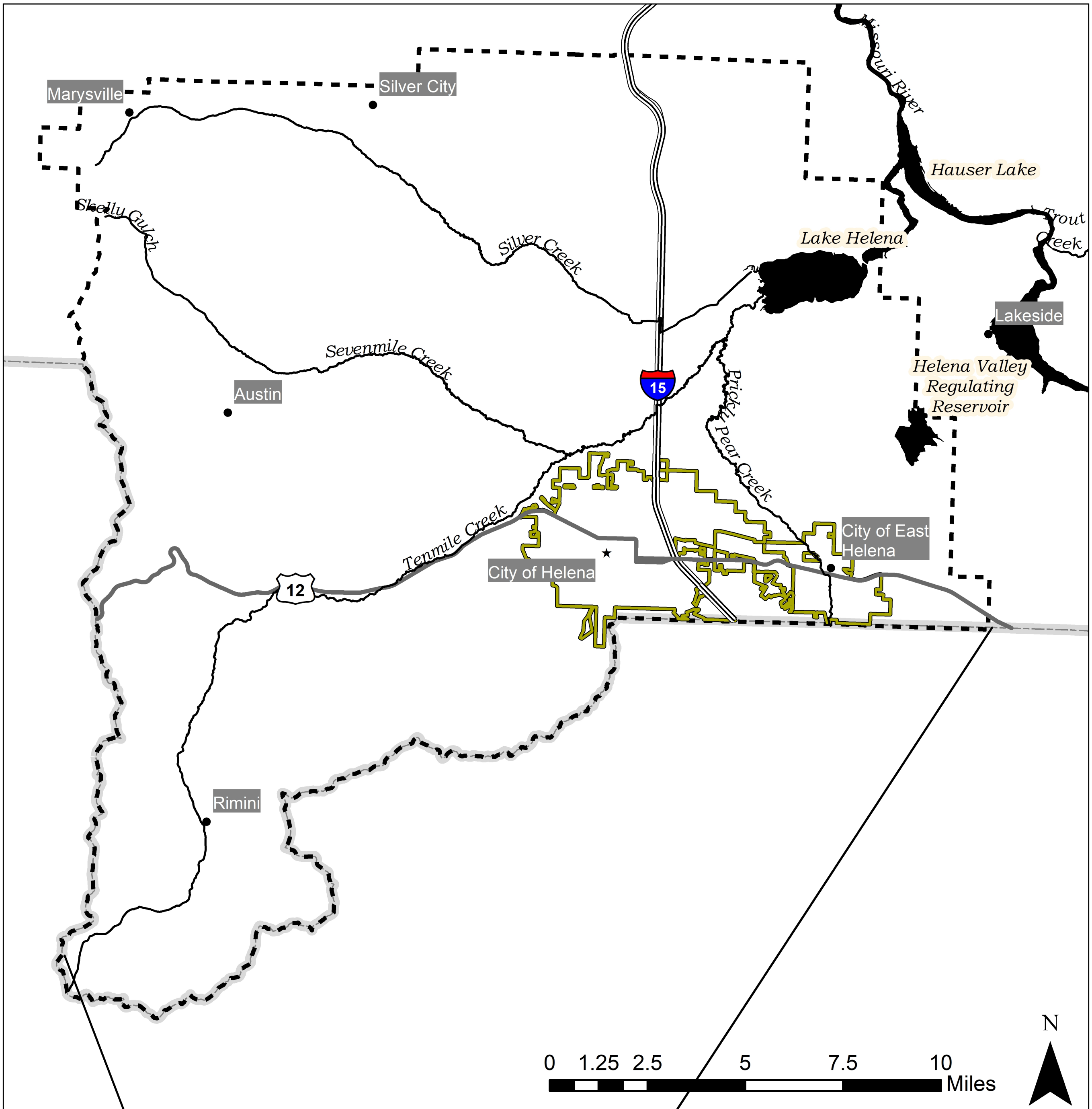
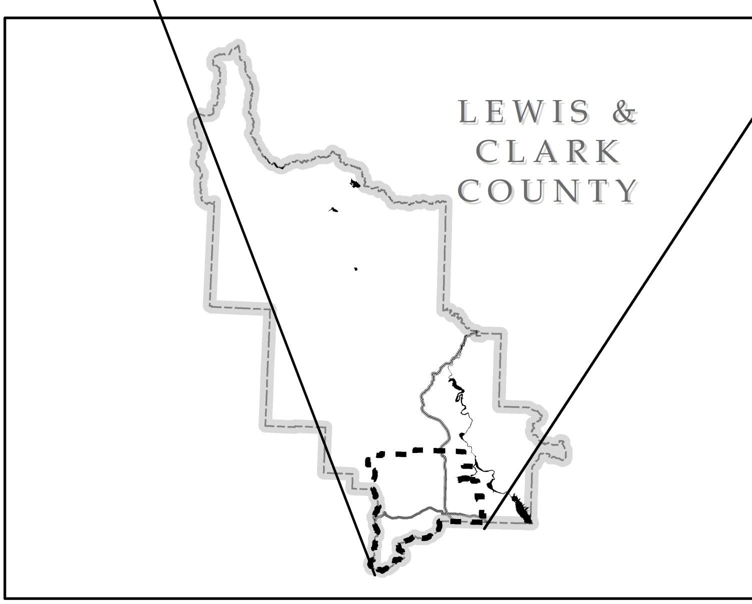
Lewis and Clark County
Water Quality Protection District

WQPD
LEWIS AND CLARK COUNTY, MT

Board Meeting Agenda
Tuesday, July 28, 2026 4:00 pm
In person and by Zoom

What *(Content)*	How *(Process)*	Who	Page	Time *(When)*
1. Call to Order & Establish Quorum –	Roll Call	Chair, Ed Kerins		4:00 p.m.
2. Review of Agenda	Present	Board	3	4:05 p.m.
3. Previous Minutes Review	Vote	Board	4	4:05 p.m.
4. Fiscal Year End Financial Report	Present	Jennifer McBroom	13	4:10 p.m.
5. Strategic Plan	Present/ Vote	Board/Staff	17	4:30 p.m.
6. Update on Subdivisions	Present	Kegan McClanahan	25	4:45 p.m.
7. Board Member Round-Robin • **LCC Commissioner** • **City of Helena** • **City of East Helena** • **Board of Health** • **HCC** • **CD** • **Public at large – Mr. Johnson, Mr. Kerins, & Ms. Johnson**	Discuss	Board/Staff	38	5:00 p.m.
7. Public Comment	Present	Board	40	5:15 p.m.
8. Adjourn Meeting	Present	Board		5:30 p.m.





Water Quality Protection District Facts:

Total Acres: ~240,000

Total Square Miles: ~370

Miles of Stream: ~100

Map Created on: 2/14/2019

LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	Agenda Item No.
July 28, 2026	**2**

___Minutes _X_Board Member Discussion ___Staff & Other Reports _X_Action ___Hearing of Delegation

AGENDA ITEMS: Review of Agenda

PERSONNEL INVOLVED: Board Members and Staff

BACKGROUND: Time is allowed for board members to review the agenda and place any items under action or to add any new agenda items.

RECOMMENDATION: n/a

__ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

NOTES:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
C. Payne						
S. Ohs-Mosley						
A. Johnson						
D. Dahl						

LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	**Agenda Item No.**
July 28, 2026	**3**

_X_ Minutes _X Board Member Discussion ____Staff & Other Reports ___Action ___Hearing of Delegation

AGENDA ITEMS: Minutes of the June 23, 2026 meeting

PERSONNEL INVOLVED: Board Members

BACKGROUND: Upon agreement, the minutes represent official actions of the Water Quality Protection District. Every effort is made to have these recommended minutes accurately portray the proceedings and procedures of the board.

RECOMMENDATION: Approval

_X ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

NOTES:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
S. Ohs-Mosley						
C. Payne						
A. Johnson						
D. Dahl						

LEWIS AND CLARK COUNTY
WATER QUALITY PROTECTION WQPD
BOARD MEETING
Hybrid – Zoom
June 23, 2026

Members Present:
Ed Kerins, Adel Johnson, Sherri Ohs-Mosley, Patrick Johnson, Diana Hammer, Commissioner Payne.

Staff & Guests Present:
Fred Sargeson, Jennifer McBroom, Kegan McClanahan, Theo Lewis, and Sandy Whittington

CALL TO ORDER
Mr. Kerins, Chair, called the 293rd meeting of the Lewis and Clark County Water Quality Protection WQPD (WQPD) Board of Directors (Board) to order at 4:00 p.m. A quorum was established. Introductions of Board members and WQPD staff were made.

REVIEW OF AGENDA
The agenda was reviewed and approved with no changes.

MINUTES
The Chair, Mr. Kerins requested a review of the minutes, and they were unanimously approved as written. Mr. Johnson and Mr. Kerins commented on the thoroughness of the minutes.

INTRODUCTION OF NEW EMPLOYEE
Ms. McBroom introduced the new Water Quality Specialist, Theodore Lewis. Mr. Lewis shared that he was born and raised in Great Falls, Montana. He discussed his professional background, noting that he worked for the Montana Department of Environmental Quality (DEQ) in the Mining Bureau for more than six years, where he focused on reclamation efforts. Mr. Lewis expressed his passion for water resource protection and preserving water quality for future generations. The Board engaged in a brief discussion regarding Mr. Lewis's upcoming responsibilities and duties.

STRATEGIC PLANNING
Mr. Kerins opened the strategic planning session by emphasizing that discussions should focus on future activities rather than past accomplishments. He noted that the Strategic Plan would be reviewed quarterly and could be modified as needed.

Ms. McBroom outlined the four focus areas of the Strategic Plan: monitoring and sampling, restoration, outreach and education, and board organization.

Ms. McBroom explained that standard operational tasks would continue regardless of whether they were included in the Strategic Plan. She also reviewed the voting process, noting that a simple "Go/No Go" vote would be used to efficiently identify activities for inclusion in the final plan for approval. The Board agreed to prioritize high-impact activities and to develop a roadmap containing approximately five to seven key activities within each focus area.

Board Organization

Approved activities for inclusion in the Strategic Plan:

- Develop annual outreach programs.
- Develop and implement a water conservation and water quality plan.
- Update Quality Assurance documents.
- Create and maintain a data management system.
- Develop and review written work plans.
- Research and apply for grants.
- Ensure adequate funding for technical and supervisory staffing.
- Create and update recruitment and retention plans as needed.
- Provide staff training.
- Provide orientation, board development, and education.
- Develop documentation for public dissemination.
- Include project budget proposal protocols as part of standard operational tasks.
- Conduct QI/PDSA activities, as necessary, as part of standard operational tasks.
- Study the potential expansion of the WQPD.
- Take a more active and effective role in development and subdivision reviews.
- Continue outreach efforts to secure a Conservation WQPD representative on the WQPD Board.
- Develop and implement staff work plans using a centralized internal service.
- Research and identify risks to water quality and water quantity, such as data centers.

Discussion on Approved Activities:

During discussion of the water conservation plan, Ms. Hammer emphasized the importance of including water quality as a component of the activity. She also requested documentation outlining the Water Quality Protection WQPD's water quality program and plan as referenced in the bylaws. The Board discussed appropriate language, relevant regulations, and the WQPD's role regarding water quantity and outreach efforts.

At the prompting of Mr. Kerins, the Board discussed whether standard operational tasks should remain within the Strategic Plan as a means of monitoring staff performance. The Board agreed that standard operational tasks would be grouped into a single Strategic Plan item and tracked through the WQPD day-to-day operations checklist.

During discussion of the potential expansion of the WQPD, Ms. Ohs-Mosely noted concerns regarding the potential costs associated with expansion. Ms. Hammer expressed support for exploring the concept but agreed that further study was warranted. Ms. McBroom noted that funds had already been allocated to study possible expansion of the WQPD boundaries. At the request of the Chair, the activity was revised to read, "Study the potential expansion of the WQPD."

The Board also discussed taking a more active role in development and subdivision reviews. Ms. Hammer expressed a desire to receive monthly updates regarding subdivision reviews and development activity. Discussion included the distinction between City and County planning boards and opportunities for the WQPD to provide comments during the planning process. Mr. Johnson suggested obtaining planning board meeting minutes for Board review. Commissioner Payne inquired about access to the Trak-It system, and Mr. McClanahan and Mr. Sargeson provided background information regarding its use.

During discussion of data centers, Ms. Hammer recommended expanding the activity to focus on research. The Board discussed potential impacts of data centers on both water quality and water quantity, including potential benefits and risks. Following discussion, the activity was revised to read, "Research and identify risks to water quality and water quantity, such as data centers."

Board Organization - Declined Activities: Addressed in other areas

The Board declined to include the following activities in the Strategic Plan:

- WQPD Board education on relevant topics through invited speakers and staff presentations.
- Increase the effectiveness of the WQPD and Board.
- Develop a Technical Advisory Group with local experts to guide and evaluate WQPD work.
- Complete a marketing plan to improve public outreach and increase public interest.
- Conduct a public relations campaign in preparation for a fee increase and highlight the value of WQPD services.
- Share and educate Board members on groundwater and surface water monitoring plans and annually updated Quality Assurance documents.
- Provide comments on all new developments within WQPD boundaries.
- Address other infrastructure needs.

Board Organization - Discussion on Declined to Include in Strategic Plan Activities:

Commissioner Payne questioned the wording of the proposed Board Education activity, while Ms. Johnson noted that the concept was already addressed under the approved board orientation, development, and education activity. The Board agreed not to include the item separately.

Discussion of the proposed activity to increase the effectiveness of the WQPD and Board centered on Board communication and engagement. Commissioner Payne requested clarification regarding the activity's scoring. Mr. Kerins and Ms. Johnson recommended striking the item, while Ms. Hammer stated that the intent was to improve communication and keep Board members informed. Ms. Ohs-Mosely suggested incorporating those objectives into the approved board orientation and development activity.

The Board questioned the purpose and function of a proposed Technical Advisory Group and ultimately chose not to advance the activity.

Discussion on the proposed marketing plan included questions from Commissioner Payne regarding WQPD funding sources and the distinction between WQPD funding and Public Health funding. Following discussion, the Board agreed not to advance the activity.

The proposed public relations campaign generated discussion regarding WQPD assessments and fees. Ms. Ohs-Mosely raised questions regarding potential fee increases for property owners, while Commissioner Payne asked about assessments paid by City residents. Mr. Kerins and Ms. Hammer both indicated that the intent of the activity was already addressed elsewhere in the Strategic Plan, and the Board chose not to include it.

The Board also declined activities related to annual education on monitoring plans and Quality Assurance documents, providing comments on all new developments within WQPD boundaries, and addressing other infrastructure needs. No further action was taken on those proposals.

Restoration Stream Work

The Board approved the following activity for inclusion in the Strategic Plan:

- General restoration activities.
- Discussion on Approved Activities
- No substantive discussion was recorded regarding the approval of general restoration activities.
- The Board declined to include the following activities in the Strategic Plan:
- River and watershed health.
- Achieve cleaner rivers and streams.

Restoration Stream Work Discussion on Declined to Include in the Strategic Plan Activities:

The Board determined that river and watershed health activities were already being addressed through ongoing educational efforts and the Water Watchers program. No additional discussion was recorded regarding the proposal to achieve cleaner rivers and streams.

Monitoring & Sampling

The Board approved the following activities for inclusion in the Strategic Plan:

- Annually reassess groundwater and surface water monitoring networks to optimize their effectiveness.
- Collect groundwater levels and conduct groundwater sampling projects.
- Collect surface water flow data and conduct surface water sampling projects.
- Assess the need to monitor recreational waters.

- Identify and prioritize critical water resource areas for protection, monitoring, and related activities.

Monitoring & Sampling Discussion on Approved Activities:

During discussion of groundwater and surface water monitoring networks, Ms. Hammer questioned the purpose of reassessing the networks, while Ms. Ohs-Mosely asked whether the process could help notify property owners when wells begin going dry. Ms. Hammer recommended revising the language to incorporate optimizing network effectiveness. Commissioner Payne inquired about long-term data storage and asked whether WQPD had provided information to Emerald Ridge residents regarding declining water levels. Mr. McClanahan explained where monitoring data is stored and noted that WQPD has collected and shared data with Emerald Ridge residents since 2012, including attendance at HOA meetings. The Board agreed to revise the activity to read, "Annually reassess groundwater and surface water networks to optimize their effectiveness."

During discussion of groundwater and surface water sampling projects, Commissioner Payne asked what parameters were being tested. Ms. McBroom explained that these monitoring efforts are ongoing. Ms. Ohs-Mosely noted that both activities are standard operational tasks and suggested they be recognized as such.

The Board also discussed recreational water monitoring. Ms. McBroom explained that testing has included nutrients, algae, and harmful algal blooms. Discussion followed regarding whether DEQ performs similar monitoring. Ms. Johnson stated that DEQ generally conducts testing in response to reports or complaints. Commissioner Payne expressed concern regarding the results and asked Ms. Hammer about her knowledge of changes to testing metrics used in water quality assessments. The Board discussed legislative changes affecting testing requirements, current monitoring methods, and opportunities for public education. Ms. McBroom emphasized the importance of continuing monitoring efforts, while Ms. Hammer recommended revising the activity to read, "Assess the need to monitor recreational waters," particularly if no other entity is conducting the monitoring.

Discussion regarding critical water resources focused on watershed and sub-watershed priorities within WQPD boundaries and areas where additional work remains. Ms. Hammer and other Board members agreed that the proposed wetland and riparian area study could be incorporated into this broader activity.

The Board placed the following activity on hold pending further discussion:

Complete a baseline study to delineate wetlands and riparian areas within the WQPD and incorporate the data into the WQPD Interactive Map.

Monitoring & Sampling Discussion- On hold:

Ms. McBroom noted that wetland mapping had previously been completed, which Ms. Johnson indicated she had not been aware of. Ms. Hammer expressed support for the activity and stated that the information would be valuable. Ms. Ohs-Mosely noted that wetlands are already protected through regulatory processes and questioned whether the activity fell within the WQPD's scope of responsibility. Following discussion, the Board agreed to place the activity on hold.

The Board declined to include the following activities:

- Public Involvement and Integration Plan.
- Test springs in Dry Gulch near the Old Shooting Range parking lot and in Orofino Gulch for drinking water parameters.
- Develop environmental indicators as a water quality performance measure.
- Achieve cleaner rivers and streams through innovative strategies.

