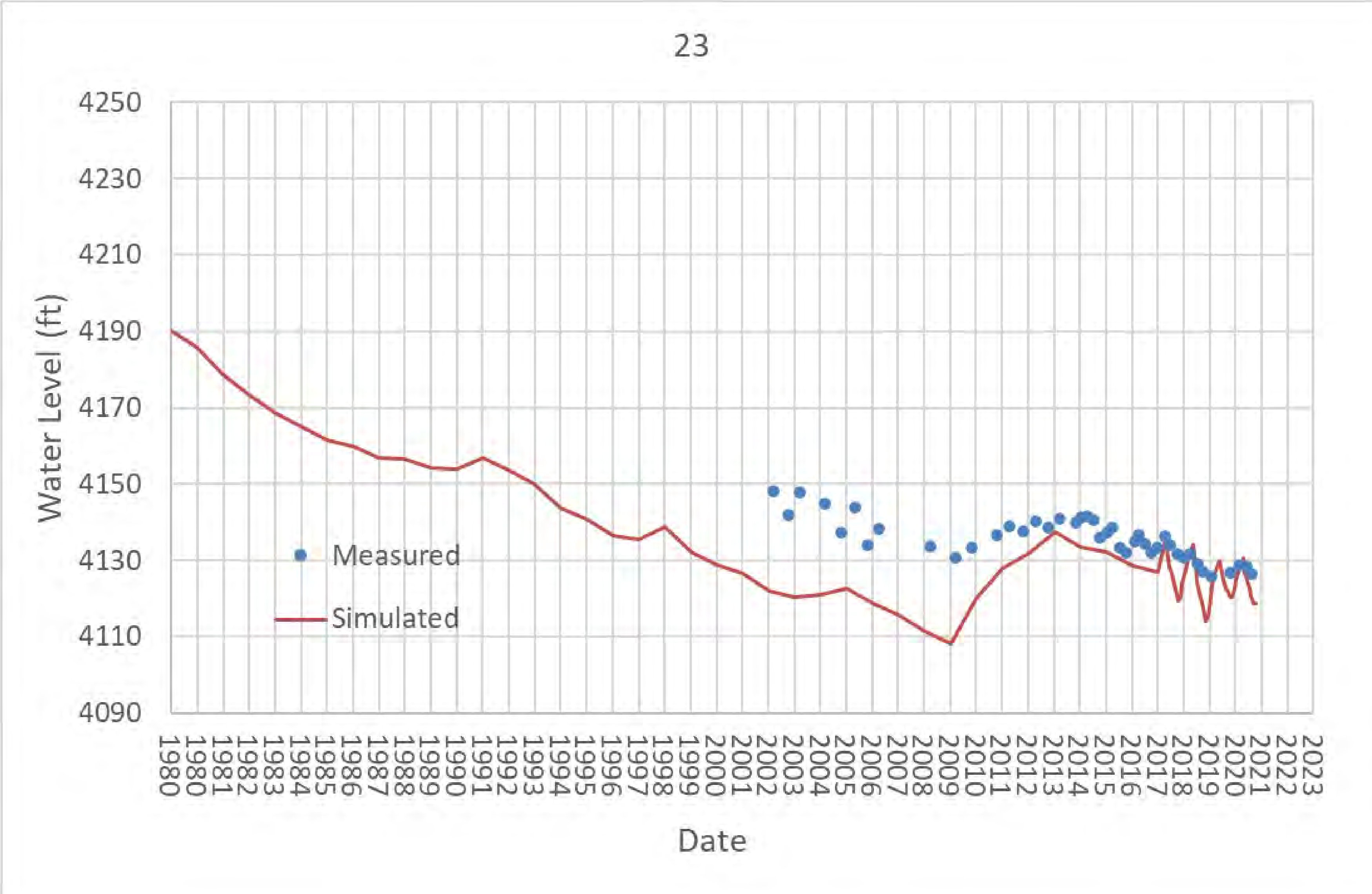

Figure 105. Measured and simulated groundwater level at point #23.

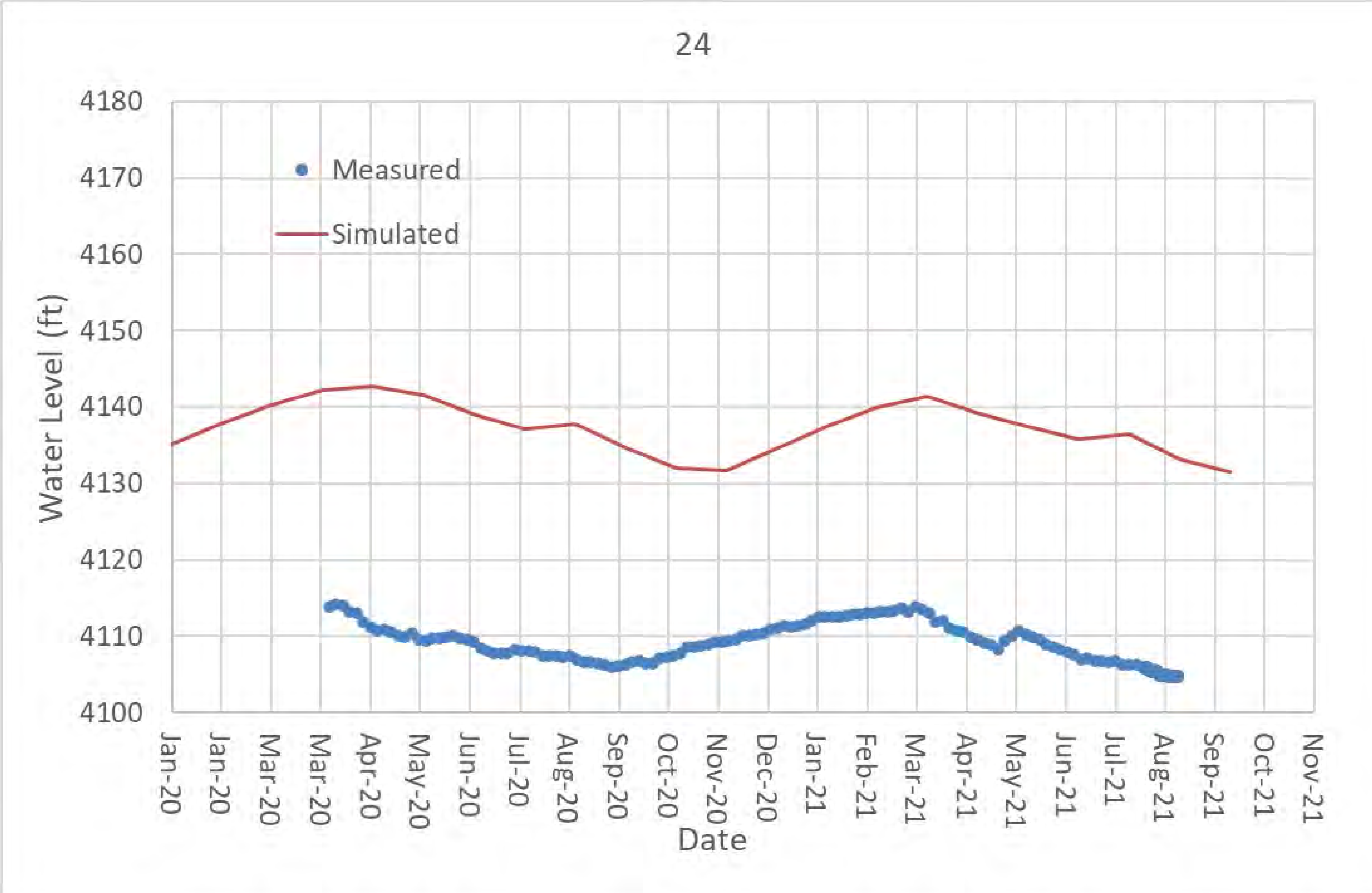

Figure 106. Measured and simulated groundwater level at point #24.

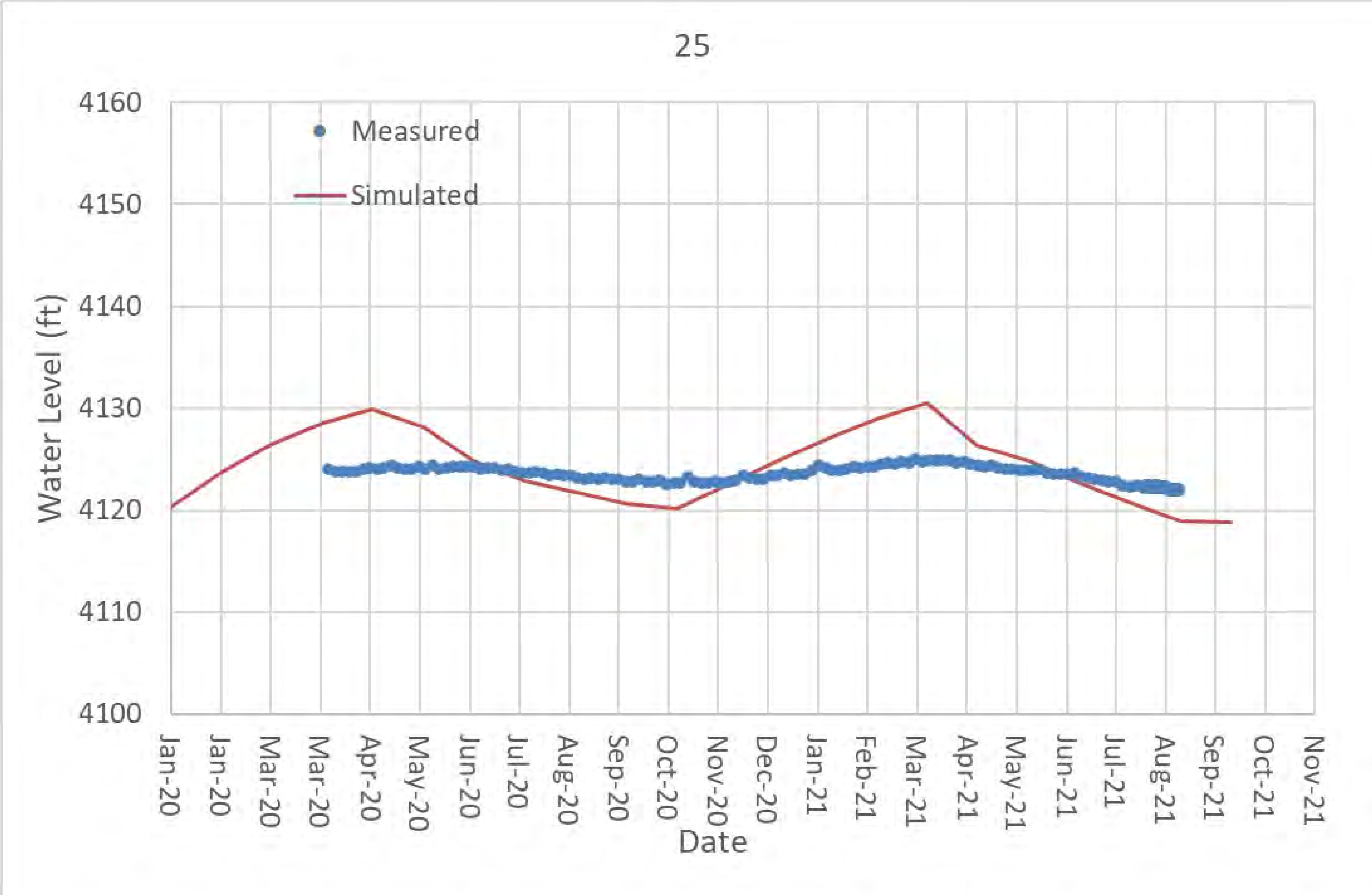

Figure 107. Measured and simulated groundwater level at point #25.

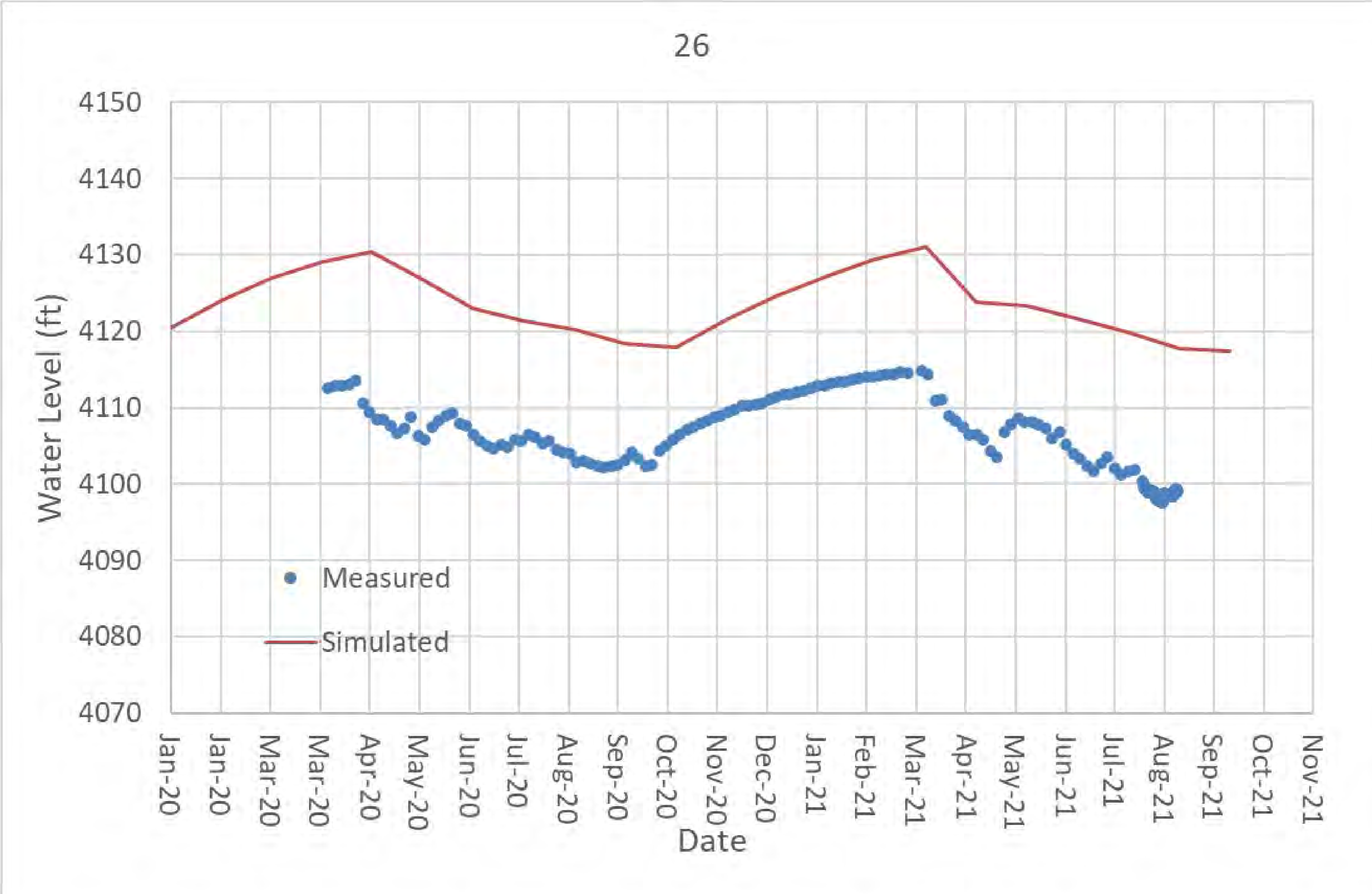

Figure 108. Measured and simulated groundwater level at point #26.

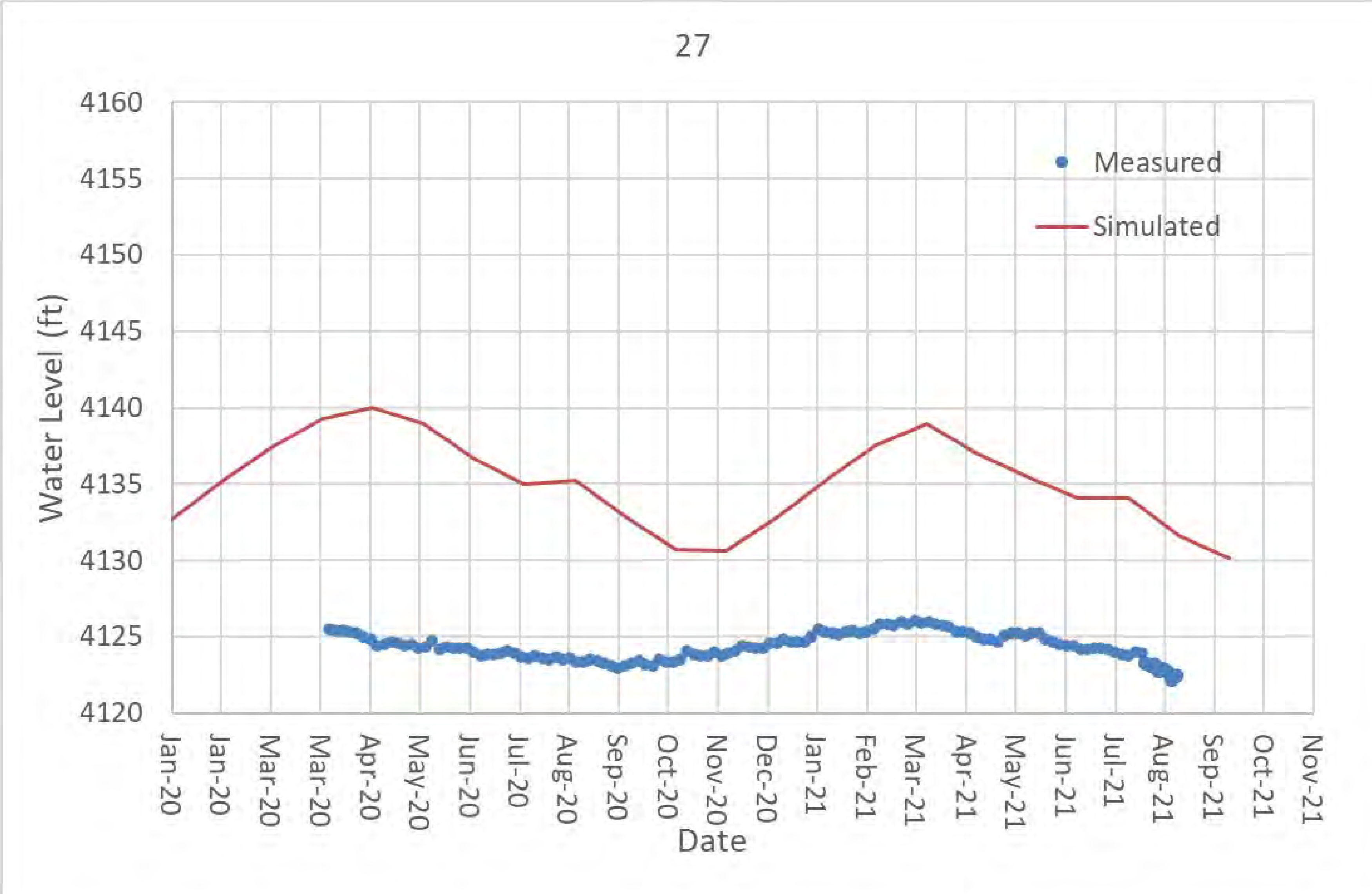

Figure 109. Measured and simulated groundwater level at point #27.

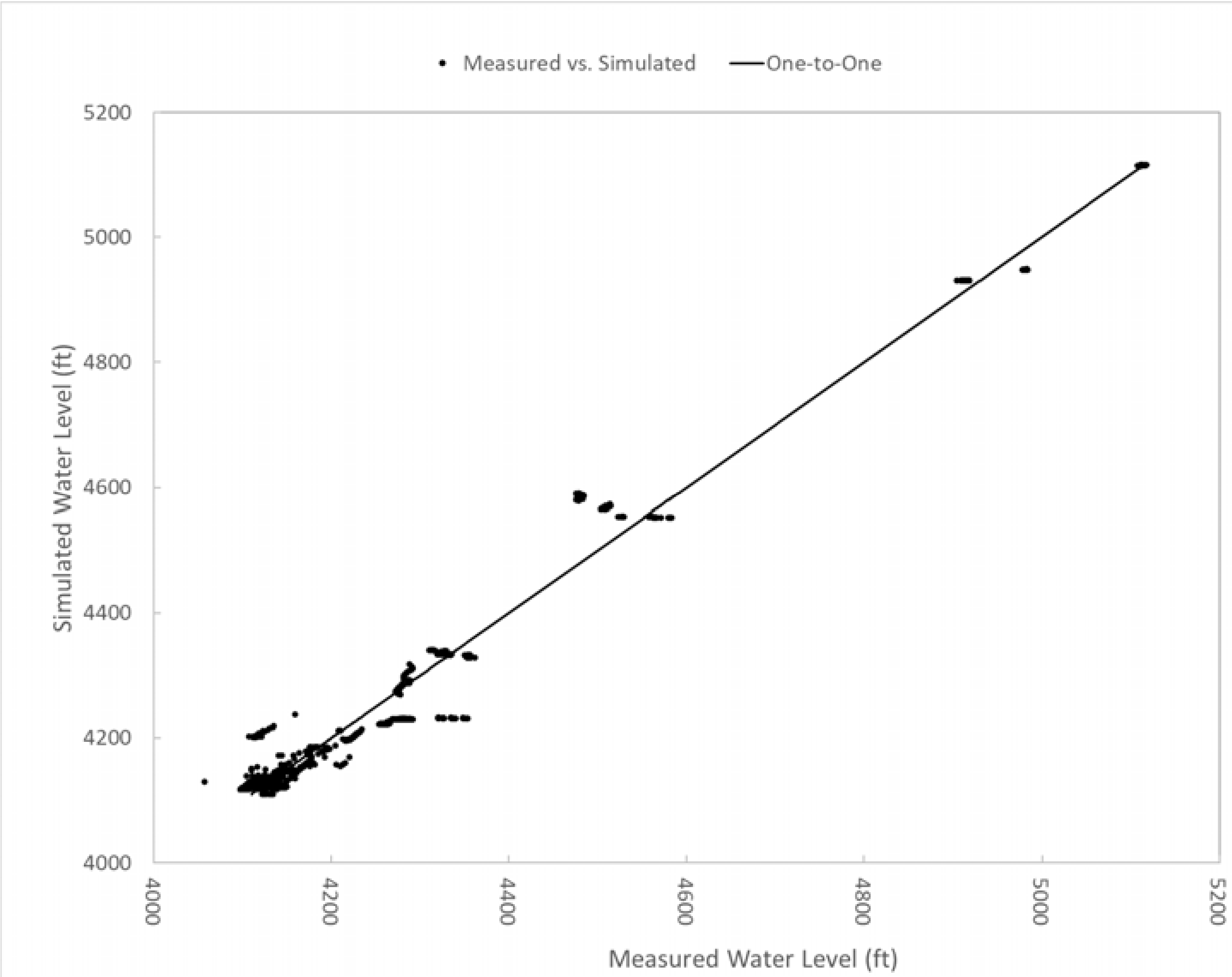

Figure 110. Simulated versus measured groundwater levels for the transient historical model.

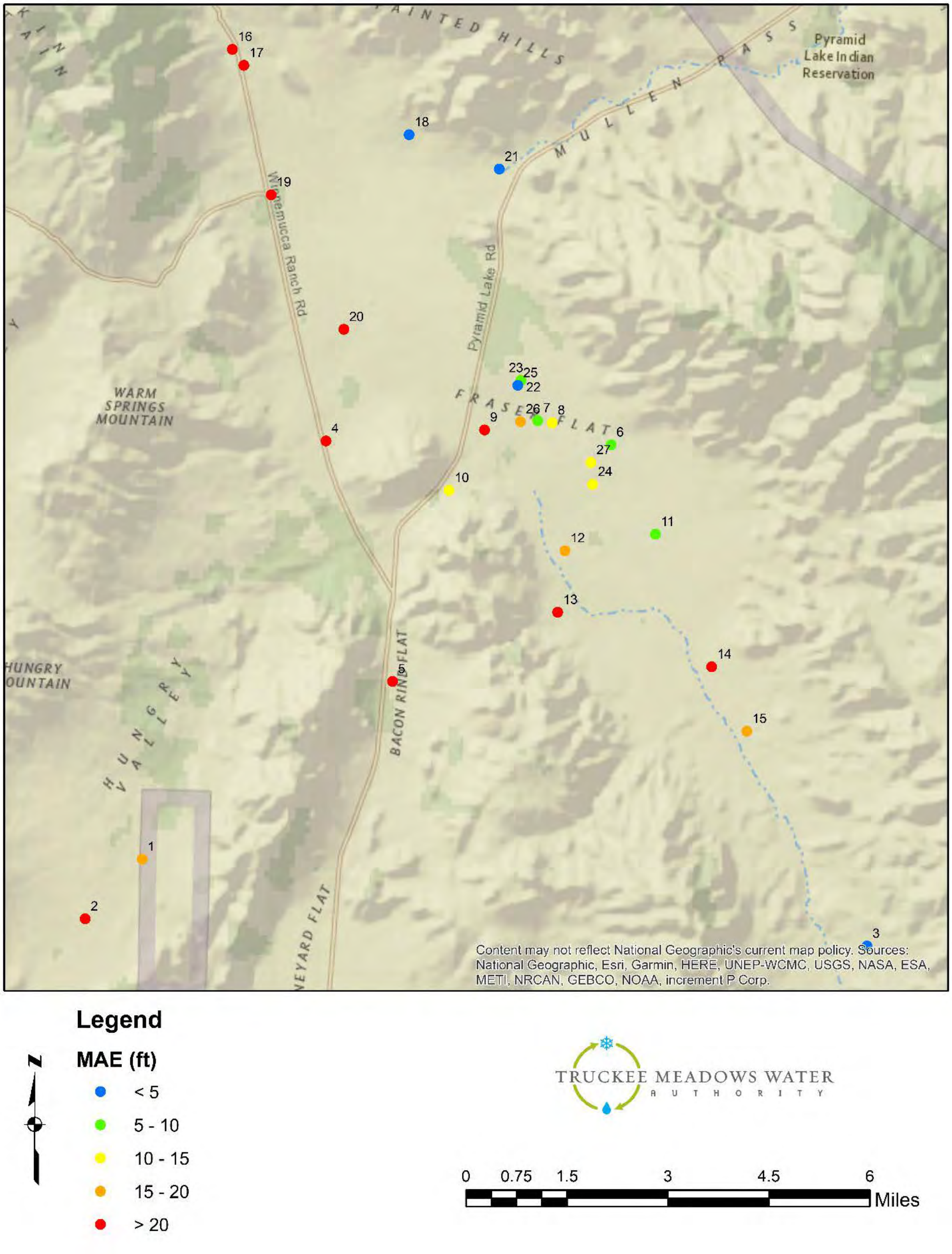

Figure 111. Mean absolute error (MAE) for the 27 target wells used for the transient historical calibration.

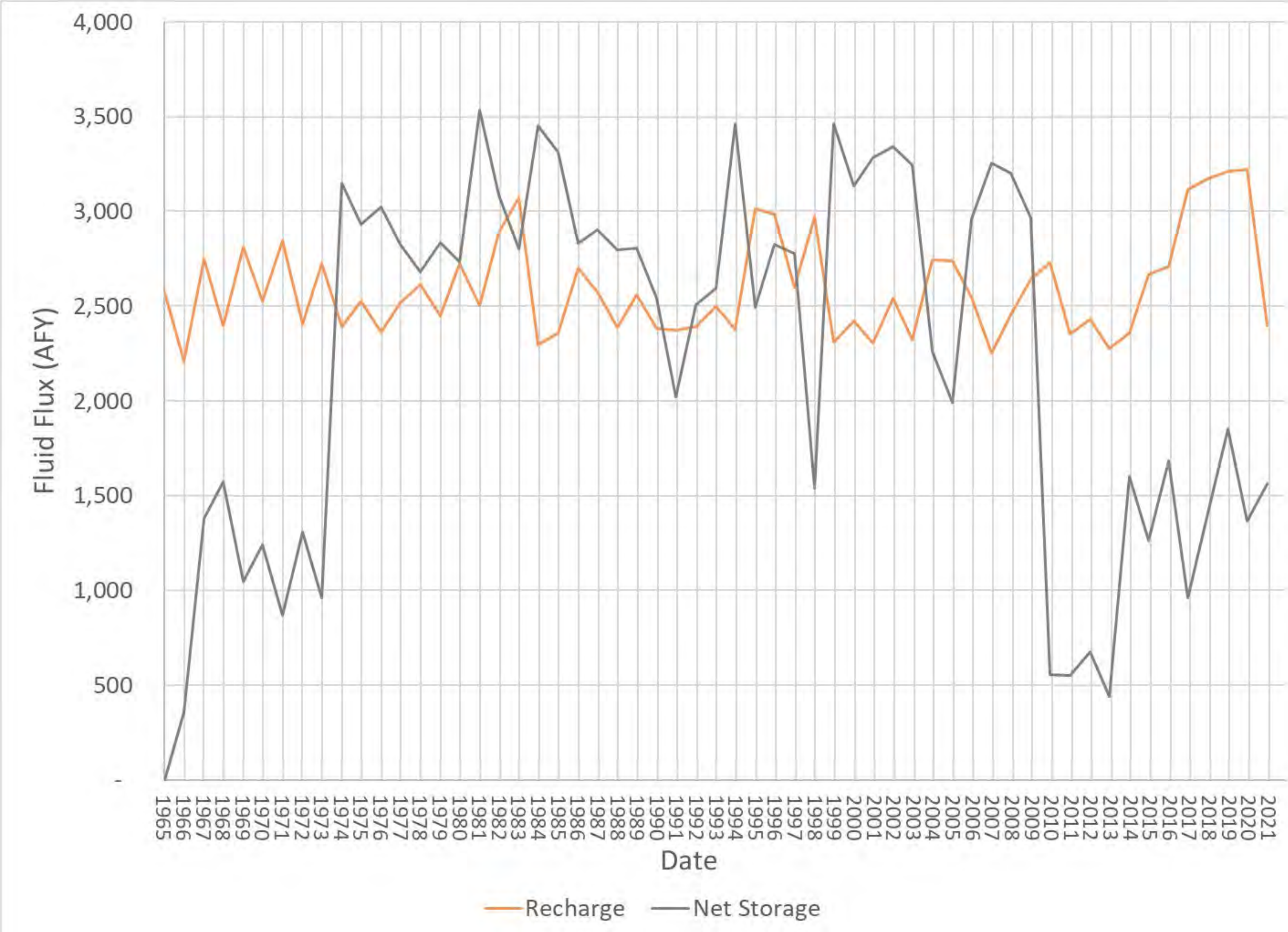

Figure 112. Recharge and net storage into the transient historical model.

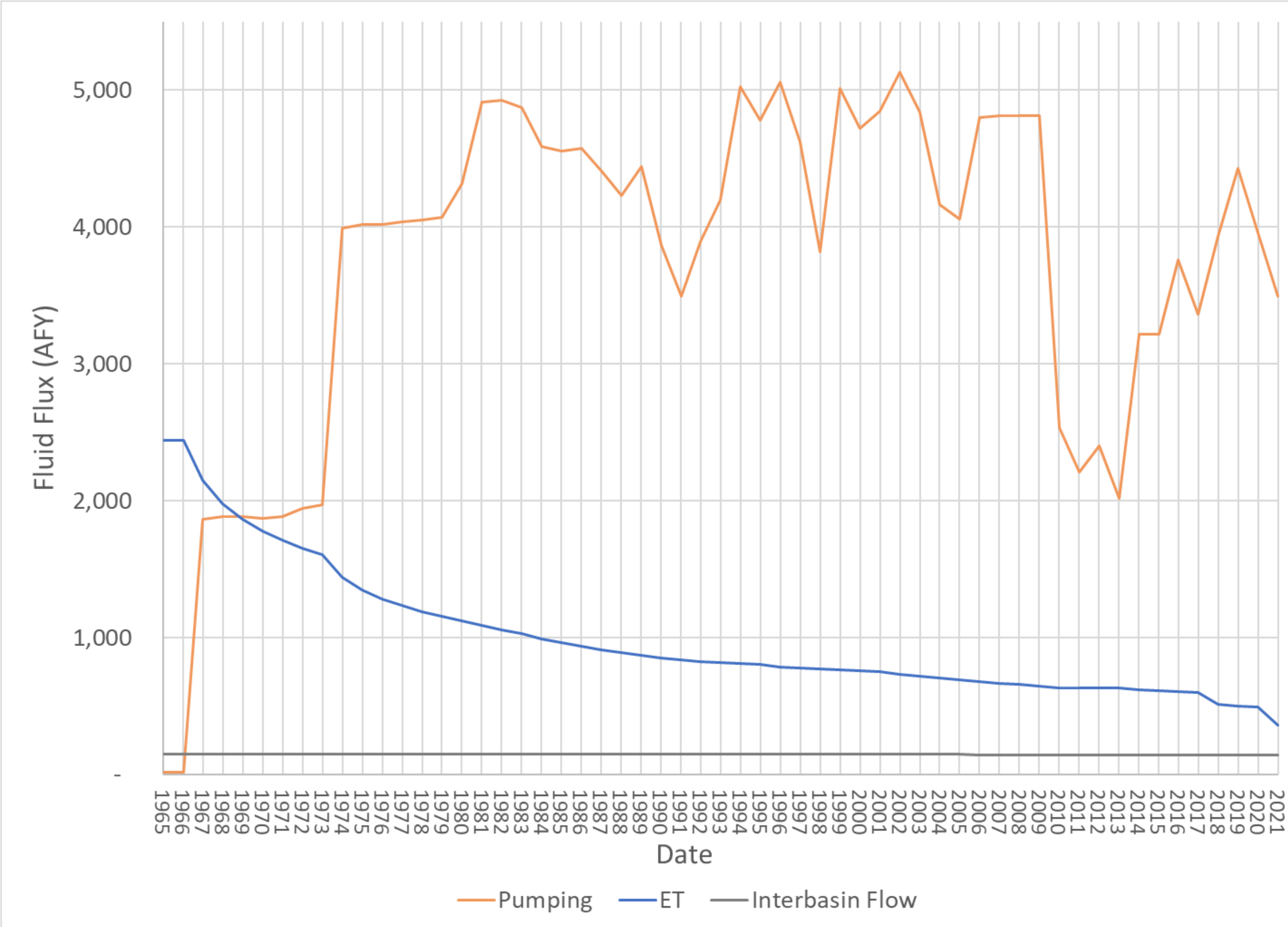

Figure 113. Pumping, evapotranspiration (ET), and interbasin flow rates for the transient historical model.

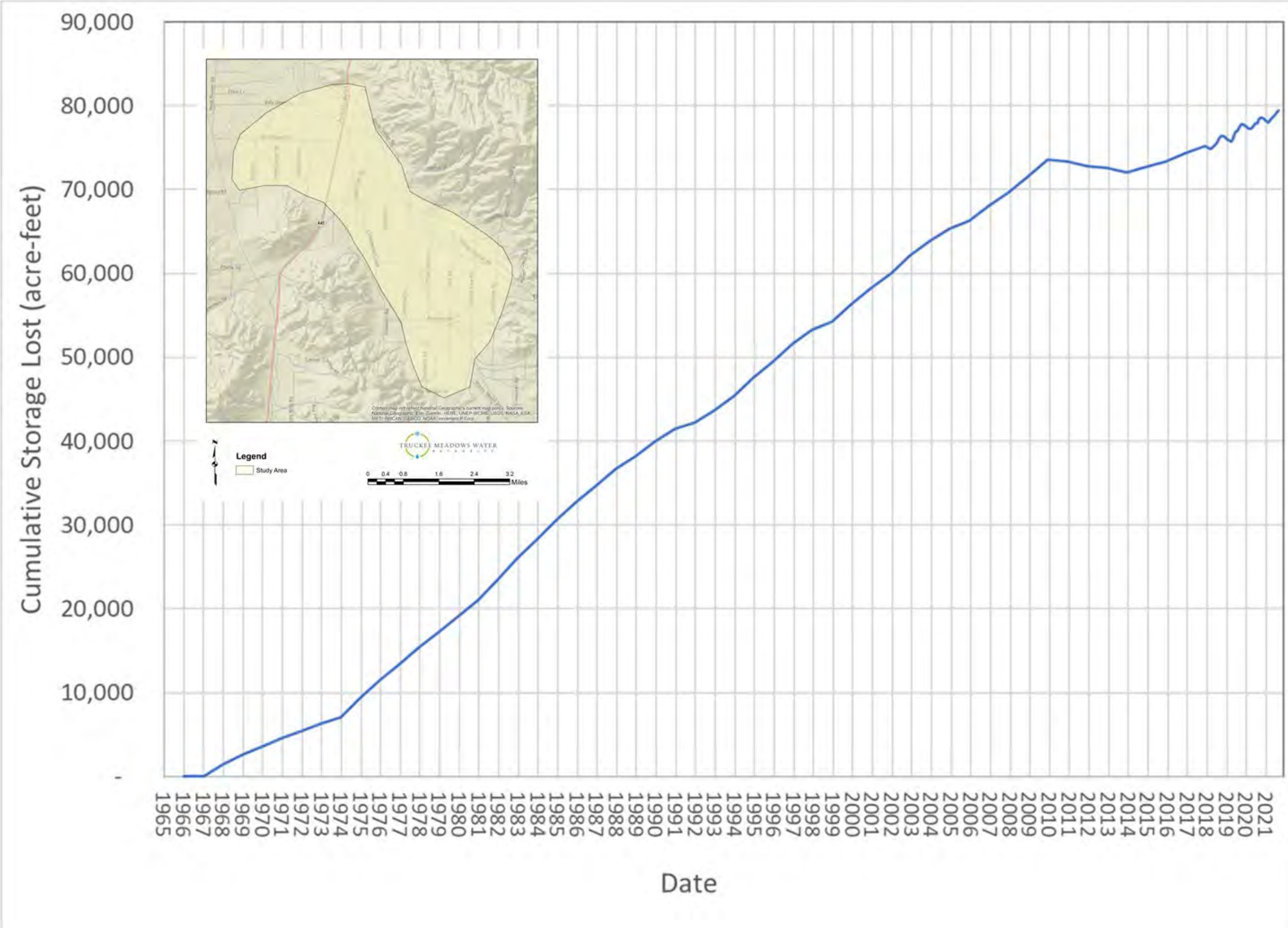

Figure 114. Cumulative storage lost from the study area (see inset figure for study area location).

Figure 115. Simulated drawdown between 1965 - 2021.

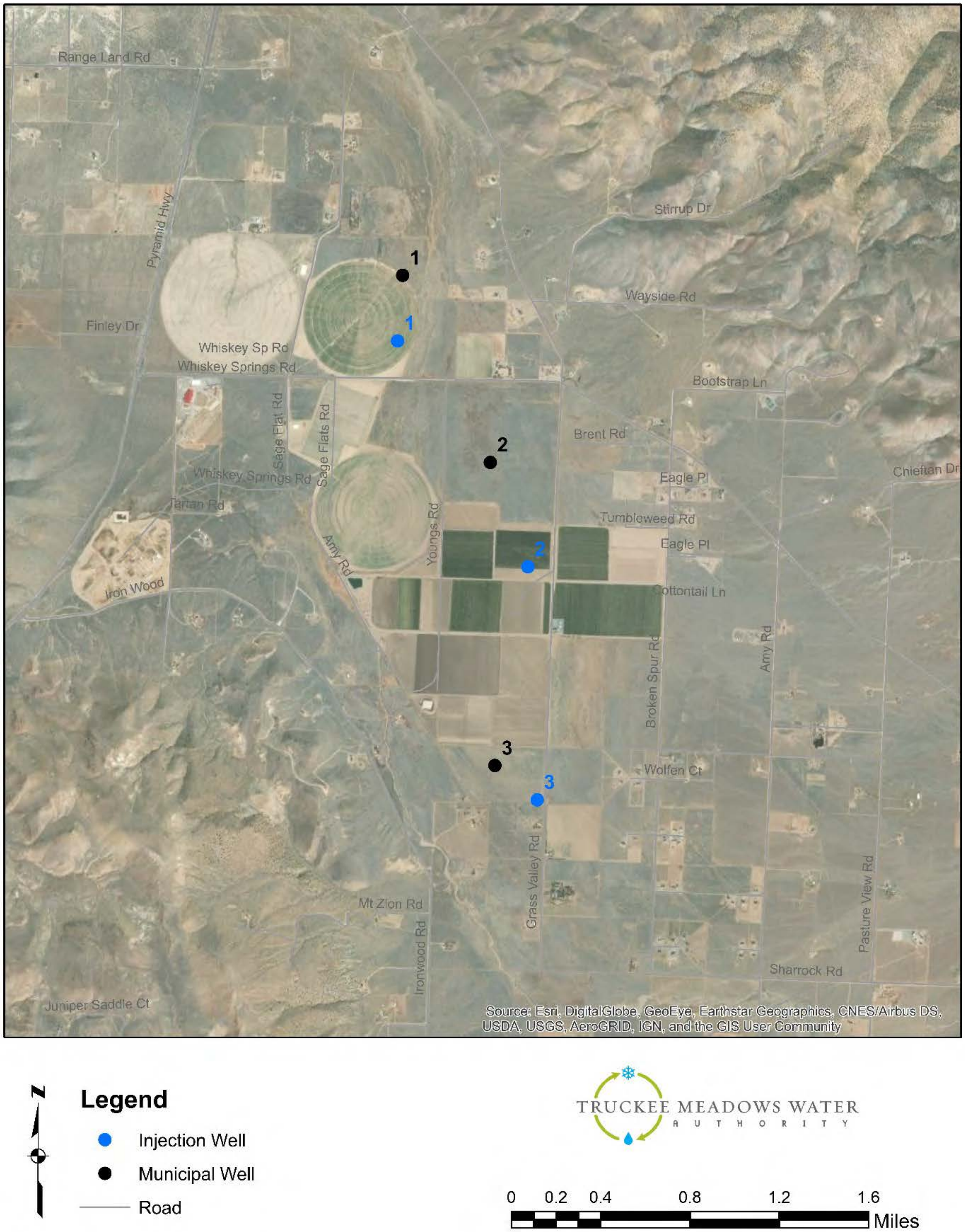

Figure 116. Injection and municipal wells used for predictive simulation scenarios.

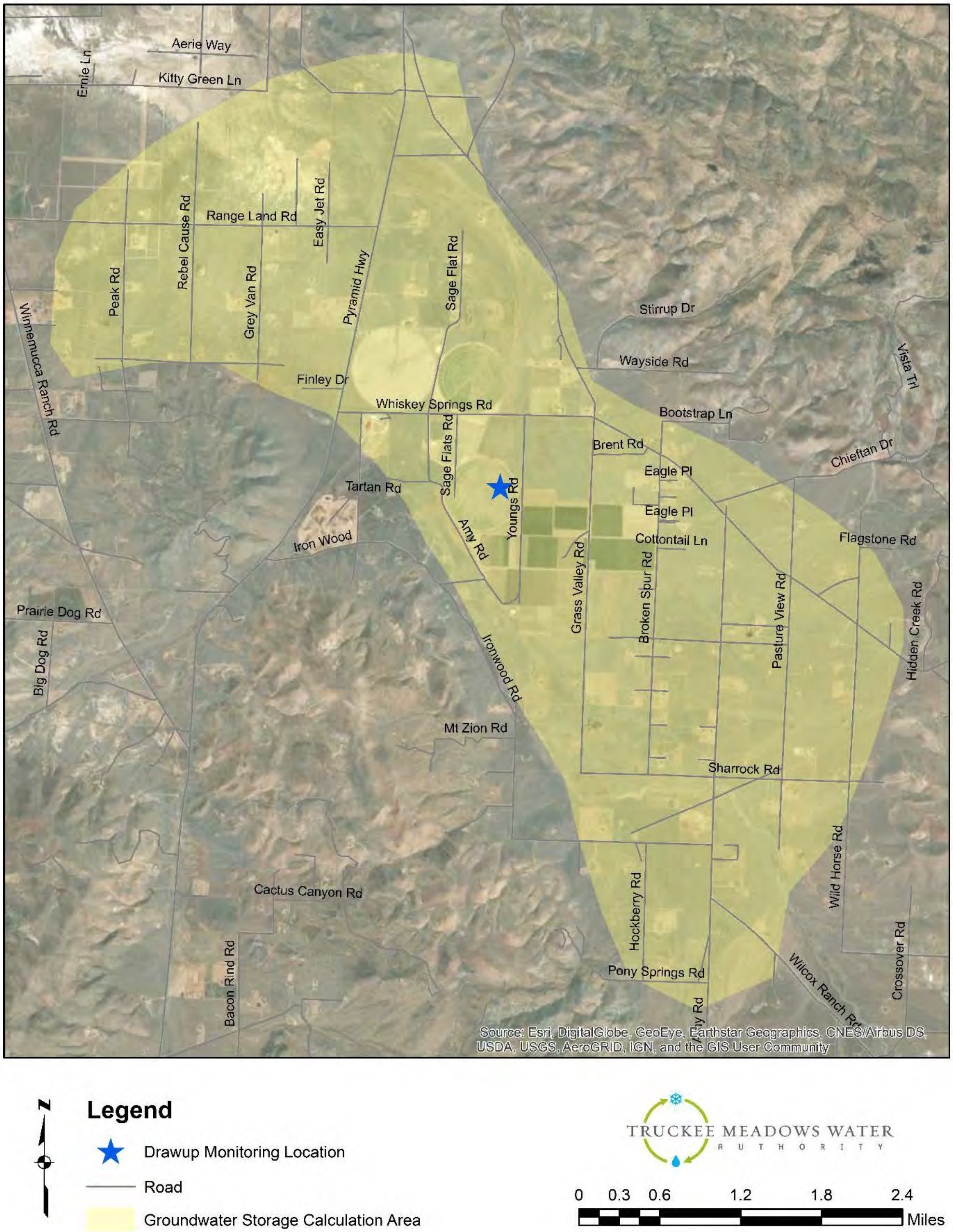

Figure 117. Area where cumulative groundwater storage and drawup is calculated for the four predictive scenarios.

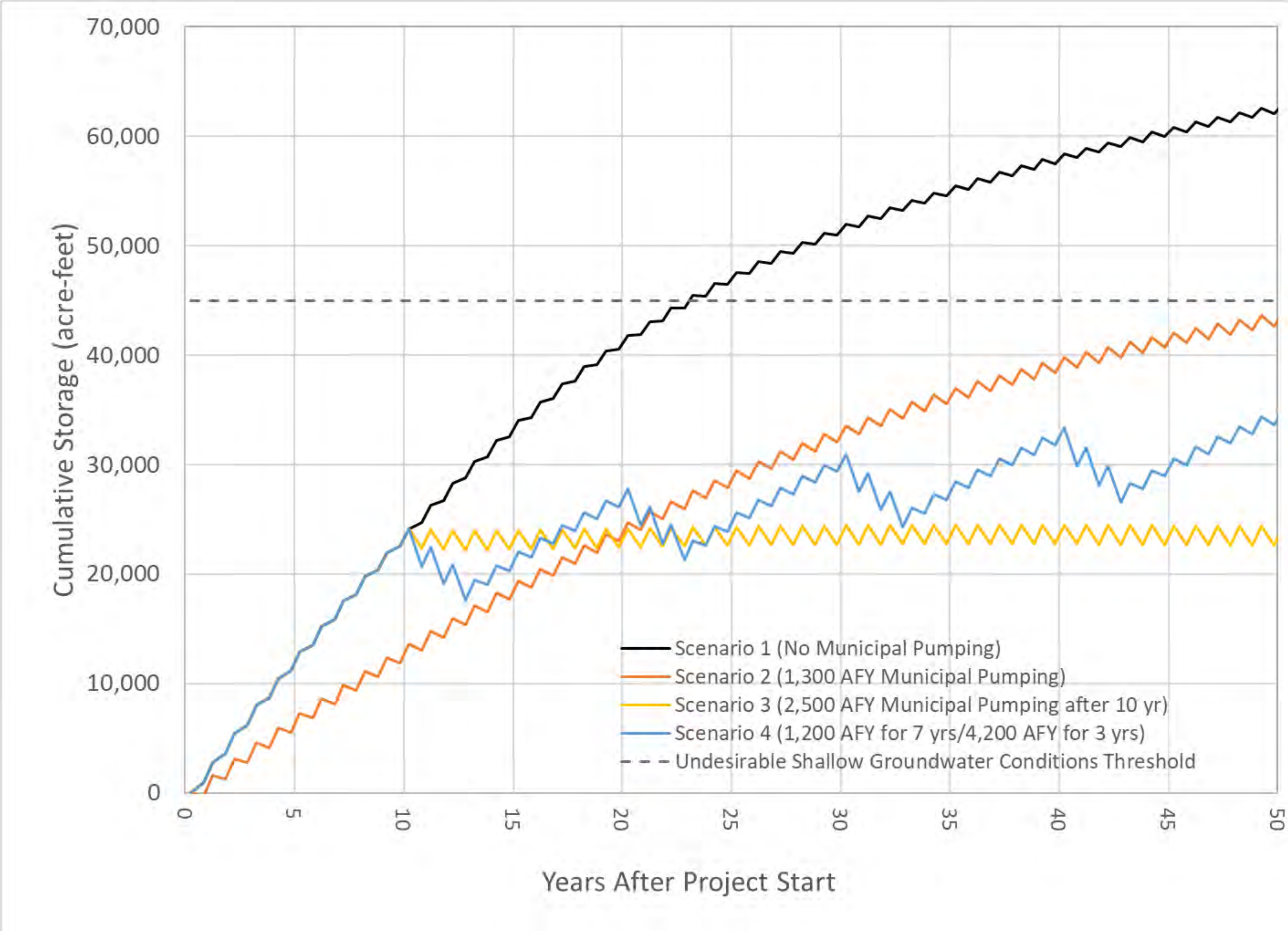

Figure 118. Predicted cumulative storage versus time for the four model scenarios.

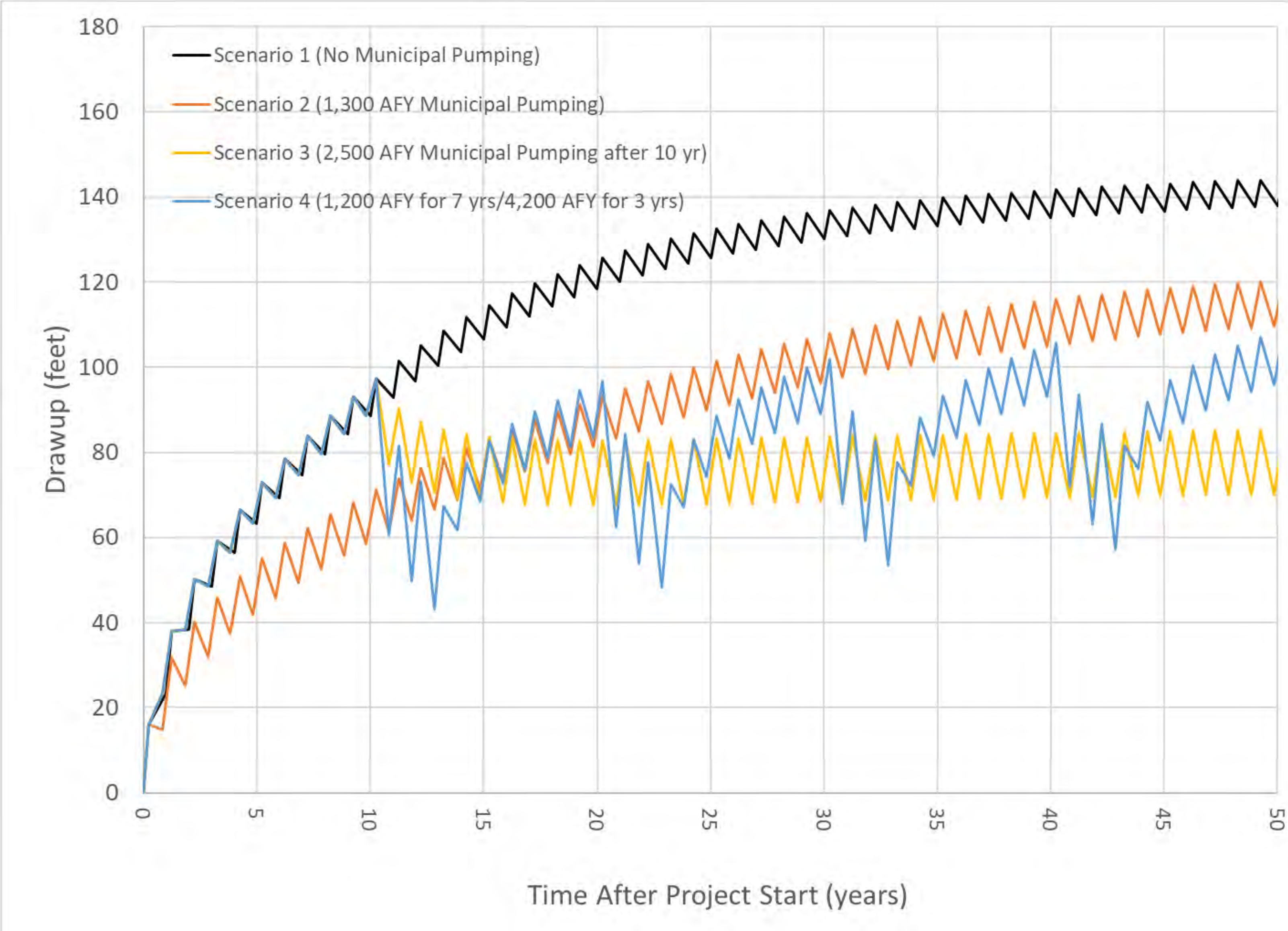

Figure 119. Predicted drawup in the center of the project area versus time for the four model scenarios.

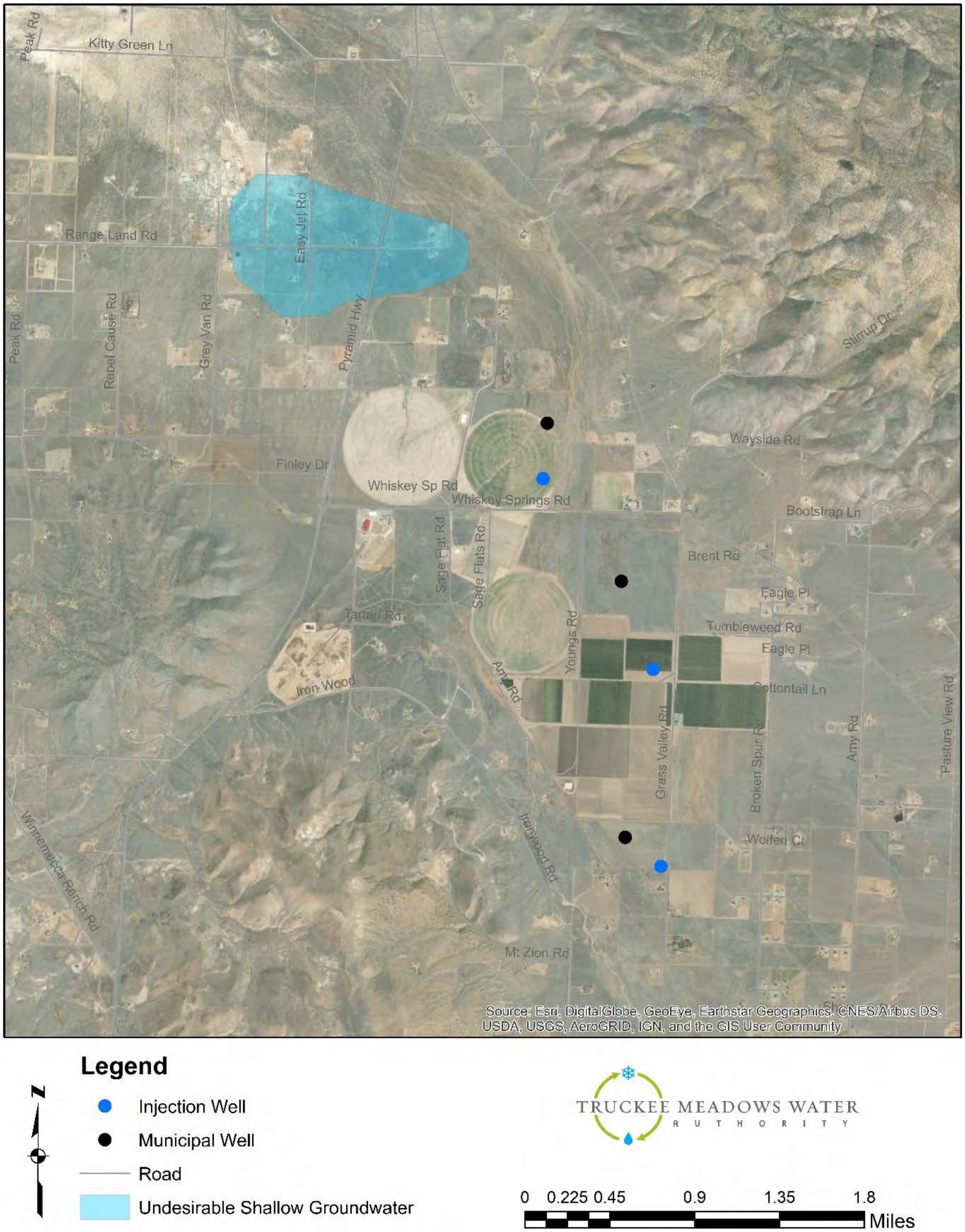

Figure 120. Location of undesirable shallow groundwater conditions simulated in Scenario 1 in 2072.

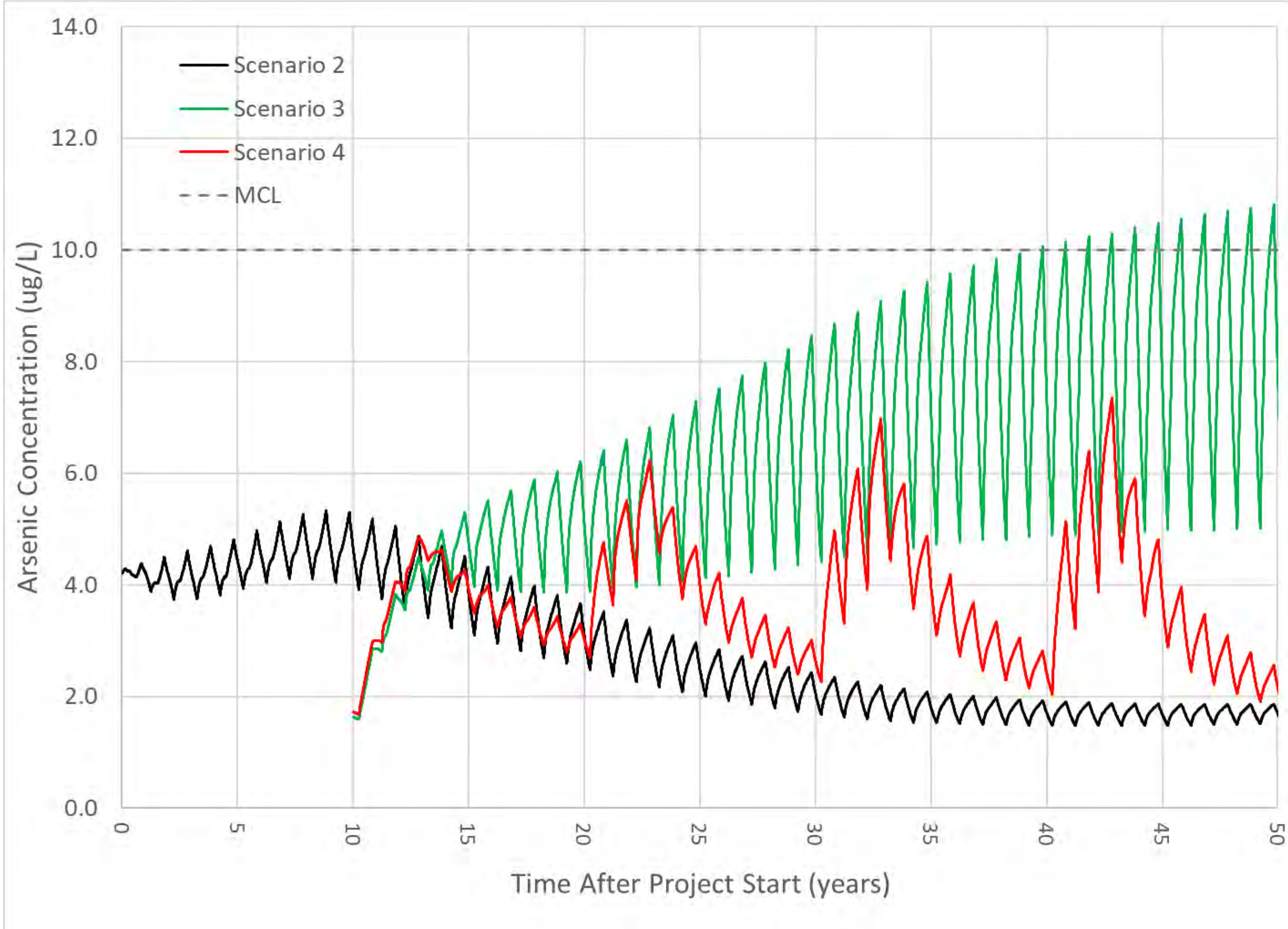

Figure 121. Simulated average arsenic concentrations for Scenarios 2 - 4.

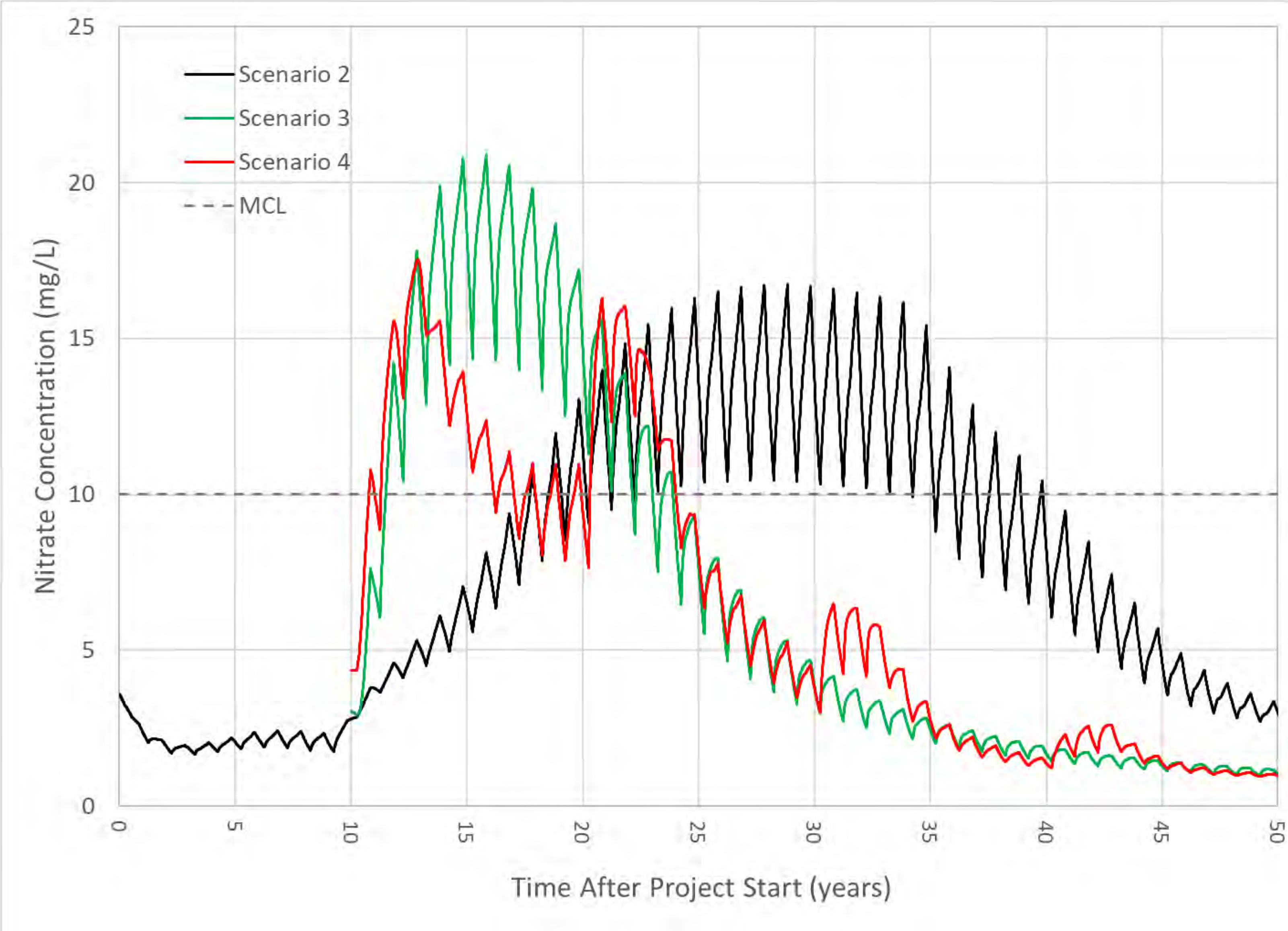

Figure 122. Simulated average nitrate concentrations for Scenarios 2 - 4.