Monitoring & Sampling Discussion on Declined to Include in the Strategic Plan Activities:

During discussion of the Public Involvement and Integration Plan, Commissioner Payne requested clarification regarding the term MS4. Ms. McBroom explained that MS4 refers to Municipal Separate Storm Sewer Systems. Ms. Ohs-Mosely asked about the need for updates, and Ms. McBroom explained that population growth exceeding 50,000 residents has resulted in DEQ requirements related to participation in county stormwater programs. Mr. Kerins suggested that the concepts associated with this activity would be better addressed through education and outreach activities already included in the Strategic Plan.

Discussion of spring water testing focused on public use of the water sources. Commissioner Payne questioned the value of testing if individuals chose to drink from unregulated sources. Mr. Lewis explained that studies have previously identified contamination concerns, though it was later clarified that he was referring to a separate water source near MacDonald Pass. After discussion, the Board agreed that installing signage warning against drinking the water would be more appropriate than conducting additional testing.

During discussion of environmental indicators, Ms. Hammer stated that the activity was one of the more important proposals under consideration. Ms. McBroom noted that performance measures are already incorporated through Quality Assurance Project Plans (QAPPs) and Surface Water Assessment Plans (SAPs), as well as existing groundwater and surface water monitoring efforts. Commissioner Payne questioned the use of the term "suite," and Mr. McClanahan explained that the term refers to the group of analyses performed by the state laboratory. The Board ultimately determined that the activity was sufficiently addressed through existing monitoring programs.

The Board declined to pursue an activity focused on achieving cleaner rivers and streams through innovative strategies, determining that the concept was either addressed by other approved activities or lacked sufficient specificity for inclusion in the Strategic Plan.

Outreach and Education

The Board approved the following activities for inclusion in the Strategic Plan:

- Work with partners to develop and participate in events as part of standard operational tasks.
- Maintain the WQPD website and display collected data as part of standard operational tasks.
- Promote the WQPD through standard operational activities.
- Distribute water quality sampling options (kits) to residents as part of standard operational tasks.

- Maintain a Volunteer Stream Team program as part of standard operational tasks.
- Collaborate with City and County planning officials, commissioners, sanitarians, and developers on new developments as part of standard operational tasks.
- Provide general information to the public as part of standard operational tasks.
- Continue the Water Watchers program as part of standard operational tasks.
- Provide education and outreach regarding wastewater discharges.
- Establish a process for reporting well water contamination.
- Focus on pollutant reduction efforts, including drinking water contaminants and emerging contaminants.
- Include hydraulic gradient data, surface water quality monitoring results, Helena Valley Controlled Groundwater Area information, and water and sewer WQPDs on the WQPD Interactive Map.
- Board education to include information on private well testing and maintenance, septic system maintenance, and water conservation.
- Support development of a Water Conservation Plan addressing drought, wildfire, and flooding in coordination with City and County partners.
- Promote and encourage green infrastructure practices.

Discussion on Approved Activities:

The Board reviewed several outreach activities that were identified as standard operational tasks and agreed they should remain ongoing components of WQPD operations.
During discussion of wastewater discharges, Ms. McBroom noted that the activity had originally been designed as a presentation topic. Board members discussed whether it would be more appropriately categorized as Board education or public outreach. The Board agreed the topic should focus on community education and public outreach efforts.

The Board discussed pollutant reduction efforts, including potential costs associated with the activity. Members emphasized the importance of focusing on drinking water quality and emerging contaminants. The activity description was revised to reflect those priorities.
While discussing additions to the WQPD Interactive Map, Mr. McClanahan provided information regarding the effort required to incorporate additional data layers. He noted that development of the hydraulic gradient layer would be the most labor-intensive component of the project.

During discussion of a Water Management Plan, Mr. Kerins noted that development of such a plan may extend beyond the primary responsibilities of the WQPD. Ms. Hammer expressed strong support for including the activity, and the Board agreed to retain it as a collaborative effort with City and County partners.

Ms. Hammer also expressed strong support for promoting green infrastructure practices. Ms. McBroom noted that green infrastructure initiatives would align with and support future MS4 program requirements and activities.

The Board declined to include the following activities in the Strategic Plan:

- Sponsor a WQPD science fair focused on water-related topics.
- Stormwater management.
- Nutrient pollution.

- Promote water conservation.
- Develop outreach and educational materials regarding xeriscaping, stormwater, nutrients, well and septic management, irrigation, and other water management best practices.

The Board declined to include the following activities in the Strategic Plan:

The Board discussed sponsoring a WQPD science fair but ultimately chose not to include the activity in the Strategic Plan.

The Board declined to include separate activities related to stormwater management and nutrient pollution, determining that those topics were sufficiently addressed through other approved activities and existing programs.

The Board also determined that promotion of water conservation was already incorporated within other approved Strategic Plan activities and did not need to be included as a standalone item.

Similarly, the Board agreed not to include a separate activity for developing outreach and educational materials related to xeriscaping, stormwater, nutrients, well and septic management, irrigation, and other water management best practices, as those topics would be addressed through broader outreach and education initiatives already approved for inclusion in the Strategic Plan.

BOARD MEMBER ROUND-ROBIN

- **LCC Commissioner Payne –** Commissioner Payne noted budget work continues with the commissioners until finalization on July 9th. She added she is a little grumpy with the public is complaining about road work needed but not wanting tax increases.
- **City of Helena –** No Report
- **City of East Helena –** No report
- **Board of Health –** No report
- **Helena Citizens Council (HCC) –** Ms. Hammer advised of the upcoming meeting to meet the new City Manager on July 10th as well as, the HCC offered comment on the City of Helenas proposed budget.
- **Conservation WQPD (CD) –** Mr. Sargeson noted the newly appointed CD Supervisor, Rebecca Boslow King might be interested in taking the open WQPD board seat.
- **Public at large –** None

PUBLIC COMMENT
There was no public comment.

There being no public comment; the meeting was adjourned at 5:53pm.

LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	Agenda Item No.
July 28, 2026	**4**

__ Minutes _X_ Board Member Discussion _X_ Staff & Other Reports ___Action __Hearing of Delegation

AGENDA ITEMS: Fiscal Year End Financial Report

PERSONNEL INVOLVED: Jennifer McBroom

BACKGROUND: WQPD Financial Information

_X_ ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

NOTES:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
A. Johnson						
C. Payne						
D. Dahl						
S. Ohs-Mosley						

WATER QUALITY DISTRICT

FUND 22754430

100% Through the Year — 7/15/2026

7/15/2026 payroll 100%

EXPENDITURES: DESCRIPTION		BUDGETED FY 2026	APRIL	MAY	JUNE	YEAR TO DATE	BUDGET REMAINING	% USED	Prior Year
11.01	SALARIES & WAGES: PERM	277,650	19,249.39	17,202.86	17,796.93	$251,280.09	$26,369.91	90.5%	241,507.66
12.01	OVERTIME				11.85	$54.85		--	82.76
13.01	TERMINATION PAY			1,905.93		$1,905.93		--	1,909.07
15-17	EMPLOYER CONTRIBUTIONS	94,035	6,876.95	5,620.04	5,387.28	$83,858.05	$10,176.95	89.2%	75,039.11
19.10	TERM PAY/UNCOMP ABSENC	0				$0.00		--	
	TOTAL PERSONNEL	$371,685	$26,126	$24,729	$23,196	$337,098.92	$34,586.08	90.7%	318,538.60
21.10	OFFICE SUPPLIES	1,000		214.63	15.00	$406.75	$593.25	40.7%	115.86
21.20	MINOR EQUIPMENT	3,500			2,033.46	$2,033.46	$1,466.54	58.1%	787.50
22.10	OPERATING SUPPLIES	2,000	707.16	1,314.69	(709.92)	$2,224.58	($224.58)	111.2%	7,458.72
22.27	SAMPLING	19,000	2,041.20	375.00	7,892.00	$13,309.00	$5,691.00	70.0%	6,672.20
23.10	REPAIR & MAINTENANCE	800				$0.00	$800.00	0.0%	150.00
23.20	GAS & OIL	2,000	155.67	121.23	219.35	$1,451.05	$548.95	72.6%	1,419.89
31.20	POSTAGE	1,000		159.15	529.37	$902.48	$97.52	90.2%	844.19
32.10	PRINTING	1,000			429.02	$1,681.80	($681.80)	168.2%	4,399.08
33.20	ADVERTISING	1,000				$846.29	$153.71	84.6%	792.71
33.50	MEMBERSHIP	1,000				$252.00	$748.00	25.2%	337.00
33.70	EDUCATION AWARENESS	7,000			4,065.00	$8,022.48	($1,022.48)	114.6%	4,110.35
33.80	HEALTH CLUB DUES	300				$0.00	$300.00	0.0%	125.00
34.50	TELEPHONE	2,683	65.46	539.46	65.46	$2,681.52	$1.48	99.9%	2,681.52
35.10	PROFESSIONAL SERVICES	2,000		87.50		$375.00	$1,625.00	18.8%	420.00
35.70	COMMUNITY PROJECTS					$182.77	($182.77)	--	0.00
36.20	OFFICE MACHINES	0				$0.00	$0.00	--	0.00
36.30	REPAIR&MAINTmotor veh	0		10.78	1,888.00	$2,080.81	($2,080.81)	--	0.00
37.10	TRAVEL	4,000			432.98	$2,192.68	$1,807.32	54.8%	2,798.35
37.50	BOARD MEETING EXPENSES	500				$0.00	$500.00	0.0%	307.00
38.10	TRAINING	1,500				$560.00	$940.00	37.3%	1,060.00
39.10	CONTRACTED SERVICES (usg	10,000			460.09	$460.09	$9,539.91	4.6%	0.00
50.10	county admin fees	10,872			2,718.00	$10,872.00	$0.00	100.0%	9,311.00
50.20	INSURANCE	4,260			1,065.00	$4,260.00	$0.00	100.0%	3,832.00
50.30	RENT	10,563		2,640.65		$10,562.57	$0.43	100.0%	10,607.49
50.40	TECHNOLOGY	12,231			3,058.00	$12,232.00	($1.00)	100.0%	9,952.00
50.41	SOFTWARE AGREEMENTS	0			3.96	$3.96	($3.96)	--	
80.15	CAPITAL TRANSFER	15,000			7,500.00	$15,000.00	$0.00	100.0%	38,135.00
	TOTAL O&M	$113,209	$2,969.49	$5,463.09	$31,664.77	$92,593.29	$20,615.71	81.8%	106,316.86
TOTAL EXPENDITURES		**$484,894**	**$29,095.83**	**$30,191.92**	**$54,860.83**	**$429,692.21**	**$55,201.79**	**88.62%**	**$424,855.46**

REVENUES: DESCRIPTION		BUDGETED FY 2026	APRIL	MAY	JUNE	YEAR TO DATE	BUDGET REMAINING	% RECEIVED	Prior Year
344.09-40	WELL MONITORING (USGS)	0			1,350.00	$2,025.00	($2,025.00)	--	2,700.00
362.01-00	OTHER MISC					$0.00	$0.00	--	0.00
363.01-00	MAINTENANCE ASSESSMEN	389,800	6,664.29	106,585.65	41,086.46	$395,596.21	($5,796.21)	101.5%	381,999.09
363.04-00	MA PENALTY & INTEREST	0	213.44	91.74	174.25	$1,952.98	($1,952.98)	--	1,555.56
371.02-00	INTEREST EARNINGS					$0.06	($0.06)	--	
383.01-00	HEALTH INSURANCE CREDI	26,426			10,853.36	$23,222.81	$3,203.19	87.9%	17,373.64
TOTAL REVENUE		**$416,226**	**$6,877.73**	**$106,677.39**	**$53,464.07**	**$422,797.06**	**($6,571.06)**	**101.58%**	**$403,628.29**

	BEGINNING CASH BALANCE				
beg cash	fund 203 unrestricted	319920.32	$237,936.46	$314,421.93	$313,025.17

Total WQPD Cash Available

$313,025.17

Grizzly Gulch 29844430

Projects : GGPMTA, GGPMT1 - 4, GGBOND

7/15/2026 11:39

	BUDGET	Apr-25	May-25	Jun-25	Aug-25	Sep-25	Nov-25	Jan-26	EXPENSES YTD Total	% expended
22.10 Operating Supplies	0								0.00	#DIV/0!
22.27 Lab Expenses	0								0.00	#DIV/0!
32.10 Printing	0								0.00	#DIV/0!
35.10 Professional Services	0								0.00	#DIV/0!
39.10 Contracted Services	0		11,147.20	239,525.75	9,481.30				289,466.75	#DIV/0!
50.11 Admin	0								0.00	#DIV/0!
80.10 Transfers Out									0.00	#DIV/0!
Subtotal Operations	0	0.00	11147.20	239525.75	9481.30				289466.75	#DIV/0!
TOTAL	0	0.00	11,147.20	239,525.75	9,481.30				289,466.75	

Revenue Received	Budget	April	May	June	Aug-25	Sep-25	Nov-25	Jan-26	
Task 1 GGPMT1	10861								8,200.00
Task 2 GGPMT2	24840								9,027.50
Task 3 GGPMT3	256440	5887.5				256172.95	9481.3		272,239.25
Task 4 GGPMT4	0								0.00
Task 5 GGPMTA	470								0.00
total	292611	5887.5	0	0	0	256172.95			289,466.75
GGBOND	10000							10000	10,000.00
									299,466.75

beg bal	0.00
revenue	299,466.75
exp	289,466.75
balance	$10,000.00

WQPD Donated Funds(Rewater)

29864430

100%	Through the Year						7/15/2026	
grant year	7/1-6/30							

EXPENDITURES: DESCRIPTION		BUDGETED FY 2026	APRIL	MAY	JUNE	YEAR TO DATE	Contract budget Remaining	% USED
35.10	PROFESSIONAL SERVICES	13,500			6,000.00	$13,500.00	$0.00	100.0%
39.10	CONTRACTED SERVICES	0				$0.00	$0.00	--
	TOTAL O&M	$13,500	$0.00	$0.00	$6,000.00	$13,500.00	$0.00	100.0%
TOTAL EXPENDITURES		**$13,500**	**$0.00**	**$0.00**	**$6,000.00**	**$13,500.00**	**$0.00**	**100.00%**

REVENUES: DESCRIPTION		BUDGETED FY 2026	APRIL	MAY	JUNE	YEAR TO DATE	BUDGET REMAINING	% RECEIVED
3340000	State Grant		4929			$4,929.00	-$4,929.00	--
365.02-00	Gage Donations	0				$0.00	$0.00	--
365.02-00	Rewatr Donations	0				$0.00	$0.00	--
383.01-00	Interfund Transfers	0				$0.00	$0.00	--
TOTAL REVENUE		**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$4,929.00**	**($4,929.00)**	**#DIV/0!**

beginning cash bal rewatr **$34,126.00**

	REWATR
beg bal	$34,126.00
revenue	$4,929.00
expenditures	$13,500.00
current cash bal	$25,555.00

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LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	**Agenda Item No.**
July 28, 2026	**5**

___Minutes _X_Board Member Discussion _X_Staff & Other Reports _X_Action __Hearing of Delegation

AGENDA ITEMS: Strategic Plan Final

PERSONNEL INVOLVED: Board members and staff

BACKGROUND: 2026-2029 Strategic Planning

_X_ ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
S. Ohs-Mosley						
C. Payne						
A. Johnson						
D. Dahl						

NOTES:

Thematic Goals:

1	Build community awareness of local water resource value, impacts and conservation opportunities.
2	Focus on executing rigorous, standard field sampling to generate reliable data across all water resources.
3	Improve the overall health and natural functions of local waterbodies.
4	Strengthen organizational capacity and performance to maximize board governance efficiency and operational resilience.

Thematic Goal #1 – Outreach and Education					
Build community awareness of local water resource value, impacts and conservation opportunities.					
Objective #1					
Launch an integrated three – year public information campaign across digital, print, and event channels to reach at least 500 residents annually with local water resource messaging.					
Performance Activity Details & Metrics					
What	When		Metric	Resources	Collaborators
Digital - Weekly social media posts	July 8,2026		10% increase in social media engagement	Canva, Social media scheduling software	Health Department
Develop & Implement Water Quality/Quantity Conservation plan			-Draft by end of QTR 2 Year 1 -Final by QTR 3 Year 1 -Focused on activities		
Print – brochures, educational materials, project summaries			200 physical materials distributed	Budgeted	Local & State Government
Events – Tabling at community gatherings.			Attending 2 local events annually	Folding table, branded tablecloth, pop-up banner	Local & State Government

Thematic Goal #1 – Outreach and Education
Build community awareness of local water resource value, impacts and conservation opportunities.
Objective #2

Conduct 4$f s evh$f vm r k$wi wwmr wfeaturing regional water partners annually to ensure 100% of board members are fully informed on local wastewater, septic, and local water concerns and programs.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Schedule partner speakers to present during the first 30 minutes of regularly scheduled board meetings – Wastewater?. septic.systems?. PFAS?.™ .other. contaminants	Spaced out quarterly		Presentation materials, summaries documented in WQPD minutes	Shared board member access to materials	Env. Health specialists, City/State

Thematic Goal #1 – Outreach and Education					
Build community awareness of local water resource value, impacts and conservation opportunities.					
Objective #3					
Gauge school interest in Year 1 to expand our classroom visits across multiple grade levels, aiming to secure in-person presentations for three grade levels by Year 3, or alternatively, distributing self-guided educational materials to 100% of non-participating classrooms.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Year 1 Assessment	Year 1 – Curriculum design		Year 1 -90 % of local elementary grade surveyed/contacted		Local school personnel
Year 2 Pilot Program – In-person or Teacher Toolkit bags with materials	Year 2 – Active School year		Year 2 – 25% of contacted classroom are booked with In-person or accepting a printed toolkit bag through the 2 options.		
Year 3 Feedback for final	Year 3 Refinement		Year 3 – 90 % coverage of the		

classroom/material distribution			target grade population reached through the 2 options.		

Thematic Goal #1 – Outreach and Education					
Build community awareness of local water resource value, impacts and conservation opportunities.					
Objective #4					
To train a dedicated volunteer network to conduct monthly surface water monitoring and host annual one public data-sharing events, building community awareness of local watershed health and actionable conservation strategies.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Year 1-Create and conduct assessment	QTR 3 Year 1		Assessment completed by Year 1		Health Department
Year 2 - Train staff	Year 2		100% trained staff/volunteer	Budget for training staff.	MMW at FLBS or MSU Extension
Year 3 – Citizen watershed monitoring group. one stream	Year 3		# of designated testing sites monitored monthly.	Grant for analysis - DEQ	Lake Helena Watershed Group, WQPD and partners

Thematic Goal #2 – Monitoring and Sampling (Data collection)					
Focus on executing rigorous, standardized field sampling to generate reliable and representative data across all water resources.					
Objective #1					
To systematically collect, map, and create a comprehensive database of water quality and quantity data for all local hydrologic systems.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Collecting schedule	Monthly		90% sampled within the month of collection		

Visual mapping created			100% Data points link to WQPD map.		
Standardized dataset accessible to partners			One or more storymaps created in WQPD WQ portal published by year 2.		

Thematic Goal #3 – Stream Restoration					
Improve the overall health and natural function of local waterbodies.					
Objective #1					
Integrate engineered, nature-based, and process-led restoration methods across the watershed.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Conduct a comprehensive GIS and field assessment for identifying targeted projects.	May 2027		100% Desktop GIS mapping. Conduct Field assessment on 10%-20% of the most degraded stream reaches.	Lewis & Clark County	DEQ
Evaluate what intervention/technique is suitable. – Buffer zones, GW recharge areas, Engineered stream rest., Live staking, beaver dam analogues	2027-2028		Conduct site readiness		DEQ
Funding/shovel ready			Apply for grants Volunteer efforts		Grant specialist

Thematic Goal #4 –Board organization
Strengthen organizational capacity and performance to maximize board governance efficiency and operational resilience.

Objective #1					
Build and maintain workforce stability by designing, updating, and executing responsive recruitment and retention plans.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Develop a Recruitment and Retention plan			Draft Delivery Schedule – By year 1 Final by year 2		
A formal annual policy review process.			Review plans Annually		

Thematic Goal #4 –Board organization					
Strengthen organizational capacity and performance to maximize board governance efficiency and operational resilience.					
Objective #2					
Build organizational capacity and leadership excellence through continuous, structured professional development for both staff and board members.					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Develop a training needs list for both Board and Staff	1st year		100% Percentage of the staff members and active Board members who completed an initial training-needs assessment or survey in 6 months		
Develop a new-member orientation manual	1st year		Year 1 Target 100% draft of WQPD governance, function,		

			programs, by-laws,		
Individualized staff professional development plans	2nd year		Development plans		

Thematic Goal #4 –Board organization					
Strengthen organizational capacity and performance to maximize board governance efficiency and operational resilience.					
Objective #2					
Conduct a preliminary assessment in Year 1 to conduct a study of expanding the WQPD boundaries is a viable option and if it would be beneficial to the community (potential expansion).					
Performance Details & Metrics					
What	When		Metric	Resources	Collaborators
Hydrologic review of proposed expansion	QTR 2 Year 1		Options - # of wells/parcels (areas) that would be impacted by proposed expansion	Lewis & Clark County	Lewis & Clark County personnel
Hire Consultant	QTR 3 Year 1		Limited solicitation - Hire consultant – Process and understanding options of expansion	Lewis & Clark County	Consultant
Community Engagement	QTR 4 Year 1		Assessment of Need – community meetings	Consultant	Lewis & Clark County

Addendum

During the strategic planning process, the board identified multiple operational tasks that the staff are regularly engaged in throughout the year. Though these tasks did not translate into Objectives or Strategies, the board thought it important to record the list as an addendum to the plan as a reference. Those Standard Operating Tasks are listed below:

Standard Operational Tasks:

	Tasks	QTR 1	QTR 2	QTR 3	QTR 4
	Maintain WQPD Website – Display data collected				
	Distribute water quality sampling options (kits) to residents				
	Collaborate with the following but not limited to: City and County Planning/Commissioners, sanitarians, developers on developments (subdivision tracker)				
	Develop annual outreach programs				
	Update Quality Assurance documents				
	Create and maintain data management system				
	Research and apply for project grants				
	Project budget proposal protocol				
	QI PDSA when necessary				
	Develop and implement staff work plans using a centralized service				
	Annually reassess GW & SW networks to optimize effectiveness				
	Collection GW levels & Sampling projects				
	Collect SW flow a & Sampling Projects				
	Water quality results posted to map - check with labs on their side to share data(gather results).				
	Research/Identify potential risks to water quality/quantity such as data centers – Forever Chemicals, Data Centers				

LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	Agenda Item No.
June 23, 2026	**6**

__Minutes _X_Board Member Discussion _X_Staff & Other Reports __Action __Hearing of Delegation

AGENDA ITEMS: Subdivision updates: Steed Family Transfer & Grey Rock Subdivision

PERSONNEL INVOLVED: Kegan McClanahan

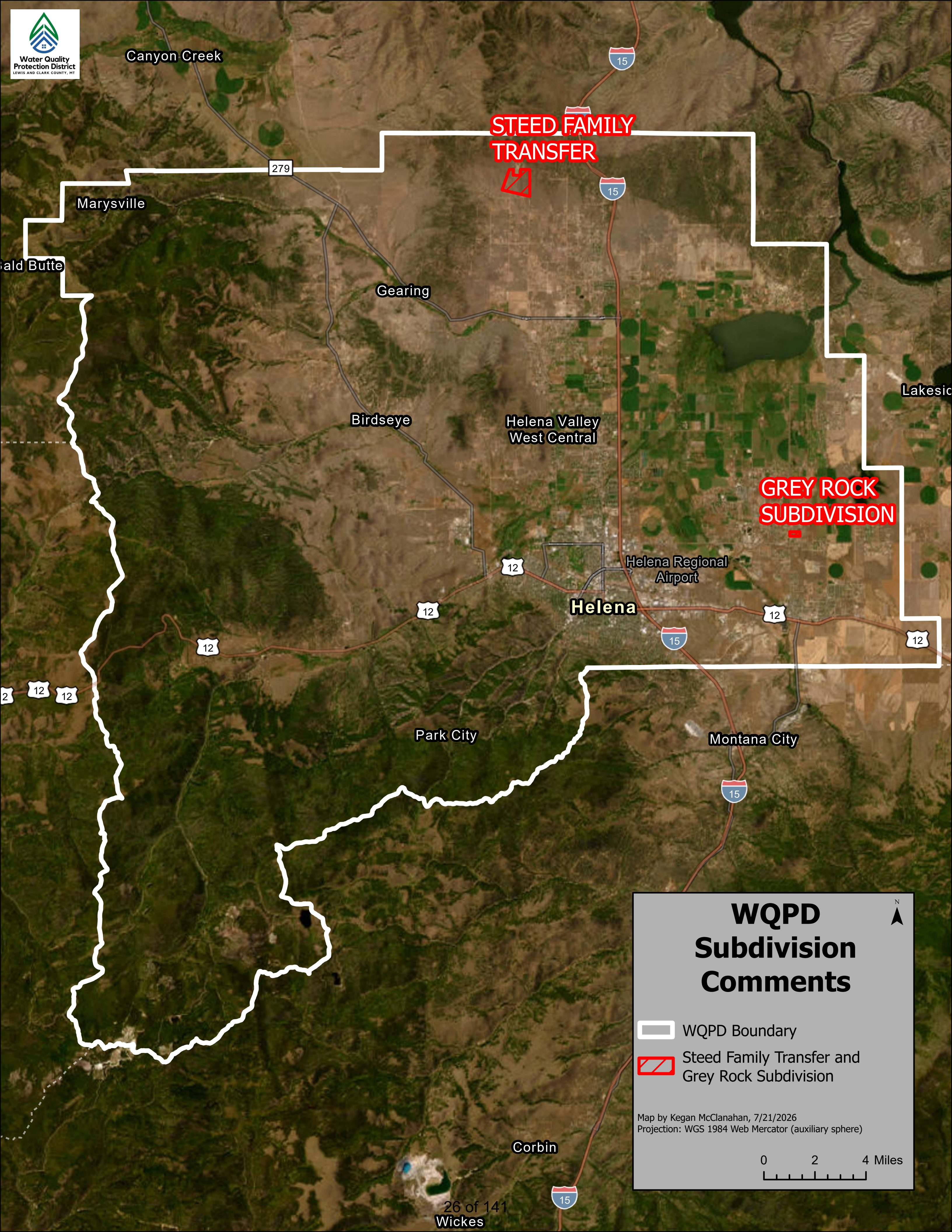
BACKGROUND: Subdivision changes and development information

_X_ ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

NOTES:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
C. Payne						
A. Johnson						
D. Dahl						
S. Ohs-Mosely						


Water Quality Protection District
LEWIS AND CLARK COUNTY, MT
Canyon Creek
STEED FAMILY TRANSFER
279
15
Marysville
Bald Butte
Gearing
Birdseye
Helena Valley West Central
Lakeside
GREY ROCK SUBDIVISION
Helena Regional Airport
12
Helena
Park City
Montana City
Corbin
Wickes
WQPD Subdivision Comments
N
WQPD Boundary
Steed Family Transfer and Grey Rock Subdivision
Map by Kegan McClanahan, 7/21/2026
Projection: WGS 1984 Web Mercator (auxiliary sphere)
0
2
4 Miles

Water Quality
Protection District
LEWIS AND CLARK COUNTY, MT

1930 9th Avenue, Helena, MT 59601
(406) 457-8584

MEMORANDUM

Date: June 26, 2026
To: Beth Norberg, *Lewis and Clark County Public Health Department*
Cc: Jennifer McBroom, *Lewis & Clark County Water Quality Protection District*
From: Kegan McClanahan, *Lewis & Clark County Water Quality Protection District*
Reference: Steed Family Transfer (E.Q. #26-2240, CS# 0842846)

The Lewis and Clark County Water Quality Protection District (LCCWQPD) is a non-regulatory agency with the mission of preserve, protect, and improve water quality and water quantity within the boundaries of the District. We work with property owners to collect data and share those data with the public, fellow agencies, and stake holders to help everyone make informed decisions.

Overview of Development

A subdivision is proposed as the Steed Family Transfer (Development) in the northwest region of the Helena Valley North Hills (Attachment 1). The Development will be located in Section 35, Township 12, Range 4 West. The Development will consist of 24 lots with each lot ranging from 5 – 10 acres. Each lot will be supplied potable water by individual wells that are planned to be 300 – 800 feet apart. The wells are considered a “combined appropriation” with respect to water rights, so all of the planned wells will be limited to a combined 10 acre-feet of water per year. Wastewater for each property will be handled by individual septic systems (Plant, J., personal communication, 2026).

On May 4, 2026, Lewis and Clark County Public Health denied the Development’s application pending additional information. The denial was due to insufficient data being presented to demonstrate sufficient groundwater availability for the Development. In response to the denial and need for additional hydrologic information, the owner of the Development hired HydroSolutions Inc., a local environmental consulting and engineering firm, to perform a more in-depth hydrogeologic investigation and conduct aquifer testing.

The investigation conducted by HydroSolutions Inc. included: (1) drilling a pumping test well and an observation well (locations shown in Attachment 1), (2) conducting a 24-hour constant rate aquifer test, (3) reviewing published hydrogeologic research in the vicinity of the Development, and (4) analyzing and reporting on the source aquifer geology and hydraulic parameters. The wells for the aquifer test were all completed within the Belt Supergroup Spokane Formation’s argillite (a mudstone similar to shale). The 24-hour constant-rate aquifer test was conducted at 57.1gpm with 21.3 feet of drawdown. The calculated transmissivity was 273 to 308ft^2/day, and hydraulic conductivity was calculated to be 2.5 to 2.8ft/day. The observation wells displayed minor responses to pumping during the test. The investigation concludes that no evidence was identified that indicates an insufficient amount of groundwater availability.

Local Hydrogeology

The North Hills of the Helena Valley are underlain by three principal aquifers: the Helena Valley Aquifer, the Tertiary Aquifer, and the Bedrock Aquifers (Attachment 2). The bedrock underlying the Development is characterized as argillite of the Belt Supergroup Spokane Formation (Attachment 1). A thin layer of colluvium (unconsolidated sediments such as gravel) is present on top of the bedrock and pinches out to the north. The Spokane Formation has limited primary porosity (pore space) but can have significant secondary porosity (fractures) and secondary permeability (Thamke, 2000). Faults are known in the area of the Development including the Helena Valley Fault that trends northwest-southeast and is located just north of the Development.

Water Quantity Concerns

The Spokane Formation's argillite exhibits transmissivity values from 43 to 11,100 ft^2/day and hydraulic conductivity values ranging from 0.09 to 163 ft/day (Waren et al., 2012), indicating a wide range of hydraulic properties. The degree of local secondary porosity (fractures) plays a controlling role in the movement of water (well recharge) in the Spokane Formation. Therefore, any heterogeneity in the secondary porosity and permeability of the bedrock can have significant impacts on well production, and by extension could induce groundwater depletion.

The 24-hour aquifer test conducted by HydroSolutions Inc. provided important data on the hydraulic properties of the local Spokane Formation aquifer, however the pump test may not be representative of the whole aquifer under the Development. Waren et al. (2012, page 19) states:

> *"It has been noted that "[w]hereas laboratory tests provide point values of the hydrogeological parameters, and piezometer tests [slug tests] provide in situ values representative of a small volume of porous media in the immediate vicinity of a piezometer tip, pumping tests provide in situ measurements that are averaged over a large aquifer volume"(Freeze and Cherry, 1979, p. 343). Thus aquifer tests offer a powerful tool for estimating the hydrogeologic properties of an aquifer. It must be kept in mind, however, that those values still only represent a relatively small area. Due to heterogeneity of the aquifer, the results of an aquifer test only provide a first approximation of what the hydrogeologic properties will be over a larger area."*

The pumping well and observation wells used in the HydroSolutions Inc. aquifer test are all located along the northern margin of the Development property (Attachment 1). The aquifer may exhibit significantly different hydraulic properties in the southern region of the Development. If the aquifer is less productive in the southern region of the Development this could negatively impact the groundwater availability of new residences in the Development.

Additionally, the 24 lots will each be served by an individual well, but all 24 wells are being considered a “combined appropriation” with respect to water rights. This limits the combined usage of all 24 wells to 10 acre-feet per year (3,258,510 gallons per year) total. Each residence, on average, then is limited to 135,771 gallons per year, or 372 gallons per day. The United States Geological Survey estimates the average resident in Montana pumps an average of 74 gallons per day of groundwater (Dieter et al., 2018). For a family of 4, the average daily water usage would be approximately 296 gallons per day out of a total of 372 (80%), on average. Is it therefore a realistic expectation that all residences, combined, will limit their water usage to stay under the 10 acre-feet per year requirement when even a small family will use 80% of the daily water, let alone a larger family or a residence wishing to irrigate a substantial portion of their property? If the situation arises that the residences are pumping more than 10 acre-feet per year from the aquifer, there exists a real chance that groundwater depletion could occur and threaten the water availability in the larger aquifer.

Water Quality Concerns

Nitrate is a common contaminant in groundwater due to the abundance of septic systems and fertilizer application within and adjacent to the Helena Valley (Briar and Madison, 1992; Thamke, 2000). The United States Environmental Protection Agency (USEPA) has established a safe drinking water limit of 10mg/L nitrate (as nitrogen) for public drinking water systems. Over time sources and concentrations of nitrate can change due to land uses changes or septic system deterioration.

There is a significant presence of volcanic bedrock surrounding the Helena Valley. The volcanic bedrock, typically granites and granodiorites, can contain naturally high levels of uranium as well as decay products of uranium, such as radon (Caldwell et al., 2014). Additionally, arsenic naturally occurs in the local bedrock. Groundwater and surface water can transport the arsenic into the Helena Valley. The Missouri River mobilizes arsenic from the bedrock and introduces it to the Helena Valley via the Helena Valley Irrigation District’s canal network (Tuck, 2001). Arsenic can then infiltrate into the groundwater in the Helena Valley thus posing a risk to human health.

Recommendations

The LCCWQPD provides the following recommendations:

- Conduct a 24-hour constant rate aquifer test in the southern half of the Development property to ensure adequate water supply for the whole development.
- Regular water quality testing. It is recommended to test for nitrates and total coliform bacteria (common contaminants with septic systems) on an annual basis. It is also recommended to test for arsenic and uranium every 3-5 years. The LCCWQPD has water quality test kits for these contaminants at our office (1930 9th Avenue, Helena, Montana, 59601).

If anyone has any questions regarding these comments and recommendations, please contact me at (406) 457-8927 or KMcClanahan@LCCountyMT.gov.

Attachments

Attachment 1: Surficial Geology Map
Attachment 2: Geologic cross section

References

Briar, D.W. and Madison, J.P. 1992, Hydrogeology of the Helena Valley-fill aquifer system, west-central Montana, United States Geological Survey, Water-Resources Investigations Report 92-4023, p. 92.

Caldwell, R.C., Nimick, D.A., and DeVaney, R.M., 2014, Occurrence and hydrogeochemistry of radiochemical constituents in groundwater of Jefferson County and surrounding areas, southwestern Montana, 2007 through 2010, United States Geological Survey, Scientific investigations report 2013-5235, p. 76.

Dieter, C.A., Maupin, M.A., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2018, Estimated use of water in the United States in 2015, United States Geological Survey Circular 1441, 65p.