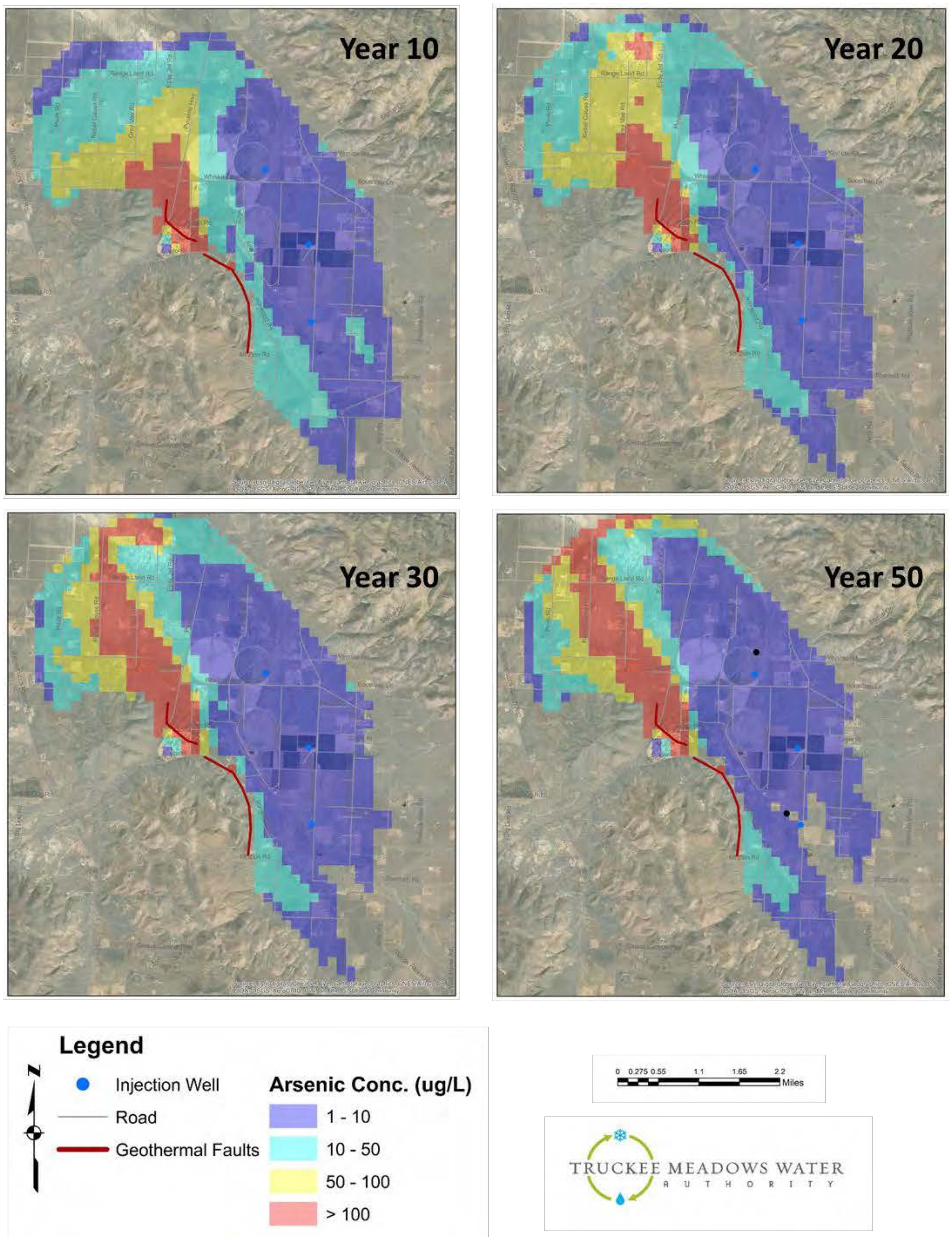

Figure 123. Simulated arsenic concentrations in layer 1 for Scenario 1.

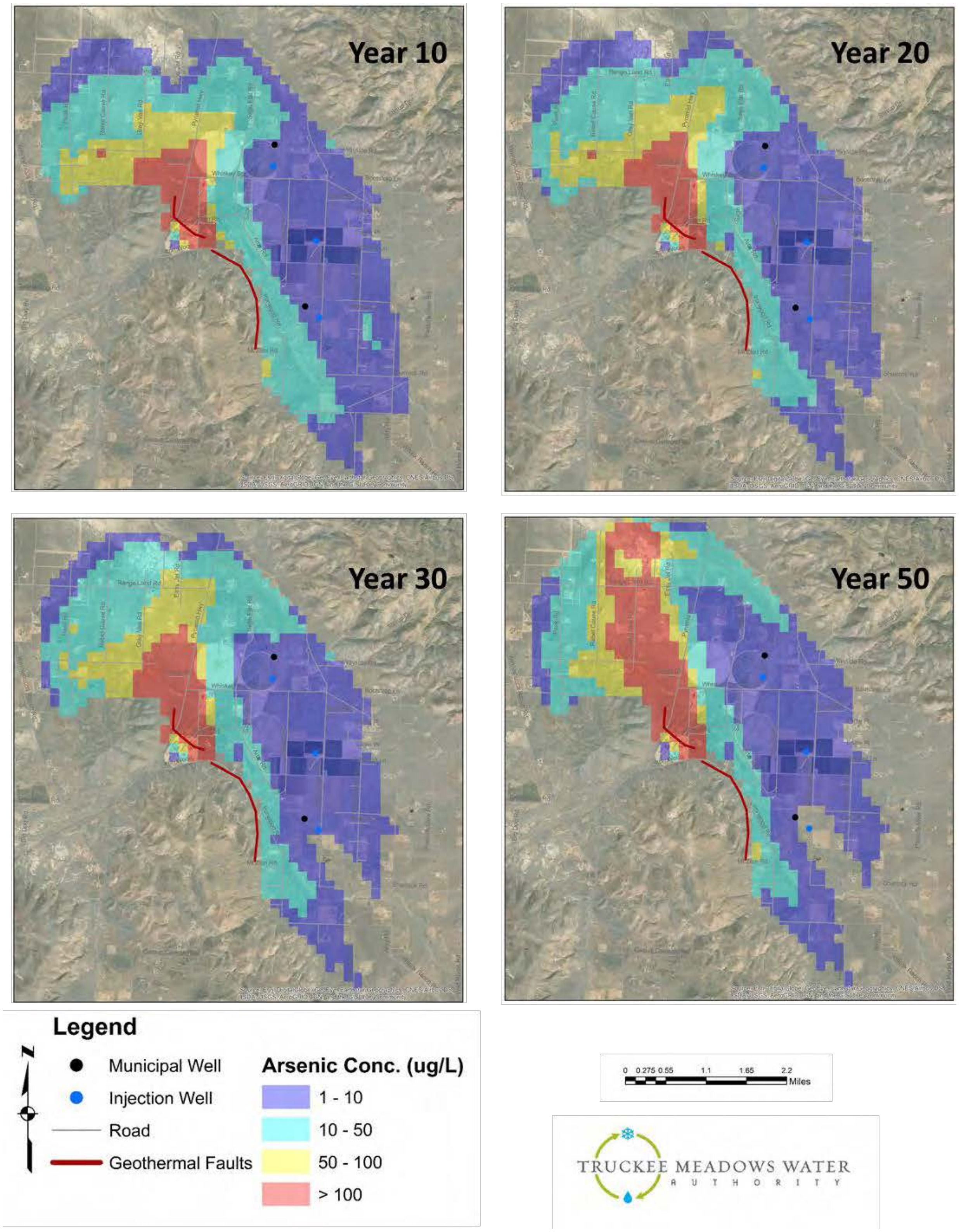

Figure 124. Simulated arsenic concentrations in layer 1 for Scenario 2.

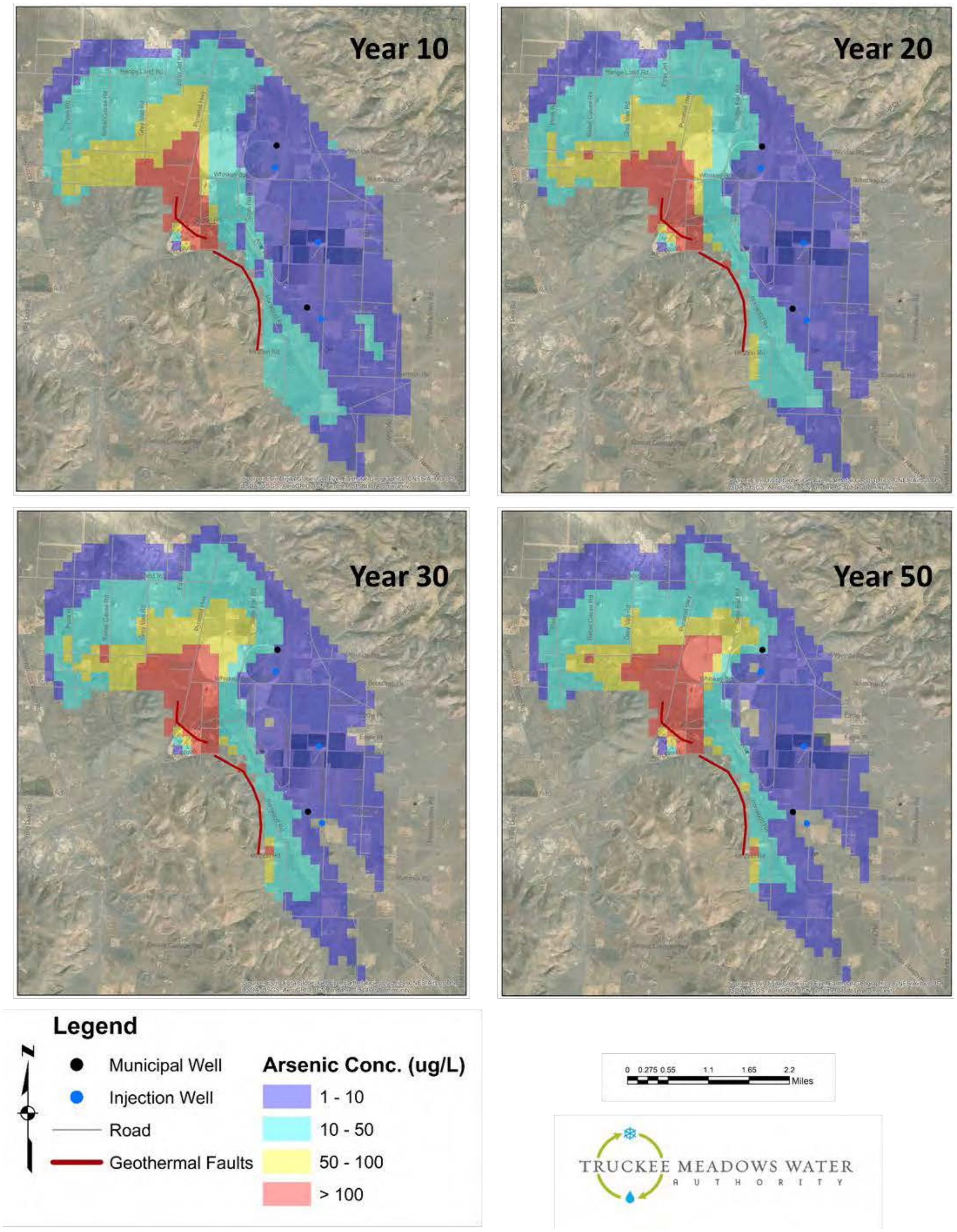

Figure 125. Simulated arsenic concentrations in layer 1 for Scenario 3.

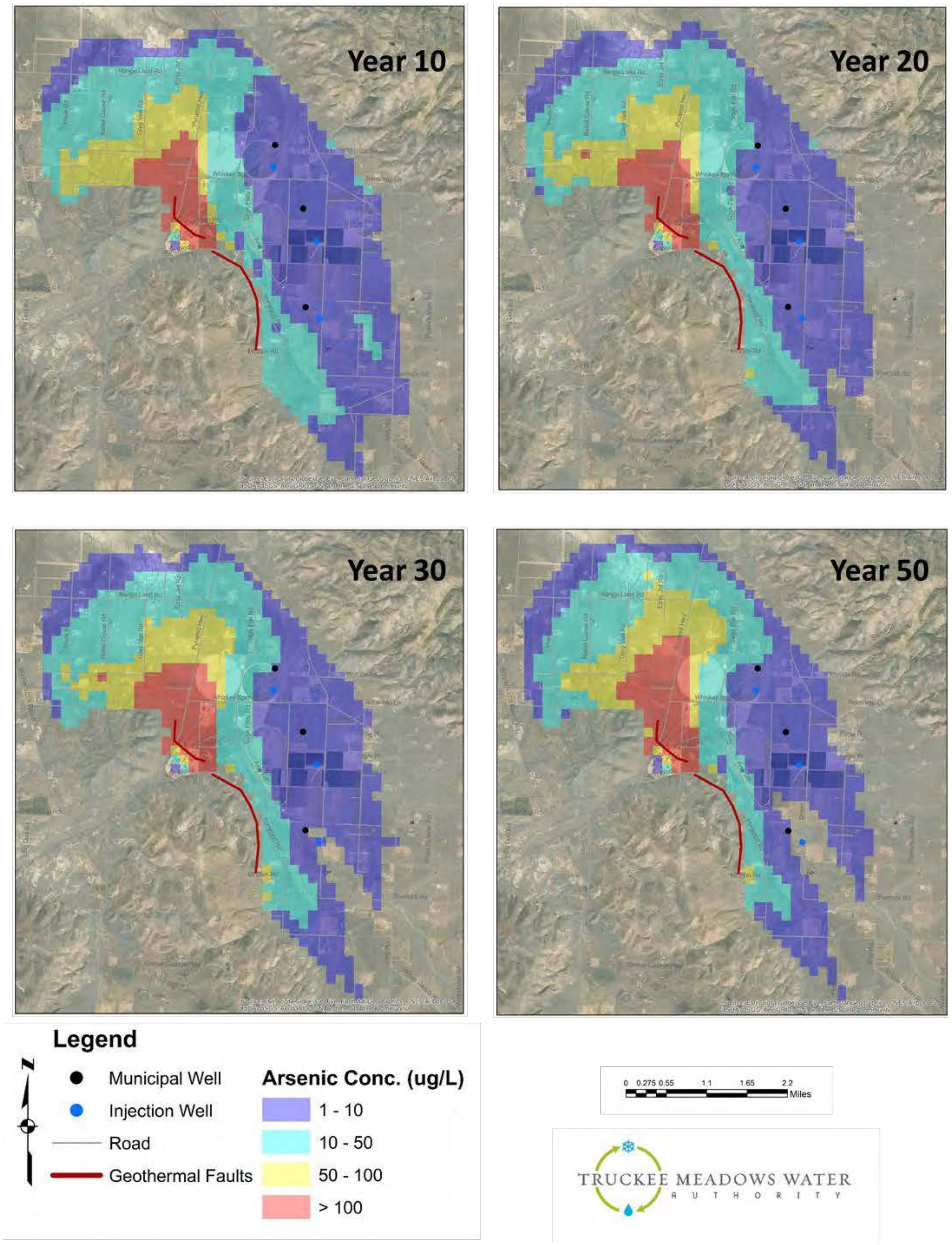

Figure 126. Simulated arsenic concentrations in layer 1 for Scenario 4.

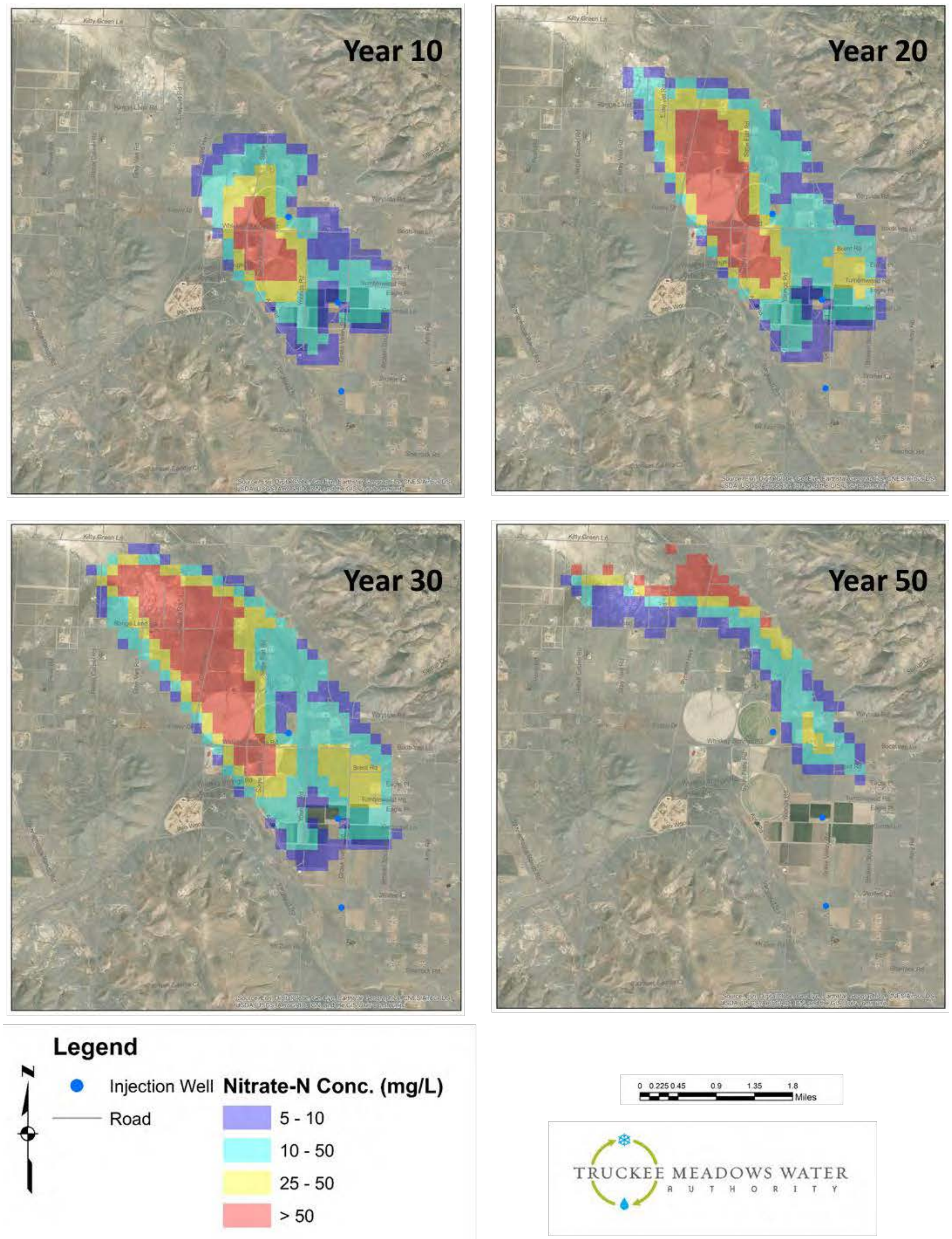

Figure 127. Simulated nitrate concentrations in layer 1 for Scenario 1.

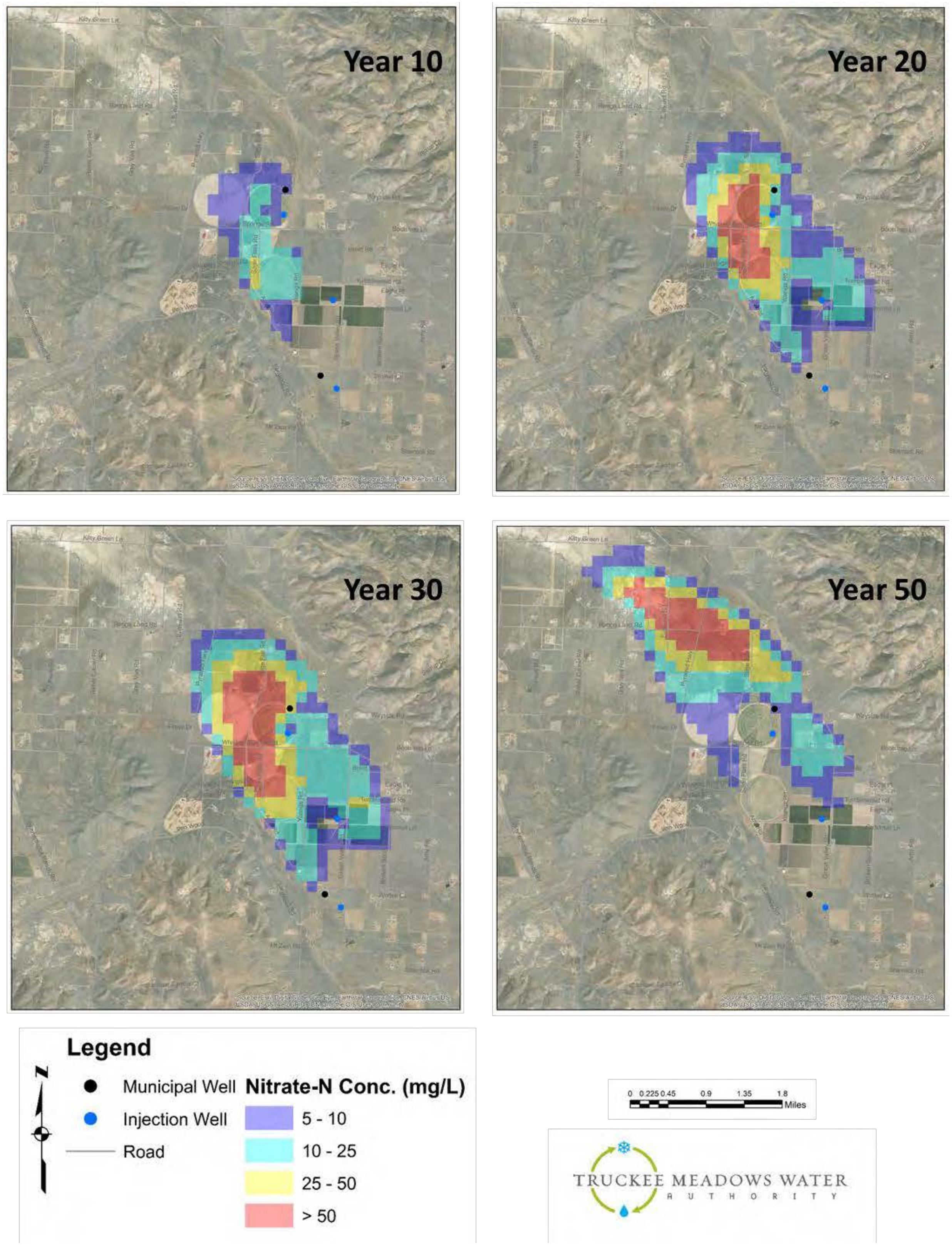

Figure 128. Simulated nitrate concentrations in layer 1 for Scenario 2.

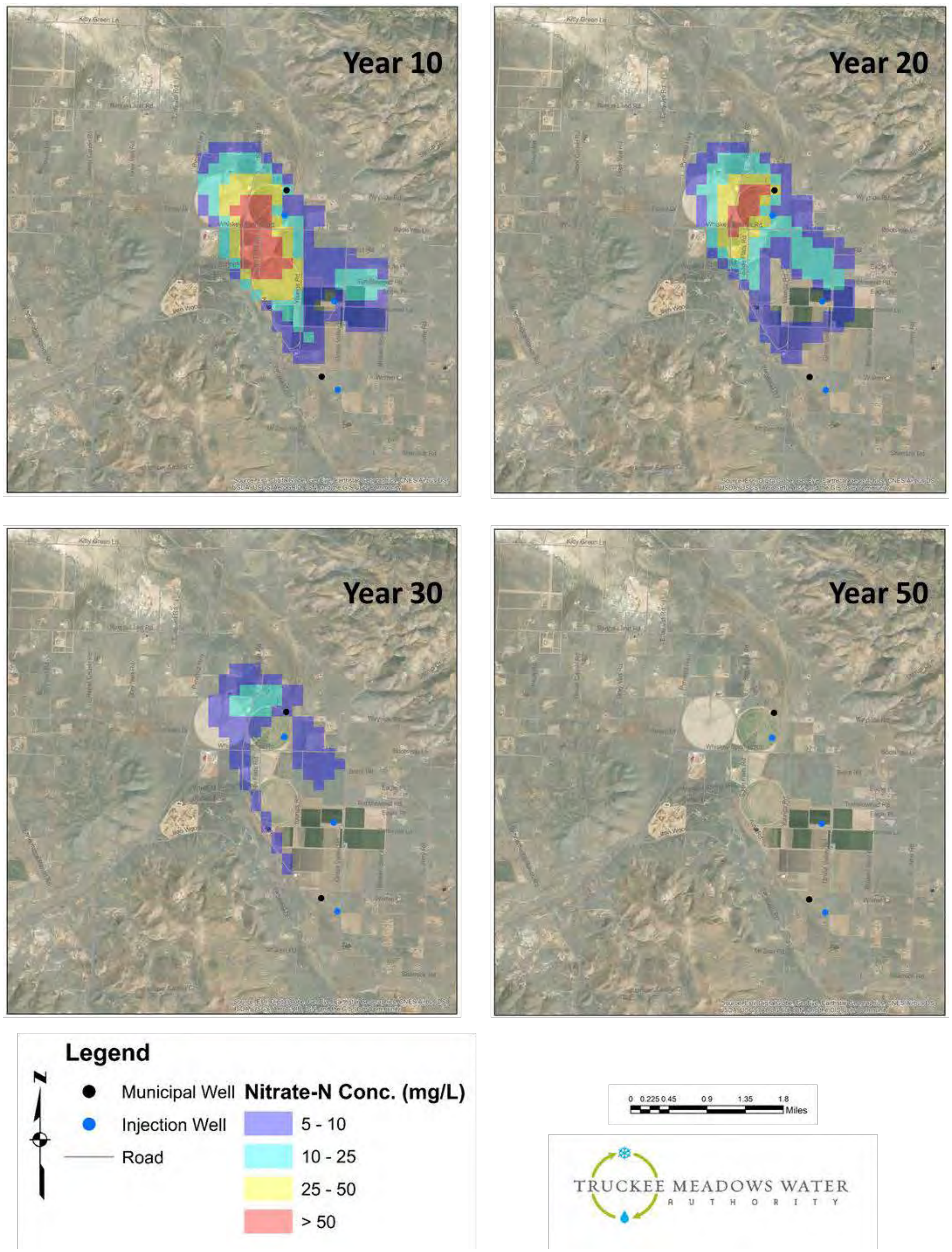

Figure 129. Simulated nitrate concentrations in layer 1 for Scenario 3.

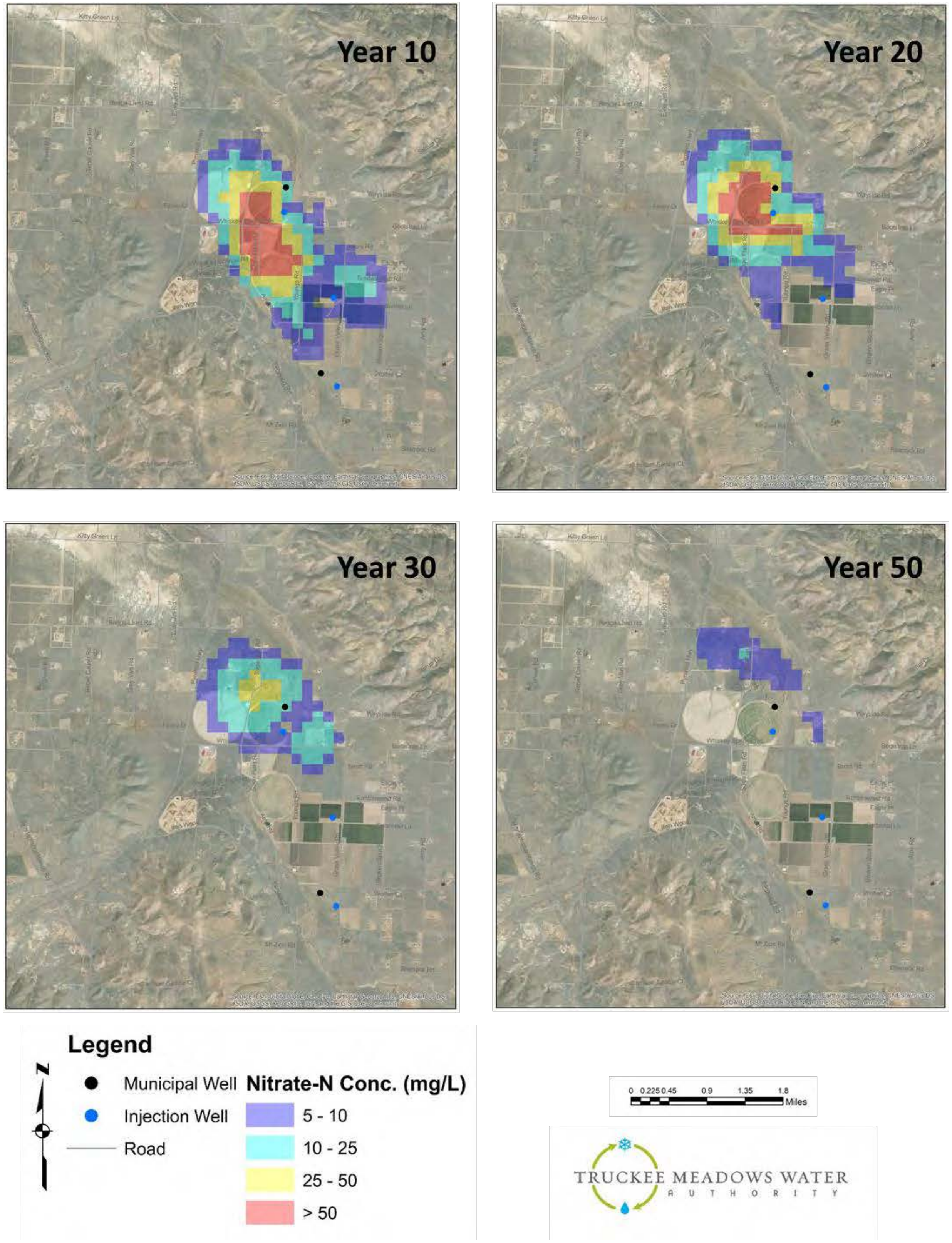

Figure 130. Simulated nitrate concentrations in layer 1 for Scenario 4.

Tables

Table 1. Irrigation volume, volumetric NIWR, and the ratio of irrigation volume to NIWR for each Pratt field.

Year	NIWR (ft)	Well #1 Vol (AF)	Field 10 NIWR (AF)	Field 10 % NIWR	Well #2 Vol (AF)	Field 20 NIWR (AF)	Field 20 % NIWR	Well #3 Vol (AF)	Field 40 NIWR (AF)	Field 50 NIWR (AF)	% NIWR (40&50)	Total Vol (AF)	Total NIWR (AF)	% NIWR (AF)
2017	2.8	593	547	108%	424	367	115%	290	No Crop	380	76%	1,307	1,294	1.01
2018	4.2	637	828	77%	416	556	75%	713	36	575	117%	1,766	1,996	0.88
2019	3.8	773	749	103%	459	503	91%	765	48	520	135%	1,997	1,821	1.10
2020	4.9	172	482	36%	459	647	71%	700	17	669	102%	1,331	1,815	0.73
2021	4.3	417	851	49%	335	572	59%	668	23	591	109%	1,420	2,037	0.70

Table 2. List of herbicides and pesticides sampled.

Chemical	Units	MRL	Chemical	Units	MRL
2,4,5-T	ug/L	0.2	Di-n-Butylphthalate	ug/L	1
2,4,5-TP (Silvex)	ug/L	0.2	Dinoseb	ug/L	0.2
2,4-D	ug/L	0.1	Diquat	ug/L	0.4
2,4-DB	ug/L	2	Diuron	ug/L	0.01
2,4-Dinitrotoluene	ug/L	0.1	Endothall	ug/L	5
3,5-Dichlorobenzoic acid	ug/L	0.5	Endrin	ug/L	0.01
3-Hydroxycarbofuran	ug/L	0.5	Endrin	ug/L	0.1
Acenaphthylene	ug/L	0.1	Ethylene Dibromide (EDB)	ug/L	0.01
Acifluorfen	ug/L	0.2	Fluoranthene	ug/L	0.1
Alachlor	ug/L	0.05	Fluorene	ug/L	0.05
Alachlor (Alanex)	ug/L	0.1	gamma-Chlordane	ug/L	0.05
Aldicarb (Temik)	ug/L	0.5	Glyphosate	ug/L	6
Aldicarb sulfone	ug/L	0.5	Heptachlor	ug/L	0.01
Aldicarb sulfoxide	ug/L	0.5	Heptachlor	ug/L	0.04
Aldrin	ug/L	0.01	Heptachlor Epoxide	ug/L	0.01
alpha-Chlordane	ug/L	0.05	Heptachlor Epoxide	ug/L	0.05
Anthracene	ug/L	0.02	Hexachlorobenzene	ug/L	0.05
Atrazine	ug/L	0.05	Hexachlorocyclopentadiene	ug/L	0.05
Baygon	ug/L	0.5	Hexazinone	ug/L	0.01
Bentazon	ug/L	0.5	Indeno(1,2,3,c,d)Pyrene	ug/L	0.05
Benz(a)Anthracene	ug/L	0.05	Isophorone	ug/L	0.5
Benzo(a)pyrene	ug/L	0.02	Lindane	ug/L	0.04
Benzo(b)Fluoranthene	ug/L	0.02	Lindane (gamma-BHC)	ug/L	0.01
Benzo(g,h,i)Perylene	ug/L	0.05	Methiocarb	ug/L	0.5
Benzo(k)Fluoranthene	ug/L	0.02	Methomyl	ug/L	0.5
Bromacil	ug/L	0.1	Methoxychlor	ug/L	0.05
Butachlor	ug/L	0.05	Methoxychlor	ug/L	0.1
Butylbenzylphthalate	ug/L	0.5	Metolachlor	ug/L	0.05
Carbaryl	ug/L	0.5	Metribuzin	ug/L	0.05
Carbofuran (Furadan)	ug/L	0.5	Molinate	ug/L	0.1
Chlordane	ug/L	0.1	Oxamyl (Vydate)	ug/L	0.5
Chlorpyrifos	ug/L	0.01	Paraquat	ug/L	2
Chrysene	ug/L	0.02	PCB (1016)	ug/L	0.08
Dalapon	ug/L	1	PCB (1221)	ug/L	0.1
DCPA Total	ug/L	0.1	PCB (1232)	ug/L	0.1
DCPMU	ug/L	0.01	PCB (1242)	ug/L	0.1
Di-(2-Ethylhexyl)adipate	ug/L	0.6	PCB (1248)	ug/L	0.1
Di(2-Ethylhexyl)phthalate	ug/L	0.6	PCB (1254)	ug/L	0.1
Diazinon	ug/L	0.1	PCB (1260)	ug/L	0.1
Dibenz(a,h)Anthracene	ug/L	0.05	Pentachlorophenol	ug/L	0.04
Dibromochloropropane (DBCP)	ug/L	0.01	Phenanthrene	ug/L	0.04
Dicamba	ug/L	0.1	Picloram	ug/L	0.1
Dichlorprop	ug/L	0.5	Propachlor	ug/L	0.05
Dieldrin	ug/L	0.01	Pyrene	ug/L	0.05
Dieldrin	ug/L	0.2	Simazine	ug/L	0.05
Diethylphthalate	ug/L	0.5	Thiobencarb (ELAP)	ug/L	0.2
Dimethoate	ug/L	0.1	Toxaphene	ug/L	0.5
Dimethylphthalate	ug/L	0.5	trans-Nonachlor	ug/L	0.05

Table 3. Summary of recharge estimates for Warm Springs Valley.

Study	Recharge (AFY)	Methodology
Glenn, 1968	4,000	Modified Maxey and Eakin, 1949
Rush and Glancy, 1967	6,000	Maxey and Eakin, 1949
Rush and Glancy, 1967	1,700	ET and interbasin-flow discharge estimates
Epstein et al., 2004	4,400	Modified Maxey and Eakin, 1949
Epstein et al., 2004	9,500	Bootstrap Brute-Force Method
Sharp, Krater Associates	4,400 - 4,900	Discharge estimates
Katzer, 1997	4,500	ET and spring discharge estimates
Ross, 1997	2,300	Chloride mass balance
This study	2,900	ET calculated based on Nichols, 1994 depth to water curve within discharge zone defined by Katzer, 1997 and interbasin flow estimates
This study, best estimate	2,600	Interpreted from discharge estimates and chloride mass balance

Table 4. USCS and USCS soil classifications for MW-03.

Depth (ft)	USCS Texture	USDA Texture
5	ML	Silt Loam
10	ML	Silt Loam
15	ML	Silt Loam
20	SM	Loamy sand
25	SM	Loamy sand
30	SM	Loamy sand
35	SP	Sand
40	SM	Loamy sand
50	SP	Sand
60	SW	Sand
70	ML	Silt Loam
80	SM	Loamy sand
90	ML	Silt Loam
100	SM	Loamy sand
120	ML	Silt Loam
140	CL	Clay loam
160	CL	Clay loam
180	CL	Clay loam
190	ML	Silt Loam
200	SM	Loamy sand
245	SM	Loamy sand
260	SM	Loamy sand

Table 5. USCS and USCS soil classifications for MW-08.

Depth (ft)	USCS Texture	USDA Texture
5	SM	Loamy sand
10	ML	Silt Loam
15	SM	Loamy sand
20	SM	Loamy sand
25	SM	Loamy sand
30	SM	Loamy sand
35	SM	Loamy sand
40	SM	Loamy sand
50	SM	Loamy sand
60	SM	Loamy sand
70	SM	Loamy sand
80	SM	Loamy sand
90	SM	Loamy sand
100	ML	Silt Loam
120	SM	Loamy sand
140	SM	Loamy sand
160	ML	Loamy sand
180	SM	Loamy sand
190	SM	Loamy sand
200	SM	Loamy sand
230	SM	Loamy sand
280	SM	Loamy sand

Table 6. Vadose zone hydraulic parameters for each USDA soil class.

USDA Texture	Θ_r (-)	Θ_s (-)	α (ft^{-1})	n (-)	K_s (ft/day)
Sand	0.05	0.43	4.42	2.68	14.5
Loamy sand	0.06	0.41	3.78	2.28	12.4
Silt loam	0.07	0.45	0.61	1.41	2.0
Clay loam	0.10	0.41	0.58	1.31	1.9

Table 7. Magnitude and timing of nitrate mass loading for the four model scenarios. Start and end years represent time after project start in years.

Scenario	Mobilized NO_3-N Mass (pounds)	Mobilization Year Start	Mobilization Year End
1	4,900,000	5	29
2	3,300,000	10	34
3	1,800,000	5	14
4	1,800,000	5	14

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Date: February 15, 2022

To: **John Enloe**

Through: **Scott Estes**

From: **David Kershaw**

Subject: **Warm Springs Valley Effluent Irrigation Supply Modeling Summary Memo**

Overview

A preliminary high level hydraulic modeling evaluation was performed to help identify recycled treated wastewater (effluent) distribution system improvements required to supply effluent from the current northern terminus of the Sparks effluent reuse system to the Warm Springs Valley area. This evaluation included development of estimated planning flows to satisfy irrigation demands at the existing Palomino Valley Farm and LW (Murphy) Farms. Potential demands from the Western Turf Farm are also included. This specific effort was limited to satisfying irrigation demands during the peak irrigation season. The effort did not include addressing the potential effluent demands associated with possible advanced purified water treatment to A+ quality and aquifer injection/storage. It should be noted that there would be the potential to use excess supply capacity for advanced treatment and injection during non-peak irrigation periods.

Background & Irrigation Demand Estimates

As part of the feasibility study for using effluent for irrigation in the Warm Springs Valley area, a hydraulic model was developed to help determine major water infrastructure required to supply effluent from the northern terminus of the Sparks effluent reuse system to the Warm Springs Valleys Area.

One of the first items that needed to be defined is the design flow for the proposed facility. Truckee Meadows Water Authority (TMWA) staff investigated the current groundwater irrigation usage in the Warm Springs Area. Specific usage information was provided for some of the wells and crops in the area. Table 1 contains a summary of groundwater usage and groundwater well capacities. Based on this information which included approximately three years of irrigation usage, and per discussions with operations staff out at the farms, the wells generally pump to irrigation ponds that are then used as the irrigation water source. During peak irrigation months, wells are generally in constant operation with a couple of exceptions to allow the ponds to be drawn down (cycled) and temporary termination of irrigation to allow some drying time of the crops just before harvest. Based on this information, it was decided that the minimum design flow for the effluent supply system should attempt to replace the identified groundwater supply capacity in the study area. Based on Table 1, the estimated design supply capacity for the proposed facility ranges from 4,900 to 5,900 gpm.

Table 1: Existing Irrigation Well Usage Summary

Description	Well Flow Capacity (gpm)	max Month Average Flow (gpm)	Existing Irrigated Acres	Average Annual Irrigation Demand (AFA)	Flow Capacity per Irrigated Acre
Pratt Well 1	1,000	967	193	637	5.2
Pratt Well 2	617	623	129	426	4.8
Pratt Well 3	1,039	1231	186	614	5.6
Murphy Well	1,250	892	220	705	6.8
Western Turf Well	1500/2000*	1451			
Total	5406/5906	5164	728	2382	

* 2,000 gpm design, declining water levels limit flows to 1,500 gpm, but would like 2,000 gpm.

The existing Sparks effluent reuse system consists of a primary booster pump station at Truckee Meadows Water Reclamation Facility (TMWRF) that supplies up to 16,000 gpm of effluent through a 30-inch diameter transmission main, north through Sparks, to a 3.2-million-gallon storage tank adjacent to the Golden Eagle Regional Park, and to effluent demands along the alignment. Effluent is also pumped from the northern end of the 30-inch main by the Kiley Booster Pump Station (BPS) to supply additional demands in northern Spanish Springs. See attached Figure 1 from the Sparks Effluent Reuse System Calibration Memo (July 2020). The Kiley BPS pumps into a 20-inch backbone main that ends at Sha-Neva Road in northern Spanish Springs. The area supplied by the Kiley BPS does not include storage and the pumps must constantly operate to maintain pressure. The calibrated model was used as the basis of the hydraulic model for this investigation, and it included existing pump curves for the facilities.

Hydraulic Modeling Results

The hydraulic model for supplying effluent from TMWRF to the Warm Springs area was developed using the Sparks Effluent System calibrated model and the proposed design supply capacity that ranged from 5,400 to 5,900 gpm. The following items summarizes some of the constraints used to develop the model:

- Maximum Pressure: 250 psi (based on available information, existing facilities pressure rating is estimated to exceed 250 psi with individual pressure reducing valves on services)
- Maximum Pipe Velocity: 8 fps
- Assumes termination into existing irrigation ponds to provide operational flexibility of the system

- Available TMWRF BPS capacity is 16,000 gpm (Unused capacity 16,000 gpm – 8,300 gpm = 7,600 gpm). Therefore, no new facilities required on the suction side of the Kiley BPS.

The initial strategy was to estimate the available flow capacity using as much of the existing effluent reuse system as reasonable and minimize the investment in new infrastructure. Therefore, the initial modeling scenarios consisted of using the existing Kiley BPS pumps, existing distribution piping and new infrastructure extending to the north to estimate the flow that could be conveyed to the Warm Springs area during maximum day irrigation demand periods. Based on topography, existing facilities and property ownership, the preferred alignment is adjacent to Pyramid Highway. The high point along Pyramid Highway requires the construction of a storage tank to allow for proper system operation by changing from a pumped system between Kiley BPS and the high point, and gravity flow from the proposed tank to the Warm Springs irrigation ponds. As shown in Figure 2, the proposed improvements include the following:

- Installation of approximately 1,800 feet of 16-inch main parallel to existing effluent reuse main near the Pyramid Hwy and La Posada intersection.
- Connection to the existing 20-inch effluent reuse main in Sha Neva Road
- Installation of approximately 22,900 feet of 18-inch/24-inch main from connection point to proposed tank
- Installation of proposed tank with an approximate pad elevation of 4,720 feet.
- Installation of approximately 34,800 feet of 16-inch/18-inch gravity flow main from tank north to Warm Springs Valley
- Installation of approximately 11,500 feet of 16-inch distribution mains in the vicinity of the Warm Springs irrigation ponds.

The following table summarizes the estimated flow capacity to Warm Springs given specific designs during maximum day demands in the existing effluent reuse system. The first two scenarios vary pipe sizes and propose to use the existing pumps in the Kiley BPS. Scenarios 3 and 4, assume replacement of the existing Kiley BPS pumps with higher capacity pumps and vary the pipe diameters.

Table 2: Effluent System Capacity to PV During Existing Max Month Irrigation Demands (1,159GPM)

Scenario	Description	NEW BPS	Parallel Main	SS to HP Tank Main Dia (inches)	BPS Discharge Pressure (PSI)	Available Flow Capacity to Warm Springs (gpm)
1	Use existing Kiley BPS, limit max pressure <250psi, Eff. Sys. Max Demands	No	1800' of 16"	18	238	4250
2	Use existing Kiley BPS, limit max pressure <250psi, Eff. Sys. Max Demands	No	1800' of 16"	24	222	5250

3	Replace BPS Pumps or New BPS, limit max pressure <250psi, Eff. Sys. Max Demands	YES	1800' of 16"	18	249	4500
4	Replace BPS Pumps or New BPS, limit max pressure <250psi, Eff. Sys. Max Demands	YES	1800' of 16"	24	244	5900

The proposed improvements for Scenario 2 are shown in Figure 2. Per Table 2, Scenarios 1 and 2 are proposed to have an estimated Warm Springs supply capacity of 4,250 and 5,250 gpm, respectively. The estimated supply capacities are a little less than the existing irrigation demands (5,400 to 5,900 gpm). Flexibility in operation, pond storage and some minor local groundwater usage will help to meet known irrigation demands.

Opinion of Probable Cost

Table 3: Scenario 1 Planning Costs

Scenario 1 - Use Existing Sparks Effluent Infrastructure (4,250 GPM MDD capacity, Velocity < 7 fps, irrigation)						
1	Pump Station Construction (Not Required)	1	L.S.		$ -	
2	Storage Tank - High Point on Pyramid (4720')	250,000	Gals	$2.00	$ 500,000	
3	16-inch System Parallel Mains	1,800	L.F.	$320	$ 576,000	
3	18-inch Transmission Main to High Point Tank	22,900	L.F.	$360	$ 8,244,000	
4	16-inch Transmission Main from Tank to Warm Springs Site	34,800	L.F.	$320	$ 11,136,000	
5	16-inch On-site Distribution Mains	11,500	L.F.	$320	$ 3,680,000	
					Subtotal	**$ 24,136,000**
6	Other Costs:					
					Subtotal	**$ -**
7	Contingency (30%)				$ 7,240,800	
					Total	**$ 31,376,800**

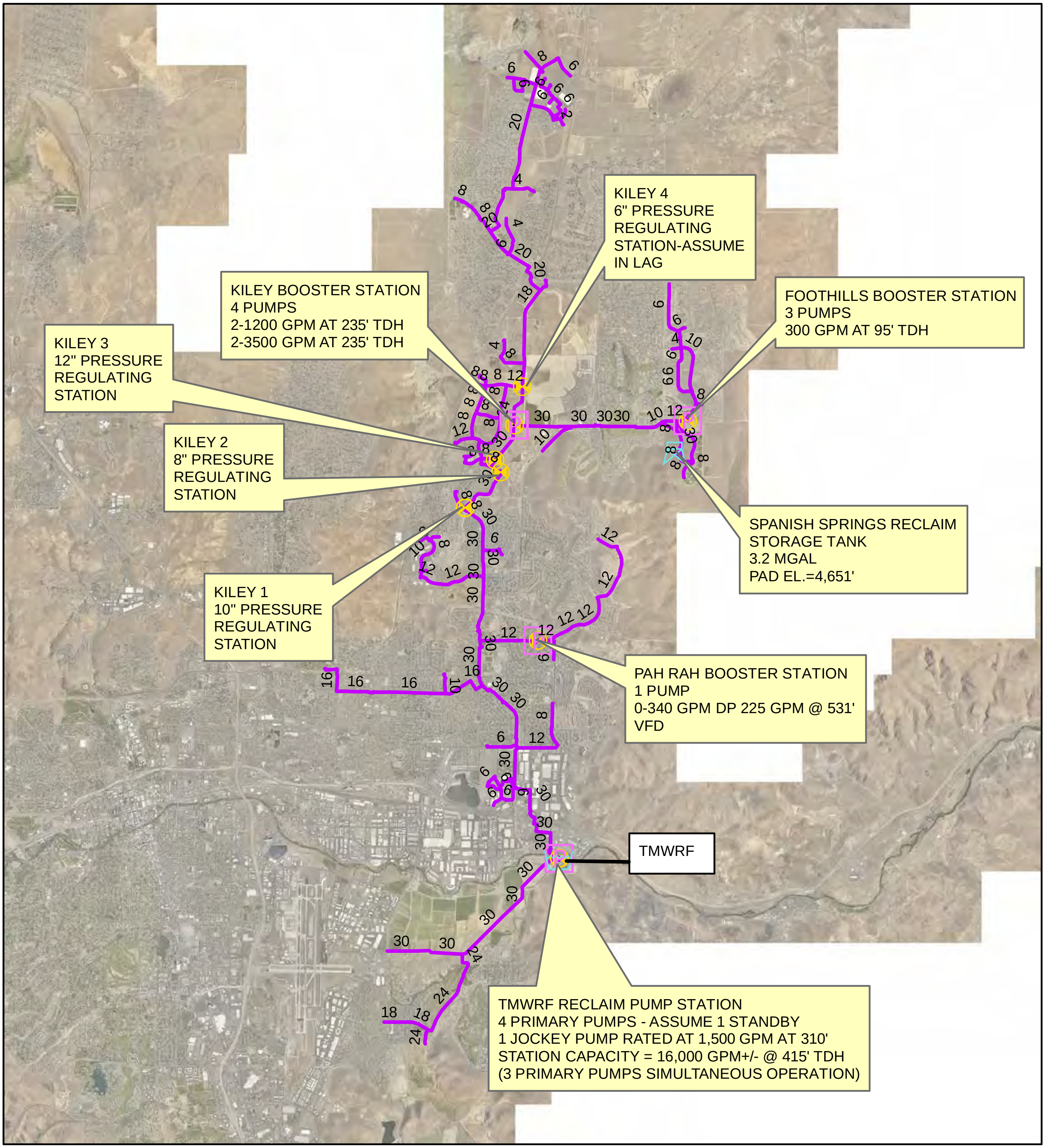
Table 4: Scenario 2 Planning Costs

Scenario 2 - Use Existing Sparks Effluent Infrastructure (5,250 GPM MDD capacity, Velocity < 8 fps, irrigation)						
1	Pump Station Construction (Not Required)	1	L.S.		$ -	
2	Storage Tank - High Point on Pyramid (4720')	250,000	Gals	$2.00	$ 500,000	
3	16-inch System Parallel Mains	1,800	L.F.	$320	$ 576,000	
3	24-inch Transmission Main to High Point Tank	22,900	L.F.	$480	$ 10,992,000	
4	18-inch Transmission Main from Tank to Warm Springs Site	34,800	L.F.	$360	$ 12,528,000	
5	16-inch On-site Distribution Mains	11,500	L.F.	$320	$ 3,680,000	
					Subtotal	**$ 28,276,000**
6	Other Costs:					
					Subtotal	**$ -**
7	Contingency (30%)				$ 8,482,800	
					Total	**$ 36,758,800**

<u>Recommendation & Additional Considerations.</u>

Given the marginal increase in cost and significant increase in future capacity, with and without new pumps, Scenario 2 is the recommended alternative that should be considered in the current feasibility study.

In the future, a more detailed operational evaluation should be performed to refine recommendations in this memo. The operational evaluation will refine the tank size. Increased tank sizing is likely since it would benefit the existing Sparks Kiley pressure zone to change if from a constant pump zone to a tank zone. Additional items that need to be addressed include confirmation and possibly testing of the existing effluent system to operate both existing large pumps with throttled flows at the northern end of the system to result in discharge pressures near 250 psi during non-irrigation season. This test will help confirm the hydraulic model results.



SB engineering

775-223-0922 scott@sbcivilengineering.com

586 CITADEL WAY
RENO, NV 89503

FIGURE 1: TMWRF RECLAIM PUMP AND STORAGE SYSTEM MAJOR FACILITES AND LOCATIONS

0 2,500 5,000 10,000 15,000 20,000 Feet

DATE: 7/5/20

MAP BY: SWB

WORK ORDER #: 20-0019

SCALE: 1 inch = 10,000 feet

N

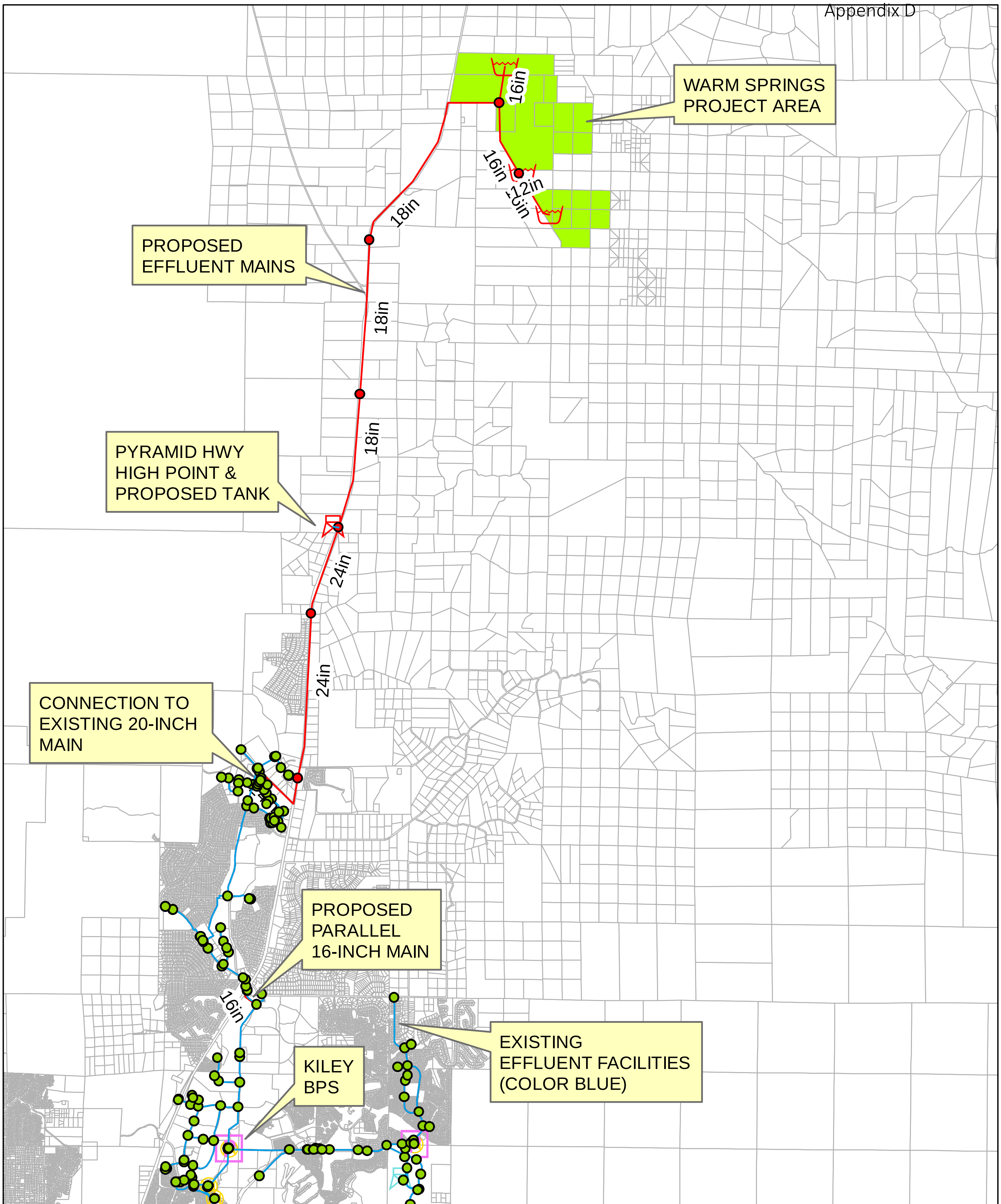


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FIGURE 2

EXISTING & PROPOSED EFFLUENT FACILITIES MAP

DATE	9/15/2021
MAP BY:	DSK
REQUESTED BY:	JE
SCALE:	1 inch = 9,000 feet

NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

Technical Memorandum

201 N. Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010
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Prepared for: City of Sparks

Project Title: TMWRF Facility Plan

Project No.: 153299

Technical Memorandum No. 11

Subject: Revised CIP Recommendations

Date: September 23, 2021

To: Mike Drinkwater, TMWRF

From: Mike Harrison, PE, Project Manager, Brown and Caldwell

Copy to: File

Prepared by: ______________________
Seppi Henneman, Brown and Caldwell

Reviewed by: ______________________
Mike Harrison, PE, Project Manager

Limitations:

This document was prepared solely for City of Sparks in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Sparks and Brown and Caldwell dated 11 February 2019. This document is governed by the specific scope of work authorized by City of Sparks; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Sparks and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Acronyms

AA	annual average
AFA	acre-feet annually
AGS	aerated granular sludge
BOD	biological oxygen demand
CIP	capital improvement plan
DAFT	dissolved air flotation thickener
DON	dissolved organic nitrogen
FBR	fluidized bed reactor
FOP	filtered ortho-phosphate
GMF	granular media filter
H_2S	hydrogen sulfide
lb-N/d	pound(s) nitrogen per day
lb-P/d	pound(s) phosphorus per day
mgd	million gallons per day
mg-N/L	milligrams nitrogen per liter
mg-P/L	milligrams phosphorus per liter
MLSS	mixed liquor suspened solids
NOx	nitrogen oxides
NTF	nitrifying trickling filter
O&M	operations and maintenance
OPCC	opinion of probable construction cost
PACl	poly aluminum chloride
R/R/R	replacement, repair, and rehabilitation
RW	recycled water
scfm	standard cubic feet per minute
SRT	solids retention time
sTP	soluable total phosphorus
TDS	total dissolved solids
TM	technical memorandum
TMDL	total maximum daily load
TMWRF	Truckee Meadows Water Reclamation Facility
TN	total nitrogen
TPS	thickened primary sludge
TWAS	thickened waste activated sludge
UNR	University of Nevada-Reno
UV	ultraviolet

Section 1: Introduction

This technical memorandum (TM) summarizes capital improvement plan (CIP) project costs that have been developed in TM 5 (Alternative Evaluation) and TM 10 (Supporting Facility Condition Assessment) as part of the Truckee Meadows Water Reclamation Facility's (TMWRF) Facility Plan. Projects have been consolidated and prioritized based on the completed process alternative and condition assessment results.

In collaboration with TMWRF, it was determined that TMWRF's path forward from the 2020 Facility Plan should include process alternatives 1 (Status Quo^{+}) and 3 (Hybrid), described in detail in TM 5. These alternatives follow the same treatment scheme currently used at TMWRF, until TMWRF's raw influent annual average flow rate reaches 34 million gallons per day (mgd), which will require significant expansion at TMWRF to continue to meet TMWRF's existing permit requirements. This TM (TM 11) presents two versions of the entire CIP, one for Alternative 1 and the other for Alternative 3.

To confirm CIP recommendations, TMWRF will self-perform full-scale testing of dewatering raw, thickened waste activated sludge (TWAS). The results of this testing (specifically centrate water quality and mass loading of nutrient-rich return streams) will be used to issue an addendum to the Facility Plan. This addendum incorporates updated operating data to revise TMWRF's CIP accordingly, specifically regarding the timing of key projects.

This TM is organized by the following sections, updated as noted:

Section 1 Introduction – Updated August 2020

Section 2 Cost Estimating – Original September 2020

Section 3 AquaNereda Pilot Results – Updated August 2021

Section 4 TWAS Dewatering Study Results – Updated August 2021

Section 5 TMDL Evaluation – Updated August 2021

Section 6 Revised CIP and Implementation Schedule – Updated August 2021

Section 2: Cost Estimating

Conceptual-level opinion of probable construction costs (OPCC) prepared for this TM represent order-of-magnitude estimates as defined by the Association for the Advancement of Cost Engineering International criteria for a Class 5 estimate (minus 50 percent to plus 100 percent accuracy). The OPCCs are based on a recommended project's scopes of work and material quantity and represent costs that would be incurred if the project were bid in 2020 under pre-COVID-19 market conditions. The estimate includes costs for demolition, mechanical equipment and piping, and structural and electrical improvements. The OPCCs include contractors' overhead, profit, mobilization, bonds, insurance, and contingency markups. A capital project cost, in 2020 dollars, is the sum of the OPCCs and project delivery costs. Project delivery costs are 35 percent of the OPCCs and are rounded to the nearest $100,000. Project delivery cost markups are shown in Table 2-1, which were used to convert the construction costs into capital costs. All costs described in this TM are shown as capital costs.

Table 2-1. Project Delivery Markups for Capital Projects

Project Element	Percentage
Project Administration	5%
Planning/Environmental	10%
Design	10%
Construction Management	10%
Total	**35%**

Section 3: AquaNereda Pilot Results

An aerobic granular sludge (AGS) secondary treatment process was pilot tested at TMWRF. This pilot project started operation in January 2021 and is planned to continue through fall 2021 or later. The City contracted with AquaNereda to configure a two-reactor (each two-foot-diameter columns) pilot test to operate as a sequencing batch reactor. Each reactor operates in parallel but with differing operating parameters in an effort to determine the optimal configuration and loading pattern.