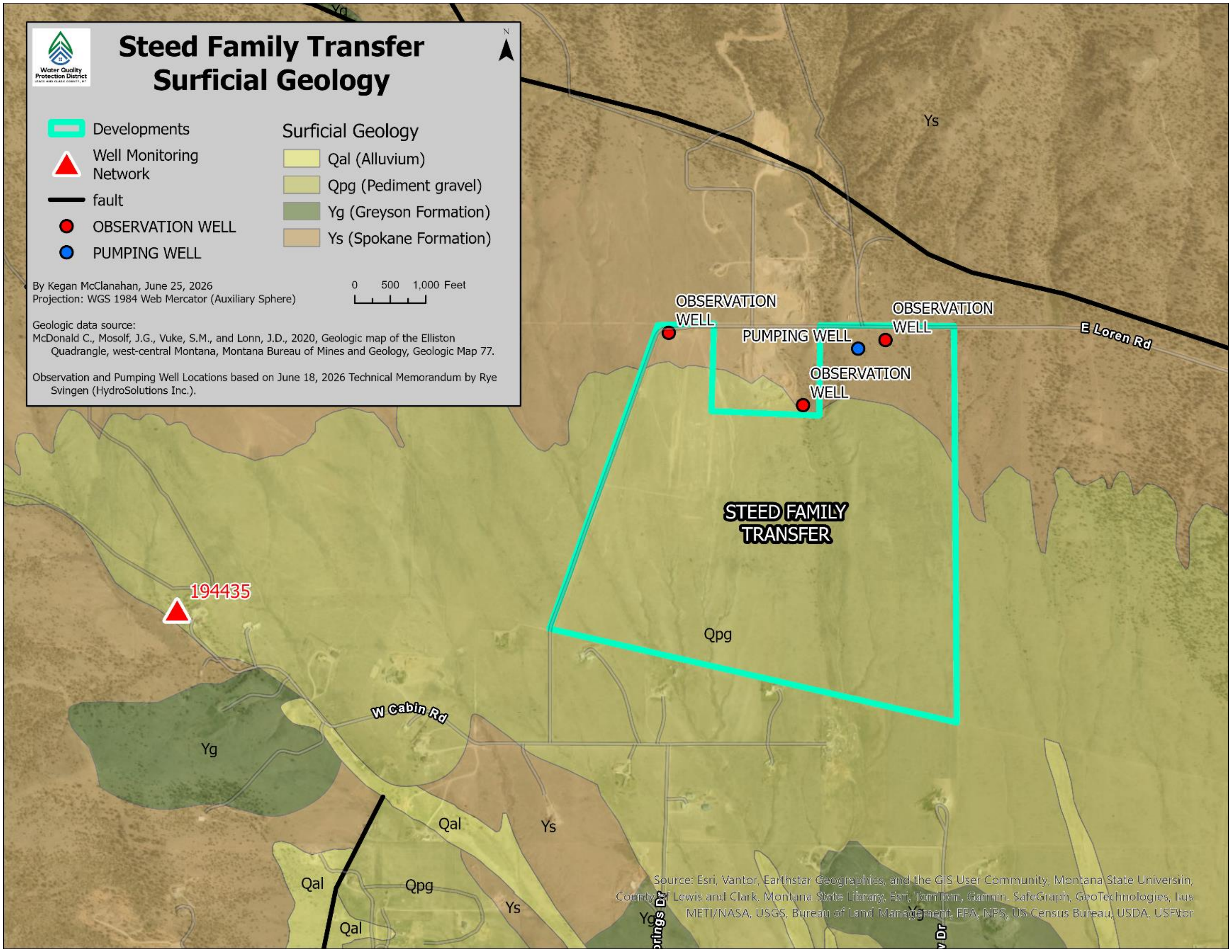
Plant, J, 2026, Personal communication. June 23, 2026.

Thamke, J.N., 2000, Hydrology of the Helena area bedrock, west-central Montana, 1993-98, with a section on geologic mapping and a generalized bedrock geologic map by Mitchell W. Reynolds, United States Geological Survey Water: Water-resources investigations report 00-4212, p. 119.

Tuck, L.K., 2001, Reconnaissance of arsenic in surface and ground water along the Madison and Upper Missouri Rivers, southwestern and west-central, Montana, United States Geological Survey, Water-resources investigations report 00-4028, p. 79

Warren , K., Bobst, A., Swierc, J., and Madison, J.D., 2012, Hydrogeologic investigation of the North Hills study area, Lewis and Clark County, Montana, Interpretive report, Montana Bureau of Mines and Geology, Ground water investigation program, Open-file report 610.

Attachment 1: Surficial Geology Map



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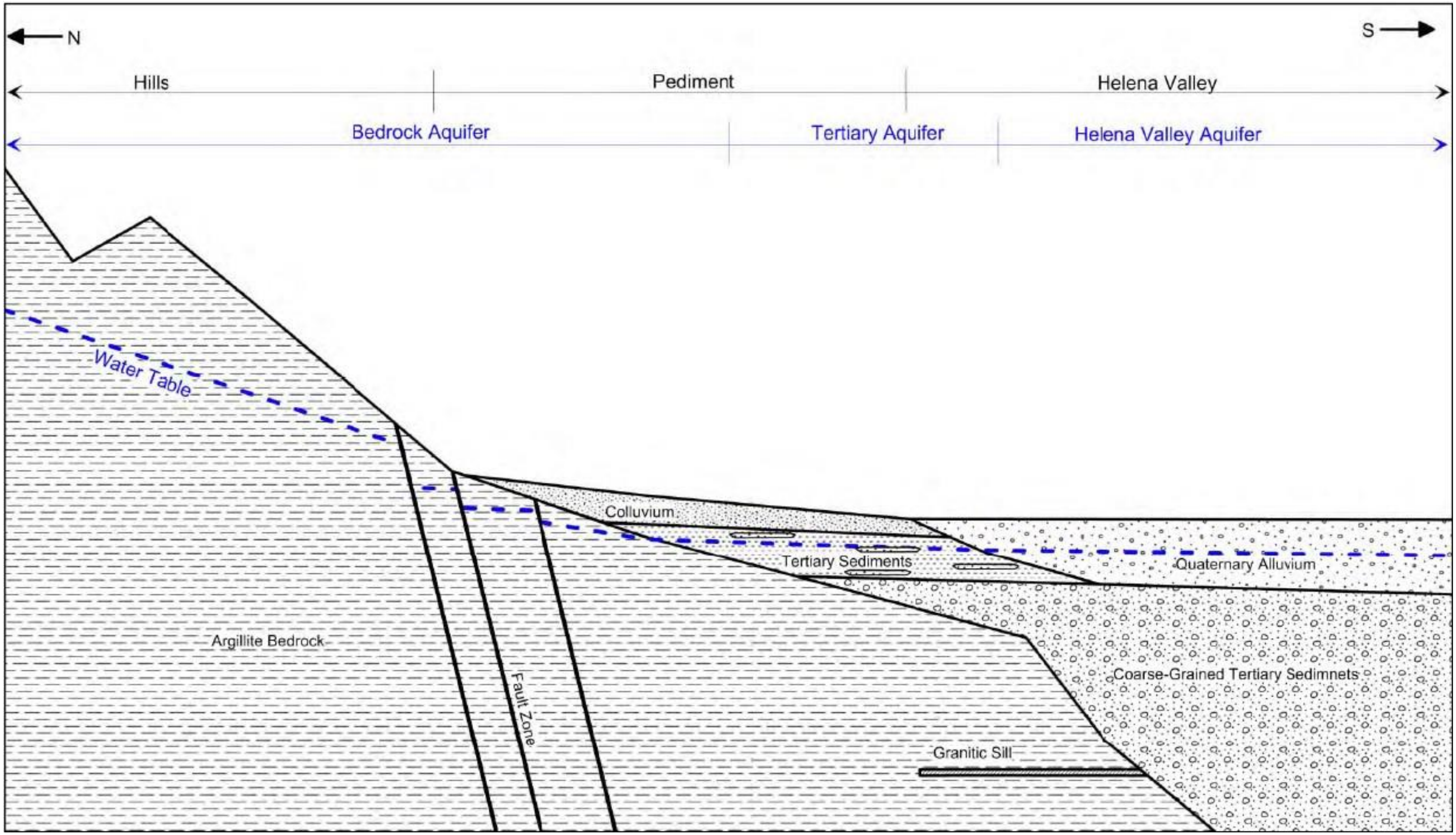
Attachment 2: Geologic cross section



Source: Waren et al., 2012, Figure 10

6

Water Quality Protection District
LEWIS AND CLARK COUNTY, MT

1930 9th Avenue, Helena, MT 59601
(406) 457-8584

MEMORANDUM

Date: June 26, 2026
To: Lindsay Morgan, *Lewis and Clark County Community Development and Planning*
Cc: Jennifer McBroom, *Lewis & Clark County Water Quality Protection District*
From: Kegan McClanahan, *Lewis & Clark County Water Quality Protection District*
Reference: Grey Rock Subdivision

The Lewis and Clark County Water Quality Protection District (LCCWQPD) provides the comments and recommendations as a nonregulatory agency. The comments and recommendations in this document are provided to help property owners be aware of, and understand, their water resources. If anyone has any questions, please contact me at (406) 457-8927 or KMcClanahan@LCCountyMT.gov.

Overview of Development

The proposed Grey Rock Subdivision (Development) is located northeast of the intersection of Valley Drive and Canyon Ferry Road (Attachment 1). The Development will consist of 33 lots across 20.04 acres. Of the 33 lots, 32 are designated for single family residences, and 1 lot is designated for a community wastewater treatment system. Lot sizes range from 0.46 acres to 2.44 acres. The wastewater treatment system is located on 2.11 acres. All residences will be served potable water by individual wells or multi-user water systems.

Local Hydrogeology

The Helena Valley is underlain by the valley-fill aquifer which is composed of a thick sequence of clays and silts with interbedded sand and gravel lenses. The clays and silts are laterally discontinuous such that the sands and gravels act as a single complex aquifer body. The valley-fill aquifer exhibits a high degree of horizontal hydraulic conductivity through the sands and gravels. The hydraulic conductivity is estimated to be 200 feet per day with groundwater flow generally to the north, toward Lake Helena (Briar and Madison, 1992).

The high hydraulic conductivity of the valley-fill aquifer allows for high production wells; however, the high hydraulic conductivity can also allow contaminants to quickly infiltrate into the groundwater and move through the aquifer. The combination of high hydraulic conductivity and shallow groundwater means the groundwater is highly susceptible to surface contaminants (Briar and Madison, 1992).

Water Quantity Concerns

The LCCWQPD monitors the depth to groundwater in 4 wells surrounding the Development (Attachment 1). A hydrograph showing the long-term depth to groundwater for each well is also included (Attachment 2). The groundwater surrounding the Development averages between 30 and 75 feet below ground surface, and the depth to groundwater has remained relatively consistent over the past 20 years, with an average drop in the groundwater level of 0.65 feet per year.

Seasonally, the groundwater fluctuates up to 20 feet between the peak of recharge and the end of irrigation season. Depending on the time of year that wells are drilled, the depth to groundwater at the time of drilling may not be the seasonal low. This could lead to wells being drilled to shallower depths and increasing the risk of property owners needing to drill new wells in the future.

The Development is located near the main Helena Valley Irrigation District (HVID) canal and a lateral. During the irrigation season (May through October), the canal and lateral provide additional groundwater recharge to the local aquifer through infiltration. This causes the groundwater level to peak in the late summer/fall and then drop throughout the winter. The HVID is pursuing a long-term project to line the laterals with an impermeable material which will severely reduce the amount of recharge into the aquifer. A long-term effect of this is likely to be a lowering of the groundwater level in the aquifer.

Water Quality Concerns

Water quality contaminants of concern come from both local sources within the Helena Valley and from the surrounding bedrock aquifers at the margins of the Helena Valley. Thamke (2000) studied the bedrock aquifers surrounding Helena and concluded that significant volumes of water from the surrounding bedrock recharge the valley-fill aquifer underlying the Helena Valley.

Nitrate is a common contaminant in groundwater due to the abundance of septic systems and fertilizer application within and adjacent to the Helena Valley (Briar and Madison, 1992; Thamke, 2000). The United States Environmental Protection Agency (USEPA) has established a safe drinking water limit of 10mg/L nitrate (as nitrogen) for public drinking water systems. Over time sources and concentrations of nitrate can change due to land uses changes or septic system deterioration.

There is a significant presence of volcanic bedrock surrounding the Helena Valley. The volcanic bedrock, typically granites and granodiorites, can contain naturally high levels of uranium as well as decay products of uranium, such as radon (Caldwell et al., 2014). Additionally, arsenic naturally occurs in the local bedrock. Groundwater and surface water can transport the arsenic into the Helena Valley. The Missouri River mobilizes arsenic from the bedrock and introduces it to the Helena Valley via the Helena Valley Irrigation District’s canal network (Tuck, 2001). Arsenic can then infiltrate into the groundwater in the Helena Valley thus posing a risk to human health.

Recommendations

The LCCWQPD recommends the following:

- Regular water quality testing. It is recommended to test for nitrates and total coliform bacteria (common contaminants with septic systems) on an annual basis. It is also recommended to test for arsenic and uranium every 3-5 years. The LCCWQPD has water quality test kits for these contaminants at our office (1930 9th Avenue, Helena, Montana, 59601).
- Drilling new groundwater wells to depths well below the seasonal low of the groundwater level (late summer/fall). If it is economically feasible, it is recommended to drill new wells an additional 30-50 feet below the seasonal low. If the nearby HVID lateral is lined, the groundwater recharge from the lateral will be severely reduced. This will likely cause the groundwater level to drop. Drilling the wells deeper will maximize the life-span of each well and minimize the need to drill a new well deeper in the distant future, thereby saving the property owners money.

Attachments

Attachment 1: Aquifer Map
Attachment 2: Graph of Depth to Groundwater

References

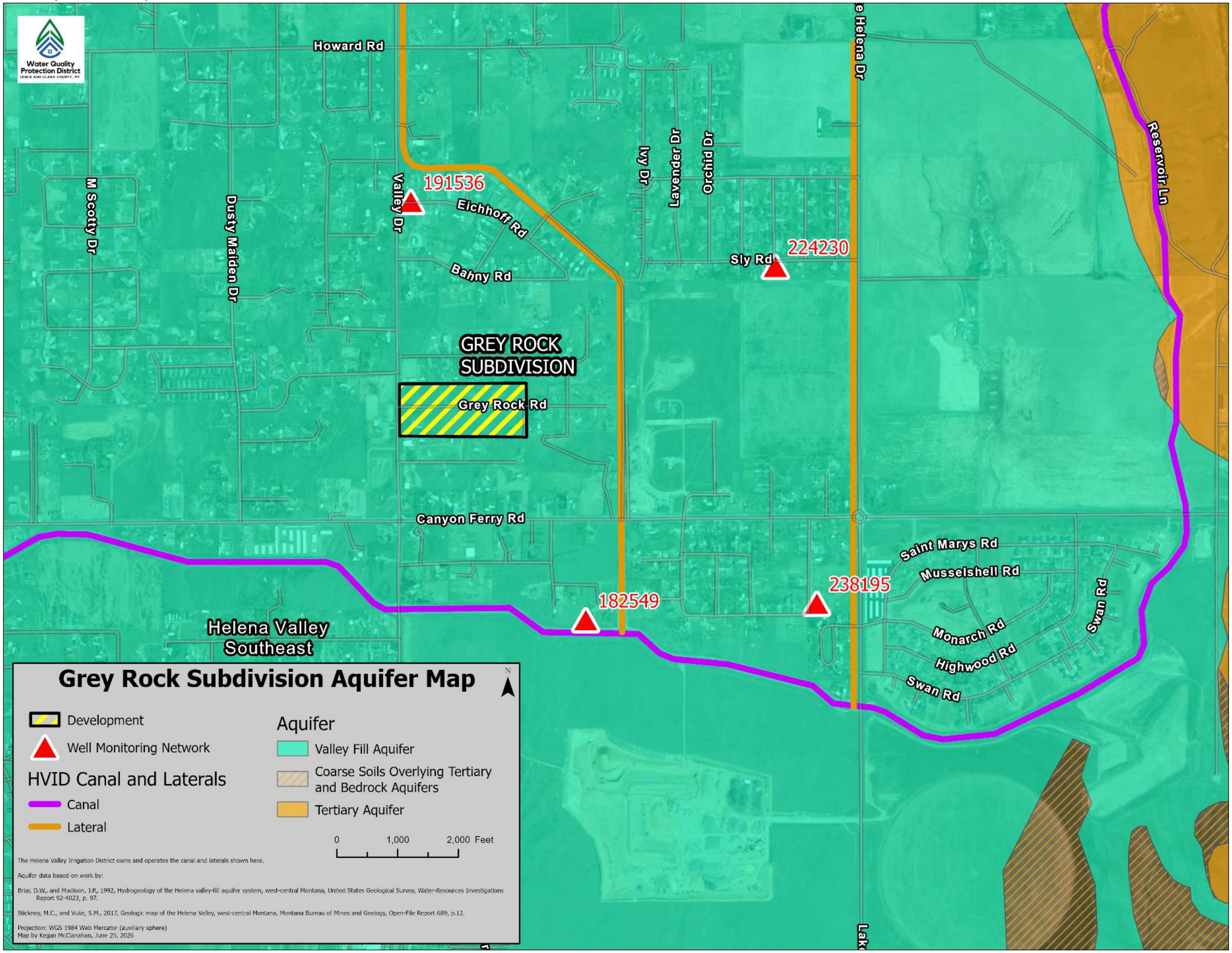
Briar, D.W. and Madison, J.P. 1992, Hydrogeology of the Helena Valley-fill aquifer system, west-central Montana, United States Geological Survey, Water-Resources Investigations Report 92-4023, p. 92.

Caldwell, R.C., Nimick, D.A., and DeVaney, R.M., 2014, Occurrence and hydrogeochemistry of radiochemical constituents in groundwater of Jefferson County and surrounding areas, southwestern Montana, 2007 through 2010, United States Geological Survey, Scientific investigations report 2013-5235, p. 76.

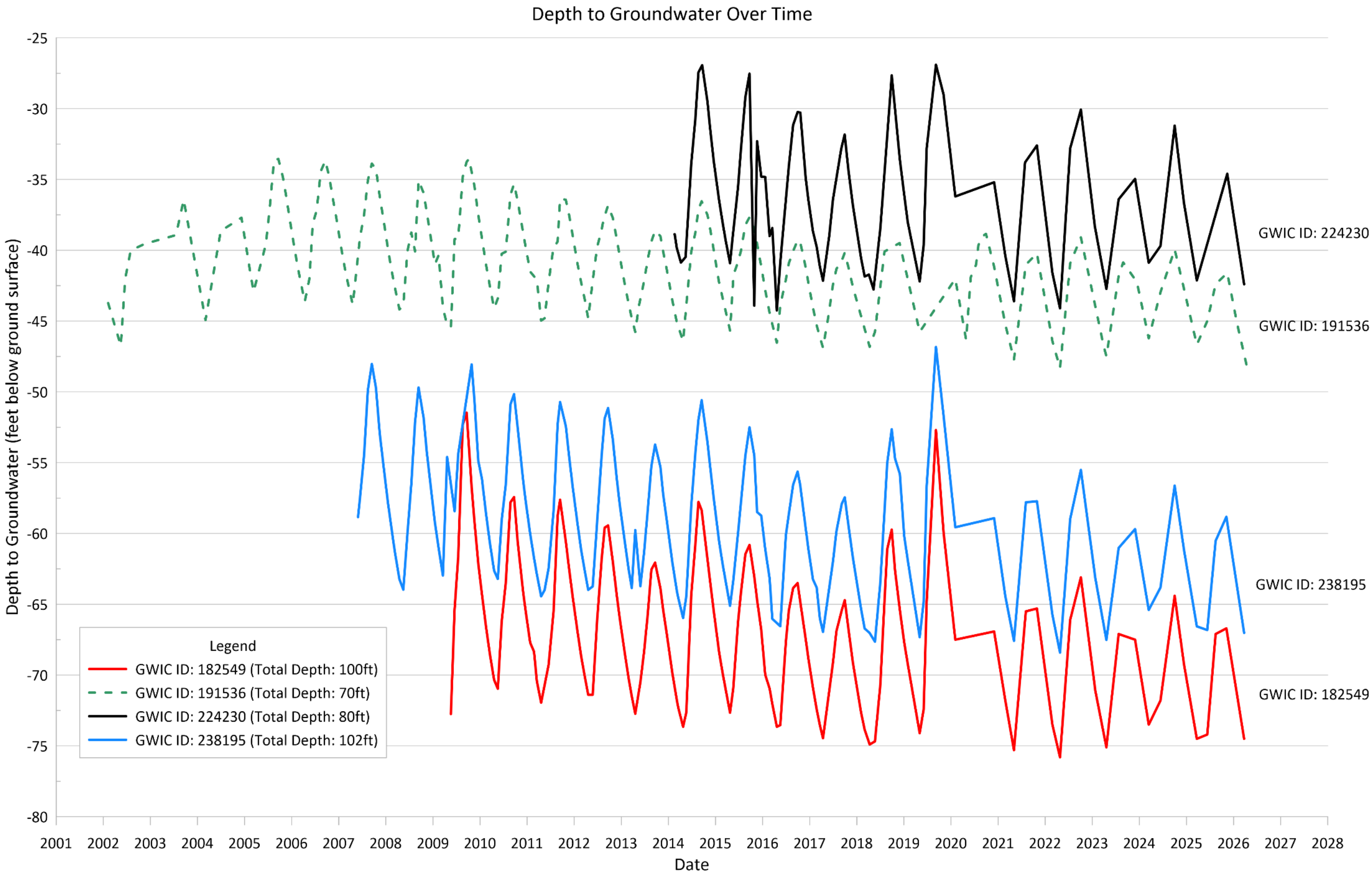
Thamke, J.N., 2000, Hydrology of the Helena area bedrock, west-central Montana, 1993-98, with a section on geologic mapping and a generalized bedrock geologic map by Mitchell W. Reynolds, United States Geological Survey Water: Water-resources investigations report 00-4212, p. 119.

Tuck, L.K., 2001, Reconnaissance of arsenic in surface and ground water along the Madison and Upper Missouri Rivers, southwestern and west-central, Montana, United States Geological Survey, Water-resources investigations report 00-4028, p. 79.

Attachment 1: Aquifer Map



Attachment 2: Hydrograph of the long-term depth to groundwater.



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LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	Agenda Item No.
July 28, 2026	**7**

__Minutes _X_Board Member Discussion __Staff & Other Reports __Action __Hearing of Delegation

AGENDA ITEMS: Board Member Round Robin

PERSONNEL INVOLVED: Board members

BACKGROUND: Updates from board members on other community groups

_X_ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
S. Ohs-Mosley						
C. Payne						
A. Johnson						
D. Dahl						

NOTES:

July 14, 2026

To: Lewis and Clark County Water Quality Protection District Board

From: Edward Kerins, Chairman

During our board meeting on July 28, 2026 we hope we can finalize the Strategic Plan for the next three years. This is a necessary process for us to fulfil a component of our governance responsibilities.

This governing board was appointed and approved by elected officials and therefore is ultimately accountable to these officials and the public. It is the affirmative duty of the board to ensure that the Water Quality Protection District is maintained in a manner that supports the projected growth of the community. Because we are accountable to the customer base, we must ensure that management maintains an efficient operation that provides the best service at the most reasonable cost to the community. We must set the policies that the management must follow. Because we are not involved in the day-today activities of the district, we must rely on management's suggestions for many of the policies. We must have a procedure to monitor the progress towards the goals we have established in our policies.

I am hoping that you will take some time, before the meeting, to review the work we have done on the Strategic Plan and come prepared to finalize and approve the initial plan at our meeting.

Thank you for all your time and efforts.

Sincerely,

Ed Kerins

LEWIS & CLARK COUNTY
WATER QUALITY PROTECTION DISTRICT
Helena, Montana

BOARD AGENDA ITEM

Meeting Date	**Agenda Item No.**
July 28, 2026	**8**

___Minutes __X__Board Member Discussion ____Staff & Other Reports ___Action ___Hearing of Delegation

AGENDA ITEMS: Public Comment

PERSONNEL INVOLVED: Public and Board Members

BACKGROUND: Time is allowed for public comment on matters within the Water Quality Protection District's boundaries not mentioned on the agenda.

RECOMMENDATION: n/a

___ADDITIONAL INFORMATION ATTACHED

BOARD ACTION:

	MOTION	SECOND	AYE	NAY	ABSTAIN	OTHER
D. Hammer						
P. Johnson						
E. Kerins						
R. Leland						
A. Johnson						
C. Payne						
S. Ohs-Mosley						
D. Dahl						

NOTES:

Attendance Record for the
Lewis & Clark County Water Quality Protection District
FY 2026

Board Member	Jul	Aug	Sep	Oct	Dec	Jan	Feb	Mar	Apr	May	Jun
P. Johnson	T	X	*	X	X	X	X	X	X	X	X
E. Kerins		Xp	*	X	X	OE	X	Xp	X	X	X
D. Hammer		O	*	X	Xp	Xp	O	Xp	X	X	X
R. Leland	T	O	*	X	X	X	X	OE	X	Xp	OE
A. Johnson	T	X	*	X	X	X	X	X	X	X	Xp
T. Rolfe	T	X	*	X	X						
S. Ohs-Mosley	T	X	*	X	X	X	O	X	X	X	X
C. Payne						X	X	X	OE	OE	X

Legend:
X = Present
Xp = By phone/video
* = No meeting held
O = Absent
OE = Absent/Excused
T = Tour

Commissioner Candace Payne — Representing the Board of County Commissioners
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Email: cpayne@lccountymt.gov

Don Dahl — Representing the East Helena City Council
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Vacant — Representing the L & C Conservation District

Ryan Leland — Representing the Helena City Commission
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Sheri Ohs-Mosley — Representing the Board of Health
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Patrick Johnson — Term ends 06/30/27 – General Public 2nd Term
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(406)465-3428 (C)
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Adel Johnson, Vice Chair — Term ends 06/30/26 – General Public 1st Term
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Lewis and Clark County
Water Quality Protection District

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MEETING DATES FOR FISCAL YEAR 2027

July 28, 2026

August 25, 2026

September 22, 2026

October 27, 2026

December 1, 2025

January 26, 2027

February 23, 2027

March 23, 2027

April 27, 2027

May 25, 2027

June 22, 2027

All board meetings are held in room 72 of the Murray Building- Lewis and Clark Public Health, 1930 Ninth Ave, Helena, Montana and via Zoom at 4:00 p.m. The meetings are generally completed by 5:30 p.m. The public is always welcome to join and meeting.

For Your Information

Lewis & Clark City-County
Water Quality Protection District
316 North Park
Helena, MT 59601

Water Quality
Protection District
LEWIS AND CLARK COUNTY, MT

SURFACE WATER SAMPLE COLLECTION STANDARD OPERATING PROCEDURE

(F04)

DATE OF ISSUE: 07/06/2026

REVISION: 1.1

	Hydrogeologist	07/06/2026
PREPARED BY	TITLE	DATE
APPROVED BY	TITLE	DATE

Revision History

The following table records any and all modifications to this document. Following any modification to this document, the Water Quality Protection District Supervisor must approve before the modifications are effective.

Date	Individual	Section(s) Modified	Comments
10/03/2024	MCCLANAHAN, KEGAN	ALL	DOCUMENT CREATED
07/06/2026	MCCLANAHAN, KEGAN	8.0, 9.0	ADDED FILTERED SAMPLES, COMBINED FLOWING AND NON-FLOWING SITE PROCEDURE

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1.0 SCOPE AND APPLICABILITY

This procedure applies to collecting geochemistry and stable isotope samples from surface water bodies. Samples may be collected from flowing and stagnant water for non-regulatory purposes.

2.0 SUMMARY OF METHOD

Sample collection sites are selected based on the investigation objectives and data quality objectives. Samples are collected in method-analyte specific containers. Sample collection water depth is based on data quality objectives and representativeness. Samples are then preserved and transported to a state-certified laboratory for analysis.

3.0 DEFINITIONS, ACRONYMS, AND UNITS

Definitions

Data Validation	Data validation is "an analyte and sample-specific process that extend the evaluation of data beyond method, procedural, or contractual compliance…" (U.S. EPA 2002, Section 3.1).
Data Verification	Data verification is "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements" (U.S. EPA 2002, Section 2.1).
Eddy	Circular current of water.
Laminar flow	Flow regime in which water particles move in straight paths and are not affected by the movement of neighboring particles.
Turbulent Flow	Flow regime in which water particles velocities are continuously changing in all directions.

Acronyms

QA	Quality assurance
QC	Quality control
USGS	Unites States Geological Survey
WQPD	Water Quality Protection District

Units

<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
µg/L	micrograms per liter
CFS	cubic feet per second
CFU/mL	colony forming units per milliliter
ft	feet
mg/L	milligrams per liter
MPN/100mL	most probable number per 100 milliliters
NTU	nephelometric turbidity units
pCi/L	picocuries per liter
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
Q	discharge, in cubic feet per second
s	second (time)
S.U.	standard units
δ	lowercase Greek delta. Used to denote stable isotopes.

4.0 HEALTH AND SAFETY

Working in and around surface water bodies involves inherent dangers associated with the natural environment. Conditions may include but are not limited to, uneven terrain, inclement weather, extreme heat and cold, electrical hazards, and potentially dangerous wildlife. Snakes, spiders, and insects commonly inhabit the vegetation surrounding bodies of water and the fields used to access them. If anyone is bitten, scratched, or stung by wildlife, seek medical attention immediately.

Weather conditions range from extreme heat in the summer to extreme cold in the winter. Field personnel must dress appropriately for the weather. Summer conditions can expose field personnel to sunburn and heat exhaustion / heat stroke while winter conditions can cause hypothermia and frostbite. High winds are also common in the WQPD. Personnel must be cautious of airborne debris that could cause bodily harm.

Accessing a water body may require personnel to traverse fences. Be aware of electrified fencing and if the fencing is energized. Do not assume it is de-energized even if it was recently crossed. When in doubt always request the property owner provide an alternative route to the well or confirm the fencing is de-energized. Electrical shock can cause serious and life-threatening bodily harm. Electrical current causes muscle contractions which can cause a person's hand to grip the source of electricity, preventing the person from letting go which severely increases the exposure and likelihood of fatal effects.

While the streams in the Helena valley are not as large as those in other parts of the country, flash flooding is always a possibility. Storm systems commonly move through the area rapidly and only impact certain areas of the valley or surrounding mountains. This means that field personnel may not experience any precipitation, but upstream reaches may. This can lead to flash floods. Field personnel should always be cognizant of the surrounding weather conditions and stream flow. If stream flow begins to rapidly increase, evacuate the area immediately and seek high ground. Do not enter a stream if the depth and/or flow velocity are too high to do so safely.

When working in and around streams, personnel may encounter unstable rocks or substrate. This can cause a person's balance to be compromised resulting in a fall. Streambeds often include cobbles and boulders that can cause serious physical injury during a fall. Additionally, the wide range of temperature conditions means the water temperature can be dangerously cold even during warm days. If personnel are exposed to cold water, especially if clothing becomes wet, halt field activities and seek warm dry clothes immediately. Do not underestimate the impact of cold water on the human body.

Personal Protective Equipment

- Nitrile gloves
- Safety goggles
- Close-toed footwear
- Long pants that cover the ankle
- Hair tie to keep long hair secured away from the face

5.0 CAUTIONS

Personnel must avoid causing damage to landowner property while accessing streams. It is common to cross fields, fences, and gates to access streams. Vehicles can cause ruts during muddy or snowy conditions and can lead to fires if driven over extremely dry vegetation. When cross fences and gates, avoid damaging wire strand fencing, loose fence posts, or gate hinges.

Samples must be representative of the environmental conditions. Site selection to avoid bias is critical. Surface water can often become stratified with respect to numerous parameters including but not limited to, temperature, dissolved oxygen, salinity, inorganic carbon, and solids. Failure to account for this can lead to an inherent bias in the samples and invalidation of results.

Sample integrity relies on samples preservation promptly following collection. Samples may contain volatile fractions that can be lost if samples are not physically and chemically preserved. Environmental factors including, but not limited to, inclement weather, high winds, extreme high/low temperatures, and fire smoke can impact samples during the collection process. Be aware of local environmental conditions and take appropriate steps to mitigate potential impacts.

Environmental factors including but not limited to, inclement weather, high winds, extreme high/low temperatures, and fire smoke can impact samples during the collection process. Be aware of local environmental conditions and take appropriate steps to mitigate potential impacts.

Table 1: Common environmental factors that could influence/bias sample collection.

Environmental Factor	Recommended Action
Inclement weather	If possible, avoid field work on days with anticipated inclement weather. If this is not possible, shield field equipment and sampling operations under a shelter (e.g. tent or within a vehicle) to protect equipment and personnel.
High winds	Adjust the location of the work site to put a barrier upwind of the equipment. This can be accomplished using a building or vehicle.
Extreme high/low temperature	Sample temperature may be impacted by extreme atmospheric temperatures, so it is recommended to insulate sample tubing and other equipment. Be cautious of the impact of temperature on volatile sample fractions – under higher temperatures there is an increased risk of losing the volatile fraction. More importantly, field personnel should wear appropriate clothing and utilize any shelters possible to mitigate temperature extremes on their bodies. Be aware of the symptoms of a heat stroke. When conducting field work in extreme heat field personnel should hydrate frequently and utilize any shade possible. When working in extreme cold, field personnel must be wearing appropriate clothing and limit skin exposure to avoid frostbite and hypothermia.
Fire smoke	If extensive smoke is present due to forest fires, avoid sampling carbon-sensitive analytes (Volatile Organic Compounds, total organic carbon, etc.) as the smoke could contaminate the sample vial during sample collection.

6.0 INTERFERENCES

Before collecting samples there are numerous considerations to be made to ensure that samples are representative of the water body. The following considerations and guidance are adapted from the USGS National Field Manual, Chapter A4 (United States Geological Survey, 2006). These considerations are not all inclusive and rely on field personnel experience and knowledge to minimize potential bias while sampling.

- When sampling with bottles there can be substantial error if the target analytes are sorbed onto suspended solids that are not uniformly distributed in the water column.
- There are numerous air-water interactions occurring at and near the water surface. These interactions can bias samples collected at the surface.
- Stream beds consisting of fine silt and clay particles can often become anoxic environments. Samples collected near the stream bed can be biased by these environments.
- Riparian vegetation can alter water chemistry, so it is recommended to avoid areas of high vegetation growth.
- Stagnant water can become stratified with respect to salinity, temperature, or chemical contaminants leading to sample bias if samples are not collected at a uniform depth.

7.0 PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

Field personnel must be familiar with basic surface water hydrology, sample collection, chemical safety, and field data entry.

8.0 EQUIPMENT AND SUPPLIES

Equipment

- YSI ProDSS water quality meter (with pH, specific conductivity/temperature, and dissolved oxygen sensors installed)
- Waterproof footwear (waders, tall boots, etc.)
- Cooler with ice

Supplies

- Sample containers (supplied by laboratory)
- 1000mL glass container (for volatile sample collection)
- When filtering:
  - 47mm 0.45µm filters
  - 47mm 0.2µm filters

    - 47mm filter holder
    - 60mL syringe (2)
    - 1000mL HDPE wide-mouth container (2)

Reagents

- Sample preservatives (typically supplied with sample containers from laboratory)
- Decontamination supplies (see standard operating procedure *(F07) Decontamination of Field Equipment*)

Personal Protective Equipment

- Nitrile gloves
- Safety goggles
- Close-toed footwear
- Long pants that cover the ankle
- Hair tie to keep long hair secured away from the face

9.0 PROCEDURE

Surface water sampling requires field personnel to understand the data objectives to properly assess sample sites and sampling methodologies. Sample collection is performed on both flowing-water (streams) and stationary-water (lakes) sites.

9.1 Site Selection

In most situations, a single surface water sampling location is insufficient to adequately characterize the physiochemical conditions. The location, distribution, and number of sites can significantly affect the quality and usefulness of the resulting data. Consider the following when selecting sites:

- Be aware of the objectives, data quality needed, and sampling methods.
- Review all historical information.
- Land use, geomorphology, geology, point and non-point sources of contamination, and fluvial-sediment transport.
- Aquatic and terrestrial biological characteristics

9.1.1 Flowing Water Sites

Flowing water sites refer to streams, irrigation canals, ditches, and conduits that exhibit unidirectional flow. Flowing-water sites are ideally located:

- Proximal to a stream gaging station.
- Along straight reaches that exhibit uniform flow.
- Sufficiently above or below confluences to avoid mixing zones or point sources of contamination.

- Upstream of bridges or industrial outflows to avoid contamination (unless this is part of the study design).
- Away from eddies.
- Proximal to locations where other data are collected.
- At cross sections that allow sample collection at a wide range of stage conditions.
- At cross sections that allow for sampling at one-half the depth of the stream to minimize air-water interface interferences without disturbing sediment along the stream bed (unless analytes are non-polar and must be sampled from the surface of the water such as oil and grease).

9.1.2 Stationary Water Sites

Stationary-water sites refer to ponds, lakes, swamps, reservoirs, and other water bodies that do not exhibit unidirectional flow. Stationary-water sites are ideally located:

- Away from structures such as boat ramps, piers, and bridges unless these features are part of the study design.
- Where historical data are available.

Finer sediments may take a substantial amount of time to settle out in water with minimal movement. This means field personnel can easily mobilize sediments and contaminants and bias samples. Personnel should avoid disturbing sediments as much as possible to minimize sampling bias.

9.2 Sample Collection

The WQPD conducts surface water sampling using the USGS Dip Sampling Method (United States Geological Survey, 2006). The sample containers are filled underwater at approximately half the depth. This is to minimize biasing the sample from air-water interactions, riparian vegetation, and mobilized sediment.

Field personnel should take care to minimize any disturbance to the sampling site. Walking along the stream bed can mobilize contaminants and sediment that have settled. When possible, approach the sample site from downstream. If stream conditions do not allow field personnel to safely enter the stream, samples should be collected from as close as possible to the main flow path.

9.2.1 Non-Volatile Samples

Non-volatile samples comprise the most common analytes. Samples are collected by lowering the sample container into the water and removing the cap underwater. This allows field personnel to sample water at a specific depth and avoid potential interferences.