This Facility Plan update incorporated pilot data from January 2021 through June 6, 2021. The pilot was on-going, and this TM documents the pilot data and recommendations on the applicability of this data as it related to this Facility Plan Update.

The pilot data presented herein is entirely indicative of a reactor loaded with primary influent, which was the original Facility Plan assumption. There are plans to test the pilot plant with primary effluent, which is likely how TMWRF would operate a full-scale AGS system initially. Treating primary effluent initially would maximize biogas production, which was reduced significantly as a result of direct TWAS dewatering (Section 4.3).

Figures 3-1 through 3-5 present AGS effluent data for ammonia, total nitrogen (TN), nitrogen oxides (NOx), dissolved organic nitrogen (DON), and soluble total phosphorus (sTP), respectively, along with each targeted concentration. The AGS pilot has not consistently achieved effluent ammonia requirements. It should be noted that the pilot started up during the lowest temperature time period (end of January) which may have impacted performance early on. In addition, further optimization of operating DO concentrations and aerated cycles could be used to further reduce effluent ammonia concentrations.

The Facility Plan assumed AGS effluent would combine with nitrifying trickling filter (NTF) effluent through an existing pipe stub that was left available for future NTFs 7 and 8. Some of this flow would be recirculated to the NTFs for additional treatment, but the majority would go directly to the denitrification reactors; therefore, a low ammonia target of 0.5 milligrams nitrogen per liter (mg-N/L) for the AGS system was assumed. There are many full-scale AGS systems operated around the world that achieve low effluent ammonia, so it is assumed that the pilot team will be able to achieve this once optimization of the pilot is achieved.

The AGS pilot has achieved lower TN values than the target (average around 8 mg-N/L instead of 10 mg-N/L). During the original Facility Plan creation, Aqua Aerobics had communicated that a TN of 10 mg-N/L was assumed for design but that a TN of 7 mg-N/L may be achievable by treating primary influent. The pilot plant results are in line with Aqua Aerobic's original assumptions; however, modifications may be needed to reliably achieve the effluent ammonia target, which may impact the effluent TN concentrations. Additional operating data is required to understand the effluent quality from the optimized system.

The AGS pilot plant has been capable of mostly achieving the effluent phosphorus limit since May 2021. The phosphorus target is not as impactful to the overall compliance regimen at TMWRF because the future dissolved organic nitrogen (DON) removal system will also achieve significant phosphorus polishing. The level of phosphorus removal achieved by the AGS system appears adequate for what is required at TMWRF. Table 3-1 presents a summary of pilot influent and effluent data.

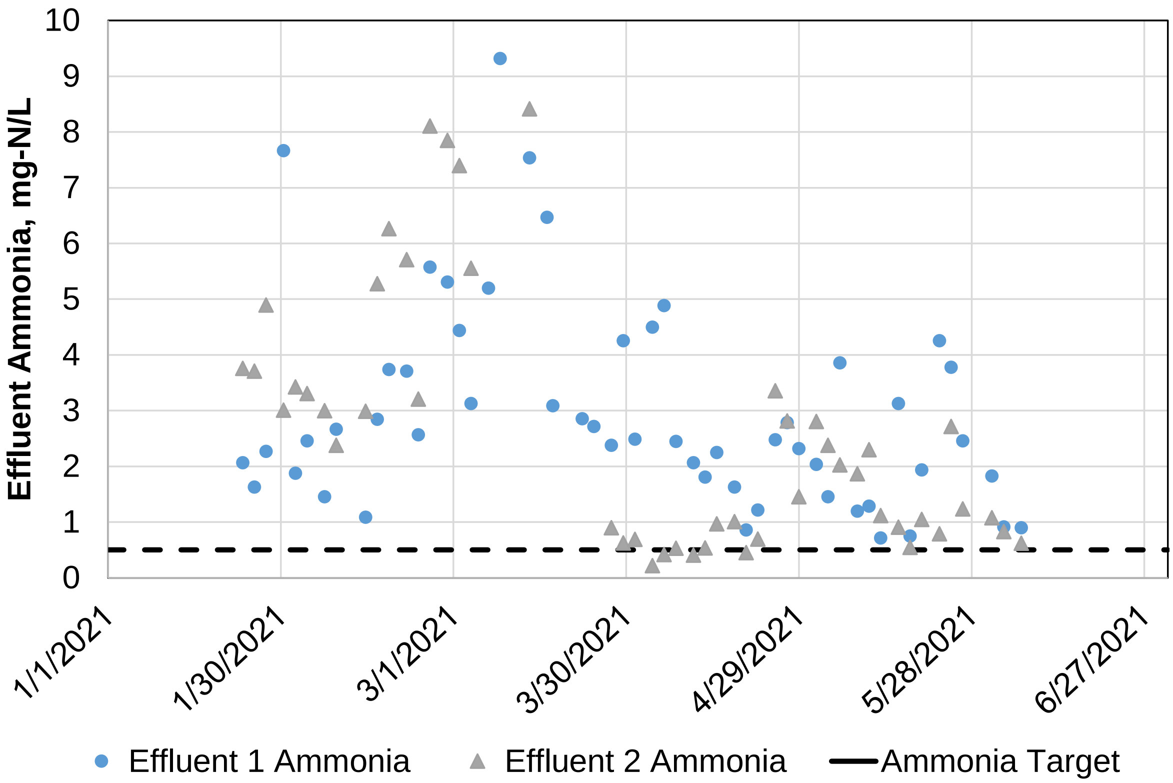

Figure 3-1. Effluent ammonia data from each pilot reactor

Note that the y-axis was capped at 10 mg-N/L; there are two data points not shown

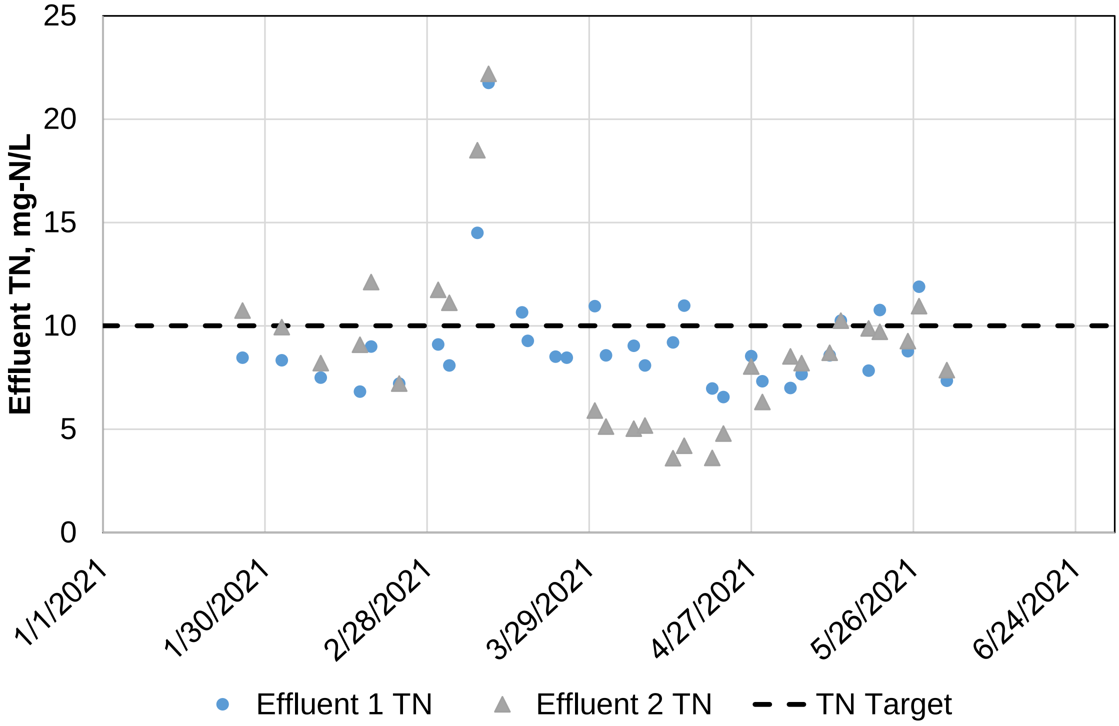

Figure 3-2. Effluent TN data from each pilot reactor

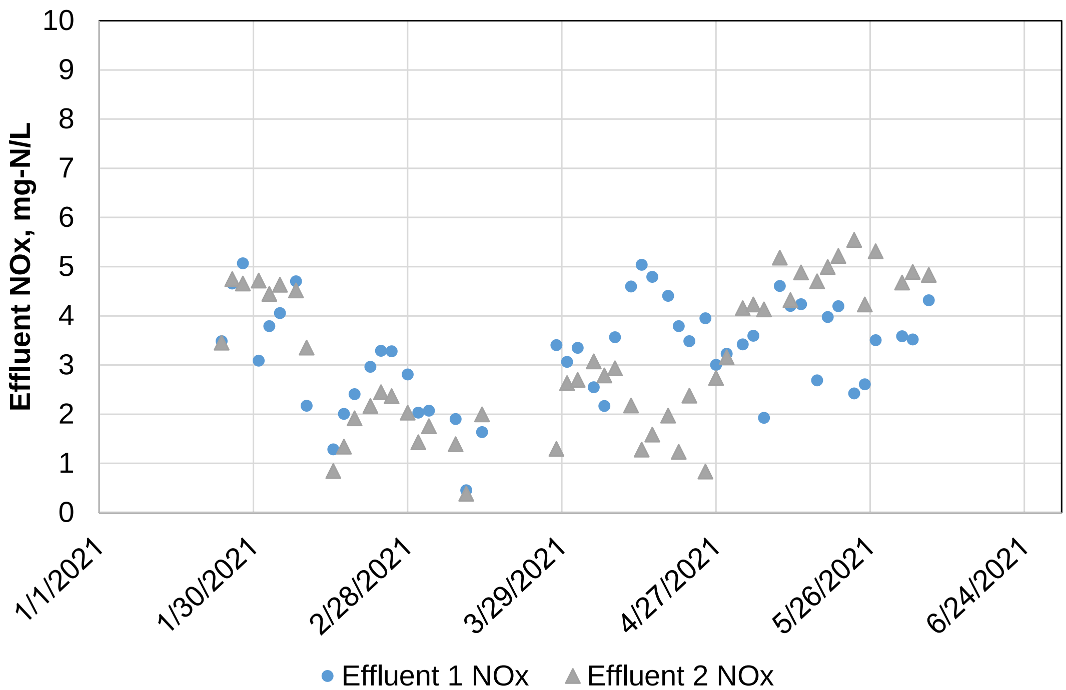

Figure 3-3. Effluent NOx data from each pilot reactor

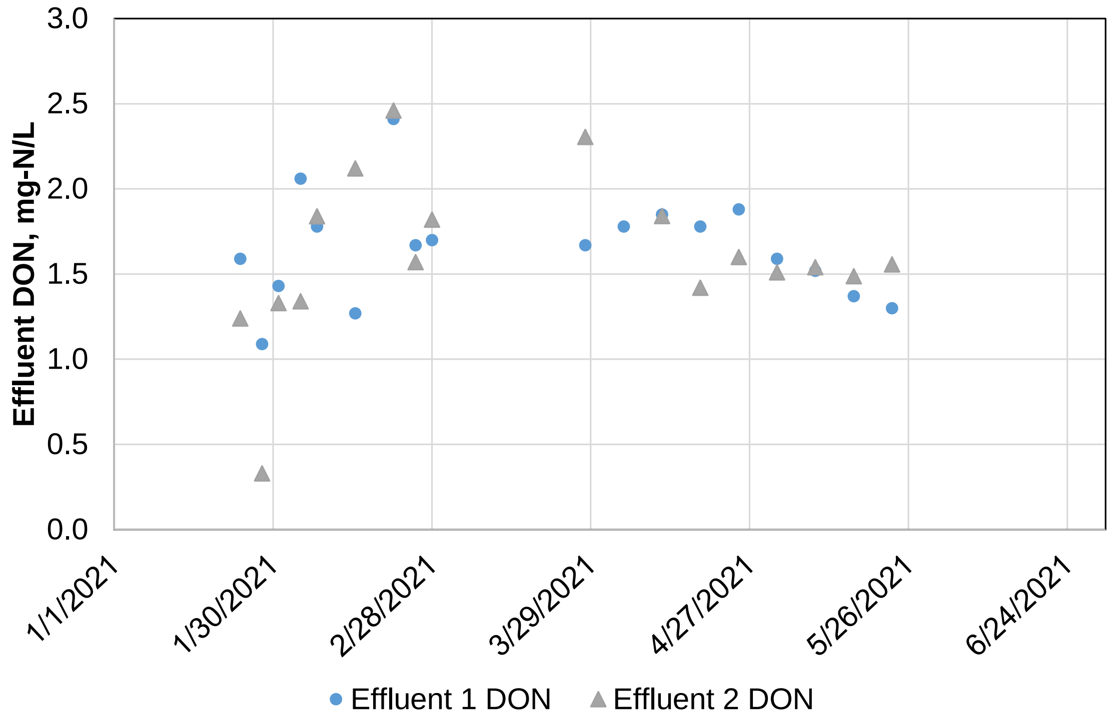

Figure 3-4. Effluent DON data from each pilot reactor

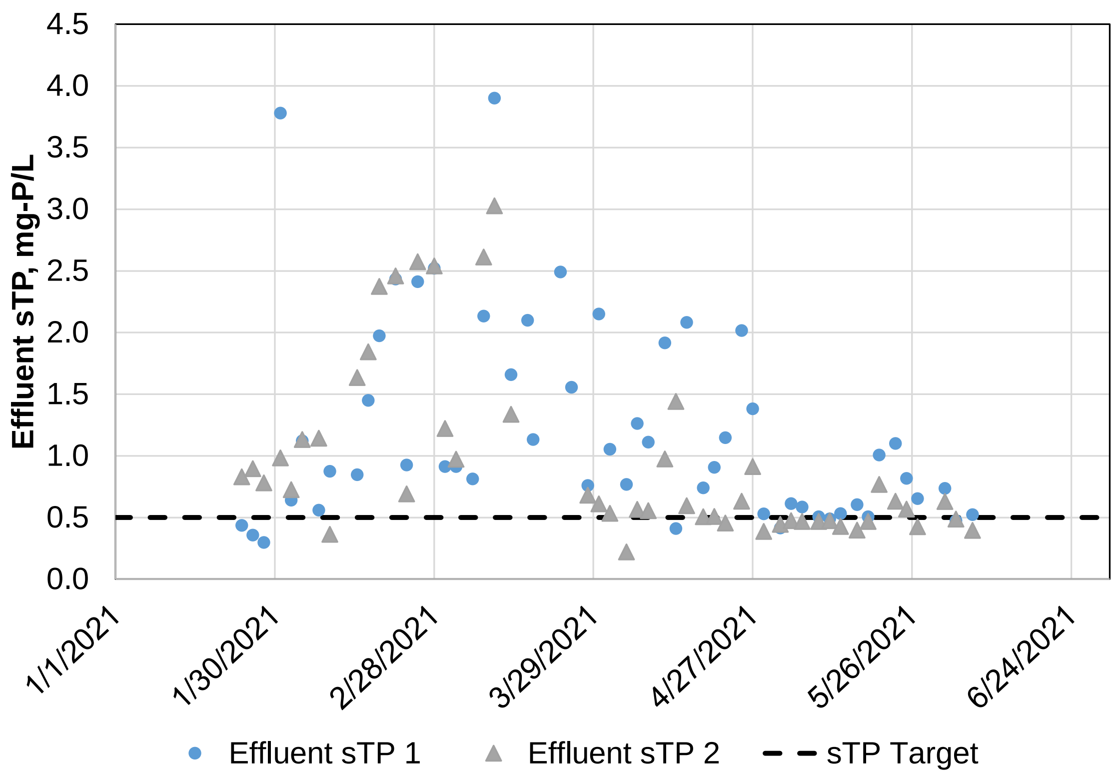

Figure 3-5. Effluent sTP from each pilot reactor

Parameter	Influent Median Data (entire dataset)			Effluent Median Data (4/1/21 through present)				
	Facility Plan Assumption	Pilot Influent Data		AquaNereda Facility Plan Target	Reactor 1		Reactor 2	
		Mean	S.D.		Mean	S.D.	Mean	S.D.
BOD	263	272	61.7	10	28.7	14.5	16.1	12.7
TSS	218	148	59.4	10	18.1	15.2	11.0	11.4
Ammonia	NA	30.6	2.0	0.5	2.2	1.1	1.3	0.9
TN	43	45	3.3	10	8.6	1.5	7.2	2.4
TP or sTP	6.4	7.7	1.1	0.5	0.9	0.5	0.6	0.2

Table 3-1. Summary of Pilot Median Data

Note that effluent data is only shown from 4/1/21 to remove data attributed with pilot system startup, which may not be representative of typical operation. Red text shows values that exceeded the effluent target.

BOD = biological oxygen demand

TSS = total suspended solids

TP = total phosphorus

Notably, the AGS pilot has not achieved the target mixed liquor suspended solids (MLSS) concentration (Figure 3-6) nor the expected granulation target (i.e., percentage of biomass in granule form, data not shown). The TMWRF-Aqua Aerobics Team is still working to achieve these objectives. If the MLSS is low, it may be possible that the solids retention time (SRT) is too low for full nitrification, which would impact effluent ammonia concentrations. BC did not receive sludge volume index (SVI) data points, but was able to review a pilot summary report from Aqua Aerobics which indicated that the median SVI was around 100 milliliters per gram (mL/g).

Figure 3-7 shows the average TSS concentration of the primary influent, primary effluent, and pilot influent. Note that the TSS entering the pilot is significantly reduced from its source water (primary influent). This is attributed to a pilot artifact and the way the influent is pumped to the pilot; however, it may be part of the reason for the much lower MLSS compared to the target. The pilot influent concentrations are similar to what was planned for in the Facility Plan, with the exception of influent TSS.

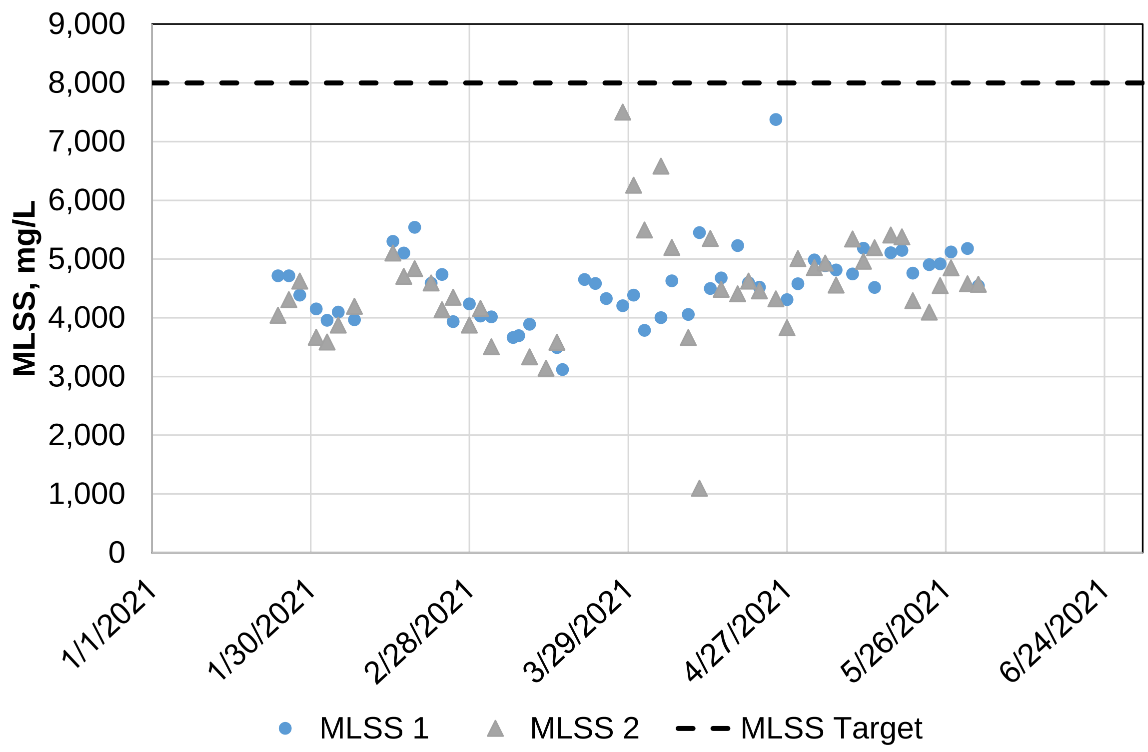

Figure 3-6. MLSS from each reactor (plotted the bottom sample)

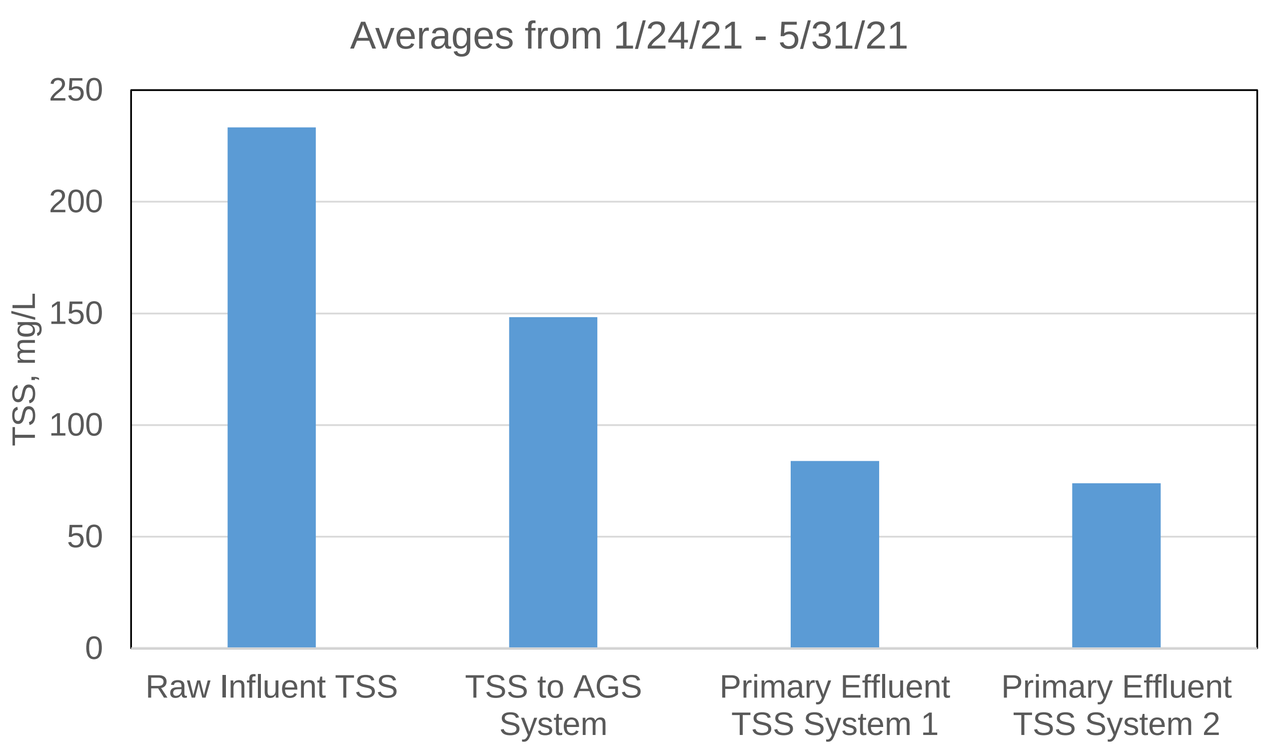

Figure 3-7. Comparison of TSS data

3.1 Updated AquaNereda Pilot Information

There were some initial challenges with seeding the reactors. In early August 2021 there was a much better reseed on reactor 1 which has since resulted in better process performance. Although at the time of this writing a lot of data post reseed was available, there was enough to show more promising data with regards to effluent ammonia data. More recent test data suggest that the system can meet the effluent targets. This will be tracked by TMWRF staff and the final report is expected in early 2022 which should help guide TMWRF decision making for the future biological process selection at TMWRF.

Figures 3-8 through 3-11 show recent time series plots provided by TMWRF staff for MLSS, TIN, sTP, and ammonia, respectively. Note that reactor 1 was reseeded while reactor 2 was not.

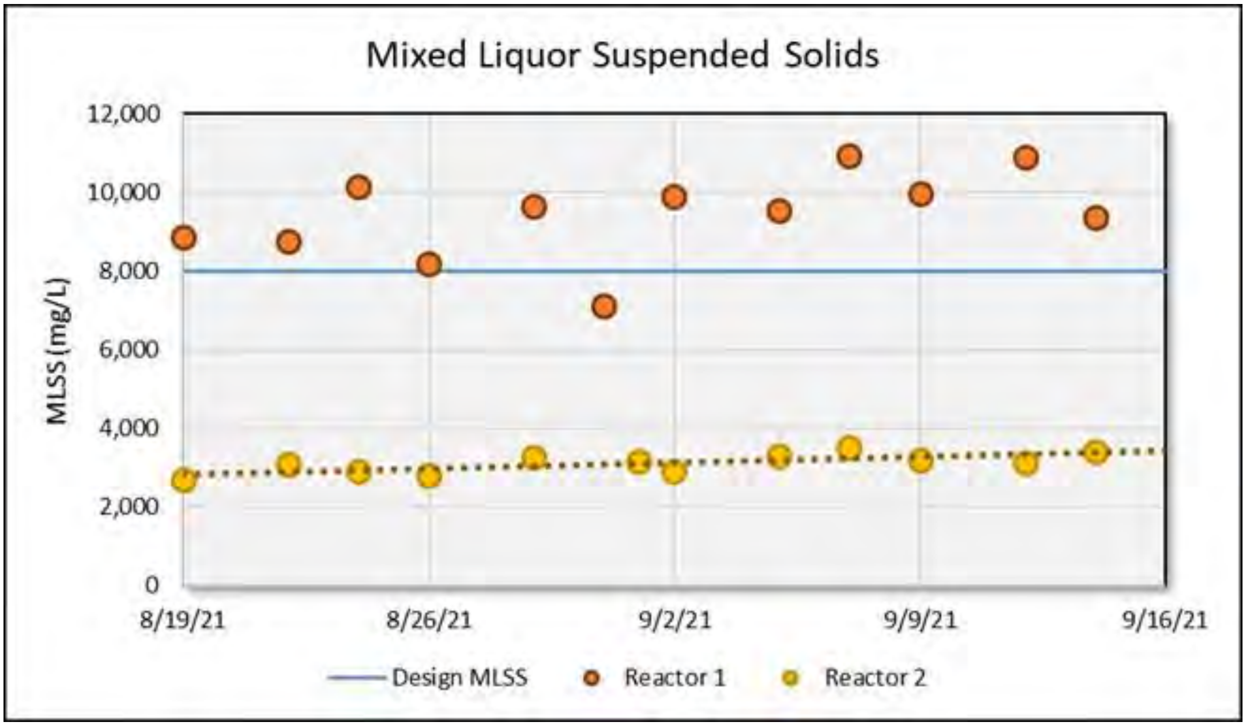

Figure 3-8. Post reseed MLSS concentrations.

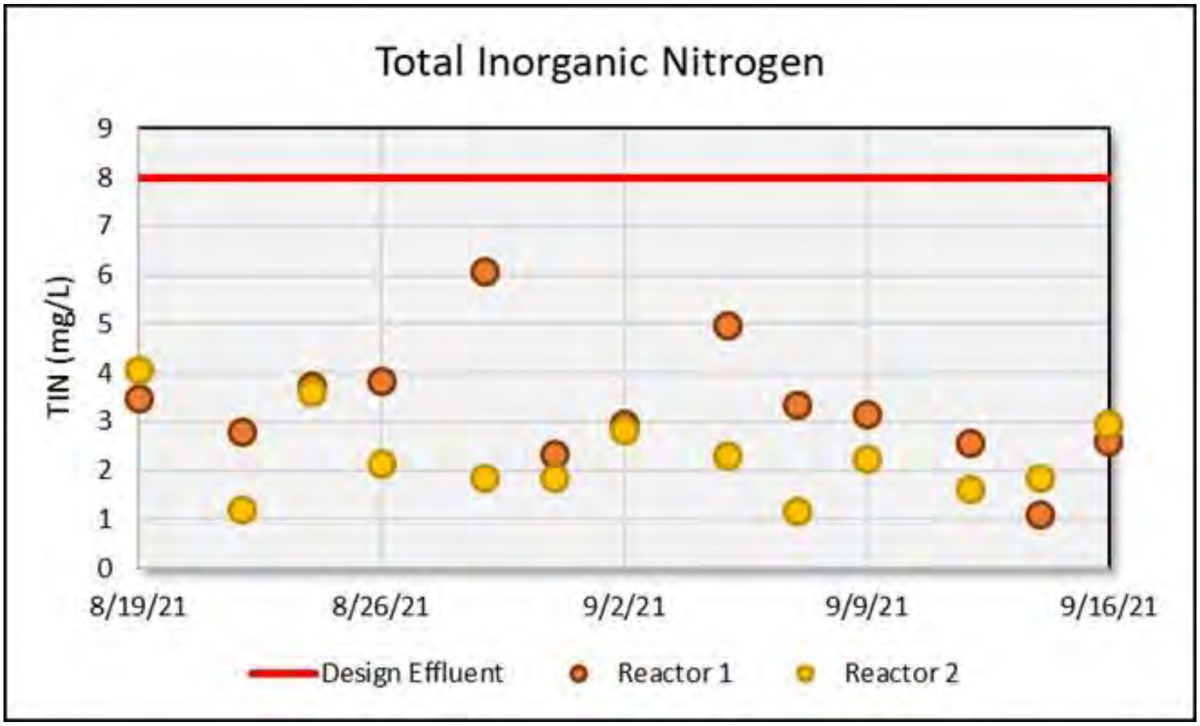

Figure 3-9. Post reseed effluent TIN concentrations.

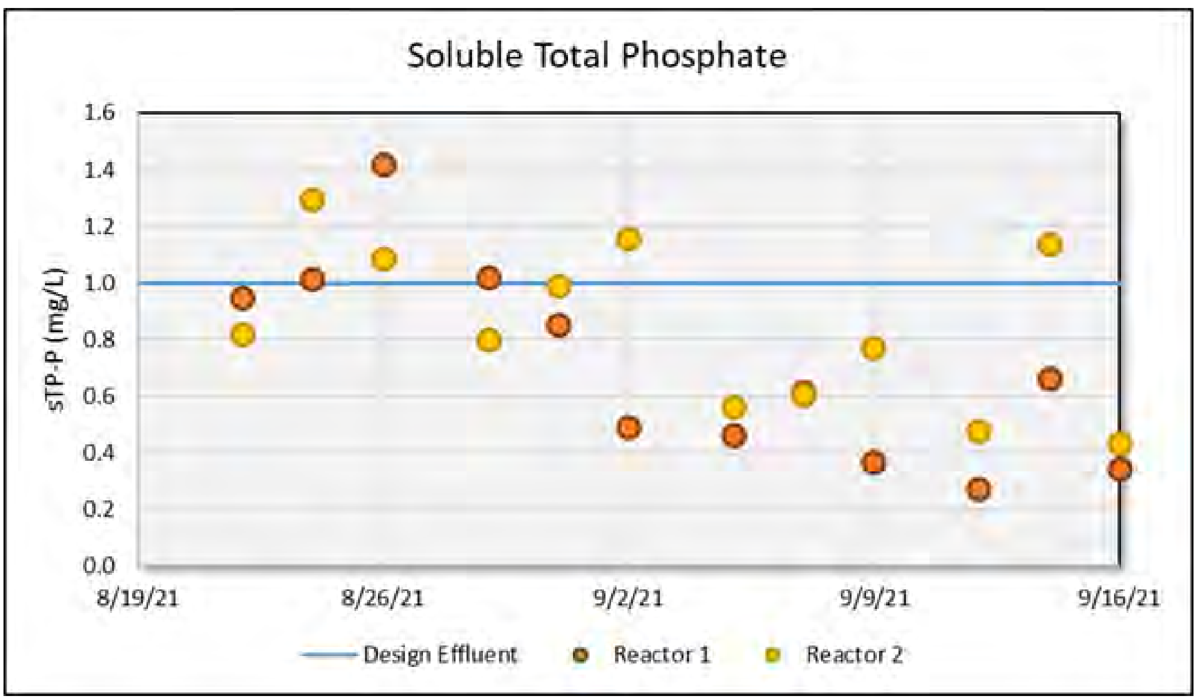

Figure 3-10. Post reseed effluent sTP concentrations.

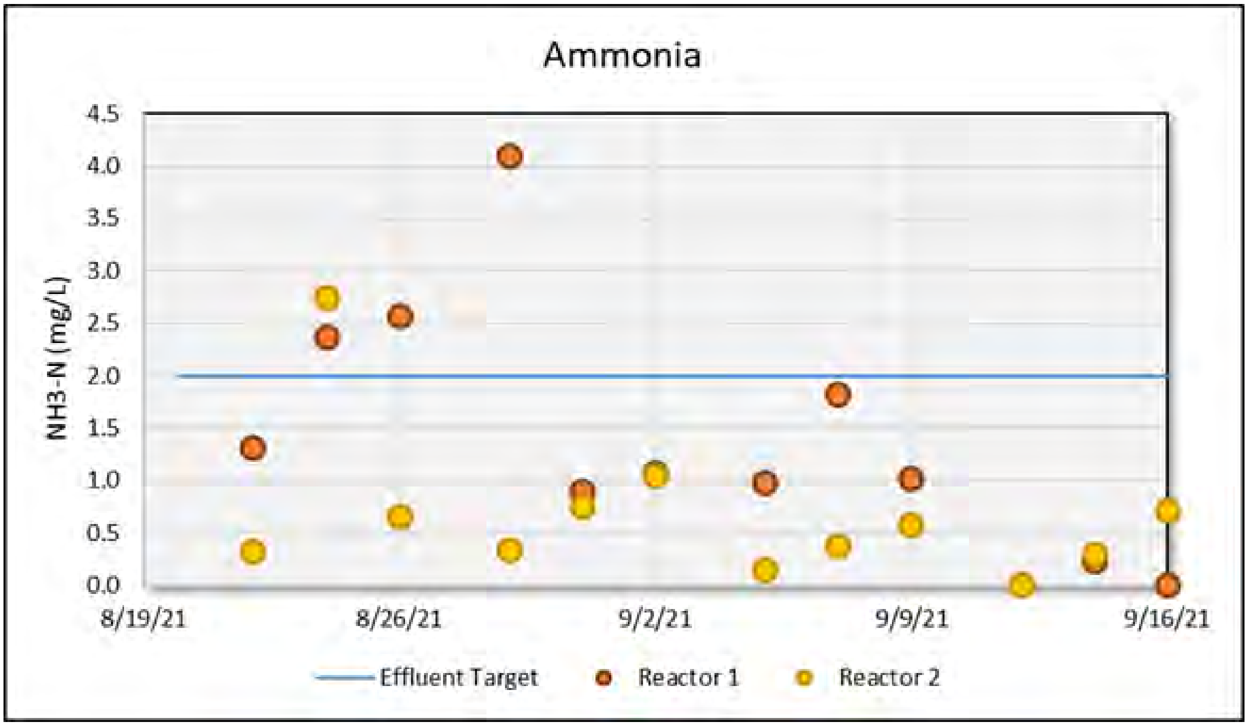

Figure 3-11. Post reseed effluent ammonia concentrations.

3.2 Conclusions and Recommendations

BC offers the following conclusions and recommendations after reviewing the AGS pilot data:

<u>Conclusions:</u>

- Initial effluent ammonia concentrations did not reliably met the target concentration presented in the Facility Plan. Data post reseed showed promising results that were meeting the effluent ammonia target of 0.5 mg-N/L.
- Effluent TN values are within the range expected from the Facility Plan.
- Effluent phosphorus concentrations are close to the target.
- Pilot influent TSS loading is artificially low (actual source water appears to have higher TSS).
- Pilot influent BOD, TSS, and total kjeldahl nitrogen (TKN) concentrations are similar to what was assumed in the Facility Plan.
- Overall, pilot effluent has met all effluent requirements during select periods, and it appears that with more run time the pilot will be capable of achieving the planning target concentrations more reliably.

<u>Recommendations:</u>

- Correct the influent TSS loading issue, if feasible.
- Optimize the pilot plant to achieve design SRT/MLSS, which may help reduce the effluent ammonia concentrations (this has been performed on reactor 1 in August 2021).
- Coordinate with Aqua Aerobics at the conclusion of the pilot to understand any implications of the pilot plant results to reactor and/or equipment sizing.
- Use the final results of the pilot plant to better estimate impacts to downstream processes (i.e., methanol use).

- Perform bench scale tests to determine comparatively how well the AGS sludge can thicken (i.e. how high of a percent TS it can achieve) compared to existing WAS. Similarly, it is recommended to perform bench tests to determine how well the AGS sludge can dewater compared to existing TWAS.

Section 4: TWAS Dewatering Study Results

TMWRF staff investigated direct TWAS dewatering through a full-scale trial that began on June 9, 2020. Data in this Section are shown from January 1, 2019, through May 31, 2021, unless otherwise noted. Various iterations of how to route TWAS to and around the digesters were tested, as described by Mentzer et al. 2021 and, therefore, will not be re-described here. Figure 4-1 shows the final configuration that was determined to be the best path forward.

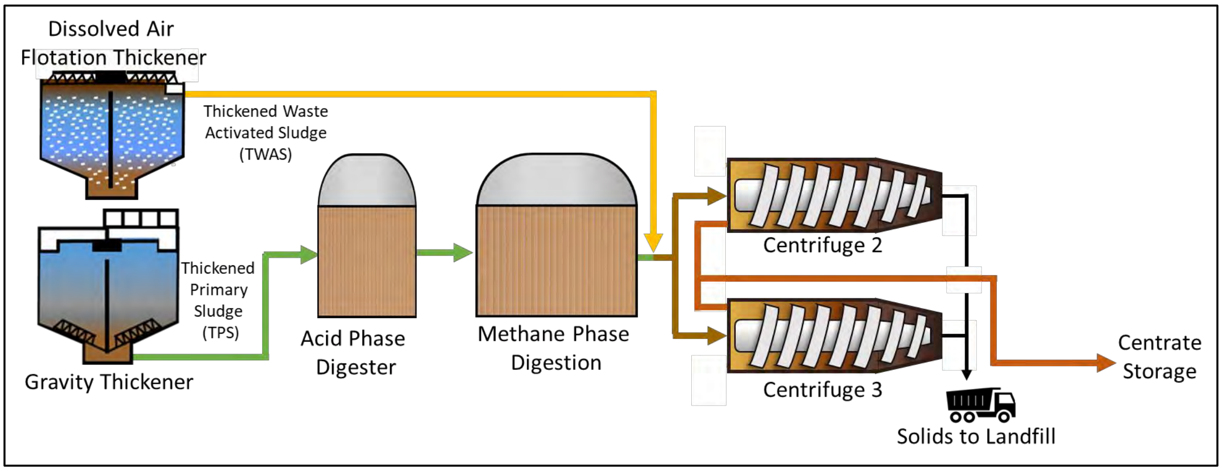

Figure 4-1. Direct TWAS dewatering schematic

The purpose of this study was to quantify the impacts across the entire treatment plant when TWAS was re-directed around the digesters straight into the centrifuge. Of specific interest for updating this Facility Plan were the changes to nutrient concentrations and loading in the combined centrate stream.

4.1 Centrate Flow and Loading Changes

Flow to the centrifuges increased significantly after initiating direct TWAS dewatering. The anaerobic digesters typically destroy approximately 50 percent of the total solids. By bypassing the TWAS stream around the digesters, no solids were destroyed in the TWAS and the TWAS stream retained its full solids content, which resulted in higher loading rates to the centrifuges. The centrifuge feed flow and flow variability increased after implementing TWAS dewatering. It is assumed that the variability would decrease over time as TMWRF staff gain more experience optimizing the system.

Nitrogen and phosphorus concentrations in the combined centrate were significantly lower by directly dewatering TWAS. Figures 4-2 through 4-4 show box and whisker plots for centrifuge feed flow, ammonia concentration and load, and filtered ortho-phosphate concentration and load.

Attachment A shows time series plots from January 1, 2019, through May 31, 2021, with several outliers identified. These outliers were removed from the dataset for the statistical analyses presented in this work.

Attachment B contains updated capacity calculations, including the centrifuge capacity which accounts for the on-going centrifuge design project. The project is specifying a centrifuge with a minimum flow of 320 gpm. TMWRF staff have indicated that the existing two centrifuges can achieve 180 gpm each, or 360 gpm combined. This was used to estimate capacity of the planned centrifuge system (see Attachment B).

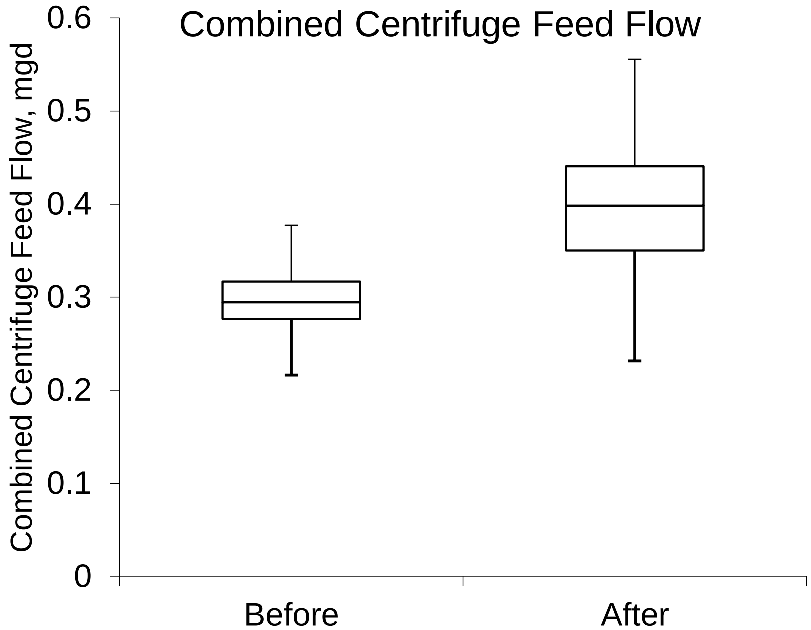

Figure 4-2. Box and whisker plot of combined centrifuge feed flow

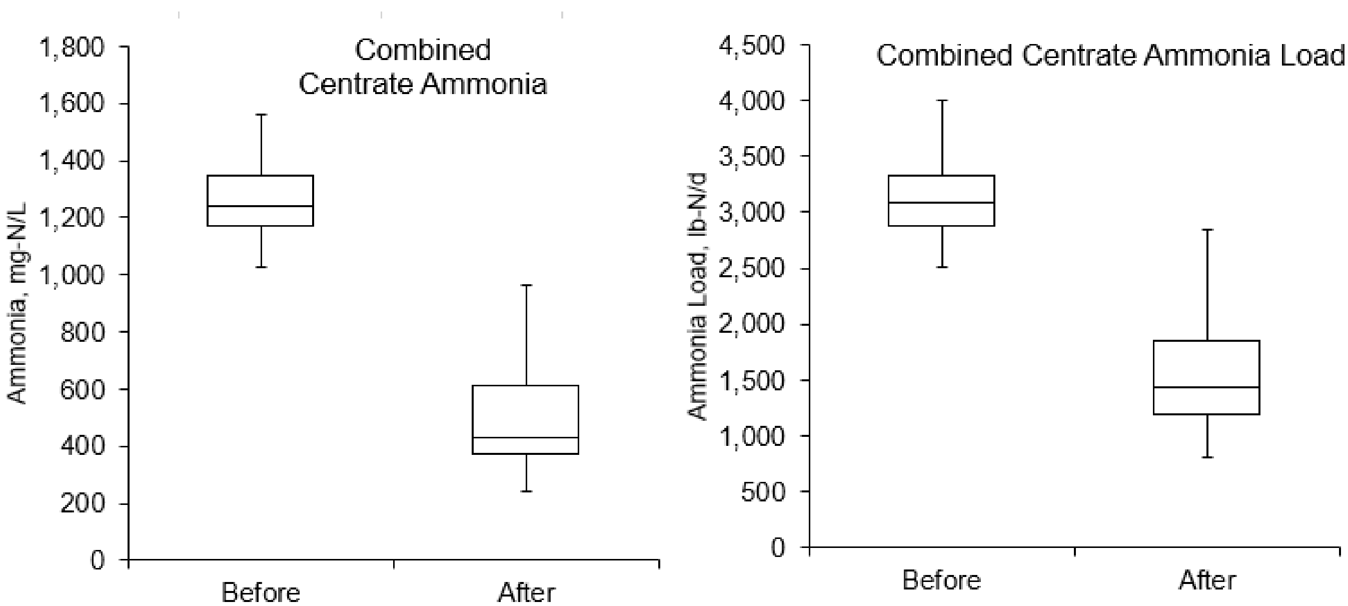

Figure 4-3. Box and whisker plots of ammonia concentration (left) and load (right) in combined centrate

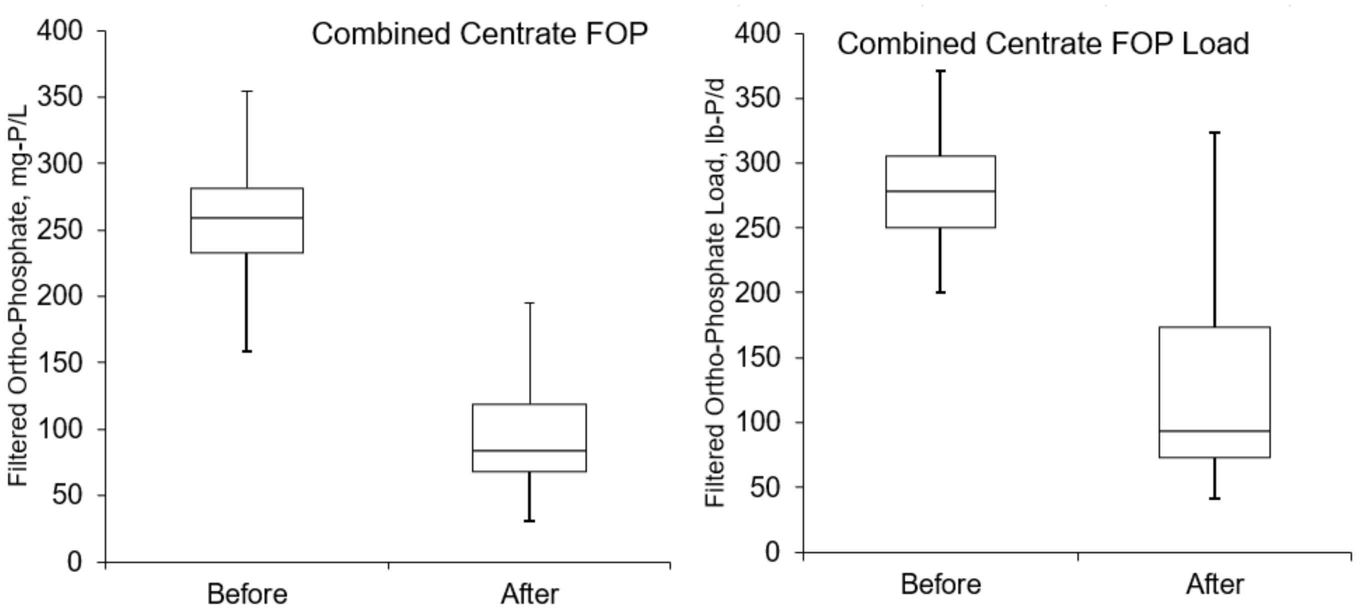

Figure 4-4. Box and whisker plot of filtered ortho-phosphate concentration (left) and load (right) in combined centrate

In discussions with TMWRF staff, it was determined that a combined centrate flow of 0.33 mgd with an associated ammonia concentration of 500 mg-N/L is representative of optimized dewatering operation (additional data not shown), and was used for projecting CIP data.

4.2 Sludge Hauling Changes

The Facility Plan anticipated a 31 percent average increase in sludge production (based on wet tons) as a result of directly dewatering TWAS without first destroying a portion of the TWAS solids in the digesters. Sludge hauling invoices were reviewed from January 2020 through July 2021 to understand the actual increase in biosolids hauling as well as the associated cost. Table 4-1 summarizes the hauling changes for the two periods. The sludge hauling increased 39 percent when comparing the period before TWAS dewatering was implemented (January through May 2020) with the period starting 2-months after TWAS was implemented (August 2020 through May 2021). A 2-month period after implementation of TWAS dewatering was selected because the June invoice was during the transition period, and there was no invoice available for July 2020.

Notably, hauling costs increased by 47 percent when comparing annual costs from fiscal year 18-20 to fiscal years 21-22 (fiscal year 22 was extrapolated), though sludge quantity increased by only 39 percent. This is due to the observed change in sludge viscosity, which was described by TMWRF staff as having properties similar to gelatin. This change has resulted in requiring hauling trucks to haul less tonnage per truck load, which in turn increases the number of truck trips needed to haul sludge offsite, which adds additional hauling costs.

Table 4-2 presents a summary of data manipulated, removed, or missing from the sludge hauling invoice evaluation. Figure 4-5 shows a time series plot of the monthly hauling costs as well as the average cost before implemented direct TWAS dewatering and the average cost after implementing direct TWAS dewatering. The average cost increased by 80 percent.

Table 4-1. Summary of Average Sludge Hauling	
	Monthly Sludge Hauled, tons
Pre-TWAS Dewatering (1/1/20 – 5/31/20)	3,200
Post-TWAS Dewatering (9/1/20 – 5/31/21)	4,500
Percent Change	39%
Hauling Cost Summary	
Fiscal Year 2018	$1,001,000
Fiscal Year 2019	$1,080,000
Fiscal Year 2020	$1,070,000
Fiscal Year 2021	$1,510,000
Fiscal Year 20212 (Extrapolation)	$1,570,000
Percent Increase from TWAS Dewatering	47%

Table 4-2. Summary of Invoice Discrepancies Removed from Analysis	
Invoice Date (Invoice Number)	Monthly Sludge Hauled, tons
February 2020 (CS-022820)	Sludge volume corrected by changing 2,335 tons to 23.35 tons on February 2, 2020. Cost from invoice matches the lower value, so it was assumed to be a typo on the invoice.
September 2020 (CS-093020)	No invoice available.
October 2020 (CS-103120-2)	An additional item called "Load and haul 1,000 cubic yards of sludge from TMWRF drying beds to Lockwood haul" was removed from cost and sludge calculations. It was an additional $25,000 and appeared unrelated to normal sludge hauling practices.
November 2020 (CS-113020)	No invoice available.

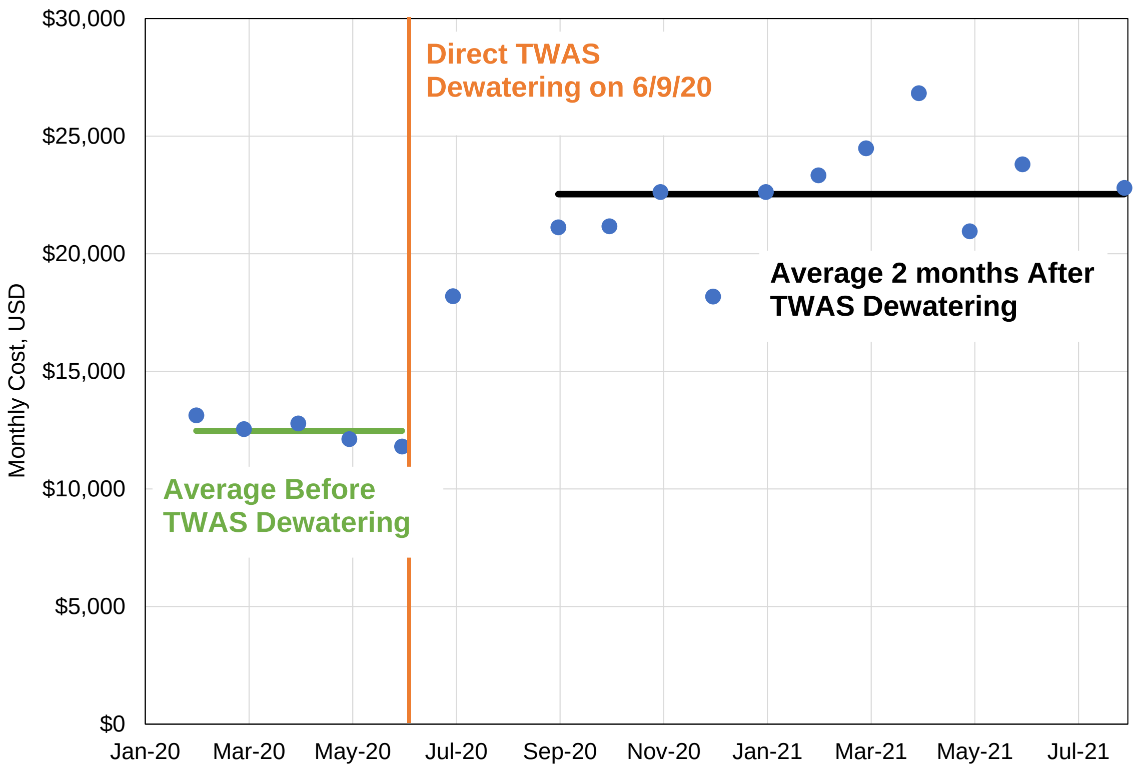

Figure 4-5. Monthly hauling cost summary

Note that this invoice review is showed for comparative purposes and does not include all costs associated with hauling.

The Facility Plan capacity assessment described the existing solids loadout facility and sludge storage hoppers as having a capacity of 27.2 mgd annual average influent flow (assuming 2 days of cake storage at peak day conditions with digestion of thickened primary sludge and TWAS), meaning the solids loadout facility was already beyond the planned capacity using standard engineering assumptions. Additional solids production due to direct TWAS dewatering exacerbates the situation. The Facility Plan included a TWAS implementation project for $21 million (reference Tables 6-1 and 6-2), which included a new dewatering facility with new solids loadout. The higher solids loading values from the TWAS dewatering full-scale trial further emphasizes the need for additional biosolids handling and storage facilities.

An updated capacity calculation for the sludge storage facility (hoppers) was performed. It was assumed that dry cake production increased by 39 percent (based on updated sludge hauling values), and that the cake solids would be 16.8 percent total solids (based on updated data). Using this calculation, it was determined that an additional storage volume of 75,000 gallons of hopper volume would be required to achieve 2 days of storage at peak day conditions at 44 mgd of AA influent flow. This translates to three additional hoppers if the existing hopper dimensions are used. The updated calculation is provided in Attachment B. Figure 4-6 shows that two hoppers should be constructed to meet existing treatment capacity needs, and the third hopper should be constructed when AA influent flows reach 34 mgd.

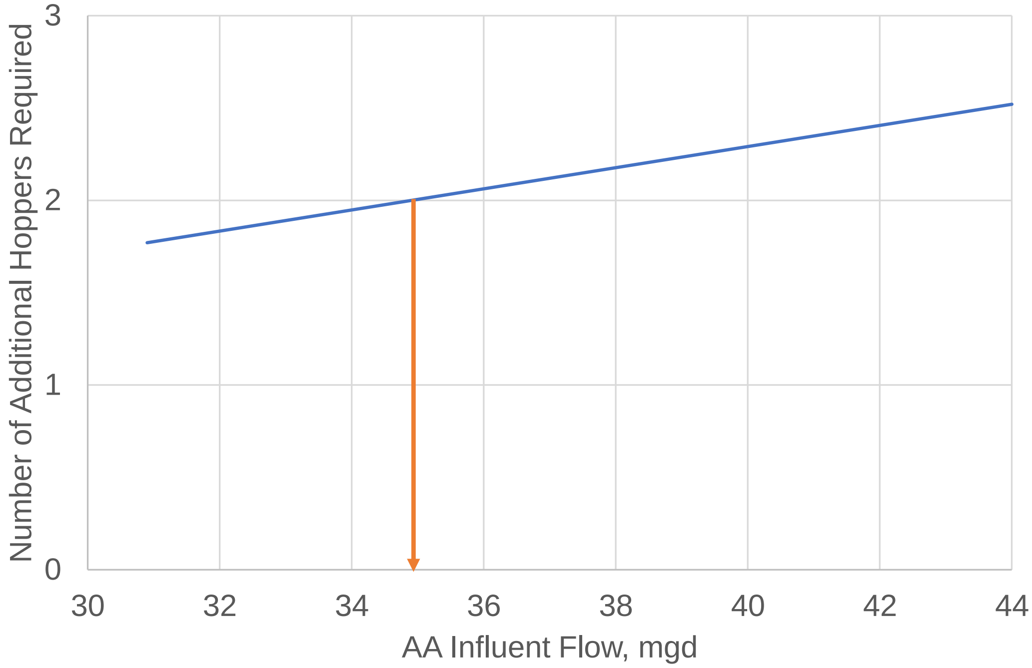

Figure 4-6. Summary of hopper capacity expansion calculations.

The orange arrow shows when the third additional hopper is required to maintain 2-days of storage at peak day conditions.

It should be noted that there are other ways to optimize storage volume that may reduce the number of hoppers required to store the sludge. These include:

- Drying or partially drying the sludge to reduce the volume and weight required to be stored and hauled
- Conditioning the sludge using Clean-B, SLG solution by Orege, or other technology to modify the dewaterability and viscosity of the sludge

TMWRF staff have decided to utilize operational strategies to expand capacity of the existing hopper system until a new dewatering facility can be constructed. These include:

- Installing a third centrifuge that is larger than the existing two (currently in design)
- Adjusting the sludge hauling schedule by hauling up to 6 days per week and reducing dewatering throughput on Sundays. This requires managing the level in the secondary digester.

It is recommended that TMWRF staff investigate/test sludge conditioning technologies to determine if these can be utilized to expand the overall capacity of the existing dewatering building by improving hopper storage capacity (by reducing the volume of stored solids). It is assumed that optimization of the dewatering building using the methods described above would expand capacity to approximately 34 mgd AA influent flow.

It is recommended that TMWRF initiate a preliminary engineering report to determine appropriate sizing of a new dewatering facility. This new facility can be optimized to be significantly more effective than the existing dewatering building, which requires significant expense to upgrade to meet seismic design criteria. This preliminary engineering design report should also evaluate TMWRF staff's efforts to optimize solids handling and update the trigger point for the new dewatering facility.

4.2.1 Changes in Gas Production

Less sludge was digested in the digesters due to direct TWAS dewatering. Due to this, gas production decreased significantly. The hydrogen sulfide (H_2S) concentrations in the raw digester gas also decreased significantly. Secondary sludge, or waste activated sludge (WAS), is a known source of significant H_2S generation due to the high protein content of the biomass. The lower gas flow and H_2S content resulted in additional benefits in the downstream bio-tower H_2S treatment and iron sponge H_2S treatment. Table 4-3 presents average values before TWAS dewatering (1/1/2019 to 6/8/2020) and after TWAS dewatering (8/1/2020 to 5/31/2021). August 1, 2020, was selected as the starting point for statistical analysis because it was approximately 3 hydraulic residence times after the direct TWAS dewatering change. These changes resulted in a gas conditioning system that does not exceed capacity within the planning range of this Facility Plan (i.e., 30 mgd to 44 mgd annual average influent flow). Therefore, the CIP project to add a second bio-tower has been removed from the CIP tables presented in Section 6. See Attachment B for capacity calculation documentation.

Table 4-3. Summary of Changes in Gas Flow and Quality (Average Values Presented)

Date Range	Gas Flow to Conditioning System, scfm		Digester Gas H_2S, ppm		Bio-tower Effluent H_2S, ppm		Iron Sponge Effluent H_2S, ppm	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1/1/19 – 6/8/20	547	37	2,074	234	517	596	237	279
8/1/20 – 5/31/21	410	38	1,431	231	67	182	7	10
Percent Change	(-) 25%		(-) 31%		(-) 87%		(-) 97%	

Figure 4-7 presents a time series plot of flow to the gas conditioning system. Figure 4-8 presents a time series plot of digester gas H_2S concentrations. Figures 4-9 and 4-10 present bio-tower effluent and iron sponge effluent H_2S concentrations, respectively.

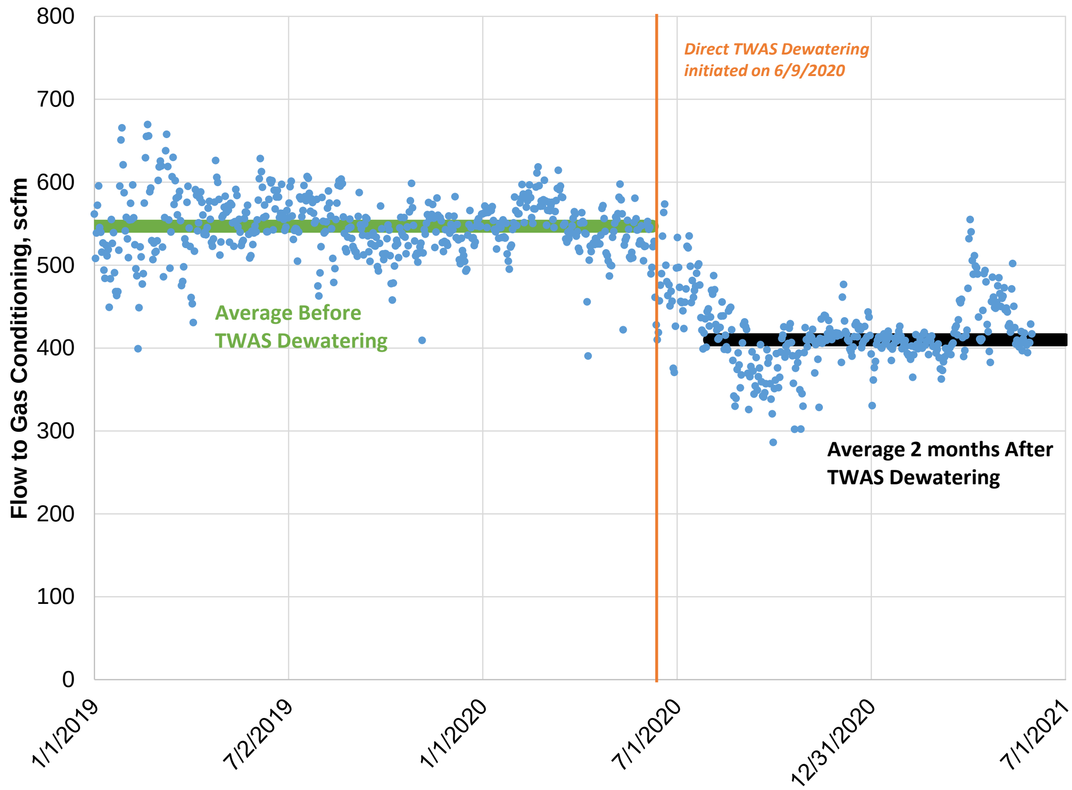

Figure 4-7. Flow to gas conditioning

scfm = standard cubic feet per minute

ppm = parts per million

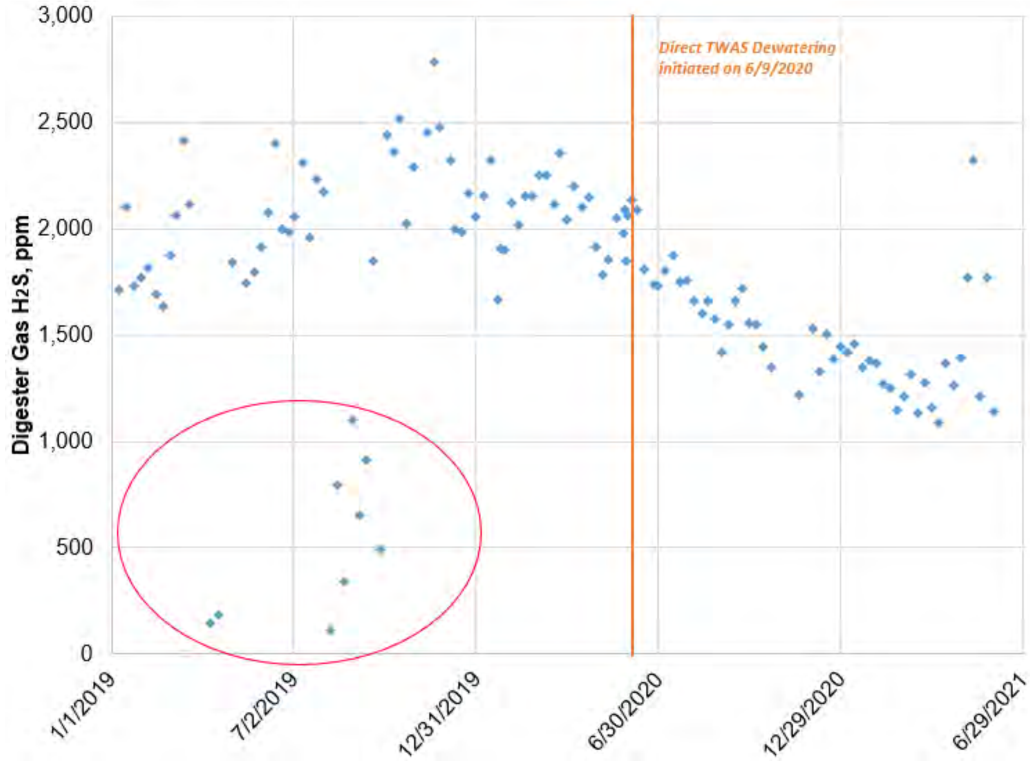

Figure 4-8. Digester gas H_2S concentrations

Data points in the red circle were removed from the analysis and were considered outliers by visual observation.