1. Deploy the YSI ProDSS field meter into the flowing water downstream of the sampling location. The probes should be as close to the center of flow as possible to gather the most representative data.
2. Document the collection date and time on the chain of custody.
3. Label the sample bottle. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:
    a. Lewis and Clark County – WQPD
    b. Project name
    c. Collection date and time
    d. Site name
    e. Sample ID (YYYYMMDD_Site ID)
    f. Analysis requested
4. Approach the sample site while minimizing any disturbances to the site. Stand downstream of the sample collection location.
5. For most analytes that are distributed throughout the stream, lower each sample container into the water until it is approximately at 50% of the water depth. If sampling for analytes less dense than water (e.g. oil and grease), collect the sample at the surface of the water.
6. Remove the cap and allow the container to fill.
7. Rinse each container 3x with a small amount of sample water. Discard the rinsate downstream of the sample location.
8. After rinsing the container, replace the cap and lower the container into the water until it is approximately at 50% of the water depth.
9. Remove the cap and allow the container to fill.
10. Replace the cap underwater.
11. Repeat this process for each container. If sediment is mobilized, wait until the turbidity returns to baseline conditions before collecting subsequent samples.
12. Collect the field measurements from the YSI ProDSS.

9.2.2 Volatile Samples

Volatile samples such as volatile organic compounds (VOCs) require samples be collected without any headspace. The absence of headspace (atmosphere) keeps the volatile compounds dissolved in the sample which drastically improves analyte recovery during analysis. Any headspace in the sample container can allow the volatile compounds to not be analyzed by the laboratory.

1. Deploy the YSI ProDSS field meter into the flowing water downstream of the sampling location. The probes should be as close to the majority of flow as possible to gather the most representative data.

2. Document the collection date and time on the chain of custody.
3. Label the sample bottle. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:
    a. Lewis and Clark County – WQPD
    b. Project name
    c. Collection date and time
    d. Site name
    e. Sample ID (YYYYMMDD_Site ID)
    f. Analysis requested
4. Approach the sample site while minimizing any disturbances to the site. Stand downstream of the sample collection location.
5. Rinse a 1000mL glass sample container 3x in the stream water.
6. Submerge the 1000mL glass sample container with the lid sealed into the stream to approximately 50% of the water depth.
7. Remove the lid and point the container upstream to allow it to fill completely with water.
8. Reinstall the lid to seal the container.
9. Carefully transfer the sample water from the 1000mL container to the final 40mL glass vials for the VOC samples.
10. Overfill each 40mL vial until an inverse meniscus forms on the top of the vial.
11. Cap the vial and gently invert 3x to check for any residual air pockets in the sample. If any air remains in the vial, add additional sample to the vial and retest for air.
12. Repeat this process for each container. If sediment is mobilized, wait until the turbidity returns to baseline conditions before collecting subsequent samples.
13. Collect the field measurements from the YSI ProDSS.

9.2.3 Filtered Samples

Samples collected for standard geochemical parameters (nutrients, metals, organics, solids, etc.) that are analyzed at a local drinking water laboratory are not field filtered. It is generally more cost effective to pay the laboratory a small fee to have their staff filter the samples as needed. However, there are times when samples must be field filtered. This is common with stable isotope samples that are shipped to an out-of-state lab. These samples are not chemically preserved, so the field filtering acts as the only preservation method. Most stable isotope samples are filtered to 0.2μm.

1. Document the collection date and time on the chain of custody.
2. Label the sample bottle. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:
    a. Lewis and Clark County – WQPD
    b. Project name

    c. Collection date and time
    d. Site name
    e. Sample ID (YYYYMMDD_Site ID)
    f. Analysis requested
3. Triple rinse the 1000mL wide-mouth HDPE container with sample water.
4. Submerge the 1000mL glass sample container with the lid sealed into the stream to approximately 50% of the water depth.
5. Remove the lid and point the container upstream to allow it to fill completely with water.
6. Reinstall the lid to seal the container.
7. Using water from the 1000mL HDPE container, triple rinse the syringe with sample water.
8. Unscrew the blue filter holder locking ring (Figure 3).

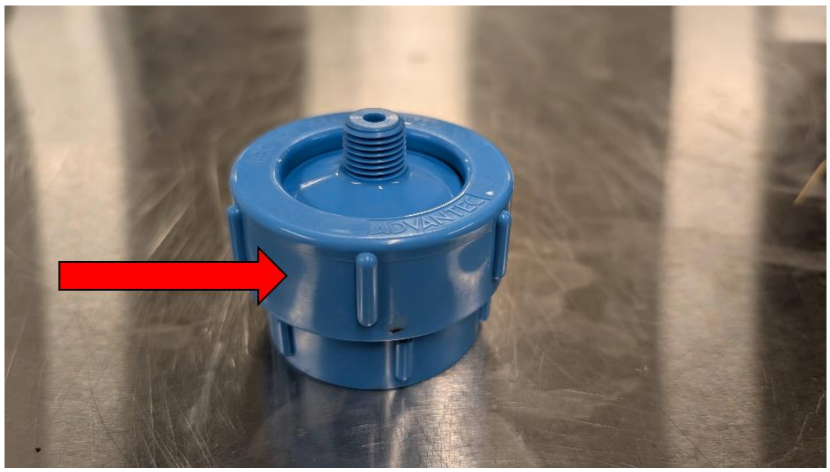

Figure 3: The outer locking ring holds the filter assembly together.

9. Separate the two halves of the filter holder (Figure 4).

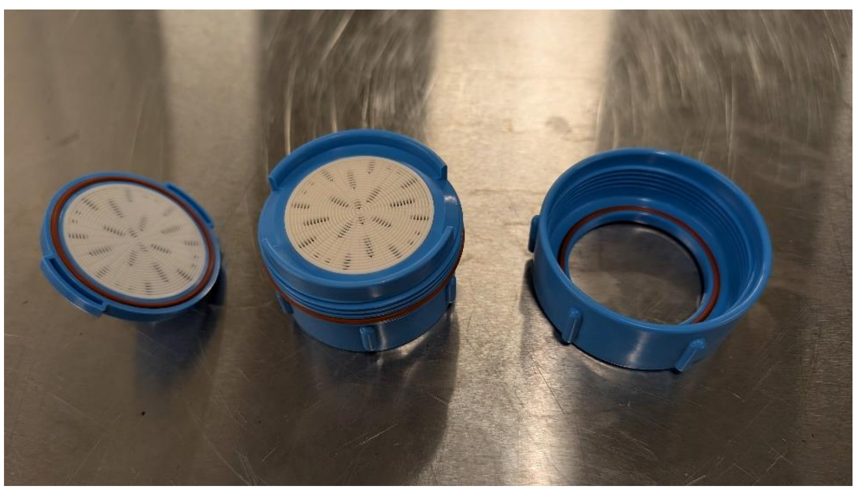

Figure 4: The filter assembly comes apart into three pieces: the main body, cap, and locking ring.

10. Place a filter (not the paper that separates each filter) in the filter holder and reassemble the filter holder. Be sure not to damage any of the o-rings.
11. Fill syringe with sample water from the 1000mL HDPE container and insert the tip of the syringe into the filter holder (Figure 5).

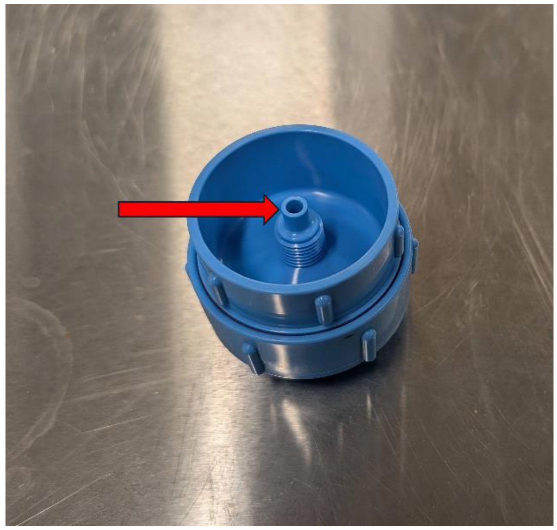

Figure 5: The port on the bottom of the filter holder accepts a standard 60mL syringe tip. Be careful to avoid damaging the syringe and filter holder when inserting the syringe.

12. With firm steady pressure push the water through the filter into the final sample container.

Do not use excessive force on the syringe as this can rupture the filter, rupture the filter holder seals, or break off the syringe tip. If unfiltered water is introduced into the final sample container, the filtered water must be thrown out and filtered re-started.

13. Repeat steps 6-10 to continue filling the final sample container.
14. If the sample contains high suspended solids (or it is below freezing) the filter may clog. Replace the filter as needed to avoid needing excessive force when filtering.

When filtering water with high suspended solids down to 0.2µm, it may be beneficial to split the filtering into two phases. Using two HDPE sample containers, filter the raw water to 0.45µm from the initial HDPE container into the second HDPE container. Once a sufficient volume of raw water is filtered to 0.45µm, filter the 0.45µm filtrate down to the final 0.2µm in the final sample container.

9.4 Sample Preservation and Transport

All water samples must be preserved immediately following collection to ensure representativeness and integrity. Samples requiring a chemical preservative have the preservative added as soon as safely possible after collection. Due to environmental and personal safety, chemical preservatives may not be added directly at the sample site to avoid accidental release of hazardous materials. In this situation, preserve samples as soon as safely possible.

All samples are promptly chilled to approximately 6°C (unless otherwise specified by the analytical method) for transport to the laboratory.

Samples are transported to the project laboratory in person, generally on the same day as samples are collected, or within 24 hours of sample collection. If samples are shipped to the project laboratory (e.g. isotopes), the samples are packaged in an ice-packed cooler along with the CoC and delivered to the shipping courier within 24 hours of collection. Shipping times depend on hold times of the samples, but the minimal shipping time within project funding is preferred.

9.5 Sample Analysis

All water quality samples are analyzed by a Montana Department of Public Health and Human Services (DPHHS) certified laboratory. The three laboratories located in Helena, Montana are Alpine Analytical, DPHHS Environmental Laboratory, and Energy Labs-Helena. Samples are analyzed using the laboratory's approved methodologies for each analyte and reported using standard formats. If a specific method is required to meet detection limits or other data objectives for a project, discuss this with the laboratory prior to sample collection. Any method/reporting requirements should be noted on the CoC before sample receipt by the laboratory.

10.0 DATA AND RECORDS MANAGEMENT

During sample collection the sample collector is responsible for completing the laboratory's chain of custody documentation. At the conclusion of field work, the original field sheet and a copy of the chain of custody (original stays with the laboratory) are placed in file storage. The field sheet data are then added to a digital spreadsheet for future data processing pursuant to the overall project.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Prior to field work, the YSI ProDSS multi-parameter field meter must be calibrated and decontaminated according to the respective SOPs.

All water samples (excluding isotope samples) have a USEPA regulated hold-time. The hold-time is the length of time between the completion of sample collection and the beginning of analysis at the laboratory. Due to the hold-time restrictions on many analytes being short (24 hours or less), samples should be collected early enough in the day so that there is sufficient time to transport/ship all samples to the laboratory the same day as collection. It is also recommended to collect samples early in the work week to avoid weekends as many laboratories increase costs or do not receive samples over the weekends.

All water samples are placed into an ice-packed cooler for transport immediately after collection. Proper chain of custody (CoC) documentation is completed at the time of collection and accompanies all samples until they are delivered to the laboratory.

Additional samples for quality control are collected alongside project samples to document the sterility, cleanliness, and reproducibility of sample results. The following quality control samples are collected at a minimum during projects. If there are concerns of contamination during sample collection, additional quality control samples may be collected to document any potential sources of contamination to the samples.

It is recommended to keep samples anonymous from the laboratory to prevent any possible analytical bias. To do so, the field sampler can document each sample as "Sample 1, Sample 2, etc." while keeping a separate list documenting the sample locations and identities.

Sample Duplicate

A sample duplicate is an additional sample container collected at the same time and location as the original. The sample duplicate undergoes the same treatment as the original sample. The purpose of this sample is to verify the reproducibility of the sample collection. A minimum of 1 duplicate is required for each batch of 10 samples.

Table 2: Required number of duplicate samples based on the number of unknown samples collected.

Number of Unknown Samples	Number of Sample Duplicates Required
1-10	1
11-20	2
21-30…	3…

Field Blank

A field blank is a sample container that has undergone the same treatment as all other sample containers. A field blank sample is collected with each sampling event and the collection procedure is identical to all other environmental samples including triple rinsing and filtering. Field blanks typically provide a holistic view of the sample collection process, rather than individual steps. If there are concerns over individual sample collection steps introducing contamination or bias into the samples, field blanks can be collected at the field site that represent each step of the process (e.g. filter blank, pump blank, bailer blank, etc.).

Equipment Blank (Rinsate Blank)

An equipment/rinsate blank is collected to document if the equipment (pumps, tubing, filters, etc.) are properly decontaminated between samples. If any cross-contamination occurs between samples due to insufficient decontamination procedures, the equipment/rinsate blank will highlight this. Equipment blanks are collected by passing analyte-free reagent grade water through all the same sample collection steps as environmental samples. The equipment blank is collected in an appropriate sample container with the appropriate preservative. One equipment blank should be collected per 20 samples per matrix per equipment type. Equipment blanks are analyzed by the laboratory for the same analyte suite as the environmental samples.

Temperature Blank

Temperature blanks provide documentation that site-specific samples are adequately cooled during transport to the laboratory. A temperature blank, which consists of water, is typically provided by the project laboratory alongside the sample container. However, it can also be prepared by the sample collection personnel either before or during sample collection by adding water to an appropriate container. It is recommended to use a similar container to environmental samples in the same cooler (material and volume). The temperature blank is measured upon receipt by the laboratory staff.

Trip Blank

Trip blanks are used when collecting samples for Volatile Organic Compounds (VOCs) to ascertain if any cross-contamination of samples occurs during transport and storage. Trip blanks are provided by the analytical laboratory in a 40ml Teflon™-lined glass vial (same container as used for environmental samples) and consist of analyte-free reagent grade water. Trip blanks should be collected for each cooler used to transport VOC samples and on each day that VOC samples are collected. The trip blank is prepared by the laboratory; LCCWQPD staff do not collect or manipulate this sample.

12.0 WASTE DISPOSAL

All waste generated by this procedure is natural surface water. The unpreserved waste can be disposed of on-site by conveying it back to the same surface water body from which it was collected.

13.0 REFERENCES

United States Geological Survey. 2006. National Field Manual for the Collection of Water-Quality Data. Chapter A4: Collection of Water Samples. Version 2.0.

Water Quality Protection District
LEWIS AND CLARK COUNTY, MT

GROUNDWATER AQUIFER SAMPLE COLLECTION STANDARD OPERATING PROCEDURE

(F03)

DATE OF ISSUE: 06/11/2026

REVISION: 1.1

	Hydrogeologist	06/11/2026
PREPARED BY	TITLE	DATE
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Revision History

The following table records any and all modifications to this document. Following any modification to this document, the Water Quality Protection District Supervisor before the modifications are effective.

Date	Individual	Section(s) Modified	Comments
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06/11/2026	KNM	9.0	Updated procedure

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1.0 SCOPE AND APPLICABILITY

This procedure applies to collecting geochemistry samples and stable isotope samples that represent the groundwater aquifer. Samples may be collected from potable source wells, irrigation wells, and monitoring wells.

This procedure does not apply to collecting drinking water that is being served at a tap.

2.0 SUMMARY OF METHOD

The standing water in a well is purged by removing 3-5 well volumes of water based on the static water level. The removal of water from the well column induces the surrounding formation water to recharge the well column. Field parameter stabilization is assumed to represent formation water presence in the well column. Samples are then collected and delivered to a laboratory for analysis.

Procedures are included for both potable water wells (with an in-place plumbing) and monitoring style wells (without in-place plumbing).

3.0 DEFINITIONS, ACRONYMS, AND UNITS

Definitions

Data Validation	Data validation is “an analyte and sample-specific process that extend the evaluation of data beyond method, procedural, or contractual compliance…” (U.S. EPA 2002, Section 3.1).
Data Verification	Data verification is “the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements” (U.S. EPA 2002, Section 2.1).
Monitoring Tube	A small vertical pipe installed down the inside of a well casing (commonly made of polyvinylchloride, PVC). The pipe allows for a datalogger or water level meter to be safely deployed inside a well where the built-in pump infrastructure commonly interferes.
Saturated Zone	Vertical space below the unsaturated zone in which all void spaces are water filled. This zone is characterized by horizontal water movement. Also known as the Phreatic Zone.
Sonic	Water level meter that emits an acoustic signal down a well. By measuring the time delay before the echo is heard, the instrument is able to calculate the depth to groundwater. The instrument includes two depth settings and is temperature adjustable based on the average temperature inside the well column.

Sounder	Water level meter with graduated cable connecting a probe to the cable reel. The probe is lowered into a well until the probe contacts groundwater. At which time a buzzer/light is activated informing the operator that groundwater has been reached. The graduated cable allows the operator to measure the depth to groundwater.
Unsaturated Zone	Vertical space between the ground surface and the top of the water table. This zone is characterized by vertical groundwater movement, biological activity, and contaminant transport. Also known as the Vadose Zone.

Acronyms

AGOL	ArcGIS Online
GWIC	Groundwater Information Center
MBMG	Montana Bureau of Mines and Geology
PWS	Public Water Supply
QA	Quality assurance
QC	Quality control
SWL	Static Water Level
LCCWQPD	Lewis and Clark County Water Quality Protection District

Units

<	less than
>	greater than
±	plus, or minus
≤	less than or equal to
≥	greater than or equal to
µg/L	micrograms per liter
CFU/mL	colony forming units per milliliter
mg/L	milligrams per liter
MPN/100mL	most probable number per 100 milliliters
NTU	nephelometric turbidity units
pCi/L	picocuries per liter
ppb	parts per billion
ppm	parts per million

ppt	parts per trillion
S.U.	standard units
δ	lowercase Greek delta. Used to denote stable isotopes.

4.0 HEALTH AND SAFETY

This procedure revolves exclusively around working in the field. Field work inherently includes numerous risks such as working in hazardous weather, lifting and moving heavy objects, working on uneven terrain, handling potentially hazardous materials, and working with mechanical and electrical equipment.

Electrical Warning
This procedure involves working in close proximity to severe electrical hazards including car batteries and residential well pumps. Care should always be taken to ensure circuits are deenergized before handling equipment as there is a high risk of electric shock. If you are unsure if a circuit is energized, check for voltage with a multimeter.

High Pressure Water
When in operation, water pumps generate pressurized water. Take care when working with tubing connections during and after pump operation to avoid high pressure water striking your body. Even after a pump is shut down pressurized water may still be present in the pump or tubing.