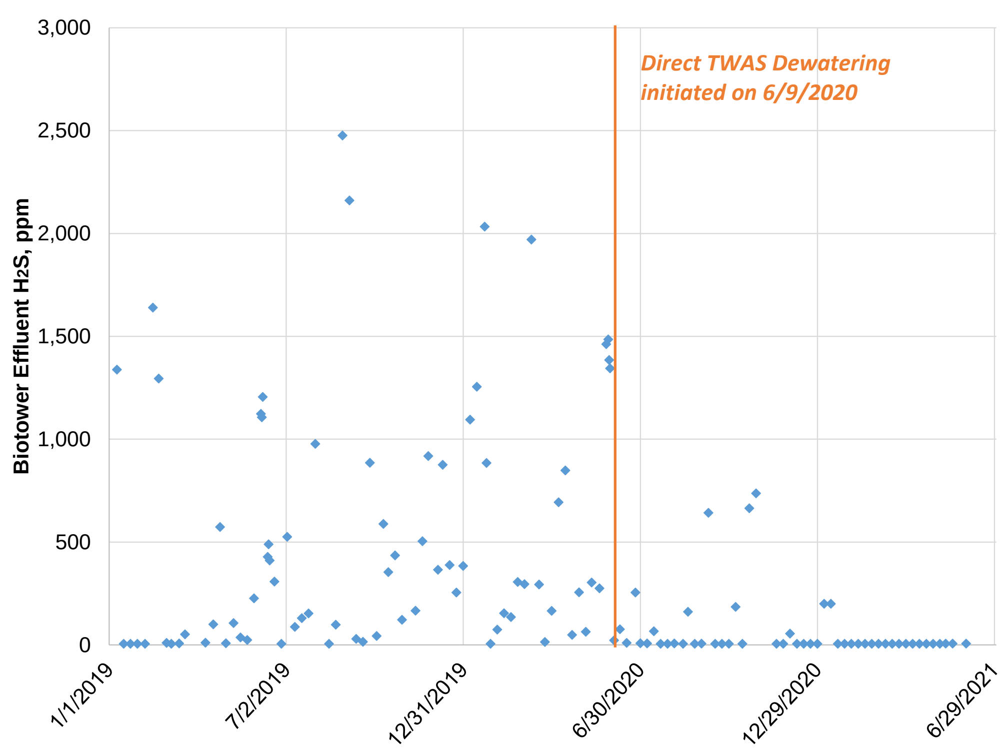

Figure 4-9. Bio-tower effluent H_2S concentrations

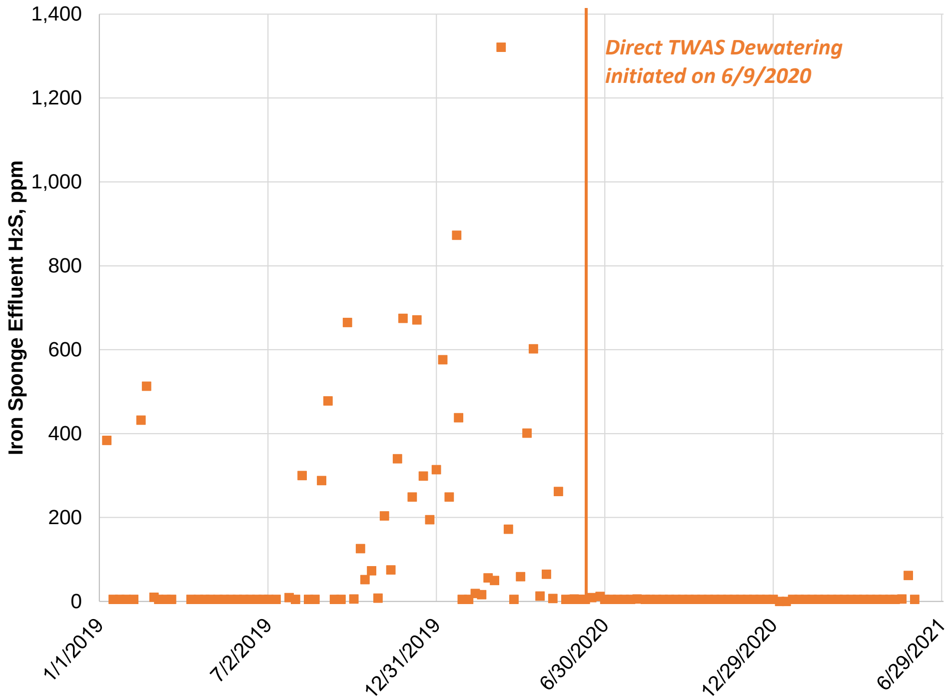

Figure 4-10. Iron sponge effluent H_2S concentrations

4.3 Aeration Tank Optimization Project

TMWRF staff were optimizing the operation of the aeration tanks at the same time that direct TWAS dewatering was implemented (June 9, 2020). Aeration tank optimization consisted of adjusting operational parameters such as seasonal DO targets, revised SRT conditions, and RAS setpoints to achieve a greater and more consistent level of total carbon, nitrogen, and phosphorus removal. In addition, the use of System 3 to treat a portion of the centrate was optimized starting April 1, 2019. In general, System 3 is used to remove nitrogen from a portion of the centrate and some of the primary effluent for approximately 9 months a year. System 3 is typically not used in the summer months when water temperatures are highest and there is a controlled level of nitrification in the aeration tanks.

The purpose of this work is to quantify the changes in secondary effluent water quality to determine any changes to CIP implementation triggers.

The TMWRF secondary system is separated into three systems: System 1, System 2, and System 3. Systems 1 and 2 are configured similarly and are used for treating the majority of the flow. System 3 is separate and typically operates as a step-feed treatment system used to remove nitrogen from the centrate. For the purposes of this update, the secondary effluent quality from System 1 was used as a surrogate for the majority of the flow because the sampling point for System 2 also contains effluent from System 3.

Table 4-4 presents difference in secondary effluent water quality. Figure 4-11 presents some of this information in a box and whisker plot.

Table 4-4. Summary of Secondary Effluent System 1 Changes Associated with Aeration Tank Optimization and Direct TWAS Dewatering							
Time Period	Date Range	Ammonia, mg-N/L		NOx, mg-N/L		FOP, mg-P/L	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Original Facility Plan Data	1/1/2014 – 12/31/2018	26.0	5.8	2.9	2.2	0.25	0.28
Before	6/19/19 – 6/8/20	23.7	3.7	3.0	2.3	0.29	0.12
After	6/15/20 – 5/31/21	18.4	2.7	4.8	1.6	0.13	0.15
Percent Change Between Before and After Periods		(-) 22%		(+) 57%		(-) 54%	

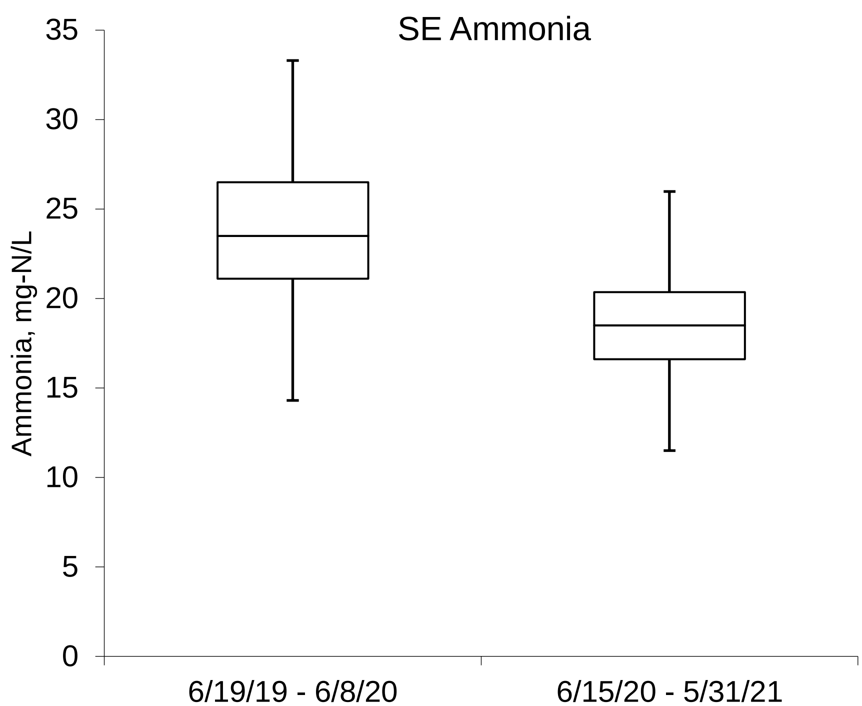

Figure 4-11. Box and whisker plot comparing secondary effluent ammonia concentrations

Section 5: TMDL Evaluation

This section provides an updated analysis on the total maximum daily loads (TMDL) evaluation, which was originally presented in TM 5 (June 25, 2020). The updated analysis focused on data from January 1, 2019, through May 31, 2021, and this new data to update trigger points associated with when certain TMDL limitations were expected to be exceeded.

5.1 Nitrogen TMDL

The effluent TN has been lower recently due to various changes at TMWRF. The original draft of the Facility Plan assumed the maximum annual average effluent TN concentration of 2.04 mg-N/L. More recently, TMWRF has calculated final effluent TN concentrations lower than 2.04 mg-N/L, on average. Tables 5-1 and 5-2 summarize the effluent TN and DON concentrations and provides statistical comparisons. The date ranges that are compared in Table 5-1 are described below:

- Period A - 1/1/15 to 12/31/18: Data used in the original Facility Plan
- Period B – 4/1/19 to 6/8/20: Recent data leading up to the TWAS dewatering test and the aeration tank optimization period. This period does not include data from 1/1/19 to 3/31/19 which were not indicative of normal operation. During this time period, the plant carried out a major rehabilitation of their electrical substation. Rather than supplying temporary power through diesel generators, the facility attempted to route power from a temporary transformer through a spare breaker in their power building that was rated for an amperage draw very near that of the plant during startups. This approach was moderately successful but did result in an extremely inordinate number of power outages due to both the need to switch transformers, as well as the temporary power at times exceeding its amperage draw during changeover events. Power outages are particularly impactful to the facility's FBR denitrification reactor as sudden collapse of the fluidized beds create excessive shearing of biomass from the sand media. As a result, these data are omitted.
- Period C - 6/15/20 to 12/31/20: half year of data that incorporates changes from TWAS dewatering and aeration tank optimization but does not account for the NTF process upset that occurred in winter and spring of 2021. The NTF process upset was an unanticipated consequence of the lower ammonia loading and this lesson learned will be carried forward to prevent such instances in the future.

Figure 5-1 presents the average composition of effluent TN for Periods B and C. Figure 5-2 shows final effluent TN and DON concentrations over time. In general, it appears that the effluent TN has been lower than what was seen over the dataset used as part of the original Facility Plan. It appears the aeration tank and sidestream optimization which was finalized on April 1, 2019 reduced effluent TN; however, it does not appear that TWAS dewatering change had a significant impact on effluent TN concentrations.
Figure 5-2 has some key dates highlighted from which data were not used. These events are described in more detail by Mentzer et al. 2021. Briefly, the crane fly infestation caused a reduction in ammonia oxidation in the NTFs. This infestation was attributed to having much lower ammonia loading values compared to design, which resulted in an environment where the crane flies flourished and consumed significant amounts of the biofilm responsible for treatment. The facility responded by ultimately decommissioning an NTF to increase the loading on each of the remaining towers which has now unlocked redundancy in the nitrification process.

Based on recommendations received from Nevada Division of Environmental Protection, an insecticide was then used for added control of the crane flies and was shortly followed by a massive proliferation of snails prolonging the recovery of the NTFs. Following these unprecedented and anonymous events, the plant has seen a return to performance with TN values averaging 1.62 mg/L for the months of Jun-Aug of 2021.

Lessons learned from these events were implemented into the operating strategy at TMWRF and it is not expected to occur in the future at any regular frequency. Therefore, the data was not included in this analysis. It should be noted that crane fly infestation and snail proliferation present higher risk for Alternative 1, which relies on the NTFs for nearly all ammonia removal at TMWRF. However, Alternative 3 still relies on the NTFs for the majority of ammonia oxidation, so the risk is present for both alternatives to some extent.

In addition, an upset occurred in January and March 2019, where electrical power outages occurred simultaneously with upset conditions in the System 3 sidestream treatment system which resulted in higher than normal effluent TN. As a result of lessons learned from these events, TMWRF staff have since optimized the system to balance nitrogen loading going to the NTFs. This has resulted in superior treatment performance and lower effluent TN than historical. It is the opinion of TMWRF staff that an effluent TN of 1.8 mg-N/L is achievable as a maximum annual average value to plan to, as reflected by 24 months of recent plant performance data, omitting the unprecedented anomalous events described above. This opinion is documented in Attachment C and is used for TMDL calculations.

Figure 5-3 shows the breakdown of nitrogen species assumed from the original facility plan, and the updated assumption, the latter of which is based on water quality data from June 9, 2020 through December 31, 2020, and June 1, 2021 through August 31, 2021. This time period is indicative of aeration tank and sidestream treatment optimization and also includes data after direct TWAS dewatering.

Table 5-1. Summary of Final Effluent TN Concentrations and Statistical Comparison of Various Time Frames

Period	TN Mean, mg-N/L	Period	TN Mean, mg-N/L	p-value	Conclusions
A	1.98	C	1.74	6.5E-11	Original Facility Plan effluent TN data is statistically different than the post-TWAS dewatering data
A	1.98	B	1.69	5.0E-16	Original Facility Plan effluent TN data is statistically different than the recent pre-TWAS dewatering data
B	1.69	C	1.74	4.3E-03	Recent pre-TWAS dewatering data is NOT statistically different than the post-TWAS dewatering data

Table 5-2. Summary of Final Effluent DON Concentrations and Statistical Comparison of Various Time Frames

Period	DON Mean, mg-N/L	Period	DON Mean, mg-N/L	p-value	Conclusions
A	1.50	C	1.38	5.5E-06	Original Facility Plan effluent data is statistically different than the post-TWAS dewatering data
A	1.50	B	1.39	1.1E-04	Original Facility Plan effluent data is statistically different than the recent pre-TWAS dewatering data
B	1.38	C	1.39	8.3E-01	Recent pre-TWAS dewatering data is NOT statistically different than the post-TWAS dewatering data

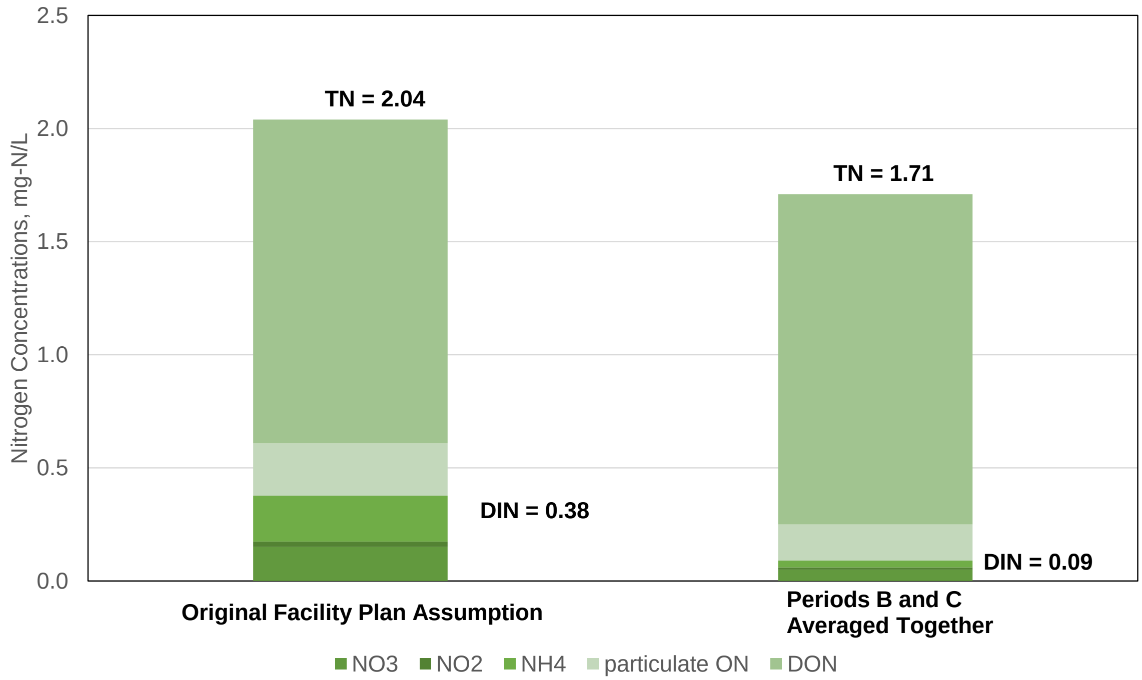

Figure 5-1. Average concentrations of final effluent nitrogen species for two select periods

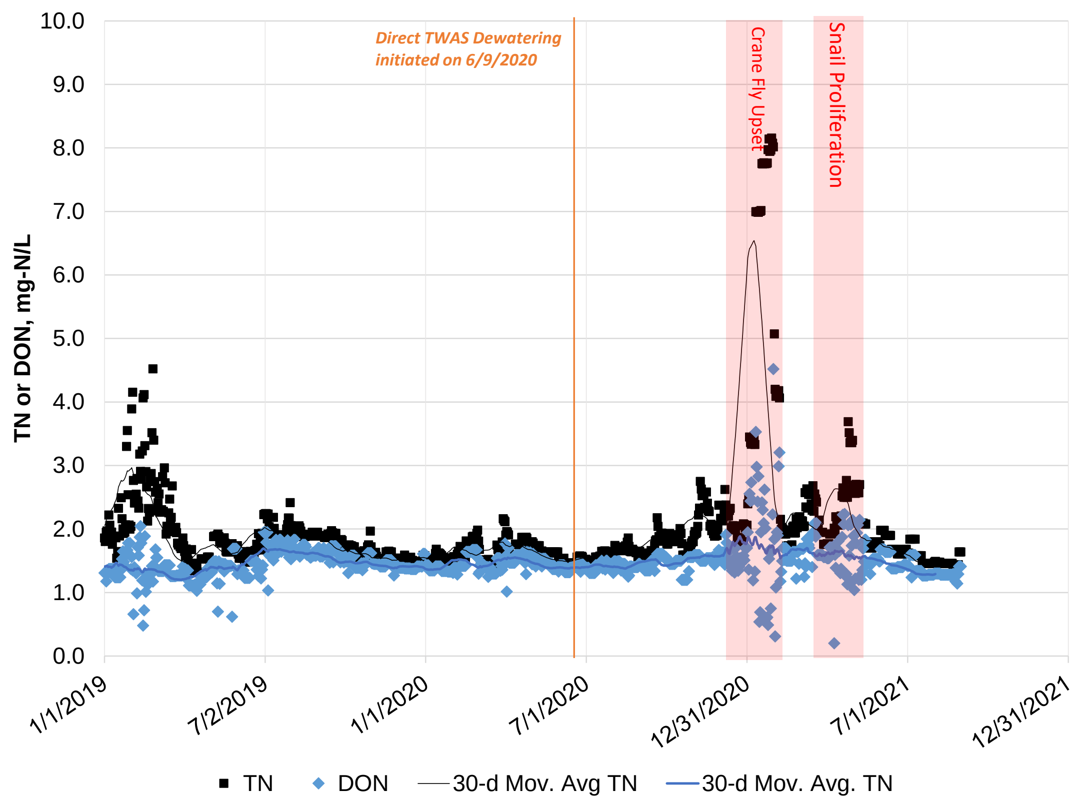

Figure 5-2. Final effluent TN and DON concentrations

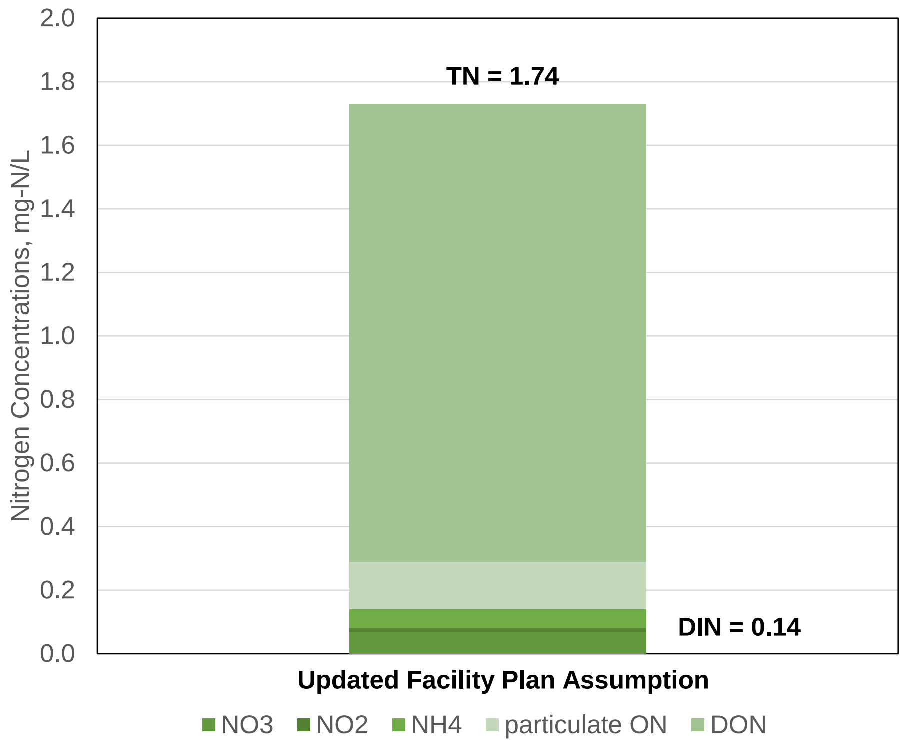

Figure 5-3. Final effluent nitrogen species (rounded up to 1.80 mg-N/L for TMDL calculations)

Based on the latest effluent TN data described above, a value of 1.8 mg-N/L effluent TN (rounded up from 1.74) was assumed for updating the TN TMDL trigger points described in this TM. Figures 5-4 and 5-5 present updated TMDL capacity plots for the current mode of treatment (Figure 5-3), and for treatment assuming 46 percent removal of DON (Figure 5-4). The 46 percent removal of DON was assumed based on work by UNR and is further documented in TM5 The capacities shown are relevant to the TN TMDL only and do not account for other TMDL limits (See Section 5.3 for overall TMDL conclusions).

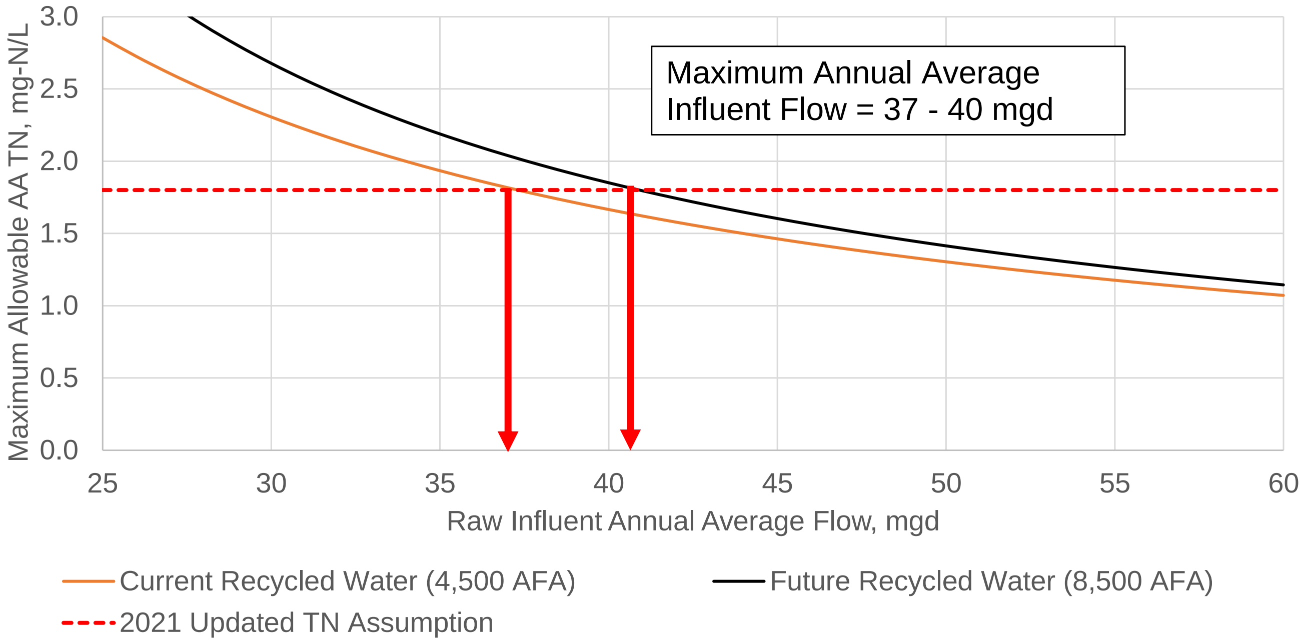

Figure 5-4. Maximum raw influent flow that TMWRF can treat while meeting the TN TMDL

This plot correlates the maximum allowable final effluent concentration to historical values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

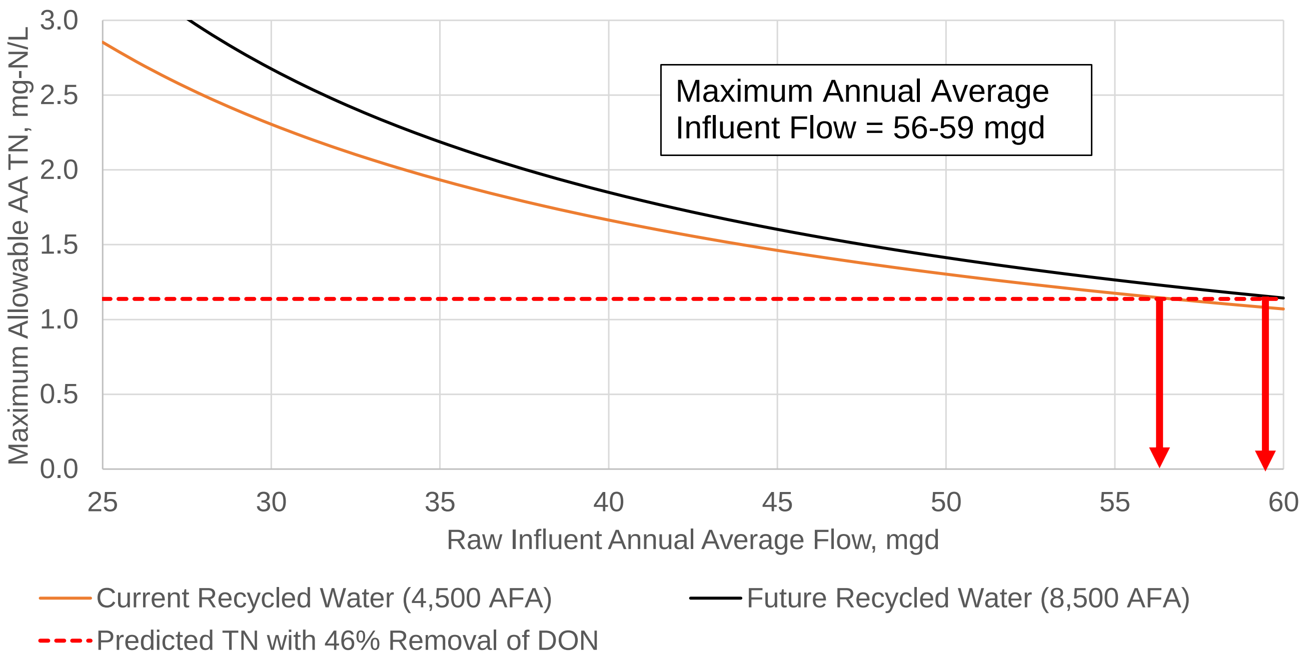

Figure 5-5. Maximum raw influent flow that TMWRF can treat while meeting TN limit, if 46 percent removal of DON is achieved

This plot correlates the maximum allowable final effluent concentration to historical values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement. Table 5-3 presents a summary of the capacity limitations for the TN TMDL.

Table 5-3. Summary of Maximum Annual Average Flow Rates Based on TN TMDL

	Maximum AA Influent Flow Assuming Current RW Flows, mgd	Maximum AA Influent Flow Assuming Future RW Flows, mgd
No DON removal	37	40
46% DON removal (PACl)	56	59

PACl =poly aluminum chloride
RW = recycled water

5.2 Total Dissolved Solids TMDL

The total dissolved solids (TDS) TMDL results presented previously still apply, excluding the impact of advanced coagulation using PACl on TDS. TMWRF engaged the University of Nevada-Reno (UNR) to perform follow-up bench-scale jar tests to determine the impact of advanced coagulation using PACl for DON removal on TDS concentration. The Facility Plan originally assumed that the TDS would increase by 12 mg/L due to PACl dosing for DON removal. This follow-up work showed that while dosing PACl at 40 mg/L, the TDS was reduced on average by approximately 2.1 percent (ranged from 0 to 7 percent reduction) from jar testing (36 data points) and by 6.0 percent from pilot testing (only four data points). Due to the limited number of pilot data points, it was assumed that the jar testing results would be used for the purposes of this Facility Plan Update. The test was performed at an average influent TDS concentration of 350 mg/L, which resulted in a net decrease in TDS of 7 mg/L. Therefore, instead of the advanced coagulation adding 12 mg/L of TDS (original facility plan assumption), the updated calculations shown below assume a net removal of 7 mg/L TDS. Figure 5-6 shows the jar testing results from UNR. Figure 5-7 shows the updated TDS capacity plot. Figure 5-8 shows the same plot as Figure 5-7 but with UV implementation (and subsequent reduction in TDS). Table 5-4 presents a summary of the capacity limitations for the TDS TMDL.

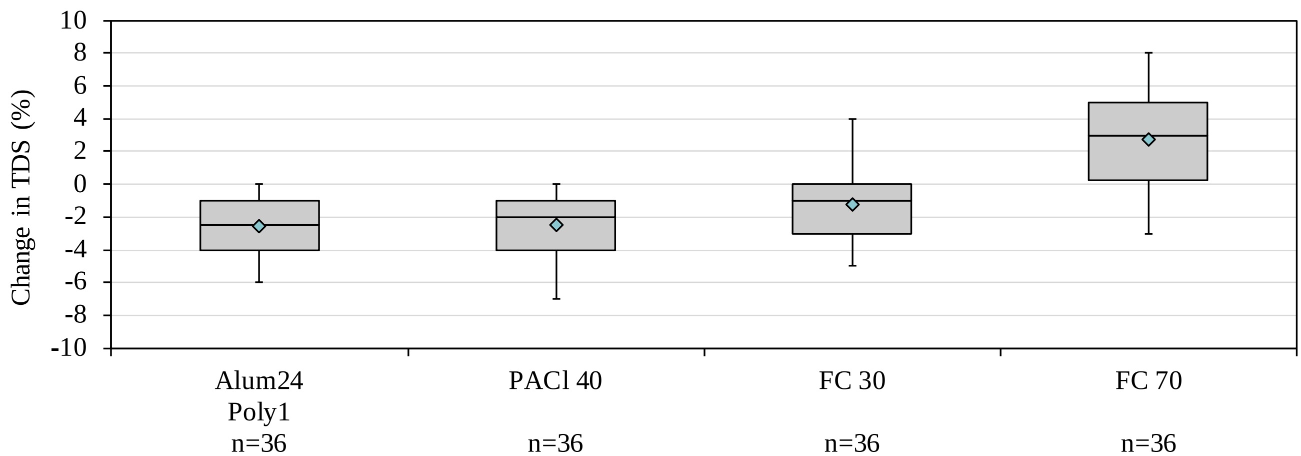

Figure 5-6. Summary of jar testing by UNR (figure developed by UNR)

Note that this figure indicates TDS removal (i.

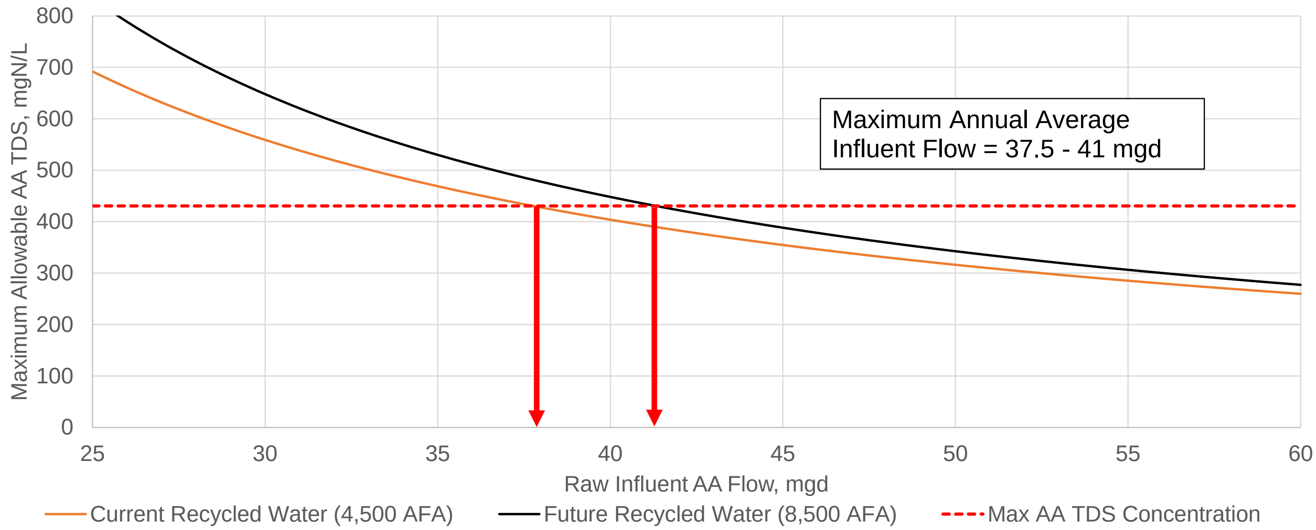

Figure 5-7. Maximum raw influent flow that TMWRF can treat while meeting TDS limit, if 46 percent removal of DON is achieved

This plot correlates the maximum allowable final effluent concentration to historical values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

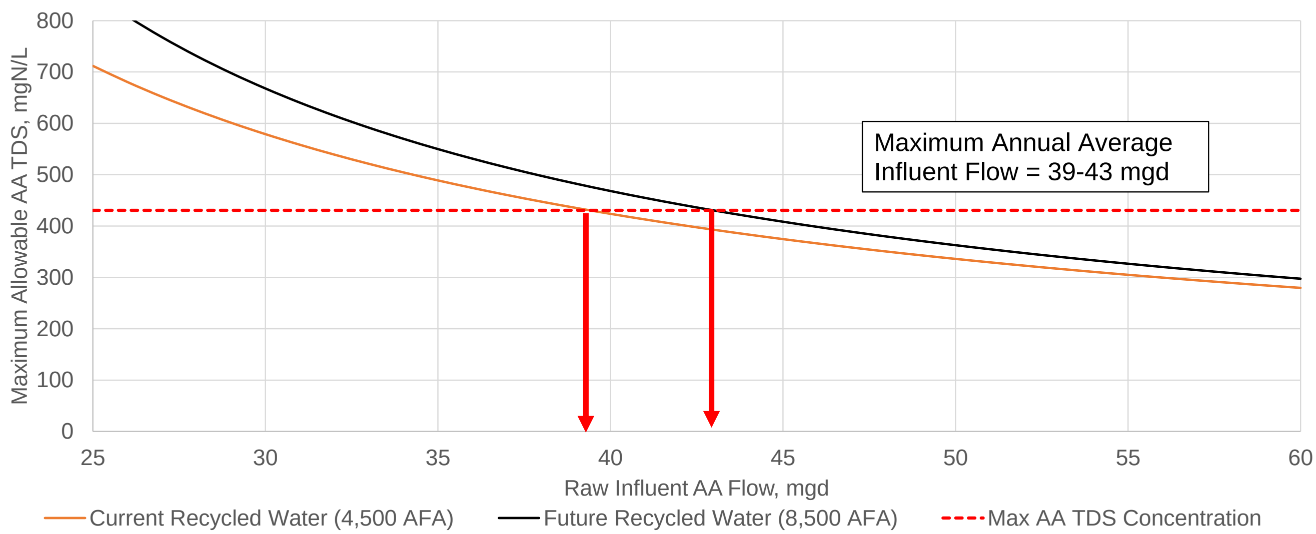

Figure 5-8. Maximum raw influent flow that TMWRF can treat while meeting TDS limit, if 46% removal of DON is achieved and ultraviolet (UV) disinfection is implemented

This plot correlates the maximum allowable final effluent concentration to historical values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

Table 5-4. Summary of Maximum AA Flow Rates Based on TDS TMDL		
	Maximum AA Influent Flow Assuming Current RW Flows, mgd	Maximum AA Influent Flow Assuming Future RW Flows, mgd
46% DON removal (PACl)	37.5	41
46% DON removal (PACl) + UV disinfection	39	43

5.2.1 TDS Changes Associated with Direct TWAS Dewatering

Direct TWAS dewatering was found to have many impacts to the facility. One positive benefit is that the struvite mitigation methods were found to no longer be needed. This included shutting down the phosphorus recovery facility and eliminating the regular addition of sulfuric acid into the sludge pipes to reduce struvite scaling. The main cause of high struvite scaling was the high phosphorus content of the biological sludge being digested, which is no longer the case. This has reduced TDS impacts from significantly reduced chemical use due to no longer needing sodium hydroxide and magnesium chloride at the phosphorus recovery facility nor sulfuric acid in the sludge pipes. The savings are described in more detail by Mentzer et al. 2021. Figure 5-9 shows the influent and effluent TDS concentrations over the historical period. Figure 5-10 shows the raw influent TDS minus the effluent TDS over the historical period. In general, effluent TDS concentrations were found to be statistically lower than other time periods, which is attributed to significant chemical reductions associated with TWAS dewatering. Table 5-5 summarizes the statistical analysis of changing TDS conditions.

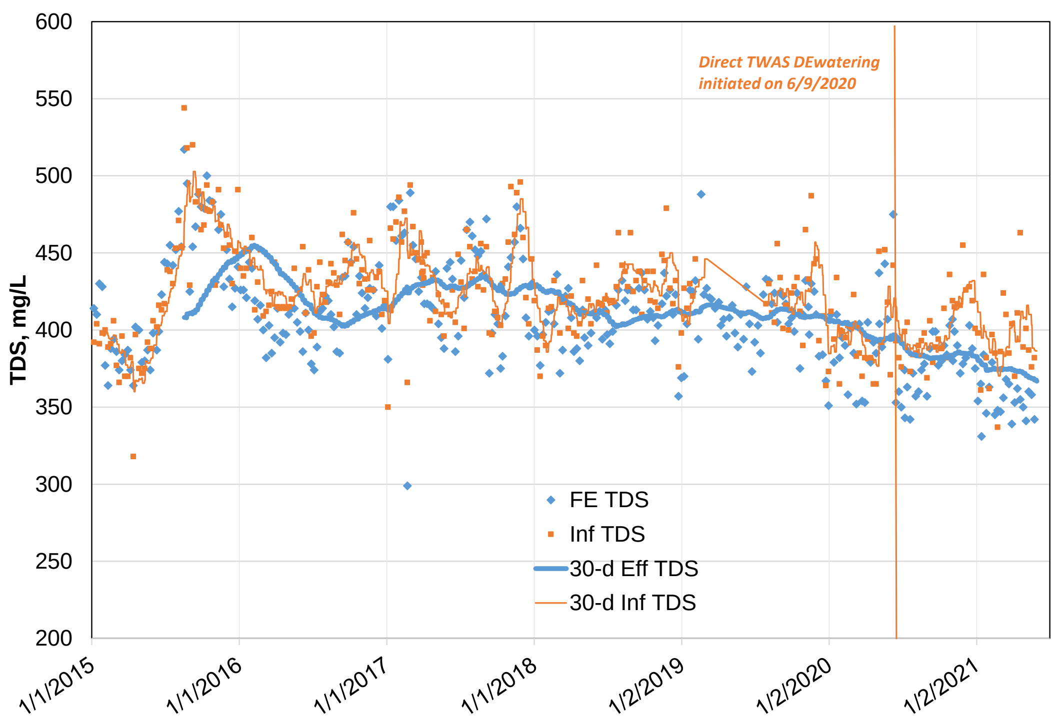

Figure 5-9. Influent and effluent TDS concentrations

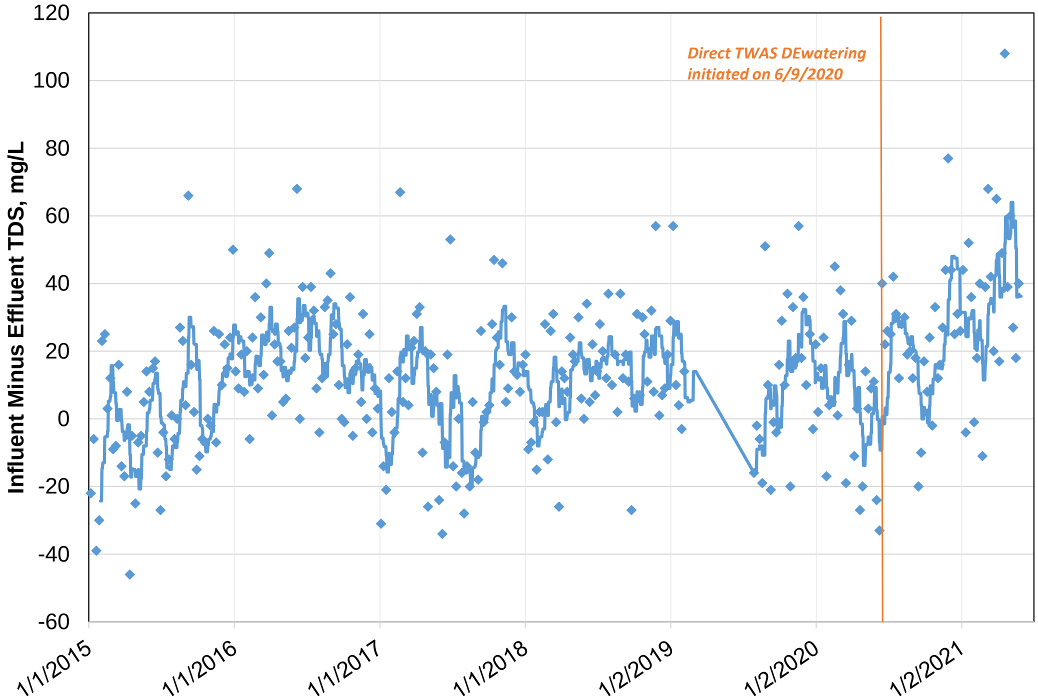

Figure 5-10. Influent minus effluent TDS concentrations

Table 5-5. Summary of TDS Statistical Analysis						
				p-value comparing average values to post dewatering period		
Timeframe	Influent TDS Average, mg/L	Effluent TDS Average, mg/L	Influent Minus Effluent TDS Average, mg/L	Influent TDS Average	Effluent TDS Average	Influent Minus Effluent TDS Average
2015	429	427	2	2.3E-04	2.1E-13	1.5E-07
2016	431	412	19	6.4E-10	5.9E-18	2.1E-02
2017	437	431	7	6.6E-10	1.3E-16	1.3E-05
2018	421	408	13	1.9E-05	2.3E-16	4.5E-04
2019	423	409	19	2.8E-04	9.6E-16	6.7E-03
1/1/20 - 6/8/20	396	390	7	**6.4E-01***	1.1E-03	2.1E-04
8/1/20-5/31/21*	399	370	29			

** Asterisk value was the only value found to __not__ be statistically different than the post TWAS dewatering period (8/1/21 – 5/31/21) based on a t-test comparison. Note that sulfuric acid was turned off on 7/27/20.*

The average influent minus effluent TDS concentration from January 1, 2015 through June 8, 2020, was found to be 10.1 mg/L. The average influent minus effluent TDS concentration post TWAS dewatering from August 1, 2020 through May 31, 2021, was 29 mg/L. This indicates that removing the chemicals associated with struvite mitigation had a beneficial impact by further reducing effluent TDS. The overall TDS concentration is not something that is readily controllable by the time wastewater reaches TMWRF, and may be impacted by industrial contributions, source water, and inflow and infiltration. Therefore, CIP triggers for advanced treatment facilities were not updated for this reduction in TDS. However, a sensitivity analysis was performed to evaluate the timing of the advanced treatment system such that if TDS concentrations stay low, the advanced treatment project could be delayed, saving significant capital dollars.

A sensitivity analysis was performed which evaluated the impact of further reducing the effluent TDS by 19 mg/L (equivalent to the additional average reduction between historical performance and post TWAS dewatering performance). This resulted in evaluating a maximum AA effluent TDS concentration of 412 mg/L (calculated as the previous assumption of 431 mg/L minus 19 mg/L).

Figures 5-11 and 5-12 present TMDL capacity plots for the scenarios described above.

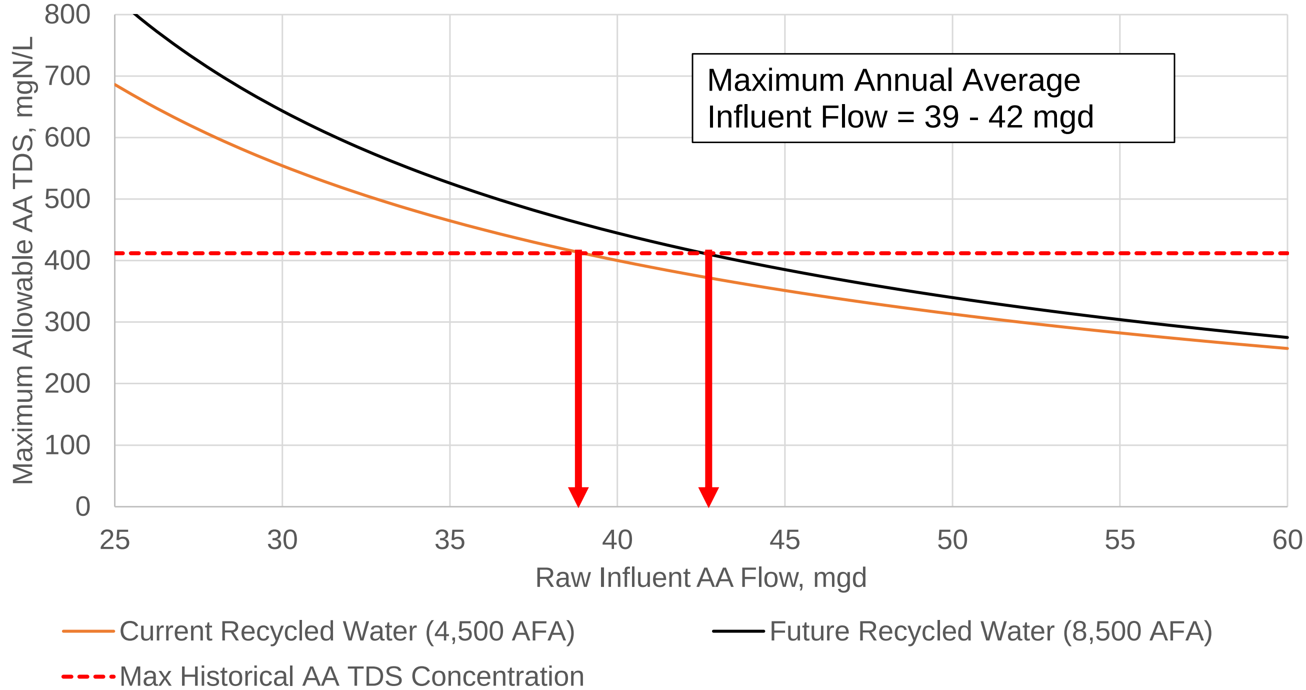

Figure 5-11. Maximum raw influent flow that TMWRF can treat while meeting TDS limit, if the maximum AA effluent TDS concentration were reduced to 412 mg/L

This plot correlates the maximum allowable final effluent concentration to post TWAS dewatering values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

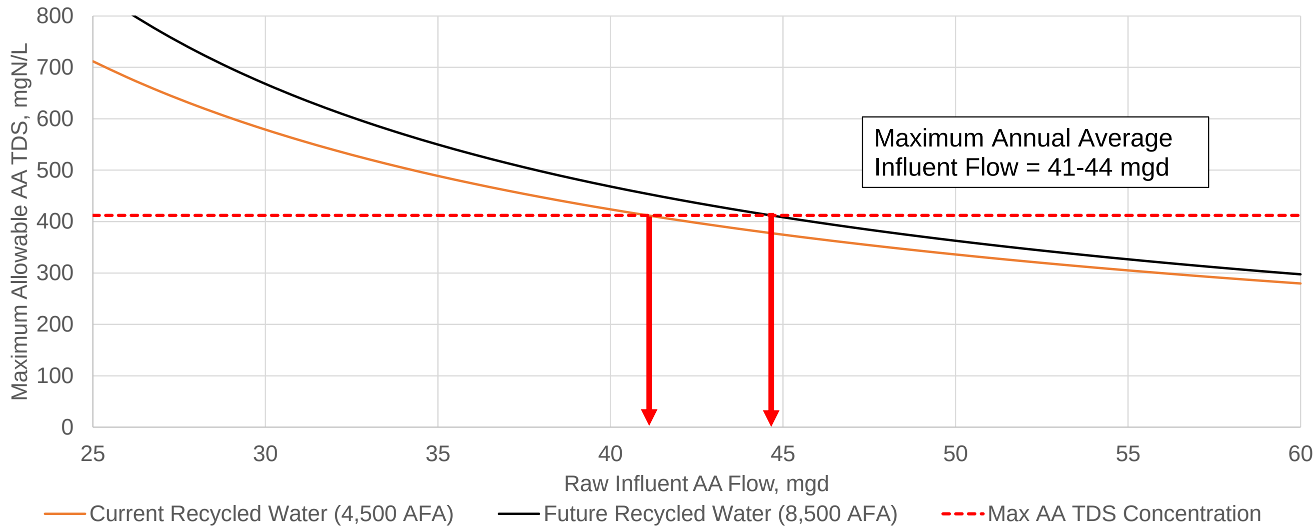

Figure 5-12. Maximum raw influent flow that TMWRF can treat while meeting TDS limit, if effluent TDS was reduced to 412 mg/L and 46%removal of DON is achieved and ultraviolet (UV) disinfection is implemented

This plot correlates the maximum allowable final effluent concentration to post TWAS dewatering values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

The result of this sensitivity analysis shows that the zero liquid discharge facility may not be needed, given the following:

- Effluent TDS is maintained below 412 mg/L with the current treatment scheme
- DON removal and UV disinfection are implemented, both of which would result in lowering effluent TDS further
- Future recycled water flows are achieved (8,500 AFA)

An additional scenario was evaluated to determine the impact to advanced treatment systems if the 90th percentile effluent TDS was achieved post TWAS dewatering (399 mg/L). The result was that 44 mgd could be achieved without UV disinfection, given the future recycled water flows were achieved (8,500 AFA). Figure 5-13 presents this information.

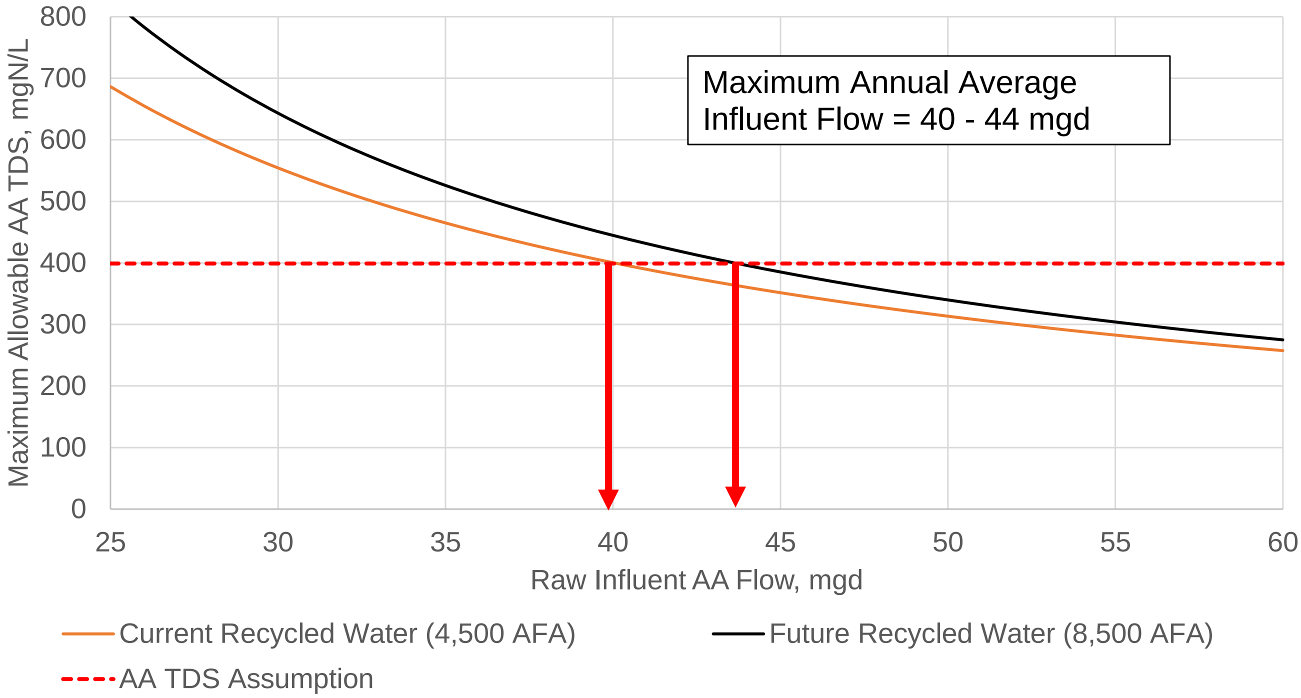

Figure 5-13. Maximum raw influent flow that TMWRF can treat while meeting TDS limit, if the maximum AA effluent TDS concentration were reduced to 399 mg/L

This plot correlates the maximum allowable final effluent concentration to post TWAS dewatering values to determine the maximum allowable influent flow rate that can be treated at TMWRF without exceeding the associated TMDL requirement.

Results from this section were not incorporated into Section 6 and therefore did not modify the CIP projects. It is recommended that TMWRF staff continue to monitor TDS concentrations closely and update the CIP as appropriate.

5.3 TMDL Conclusions

The capacity of TMWRF to discharge to Steamboat Creek is limited by the TN and TDS TMDLs, not the phosphorus TMDL. The updated annual average flow capacity ranges from 35 to 43 mgd, depending on the actual future recycled water flow and the disinfection method (UV versus chlorine). If a DON removal system and UV disinfection were implemented, TMWRF could expand capacity of the facility and still meet the various TMDL requirements up to 39 to 43 mgd (depending on recycled water flow rates). If TMWRF continued with the current wastewater treatment methods, the TN TMDL will be exceeded when influent annual average flows reach 35 to 39 mgd (16 to 30 percent higher than current annual average flow rates). It should be noted that these calculations do not account for any safety factor, and the flow rates shown are when the various TMDLs will be exceeded at the concentrations listed. In addition, if effluent TN or TDS concentrations change, the exceedance periods also will change.

Table 5-6 summarizes the maximum annual average flow rate that TMWRF can treat while maintaining compliance with the various TMDL requirements.

Table 5-6. Summary of Maximum Annual Average Influent Flow Rates Based on TMDL Requirements

Scenario	Maximum Annual Average Influent Flow			Limiting Factor
	Effluent TN Assumption	Assuming Current RW Flows	Assuming Future RW Flows	
Original Facility Plan Estimate	2.04 mg-N/L	34	37	TN TMDL
Updated Facility Plan Estimate	1.80 mg-N/L	37	40	TN TMDL
46% DON removal (PACl)	1.80 mg-N/L	37	41	TDS TMDL
46% DON removal (PACl) + UV disinfection for creek discharge	1.80 mg-N/L	39	43	TDS TMDL
Optimized system with a 15-mgd DON removal system, UV disinfection, and 9-mgd AA of recycled water flow	1.80 mg-N/L	44		TDS TMDL

5.3.1 Potential Changes to Advanced Treatment Options

The original facility plan assumed a 25-mgd DON removal system and a zero liquid discharge advanced treatment facility that produced 6 mgd of permeate in order to meet the various TMDLs at an influent annual average flow of 44 mgd and current recycled water flow rates. Due to the changes in effluent TN concentration and the revised TDS impact from PACl, the advanced treatment facilities can be smaller than originally anticipated to achieve 44 mgd of AA flow. Updated costs were not provided for smaller facilities. However, it is recommended that effluent TN and TDS concentrations continue to be monitored closely and sizing for advanced treatment systems can be updated after more effluent data is collected.

Section 6: Revised CIP and Implementation Schedule

Projects to increase the treatment capacity at TMWRF were identified during the alternative evaluation phase of this project. Projects were also identified to replace, repair, and rehabilitate (R/R/R) identified assets during the condition assessment phase of the project. Condition assessment included visual inspection of existing facilities and equipment that would be affected by each process alternative's implementation. Information obtained for the condition assessment was presented in TM 10. Information on the alternatives analysis is presented in TM 5.

A total of 44 projects were identified for Alternative 1 and a total of 42 projects were identified for Alternative 3 to improve TMWRF operations and to implement process capacity improvements to maintain permit compliance at a raw influent annual average flow rate of 44 mgd. Tables 6-1 and 6-2 present the recommended projects to include in the CIP for each alternative. Projects have been categorized for one of the following four purposes:

- **Process Capacity** – Projects identified as upgrades or additions to TMWRF facilities needed to increase process capacity and meet industry standards for redundancy requirements.
- **TMDL Compliance** –Projects required for TMWRF to maintain its TMDL compliance at increased process capacity.
- **Replacement, repair, and rehabilitation (R/R/R)** –Projects recommended for R/R/R due to mechanical, electrical, structural, or operational deficiencies determined during the condition assessment.
- **Support Facility Improvements** –Projects that include enhancements to TMWRF that make the facility operate more efficiently but are not necessary for achieving discharge permit compliance, which is the main goal of TMWRF.

Projects recommended for each alternative range from equipment replacements to facility rehabilitations and new process installations. Construction of these projects is far reaching and will affect many process areas within TMWRF. It was assumed TMWRF will pursue the TMDL compliance method by constructing a DON removal system, followed by an advanced treatment system for additional nitrogen and TDS reduction. Alternative 1 continues to expand TMWRF's existing treatment processes to meet future flows and loads. Alternative 3 requires the construction of a new Aqua Nereda process system to treat additional flow and loading. Additional process treatment and project details are outlined in TM 5.

Flow triggers for recommended CIP projects are based on the assumption that existing recycled water flow rates will be maintained. If future recycled water flow rates grow as planned, the triggers for TMDL compliance projects can be extended. In addition, flow triggers represent when the project needs to be in service and operating; therefore, planning, design, and construction will need to be planned beforehand. The TMDL compliance projects were developed to consume the entire waste load allocation for TMWRF at the design flow rate.

The costs presented are based on Class 5 estimates of proposed future projects for this Facility Plan, and these have been estimated with current costs (based on 2020 dollars) that may or may not reflect current inflationary trends. BC recommends that these estimates be revisited and updated closer to the time period that these projects will be implemented taking into consideration future escalation and market conditions.

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Table 6-1. Summary of CIP Projects for Alternative 1 – Status Quo+					
ID	Project	Project Description	Flow Trigger (mgd)	Project Driver	Capital Cost ($ Million)
1	Third Centrifuge and Cake Pump	Improves sludge dewatering performance and provides critical centrifuge redundancy.	30	Process Capacity	3.1
2	Replace two existing centrifuges with larger centrifuges to match new centrifuge	Improves sludge dewatering redundancy by adding two centrifuges to match new centrifuge. The timing of this project is based on providing n+2 redundancy.	30	Process Capacity	6.6
3	Nitrification Pump Repairs	Planned rebuilds of remaining three influent and three effluent pumps at $60k per pump.	30	R/R/R	0.5
4	NTFs 1, 3, 4 rehab	TMWRF recently completed rehab of NTF 2. This line item includes rehab for NTFs 1, 3, and 4.	30	R/R/R	16.5
5	Top Deck Recoating	Addresses concrete repairs, joint rehabilitation, and coatings on the top decks of each process area.	30	R/R/R	2.0
6	Pipe Gallery C Structural Repair	Addresses needed structural repairs and corrosion in the Pipe Gallery C ceiling, including broken concrete and cracking.	30	R/R/R	0.2
7	*RAS System 2 and 3 Improvements*	*Replaces existing RAS pumps, piping, and appurtenances that have surpassed their useful life and to improve pumping efficiency. System improvements similar to recently completed RAS System 1 improvements.*	30	R/R/R	*6.6*
8	Septage Receiving Improvements	Replaces the existing Franklin Miller septage receiving unit, rock trap, and miscellaneous piping; includes installing a new Vaugh chopper pump, and adding fall protection grating on septage wet well hatches to improve safety.	30	R/R/R	0.7
9	New Chiller for Gas Conditioning System	Improves reliability and adds redundancy that is not currently available. Cost estimate for new chiller installation from CR Engineering Heat Loop Report (4/2/20).	30	Process Capacity	0.4
10	New Sludge Heater Pumps	Replaces pumps that are at the end of their useful life.	30	R/R/R	0.8
11	Process Air Piping Replacement in Pipe Gallery A (West)	Fixes sections of process air piping in Pipe Gallery A, which are currently audibly leaking air.	30	R/R/R	1.1
12	FBR Expansion Phase 1	Provides a fifth fluidized bed reactor (FBR) cell needed to continue to treat peak week hydraulic capacity (existing system exhausts capacity at 30.3 mgd based on peak week hydraulic capacity)	30	Process Capacity	7.2
13	Gravity Filters Rehab	Rehabilitates concrete, pumps, compressors, and valves, and replaces media for all 12 filters. This rehab will be phased and likely not be performed as part of one project.	30	R/R/R	5.1
14	Gravity Thickeners Rehab	Structural rehabilitation of the concrete, re-coating of the mechanism and tank walls, replacement of all three thickened primary sludge (TPS) pumps, replacing all 6" TPS piping with 8" piping, and replacing primary sludge screens. This cost accounts for both thickeners.	30	R/R/R	4.1
15	DAFTs Rehab	Includes upgrades described in the Thickened Waste Activated Sludge (TWAS) Evaluation, February 6, 2019, assuming that the floor modifications, pump replacement, and temporary thickeners that are described in that report do not need to be implemented. The new TWAS dewatering facility assumes thinner sludge will be needed to maintain dewaterability of the TWAS, which prevents needing to incorporate the additional modifications recommended from the 2019 report needed to be able to handle sludge concentrations greater than 5 percent.	30	R/R/R	4.2
16	Grit Facility Rehab	Short-term improvements identified in the Grit Removal Recommendations Report, February 6, 2019.	30	R/R/R	6.0
17	Install new natural gas connection	Needed to meet peak demands based on Heat Loop Report, July 2019	30	Process Capacity	2.3
18	Nevada Energy Electrical Study	Study to determine if Nevada Energy can provide sufficient power to meet the requirements of the future electrical upgrades.	30	Process Capacity	0.3
19	AquaNereda Pilot	Study to confirm or update AquaNereda treatment performance and design criteria. Assumed an allowance of $1M for this study and associated equipment from the vendor.	30	Process Capacity	1.0
20	Aeration Tanks Rehab	Includes concrete repair/coating and diffuser replacement. This is a phased project, one for each tank and likely split into multiple projects.	30	R/R/R	8.4
21	Filter Expansion Phase 1	Requires filter expansion to maintain hydraulic capacity of filters. This cost includes construction of two new gravity filters.	32	Process Capacity	9.6
22	FBR Rehab	*Includes concrete repair and equipment replacement (all laterals, nozzles and main distribution header in stainless steel, media abrasion pumps). This is a phased project, one for each tank and likely split into multiple projects.*	32	R/R/R	*11.1*
23	Primary and Secondary Clarifiers Rehab Phase 1	Assumed to finish rehab of the primary and secondary clarifiers (8 tanks total). This is a phased project, one for each tank and likely split into multiple projects.	32	R/R/R	4.0
24	*New Dewatering Facility*	*This includes a new building with three centrifuges, centrate pumps and solids load out. It is assumed to operate with 2 duty centrifuges and 1 standby, to dewater blended raw TWAS and digested sludge. This project is key to the timing of future capacity improvements related to digestion and nutrient removal.*	34	Process Capacity	21.1
25	Two Additional Methanol Storage Tank	Two new methanol tanks required to maintain 14-day storage at peak conditions.	34	Process Capacity	2.7
26	System 3 Expansion Phase 1	Additional capacity required from System 3. Primary clarifiers exhaust capacity at 34 mgd as well as the secondary process. This project includes constructing one new primary clarifier, one new aeration tank, and one new secondary clarifier as part of System 3. Includes flow splitting structure upgrades to convey more primary effluent to System 3.	34	Process Capacity	29.1
27	NTFs 5-6 Rehab	Timed maintenance event expected to start in 2030. Assumed 34 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	34	R/R/R	11.0
28	Digester Rehab Phase 1	Timed maintenance event expected to start in 2030. Assumed 34 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	34	R/R/R	10.0
29	Electrical Upgrades	Allowance for a new 20-megavolt-amp (MVA) substation, transformers and other electrical upgrades. The highest cost alternative (larger substation) was included to provide a conservative planning cost to account for unknown costs (new transmission line, potential substation upgrade on the electric utility's side [Nevada Energy]).	34	Process Capacity	10.7

Table 6-1. Summary of CIP Projects for Alternative 1 – Status Quo+

ID	Project	Project Description	Flow Trigger (mgd)	Project Driver	Capital Cost ($ Million)
30	New Gravity Thickener	Required at this annual average flow based on capacity assessment and redundancy requirements.	35	Process Capacity	4.9
31	Replace existing blowers and associated electrical equipment	This is a timed replacement of the existing blowers in 2035. Assumed 36 mgd was appropriate for this timing.	36	R/R/R	10.2
32	Filter Bldg Bypass Pipeline	Provides redundancy in a critical pipeline leaving the granular media filters (GMFs). This project could be performed at same time as ultraviolet (UV) disinfection project due to similar yard piping work.	36	Process Capacity	0.6
33	DON Removal System	Used for TN compliance with a capacity of 25 mgd. Includes rapid mix and flocculation chambers and mixers as well as a lamella plate settler. This cost also includes a new PACl storage facility with three storage tanks with a volume of 10,500 gallons each.	37	TMDL Compliance	26.0
34	UV Disinfection System	Switching to UV provides operations and maintenance (O&M) savings and reduces TDS concentration to help with TMDL compliance.	37	TMDL Compliance	13.1
35	New Admin and Maint. Building	The Maintenance Building will need to be re-located when the advanced treatment facility is constructed. The location of the Maintenance Building will be determined during preliminary design. During preliminary design, an evaluation can be conducted to determine if it is more cost effective to construct a multi-level advanced treatment facility to reduce footprint and maintain the existing Admin and/or Maintenance Building. This cost estimate may be high/conservative if either building were to remain.	38	Support Facility	10.5
36	Advanced Treatment Facility	Used for TMDL (TN and TDS) compliance	39	TMDL Compliance	195.0
37	Filter Expansion Phase 2	Required to maintain hydraulic capacity of filters. Assuming two filters offline (one for maintenance and one for backwash).	39	Process Capacity	9.6
38	FBR Expansion Phase 2	Provides a sixth FBR cell needed to continue to treat peak week hydraulic capacity (4+1 configuration capacity exhausts at annual average flow of 40.4 mgd based on peak week hydraulic capacity). This also includes an allowance for improving hydraulics of the NTF effluent pumping station.	40	Process Capacity	7.2
39	Primary and Secondary Clarifiers Rehab Phase 2	***Rehab of primary and secondary clarifiers needed approximately 20 years after Phase 1. This is a phased project, one for each tank and likely split into multiple projects. Assumed to rehab all 14 existing clarifiers, plus 4 PHOstrip tanks, plus the 2 clarifiers installed as part of System 3, Phase 1 CIP project. Assumed to be a phased project broken into multiple projects.***	40	R/R/R	***14.0***
40	System 3 Expansion Phase 2	Add one new primary clarifier and one new secondary clarifier to complete the build out of System 3 to match Systems 1 and 2.	40	Process Capacity	15.8
41	Digester Rehab Phase 2	Timed maintenance event expected to start in 2045. Assumed 41 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	41	R/R/R	10.0
42	Sidestream Nutrient Removal	Either sidestream nitrogen treatment or a 7th NTF is needed at this time, based on maximum month loading to the NTFs.	***41***	Process Capacity	14.2
43	NTFs 1-4 Rehab	Timed maintenance event expected to start in 2050. Assumed 42 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	42	R/R/R	22.0
44	Convert Acid Phase Digester to Sludge Holding Tank	Convert acid phase digester to sludge holding tank. Includes wall coating on interior of digester, piping and valves, and new recirculation pump. This project is not needed immediately for capacity (due to digester capacity relief from TWAS dewatering project) but can be used to streamline operations by removing the intermediate digestion step.	42	Process Capacity	8.0

Table 6-2. Summary of CIP Projects for Alternative 3 - Hybrid

ID	Project Name	Project Description	Flow Trigger (mgd)	Project Driver	Capital Cost ($ Million)
1	Third Centrifuge and Cake Pump	Improves sludge dewatering performance and provides critical centrifuge redundancy.	30	Process Capacity	3.1
2	Replace two existing centrifuges with larger centrifuges to match new centrifuge	Improves sludge dewatering redundancy by adding two centrifuges to match new centrifuge. The timing of this project is based on providing n+2 redundancy.	30	Process Capacity	6.6
3	Nitrification Pump Repairs	Planned rebuilds of remaining three influent and three effluent pumps at $60k per pump.	30	R/R/R	0.5
4	NTFs 1, 3, 4 Rehab	TMWRF recently completed rehab of NTF 2. This line item includes rehab for NTFs 1, 3, and 4.	30	R/R/R	16.5
5	Top Deck Recoating	Addresses concrete repairs, joint rehabilitation, and coatings on the top decks of each process area.	30	R/R/R	2.0
6	Pipe Gallery C Structural Repair	Addresses needed structural repairs and corrosion in the Pipe Gallery C ceiling, including broken concrete and cracking.	30	R/R/R	0.2
7	*RAS System 2 and 3 Improvements*	*Replaces existing RAS pumps, piping, and appurtenances that have surpassed their useful life and to improve pumping efficiency. System improvements similar to recently completed RAS System 1 improvements.*	30	R/R/R	*6.6*
8	Septage Receiving Improvements	Replaces the existing Franklin Miller septage receiving unit, rock trap, and miscellaneous piping; includes installing a new Vaugh chopper pump, and adding fall protection grating on septage wet well hatches to improve safety.	30	R/R/R	0.7
9	New Chiller for Gas Conditioning System	Improves reliability and adds redundancy that is not currently available. Cost estimate for new chiller installation from CR Engineering Heat Loop Report (4/2/20).	30	Process Capacity	0.4
10	New Sludge Heater Pumps	Replaces pumps that are at the end of their useful life.	30	R/R/R	0.8
11	Process Air Piping Replacement in Pipe Gallery A (West)	Fixes sections of process air piping in Pipe Gallery A, which are currently audibly leaking air.	30	R/R/R	1.1
12	FBR Expansion Phase 1	Provides a fifth FBR cell needed to continue to treat peak week hydraulic capacity (existing system exhausts capacity at 30.3 mgd based on peak week hydraulic capacity)	30	Process Capacity	7.2
13	Gravity Filters Rehab	Rehabilitates concrete, pumps, compressors, and valves, and replaces media for all 12 filters. This rehab will be phased and likely not be performed as part of one project.	30	R/R/R	5.1
14	Gravity Thickeners Rehab	Structural rehabilitation of the concrete, re-coating of the mechanism and tank walls, replacement of all three thickened sludge (TPS) pumps, replacing all 6" TPS piping with 8" piping, and replacing primary sludge screens. This cost accounts for both thickeners.	30	R/R/R	4.1
15	DAFTs Rehab	Includes upgrades described in the Thickened Waste Activated Sludge (TWAS) Evaluation, February 6, 2019, assuming that the floor modifications, pump replacement, and temporary thickeners that are described in that report do not need to be implemented. The new TWAS dewatering facility assumes thinner sludge will be needed to maintain dewaterability of the TWAS, which prevents needing to incorporate the additional modifications recommended from the 2019 report to be able to handle sludge concentrations greater than 5 percent.	30	R/R/R	4.2
16	Grit Facility Rehab	Short-term improvements identified in the Grit Removal Recommendations Report, February 6, 2019.	30	R/R/R	6.0
17	Install new natural gas connection	Needed to meet peak demands based on Heat Loop Report, July 2019	30	Process Capacity	2.3
18	Nevada Energy Electrical Study	Study to determine if Nevada Energy can provide sufficient power to meet the requirements of the future electrical upgrades.	30	Process Capacity	0.3
19	AquaNereda Pilot	Study to confirm or update AquaNereda treatment performance and design criteria. Assumed an allowance of $1M for this study and associated equipment from the vendor.	30	Process Capacity	1.0
20	Aeration Tanks Rehab	Includes concrete repair/coating and diffuser replacement. This is a phased project, one for each tank and likely split into multiple projects.	*30*	R/R/R	8.4
21	Filter Expansion Phase 1	Requires filter expansion to maintain hydraulic capacity of filters. This cost includes construction of two new gravity filters.	32	Process Capacity	9.6
22	FBR Rehab	*Includes concrete repair and equipment replacement (all laterals, nozzles and main distribution header in stainless steel, media abrasion pumps). This is a phased project, one for each tank and likely split into multiple projects.*	32	R/R/R	*11.1*
23	Primary and Secondary Clarifiers Rehab Phase 1	Assumed to finish rehab of the primary and secondary clarifiers (8 tanks total). This is a phased project, one for each tank and likely split into multiple projects.	32	R/R/R	4.0
24	*New Dewatering Facility*	*This includes a new building with three centrifuges, centrate pumps and solids load out. It is assumed to operate with 2 duty centrifuges and 1 standby, to dewater blended raw TWAS and digested sludge. This project is key to the timing of future capacity improvements related to digestion and nutrient removal.*	34	Process Capacity	21.1
25	Fourth Methanol Storage Tank	One new methanol tank required to maintain 14-day storage.	34	Process Capacity	1.7
26	Aqua Nereda Process Phase 1	Used to take additional load once aeration tanks run out of capacity. Install primary influent splitting upgrades, new primary influent pump station with screening, two Aqua Nereda reactors, one water level correction tank, one sludge buffer tank, and new blower building.	34	Process Capacity	62.6
27	NTFs 5-6 Rehab	Timed maintenance event expected to start in 2030. Assumed 34 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	34	R/R/R	11.0
28	Digester Rehab Phase 1	Timed maintenance event expected to start in 2030. Assumed 34 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	34	R/R/R	10.0
29	Electrical Upgrades	Allowance for a new 20-MVA) substation, transformers and other electrical upgrades. The highest cost alternative (larger substation) was included to provide a conservative planning cost to account for unknown costs (new transmission line, potential substation upgrade on the electric utility's side [Nevada Energy]).	34	Process Capacity	10.7

Table 6-2. Summary of CIP Projects for Alternative 3 - Hybrid					
ID	Project Name	Project Description	Flow Trigger (mgd)	Project Driver	Capital Cost ($ Million)
30	Replace existing blowers and associated electrical equipment	This is a timed replacement of the existing blowers in 2035. Assumed 36 mgd was appropriate for this timing.	36	R/R/R	10.2
31	Filter Bldg Bypass Pipeline	Provides redundancy in a critical pipeline leaving the GMFs. This project could be performed at same time as UV disinfection project due to similar yard piping work.	36	Process Capacity	0.6
32	DON Removal System	Used for Total Nitrogen (TN) compliance with a capacity of 25 mgd. Includes rapid mix and flocculation chambers and mixers as well as a lamella plate settler. This cost also includes a new PACl storage facility with three storage tanks with a volume of 10,500 gallons each.	***37***	TMDL Compliance	26.0
33	UV Disinfection System	Switching to UV provides O&M savings and reduces TDS concentration to help with TMDL compliance.	37	TMDL Compliance	13.1
34	New Admin and Maint. Building	The Maintenance Building will need to be re-located when the advanced treatment facility is constructed. The location of the Maintenance Building will be determined during preliminary design. During preliminary design, an evaluation can be conducted to determine if it is more cost effective to construct a multi-level advanced treatment facility to reduce footprint and maintain the existing Admin and/or Maintenance Building. This cost estimate may be high/conservative if either building were to remain.	38	Support Facility	10.5
35	Advanced Treatment Facility	Used for TMDL (TN and TDS) compliance	***39***	TMDL Compliance	195.0
36	Filter Expansion Phase 2	Required to maintain hydraulic capacity of filters. Assuming two filters offline (one for maintenance and one for backwash).	39	Process Capacity	9.6
37	Aqua Nereda Process Phase 2	Construct two additional Aqua Nereda reactors and add additional blowers and pumps to the facilities constructed as part of Phase 1.	39	Process Capacity	52.9
38	FBR Expansion Phase 2	Provides a sixth FBR cell needed to continue to treat peak week hydraulic capacity (4+1 configuration capacity exhausts at annual average flow of 40.4 mgd based on peak week hydraulic capacity). This also includes an allowance for improving hydraulics of the NTF effluent pumping station.	40	Process Capacity	7.2
39	Primary and Secondary Clarifiers Rehab Phase 2	***Rehab of primary and secondary clarifiers needed approximately 20 years after Phase 1. This is a phased project, one for each tank and likely split into multiple projects. Assumed to rehab all 14 clarifiers plus 4 PHOstrip tanks.***	40	R/R/R	***12.6***
40	Digester Rehab Phase 2	Timed maintenance event expected to start in 2045. Assumed 41 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	41	R/R/R	10.0
41	NTFs 1-4 Rehab	Timed maintenance event expected to start in 2050. Assumed 42 mgd was appropriate for this timing. This is a phased project, one for each tank and likely split into multiple projects.	42	R/R/R	22.0
42	Convert Acid Phase Digester to Sludge Holding Tank	Convert acid phase digester to sludge holding tank. Includes wall coating on interior of digester, piping and valves, and new recirculation pump. This project is not needed immediately for capacity (due to digester capacity relief from TWAS dewatering project) but can be used to streamline operations by removing the intermediate digestion step.	42	Process Capacity	8.0

It should be noted that this CIP includes a cost for a new dewatering facility. The purpose of the new dewatering facility was to dewater TWAS and provide a separate solids loadout for dewatered TWAS. TMWRF staff have since optimized the dewatering system such that a blend of TWAS and digested sludge is processed through the centrifuges. However, TMWRF's existing hoppers and centrifuges do not have sufficient capacity to process the solids (hoppers are already past their rated capacity at peak day conditions with two days of storage, and the current centrifuge project will result in a process capacity near 34 mgd). The solids cake pumps, centrate sump, and piping within the existing Sludge Dewatering Building are also thought to be capacity limited. As described in Section 4.2, BC recommends that a preliminary design report evaluating the construction of a new dewatering facility to dewater sludge from a blend of digested sludge and raw TWAS be completed. At this time, it is estimated that a new dewatering building is needed by the time TMWRF reaches 34 mgd AA flow. The preliminary design report should revisit this trigger based on additional operational optimization efforts that TMWRF staff are planning on conducting soon. If optimizations are found to be beneficial, then the trigger point for having the new dewatering facility operational may be later than 34 mgd.

As a result of the optimization efforts described earlier in this TM, the following changes to the CIP were made:

Changes to both alternatives:

- Removed installation of Gas Conditioning Biotower 2, since additional gas treatment capacity was unlocked from TWAS dewatering.
- Changed the TWAS Dewatering project to a new, combined Dewatering Facility at a flow trigger of 34 mgd.
- Moved the Aeration Tank Rehabilitation project from a flow trigger of 32 mgd to 30 mgd, because the planning for this project by TMWRF is already underway.
- Replaced RAS System 3 pump replacement project with RAS System 2 and 3 Improvements project, which increased the cost from $1.2M to $6.6M.
- Reduced the FBR Rehabilitation project cost from $13.3M to $11.1M by removing media replacement and fluidization pump replacement. Media is replaced regularly through the Operations Budget and the fluidization pumps are being rebuilt under a separate CIP project (Nitrification Pump Repairs)
- Moved the DON Removal System project to a flow trigger of 37 mgd (from 34 mgd).
- Moved the Advanced Treatment Facility project to 39 mgd (from 38 mgd) based on reduced TDS concentrations.

Changes to Alternative 1:

- Removed construction of the NTF 7 due to lower nitrogen loading associated with TWAS dewatering.
- Moved the sidestream nutrient removal project from a flow trigger of 42 mgd to 41 mgd.
- Added four PHOstrip tanks and two of the newer System 3 Clarifiers to the Primary and Secondary Clarifiers Rehabilitation Phase 2 Project, increasing the cost from $9.8M to $14M.

Changes to Alternative 3:

- Removed new gravity thickener project (previously at a flow trigger of 35 mgd) because it is not needed for this alternative.
- Removed the sidestream nutrient removal project because it is no longer needed for this alternative.
- Added four PHOstrip tanks to the Primary and Secondary Clarifiers Rehabilitation Phase 2 Project, increasing the cost from $9.8M to $12.6M.

6.1 Implementation Influent Flow Triggers

The amount of AA influent flow received at TMWRF is a pivotal factor affecting project initiation. Critical flow thresholds were determined to continue appropriate and effective process treatment capabilities. Figures 6-1 and 6-2 summarize the breakdown of capital expenditure for Alternatives 1 and 3, respectively. These plots separate capital cost based on the driver for each project, the AA influent flow rate that will trigger the project, and the planning-level capital cost estimate. Flow triggers assume existing recycled water flow rates are unchanged in the future. If future recycled water flow rates increase, the TMDL compliance projects can be pushed into the future.

The AA influent flow rate triggers begin at 30 mgd and were evaluated through 44 mgd. Projects listed with an implementation trigger of 30 mgd are assumed to begin implementation in 2021. Projects with triggers less than 30 mgd are shown as 30 mgd since the annual average flow is already close to 30 mgd. Nineteen of the projects are triggered at the 30-mgd influent flow threshold for both alternatives.

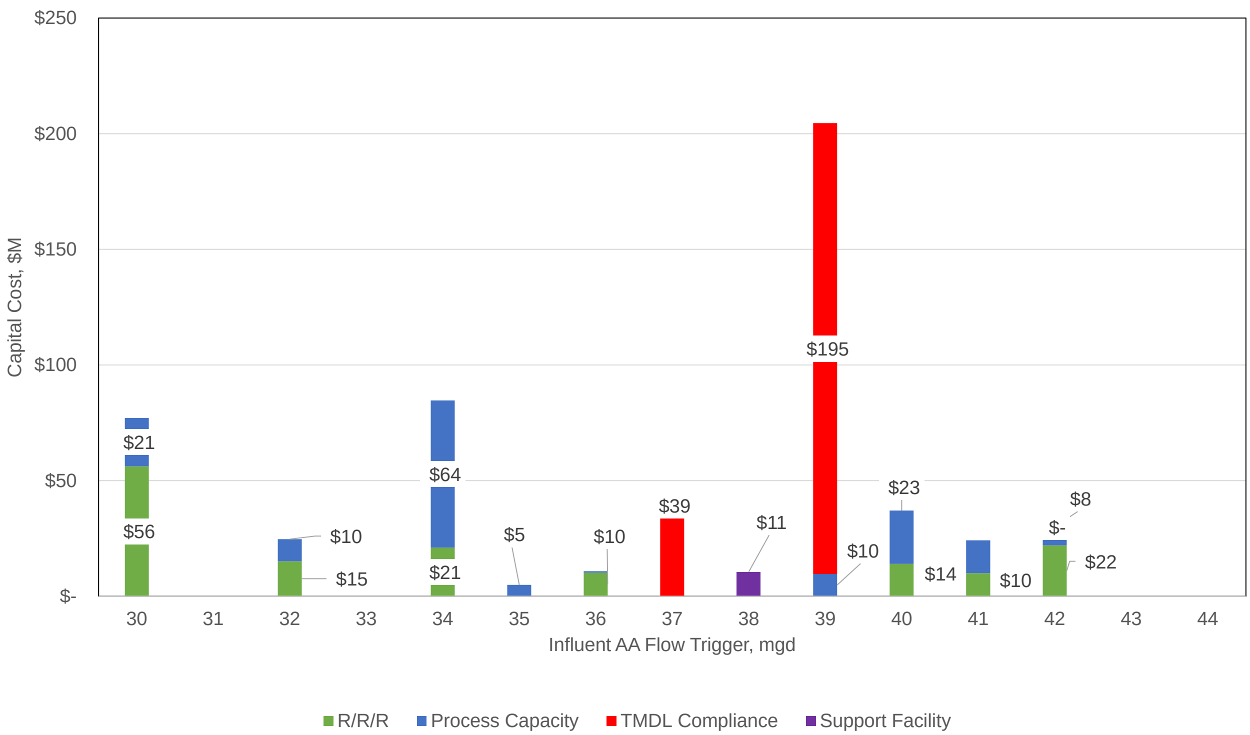

Figure 6-1. Alternative 1 (Status Quo+): Capital costs for project drivers for influent AA flow rates

The trigger points assume that existing RW production does not change.

Increasing RW flow rates may enable delaying projects compared to that shown.

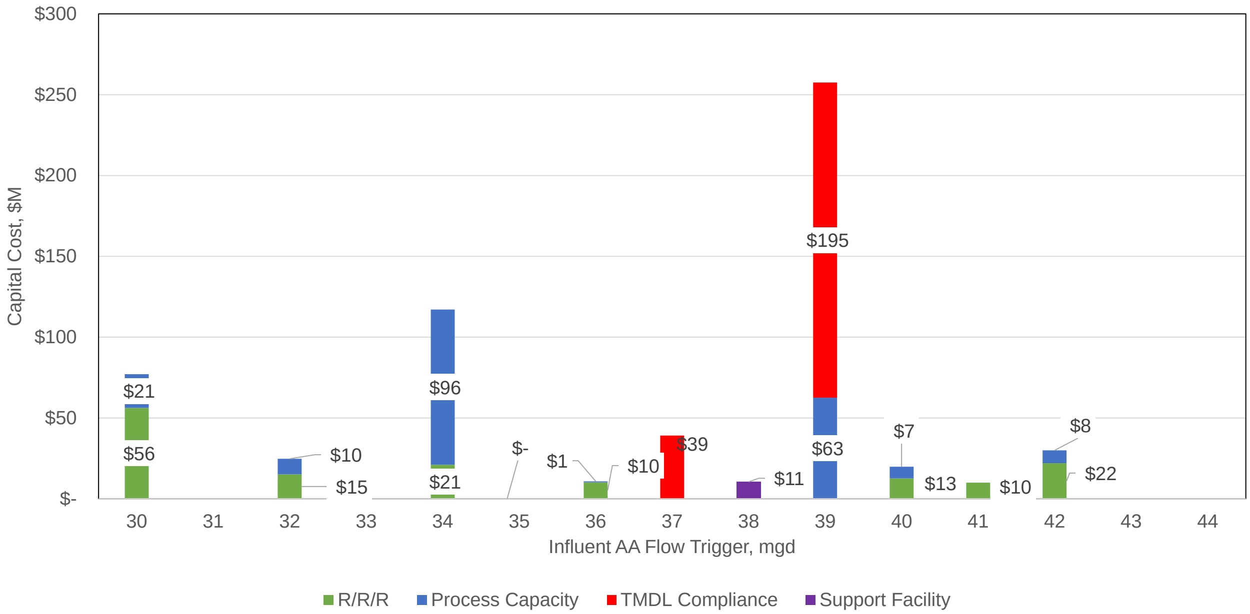

Figure 6-2. Alternative 3 (Hybrid): Capital costs for project drivers for influent AA flow rates

The trigger points assume that existing RW production does not change.

Increasing RW flow rates may enable delaying projects compared to that shown.

6.2 Total CIP Cost Estimates

A planning-level capital cost was developed for each project to provide a financial context for evaluation. Total estimated capital costs to complete all projects for TMWRF to reach the 44 mgd AA flow is $620 million. All estimated project costs are in 2020 dollars. Since TMWRF is expected to reach an AA influent flow of 30 mgd relatively soon, planning should begin to complete the 30-mgd projects that are triggered at this flow threshold.

Figure 6-3 shows the CIP spending for Alternative 1 (Status Quo^{+}) at each flow trigger. The 30-mgd-triggered projects are estimated to total approximately $78 million. Planning for longer-term projects capable of treating AA influent flow of 34 mgd are estimated to cost approximately $187 million. The advanced treatment facility is the largest CIP project and is needed to be in operation by the time TMWRF reaches 39-mgd AA flow. To meet the process requirements for the 39-mgd AA flow, a total of $457 million in capital spending will be needed. To meet the process requirements for the 44-mgd AA flow, a total of $548 million is required.

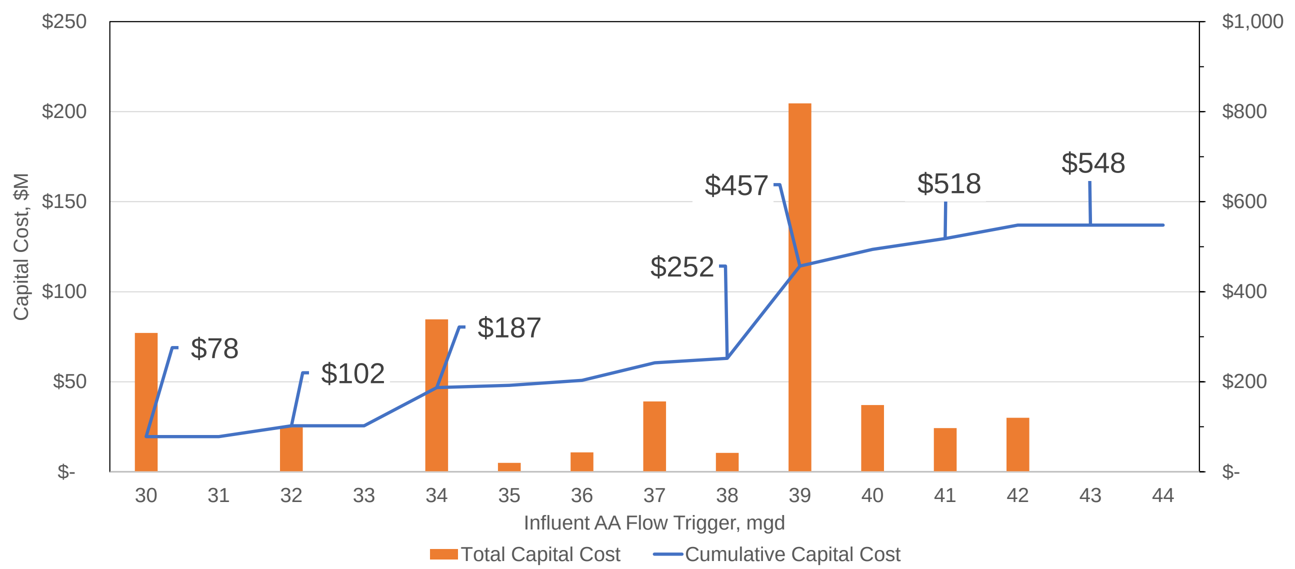

Figure 6-3. Alternative 1 (Status Quo⁺): Total and cumulative capital costs for influent AA flow rates

The data labels display the cumulative capital costs at key trigger points.

Capital costs assume existing RW flow rates are maintained.

Figure 6-4 shows the CIP spending for Alternative 3 (Hybrid) at each flow trigger. The 30-mgd-triggered projects are estimated to total approximately $78 million, equal to the Status Quo⁺ alternative. Planning for longer-term projects capable of treating AA influent flow of 34 mgd are estimated to cost approximately $219 million. The advanced treatment facility is the largest CIP project and is needed to be in operation by the time TMWRF reaches 39-mgd AA flow. To meet the process requirements for the 39-mgd AA flow, a total of $537 million in capital spending is needed. To meet the process requirements for the 44-mgd AA flow, a total of $597 million is required.

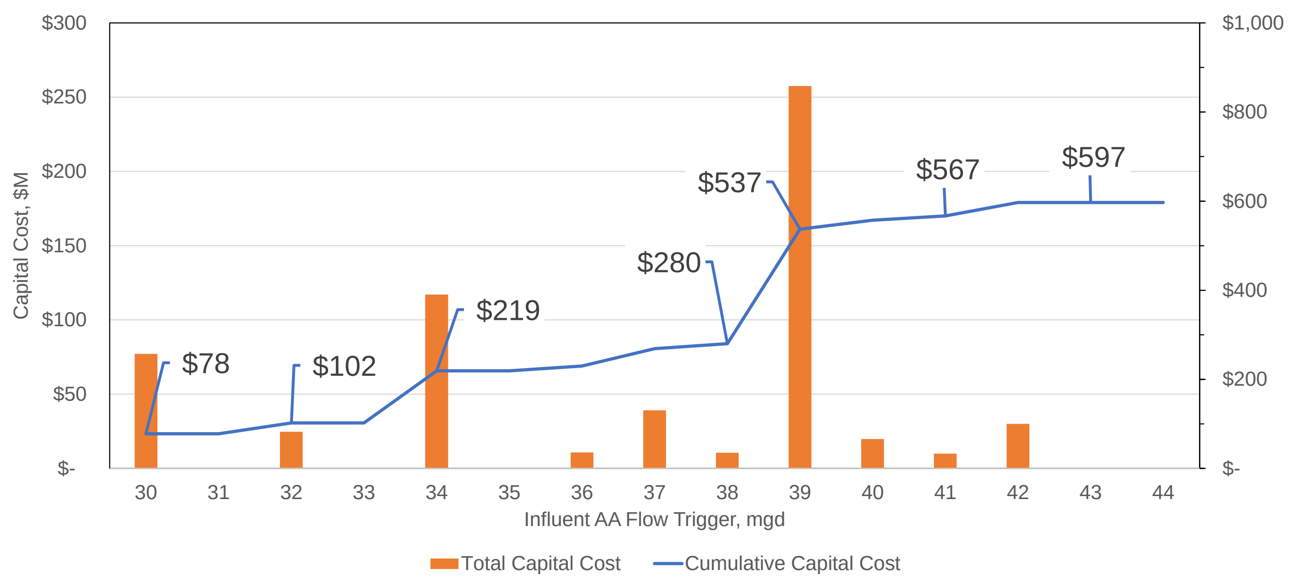

Figure 6-4. Alternative 3 (Hybrid): Total and cumulative capital costs for influent AA flow rates

The data labels display the cumulative capital costs at key trigger points.

Capital costs assume existing RW flow rates are maintained.

Section 7: References

Mentzer, C., Drinkwater, M. Wide-Reaching Improvements Through Direct TWAS Dewatering, WEF Biosolids Conference, 2021.

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Attachment A: Additional Time Series Data Plots

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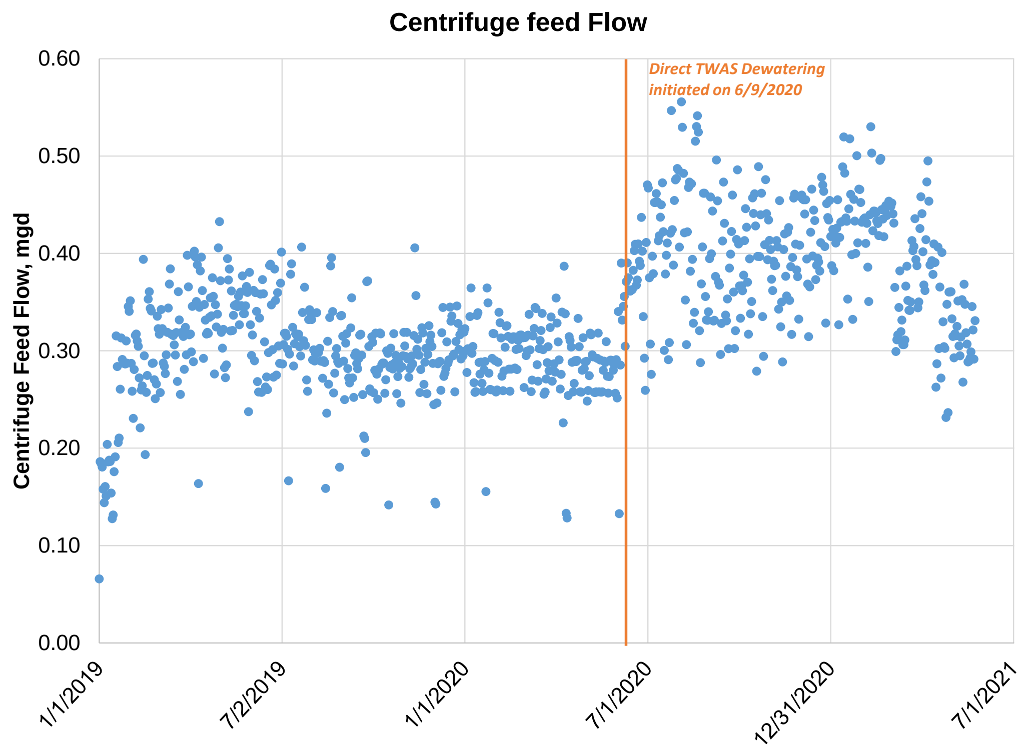

Figure A-1. Centrifuge feed flow

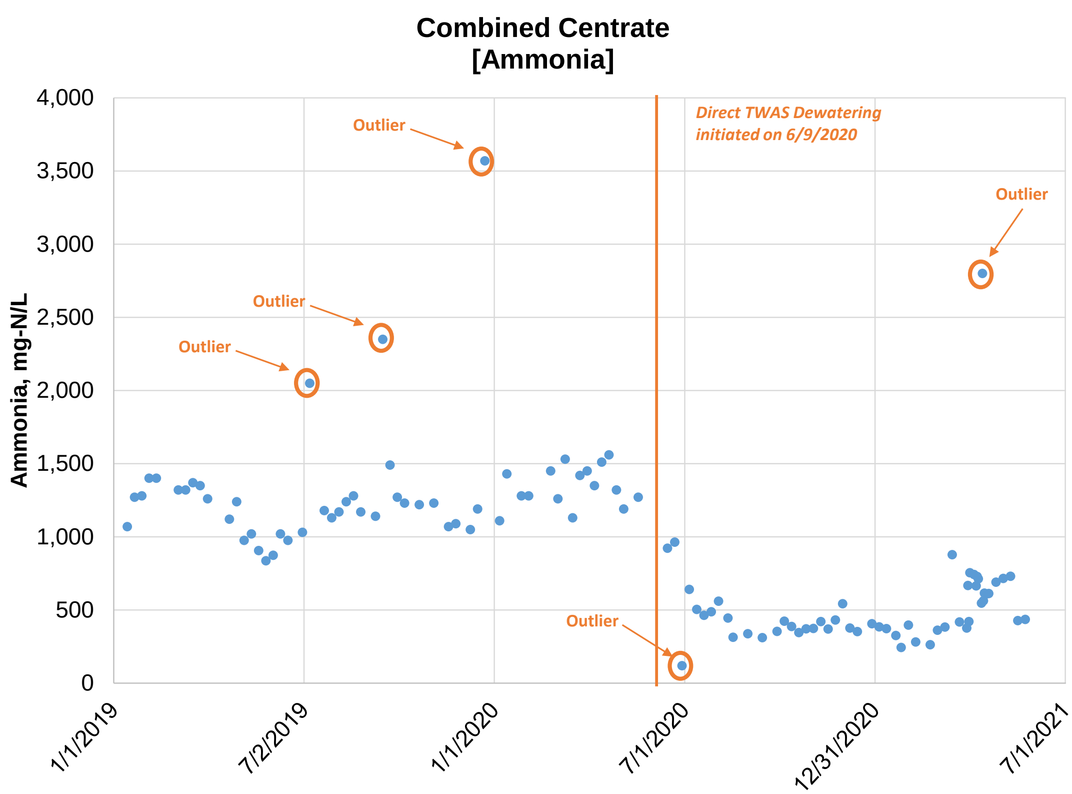

Figure A-2. Combined centrate ammonia concentrations

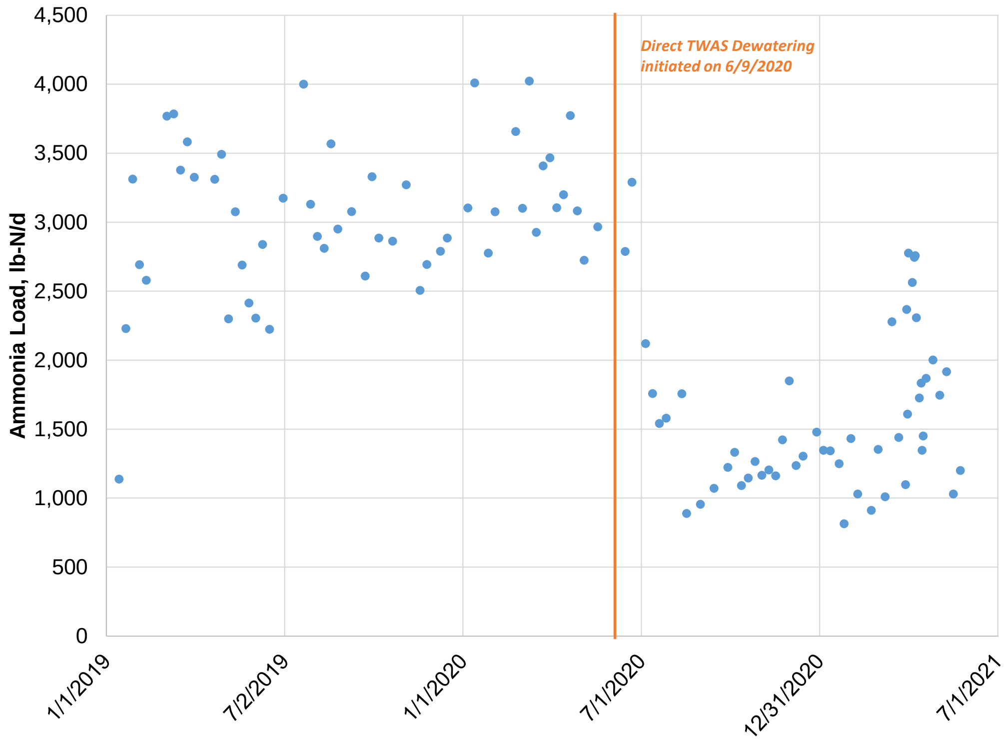

Figure A-3. Combined centrate ammonia load

Attachment B: Updated Capacity Calculations

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153299 TMWRF
TREATMENT CAPACITY
EVALUATION T005

Problem Statement: This MathCad sheet is used to evaluate existing process capacity of the Nitrification Towers at the TMWRF. This calculation is for the Status Quo Alternative.

Secondary effluent ammonia concentration and max month peaking factor for 2017 (see TMWRF SE Flow and Load Analysis)

$Flow := 30.9mgd$ ***Influent average flow from 2017 (Collection system flow meter)***

$PF_{NH330d} := 1.20$

$NH3_C := 18.5\frac{mg}{L}$ ***Average SE system 1 ammonia concentration from 6/15/20 to 5/31/21 was 18.5***

$NH3_{ADL} := NH3_C \cdot Flow \cdot 1.1 = 5.248 \times 10^3 \cdot \frac{lb}{day}$ ***Used average ammonia concentration in SE 1 plus added 10% buffer for other unquantified (flow) return streams/uncertainty.***

$Centrate_{ADL} := 0.33mgd \cdot 500\frac{mg}{L} = 1377 \cdot \frac{lb}{day}$ ***Centrate Load based discussions with TMWRF staff based on dewatering optimization assumptions and data from 2020/2021***

$Loading_{Max} := 0.22\frac{lb}{1000\,ft^2 day}$ ***Maximum secondary effluent ammonia loading criterion based on design value for Towers 1 through 4***

$Media := 68\frac{ft^2}{ft^3}$ ***Media used in existing towers***

$n_{Towers} := 6$

$d_{Media} := 20ft$

There are 6 towers that are assumed to all be in operation at all times. Each tower is 88-ft diameter with 20-ft of media.

$diameter := 88ft$

153299 TMWRF
TREATMENT CAPACITY
EVALUATION T005

Calculate the maximum month loading the towers can treat

$$MML_{Ammonia} := Loading_{Max} \cdot n_{Towers} \cdot d_{Media} \cdot \left(\frac{\pi}{4} diameter^2\right) Media = 10919 \cdot \frac{lb}{day}$$

Calculate annual average flow capacity with return streams

$Q_{assumed} := 41.4mgd$ Iterate to match capacity below, to scale centrate load up with flow

$$Capacity := \frac{MML_{Ammonia}}{NH3_{ADL} \cdot PF_{NH330d} + Centrate_{ADL} \cdot \frac{Q_{assumed}}{Flow}} Flow = 41.4 \cdot mgd$$

Need to construct additional NTF or else sidestream treatment at 41 mgd.

153299 TMWRF
TREATMENT CAPACITY
EVALUATION T005

Problem Statement: This MathCad sheet is used to evaluate the dewatering process at the TMWRF.

$Number := 2$	Duty centrifuges (1 standby, 3 total)
$AAF_{centrifuge} := 230gpm$	Annual average centrifuge flow with digested sludge and raw TWAS blended sludge flow (per Casey Mentzer, 8/4/21)
$InfQ := 30.9mgd$	Annual average influent flow rate
$PDPF := 1.43$	Peak day dewatering flow peaking factor
$Capacity_{obs} := 360\,\frac{gal}{min}$	Actual hydraulic capacity observed by plant staff with two alpha lavals online (2 of the smaller centfrifuges, 180-200 gpm each, so 360 gpm total)

$$InfluentQ_{PD} := \frac{Capacity_{obs}}{PDPF \cdot \left(\frac{AAF_{centrifuge}}{InfQ}\right)} = 33.8 \cdot mgd$$

Capacity with planned upgrades reaches close to 34 mgd. Assuming TMWRF continues to use tools available to them for dampening peak day loading, it is reasonable to assume this centrifuge capacity can reach 34 mgd AA influent flow.

Brown AND Caldwell

153299 TMWRF
TREATMENT CAPACITY
EVALUATION T005

Problem Statement: This MathCad sheet is used to evaluate the hopper storage at the TMWRF.

$Number := 4$

$V_{hopper} := 3800 ft^3 = 28426 gal$

$TotalV_{hopper} := Number \cdot V_{hopper} = 113704 gal$

Assume all hoppers are in service during peak day (which equals peak week conditions)

Assume capacity based on providing 2 days of storage at Peak Week conditions (Similar to City of San Jose design criteria which is based on survey of Bay Area agencies)

$Storage_{duration} := 2day$

$$Capacity_{hopper} := \frac{TotalV_{hopper}}{Storage_{duration}} = 56852 \cdot \frac{gal}{day}$$

Existing Conditions:

$PD_{dewateredcake} := 82700 \frac{lb}{day}$

Original Facility Plan Value with Mesophliic Digestion

$PD_{TSconc} := 168000 \frac{mg}{L}$

Updated Average %TS for Cake Solids

$$PD_{flow} := \frac{PD_{dewateredcake} \cdot 1.39}{PD_{TSconc}} = 81991 \cdot \frac{gal}{day}$$

Solids hauling has gone up by 39% compared to previous, assume 1.39 factor to peak day dewatered cake

$AA_{InfQ} := 30.9mgd$

$$AA_{capacity} := \frac{\left(Capacity_{hopper} \cdot AA_{InfQ}\right)}{PD_{flow}} = 21.4 \cdot mgd$$

Capacity is below current AA influent flow conditions. Expand hopper or improve solids dewatering. Or decrease storage volume required under peak conditions by increasing trailers from hauler.

153299 TMWRF
TREATMENT CAPACITY
EVALUATION T005

$$AddlV_{hopper} := (PD_{flow} - Capacity_{hopper}) \cdot Storage_{duration} = 50277\,gal$$

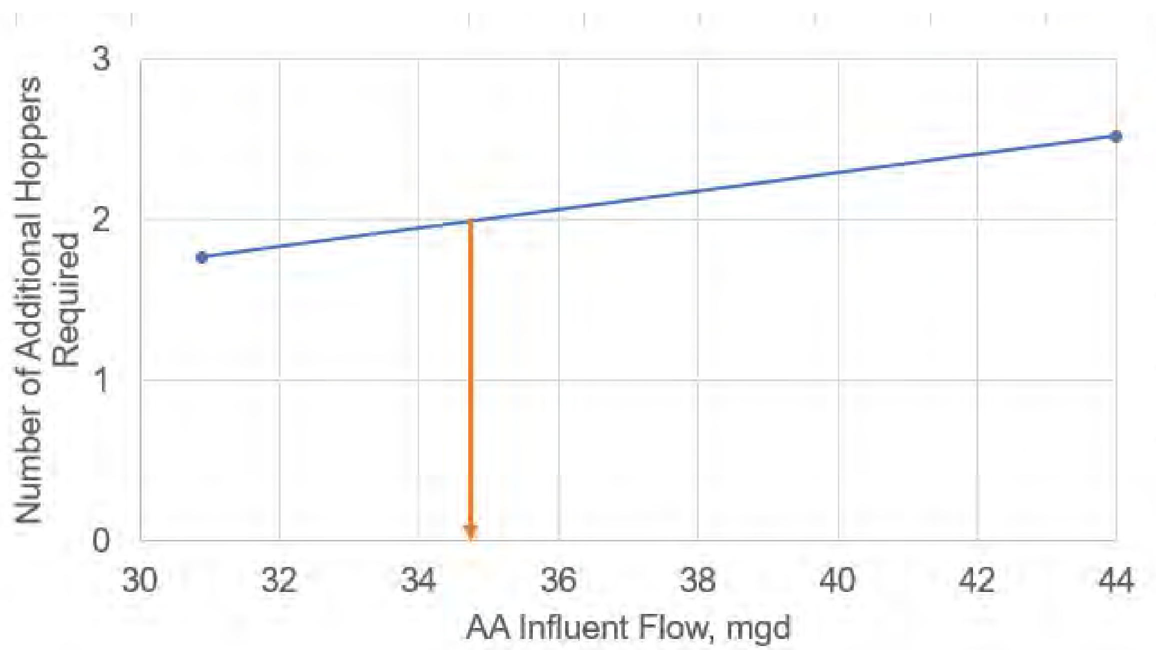
$$\frac{AddlV_{hopper}}{V_{hopper}} = 1.77$$

To acheive adequate capacity for current flows with TWAS dewatering, need to add 50,000 gallons, or two hoppers.

$$AddV_{hopper.design} := \frac{44mgd}{AA_{InfQ}} \cdot (PD_{flow} - Capacity_{hopper}) \cdot Storage_{duration} = 71592\,gal$$

$$\frac{AddV_{hopper.design}}{V_{hopper}} = 2.52$$

For direct TWAS dewatering, need three new hoppers of the same volume of existing hoppers to achieve 2 days storage time at design conditions (i.e. 44 mgd inf flow). Based on the plot below, a third hopper will be required around 34 mgd AA influent flow, unless other operating SOPs are revised to store the solids (i.e. use secondary digester and sludge equalization to dampen peak day conditions.



Problem Statement: This MathCad sheet is used to evaluate the capacity of biogas for Truckee Meadows.

Assume that exisiting data is based on a raw influent annual average flow of 30.9 MGD to be consistent with Original Facility Plan assumptions.

$$Q_{Current} := 30.9\text{mgd}$$

$$Q_{Design} := 44\text{mgd}$$

Existing Conditions (Feedgas):

$$Q_{PeakFeed} := 555\text{cfm}$$

Peak Day Flow for Post T-WAS Feedgas on 4/3/2021

$$Q_{AverageFeed} := 410\text{cfm}$$

Average Flow for Feedgas from 8/1/2020 - 5/31/2121 (post TWAS dewatering

$$Q_{Capacity} := 900\text{cfm}$$

H2S capacity based on 900 scfm and 1900 ppm

Assume linear growth in gas flow from future growth from 30.9 mgd AA influent flow to 44 mgd.

$$Q_{PeakSFeed} := Q_{PeakFeed} \cdot \frac{Q_{Design}}{Q_{Current}} = 790 \cdot \text{cfm}$$

Peak flow scaled to design flow rate

$$Q_{AverageSFeed} := Q_{AverageFeed} \cdot \frac{Q_{Design}}{Q_{Current}} = 584 \cdot \text{cfm}$$

Average flow scaled to design flow rate

Comparison (Feedgas):

$$Q_{PeakSFeed} < Q_{CapacityDesign}$$

The new treatment scheme results in an estimated peak day gas flow of less than 800 scfm at peak day conditions, with an average concentraiton of 1,431 ppm H2S. The biotower is designe

The new treatment scheme results in an estimated peak day gas flow of less than 800 scfm at peak day conditions, with an average concentration of 1,431 ppm H2S. The biotower is designed for a flow of 900 scfm with corresponding concentration of 1,900 ppm. The scaled gas flows are less than the capacity of the existing biotower and the concentrations are also lower, therefore the loading is also within the design of the biotower. The biotower has sufficient capacity for treating this new gas stream, which is lower flow and lower concentration than historical operation.

Attachment C: Effluent TN Determination

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Memorandum

August 3, 2021

To: Michael Harrison, P.E. - Director
Brown and Caldwell
11020 White Rock Road, Suite 200
Rancho Cordova, CA 95670

From: Michael Drinkwater, P.E. – TMWRF Plant Manager

Prepared by: Casey Mentzer, P.E. – TMWRF Process Engineer

Subject: Scope of Data Review

Background

TMWRF contracted Brown and Caldwell (B&C) to carry out a facility plan for the Truckee Meadows Water Reclamation Facility (TMWRF), which they completed in November of 2020. During the generation of this report, TMWRF staff began to implement recommended process changes such as the direct dewatering of thickened waste activated sludge (TWAS). The impacts from these changes and others carried out by facility staff produced major impacts to unit processes and overall plant performance. With the marked differences noted to the operation, TMWRF consulted B&C to revisit the facility plan and update it to incorporate the recent operating strategies and effluent quality.

Scope of Data Review and Assumptions

In September of 2018, TMWRF converted System 3 into a biological centrate treatment, which proved majorly effective at removing nitrogen from the dewatering sidestream. Without a firm understanding of the full downstream impacts of this experimental treatment, the nitrifying trickling filters (NTF) were ultimately severely underloaded for the winter of 2018 with individual tower loading reaching a minimum of 387 pounds of nitrogen. This exacerbated the seasonal variation the NTFs experience and resulted in excess nitrogen being discharged over the winter where the average loading rose to 1280 pounds of nitrogen per tower. TMWRF staff significantly refined their approach to sidestream treatment though the procurement of additional control valves and development of new operational strategies and control logic which allowed for a high degree of NTF load control and the ability to moderate the seasonal swings. That sidestream optimization marked the point at which nitrogen management facility-wide improved and effluent nitrogen declined at a statistically significant level. As such, TMWRF views 4/1/2019 – 6/9/2020 as the period in which the first notable change was made to plant operations impacting nitrogen.

On 6/9/2020, TMWRF began implementing direct TWAS dewatering which caused further change to overall nitrogen management. This operation dramatically reduced the return loading of ammonia and maintained the lower levels of nitrogen discharge. Ammonia levels in particular were reduced by such a degree within the mainstream plant flow by this change that the NTFs were again underloaded moving into 2021 and facilitated an infestation by a species of crane fly that is able to flourish in environments with lower pollutant concentrations. This caused a catastrophic and unprecedented failure of the NTFs which has since been identified and mitigated by removing one NTF from service and adding a greater pollutant load to each individual NTF. This resulted in higher nitrogen discharge after 1/1/2021 and is viewed by facility staff as a remarkably abnormal event, an unanticipated consequence of the new operating strategy since rectified, and the data not considered representative of a typical process upset condition.

The data that is reflective of the standard operation of the plant since the notable optimizations have taken place is therefore between 4/1/19 – 12/31/2020.The summary of these data are shown in table 1. To employ a level of conservancy, TMWRF staff recommends a total effluent nitrogen concentration of 1.80 mg/L-N be used in the updated facility planning estimates.

Table 1: Post-process optimization final effluent nitrogen concentrations.

Constituent	Concentration (mg/L-N)
• Total Inorganic Nitrogen	0.14
o Ammonia	0.06
o Nitrite	0.01
o Nitrate	0.07
• Total Organic Nitrogen	1.60
o Dissolved	1.44
o Particulate	0.15
Total Nitrogen	1.74

TRUCKEE MEADOWS WATER AUTHORITY
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Date: February 14, 2022

To: **John Enloe**

Through: **Scott Estes**

From: **David Kershaw**

Subject: **Warm Springs Valley Potable ASR Supply Modeling Summary Memo**

Overview

A preliminary high level hydraulic modeling evaluation was performed to help identify potable water distribution system improvements required to supply water from the existing Truckee Meadows Water Authority facilities in northern Spanish Springs Area to the Warm Springs Valley area for aquifer storage. These facilities also included the ability to supply groundwater from Warm Springs area back to the existing TMWA potable water system in Spanish Springs. The intent of the proposed potable water infrastructure is to supply water to Warm Springs during winter months for aquifer storage, which can then be recovered during peak summer months to meet potable water demands in the Spanish Springs area. The ability to develop a significant water supply source that can be conveyed from the north to Spanish Springs area helps diversify water supply sources and delay/eliminate other capital improvement expenditures in the existing system. The proposed improvements could also be used to convey potential additional future water supplies associated with effluent advanced water purification processes. The attached figure shows the location and alignment of the project.

Background & Irrigation Demand Estimates

As part of the feasibility study for using aquifer storage and recovery in the Warm Springs Valley area, a hydraulic model was developed to help determine major water infrastructure required to convey potable water between the TMWA water system in Spanish Springs and Warm Springs Valleys Area depending upon time of year.

The first items that needed to be defined were the design flows for the proposed facility in both flow directions. Given that the facility could be constructed in the next five years and associated capital improvement facilities already planned within that time period will be constructed, Truckee Meadows Water Authority (TMWA) staff identified excess system capacity during non-peak demand periods (winter demands and less than average day demands). The available excess surface water capacity (non-peak demands) is estimated to range between 1,850 to 2,600 gallons per minute (gpm). It should be noted that the excess supply capacity could also be used to recharge local groundwater wells (future SC 9 & 10 Wells) in addition to recharge in the Warm Springs region. The identified point of connection is a 16-inch main in the Ingenuity Avenue & Pyramid Hwy intersection and is supplied by the Spring Creek 6 and Desert Springs 3 Tanks.

For this planning effort, two scenarios were considered. The first scenario assumed a return groundwater design flow of 4,000 gpm during peak demand periods, and the second scenario assumed a return groundwater design flow of up to 7,000 gpm. Increasing the design flow to 7,000 gpm would provide significant drought supply benefits. The additional 3,000 gpm of supply capacity would provide supplemental drought capacity on top of the 4,000 gpm maximum day capacity. The additional 3,000 gpm is in essence equivalent to 3,000 acre feet annually of supplemental drought storage capacity. Pumping scenario 4, as depicted in Figure 118 of the Palomino Farms Sustainable Water Resource Feasibility Study, Groundwater Investigation Report, is representative of this potential pumping scenario. It should be emphasized that the additional 3,000 gpm of supply capacity would not be relied upon every year. Similar to other TMWA drought operations evaluations, for purposes of this analysis, the additional supply capacity could be utilized in only 3 out of every 10 years. Groundwater levels continue to increase modestly over time under this pumping scenario.

These planning groundwater supply flows from Warm Springs are used to evaluate the potential to defer or eliminate the need to replace multiple Desert Springs groundwater wells that could require a new water treatment system, and some Spring Creek Wells. The Warm Springs supply could also help defer/eliminate supply improvements required in the gravity system. The return design flow will need to be refined based on aquifer properties, actual potable water production capabilities from the aquifer, and potential reduction in future infrastructure improvements in the existing system.

Hydraulic Modeling Results

The hydraulic model for supplying potable water from TMWRF Spanish Springs area to the Warm Springs area was developed using key portions of the Desert Spring/Spring Creek hydraulic model and the proposed design supply capacities:

- Supply from Spanish Springs to Warm Springs (winter) = 2,600 gpm
- Supply from Warm Springs to Spanish Springs (summer) = 4,000 / 7,000 gpm

The following items summarize some of the constraints used to develop the model:

- Minimum pressure of water main high point in Pyramid Hwy = 40 psi
- Maximum Pipe Velocity: 5 feet-per-second (fps)
- Gravity flow from Springs Creek 6 and Desert Springs 3 Tanks to Warm Springs
- Booster pump system for flows from Warm Springs to Spring Creek 6 and Desert Springs 3 Tanks.
- Connection to existing 16-inch potable water main in the Ingenuity Avenue & Pyramid Hwy intersection with new transmission main from Warm Springs.

The hydraulic modeling indicates that the water transmission main should have a minimum diameter of 18 inches at 4,000 gpm and 24 inches at 7,000 gpm to not exceed a maximum pipe velocity of 5 fps given the proposed flows. The static pressure at the end of the transmission main in Warm Springs is approximately 230 psi. When pumping groundwater at 4,000 or 7,000 gpm from Warm Springs to Spanish Springs Tanks, the resulting pressure will increase to approximately 380 psi. Given the very high pressure required to convey flows to Spanish Springs, the recommended pumping facility layout consists of the following:

- Multiple groundwater production wells
- Wellfield collection mains (diameter and length dependent upon well characteristics)
- Wellfield tanks (2 – 250,000 gallon tanks)
- Booster Pump Station with surge protection system, and pressure reducing / flow control bypass

Therefore, the groundwater wells will pump to the ground level storage tanks to be located adjacent to the proposed booster pump station through the wellfield collection mains. The booster pump station will convey water from the storage tanks to the 18-inch / 24-inch transmission main that will connect to the existing TMWA water system for distribution. The proposed booster pump station layout is the preferred alternative versus the operational difficulty and increased life cycle costs of having groundwater production wells discharge directly to a high-pressure transmission main.

Figure 1 shows the predicted hydraulic grade line (HGL) associated with pumping 4,000 gpm of groundwater from the proposed Warm Springs Booster Pump Station to Spring Creek 6 Tank using a 18-inch transmission main.

Figure 2 shows the predicted hydraulic grade line (HGL) associated with the gravity flow of 2,600 gpm of water from Spring Creek 6 Tank to Warm Springs using a 18-inch transmission main.

Figure 3 shows the predicted hydraulic grade line (HGL) associated with pumping 7,000 gpm of groundwater from the proposed Warm Springs Booster Pump Station to Spring Creek 6 Tank using a 24-inch transmission main.