Additionally, groundwater can be contaminated with hazardous materials, so proper personal protection equipment (PPE) must be worn at all times to limit exposure to potentially hazardous materials. Proper PPE includes, but is not limited to, protective eyewear, nitrile gloves, close toed shoes, and pants that cover the ankle.

Chemical
After sample collection, many types of samples are chemically preserved. The preservative may be included in the sample container from the laboratory or within a small vial for addition after sample collection. These chemical preservatives commonly include acids, bases, and other hazardous materials. Always wear PPE when handling hazardous materials.

Personal Protective Equipment (PPE)
- Nitrile gloves
- Safety goggles
- Close-toed footwear
- Long pants that cover the ankle
- Hair tie to keep long hair secured away from the face

5.0 CAUTIONS

When working with a homeowner's well, there exists the potential for causing damage to the LCCWQPD's equipment and the homeowner's property. Anytime a piece of equipment (e.g. well sounder) is lowered into a well there is a risk of damage to the well pump infrastructure. For wells within the LCCWQPD's groundwater monitoring network, always use the same equipment (sonic water level meter vs sounder) as the routine monitoring uses. In most cases, the equipment selection is made due to obstructions in the well column. This also improves consistency between routine monitoring and purging data. For wells with no prior knowledge of possible obstructions, field personnel are encouraged to use their best judgement and proceed with caution when lowering a sounder into a well.

Field sample collection can degrade samples if care is not taken. Environmental factors including, but not limited to, inclement weather, high winds, extreme high/low temperatures, and fire smoke can impact samples during the collection process. Be aware of local environmental conditions and take appropriate steps to mitigate potential impacts.

Table 1: Common environmental factors that could influence/bias sample collection.

Environmental Factor	Recommended Action
Inclement weather	If possible, avoid field work on days with anticipated inclement weather. If this is not possible, shield field equipment and sampling operations under a shelter (e.g. tent or within a vehicle) to protect equipment and personnel.
High winds	Adjust the location of the work site to put a barrier upwind of the equipment. This can be accomplished using a building or vehicle.
Extreme high/low temperature	Sample temperature may be impacted by extreme atmospheric temperatures, so it is recommended to insulate sample tubing and other equipment. Be cautious of the impact of temperature on volatile sample fractions – under higher temperatures there is an increased risk of losing the volatile fraction. More importantly, field personnel should wear appropriate clothing and utilize any shelters possible to mitigate temperature extremes on their bodies. Be aware of the symptoms of a heat stroke. When conducting field work in extreme heat field personnel should hydrate frequently and utilize any shade possible. When working in extreme cold, field personnel must be wearing appropriate clothing and limit skin exposure to avoid frostbite and hypothermia.
Fire smoke	If extensive smoke is present due to forest fires, avoid sampling carbon-sensitive analytes (Volatile Organic Compounds, total organic carbon, etc.) as the smoke could contaminate the sample vial during sample collection.

6.0 INTERFERENCES AND CONSIDERATIONS

Before collecting samples, there are numerous considerations to be made to ensure that aquifer samples are representative. The well construction, local geology, aquifer hydraulics, pumping capabilities, and data quality objectives all play a role in deciding if and how a well is sampled. The following considerations and guidance are adapted from the USGS National Field Manual, Chapter A4 (2006) and the USEPA Region 4 Groundwater Sampling Operating Procedure (2007). These considerations are not all inclusive and rely on field personnel experience and knowledge to minimize potential bias while sampling.

6.1 Considerations for Collecting Aquifer Representative Sample

Field personnel should be aware of the following considerations when selecting wells from which to collect aquifer representative samples. The individual project data quality objectives will determine if particular wells are appropriate sampling locations.

Avoid the following situations:

- Wells are unable to be continuously pumped, or water level recovery time is >12 hours.
- Wells that mobilize bottom detritus that can alter analytical results or interpretations. This is common in shallow wells (<5 feet of water) or when potable source well pumps are placed too close to the bottom of the well. If this is unavoidable, be sure to document and qualify all results from these wells.
- Well columns that exhibit interactions with atmospheric gases, unless the analytes of concern are not affected by these interactions.
- Wells that must be sampled after the water passes through storage tanks (e.g. cisterns), treatment systems, or hot water heaters.

Table 2 lists additional considerations for well locations, hydrogeology, and well construction.

Table 2: Considerations for well locations, hydrogeologic unites, well design, and pump materials. Adapted from the USGS National Field Manual for the Collection of Water-Quality Data, Chapter A4, Table 4-9. (USGS 2006)

Well Locations
Location conforms to the study's network design for areal and depth distribution.
Land-use and landcover characteristics, if relevant, are consistent with study objectives.
Site is accessible for equipment needed for well installation and sample collection.
Well elevation has been determined.
Hydrogeologic Unit(s)
Hydrogeologic unit(s) that contribute water to the well can be identified.
Depth and thickness of the targeted hydrogeologic unit(s) are known or can be determined.
Yield of water is adequate for sampling (typically, a minimum of 1 gallon (3.785 liters) per minute).
Well Records, Description, Design, Materials, and Structure
Available records have sufficient information to meet the criteria established by the study. Examples: logs of well drilling, completion, and development).
Borehole or casing/screen diameter is adequate for equipment.
Depth to top and bottom of sample collection (open or screened) interval is known (to determine area of contributing water to well); well depth and other well construction and well development information is available.
Length of well screen is proportional to the vertical and areal scale of investigation.
Well has only one screened or open interval, if possible.
Top of well screen is several feet below mean annual low-water table to reduce chances of well going dry and to avoid sampling from unsaturated intervals.
Well construction materials do not leach or sorb substances that could alter ambient target-analyte concentrations.
Well structure integrity and communication with the aquifer are sound. Checks include annual depth-to-bottom measurements, borehole caliper or downhole-camera video logs, and aquifer tests.
Pump Type, Materials, Performance, and Location of Sampler Intake
Supply wells have water-lubricated turbine pumps rather than oil-lubricated turbine pumps. Avoid suction-lift, jet, or gas-contact pumps, especially for analytes affected by pressure changes, exposure to oxygen, or that partition to a gas phase.
Pump and riser-pipe materials do not affect target-analyte concentrations.
Effects of pumping rate on measurements analyses have been or will be evaluated.
Sampler intake is ahead of where the water enters treatment systems, pressure tanks, storage tanks, or hot water heaters.

Once wells have been selected, the next considerations go to sample collection. These considerations should be factored into the overall sample collection setup and selection of analytes. If bias cannot be avoided for certain analytes, those analytes should be avoided at all costs. Table 3 details these considerations.

Table 3: Factors and Strategies for maintaining sample integrity. Adapted from the USGS National Field Manual for the Collection of Water-Quality Data, Chapter A4, Table 4-8. (USGS 2006)

Factors Affecting Sample Integrity	
Time	Chemical and microbial reactions that affect the target analyte concentration can be rapid.
Loss of pressure	Pressure in groundwater can be much greater than atmospheric pressure. As the sample is brought to land surface, depressurization of the sample can cause changes in sample chemistry.
Leaching or sorption	Chemical substances can be leached from or sorbed by the equipment that contacts the sample.
Exposure to the atmosphere	Atmospheric gases and particulates that enter the sample can affect the water chemistry.
Temperature	Groundwater temperature is often lower than the atmospheric temperature at land surface. As the sample is brought to land surface, an increase in temperature can increase chemical reaction rates and microbial activity and cause degassing.
Strategies to Maintain Sample Integrity	
Plan sampling at sites in a sequence that avoids contamination	Start with pristine sites or those least contaminated or with lowest concentrations of dissolved solids or target analytes. End at the site with the highest concentrations of target analytes.
Clean equipment	Sample only with decontaminated equipment and quality assure the efficacy of the cleaning procedures (collect sample blanks).
Purge the well of standing water	Purge the well to reduce artifacts from well installation or sampler development. If possible, pump at a rate that does not overly stress the aquifer, creating drawdown and mobilizing particulates. Protocols for purging and pumping rate can depend on well type and study objectives.
Isolate the sample	Use packers downhole and processing and preservation chambers at land surface.
Avoid temperature changes	Keep sample tubing as short as possible and shaded from direct sunlight.
Avoid sample aeration	Filter in-line; use thick, nonpermeable sample tubing; completely fill filtration assemblies and sample tubing with sample; fill sample bottles from bottom up to

	overflowing whenever appropriate and handle anoxic water under an inert gas environment if necessary.
Collect quality-control samples	Review the analytical results and adjust field procedures, if necessary, before the next sampling.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

Field personnel must be familiar with basic well plumbing, operation and calibration of handheld water quality meters, sample collection, and field data entry.

8.0 EQUIPMENT AND SUPPLIES

Equipment

- YSI ProDSS water quality meter (with pH, specific conductivity/temperature, and dissolved oxygen sensors installed at minimum)
- YSI ProDSS flow cell
- Durham Geo Slope / Solinst sounder / Ravensgate Model 300 Sonic water level
- ProActive Stainless Steel (S.S.) Monsoon well pump
- Proactive S.S. Monsoon Pump Controller
- 12v automotive battery (recommended to use a running vehicle to keep battery charged during pumping)
- Cooler with ice
- 5-gallon buckets (2-3)
- Work table

Supplies

- Brass garden hose splitter with separate shutoff valves
- 3/4” garden hose male thread to 3/8 inch bard adaptor (2-3)
- 3/4” garden hose male thread to 3/4” garden hose male thread adaptor
- 3/8” ID x 1/2” OD Teflon™ tubing (sufficient length to submerge pump in well)
- 50’-100’ garden hose
- Hose Bib Vacuum Breaker
- Garden Hose Flow Meter
- Hose clamps
- Teflon™ tape (thread sealant tape)
- Sample containers (supplied by laboratory)
- When filtering:
    - 47mm 0.45µm filters
    - 47mm 0.2µm filters
    - 47mm filter holder
    - 60mL syringe (2)
    - 1000mL HDPE wide-mouth container (2)

Reagents

- Sample preservatives (typically supplied with sample containers from laboratory)
- Decontamination supplies (see standard operating procedure *(F07) Decontamination of Field Equipment*)

Personal Protective Equipment (PPE)

- Nitrile gloves
- Safety goggles
- Close-toed footwear
- Long pants that cover the ankle
- Hair tie to keep long hair secured away from the face

9.0 PROCEDURE

Collecting aquifer-representative samples begins by purging (removing) the potentially stagnant water from the well column. Removing this water induces the flow of formation water into the well column for sampling. During the purging process the water level in the well is monitored along with a variety of field parameters. Once the field parameters stabilize, it is assumed formation water is being analyzed. At this point the water is collected in sample containers and preserved for laboratory analysis.

Prior to purging and sampling, all field equipment must be thoroughly decontaminated and calibrated according to the respective SOPs.

9.1 Well Selection

Well selection must be based on study-specific data quality objectives. The specific questions each study seeks to answer determines the types and quantities of samples to be collected. Specific analytes of interest may have interferences with the environment that must be considered when selecting wells. Refer to section *6.0 Interferences and Considerations* for more information on this.

9.2 Purging

Before collecting samples that represent the groundwater, aquifer can be collected, the potentially stagnant water sitting in the well column must be removed. By removing this stagnant water, the surrounding groundwater will recharge the well column with water that is representative of the aquifer.

The standard USGS procedure to purge a well removes between three to five well volumes. The assumption is that volume of water is sufficient to induce recharge to the well column, however depending on the aquifer characteristics, this volume may not be enough purge water. While purging, standard geochemical parameters (pH, specific conductivity, dissolved oxygen, and temperature) are continuously monitored for stability. Refer to Table 4 on page 15 for more information on stability criteria.

Once stability occurs, it is assumed that the water chemistry represents the aquifer and not the standing water in the well column. If the well is pumped regularly, stability may be achieved before reaching three times the well volume.

9.2.1 Purge Calculations

Purging wells typically rely on removing 3x the volume of water that is stored in the well casing at static water level. This calculation can be made ahead of time to plan field logistics using recent measurements; however, a static water level measurement must be collected on-site the day of sample collection to verify the calculations.

To calculate this volume, the following equation is used:

$$V_{well,cubic\ feet} = 0.785d^2(h_2 - h_1)$$

Where:

h_1 = depth of static water level (feet)
h_2 = total depth of well (feet)
d = diameter of well casing (feet)
V_{well} = volume of water (cubic feet)

This volume must be converted to gallons:

$$V_{well,gallons} = V_{well-cubic\ feet} \times 7.48\ \frac{gallons}{cubic\ foot}$$

Next, multiply the $V_{well,\ gallons}$ by 3 and by 5 to find the purge volume range.

$$V_{purge,3} = V_{well}\ x\ 3$$

$$V_{purge,5} = V_{well}\ x\ 5$$

Where:

V_{purge} = purge volume (gallons)

In planning the logistics of a study, it is helpful to estimate the length of time required to purge this volume of water. This depends on the potential flow rate of the pump used, the ideal flow rate based on the aquifer hydraulics, and analytical equipment capabilities. When using an installed pump in a potable source well, it is common to see 5-10 gallons per minute of flow. A small environmental pump that runs off a car battery typically outputs 1-4 gallons per minute of flow. Flow rates decrease as pump depth increases as the pump requires more power to lift the water.

To calculate the estimated duration, divide V_{purge} by the expected flow rate from the pump:

$$t_{purge} = {}^{V_{purge-3}}\!/_{f}$$

Where:

t_{purge} = purge time (minutes)
f = flow rate of pump (gallons per minute)

Use these calculations to plan the logistics of the study. If the wells require extended lengths of time to complete purging, plan for sampling fewer wells per day.

9.2.2 Purging Setup Overview

Now that the volume of purge water is known, it is time to purge the well. The general setup is shown in Figure 1. Every site will require various degrees of modifications to this setup, so use it only as general guidance. These modifications may be due to physical layout of the property, access to yard hydrants, etc.

The includes the following components:

Hose Bib Vacuum Breaker
To protect the potable water supply from the possibility of backflow or back siphonage, a vacuum breaker is installed directly onto the hydrant. In the event the water pressure drops suddenly (e.g. pump shut down or additional water usage by property owner), the vacuum breaker will prevent water from flowing backward into the potable supply. The possibility exists that the tubing contacts the ground or other contaminated surface which, in turn, contaminates the water. This device prevents that potentially contaminated water from flowing backward and entering the drinking water supply of the residence.

Back flow is any reversal of water flow, while back siphonage is a specific type of back flow caused by negative pressure upstream.

Flow Meter
A flow meter is installed directly after the vacuum breaker to monitor the flow rate and the total volume of water purged. This device is reset before purging each site to allow accurate consistent volumetric data during purging.

Splitter
The water chemistry is recorded through a flow cell for the handheld water quality meter. This flow cell has a limit of approximately 0.25gal/min of flow through it. Most residential supply well pumps generate 5-10gal/min. This necessitates most of the flow bypassing the flowcell and going straight to waste through large diameter tubing (garden hose), while a smaller, but still representative, fraction of the water enters the flow cell and is sampled.

Primary Purge Line
Due to the high flow rate of most well pumps and to accelerate the purging process, most of the waste will be sent through a standard garden hose away from the well. The goal of this is to deposit the wastewater as far away from the well as practical to remove the possibility of the wastewater influencing the well during purging and sampling.

To remain cognizant of water resources, it is recommended to inquire with property owners if there are beneficial uses (e.g. water plants) for the discharged water.

Flow Cell
A flowcell is used to allow accurate representative monitoring of field parameters during purging and subsequent sampling. The flow cell has the added benefit of keeping the sample water isolated from atmospheric influences.

Sample Collection Tubing
Between the splitter and the sample collection point, Teflon™ or LDPE (Low density polyethylene) tubing is used to minimize the possibility of equipment-induced cross-contamination. The sample tubing is kept as short as possible to minimize any light or temperature influences.

General Setup Guidelines

- Use Teflon™ tape to wrap each threaded connection. This will help waterproof connections without the need to apply a high amount of torque to the connection possibly damaging the equipment and/or homeowner property.
- Elevate the ends of the sample tubing and waste lines a minimum of 4-6 inches off the ground. This will act as an air gap backflow assembly to prevent contaminated water from entering the potable water supply during a backflow/back siphonage situation.
- Shield the sample tubing from sunlight and heat as much as practical. It is recommended to add pipe insulation to the sample tubing.

Purging Guidelines

The following are overall guidelines for the purging process. Ultimately, field personnel should use their own knowledge and experience to determine the most appropriate techniques to achieve a specific project's data objectives.

- Purging should not create a substantial amount of drawdown in a well when pumping at a rate of at least 1gal/min. Drawdown should ideally equal recharge such that the water level in the well remains constant.
- According to local well drillers, residential water pumps are commonly placed approximately 20 feet above the bottom of a well, however this is dependent on the well construction and the individual well driller. If the water level drops a substantial amount, be aware of air being discharged from the well pump as this may indicate the water level is close to the pump (air in the tubing may also indicate the pump is cavitating and needs to be slowed down). Water pumps are not designed to work in atmosphere, so damage could occur to the pump if it is not kept submerged.
- The number of well columns to remove is based on the time required for field parameters to stabilize. A well that is regularly pumped (e.g. a home's potable water well) may take less than 3 well volumes to stabilize.

9.2.3 Purging with In-Place Plumbing (Potable Source Wells)

While most residential potable source well pumps output 5-10 gallons per minute, the YSI ProDSS handheld's flow cell has a recommended throughput of 0.25 gallons per minute. This means most of the flow will be directed around the flowcell to waste while a smaller representative percentage of the flow will be directed at the flowcell. A splitter is used to direct flow simultaneously to waste and to the flowcell.

While purging with in-place plumbing provides easier logistics of not having to provide and supply electrical power to a pump, there are several drawbacks. Primarily, the pump is located in a fixed position in the well column that may not be ideal for purging or sampling representative water and the flow rate may be less controllable than a standard environmental submersible pump.

The general setup is indicated in Figure 1.