Opinion of Probable Cost

Table 1: Planning Costs – 4,000 gpm from Warm Springs

Potable Water Improvements (2,600 gpm gravity flow to Warm Springs: 4,000 gpm pumped flow from Warm Springs, velocity < 5 fps)						
1	Pump Station Construction (Discharge Pressure approx. 380 psi)	1	L.S.	$3,000,000	$ 3,000,000	
2	BPS Storage Tanks	500,000	Gals	$2.00	$ 1,000,000	
3	18-inch Transmission Main	52,500	L.F.	$360	$ 18,900,000	
3	12-inch Wellfield Mains	12,000	L.F.	$240	$ 2,880,000	
4	Municipal Groundwater Production Wells	4	E.A.	$2,000,000	$ 8,000,000	

5						
					Subtotal	$ 33,780,000
6	Other Costs:					
					Subtotal	$ -
7	Contingency (30%)				$ 10,134,000	
					Total	$ 43,914,000

Table 2: Planning Costs – 7,000 gpm from Warm Springs

Potable Water Improvements (2,600 gpm gravity flow to Warm Springs: 7,000 gpm pumped flow from Warm Springs, velocity < 5 fps)						
1	Pump Station Construction (Discharge Pressure approx. 380 psi)	1	L.S.	$4,000,000	$ 4,000,000	
2	BPS Storage Tanks	500,000	Gals	$2.00	$ 1,000,000	
3	24-inch Transmission Main	52,500	L.F.	$480	$ 25,200,000	
3	12-inch Wellfield Mains	15,000	L.F.	$240	$ 3,600,000	
4	Municipal Groundwater Production Wells	7	E.A.	$2,000,000	$ 14,000,000	
5						
					Subtotal	$ 47,800,000
6	Other Costs:					
					Subtotal	$ -
7	Contingency (30%)				$ 14,340,000	
					Total	$ 62,140,000

Potential Capital Improvement Deferrals / Eliminations

As mentioned previously, implementing a new water supply from the north has the potential to defer and/or eliminate some proposed capital improvements (CIPs) required to meet estimated future water demands in the Spanish Springs region. The following is a summary of CIPs that could be deferred or eliminated:

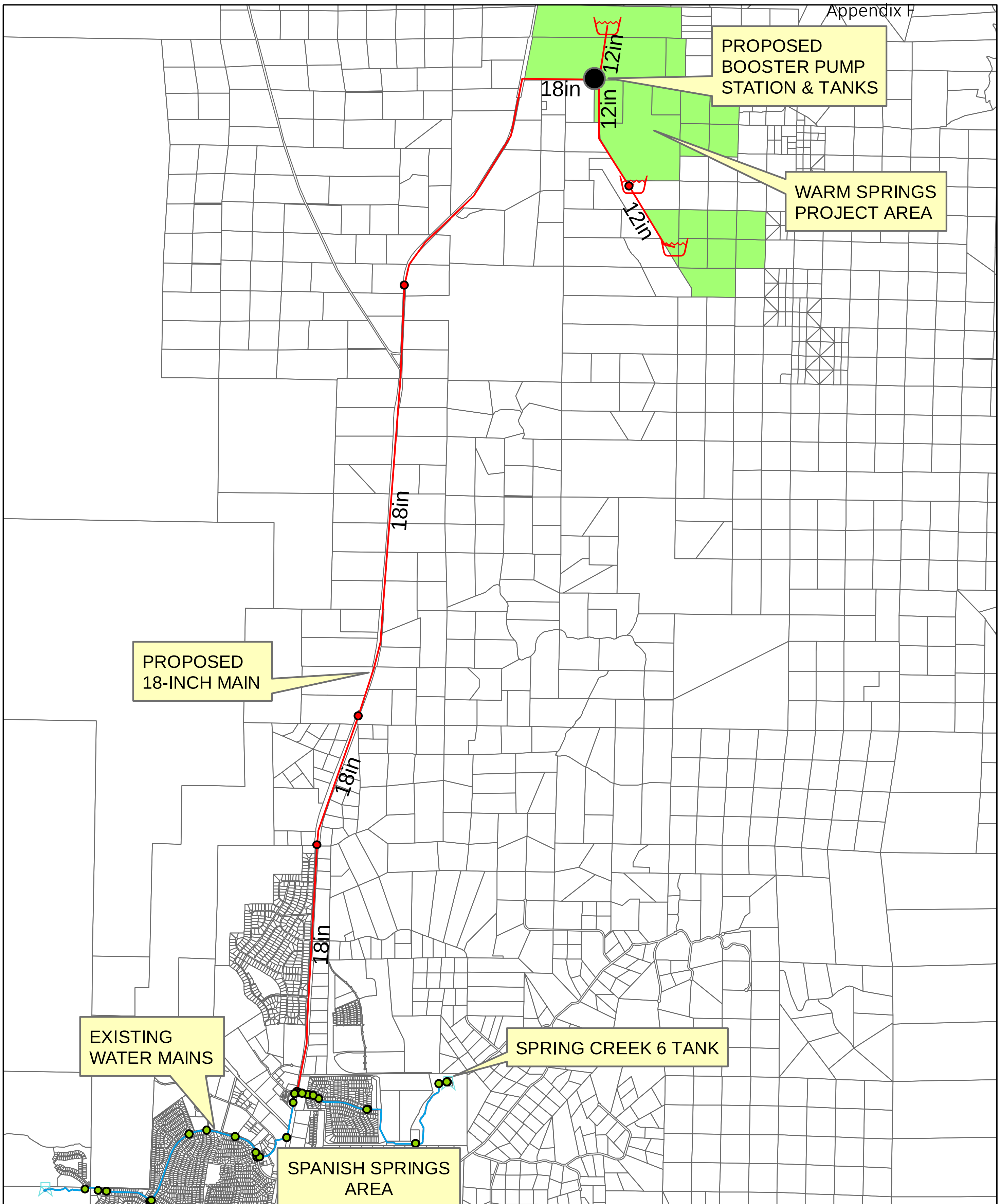
- GWTP in Desert Springs PH1: Capacity - 800 gpm: Cost Est. - $6M
- GWTP in Desert Springs PH2: Capacity – 1,200 gpm: Cost Est. - $4M
- Sparks GWTP Ph 1: Capacity – 5,300 gpm: Cost Est. - $57M: Delay up to 5 years
- Sparks GWTP Ph 2: Capacity – 3,000 gpm: Cost Est. - $25M: Delay or eliminate

Recommendation & Additional Considerations.

The design flow assumptions used in this evaluation will need to be refined prior to formal design. The return design flow will need to be adjusted based on aquifer properties, actual potable water production capabilities from the aquifer, and potential reduction in future infrastructure improvements in the existing system. Additional investigations should be performed on available potable water off-peak supply capacity to determine the benefits of increased/decreased recharge flows.

Additional investigations should be performed to help confirm CIP deferrals and/or elimination.

A preliminary transmission main alignment along Pyramid Highway is attached for reference.



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WARM SPRINGS PROPOSED POTABLE WATER SYSTEM IMPROVEMENTS VICINITY MAP

DATE	10/5/2021
MAP BY:	DSK
REQUESTED BY:	DSK
SCALE: 1 inch = 6,000 feet	

NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

Figure 1 - Pumping 4,000 gpm From Proposed Warm Springs BPS

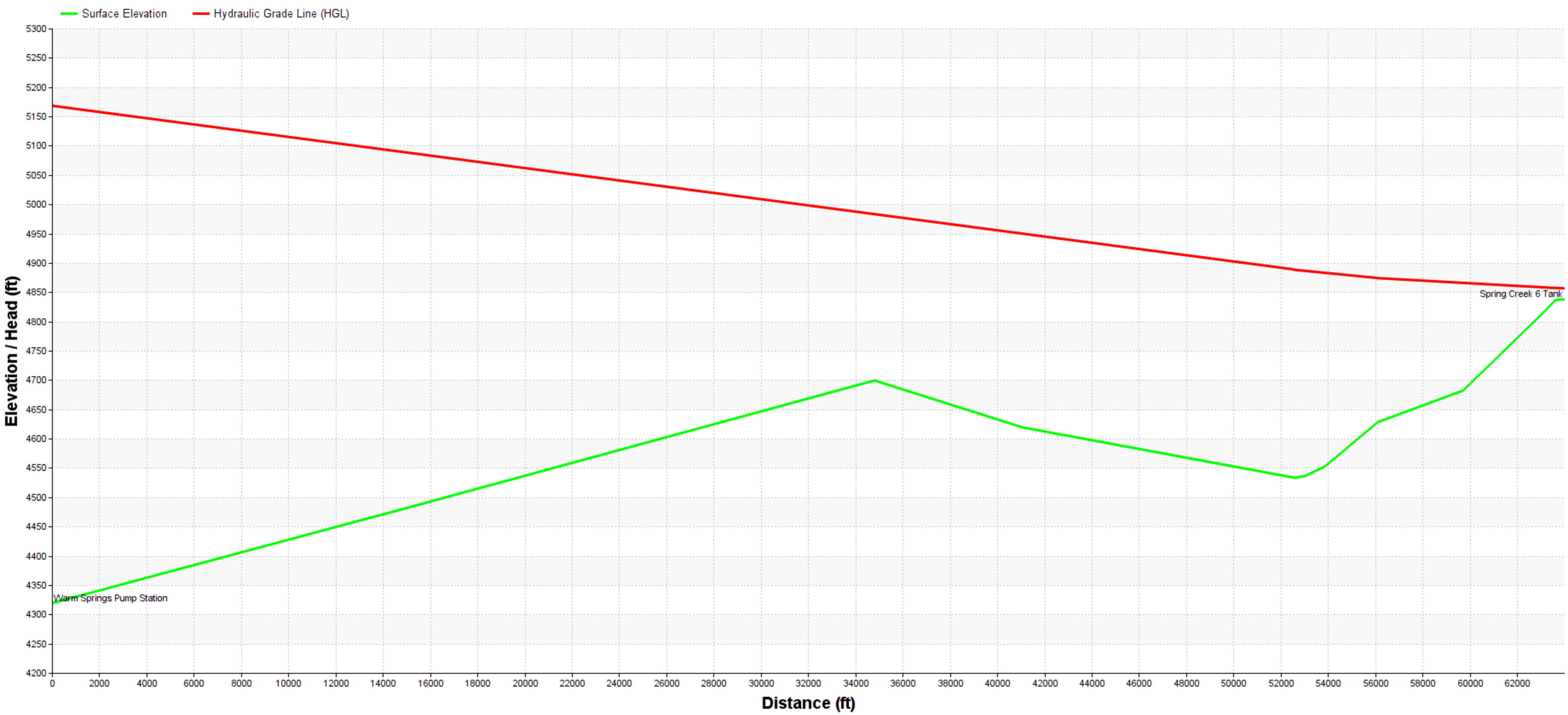
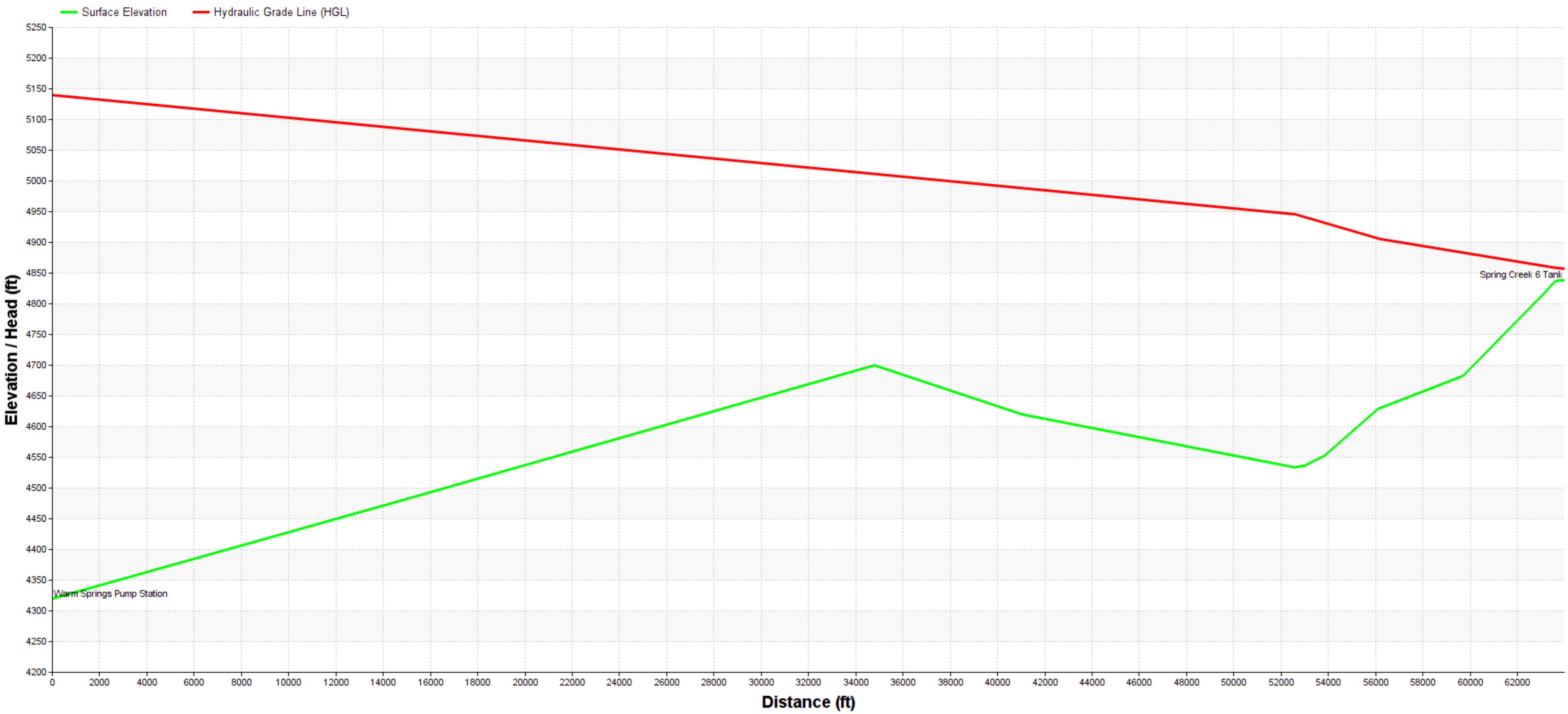
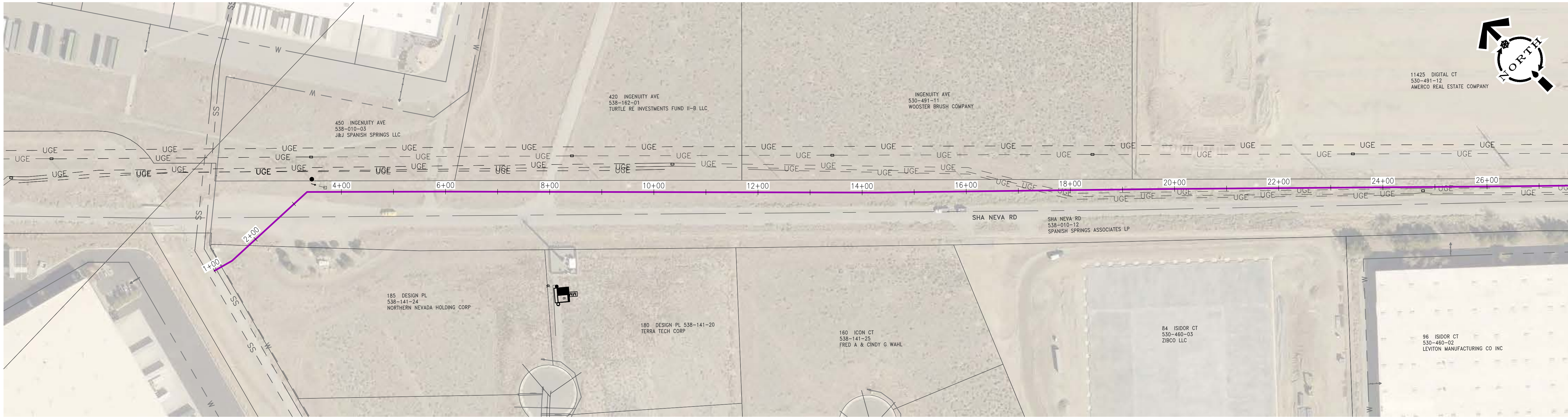


Figure 2 - Gravity Flow 2,600 gpm To Warm Springs

Figure 3 - Pumping 7,000 gpm From Proposed Warm Springs BPS





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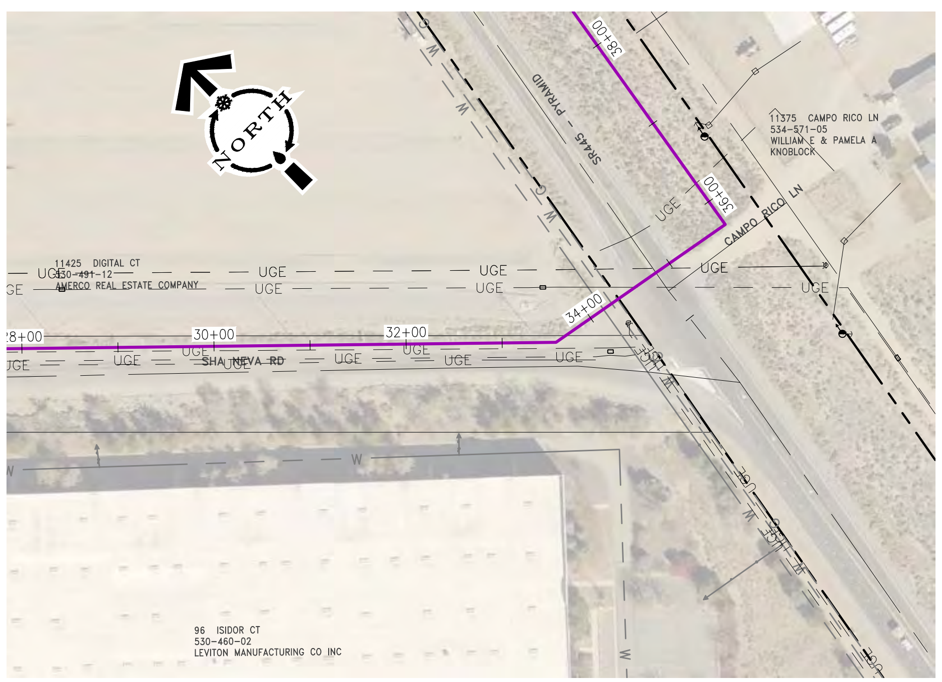

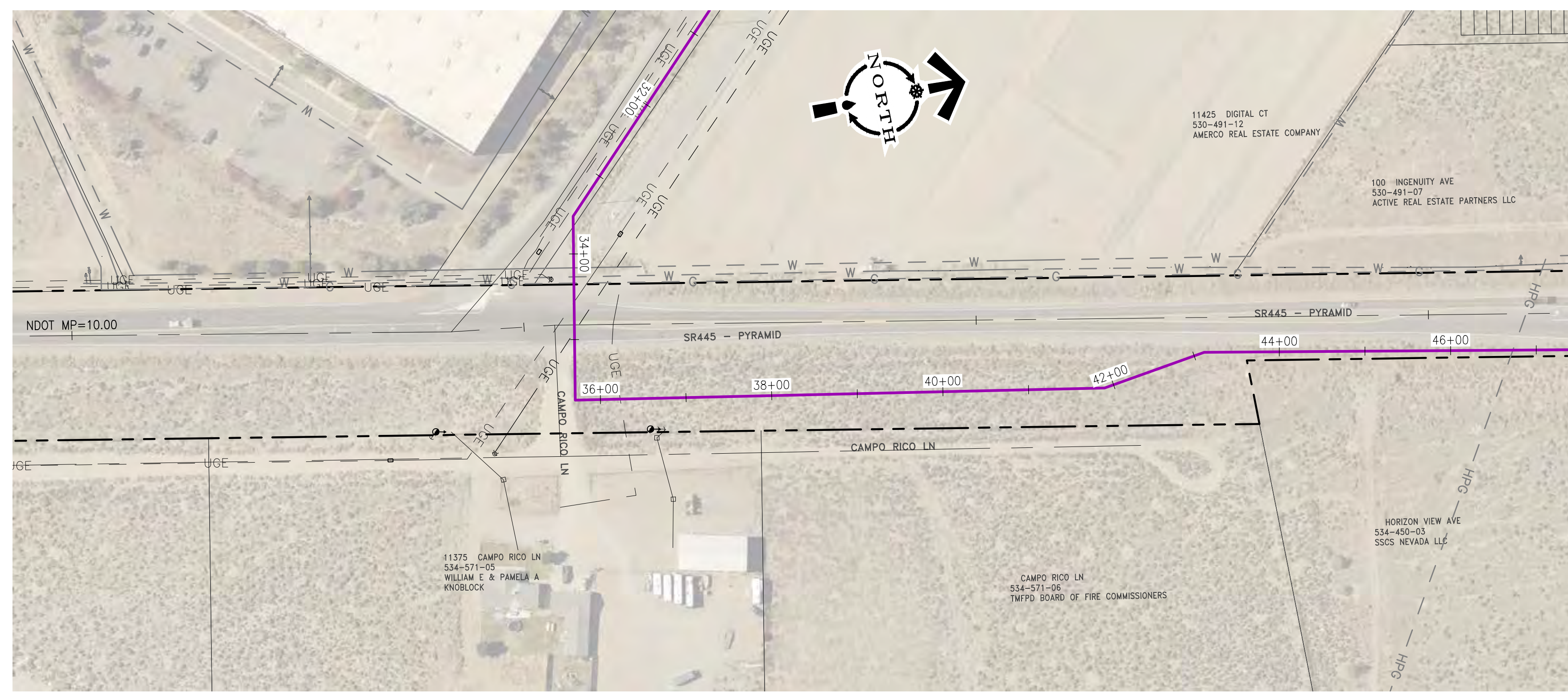

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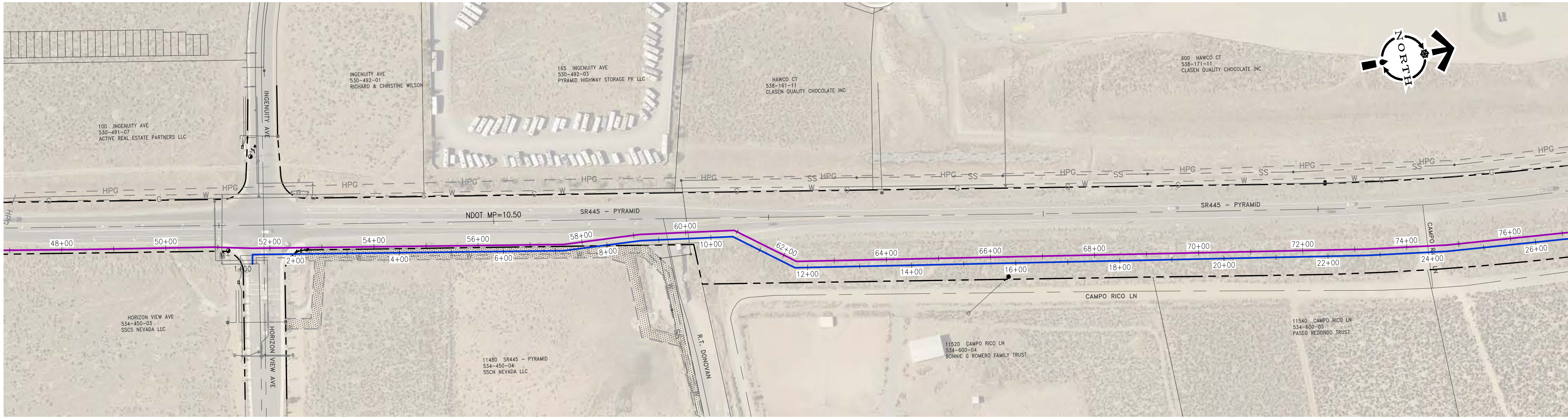

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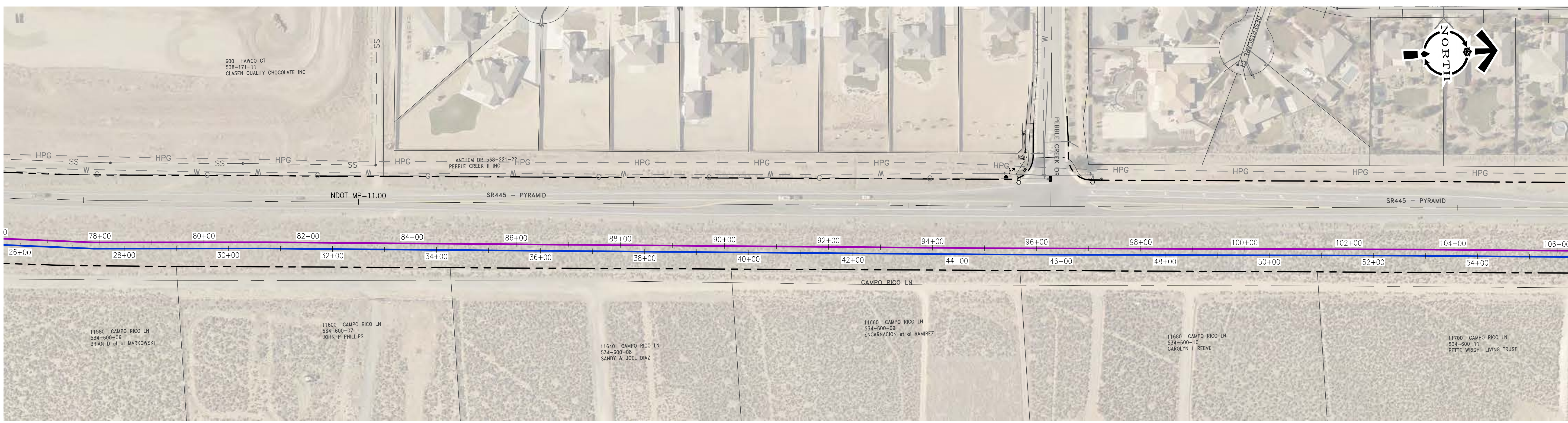

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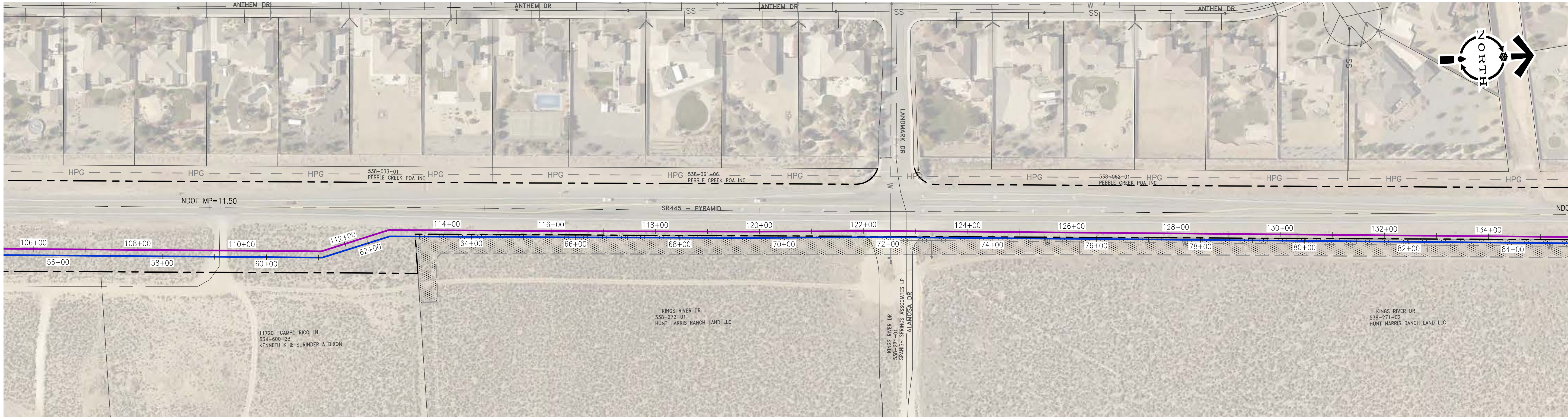

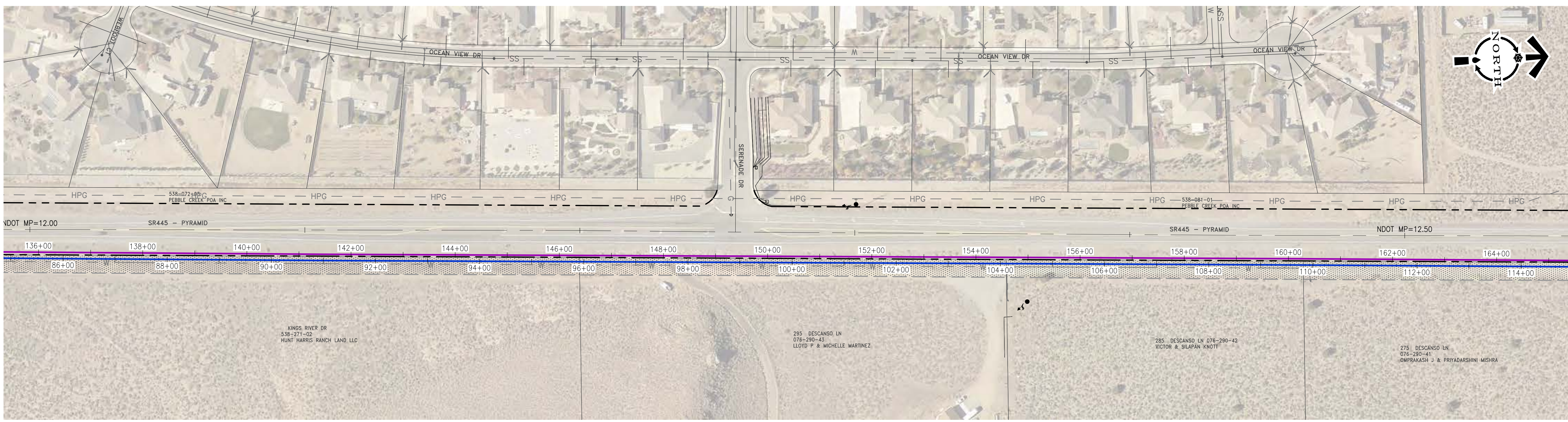

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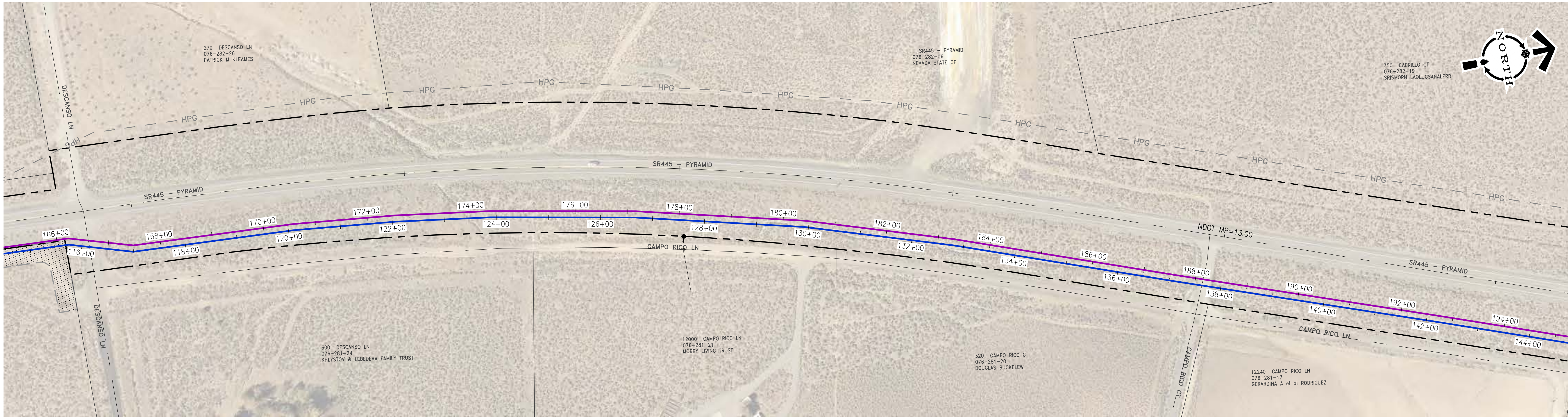

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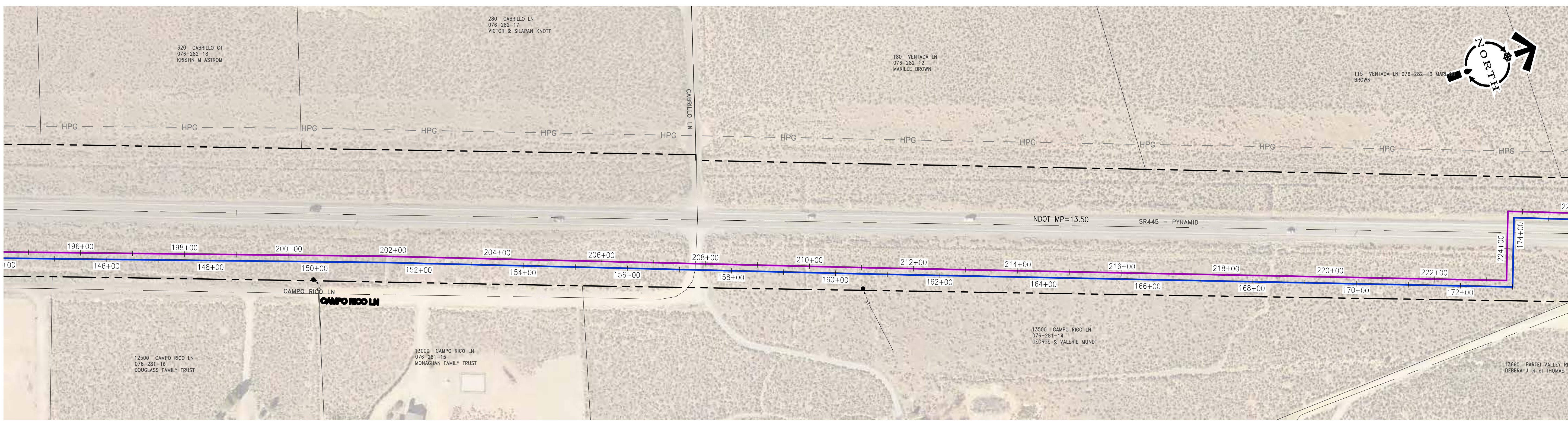

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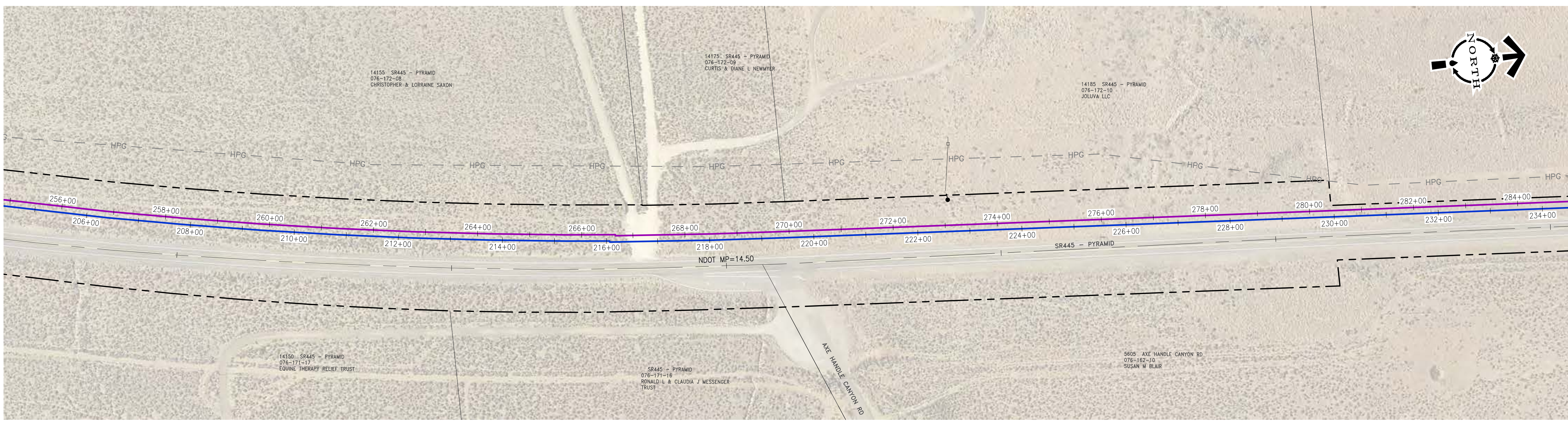

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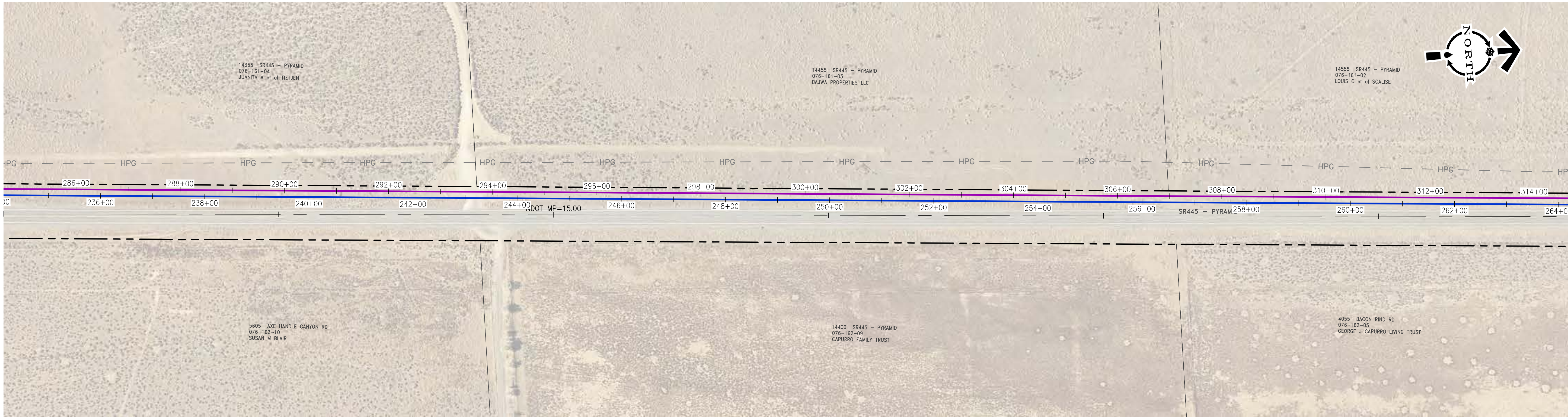

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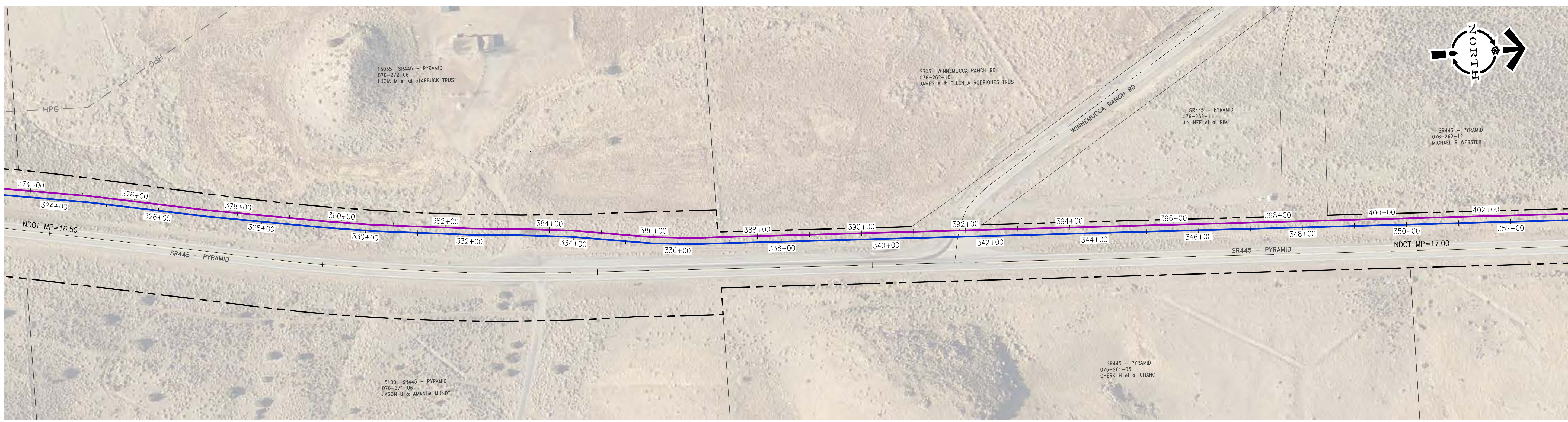

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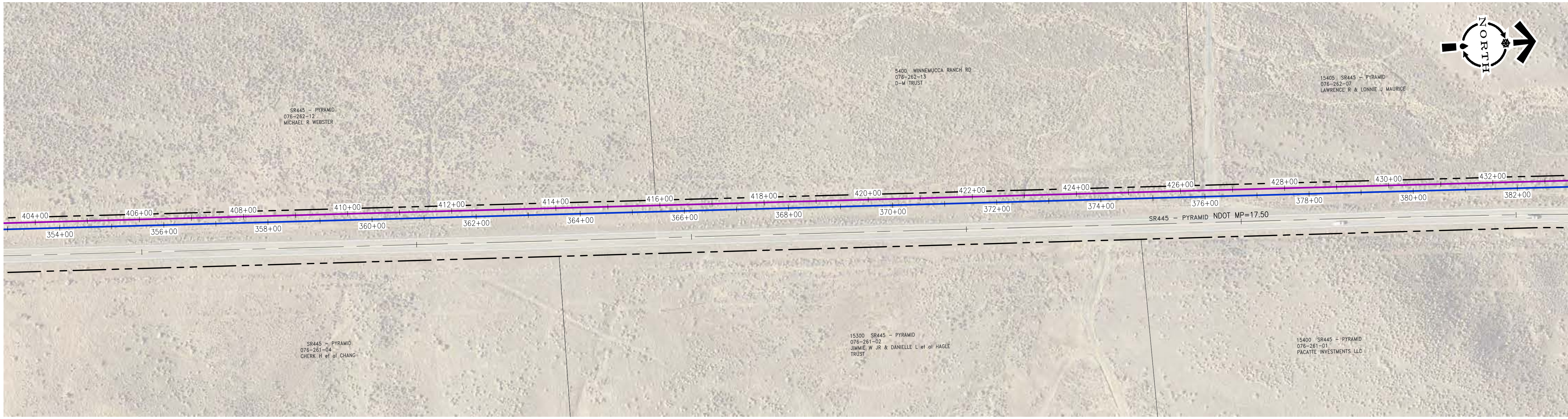

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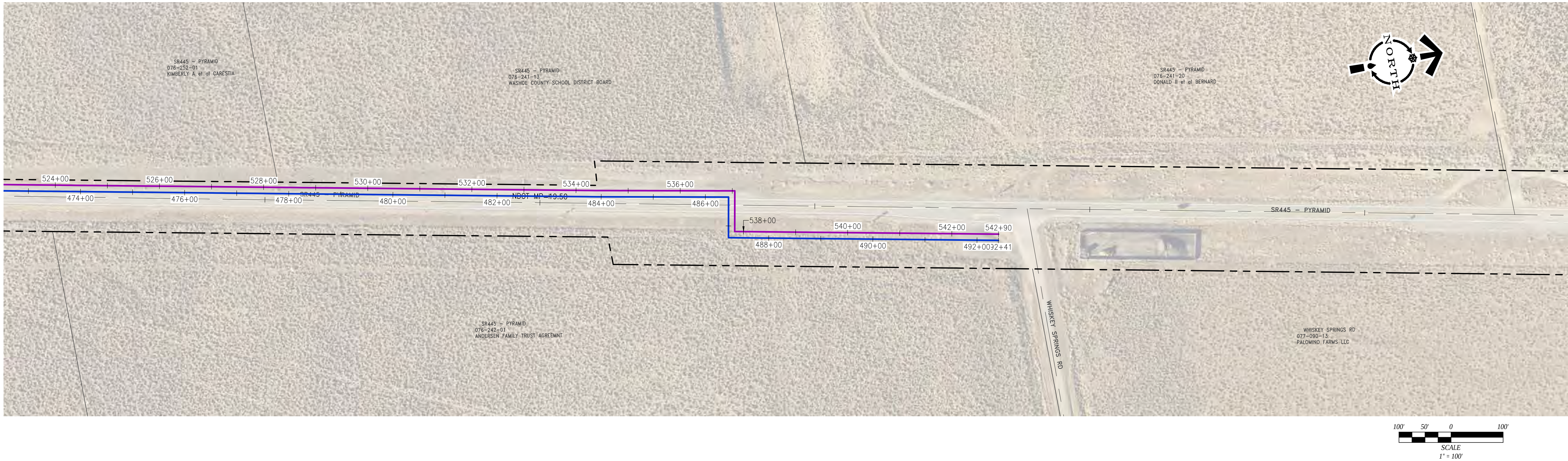

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House Moran Consulting, Inc.
Water Resources and Environmental Engineering

TECHNICAL MEMORANDUM

Date:	February 10, 2022
To:	Truckee Meadows Water Authority David Kershaw, P.E.– Principal Planning Engineer
From:	Todd Cochran, P.E., CFM Vice-President Jeff House, CEO
Subject:	**Planning-Level Evaluation of TMWA Future Facilities Palomino Feasibility Project – Washoe County, NV**

PROFESSIONAL ENGINEER-STATE OF NEVADA
JEFFREY T. COCHRAN
Exp: 12/31/2022
CIVIL
No. 17797

INTRODUCTION

The purpose of this Technical Memorandum is to provide a planning-level evaluation of impacts and mitigation measures at potential future TMWA Palomino facilities being considered at Pyramid Highway and Whiskey Springs Road, including one or more of the following site constraints:

- Waters of the U.S. (i.e., jurisdictional wetlands) in accordance with 33 CFR Part 328;
- Waters of the State (i.e., all streams, lakes, ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation systems and drainage systems; and all bodies or accumulations of water, surface and underground, natural or artificial), in accordance with NRS 445A.415;
- Sedimentation; and
- FEMA Floodplains (i.e., 100-year) in accordance with 44 CFR Ch.1, §72.1 - §72.7.

The corridor for TMWA future facilities to be evaluated is about 9 miles long starting at Sha Neva Road in Spanish Springs, proceeding northeast along Pyramid Highway to the Whiskey Springs Road area, about 18 miles southwest of Pyramid Lake, as shown in **Figure 1** – Location Map on the following page. This planning-level evaluation only considers the potential facilities at Whiskey Springs Road, where portions of the existing and future facilities are located within a FEMA Special Flood Hazard Area (SFHA), as shown on the effective FEMA Flood Insurance Rate Map (FIRM), dated 3/16/2009 (Exhibit 1). Also shown in **Figure 1** are the Warm Springs Zone of High Permeability and Estimated Future Groundwater Facility Areas, provided by TMWA.

WATERS OF THE U.S.

A desktop survey of the U.S. Army Corps of Engineers jurisdictional wetlands was performed to identify previously mapped wetlands. The National Wetland Inventory (NWI) data was obtained from the US Fish and Wildlife Service (FWS). While the NWI is advisory and wetland delineation must be verified in the field. The data used in this report was sufficient for a planning-level evaluation. As shown in Exhibit 2, there are several channels that flow through the project area and are classified as riverine wetlands. Several additional small areas classified as Freshwater Ponds and Freshwater Emergent Wetlands are also located within the area of interest. Due to the small size of the wetland areas and stream channels, it may be possible to design the proposed improvements to avoid impacts to these Waters of the U.S. and if necessary, minor impacts can be permitted through the Nationwide Permit process. If the proposed impacts exceed the Nationwide Permit thresholds, an individual permit will be required. All impacts to Waters of the U.S. will need to be coordinated with the U.S. Army Corps of Engineers regional staff.

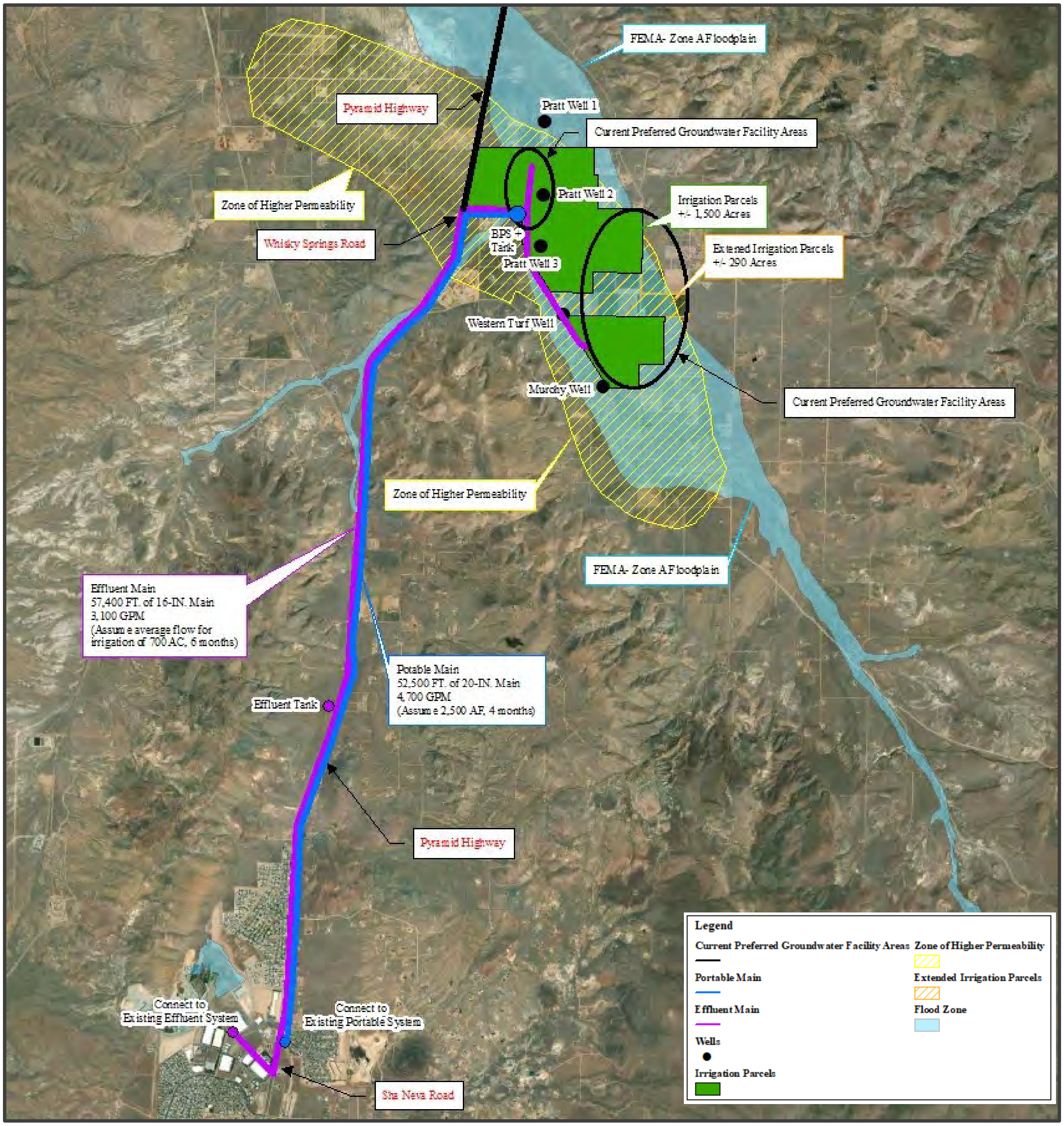


Figure 1. Location Map

FEMA Floodplains

The effective flood zones are Zone A (approximate), which means that they were mapped using approximate methods. There were no existing hydrologic or hydraulic models completed for this study area. Therefore, a simple HEC-HMS hydrologic model was developed by House Moran for this assessment to provide a reasonable estimate of peak flows that could be expected. A large-scale 2D HEC-RAS model was also developed by House Moran to estimate flooding extents, maximum flood depths, and maximum flood velocities from a 100-year storm event.

HEC-HMS Model

The HEC-HMS model includes four subbasins from the USGS Watershed Boundary Dataset (HUC12). The HUC12 boundaries were modified slightly to match the latest topo and to include all flow draining to the potential project area. **Figure 2** shows a schematic of the HEC-HMS model, which includes Cottonwood Creek and the Paiute Creek and Bacon Rind Flat tributaries. The combined drainage area is 155.2 square miles.

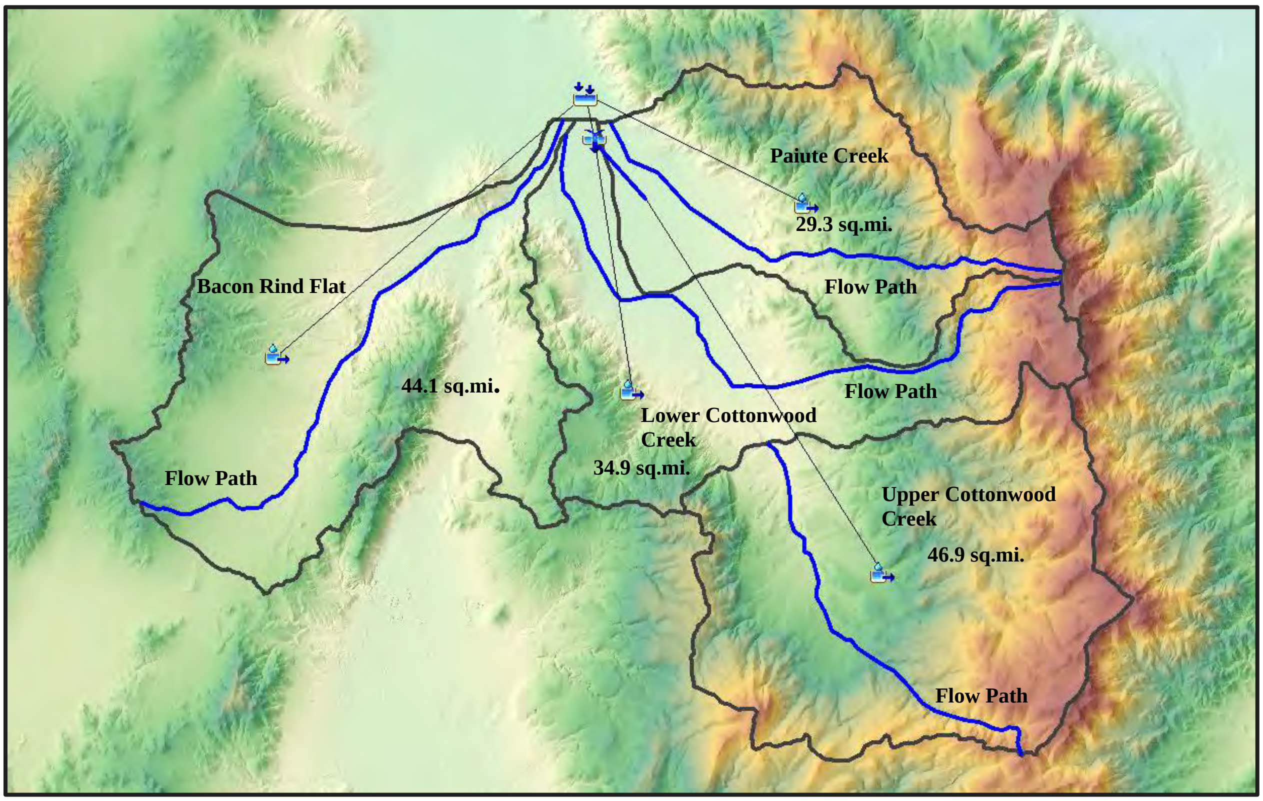


Figure 2. HEC-HMS Model Schematic

A summary of the HEC-HMS model input is provided in Table 1 and the results are summarized in Table 2.

Table 1: Summary of HEC-HMS Model Input Parameters

HEC-HMS Subbasin	Drainage Area (sq. miles)	Green & Ampt Parameters				Snyder Unit Hydrograph	
		Initial Content	Saturated Content	Suction (in)	Conductivity (in/hr)	Lag Time (hrs)	Peaking Coefficient
Upper Cottonwood Creek	46.856	0.21	0.42	3.85	0.33	6.054	0.6
Lower Cottonwood Creek	34.916	0.17	0.41	3.88	0.72	8.511	0.5
Paiute Creek	29.304	0.18	0.41	4.13	0.45	6.348	0.6
Bacon Rind Flat	44.137	0.16	0.42	3.76	0.92	9.556	0.4

Table 2: Summary of HEC-HMS Model Results

HEC-HMS ID	Drainage Area (sq. miles)	Peak Discharge (cfs)	Time of Peak Discharge	Volume (ac-ft)
Upper Cottonwood Creek	46.856	3,275.7	DEC 01, 2021 17:49	2,867.4
R-Cottonwood	46.856	3,275.7	DEC 01, 2021 18:52	2,867.4
Lower Cottonwood Creek	34.916	937.01	DEC 01, 2021 20:11	1,371.0
J-Cottonwood	81.772	4,168.4	DEC 01, 2021 19:00	4,238.4
Paiute Creek	29.304	1,640.39	DEC 01, 2021 18:06	1,510.91
Bacon Rind Flat	44.137	727.59	DEC 01, 2021 21:15	1,447.30
Outlet	155.213	6,368.0	DEC 01, 2021 18:45	7,196.7

Peak Flow Comparison

The National Streamflow Statistics (NSS) program was used to generate regression equations for estimating streamflow statistics for the ungagged streams. The estimated peak flows have a high standard error, which can be seen in Table 3. The subbasins are in a rural area in the Northern Great Basin Region 6, as well as the Crippen & Blue Region 6. Therefore, the required input includes the subbasin drainage area and the mean subbasin elevation.

The subbasin drainage area is 155.2 square miles and the mean subbasin elevation is 4,800. The calculated 100-year peak flow at junction "J-Cottonwood" of 7,196.7 cfs is within the standard error of the estimated peak flow of 7,100 cfs using the USGS Regression Equations in the NSS program.

Table 3: Results from USGS National Streamflow Statistics Program

Return Interval (years)	Mean Basin Elevation (ft)	Estimated Peak Flow (ft3/s)	Standard Error (Log)
100-Year	4800	7,100	1.84

HEC-RAS Model

A planning-level 2D HEC-RAS model was developed to estimate the flooding extents, flood depths, and flood velocities. The 2D model extents include the potential project area as shown in **Figure 3**. The 2017 USGS LiDAR data was used to develop a ground surface terrain for the HEC-RAS model. The 2D area was divided into 200-foot by 200-foot grid cells. The downstream boundary condition ("Downstream BC") was set to normal depth with a slope of 0.012 feet/feet. The upstream boundary conditions ("Bacon Rind BC", "Cottonwood Creek BC", and "Paiute Creek BC") are the inflow hydrographs from the HEC-HMS model, including the "J-Cottonwood" junction, the "Paiute Creek" subbasin, and the "Bacon Rind Flat" subbasin.

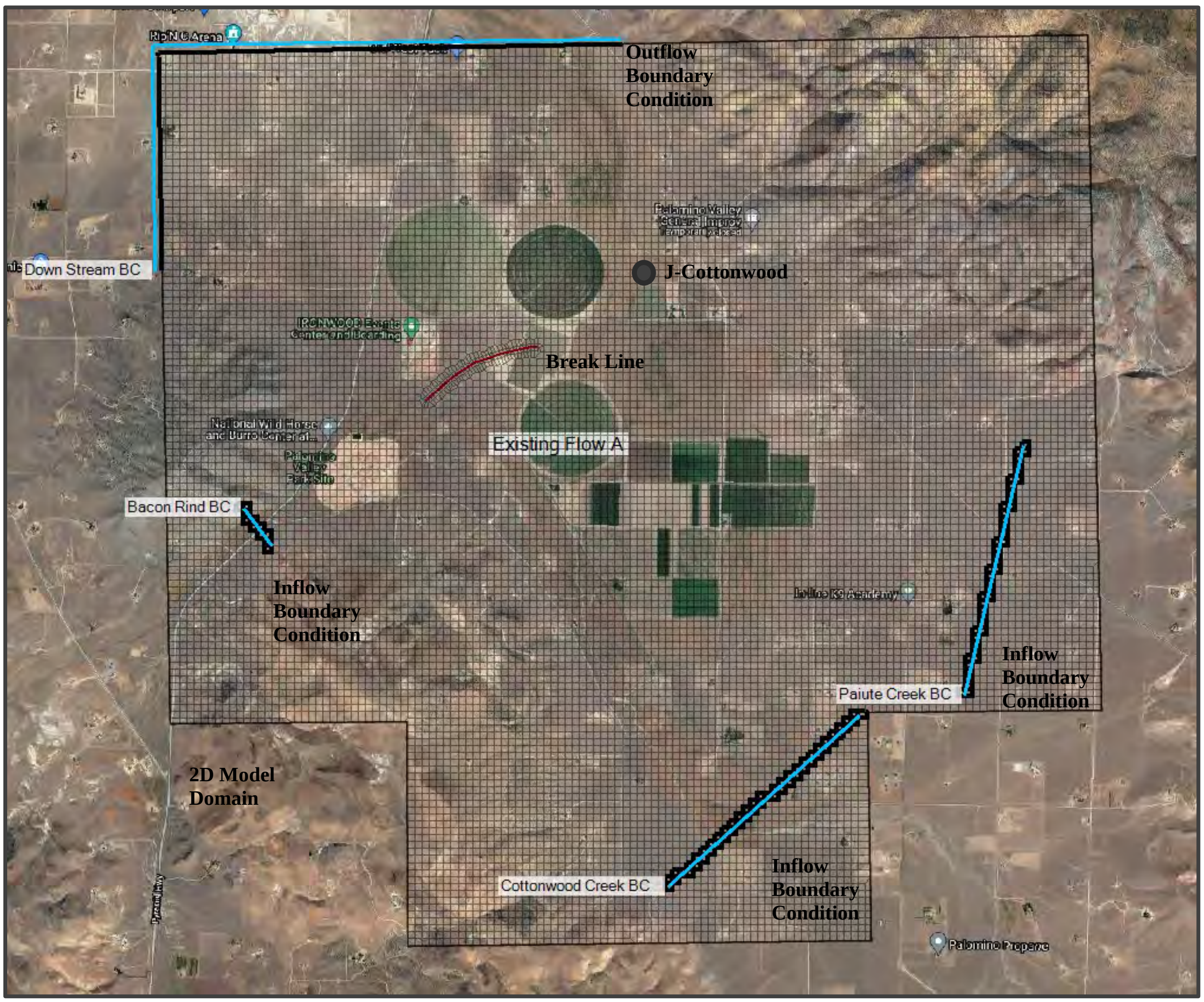


Figure 3. HEC-RAS Model Schematic

The HEC-RAS model results estimate the flow depths, flow velocities, and water surface elevations for each timestep. Exhibit 3 shows the maximum velocities and Exhibit 4 shows the maximum flow depths from the HEC-RAS model. Most of the overbank areas have a flood depth of less than 1.5 feet. The flood depths within the Cottonwood Creek channel range from 4 to 9 feet.

SEDIMENT YIELD ESTIMATION

In addition to flood runoff from the watershed, sediment can create issues within lower floodplain areas. Sediment loading is associated with stormwater runoff caused by both rainfall dislodging soils and concentrated flow in rills and channels.

The contributing drainage area to the project area to the east of Pyramid Highway (**Figure 2**) consists mostly of shrub/scrub vegetation with some agricultural and rural residential areas. Soils data was obtained from the Natural Resource Conservation Service (NRCS) Web Soil Survey. The NRCS provides the distribution of sediment sizes for each soil class in the area. The average D_{90} (90% of the particle sizes are less than the D_{90}) of the surface soils in the contributing area to the project area is about 0.75 inches (**Figure 2**).

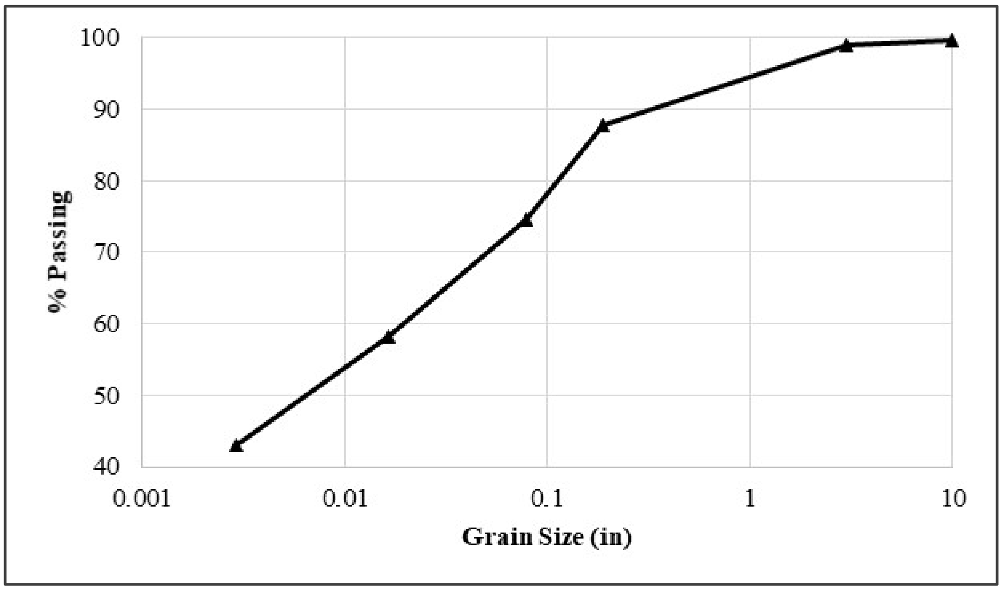


Figure 4. Average Surface Soil Grain Size Distribution

The Truckee Meadows Regional Drainage Manual (TMRDM), Section 1305.3.4, recommends using the Modified Universal Soil Loss Equation (MUSLE) to estimate the sediment yield of the wash load, where sediment yield for a single storm event is estimated using:

$$Y_s = 95 \times (Q \times q_p)^{0.56} \times K \times LS \times C \times P \qquad \text{(Equation 1)}$$

where:

Y_s = sediment yield (tons) for the given storm
Q = surface water runoff volume (acre-feet)
q_p = peak surface water runoff rate (cfs)
K = soil erodibility factor

LS = topographic factor
C = cover factor
P = support practice factor

To estimate the average annual sediment yield, the weighted storm yield is multiplied by the ratio of annual water yield to a probability-weighted water yield using:

$$A_s = V_A \frac{(0.01Y_{S100}+0.02Y_{S50}+0.04Y_{S25}+0.1Y_{S10}+0.5Y_{S2})}{(0.01V_{100}+0.02V_{50}+0.04V_{25}+0.1V_{10}+0.5V_2)} \qquad \text{(Equation 2)}$$

Where, A_s is the annual sediment yield (tons), V_A is the average annual water yield (acre-feet), and the numerical subscripts refer to the return period of the storm.

The Soil Erodibility Factor (*K*) is based on soil type and can be downloaded directly from the USDA Natural Resource Conservation Service Web Soil Survey. Soil Erodibility Factors were downloaded from the Web Soil Survey and the subbasin weighted average was determined for each subbasin.

The Practice Factor (*P*) describes the reduction of sediment yield from specific soil conservation practices (e.g., strip cropping, terracing, or contouring). It was assumed here there are no conservation practices, thus *P* was set to 1.0 for all subbasins.

To account for complex terrain and eliminate the subjectivity in determining the Topographic Factor (*LS*), LS was calculated in ArcMap using the LiDAR DEM. The method used was developed for use with the RUSLE 3D model that uses upslope contributing area, estimated from the DEM, as a surrogate for the length factor. This method utilizes the flow accumulation grid and slope to reflect concentrated flow (details are provided in the following link:

http://fatra.cnr.ncsu.edu/~hmitaso/gmslab/reports/CerlErosionTutorial/denix/Models%20and%20Processes/RUSLE3d/RUSLE3d.htm).

The Cover Factor (*C*), which is available from multiple sources, is subjective and can vary widely for similar cover types. TMRDM provides graphical relations to estimate the cover factor based on percent ground cover by canopy, percent of soil structure covered by mulch, and the root network in the topsoil relative to a meadow in good rotation (TMRDM Figures 1305 through 1307). The land use was defined using the Multi-Resolution Land Characteristics (MRLC) Consortium's land cover dataset. The land cover categories were assigned a C-value as summarized in Table 3 below.

Table 4. Summary of Cover Factor (C) Values

MRLC Land Cover ID	Land Cover Description	C
11	Open Water	0
21	Developed, Open Space	0.02
22	Developed, Low Intensity	0.1
23	Developed, Medium Intensity	0.2
24	Developed, High Intensity	0.3
42	Evergreen Forest	0.02
52	Shrub/Scrub	0.02
71	Herbaceous	0.02
81	Hay/Pasture	0.02
82	Cultivated Crops	0.2
90	Woody Wetlands	0.004
95	Emergent Herbaceous Wetlands	0.02

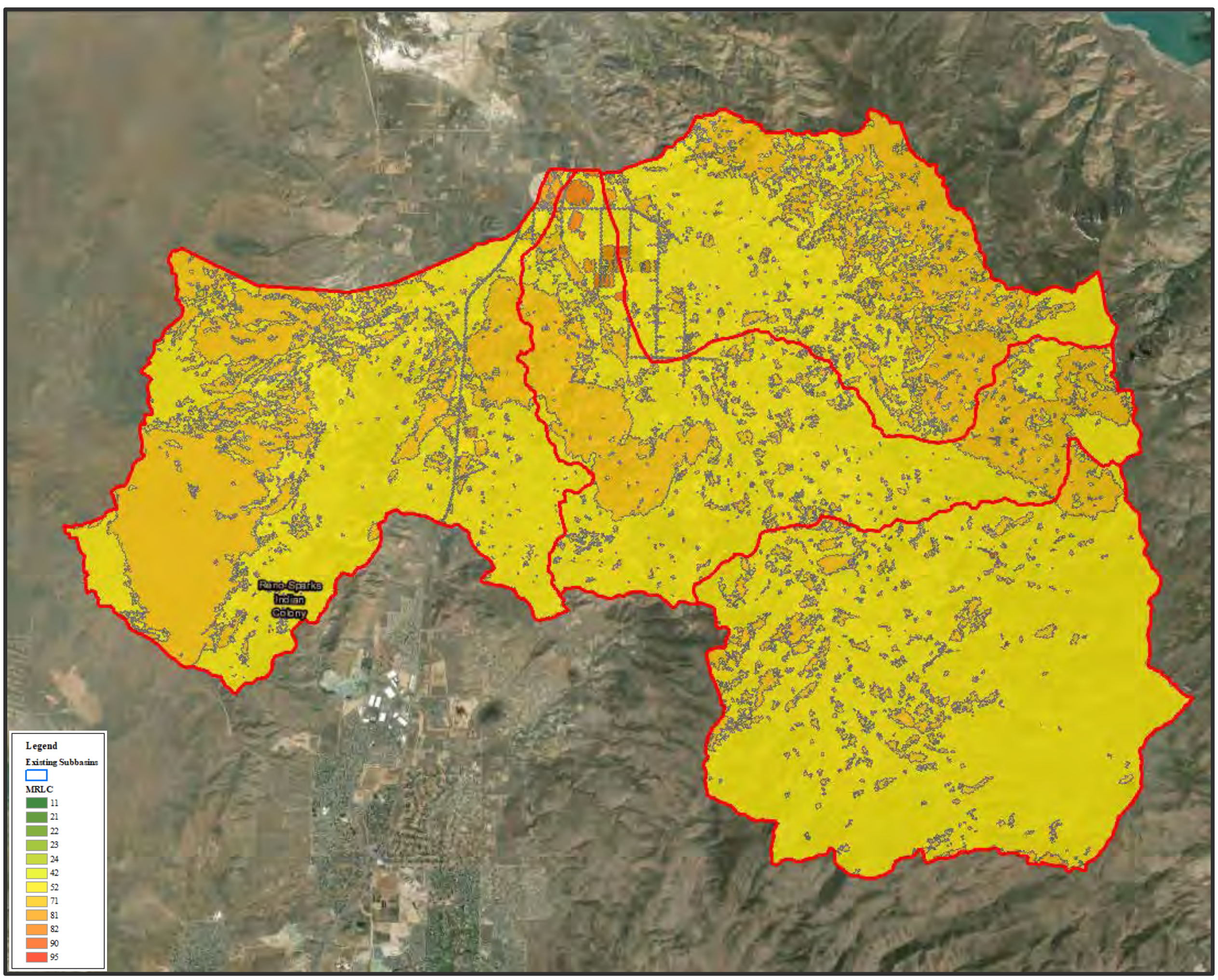


Figure 5. MRLC Land Cover

Sediment Yield Setup

HEC-HMS uses Equation 1 to estimate sediment yield from a subbasin. The Erodibility Factor, Topographic Factor, and Practice Factor were determined as discussed above. The contributing area is mostly undeveloped shrub/scrub with some residential areas. The Cover Factor used here was based on a land cover of shrub/scrub since the watershed is predominately shrub/scrub. The average Cover Factor was calculated for each subbasin using an area weighted average.

Table 5: Summary of Calculated MUSLE Input Parameters

HEC-HMS Subbasin	Drainage Area (sq. miles)	MUSLE Input Parameters			
		Erodibility Factor (K)	Topographic Factor (Ls)	Cover Factor (C)	Practice Factor (P)
Upper Cottonwood Creek	46.856	.37	2.3	.02	1
Lower Cottonwood Creek	34.916	.28	2.3	.02	1
Paiute Creek	29.304	.30	2.3	.02	1
Bacon Rind Flat	44.137	.27	2.3	.02	1

Sediment Transport Setup

The sediment transport potential through a reach is linked directly to the capacity of the stream to carry eroded soil. The capacity is calculated from the flow parameters and sediment properties. The transport potential method used here is the Meyer-Peter Muller method, which applies to fine sediment with some gravel.

Sediment is routed through the reach using the Volume Ratio method which links the transport of sediment to the transport of flow in the reach using a conceptual approach. For each time interval, sediment from upstream elements is added to the sediment already in the reach. The deposition and erosion of the sediment are calculated for each grain size to determine the available sediment for routing. In HEC-HMS, the proportion of the available sediment that leaves the reach in each time interval is assumed equal to the proportion of stream flow that leaves the reach during the same interval. This means that all grain sizes are transported through the reach at the same rate, even though erosion and deposition are determined separately for each grain size.

The Volume Ratio method is used here because it is the simplest method and requires the least input parameters. The input parameters for the Volume Ratio method are the initial gradation curve, bed width (ft), bed depth (ft), and Active Bed Factor. The parameters used are summarized in Table 6.

Initial Gradation Curve: The Initial Gradation Curve defines the distribution of the bed sediment by grain size at the beginning of the simulation. The initial grain size distribution was estimated from the NRCS Web Soil Survey engineering properties for the surface soils from each map unit symbol in the study area and weighted for each subbasin. The average grain size distribution for the study area is provided in **Figure 4**. The average D_{90} (diameter at which 90 percent of the sediment sizes are smaller) is 1.7 inches.

Bed Width (ft): The width is set to the typical reach with and is used in computing the upper and lower layers of the bed model. The width for each reach was set to the typical reach cross-section width.

Bed Depth (ft): The depth is set to the typical total depth of the upper and lower layers of the bed, representing the maximum depth of mixing over long time periods. A depth of 2-feet was used for all reaches.

Active Layer Factor: The Active Layer Factor is used to calculate the depth of the upper layer of bed material. At each time interval, the upper layer depth is computed as the sediment D_{90}, multiplied by the active layer factor. The factor was set such that the active depth of the upper layer was 1-foot.

Table 6. Summary of Inputs for Sediment Transport (Volume Ratio Method)

HEC-HMS Node ID	Initial Gradation Curve	Bed Width (ft)	Bed Depth (ft)	Active Layer Factor
R-Cottonwood	Figure 4	20	2	5.8

Sediment Yield Results

The HEC-HMS results provide a sediment-graph from each subbasin for the 100-year event. The sediment from the Upper Cottonwood Creek subbasin is transported through the "R-Cottonwood" reach routing which conveys the sediment to the junction with the Lower Cottonwood Creek subbasin. Table X summarizes the peak sediment volume from each subbasin and the combined volume at the model outlet. The sediment load in tons is converted to acre-feet of volume using the conversion factor of 1 ac-feet of soil = 2,000 tons (approximately 92 lbs/cu.ft.).

Table 7. Summary of Sediment Load Estimated using MUSLE in HEC-HMS

HEC-HMS Node ID	Peak Sediment Load (ton)	Total Sediment Volume (ton)	Total Sediment Volume (ac-ft)
Upper Cottonwood Creek	33.6	12,688.6	6.3443
R-Cottonwood	9.8	4,620.3	2.3102
Lower Cottonwood Creek	5.1	3,137.4	1.5687
J-Cottonwood	13.7	7,763	3.8815
Paiute Creek	12.3	4,868	2.434
Bacon Rind Flat	3.1	2,704	1.352
Outlet	28.0	15,366.3	7.6832

The above sediment loading volumes are estimates of the total loading during a 100-year event. All of the sediment loading would not settle out in the project area. To estimate a sediment depth would require a more detailed sediment transport analysis. However, from field observations, it would be expected that several inches of sediment could be deposited in the overbank areas of Cottonwood Creek. The bulk of the sediment in the channel would be conveyed downstream.

CONCLUSIONS

A summary of our findings is provided below:

- Flooding in the overbanks is relatively shallow across most of the overbank areas (1.5 feet or less in a 100-year storm);

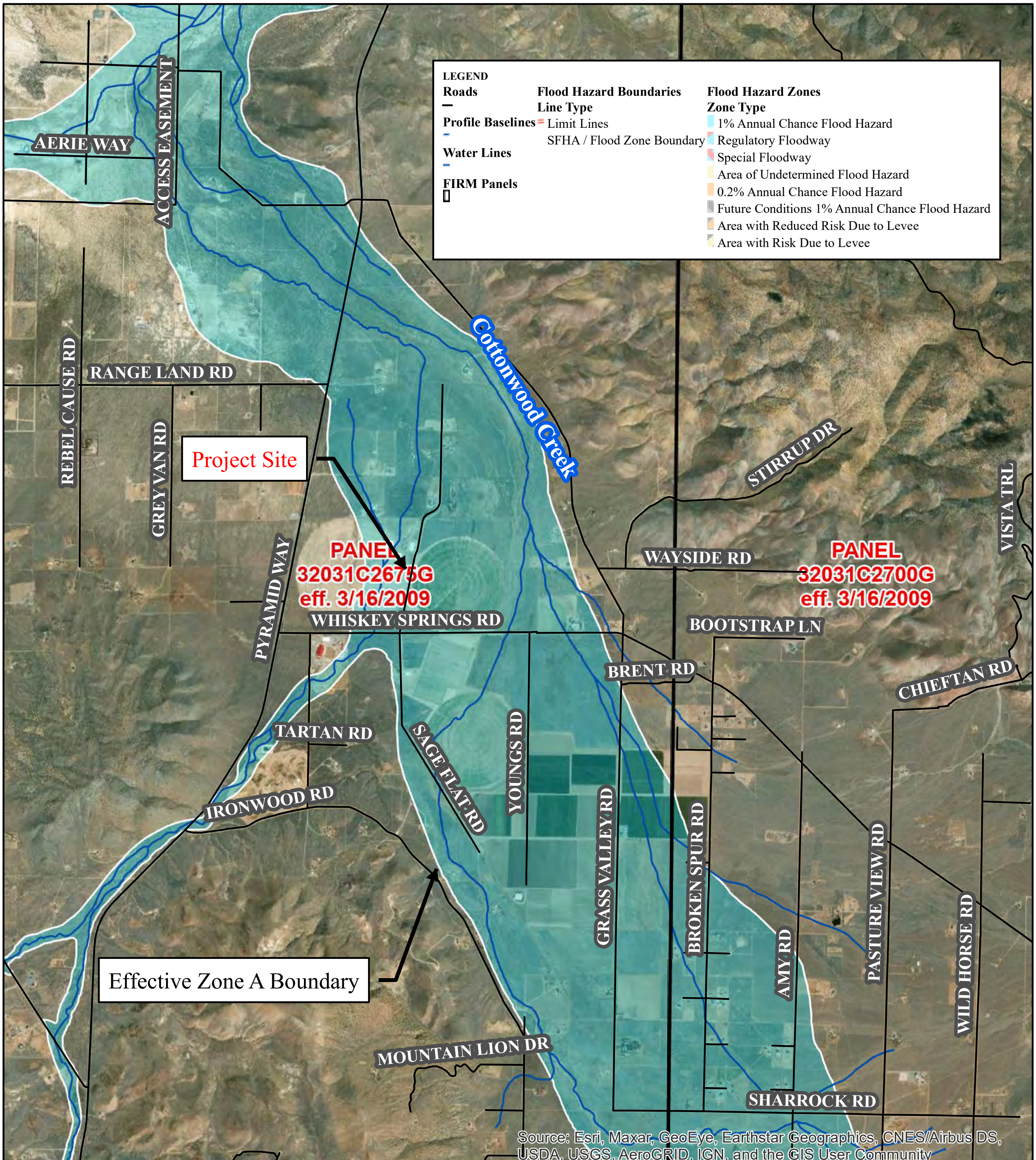
- Sediment should be expected, but not a serious maintenance problem;

- The well pads should be elevated above the BFE to reduce flooding/sediment issues; and

- Elevating the well pads should not impact the overall floodplain depths or flow patterns significantly.

Attachments

- Appendix A – HEC-HMS Report
- Appendix B – HEC-RAS Report
- Appendix C – Green & Ampt Parameter Calculations
- Appendix D – Engineering Soil Properties



Prepared For:

Truckee Meadows Water Authority
1355 Capital Blvd.
Reno, NV 89502
Office: (775) 834-8201

Prepared On: 12/9/2021

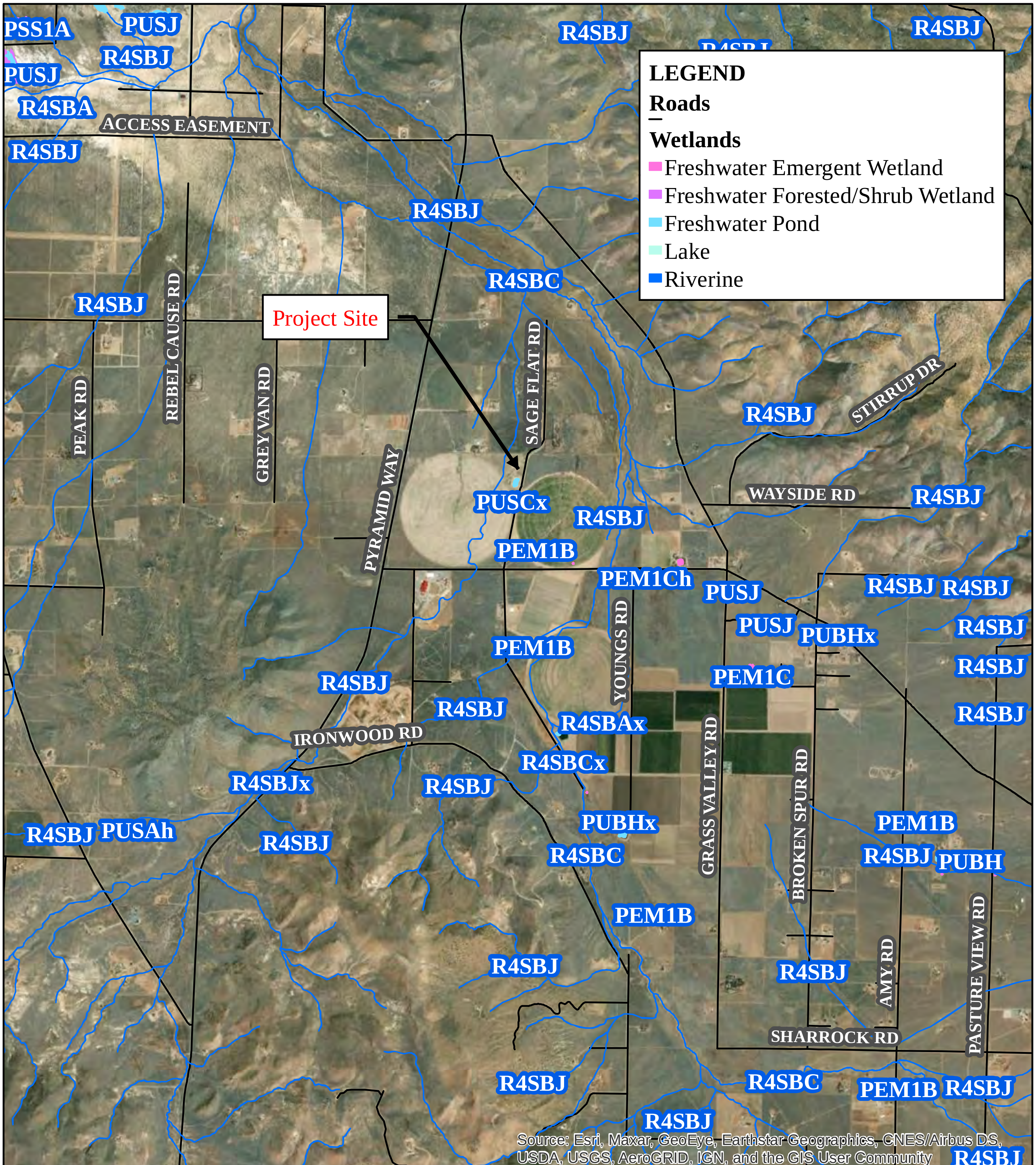
Exhibit 1
Palomino Valley
FEMA FIRM Map

N
W E
S

0 2,000 4,000
1 inch = 4000 feet

Prepared By:

House Moran Consulting, Inc.
Water Resources and Environmental Engineering
5470 Kietzke Lane, Suite 300
Reno, NV 89511
Office: (775) 293-4000
Nevada PE Firm No. 23484



Prepared For:

Truckee Meadows Water Authority
1355 Capital Blvd.
Reno, NV 89502
Office: (775) 834-8201

Prepared On: 12/9/2021

Exhibit 2
Palomino Valley
NWI Map

N
W E
S

0 2,000 4,000

1 inch = 4000 feet

Prepared By:

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Water Resources and Environmental Engineering
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Nevada PE Firm No. 23484

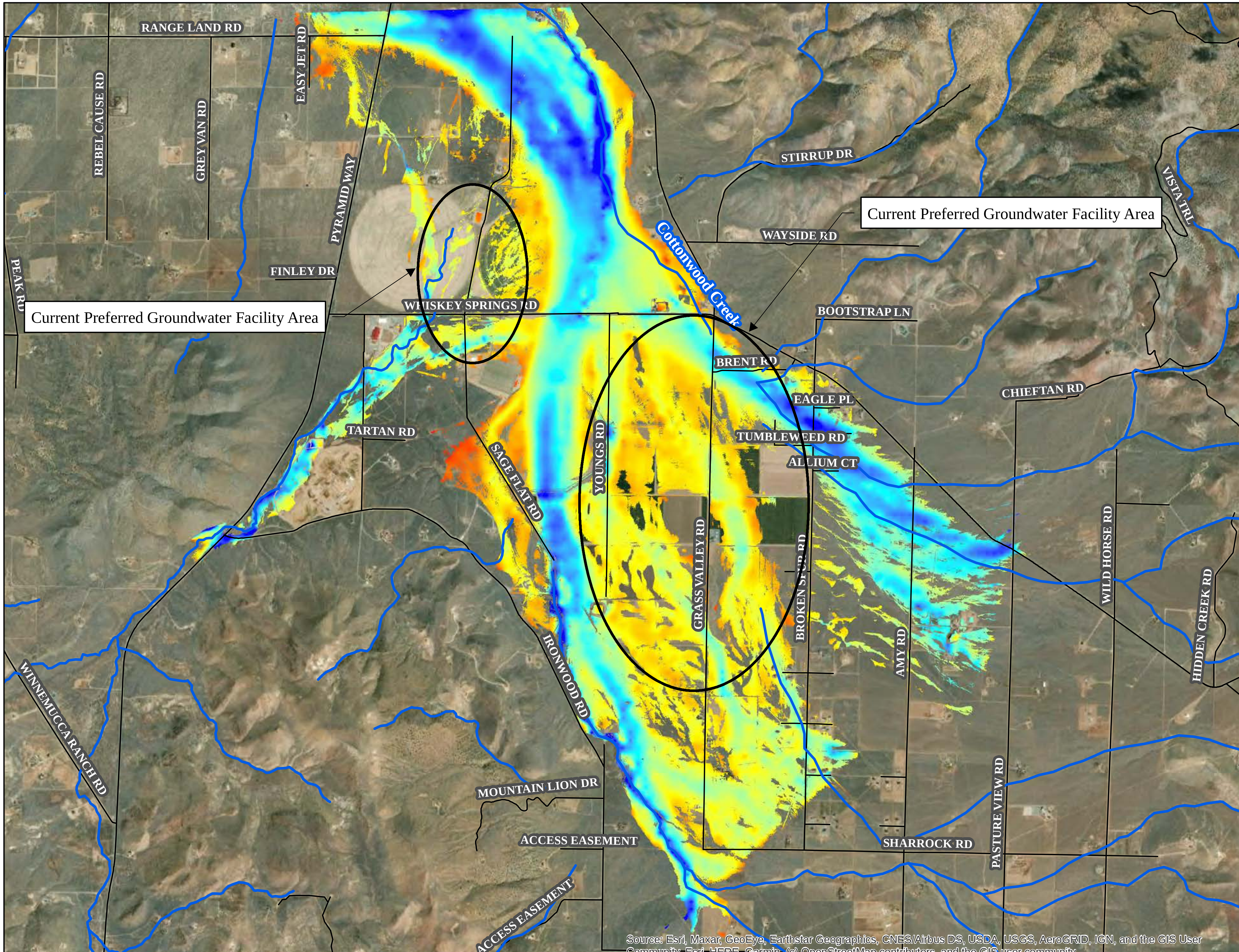

Exhibit 3
Palomino Valley
Velocity Grid
100-Year Max Flows

Prepared On: 02/09/2022

LEGEND

Roads

Velocity (FPS)
High : 4.352
Low :0.0

Streams

0 2,500
1 inch = 2500 feet

N W E S

Coordinate System:
NAD 1983 StatePlane Nevada West

CLIENT

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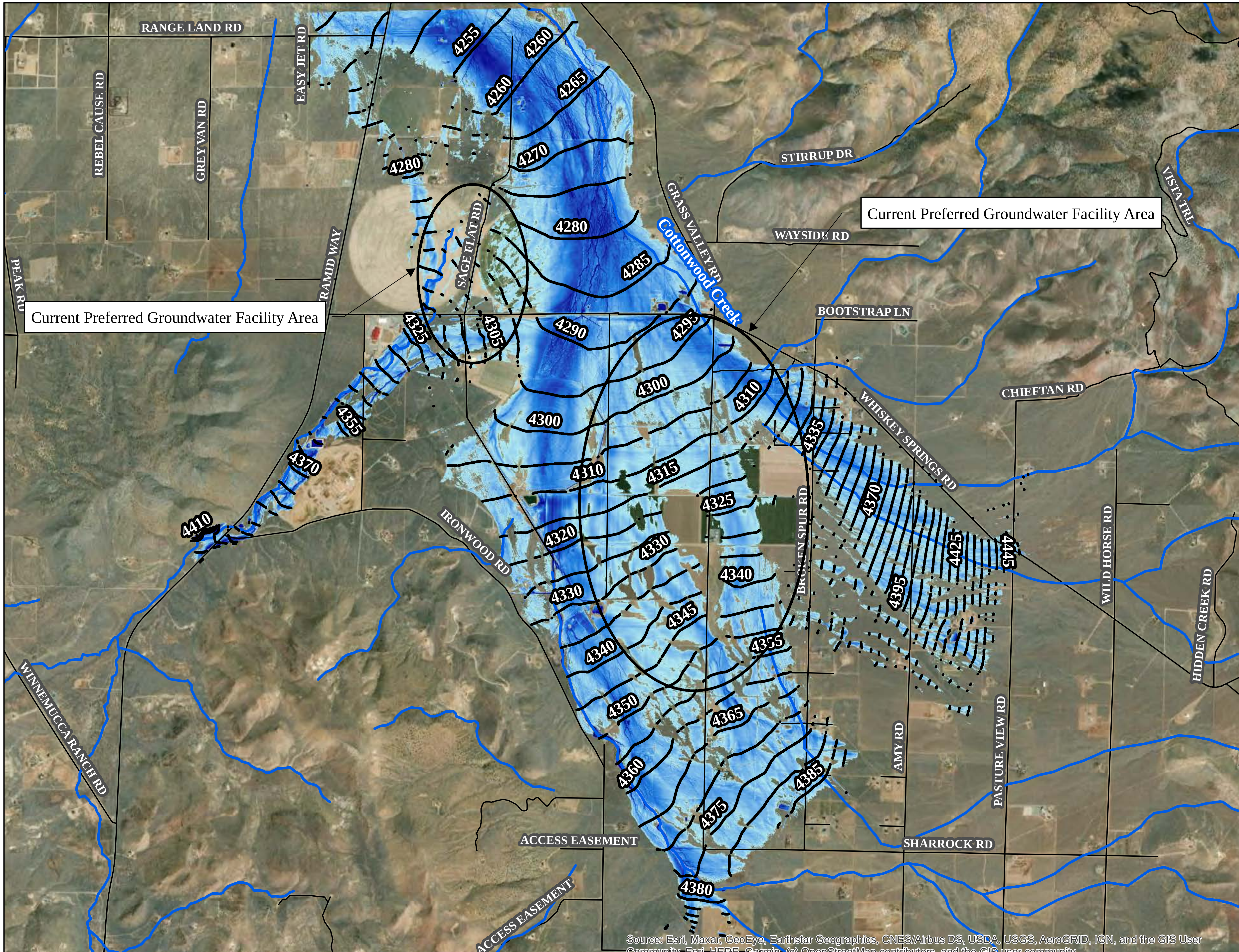

Exhibit 4
Palomino Valley
Depth Grid
100-Year Max Flows

Prepared On: 02/09/2022

LEGEND

Roads

Depth (Feet)
High : 12.43
Low : 0.0

WSE Contours 5ft Intervals

Streams

0 2,500
1 inch = 2500 feet

N W E S

Coordinate System:
NAD 1983 StatePlane Nevada West

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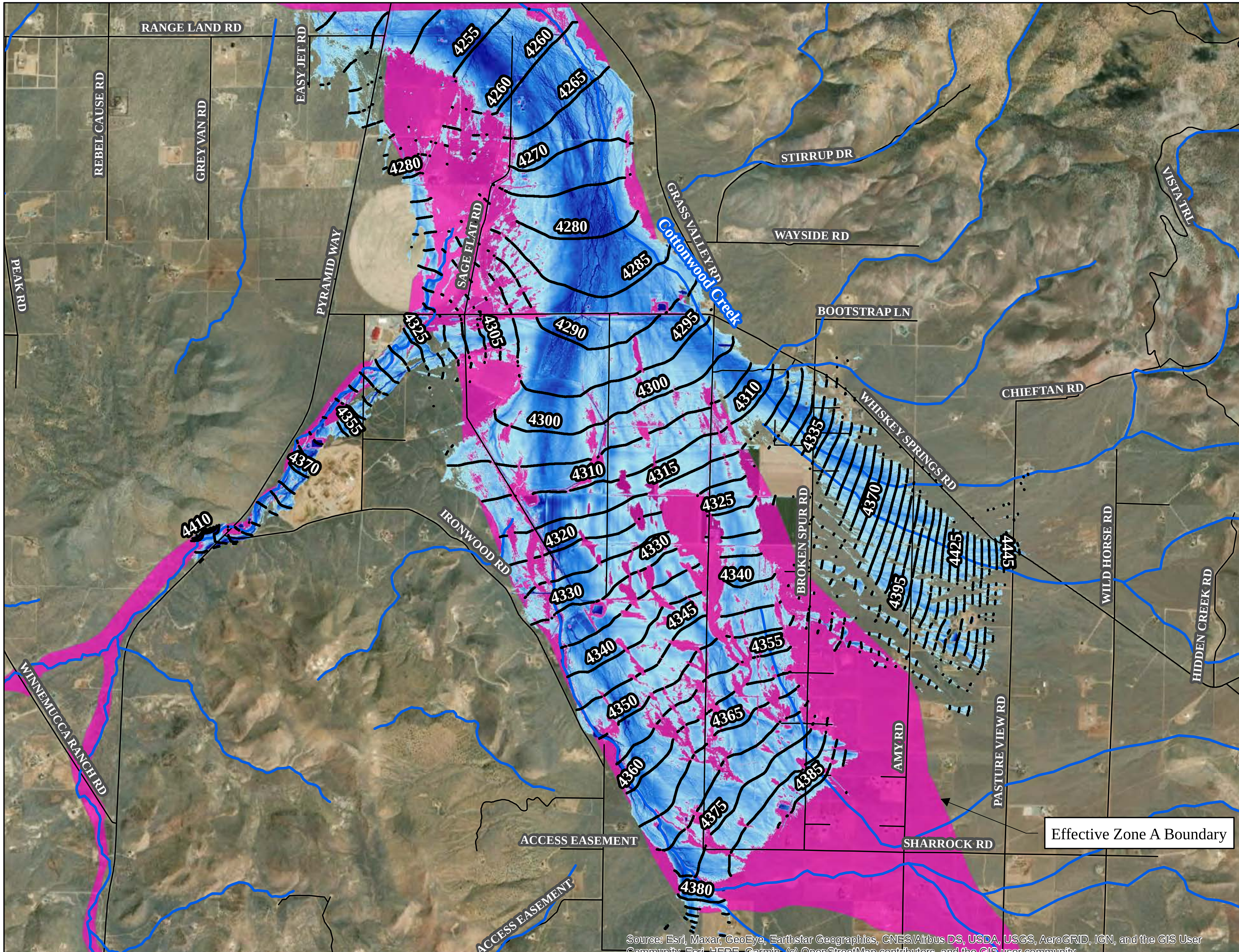

Exhibit 5
Palomino Valley Depth Grid
100-Year Max Flows
with NFHL Floodplain

Prepared On: 01/06/2022

LEGEND

Roads

WSE Contours 5ft Intervals

Depth (Feet)

High : 12.43

Low : 0.0

FEMA Zone A Floodplain Boundary

Streams

0 2,500

1 inch = 2500 feet

N W E S

Coordinate System:
NAD 1983 StatePlane Nevada West

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APPENDIX A: HEC-HMS Report

Global Summary Results for Run "Existing 100-yr"

Project: Palomino Valley_Updated   Simulation Run: Existing 100-yr

Start of Run: 01Dec2021, 00:00   Basin Model: Existing
End of Run: 04Dec2021, 00:00   Meteorologic Model: MET_ACE_100_YR_LT
Compute Time: 10Feb2022, 09:37:40   Control Specifications: Control 1

Show Elements: All Eleme...   Volume Units: IN ACRE-FT   Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
Bacon Rind Flat	44.137	727.6	01Dec2021, 21:15	1447.3
J-Cottonwood	81.772	3061.4	01Dec2021, 19:47	4228.4
Lower Cottonwood Creek	34.916	1536.2	01Dec2021, 17:49	1376.2
Outlet	155.213	5244.5	01Dec2021, 18:39	7186.7
Paiute Creek	29.304	1640.4	01Dec2021, 18:06	1510.9
R-Cottonwood	46.856	1985.8	01Dec2021, 21:22	2852.3
Upper Cottonwood Creek	46.856	1986.1	01Dec2021, 20:10	2856.9

Subbasin Area [Existing]

Show Elements: All Elements

Subbasin	Area (MI2)
Upper Cottonwood Creek	46.856
Lower Cottonwood Creek	34.916
Paiute Creek	29.304
Bacon Rind Flat	44.137

Green and Ampt [Existing]

Filter: --None--

Subbasin	Initial Type	Initial Deficit	Initial Content	Saturated Content	Suction (IN)	Conductivity (IN/HR)	Impervious (%)
Bacon Rind Flat	Water Content		0.16	0.42	3.76	0.92	5
Lower Cottonwood Creek	Water Content		0.17	0.41	3.88	0.72	5
Paiute Creek	Water Content		0.18	0.41	4.13	0.45	5
Upper Cottonwood Creek	Water Content		0.21	0.42	3.85	0.33	5

Snyder Transform[Existing]

Show Elements: All Elements

Standard | Ft Worth | Tulsa

Subbasin	Lag Time (HR)	Peaking Coefficient
Bacon Rind Flat	9.556	0.4
Lower Cottonwood Creek	6.054	0.6
Paiute Creek	6.348	0.6
Upper Cottonwood Creek	8.511	0.5

Modified USLE Erosion [Existing]

Show Elements: All Elements

Sorting: Alphabe...

Subbasin	Erodibility Factor	Topographic Factor	Cover Factor	Practice Factor	Threshold (CFS)	Exponent	Gradation Curve
Bacon Rind Flat	0.27	2.3	0.02	1	1.0	1	Soil_Distribution
Lower Cottonwood Creek	0.28	2.3	0.02	1	1.0	1	Soil_Distribution
Paiute Creek	0.30	2.3	0.02	1	1.0	1	Soil_Distribution
Upper Cottonwood Creek	0.37	2.3	0.02	1	1.0	1	Soil_Distribution

Muskingum Cunge Routing [Existing]

Show Elements: All Elements

Sorting: Alphabe...

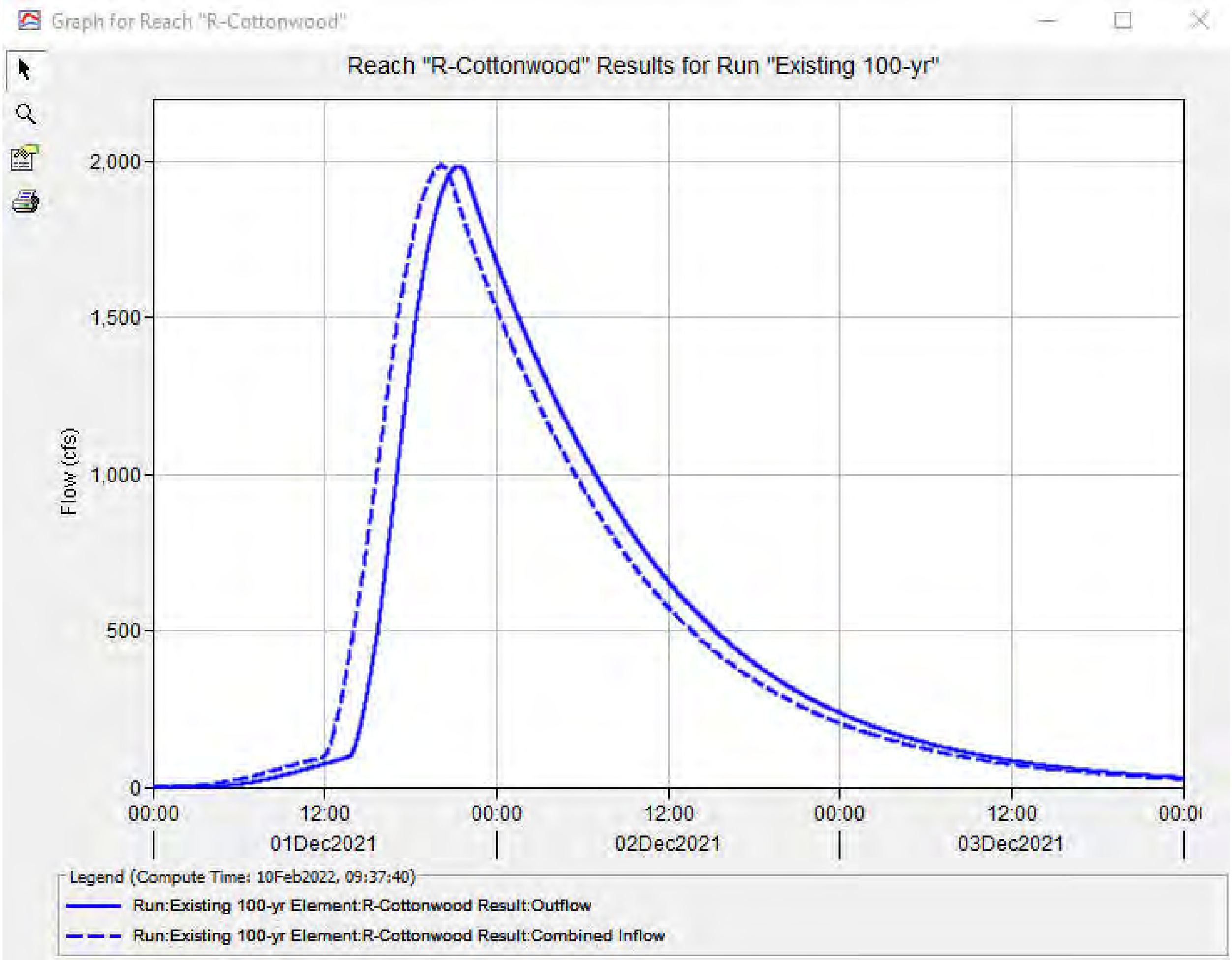
Reach	Initial Type	Initial Dis... (CFS)	Length (FT)	Slope (FT/FT)	Manning's n	Space-Time Method	Subreaches	Subinterval	Index Method	Index Flow (CFS)	Index Celerity (FT/S)
R-Cottonwood	Discharge = Inflow		45000	0.060	0.038	Auto DX Auto DT			Flow	696	

Reach	Shape	Diameter (FT)	Width (FT)	Side Slope (xH:1V)	Left Manning's n	Right Manning's n	Cross Section	Elevation...	Elevation...	Elevation...	Elevation...	Invert (FT)
R-Cottonwood	Eight Point				0.1	0.1	Cottonwood Creek XS					

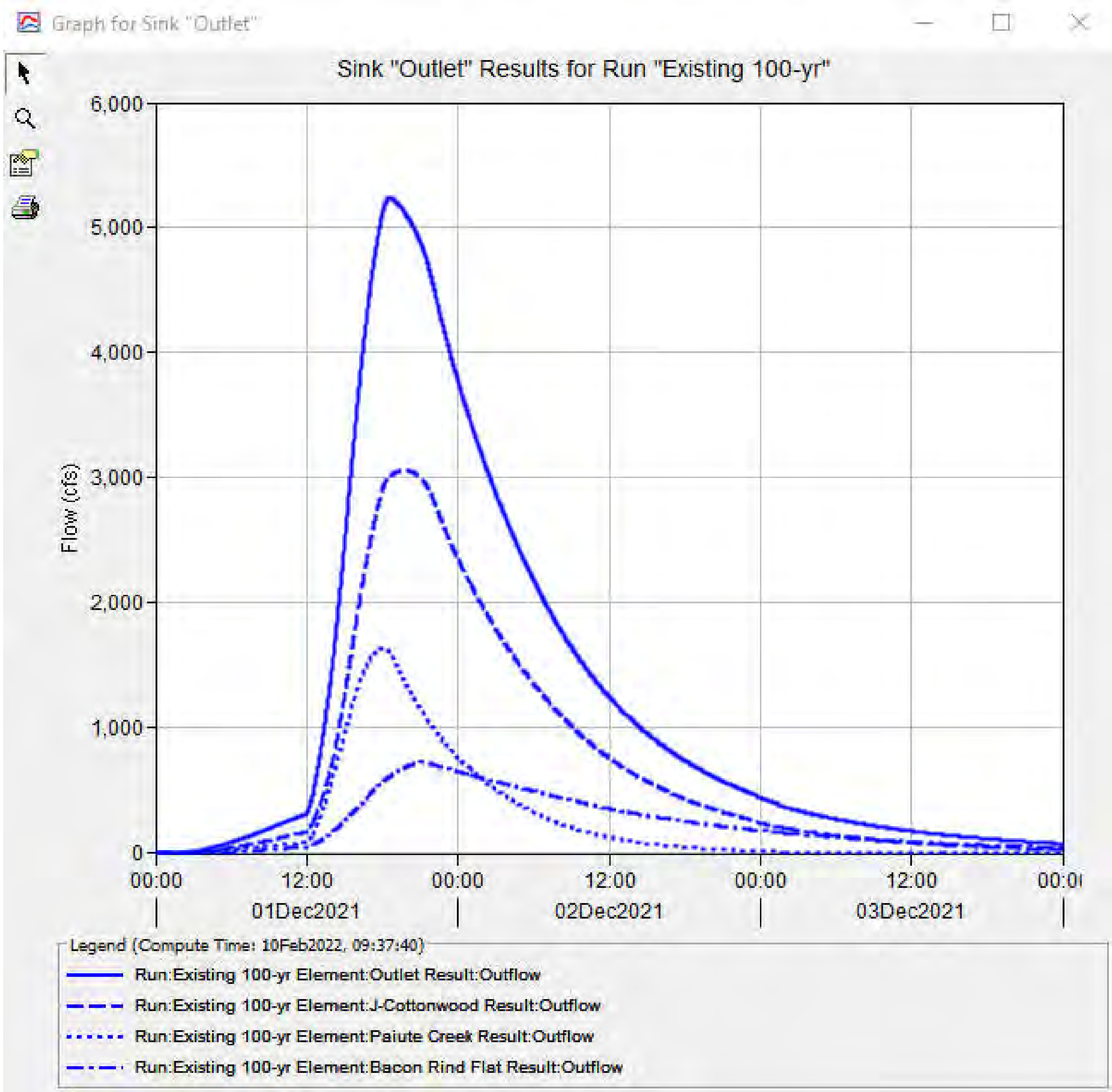
Volume Ratio [Existing]

Show Elements: All Elements

Reach	Initial Bed Curve	Erosion Limit	Deposition Limit	Temperature Method	Temperature (DEG F)	Temperature Gage	Bed Width (FT)	Bed Depth (FT)	Active Bed Factor
R-Cottonwood	Soil_Distribution	Length-Depth Ratio	EffectiveDepth	Average	55.4		30	2	5.8



Graph for Reach "R-Cottonwood"
Reach "R-Cottonwood" Results for Run "Existing 100-yr"
Flow (cfs)
2,000
1,500
1,000
500
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Dec2021
02Dec2021
03Dec2021
Legend (Compute Time: 10Feb2022, 09:37:40)
Run:Existing 100-yr Element:R-Cottonwood Result:Outflow
Run:Existing 100-yr Element:R-Cottonwood Result:Combined Inflow



Graph for Sink "Outlet"
Sink "Outlet" Results for Run "Existing 100-yr"
Flow (cfs)
6,000
5,000
4,000
3,000
2,000
1,000
0
00:00
12:00
00:00
12:00
00:00
12:00
00:00
01Dec2021
02Dec2021
03Dec2021
Legend (Compute Time: 10Feb2022, 09:37:40)
Run:Existing 100-yr Element:Outlet Result:Outflow
Run:Existing 100-yr Element:J-Cottonwood Result:Outflow
Run:Existing 100-yr Element:Paiute Creek Result:Outflow
Run:Existing 100-yr Element:Bacon Rind Flat Result:Outflow

APPENDIX B: HEC-RAS Report

HEC-RAS Model Report For Existing Conditions

```
                    HEC-RAS HEC-RAS 6.1.0 September 2021
                      U.S. Army Corps of Engineers
                     Hydrologic Engineering Center
                           609 Second Street
                           Davis, California

      X     X  XXXXXX    XXXX        XXXX       XX      XXXX
      X     X  X        X    X       X   X     X  X    X
      X     X  X        X            X   X    X    X   X
      XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
      X     X  X        X            X  X     X    X        X
      X     X  X        X    X       X   X    X    X        X
      X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

```
PROJECT DATA
Project Title: Palomino Valley_Updated
Project File : PalominoValley_Upd.prj
Run Date and Time:

Project in English units



PLAN DATA

Plan Title: Existing Conditions
Plan File : C:\Projects\TMWA\Models\HEC-RAS\PalominoValley_Upd.p01

           Geometry Title: Existing Palomino Valley Geometry
           Geometry File : C:\Projects\TMWA\Models\HEC-
RAS\PalominoValley_Upd.g01

           Flow Title    :
           Flow File     :

Plan Summary Information:
Number of:  Cross Sections =    0    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow
```

HEC-RAS Model Report For Existing Conditions

```
GEOMETRY DATA

Geometry Title: Existing Palomino Valley Geometry
Geometry File : C:\Projects\TMWA\Models\HEC-RAS\PalominoValley_Upd.g01


STORAGE AREA: Existing Flow A
Volume Method : Rating Curve

  Elevation     Volume



SUMMARY OF MANNING'S N VALUES



SUMMARY OF REACH LENGTHS



SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
```

APPENDIX C: G&A Parameter Calculations

Green and Ampt Calculations By Subbasin

Subbasin	MUKEY	Area (ac)	InitC*A	Initial Content	SatC*A	Saturated Content	PSIF*A	Suction Head (in)	KSat*A	Conductivity (in/hr)
Bacon Rind Flat										
Bacon Rind Flat	1907620	1328.86	225.9	0.17	544.8	0.41	5714.1	4.3	571.4	0.43
Bacon Rind Flat	1907621	230.50	39.2	0.17	94.5	0.41	991.1	4.3	99.1	0.43
Bacon Rind Flat	1907622	2537.24	406.0	0.16	1040.3	0.41	10707.2	4.22	1167.1	0.46
Bacon Rind Flat	1907623	4123.05	659.7	0.16	1690.4	0.41	17399.3	4.22	1896.6	0.46
Bacon Rind Flat	1907624	66.14	11.2	0.17	27.1	0.41	284.4	4.3	28.4	0.43
Bacon Rind Flat	1907625	144.23	24.5	0.17	59.1	0.41	614.4	4.26	60.6	0.42
Bacon Rind Flat	1907626	263.81	44.8	0.17	108.2	0.41	1129.1	4.28	110.8	0.42
Bacon Rind Flat	1907627	332.91	56.6	0.17	136.5	0.41	1424.8	4.28	139.8	0.42
Bacon Rind Flat	1907628	748.69	172.2	0.23	321.9	0.43	2680.3	3.58	209.6	0.28
Bacon Rind Flat	1907629	549.64	109.9	0.2	230.8	0.42	2143.6	3.9	186.9	0.34
Bacon Rind Flat	1907630	658.64	151.5	0.23	283.2	0.43	2371.1	3.6	184.4	0.28
Bacon Rind Flat	1907631	173.06	29.4	0.17	71.0	0.41	744.2	4.3	74.4	0.43
Bacon Rind Flat	1907634	1302.08	234.4	0.18	546.9	0.42	5390.6	4.14	520.8	0.4
Bacon Rind Flat	1907635	3753.07	825.7	0.22	1613.8	0.43	13848.8	3.69	1125.9	0.3
Bacon Rind Flat	1907636	1024.97	215.2	0.21	430.5	0.42	3925.6	3.83	338.2	0.33
Bacon Rind Flat	3110183	5293.56	1058.7	0.2	2223.3	0.42	20644.9	3.9	1799.8	0.34
Bacon Rind Flat	474114	1350.18	229.5	0.17	553.6	0.41	5805.8	4.3	580.6	0.43
Bacon Rind Flat	474116	1857.27	315.7	0.17	761.5	0.41	7986.2	4.3	798.6	0.43
Bacon Rind Flat	474123	3098.37	495.7	0.16	1270.3	0.41	13075.1	4.22	1425.2	0.46
Bacon Rind Flat	474135	2613.23	261.3	0.1	1045.3	0.4	6716.0	2.57	3344.9	1.28
Bacon Rind Flat	474137	700.44	70.0	0.1	280.2	0.4	1800.1	2.57	896.6	1.28
Bacon Rind Flat	474140	7504.59	1275.8	0.17	3076.9	0.41	34671.2	4.62	3076.9	0.41
Bacon Rind Flat	474141	4863.23	826.7	0.17	1993.9	0.41	21203.7	4.36	2674.8	0.55
Bacon Rind Flat	474142	4838.50	435.5	0.09	2032.2	0.42	11176.9	2.31	19354.0	4
Bacon Rind Flat	474146	571.30	97.1	0.17	239.9	0.42	2468.0	4.32	257.1	0.45
Bacon Rind Flat	474147	1217.67	207.0	0.17	511.4	0.42	5260.4	4.32	548.0	0.45
Bacon Rind Flat	474148	670.45	60.3	0.09	281.6	0.42	1589.0	2.37	2701.9	4.03
Bacon Rind Flat	474149	725.43	116.1	0.16	297.4	0.41	3054.1	4.21	341.0	0.47
Bacon Rind Flat	474152	3850.25	1155.1	0.3	1848.1	0.48	25065.1	6.51	1039.6	0.27
Bacon Rind Flat	474154	3726.29	260.8	0.07	1527.8	0.41	7676.1	2.06	15352.3	4.12
Bacon Rind Flat	474155	2281.17	159.7	0.07	935.3	0.41	4699.2	2.06	9398.4	4.12
Bacon Rind Flat	474168	1449.17	144.9	0.1	579.7	0.4	4246.1	2.93	1826.0	1.26
Bacon Rind Flat	474183	1820.77	309.5	0.17	746.5	0.41	7829.3	4.3	782.9	0.43
Bacon Rind Flat	474196	5753.68	575.4	0.1	2301.5	0.4	14787.0	2.57	7364.7	1.28
Bacon Rind Flat	474199	12271.38	1104.4	0.09	4908.6	0.4	30187.6	2.46	18284.4	1.49
Bacon Rind Flat	474202	1776.68	159.9	0.09	710.7	0.4	4370.6	2.46	2647.3	1.49
Bacon Rind Flat	474228	2041.26	163.3	0.08	857.3	0.42	4592.8	2.25	8267.1	4.05
Bacon Rind Flat	474230	1876.53	150.1	0.08	788.1	0.42	4316.0	2.3	7637.5	4.07
Bacon Rind Flat	474231	1338.01	227.5	0.17	548.6	0.41	5753.4	4.3	575.3	0.43
Bacon Rind Flat	474244	3035.82	485.7	0.16	1244.7	0.41	12598.6	4.15	1791.1	0.59
Bacon Rind Flat	474245	3002.64	480.4	0.16	1231.1	0.41	12160.7	4.05	2101.9	0.7
Bacon Rind Flat	474250	3297.93	791.5	0.24	1418.1	0.43	12202.3	3.7	857.5	0.26
Bacon Rind Flat	474255	23727.05	3796.3	0.16	9728.1	0.41	99653.6	4.2	11151.7	0.47
Bacon Rind Flat	474256	4503.02	720.5	0.16	1846.2	0.41	19002.7	4.22	2071.4	0.46
Bacon Rind Flat	474259	748.95	127.3	0.17	307.1	0.41	3198.0	4.27	314.6	0.42
Bacon Rind Flat	474262	855.52	145.4	0.17	350.8	0.41	3678.7	4.3	367.9	0.43
Bacon Rind Flat	474264	543.58	87.0	0.16	222.9	0.41	2299.3	4.23	250.0	0.46
Bacon Rind Flat	474272	1666.82	283.4	0.17	683.4	0.41	7167.3	4.3	716.7	0.43
Bacon Rind Flat	474274	1032.04	0.0	0	0.0	0	0.0	0	0.0	0
Bacon Rind Flat	474275	1984.41	337.3	0.17	813.6	0.41	8533.0	4.3	853.3	0.43
Bacon Rind Flat	474306	12101.94	1089.2	0.09	4961.8	0.41	28197.5	2.33	24930.0	2.06
Bacon Rind Flat	474308	4315.01	388.4	0.09	1769.2	0.41	10312.9	2.39	9061.5	2.1
Bacon Rind Flat	474310	4568.10	365.4	0.08	1918.6	0.42	9730.1	2.13	19460.1	4.26
Bacon Rind Flat	474312	4640.49	371.2	0.08	1949.0	0.42	9884.2	2.13	19768.5	4.26
Bacon Rind Flat	474317	812.02	73.1	0.09	341.0	0.42	1794.6	2.21	3280.6	4.04
Bacon Rind Flat	474326	1102.38	275.6	0.25	485.0	0.44	4464.6	4.05	275.6	0.25
Bacon Rind Flat	474327	5061.69	860.5	0.17	2075.3	0.41	21765.2	4.3	2176.5	0.43
Bacon Rind Flat	474337	392.49	66.7	0.17	160.9	0.41	1687.7	4.3	168.8	0.43
Bacon Rind Flat	474349	1302.01	312.5	0.24	559.9	0.43	4999.7	3.84	338.5	0.26
Bacon Rind Flat	474350	1293.77	219.9	0.17	530.4	0.41	5899.6	4.56	543.4	0.42
Bacon Rind Flat	474351	1598.87	319.8	0.2	671.5	0.42	6331.5	3.96	575.6	0.36
Bacon Rind Flat	474360	3887.66	660.9	0.17	1593.9	0.41	16639.2	4.28	1632.8	0.42
Bacon Rind Flat	474361	1873.49	318.5	0.17	768.1	0.41	8018.5	4.28	786.9	0.42
Bacon Rind Flat	474394	4123.78	989.7	0.24	1773.2	0.43	15752.8	3.82	1072.2	0.26
Bacon Rind Flat	474396	2665.21	479.7	0.18	1092.7	0.41	12446.5	4.67	1039.4	0.39
Bacon Rind Flat	474397	21470.15	4294.0	0.2	9017.5	0.42	85236.5	3.97	7729.3	0.36
Bacon Rind Flat	474402	713.35	121.3	0.17	292.5	0.41	3003.2	4.21	292.5	0.41
Bacon Rind Flat	474404	647.49	148.9	0.23	278.4	0.43	2318.0	3.58	181.3	0.28
Bacon Rind Flat	474409	1953.84	332.2	0.17	801.1	0.41	8284.3	4.24	820.6	0.42

Green and Ampt Calculations By Subbasin

Bacon Rind Flat	474410	3734.80	634.9	0.17	1531.3	0.41	15835.5	4.24	1568.6	0.42
Bacon Rind Flat	474411	818.34	139.1	0.17	335.5	0.41	3461.6	4.23	343.7	0.42
Bacon Rind Flat	474418	4936.15	789.8	0.16	2023.8	0.41	20781.2	4.21	2320.0	0.47
Bacon Rind Flat	474419	2720.78	435.3	0.16	1115.5	0.41	11454.5	4.21	1278.8	0.47
Bacon Rind Flat	474421	4803.73	816.6	0.17	1969.5	0.41	20367.8	4.24	2113.6	0.44
Bacon Rind Flat	474422	1423.68	242.0	0.17	583.7	0.41	6036.4	4.24	626.4	0.44
Bacon Rind Flat	474424	2853.70	656.4	0.23	1227.1	0.43	10216.3	3.58	799.0	0.28
Bacon Rind Flat	474429	6558.18	1311.6	0.2	2623.3	0.4	38430.9	5.86	1639.5	0.25
Bacon Rind Flat	**Total**	237497.17	37034.72		97814.52		882188.76		242988.79	
Area Weighted Average		**Initial C =**	**0.2**	**Saturated Content =**	**0.4**	**Suction Head =**	**3.7**	**Conductivity =**	**1.0**	

Green and Ampt Calculations By Subbasin

Subbasin	MUKEY	Area (ac)	InitC*A	Initial Content	SatC*A	Saturated Content	PSIF*A	Suction Head (in)	KSat*A	Conductivity (in/hr)
Paiute Creek										
Paiute Creek	474151	2379.95	785.4	0.33	1023.4	0.43	26798.2	11.26	71.4	0.03
Paiute Creek	474152	3850.25	1155.1	0.3	1848.1	0.48	25065.1	6.51	1039.6	0.27
Paiute Creek	474154	3726.29	260.8	0.07	1527.8	0.41	7676.1	2.06	15352.3	4.12
Paiute Creek	474155	2281.17	159.7	0.07	935.3	0.41	4699.2	2.06	9398.4	4.12
Paiute Creek	474156	230.06	36.8	0.16	94.3	0.41	922.5	4.01	204.8	0.89
Paiute Creek	474157	2958.94	503.0	0.17	1213.2	0.41	13788.7	4.66	1213.2	0.41
Paiute Creek	474158	941.73	150.7	0.16	386.1	0.41	3964.7	4.21	442.6	0.47
Paiute Creek	474159	823.27	131.7	0.16	337.5	0.41	3465.9	4.21	386.9	0.47
Paiute Creek	474168	1449.17	144.9	0.1	579.7	0.4	4246.1	2.93	1826.0	1.26
Paiute Creek	474192	6427.05	1156.9	0.18	2699.4	0.42	26800.8	4.17	2570.8	0.4
Paiute Creek	474198	18865.09	4150.3	0.22	8112.0	0.43	70555.4	3.74	5848.2	0.31
Paiute Creek	474199	12271.38	1104.4	0.09	4908.6	0.4	30187.6	2.46	18284.4	1.49
Paiute Creek	474218	5883.07	1117.8	0.19	2470.9	0.42	23649.9	4.02	2176.7	0.37
Paiute Creek	474219	15527.06	2639.6	0.17	6366.1	0.41	66300.6	4.27	6521.4	0.42
Paiute Creek	474234	6364.09	1081.9	0.17	2609.3	0.41	27365.6	4.3	2736.6	0.43
Paiute Creek	474235	2660.55	611.9	0.23	1144.0	0.43	9631.2	3.62	771.6	0.29
Paiute Creek	474236	8107.77	1702.6	0.21	3405.3	0.42	33971.5	4.19	2594.5	0.32
Paiute Creek	474245	3002.64	480.4	0.16	1231.1	0.41	12160.7	4.05	2101.9	0.7
Paiute Creek	474250	3297.93	791.5	0.24	1418.1	0.43	12202.3	3.7	857.5	0.26
Paiute Creek	474251	449.10	107.8	0.24	193.1	0.43	1661.7	3.7	116.8	0.26
Paiute Creek	474255	23727.05	3796.3	0.16	9728.1	0.41	99653.6	4.2	11151.7	0.47
Paiute Creek	474260	549.68	93.4	0.17	225.4	0.41	2363.6	4.3	236.4	0.43
Paiute Creek	474266	4172.00	959.6	0.23	1794.0	0.43	15060.9	3.61	1168.2	0.28
Paiute Creek	474272	1666.82	283.4	0.17	683.4	0.41	7167.3	4.3	716.7	0.43
Paiute Creek	474300	1863.00	186.3	0.1	745.2	0.4	4843.8	2.6	2440.5	1.31
Paiute Creek	474302	2520.54	252.1	0.1	1008.2	0.4	6427.4	2.55	2747.4	1.09
Paiute Creek	474308	4315.01	388.4	0.09	1769.2	0.41	10312.9	2.39	9061.5	2.1
Paiute Creek	474309	11526.07	1037.3	0.09	4725.7	0.41	27086.3	2.35	27893.1	2.42
Paiute Creek	474337	392.49	66.7	0.17	160.9	0.41	1687.7	4.3	168.8	0.43
Paiute Creek	474359	1575.55	267.8	0.17	646.0	0.41	6743.3	4.28	661.7	0.42
Paiute Creek	474362	884.13	150.3	0.17	362.5	0.41	3784.1	4.28	371.3	0.42
Paiute Creek	474393	623.62	106.0	0.17	255.7	0.41	2781.4	4.46	255.7	0.41
Paiute Creek	474394	4123.78	989.7	0.24	1773.2	0.43	15752.8	3.82	1072.2	0.26
Paiute Creek	474396	2665.21	479.7	0.18	1092.7	0.41	12446.5	4.67	1039.4	0.39
Paiute Creek	474414	3572.52	643.1	0.18	1464.7	0.41	16040.6	4.49	1429.0	0.4
Paiute Creek	474415	6552.86	1179.5	0.18	2686.7	0.41	29750.0	4.54	2621.1	0.4
Paiute Creek	474417	3167.85	506.9	0.16	1298.8	0.41	13336.7	4.21	1488.9	0.47
Paiute Creek	474418	4936.15	789.8	0.16	2023.8	0.41	20781.2	4.21	2320.0	0.47
Paiute Creek	474419	2720.78	435.3	0.16	1115.5	0.41	11454.5	4.21	1278.8	0.47
Paiute Creek	474421	4803.73	816.6	0.17	1969.5	0.41	20367.8	4.24	2113.6	0.44
Paiute Creek	474422	1423.68	242.0	0.17	583.7	0.41	6036.4	4.24	626.4	0.44
Paiute Creek	474426	3067.89	0.0	0	0.0	0	0.0	0	0.0	0
Paiute Creek	**Total**	192346.93	31943.55		78616.03		738992.65		145377.74	
Area Weighted Average		**Initial C =**	**0.2**	**Saturated Content =**	**0.4**	**Suction Head =**	**3.8**	**Conductivity =**	**0.8**	

Green and Ampt Calculations By Subbasin

Subbasin	MUKEY	Area (ac)	InitC*A	Initial Content	SatC*A	Saturated Content	PSIF*A	Suction Head (in)	KSat*A	Conductivity (in/hr)
Lower Cottonwood Creek										
Lower Cottonwood Creek	3110183	5293.56	1058.7	0.2	2223.3	0.42	20644.9	3.9	1799.8	0.34
Lower Cottonwood Creek	474114	1350.18	229.5	0.17	553.6	0.41	5805.8	4.3	580.6	0.43
Lower Cottonwood Creek	474119	1209.81	362.9	0.3	471.8	0.39	14312.1	11.83	36.3	0.03
Lower Cottonwood Creek	474122	1416.91	425.1	0.3	552.6	0.39	16634.5	11.74	56.7	0.04
Lower Cottonwood Creek	474131	1033.69	175.7	0.17	423.8	0.41	4444.9	4.3	444.5	0.43
Lower Cottonwood Creek	474135	2613.23	261.3	0.1	1045.3	0.4	6716.0	2.57	3344.9	1.28
Lower Cottonwood Creek	474137	700.44	70.0	0.1	280.2	0.4	1800.1	2.57	896.6	1.28
Lower Cottonwood Creek	474138	2605.96	807.8	0.31	1120.6	0.43	25329.9	9.72	286.7	0.11
Lower Cottonwood Creek	474140	7504.59	1275.8	0.17	3076.9	0.41	34671.2	4.62	3076.9	0.41
Lower Cottonwood Creek	474141	4863.23	826.7	0.17	1993.9	0.41	21203.7	4.36	2674.8	0.55
Lower Cottonwood Creek	474142	4838.50	435.5	0.09	2032.2	0.42	11176.9	2.31	19354.0	4
Lower Cottonwood Creek	474149	725.43	116.1	0.16	297.4	0.41	3054.1	4.21	341.0	0.47
Lower Cottonwood Creek	474151	2379.95	785.4	0.33	1023.4	0.43	26798.2	11.26	71.4	0.03
Lower Cottonwood Creek	474152	3850.25	1155.1	0.3	1848.1	0.48	25065.1	6.51	1039.6	0.27
Lower Cottonwood Creek	474154	3726.29	260.8	0.07	1527.8	0.41	7676.1	2.06	15352.3	4.12
Lower Cottonwood Creek	474156	230.06	36.8	0.16	94.3	0.41	922.5	4.01	204.8	0.89
Lower Cottonwood Creek	474168	1449.17	144.9	0.1	579.7	0.4	4246.1	2.93	1826.0	1.26
Lower Cottonwood Creek	474196	5753.68	575.4	0.1	2301.5	0.4	14787.0	2.57	7364.7	1.28
Lower Cottonwood Creek	474198	18865.09	4150.3	0.22	8112.0	0.43	70555.4	3.74	5848.2	0.31
Lower Cottonwood Creek	474199	12271.38	1104.4	0.09	4908.6	0.4	30187.6	2.46	18284.4	1.49
Lower Cottonwood Creek	474202	1776.68	159.9	0.09	710.7	0.4	4370.6	2.46	2647.3	1.49
Lower Cottonwood Creek	474219	15527.06	2639.6	0.17	6366.1	0.41	66300.6	4.27	6521.4	0.42
Lower Cottonwood Creek	474222	18713.60	3929.9	0.21	7859.7	0.42	72047.3	3.85	6362.6	0.34
Lower Cottonwood Creek	474226	12539.99	2884.2	0.23	5392.2	0.43	51288.5	4.09	3385.8	0.27
Lower Cottonwood Creek	474230	1876.53	150.1	0.08	788.1	0.42	4316.0	2.3	7637.5	4.07
Lower Cottonwood Creek	474231	1338.01	227.5	0.17	548.6	0.41	5753.4	4.3	575.3	0.43
Lower Cottonwood Creek	474232	1465.22	249.1	0.17	600.7	0.41	6300.4	4.3	630.0	0.43
Lower Cottonwood Creek	474233	1043.83	177.5	0.17	428.0	0.41	4488.5	4.3	448.8	0.43
Lower Cottonwood Creek	474234	6364.09	1081.9	0.17	2609.3	0.41	27365.6	4.3	2736.6	0.43
Lower Cottonwood Creek	474235	2660.55	611.9	0.23	1144.0	0.43	9631.2	3.62	771.6	0.29
Lower Cottonwood Creek	474236	8107.77	1702.6	0.21	3405.3	0.42	33971.5	4.19	2594.5	0.32
Lower Cottonwood Creek	474244	3035.82	485.7	0.16	1244.7	0.41	12598.6	4.15	1791.1	0.59
Lower Cottonwood Creek	474245	3002.64	480.4	0.16	1231.1	0.41	12160.7	4.05	2101.9	0.7
Lower Cottonwood Creek	474246	793.57	134.9	0.17	325.4	0.41	3356.8	4.23	333.3	0.42
Lower Cottonwood Creek	474247	1334.52	226.9	0.17	547.2	0.41	5685.1	4.26	560.5	0.42
Lower Cottonwood Creek	474255	23727.05	3796.3	0.16	9728.1	0.41	99653.6	4.2	11151.7	0.47
Lower Cottonwood Creek	474256	4503.02	720.5	0.16	1846.2	0.41	19002.7	4.22	2071.4	0.46
Lower Cottonwood Creek	474257	1046.29	240.6	0.23	449.9	0.43	3682.9	3.52	324.3	0.31
Lower Cottonwood Creek	474258	1497.02	344.3	0.23	643.7	0.43	5359.3	3.58	419.2	0.28
Lower Cottonwood Creek	474262	855.52	145.4	0.17	350.8	0.41	3678.7	4.3	367.9	0.43
Lower Cottonwood Creek	474270	1097.50	263.4	0.24	471.9	0.43	3896.1	3.55	296.3	0.27
Lower Cottonwood Creek	474272	1666.82	283.4	0.17	683.4	0.41	7167.3	4.3	716.7	0.43
Lower Cottonwood Creek	474275	1984.41	337.3	0.17	813.6	0.41	8533.0	4.3	853.3	0.43
Lower Cottonwood Creek	474299	523.20	83.7	0.16	214.5	0.41	2155.6	4.12	308.7	0.59
Lower Cottonwood Creek	474302	2520.54	252.1	0.1	1008.2	0.4	6427.4	2.55	2747.4	1.09
Lower Cottonwood Creek	474304	3376.72	270.1	0.08	1418.2	0.42	7192.4	2.13	14452.4	4.28
Lower Cottonwood Creek	474309	11526.07	1037.3	0.09	4725.7	0.41	27086.3	2.35	27893.1	2.42
Lower Cottonwood Creek	474317	812.02	73.1	0.09	341.0	0.42	1794.6	2.21	3280.6	4.04
Lower Cottonwood Creek	474327	5061.69	860.5	0.17	2075.3	0.41	21765.2	4.3	2176.5	0.43
Lower Cottonwood Creek	474334	979.36	166.5	0.17	401.5	0.41	4211.2	4.3	421.1	0.43
Lower Cottonwood Creek	474335	1022.44	173.8	0.17	419.2	0.41	4396.5	4.3	439.6	0.43
Lower Cottonwood Creek	474336	1011.97	172.0	0.17	414.9	0.41	4351.5	4.3	435.1	0.43
Lower Cottonwood Creek	474337	392.49	66.7	0.17	160.9	0.41	1687.7	4.3	168.8	0.43
Lower Cottonwood Creek	474339	2240.07	380.8	0.17	918.4	0.41	9341.1	4.17	1030.4	0.46
Lower Cottonwood Creek	474347	1126.45	270.3	0.24	439.3	0.39	8730.0	7.75	78.9	0.07
Lower Cottonwood Creek	474349	1302.01	312.5	0.24	559.9	0.43	4999.7	3.84	338.5	0.26
Lower Cottonwood Creek	474350	1293.77	219.9	0.17	530.4	0.41	5899.6	4.56	543.4	0.42
Lower Cottonwood Creek	474351	1598.87	319.8	0.2	671.5	0.42	6331.5	3.96	575.6	0.36
Lower Cottonwood Creek	474359	1575.55	267.8	0.17	646.0	0.41	6743.3	4.28	661.7	0.42
Lower Cottonwood Creek	474360	3887.66	660.9	0.17	1593.9	0.41	16639.2	4.28	1632.8	0.42
Lower Cottonwood Creek	474362	884.13	150.3	0.17	362.5	0.41	3784.1	4.28	371.3	0.42
Lower Cottonwood Creek	474393	623.62	106.0	0.17	255.7	0.41	2781.4	4.46	255.7	0.41
Lower Cottonwood Creek	474394	4123.78	989.7	0.24	1773.2	0.43	15752.8	3.82	1072.2	0.26
Lower Cottonwood Creek	474395	1635.75	278.1	0.17	670.7	0.41	7393.6	4.52	670.7	0.41
Lower Cottonwood Creek	474396	2665.21	479.7	0.18	1092.7	0.41	12446.5	4.67	1039.4	0.39
Lower Cottonwood Creek	474397	21470.15	4294.0	0.2	9017.5	0.42	85236.5	3.97	7729.3	0.36
Lower Cottonwood Creek	474409	1953.84	332.2	0.17	801.1	0.41	8284.3	4.24	820.6	0.42
Lower Cottonwood Creek	474414	3572.52	643.1	0.18	1464.7	0.41	16040.6	4.49	1429.0	0.4
Lower Cottonwood Creek	474415	6552.86	1179.5	0.18	2686.7	0.41	29750.0	4.54	2621.1	0.4
Lower Cottonwood Creek	474417	3167.85	506.9	0.16	1298.8	0.41	13336.7	4.21	1488.9	0.47
Lower Cottonwood Creek	474418	4936.15	789.8	0.16	2023.8	0.41	20781.2	4.21	2320.0	0.47

Green and Ampt Calculations By Subbasin

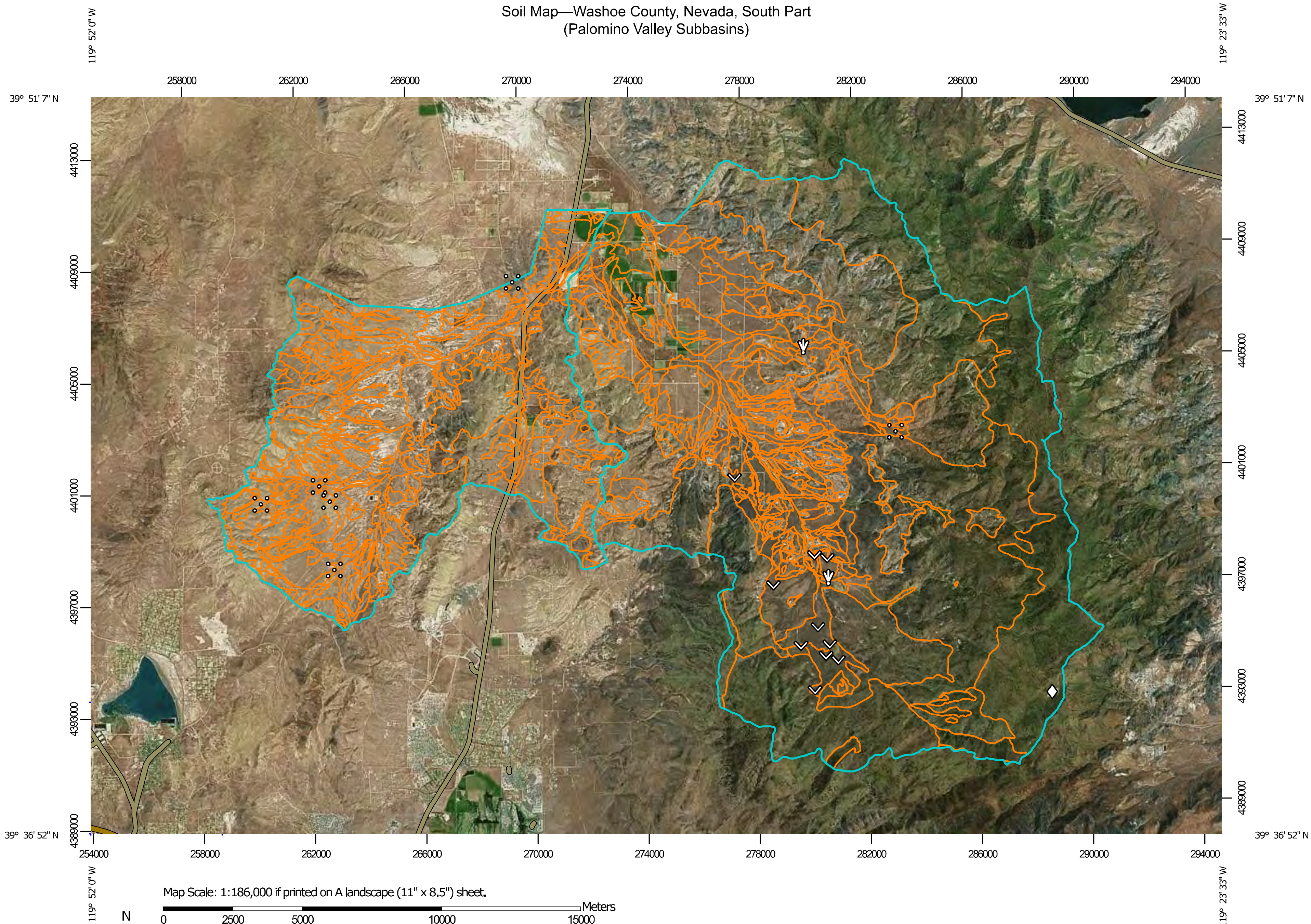
Lower Cottonwood Creek	474421	4803.73	816.6	0.17	1969.5	0.41	20367.8	4.24	2113.6	0.44
Lower Cottonwood Creek	474422	1423.68	242.0	0.17	583.7	0.41	6036.4	4.24	626.4	0.44
Lower Cottonwood Creek	474426	3067.89	0.0	0	0.0	0	0.0	0	0.0	0
Lower Cottonwood Creek	474429	6558.18	1311.6	0.2	2623.3	0.4	38430.9	5.86	1639.5	0.25
Lower Cottonwood Creek	**Total**	306329.09	53239.28		125818.35		########		219565.27	
Area Weighted Average		**Initial C =**	**0.2**	**Saturated Content =**	**0.4**	**Suction Head =**	**4.0**	**Conductivity =**	**0.7**	

Green and Ampt Calculations By Subbasin

Subbasin	MUKEY	Area (ac)	InitC*A	Initial Content	SatC*A	Saturated Content	PSIF*A	Suction Head (in)	KSat*A	Conductivity (in/hr)
Upper Cottonwood Creek										
Upper Cottonwood Creek	3110183	5293.56	1058.7	0.2	2223.3	0.42	20644.9	3.9	1799.8	0.34
Upper Cottonwood Creek	474114	1350.18	229.5	0.17	553.6	0.41	5805.8	4.3	580.6	0.43
Upper Cottonwood Creek	474122	1416.91	425.1	0.3	552.6	0.39	16634.5	11.74	56.7	0.04
Upper Cottonwood Creek	474138	2605.96	807.8	0.31	1120.6	0.43	25329.9	9.72	286.7	0.11
Upper Cottonwood Creek	474141	4863.23	826.7	0.17	1993.9	0.41	21203.7	4.36	2674.8	0.55
Upper Cottonwood Creek	474150	1550.97	248.2	0.16	635.9	0.41	6405.5	4.13	1023.6	0.66
Upper Cottonwood Creek	474152	3850.25	1155.1	0.3	1848.1	0.48	25065.1	6.51	1039.6	0.27
Upper Cottonwood Creek	474162	10110.55	2426.5	0.24	4347.5	0.43	35386.9	3.5	2628.7	0.26
Upper Cottonwood Creek	474163	4291.01	1029.8	0.24	1845.1	0.43	15104.3	3.52	1158.6	0.27
Upper Cottonwood Creek	474164	9697.84	2230.5	0.23	4170.1	0.43	34718.3	3.58	2715.4	0.28
Upper Cottonwood Creek	474198	18865.09	4150.3	0.22	8112.0	0.43	70555.4	3.74	5848.2	0.31
Upper Cottonwood Creek	474219	15527.06	2639.6	0.17	6366.1	0.41	66300.6	4.27	6521.4	0.42
Upper Cottonwood Creek	474222	18713.60	3929.9	0.21	7859.7	0.42	72047.3	3.85	6362.6	0.34
Upper Cottonwood Creek	474226	12539.99	2884.2	0.23	5392.2	0.43	51288.5	4.09	3385.8	0.27
Upper Cottonwood Creek	474234	6364.09	1081.9	0.17	2609.3	0.41	27365.6	4.3	2736.6	0.43
Upper Cottonwood Creek	474235	2660.55	611.9	0.23	1144.0	0.43	9631.2	3.62	771.6	0.29
Upper Cottonwood Creek	474236	8107.77	1702.6	0.21	3405.3	0.42	33971.5	4.19	2594.5	0.32
Upper Cottonwood Creek	474254	1834.31	311.8	0.17	752.1	0.41	7887.5	4.3	788.8	0.43
Upper Cottonwood Creek	474273	4244.82	849.0	0.2	1782.8	0.42	16767.0	3.95	1528.1	0.36
Upper Cottonwood Creek	474284	279.75	28.0	0.1	111.9	0.4	713.4	2.55	313.3	1.12
Upper Cottonwood Creek	474301	932.02	102.5	0.11	372.8	0.4	2423.2	2.6	978.6	1.05
Upper Cottonwood Creek	474302	2520.54	252.1	0.1	1008.2	0.4	6427.4	2.55	2747.4	1.09
Upper Cottonwood Creek	474314	1000.48	130.1	0.13	410.2	0.41	3361.6	3.36	780.4	0.78
Upper Cottonwood Creek	474315	670.98	147.6	0.22	288.5	0.43	2267.9	3.38	241.6	0.36
Upper Cottonwood Creek	474326	1102.38	275.6	0.25	485.0	0.44	4464.6	4.05	275.6	0.25
Upper Cottonwood Creek	474327	5061.69	860.5	0.17	2075.3	0.41	21765.2	4.3	2176.5	0.43
Upper Cottonwood Creek	474334	979.36	166.5	0.17	401.5	0.41	4211.2	4.3	421.1	0.43
Upper Cottonwood Creek	474335	1022.44	173.8	0.17	419.2	0.41	4396.5	4.3	439.6	0.43
Upper Cottonwood Creek	474336	1011.97	172.0	0.17	414.9	0.41	4351.5	4.3	435.1	0.43
Upper Cottonwood Creek	474347	1126.45	270.3	0.24	439.3	0.39	8730.0	7.75	78.9	0.07
Upper Cottonwood Creek	474349	1302.01	312.5	0.24	559.9	0.43	4999.7	3.84	338.5	0.26
Upper Cottonwood Creek	474350	1293.77	219.9	0.17	530.4	0.41	5899.6	4.56	543.4	0.42
Upper Cottonwood Creek	474351	1598.87	319.8	0.2	671.5	0.42	6331.5	3.96	575.6	0.36
Upper Cottonwood Creek	474359	1575.55	267.8	0.17	646.0	0.41	6743.3	4.28	661.7	0.42
Upper Cottonwood Creek	474366	3105.62	745.3	0.24	1335.4	0.43	11832.4	3.81	807.5	0.26
Upper Cottonwood Creek	474395	1635.75	278.1	0.17	670.7	0.41	7393.6	4.52	670.7	0.41
Upper Cottonwood Creek	474397	21470.15	4294.0	0.2	9017.5	0.42	85236.5	3.97	7729.3	0.36
Upper Cottonwood Creek	474399	1682.12	370.1	0.22	723.3	0.43	6307.9	3.75	521.5	0.31
Upper Cottonwood Creek	474407	12653.72	2277.7	0.18	5314.6	0.42	52892.5	4.18	5061.5	0.4
Upper Cottonwood Creek	474419	2720.78	435.3	0.16	1115.5	0.41	11454.5	4.21	1278.8	0.47
Upper Cottonwood Creek	474421	4803.73	816.6	0.17	1969.5	0.41	20367.8	4.24	2113.6	0.44
Upper Cottonwood Creek	474422	1423.68	242.0	0.17	583.7	0.41	6036.4	4.24	626.4	0.44
Upper Cottonwood Creek	474425	1749.46	0.0	0	0.0	0	0.0	0	0.0	0
Upper Cottonwood Creek	474429	6558.18	1311.6	0.2	2623.3	0.4	38430.9	5.86	1639.5	0.25
Upper Cottonwood Creek	474433	41723.15	0.0	0	0.0	0	0.0	0	0.0	0
Upper Cottonwood Creel	**Total**	254892.3	43069.1		88902.3		889152.8		75957.9	
Area Weighted Average		**Initial C =**	**0.2**	**Saturated Content =**	**0.3**	**Suction Head =**	**3.5**	**Conductivity =**	**0.3**	

APPENDIX D: Engineering Soil Properties

Soil Map—Washoe County, Nevada, South Part
(Palomino Valley Subbasins)



Map Scale: 1:186,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 2500 5000 10000 15000

Feet: 0 5000 10000 20000 30000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

Soil Map—Washoe County, Nevada, South Part
(Palomino Valley Subbasins)

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Washoe County, Nevada, South Part
Survey Area Data: Version 18, Sep 9, 2021

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

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
101	Aquinas sandy loam, 4 to 8 percent slopes	164.9	0.2%
102	Aquinas sandy loam, 8 to 15 percent slopes	40.7	0.0%
106	Aquinas sandy loam, 8 to 15 percent slopes, eroded	242.3	0.2%
108	Aquinas sandy loam, moist, 4 to 8 percent slopes	991.3	1.0%
109	Aquinas sandy loam, moist, 8 to 15 percent slopes	183.0	0.2%
111	Jowec variant-Greenbrae sandy loams, 4 to 15 percent slopes	15.6	0.0%
120	Doten silty clay, 0 to 2 percent slopes	218.8	0.2%
136	Greenbrae sandy loam, 4 to 8 percent slopes	53.0	0.1%
140	Haybourne loamy sand, 2 to 4 percent slopes	845.0	0.8%
141	Haybourne loamy sand, 4 to 8 percent slopes	1,593.0	1.6%
142	Haybourne loamy sand, 8 to 15 percent slopes	214.1	0.2%
160	Incy sand, 4 to 8 percent slopes	123.6	0.1%
161	Incy fine sand, hilly	287.4	0.3%
171	Indian Creek gravelly sandy loam, 0 to 4 percent slopes	28.5	0.0%
172	Indian Creek sandy loam, 4 to 8 percent slopes	276.4	0.3%
173	Indian Creek sandy loam, 8 to 15 percent slopes	92.5	0.1%
174	Indian Creek extremely stony sandy loam, 2 to 8 percent slopes	662.2	0.7%
175	Indian Creek very cobbly loam, 2 to 8 percent slopes	479.6	0.5%
176	Indian Creek-Reno-Washoe association	882.4	0.9%
210	Luppino gravelly sandy loam, 4 to 8 percent slopes	112.5	0.1%
211	Luppino gravelly sandy loam, 8 to 30 percent slopes	479.7	0.5%
221	Oppio cobbly sandy loam, 8 to 15 percent slopes	43.2	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
222	Oppio cobbly sandy loam, 15 to 30 percent slopes	7.1	0.0%
240	Updike loam	172.9	0.2%
241	Updike loam, gravelly substratum	195.3	0.2%
252	Cassiro gravelly sandy loam, 8 to 15 percent slopes	86.7	0.1%
260	Acrelane-Rock outcrop complex, 15 to 50 percent slopes	4,779.5	4.8%
262	Acrelane very stony sandy loam, 8 to 15 percent slopes	926.6	0.9%
263	Acrelane very stony sandy loam, 15 to 50 percent slopes	1,089.5	1.1%
278	Acrelane-Soar association 15 to 50 percent slopes	1,076.0	1.1%
280	Wedekind gravelly loam, 8 to 15 percent slopes	6.5	0.0%
281	Wedekind gravelly loam, 15 to 30 percent slopes	13.8	0.0%
282	Wedekind gravelly sandy loam, 30 to 50 percent slopes	0.1	0.0%
290	Verdico variant stony sandy loam, 8 to 15 percent slopes	18.1	0.0%
300	Surgem stony sandy loam, 8 to 15 percent slopes	126.1	0.1%
302	Surgem-Rock outcrop complex, 30 to 50 percent slopes	83.9	0.1%
311	Risley-Rock outcrop complex, 15 to 30 percent slopes	234.1	0.2%
341	Yuko stony loam, 15 to 30 percent slopes	175.7	0.2%
350	Mizel very gravelly coarse sandy loam, 15 to 50 percent slopes	42.2	0.0%
351	Mizel-Skedaddle-Rock outcrop association	208.4	0.2%
360	Pits	11.5	0.0%
370	Lemm very gravelly coarse sandy loam, 4 to 8 percent slopes	219.5	0.2%
423	Godecke variant loamy sand	24.0	0.0%
461	Surpass coarse sandy loam, 4 to 8 percent slopes	45.4	0.0%
470	Dalzell loamy fine sand	11.9	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
480	Holbrook gravelly loamy sand, 2 to 8 percent slopes	7.0	0.0%
482	Holbrook cobbly loamy sand complex, 0 to 15 percent slopes	478.0	0.5%
491	Graufels-Rock outcrop complex, 8 to 50 percent slopes	17.5	0.0%
493	Graufels-Glenbrook complex, 8 to 50 percent slopes	806.1	0.8%
495	Graufels-Glenbrook-Rock outcrop complex, 4 to 15 percent slopes	575.9	0.6%
496	Graufels-Glenbrook-Haypress association	1,862.0	1.9%
500	Mottsville sand, 0 to 4 percent slopes	339.3	0.3%
505	Mottsville gravelly coarse sand, 4 to 8 percent slopes	316.6	0.3%
513	Settlemeyer-Notus complex	122.5	0.1%
514	Settlemeyer gravelly loam, 2 to 4 percent slopes	70.0	0.1%
530	Sagouspe sand	10.6	0.0%
570	Turria loam	168.4	0.2%
585	Barnard-Trosi association	323.9	0.3%
612	Verdico very stony sandy loam, 4 to 8 percent slopes	243.3	0.2%
613	Verdico extremely stony sandy loam, 8 to 15 percent slopes	206.5	0.2%
614	Verdico extremely stony sandy loam, 15 to 30 percent slopes	559.8	0.6%
615	Verdico sandy loam, 4 to 8 percent slopes	106.9	0.1%
618	Verdico sandy loam, dry, 4 to 8 percent slopes	66.1	0.1%
621	Orr stony sandy loam, 4 to 15 percent slopes	20.3	0.0%
650	Chalco very stony clay loam, 15 to 30 percent slopes	316.7	0.3%
652	Chalco stony loam, 4 to 8 percent slopes	146.5	0.1%
653	Chalco cobbly sandy loam, 8 to 15 percent slopes	555.9	0.6%
654	Chalco-Celeton variant complex, 2 to 8 percent slopes	1,199.5	1.2%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
658	Chalco sandy loam, dry, 2 to 8 percent slopes	36.2	0.0%
670	Galeppi sandy loam, 4 to 8 percent slopes	91.3	0.1%
671	Galeppi sandy loam, 8 to 15 percent slopes	75.8	0.1%
673	Galeppi sandy loam, 15 to 30 percent slopes	114.6	0.1%
674	Galeppi stony sandy loam, 8 to 15 percent slopes	48.9	0.0%
678	Galeppi sandy loam, dry, 8 to 15 percent slopes	235.9	0.2%
679	Galeppi sandy loam, dry, 15 to 30 percent slopes	332.9	0.3%
690	Gumble loam, 2 to 8 percent slopes	700.0	0.7%
691	Gumble-Chalco complex 2 to 8 percent slopes	549.6	0.6%
701	Fulstone association	452.6	0.5%
702	Fulstone sandy loam, 2 to 15 percent slopes	146.0	0.1%
730	Stodick very stony loam, 15 to 30 percent slopes	2.7	0.0%
870	Xman-Rock outcrop complex, 4 to 15 percent slopes	53.4	0.1%
871	Xman very stony loam, 15 to 30 percent slopes	586.5	0.6%
872	Xman very stony sandy loam, 8 to 15 percent slopes	69.3	0.1%
873	Xman-Rock outcrop complex, 30 to 50 percent slopes	855.1	0.9%
875	Xman-Zephan-Mizel association	4,347.1	4.4%
877	Xman-Frodo-Mizel association	737.5	0.7%
882	Zephan stony sandy loam, 15 to 30 percent slopes	56.9	0.1%
891	Indiano gravelly loam, warm, 30 to 50 percent slopes	31.2	0.0%
894	Indiano-Ister-Skedaddle association	0.5	0.0%
900	Flex very gravelly sandy loam, 15 to 30 percent slopes	83.9	0.1%
901	Flex very gravelly sandy loam, 30 to 50 percent slopes	207.9	0.2%
903	Flex stony sandy loam, 8 to 15 percent slopes	75.8	0.1%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
930	Old Camp stony sandy loam, 15 to 30 percent slopes	40.6	0.0%
931	Old Camp-Rock outcrop complex, 15 to 50 percent slopes	39.5	0.0%
960	Kayo stony sandy loam, 2 to 4 percent slopes	1,123.2	1.1%
961	Kayo stony sandy loam, 4 to 8 percent slopes	963.9	1.0%
962	Kayo very stony sandy loam, 4 to 8 percent slopes	478.8	0.5%
971	Aladshi sandy loam, 2 to 4 percent slopes	2,450.5	2.5%
974	Aladshi gravelly sandy loam, 4 to 8 percent slopes	648.0	0.7%
982	Koontz stony loam, 15 to 30 percent slopes	58.5	0.1%
990	Rock outcrop	6.2	0.0%
991	Xeric Torriorthents-Urban land complex	55.1	0.1%
994	Badland-Chalco-Verdico complex, 8 to 30 percent slopes	493.1	0.5%
1050	Waspo clay, 15 to 30 percent slopes	77.8	0.1%
1054	Waspo gravelly clay, 2 to 8 percent slopes	107.4	0.1%
1141	Bedell loamy sand, 2 to 4 percent slopes	477.2	0.5%
1143	Bedell loamy sand, 8 to 15 percent slopes	63.6	0.1%
1160	Jowec silty clay loam	99.8	0.1%
1170	Wedertz sandy loam, 2 to 4 percent slopes	2,527.7	2.5%
1171	Wedertz sandy loam, 4 to 8 percent slopes	1,406.0	1.4%
1172	Wedertz sand, 2 to 4 percent slopes	1,737.5	1.7%
1190	Spasprey sandy loam, 0 to 2 percent slopes	216.4	0.2%
1191	Spasprey sandy loam, 2 to 4 percent slopes	117.2	0.1%
1192	Spasprey sand, 2 to 4 percent slopes	27.7	0.0%
1193	Spasprey sandy loam, 4 to 8 percent slopes	332.1	0.3%
1194	Spasprey stony sandy loam, 4 to 8 percent slopes	84.6	0.1%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1200	Mellor silt loam	447.8	0.4%
1210	Linhart stony coarse sand, 4 to 8 percent slopes	398.3	0.4%
1211	Linhart stony coarse sand, 15 to 30 percent slopes	142.1	0.1%
1220	Calpine coarse sandy loam, 4 to 8 percent slopes	57.6	0.1%
1240	Pizene sandy loam, 0 to 4 percent slopes	40.0	0.0%
1250	Rednik very gravelly sandy loam, 4 to 8 percent slopes	43.8	0.0%
1251	Rednik very stony sandy loam, 8 to 15 percent slopes	194.7	0.2%
1271	Tristan-Barshaad-Arzo association	2,408.2	2.4%
1272	Tristan-Arzo-Reywat association	798.7	0.8%
1273	Tristan-Barshaad-Frodo association	4,410.7	4.4%
1301	Rose Creek variant, loamy fine sand	1,348.4	1.4%
1373	Singatse-Mizel-Stingdorn association	1,372.9	1.4%
1401	Softscrabble-Gabica-Sumine association	7,529.4	7.6%
1521	Duco-Yuko-Lemm association	4,489.3	4.5%
1522	Duco-Pahrange-Lemm association	6,305.3	6.3%
1540	Duco-Tristan-Arzo association	12,398.8	12.4%
1580	Frodo-Xman-Oppio association	289.5	0.3%
1610	Water	2.9	0.0%
1860	Boondock-Chalco-Gumble complex, 8 to 30 percent slopes	1,170.9	1.2%
1878	Xman-Ceejay-Mizel association 15 to 50 percent slopes	2,372.8	2.4%
1879	Xman-Boondock association 15 to 30 percent slopes	1,025.0	1.0%
3140	Fulstone-Reno complex, 2 to 30 percent slopes	2,742.7	2.8%
Totals for Area of Interest		**99,618.3**	**100.0%**

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factor Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the mineral surface horizon. Missing surface data may indicate the presence of an organic layer.

Report—RUSLE2 Related Attributes

Soil properties and interpretations for erosion runoff calculations. The surface mineral horizon properties are displayed or the first mineral horizon below an organic surface horizon. Organic horizons are not displayed.

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
101—Aquinas sandy loam, 4 to 8 percent slopes								
Aquinas	85	—	D	.28	2	65.9	19.1	15.0
102—Aquinas sandy loam, 8 to 15 percent slopes								
Aquinas	85	—	D	.28	2	65.9	19.1	15.0
106—Aquinas sandy loam, 8 to 15 percent slopes, eroded								
Aquinas, eroded	85	—	D	.28	2	65.9	19.1	15.0
108—Aquinas sandy loam, moist, 4 to 8 percent slopes								
Aquinas, moist	85	—	D	.28	2	65.9	19.1	15.0
109—Aquinas sandy loam, moist, 8 to 15 percent slopes								
Aquinas, moist	85	—	D	.28	2	65.9	19.1	15.0
111—Jowec variant-Greenbrae sandy loams, 4 to 15 percent slopes								
Jowec variant	65	—	D	.32	3	67.4	19.6	13.0
Greenbrae	25	239	C	.28	5	66.8	19.2	14.0
120—Doten silty clay, 0 to 2 percent slopes								
Doten	85	—	D	.20	5	5.3	44.7	50.0
136—Greenbrae sandy loam, 4 to 8 percent slopes								
Greenbrae	85	239	C	.28	5	66.8	19.2	14.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
140—Haybourne loamy sand, 2 to 4 percent slopes								
Haybourne	85	312	A	.17	5	84.9	9.1	6.0
141—Haybourne loamy sand, 4 to 8 percent slopes								
Haybourne	85	239	A	.17	5	84.9	9.1	6.0
142—Haybourne loamy sand, 8 to 15 percent slopes								
Haybourne	85	—	A	.17	5	84.9	9.1	6.0
160—Incy sand, 4 to 8 percent slopes								
Incy	85	239	A	.02	5	96.0	1.5	2.5
161—Incy fine sand, hilly								
Incy, hilly	85	—	A	.02	5	96.8	0.7	2.5
171—Indian Creek gravelly sandy loam, 0 to 4 percent slopes								
Indian Creek	85	—	D	.32	2	67.4	19.6	13.0
172—Indian Creek sandy loam, 4 to 8 percent slopes								
Indian Creek	85	—	D	.32	2	67.4	19.6	13.0
173—Indian Creek sandy loam, 8 to 15 percent slopes								
Indian Creek	85	—	D	.32	2	67.4	19.6	13.0
174—Indian Creek extremely stony sandy loam, 2 to 8 percent slopes								
Indian Creek	85	—	D	.32	2	66.8	19.2	14.0
175—Indian Creek very cobbly loam, 2 to 8 percent slopes								
Indian Creek	85	161	D	.49	2	44.0	41.0	15.0
176—Indian Creek-Reno-Washoe association								
Indian Creek	50	—	D	.43	2	39.2	37.3	23.5
Reno	20	—	D	.37	2	66.6	23.4	10.0
Washoe	15	—	C	.32	3	66.1	19.9	14.0
210—Luppino gravelly sandy loam, 4 to 8 percent slopes								
Luppino	85	—	D	.32	2	66.6	23.4	10.0
211—Luppino gravelly sandy loam, 8 to 30 percent slopes								
Luppino	85	69	D	.32	2	67.0	23.0	10.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
221—Oppio cobbly sandy loam, 8 to 15 percent slopes								
Oppio	85	—	D	.28	2	66.8	19.2	14.0
222—Oppio cobbly sandy loam, 15 to 30 percent slopes								
Oppio	85	—	D	.28	2	66.8	19.2	14.0
240—Updike loam								
Updike	85	—	D	.49	2	45.7	41.8	12.5
241—Updike loam, gravelly substratum								
Updike, gravelly substratum	85	997	D	.49	2	45.7	41.8	12.5
252—Cassiro gravelly sandy loam, 8 to 15 percent slopes								
Cassiro	85	—	D	.32	3	67.4	19.6	13.0
260—Acrelane-Rock outcrop complex, 15 to 50 percent slopes								
Acrelane	65	—	D	.28	2	65.3	23.2	11.5
262—Acrelane very stony sandy loam, 8 to 15 percent slopes								
Acrelane	85	—	D	.28	2	65.3	23.2	11.5
263—Acrelane very stony sandy loam, 15 to 50 percent slopes								
Acrelane	85	—	D	.28	2	65.3	23.2	11.5
278—Acrelane-Soar association 15 to 50 percent slopes								
Acrelane, very shallow	55	—	D	.24	1	67.0	24.0	9.0
Soar	30	—	D	.28	1	65.8	18.2	16.0
280—Wedekind gravelly loam, 8 to 15 percent slopes								
Wedekind	85	—	D	.43	2	45.7	41.8	12.5
281—Wedekind gravelly loam, 15 to 30 percent slopes								
Wedekind	85	—	D	.43	2	45.7	41.8	12.5
282—Wedekind gravelly sandy loam, 30 to 50 percent slopes								
Wedekind	85	—	D	.28	2	65.3	23.2	11.5

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
290—Verdico variant stony sandy loam, 8 to 15 percent slopes								
Verdico variant	85	—	D	.32	3	66.6	23.4	10.0
300—Surgem stony sandy loam, 8 to 15 percent slopes								
Surgem	85	—	D	.32	2	66.6	23.4	10.0
302—Surgem-Rock outcrop complex, 30 to 50 percent slopes								
Surgem	65	—	D	.32	2	66.6	23.4	10.0
311—Risley-Rock outcrop complex, 15 to 30 percent slopes								
Risley	65	—	D	.37	3	41.6	37.4	21.0
341—Yuko stony loam, 15 to 30 percent slopes								
Yuko	85	—	D	.43	1	39.2	37.3	23.5
350—Mizel very gravelly coarse sandy loam, 15 to 50 percent slopes								
Mizel	85	—	D	.32	1	66.3	23.7	10.0
351—Mizel-Skedaddle-Rock outcrop association								
Mizel	40	—	D	.32	1	66.3	23.7	10.0
Skedaddle	35	—	D	.43	1	39.8	37.7	22.5
370—Lemm very gravelly coarse sandy loam, 4 to 8 percent slopes								
Lemm	85	—	A	.20	5	66.3	23.7	10.0
423—Godecke variant loamy sand								
Godecke variant	85	—	C	.20	2	85.7	4.3	10.0
461—Surpass coarse sandy loam, 4 to 8 percent slopes								
Surpass	85	151	A	.24	5	69.0	23.0	8.0
470—Dalzell loamy fine sand								
Dalzell	85	—	C	.28	2	86.4	6.6	7.0
480—Holbrook gravelly loamy sand, 2 to 8 percent slopes								
Holbrook	85	259	A	.17	5	85.3	9.2	5.5

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
482—Holbrook cobbly loamy sand complex, 0 to 15 percent slopes								
Holbrook	50	151	A	.15	5	83.0	9.0	8.0
Holbrook	20	200	A	.15	5	83.0	9.0	8.0
Holbrook	15	98	A	.15	5	83.0	9.0	8.0
491—Graufels-Rock outcrop complex, 8 to 50 percent slopes								
Graufels	75	49	A	.02	3	94.0	2.0	4.0
493—Graufels-Glenbrook complex, 8 to 50 percent slopes								
Graufels	60	—	A	.02	3	82.8	10.7	6.5
Glenbrook	25	—	D	.02	2	94.6	1.4	4.0
495—Graufels-Glenbrook-Rock outcrop complex, 4 to 15 percent slopes								
Graufels	60	—	A	.02	3	82.8	10.7	6.5
Glenbrook	20	—	D	.02	2	94.6	1.4	4.0
496—Graufels-Glenbrook-Haypress association								
Graufels	35	—	A	.02	3	82.8	10.7	6.5
Glenbrook	30	—	D	.02	2	94.6	1.4	4.0
Haypress	20	—	A	.10	4	83.5	11.0	5.5
500—Mottsville sand, 0 to 4 percent slopes								
Mottsville	85	—	A	.02	5	93.6	1.4	5.0
505—Mottsville gravelly coarse sand, 4 to 8 percent slopes								
Mottsville	85	—	A	.02	5	89.7	3.8	6.5
513—Settlemeyer-Notus complex								
Settlemeyer	45	997	C	.28	5	65.4	19.6	15.0
Notus	40	—	A	.24	5	79.0	16.5	4.5
514—Settlemeyer gravelly loam, 2 to 4 percent slopes								
Settlemeyer	85	—	C/D	.37	5	43.0	38.5	18.5
530—Sagouspe sand								
Sagouspe	85	997	A	.05	5	96.0	1.5	2.5
570—Turria loam								
Turria	85	—	C	.37	5	42.1	37.9	20.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
585—Barnard-Trosi association								
Barnard	50	—	D	.32	2	66.6	23.4	10.0
Trosi	35	—	D	.37	1	65.3	23.2	11.5
612—Verdico very stony sandy loam, 4 to 8 percent slopes								
Verdico	85	—	D	.32	3	67.4	19.6	13.0
613—Verdico extremely stony sandy loam, 8 to 15 percent slopes								
Verdico	85	—	D	.32	3	67.4	19.6	13.0
614—Verdico extremely stony sandy loam, 15 to 30 percent slopes								
Verdico	85	—	D	.32	3	67.4	19.6	13.0
615—Verdico sandy loam, 4 to 8 percent slopes								
Verdico	85	—	D	.32	3	67.4	19.6	13.0
618—Verdico sandy loam, dry, 4 to 8 percent slopes								
Verdico, dry	85	—	D	.32	3	67.4	19.6	13.0
621—Orr stony sandy loam, 4 to 15 percent slopes								
Orr	85	200	C	.28	5	68.0	20.0	12.0
650—Chalco very stony clay loam, 15 to 30 percent slopes								
Chalco	85	—	D	.37	2	35.4	33.6	31.0
652—Chalco stony loam, 4 to 8 percent slopes								
Chalco	85	—	D	.43	2	42.1	37.9	20.0
653—Chalco cobbly sandy loam, 8 to 15 percent slopes								
Chalco	85	—	D	.37	2	65.7	23.3	11.0
654—Chalco-Celeton variant complex, 2 to 8 percent slopes								
Chalco	45	—	D	.37	2	65.7	23.3	11.0
Celeton variant	40	—	D	.32	1	42.4	38.1	19.5
658—Chalco sandy loam, dry, 2 to 8 percent slopes								
Chalco, dry	85	—	D	.32	2	67.4	19.6	13.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
670—Galeppi sandy loam, 4 to 8 percent slopes								
Galeppi	85	—	C	.28	5	66.6	23.4	10.0
671—Galeppi sandy loam, 8 to 15 percent slopes								
Galeppi	85	121	C	.28	5	68.0	24.0	8.0
673—Galeppi sandy loam, 15 to 30 percent slopes								
Galeppi	85	—	C	.28	5	66.6	23.4	10.0
674—Galeppi stony sandy loam, 8 to 15 percent slopes								
Galeppi	85	—	C	.28	5	66.6	23.4	10.0
678—Galeppi sandy loam, dry, 8 to 15 percent slopes								
Galeppi, dry	85	—	C	.28	5	66.6	23.4	10.0
679—Galeppi sandy loam, dry, 15 to 30 percent slopes								
Galeppi, dry	85	—	C	.28	5	66.6	23.4	10.0
690—Gumble loam, 2 to 8 percent slopes								
Gumble	90	—	D	.37	2	39.8	37.7	22.5
691—Gumble-Chalco complex 2 to 8 percent slopes								
Gumble	50	—	D	.37	2	39.8	37.7	22.5
Chalco, dry	40	—	D	.32	2	67.4	19.6	13.0
701—Fulstone association								
Fulstone	70	128	D	.43	1	44.0	41.0	15.0
Fulstone	15	128	D	.43	1	44.0	41.0	15.0
702—Fulstone sandy loam, 2 to 15 percent slopes								
Fulstone	85	128	D	.24	1	66.0	19.0	15.0
730—Stodick very stony loam, 15 to 30 percent slopes								
Stodick	85	—	D	.49	2	44.3	40.7	15.0
870—Xman-Rock outcrop complex, 4 to 15 percent slopes								
Xman	65	—	D	.24	2	65.9	19.1	15.0
871—Xman very stony loam, 15 to 30 percent slopes								
Xman	85	—	D	.37	2	44.3	40.7	15.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
872—Xman very stony sandy loam, 8 to 15 percent slopes								
Xman	85	—	D	.24	2	65.9	19.1	15.0
873—Xman-Rock outcrop complex, 30 to 50 percent slopes								
Xman	60	—	D	.24	2	65.9	19.1	15.0
875—Xman-Zephan-Mizel association								
Xman	35	—	D	.37	2	44.3	40.7	15.0
Mizel	25	—	D	.32	1	66.3	23.7	10.0
Zephan	25	—	D	.28	3	67.9	19.6	12.5
877—Xman-Frodo-Mizel association								
Xman	35	—	D	.37	2	44.3	40.7	15.0
Frodo	25	—	D	.37	1	41.6	37.4	21.0
Mizel	25	—	D	.32	1	66.3	23.7	10.0
882—Zephan stony sandy loam, 15 to 30 percent slopes								
Zephan	85	—	D	.28	3	67.9	19.6	12.5
891—Indiano gravelly loam, warm, 30 to 50 percent slopes								
Indiano, warm	85	—	C	.43	2	44.8	41.2	14.0
894—Indiano-Ister-Skedaddle association								
Indiano	40	49	C	.24	2	67.0	19.0	14.0
Ister	30	49	C	.20	2	68.0	20.0	12.0
Skedaddle	15	49	D	.43	1	42.0	38.0	20.0
900—Flex very gravelly sandy loam, 15 to 30 percent slopes								
Flex	85	—	D	.24	2	67.4	19.6	13.0
901—Flex very gravelly sandy loam, 30 to 50 percent slopes								
Flex	85	—	D	.24	2	67.4	19.6	13.0
903—Flex stony sandy loam, 8 to 15 percent slopes								
Flex	85	—	D	.24	2	67.4	19.6	13.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	**Pct. of map unit**	**Slope length (ft)**	**Hydrologic group**	**Kf**	**T factor**	**Representative value**		
						% Sand	**% Silt**	**% Clay**
930—Old Camp stony sandy loam, 15 to 30 percent slopes								
Old camp	85	—	D	.37	1	66.6	23.4	10.0
931—Old Camp-Rock outcrop complex, 15 to 50 percent slopes								
Old camp	50	—	D	.37	1	66.6	23.4	10.0
Old camp	20	—	D	.37	1	66.6	23.4	10.0
960—Kayo stony sandy loam, 2 to 4 percent slopes								
Kayo	85	—	A	.28	5	67.8	23.7	8.5
961—Kayo stony sandy loam, 4 to 8 percent slopes								
Kayo	85	—	A	.28	5	67.8	23.7	8.5
962—Kayo very stony sandy loam, 4 to 8 percent slopes								
Kayo	85	—	A	.28	5	67.8	23.7	8.5
971—Aladshi sandy loam, 2 to 4 percent slopes								
Aladshi	85	—	C	.32	4	66.6	23.4	10.0
974—Aladshi gravelly sandy loam, 4 to 8 percent slopes								
Aladshi	85	—	C	.32	5	66.6	23.4	10.0
982—Koontz stony loam, 15 to 30 percent slopes								
Koontz	85	—	D	.37	2	43.3	39.7	17.0
991—Xeric Torriorthents-Urban land complex								
Xeric Torriorthents	50	—	A	—	5	—	—	25.0
994—Badland-Chalco-Verdico complex, 8 to 30 percent slopes								
Badland	40	—	—	—	—	—	—	47.5
Chalco	25	—	D	.37	2	35.4	33.6	31.0
Verdico	20	—	D	.32	3	67.4	19.6	13.0
1050—Waspo clay, 15 to 30 percent slopes								
Waspo	85	—	D	.24	3	18.2	29.3	52.5
1054—Waspo gravelly clay, 2 to 8 percent slopes								
Waspo	85	180	D	.28	3	22.0	28.0	50.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
1141—Bedell loamy sand, 2 to 4 percent slopes								
Bedell	85	—	A	.17	5	83.8	9.2	7.0
1143—Bedell loamy sand, 8 to 15 percent slopes								
Bedell	85	—	A	.17	5	83.8	9.2	7.0
1160—Jowec silty clay loam								
Jowec	85	—	C	.37	5	20.0	49.0	31.0
1170—Wedertz sandy loam, 2 to 4 percent slopes								
Wedertz	85	—	C	.32	3	65.3	23.2	11.5
1171—Wedertz sandy loam, 4 to 8 percent slopes								
Wedertz	85	—	C	.32	3	65.3	23.2	11.5
1172—Wedertz sand, 2 to 4 percent slopes								
Wedertz	85	—	C	.05	5	93.6	1.4	5.0
1190—Spasprey sandy loam, 0 to 2 percent slopes								
Spasprey	85	997	C	.28	2	67.4	19.6	13.0
1191—Spasprey sandy loam, 2 to 4 percent slopes								
Spasprey	85	312	C	.28	2	67.4	19.6	13.0
1192—Spasprey sand, 2 to 4 percent slopes								
Spasprey	85	—	C	.15	2	90.7	1.8	7.5
1193—Spasprey sandy loam, 4 to 8 percent slopes								
Spasprey	85	—	C	.28	2	67.4	19.6	13.0
1194—Spasprey stony sandy loam, 4 to 8 percent slopes								
Spasprey	85	—	C	.28	2	67.9	19.6	12.5
1200—Mellor silt loam								
Mellor	85	—	C	.55	2	13.9	70.1	16.0
1210—Linhart stony coarse sand, 4 to 8 percent slopes								
Linhart	85	—	A	.10	5	90.1	6.4	3.5
1211—Linhart stony coarse sand, 15 to 30 percent slopes								
Linhart	85	—	A	.10	5	90.1	6.4	3.5

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
1220—Calpine coarse sandy loam, 4 to 8 percent slopes								
Calpine	85	239	A	.17	5	66.3	23.7	10.0
1240—Pizene sandy loam, 0 to 4 percent slopes								
Pizene	85	—	C	.32	5	68.5	24.0	7.5
1250—Rednik very gravelly sandy loam, 4 to 8 percent slopes								
Rednik	85	—	C	.32	4	66.6	23.4	10.0
1251—Rednik very stony sandy loam, 8 to 15 percent slopes								
Rednik	85	—	C	.32	4	66.6	23.4	10.0
1271—Tristan-Barshaad-Arzo association								
Tristan	35	—	C	.43	4	44.3	40.7	15.0
Barshaad	30	—	D	.43	3	43.0	39.5	17.5
Arzo	20	—	D	.37	3	39.2	37.3	23.5
1272—Tristan-Arzo-Reywat association								
Tristan	45	—	C	.43	4	44.3	40.7	15.0
Arzo	25	—	D	.37	3	39.2	37.3	23.5
Reywat	15	—	D	.49	1	45.4	41.6	13.0
1273—Tristan-Barshaad-Frodo association								
Tristan	35	—	C	.43	4	44.3	40.7	15.0
Barshaad	30	—	D	.43	3	43.0	39.5	17.5
Frodo	20	—	D	.37	1	41.6	37.4	21.0
1301—Rose Creek variant, loamy fine sand								
Rose Creek variant	85	—	C	.28	5	85.9	6.6	7.5
1373—Singatse-Mizel-Stingdorn association								
Singatse	50	—	D	.37	1	66.6	23.4	10.0
Mizel	20	—	D	.32	1	66.3	23.7	10.0
Stingdorn	15	—	D	.43	1	39.8	37.7	22.5

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
1401—Softscrabble-Gabica-Sumine association								
Softscrabble	35	—	C	.37	5	44.3	40.7	15.0
Gabica	25	—	D	.37	1	66.6	23.4	10.0
Sumine	25	—	C	.32	2	43.0	39.5	17.5
1521—Duco-Yuko-Lemm association								
Duco	40	—	D	.28	1	65.9	19.1	15.0
Yuko	30	—	D	.43	1	41.6	37.4	21.0
Lemm	15	—	A	.24	4	66.6	23.4	10.0
1522—Duco-Pahrange-Lemm association								
Duco	40	—	D	.28	1	65.9	19.1	15.0
Pahrange	30	—	C	.28	3	67.9	19.6	12.5
Lemm	15	—	A	.24	4	66.6	23.4	10.0
1540—Duco-Tristan-Arzo association								
Duco	40	394	D	.28	1	66.0	19.0	15.0
Tristan	30	49	C	.43	3	44.0	41.0	15.0
Arzo	15	49	D	.37	3	42.0	38.0	20.0
1580—Frodo-Xman-Oppio association								
Frodo	50	—	D	.37	1	41.6	37.4	21.0
Xman	20	—	D	.37	2	44.3	40.7	15.0
Oppio	15	—	D	.28	2	66.8	19.2	14.0
1860—Boondock-Chalco-Gumble complex, 8 to 30 percent slopes								
Boondock	45	—	D	.32	1	71.3	16.7	12.0
Chalco, dry	25	—	D	.32	2	67.4	19.6	13.0
Gumble	20	—	D	.37	2	39.8	37.7	22.5
1878—Xman-Ceejay-Mizel association 15 to 50 percent slopes								
Xman	40	—	D	.37	2	44.3	40.7	15.0
Ceejay	30	—	D	.43	1	42.1	37.9	20.0
Mizel	20	—	D	.32	1	66.3	23.7	10.0

RUSLE2 Related Attributes–Washoe County, Nevada, South Part								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
1879—Xman-Boondock association 15 to 30 percent slopes								
Xman	50	—	D	.37	2	44.3	40.7	15.0
Boondock	40	—	D	.32	1	71.3	16.7	12.0
3140—Fulstone-Reno complex, 2 to 30 percent slopes								
Fulstone	45	69	D	.43	1	44.0	41.0	15.0
Reno	40	69	D	.32	2	65.0	25.0	10.0

Data Source Information

Soil Survey Area: Washoe County, Nevada, South Part
Survey Area Data: Version 18, Sep 9, 2021

STAFF REPORT

TO: Board of Directors
FROM: Mark Foree, General Manager
DATE: May 12, 2022
SUBJECT: **General Manager's Report**

Attached please find the written reports from the Management team including the Operations Report ***(Attachment A)***, the Water Resource and the Annexation Activity Report ***(Attachment B)***, and the Customer Services Report ***(Attachment C).***

Included in your agenda packet are press clippings from April 13, 2022 through May 12, 2022.

TRUCKEE MEADOWS WATER AUTHORITY
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STAFF REPORT

TO:	Board of Directors
THRU:	Mark Foree, General Manager
FROM:	Scott Estes, Director of Engineering
BY:	Bill Hauck, Water Supply Supervisor
DATE:	May 11, 2022
SUBJECT:	**May 2022 Operations Report**

SUMMARY

- 2022 ended up being the region's third consecutive dry or drought year in a row
- The water supply outlook for the region could be better, but it is good enough to ensure that normal river flows are made through September and into early October
- This is positive news as this gets us past our peak water demand season and drought reserves will not be required this year
- Despite being in the third year of a drought TMWA's reserves are in great shape and by mid-summer more reserve storage will be in place than ever before between Donner and Independence reservoirs, and water stored under the terms of TROA
- Lake Tahoe storage is at 22% of capacity, and the elevation is 1.34' above the rim
- Combined total upstream Truckee River reservoir storage is about 33% of maximum capacity
- Customer demand averaged 94 MGD over the first full week of May
- Hydroelectric generation in April was 4,764 MWh with revenue of $357,390

(A) Water Supply

- **River Flows** - Truckee River flow at the CA/NV state line was approximately 975 cubic feet per second (CFS) this morning. This is below normal as the 113-year median flow for this day at Farad is 1,460 CFS.

- **Outlook** - While the most recent runoff forecast for the Truckee River at Farad (CA/NV state line) is showing 67% of normal, and the projections for filling of upstream reservoirs this spring could certainly be better, it looks like we're still on-track to have *normal* river flows through September and into the month of October. This gives us some breathing room, getting us past our peak demand season and means that drought reserves will not be required to meet customer demand this summer or fall.

- **Reservoir Storage** - Overall Truckee River reservoir storage is ~33% of capacity. The elevation of Lake Tahoe is 6224.34 feet. Storage values for each reservoir as of May 11th are as follows:

Reservoir	Current Storage (Acre-Feet)	% Capacity (Percent)
Tahoe	162,700	22%
Boca	29,378	72%
Stampede	121,445	54%
Prosser	16,846	57%
Donner	9,264	98%
Independence	15,074	86%

In addition to approximately 24,338 acre-feet of storage between Donner and Independence reservoirs, TMWA has about 38,426 acre-feet of water stored between Lake Tahoe, Boca, Prosser, and Stampede reservoirs under the terms of TROA. TMWA's total combined upstream reservoir storage is approximately 62,764 acre-feet. By mid-summer, it is projected that TMWA will have more than 67,000 AF of upstream reservoir storage.

(B) Water Production

- **Demand** - TMWA's customer demand averaged 94 million gallons per day (MGD) the first full week of May. Overall, surface water made up ~91% of our supply and groundwater the other 9%.

(C) Hydro Production

Generation - Truckee River flows at Farad (CA/NV state line) for the month of April averaged 938 CFS. The Washoe and Verdi plants were on-line all 30 days and 100% available. The Fleish plant was on-line 29 days and 97% available.

Statistics for the month are as follows:

Plant	Generation Days	% Availability	Generation (Megawatt Hours)	Revenue (Dollars)	Revenue (Dollars/Day)
Fleish	29	97%	1,634	$123,213	$4,107
Verdi	30	100%	1,655	$123,725	$4,124
Washoe	30	100%	1,475	$110,452	$3,682
Totals	**89**	**-**	**4,764**	**$357,390**	-

TRUCKEE MEADOWS WATER AUTHORITY
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STAFF REPORT

TO: Chairman and Board Members
THRU: Mark Foree, General Manager
FROM: Stefanie Morris, Manager, Water Resources
DATE: May 11, 2022
SUBJECT: **Report Water Resources and Annexation Activity**

RULE 7

Rule 7 water resource purchases and will-serve commitment sales against purchased water resources through this reporting period:

Beginning Balance		3,136.86 AF
Purchases of water rights	8.00 AF	
Refunds	0.77 AF	
Sales	− 76.94 AF	
Adjustments	7.64 AF	
Ending Balance		3,076.33 AF

Price per acre foot at report date: $7,700

FISH SPRINGS RANCH, LLC GROUNDWATER RESOURCES

Through the merger of Washoe County's water utility, TMWA assumed a Water Banking and Trust Agreement with Fish Springs Ranch, LLC, a subsidiary of Vidler. Under the Agreement, TMWA holds record title to the groundwater rights for the benefit of Fish Springs. Fish Springs may sell and assign its interest in these groundwater rights to third parties for dedication to TMWA for a will-serve commitment in Areas where TMWA can deliver groundwater from the Fish Springs groundwater basin. Currently, TMWA can deliver Fish Springs groundwater to Area 10 only (Stead-Silver Lake-Lemmon Valley). The following is a summary of Fish Springs' resources.

Beginning Balance		7,611.45 AF
Committed water rights	− 41.94 AF	
Ending Balance		7,569.51 AF

Price per acre foot at report date: $43,575 (for SFR and MFR); $37,800 (for all other services)[1]

WATER SERVICE AREA ANNEXATIONS

Since the date of the last report, there have been no properties annexed into TMWA's service area.

INTERRUPTIBLE LARGE VOLUME NON-POTABLE SERVICE

No new ILVNPS customers have been added during this reporting period.

[1] Price reflects avoided cost of Truckee River water right related fees and TMWA Supply & Treatment WSF charge.

TRUCKEE MEADOWS WATER AUTHORITY
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STAFF REPORT

TO: Board of Directors
THRU: Mark Foree, General Manager
FROM: Marci Westlake, Manager Customer Service
DATE: May 19, 2022
SUBJECT: **April Customer Service Report**

The following is a summary of Customer Service activity for April 2022.

Ombudsman

- No calls for April.

Communications

- Chuck Swegles & Lauren Kunin had an Irrigation System Start-up Workshop and 5 people attended.
- Chuck Swegles & Lauren Kunin had an Irrigation System Start-up Workshop and 7 people attended.
- Chuck Swegles & Lauren Kunin had a Zoom Irrigation System Start-up Workshop and 16 people attended.
- Chuck Swegles, Robert Charpentier & Lauren Kunin had a Booth at the Earth Day Event at Idlewild Park and 200 people stopped by the booth.
- Brent Eisert had a tour at TMWA's Hydroelectric facility and 30 people attended.
- Will Raymond, Kelli Burgess and Sonia Folsom, had a Chalk Bluff Tour & Water Quality activities at Chalk Bluff Water Treatment plant for Envirolutions and 30 students attended.
- Brent Eisert, Chris Hires, Cameron Shultz, John Stewart, Lee Good, Jake Trujillo and Laura Rader provided a tour of Verdi Hydroelectric Plant for Envirolutions and 30 students attended.
- Will Raymond and Brent Eisert provided a tour of Chalk Bluff Water Treatment Plant and Verdi Hydroelectric Plant for Envirolutions Northern Nevada Science & Tech Fest and 10 people attended.

Conservation (2022 Calendar year)

- 297 Water Usage Reviews
- 203 Water Watcher Contacts

Customer Calls –April

- 6,997 phone calls handled
- Average handling time 4 minutes, 54 seconds per call.
- Average speed of answer – :20 seconds per call.

Billing – April

- 134,346 bills issued.
- N/A (*0.00%)* corrected bills.
- 18,554 customers (14%) have signed up for paperless billing to date.

Remittance – April

- 17,768 Mailed-in payments
- 24,125 Electronic payments
- 45,090 Payments via AutoPay (EFT)
- 18,849 One-time bank account payments
- 131 Store payments
- 436 Pay by Text
- 4,424 IVR Payments
- 878 Reno office Payments
- 32 Kiosk Payments

Collections – April

- 11,527 accounts received a late charge
- 2,045 Mailed delinquent notices, 0.01% of accounts
- 855 accounts eligible for disconnect
- 637 accounts were disconnected (including accounts that had been disconnected-for-non-payment that presented NSF checks for their reconnection)
- .18 % write-off to revenue

Meter Statistics – Fiscal Year to Date

- 0 Meter retrofits completed
- 6,914 Meter exchanges completed
- 1,746 New business meter sets completed
- 134,234 Meters currently installed