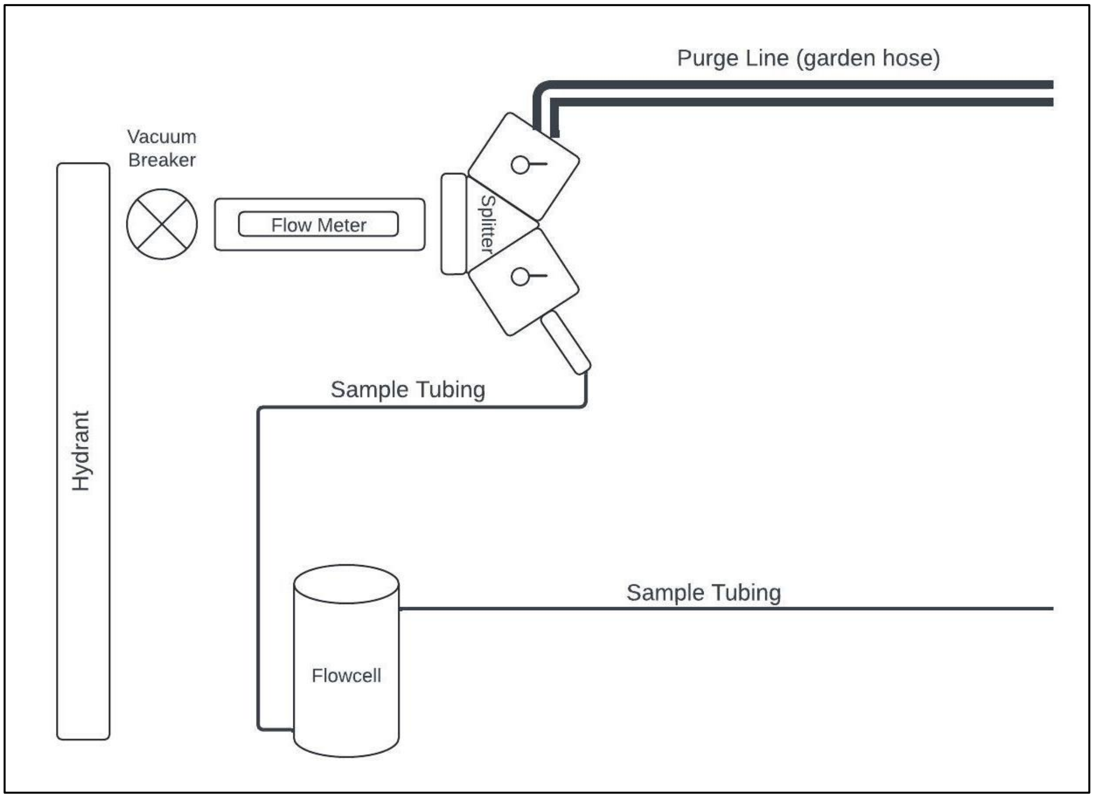

Figure 1: Purging setup for a well with in-place plumbing.

Purge Procedure:

1. Setup components as described in Figure 1.
2. Connect the hose bib vacuum breaker to the hydrant.
3. Connect the flow meter to the vacuum breaker, then connect the splitter to the flow meter. The splitter must be kept level such that one outlet is not higher/lower than the other outlet. A height difference could bias particulates in the well to favor one side of the splitter, inducing a bias in the results.
4. One outlet of the splitter is connected to a garden hose for bulk purging.
5. The end of the garden hose must be kept as far from the well as practical to prevent wastewater from recharging the well column.
6. Elevate the end of the garden hose a minimum of 4 inches off the ground to prevent contaminated water from entering the tubing during a backflow situation.
7. The other side of the splitter is connected to the sample tubing via a ¾" garden hose to barb fitting adaptor.
8. The sample tubing between the splitter and the flow cell must be kept as short as possible to minimize any temperature changes caused by the atmosphere.
9. The sample tubing entering the flow cell is connected to the bottom port of the flow cell.
10. The outlet of the flow cell is connected to an additional length of sample tubing that is also kept as short as possible.

11. Elevate the end of the sample tubing a minimum of 4-6 inches off the ground to prevent contaminated water from entering the tubing during a backflow or back siphonage situation.
12. Before purging, fill out Section 1: Site Data on field sheet (Appendix A).
13. Measure the static water level. If this well is regularly monitored, use the same equipment (sounder/sonic) as regular monitoring uses. If this well is not regularly monitored, default to using a sonic for water level measurements. This is to minimize the risk of having equipment stuck in the well and damage the pump infrastructure.
14. Calculate purge volume.
15. Double check the tubing is setup, and all connections are secure.
16. Verify the waste lines will discharge to a stormwater conveyance structure (ditch, pond, etc.) or a beneficial use away from the sampling site and will not impact neighboring properties.
17. Open both valves at the splitter.
18. Open hydrant valve to begin purging. Document date and time of beginning of purge in Section 2: Purging Data.
19. Slowly close the main waste line to encourage flow into the flow cell.
20. Without stopping the flow of water, begin recording field parameter data on the field sheet at regular intervals. Based on the flow rate and expected purge duration. Ideally, 8-10 measurements at a minimum should be collected. The first measurement can be collected once the flow cell is devoid of headspace.
21. The ideal flow rate through the flow cell is 1 gal / 4 min. If insufficient flow is reaching the flowcell, slowly close the main purge line valve at the splitter until sufficient flow is reaching the flowcell. Document this in the notes section of the field sheet.
22. Purge until the stability criteria in Table 3 are met:

Table 4: Stability criteria requirements when purging a well. Adapted from USGS National Field Manual for the Collection of Water-Quality Data, 2006, Chapter A4, Figure 4-12.

Parameter	**Stability Criteria Between 3 Sequential Measurements**
Temperature	±0.2°C
pH	±0.1 S.U.
Specific Conductivity	±5% for <100µS/cm ±3% for >100µS/cm
Dissolved Oxygen	±0.3mg/L

23. Once the stability criteria are met for all parameters, proceed to Section 9.3 for sample collection.

9.2.4 Purging without In-Place Plumbing (Monitoring Wells)

Purging with a temporary environmental pump has several benefits over an in-situ pump including more controllability with flow rate and user-controlled pump depth. Most environmental pumps include a controller that allows the user to fine adjust the flow rate depending on the specific site needs. Additionally, the user can deploy the pump at the ideal depth based on the well construction and local hydrogeology.

The general setup is indicated in Figure 2.

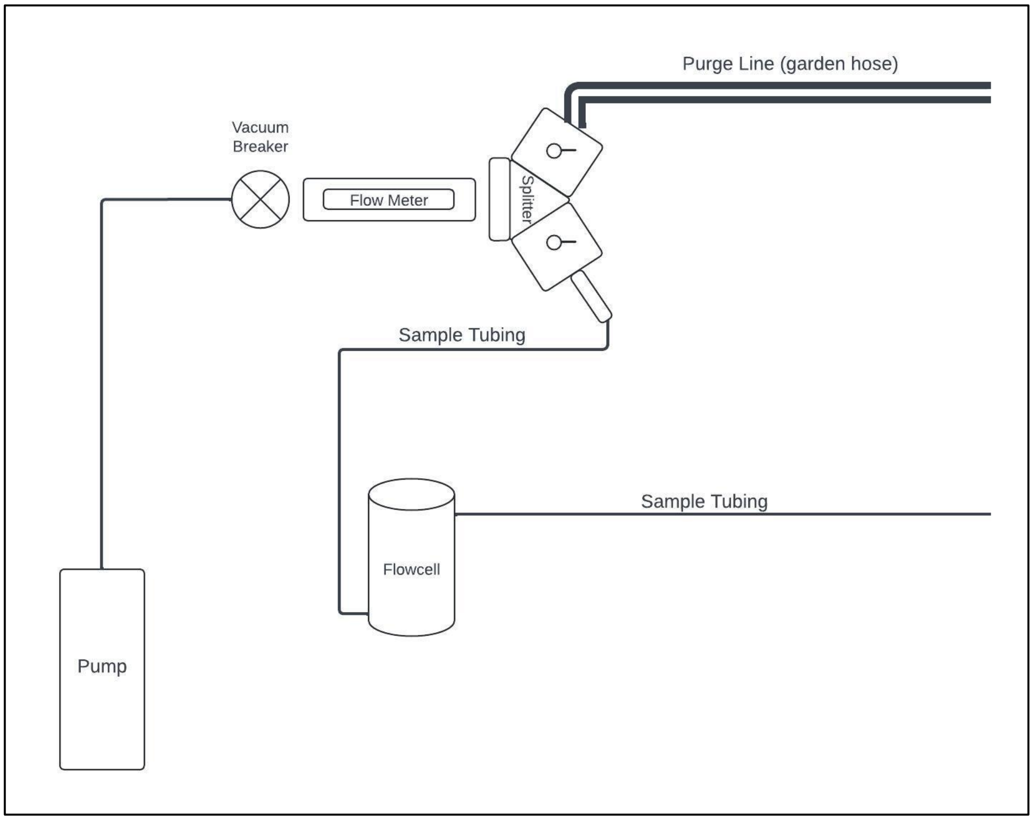

Figure 2: Purging setup for a well without in-place plumbing.

Pump Placement

The well pump must be located above any well screenings. This is to promote water being pulled through the screening and up the well column into the pump. This aids greatly in purging the entire well column and not just the portion in and around the screening. If the pump is placed deep in the well within the screened portion, the water column above the pump will not be purged.

Pump Operation

Refer to the pump's owner's manual for operation of the pump and pump controller.

Purge Procedure:

1. The pump must be set at a depth in the well based on the depth of water, depth to screening, and expected drawdown during purging.

2. Using a measuring tape (recommended not to use the sounder to avoid potential contamination), measure the tubing from the intake of the pump to the desired pumping depth.
3. Cut a length of Teflon™ tubing equal to the depth to the top of the well screening plus 5-10 feet. This will ensure the pump can be placed as deep as needed in case of drawdown, but as shallow as possible to promote purging of the whole well column. The additional 5-10 feet is to extend from the well casing to the sampling equipment.
4. Lower the pump into the well until the desired depth
5. Secure the tubing to the outside of the well casing using electrical tap in case the tubing falls into the well.
6. Before purging, fill out Section 1: Site Data on field sheet (Appendix A).
7. Double check the tubing is set up and all connections are secure.
8. Verify the waste lines will discharge to a stormwater conveyance structure (ditch, pond, etc.) away from the sampling site and will not impact neighboring properties.
9. Open both valves at the splitter.
10. Slowly increase the pump controller's output to begin pumping. The ideal pump rate is equal to the drawdown in the well. Continue increasing the pump speed until the drawdown stabilizes. The pump may need to be lowered as this stabilization occurs.
11. Document date and time of beginning of purge in Section 2: Purging Data.
12. Begin recording field parameter data on the field sheet at regular intervals. Based on the flow rate and expected purge duration. Ideally, 8-10 measurements at a minimum should be collected. The first measurement can be collected once the flow cell is devoid of headspace.
13. Purge until the stability criteria are met in Table 4.
14. Once the stability criteria are met for all parameters and a sufficient amount of water has been purged, proceed to Section 9.3 for sample collection.

9.3 Sample Collection

Now that the well has been purged, it is time to sample. Sample collection must occur as soon as possible after purging is complete. Always were proper PPE when collecting samples.

9.3.1 Nonvolatile Samples

Nonvolatile samples include, but are not limited to, metals, nutrients, and some solids. These samples are not directly altered by exposure to the atmosphere and therefore are collected with headspace in the container to facilitate homogenization prior to analysis.

1. Do not stop the flow of water once purging is complete.
2. Samples are collected from the water exiting the flowcell. This ensures the same water for which field parameters were collected is being analyzed.
3. Label the sample bottles. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:
    a. Lewis and Clark County – WQPD

   b. Project name
   c. Collection date and time
   d. Site name
   e. Sample ID (YYYYMMDD_GWIC ID)
   f. Analysis requested
4. Triple rinse each unpreserved sample container with sample water. For containers with preservatives, fill the sample container to the appropriate level.
5. Cap the sample and place in an ice-packed cooler for transport.

9.3.2 Volatile Samples

Volatile samples include, but are not limited to, volatile organic compounds, mercury, diesel and gas range organics.

1. Do not stop the flow of water once purging is complete.
2. Samples are collected from the water exiting the flowcell. This ensures the same water for which field parameters were collected is being analyzed.
6. Label the sample bottles. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:
   g. Lewis and Clark County – WQPD
   h. Project name
   i. Collection date and time
   j. Site name
   k. Sample ID (YYYYMMDD_GWIC ID)
   l. Analysis requested
3. Triple rinse each unpreserved sample container with sample water.
4. Overfill each 40mL vial with sample water until an inverse meniscus forms on the top of the vial.
5. Cap the vial and gently invert 3x to check for any residual air pockets in the sample. If any air remains in the vial, add additional sample to the vial and retest for air.
6. Repeat this process for each container.

9.3.3 Filtered Samples

Samples collected for standard geochemical parameters (nutrients, metals, organics, solids, etc.) that are analyzed at a local drinking water laboratory are not field filtered. It is generally more cost effective to pay the laboratory a small fee to have their staff filter the samples as needed. However, there are times when samples must be field filtered. This is common with stable isotope samples that are shipped to an out-of-state lab. These samples are not chemically preserved, so the field filtering acts as the only preservation method. Most stable isotope samples are filtered to 0.2µm.

1. Do not stop the flow of water once purging is complete.
2. Samples are collected from the water exiting the flowcell. This ensures the same water for which field parameters were collected is being analyzed.
3. Document the collection date and time on the chain of custody.
4. Label the sample bottle. For bottles without a laboratory label, document the following information on the bottle using a permanent marker:

   a. Lewis and Clark County – WQPD
   b. Project name
   c. Collection date and time
   d. Site name
   e. Sample ID (YYYYMMDD_GWIC ID)
   f. Analysis requested
5. Triple rinse the 1000mL wide-mouth HDPE container then fill the container with sample water. This container is not the final sample container sent to the lab.
6. Leave the water flowing until filtering is complete in case additional water is needed.
7. Using water from the 1000mL HDPE container, triple rinse the syringe with sample water.
8. Unscrew the blue filter holder locking ring (Figure 3).

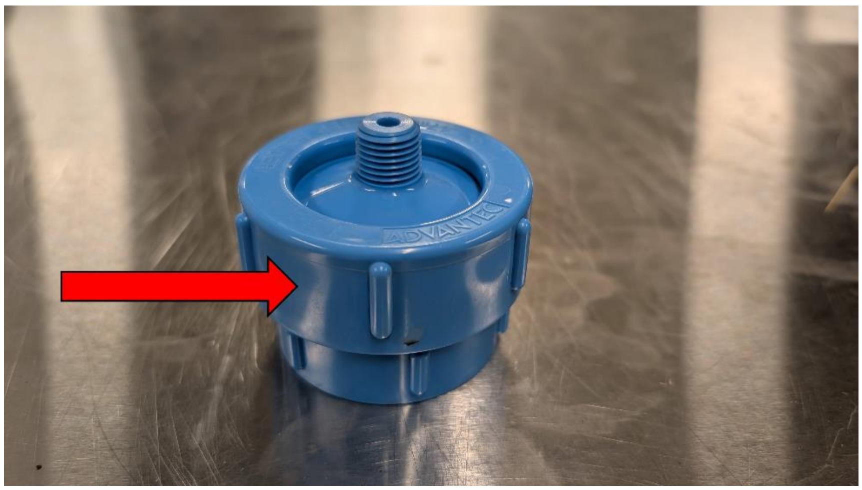

Figure 3: The outer locking ring holds the filter assembly together.

9. Separate the two halves of the filter holder (Figure 4).

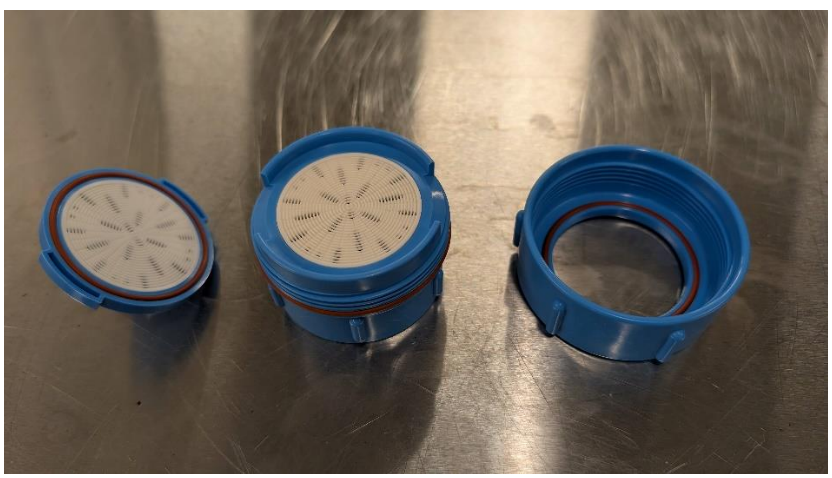
Figure 4: The filter assembly comes apart into three pieces: the main body, cap, and locking ring.

10. Place a filter (not the paper that separates each filter) in the filter holder and reassemble the filter holder. Be sure not to damage any of the o-rings.

11. Fill syringe with sample water from the 1000mL HDPE container and insert the tip of the syringe into the filter holder (Figure 5).

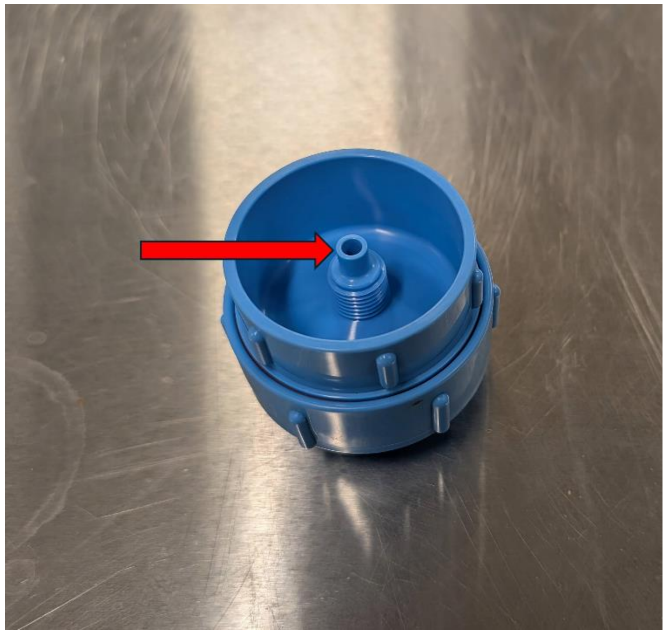

Figure 5: The port on the bottom of the filter holder accepts a standard 60mL syringe tip. Be careful to avoid damaging the syringe and filter holder when inserting the syringe.

12. With firm steady pressure push the water through the filter into the final sample container.

Do not use excessive force on the syringe as this can rupture the filter, rupture the filter holder seals, or break off the syringe tip. If unfiltered water is introduced into the final sample container, the filtered water must be thrown out and filtered re-started.

13. Repeat steps 6-10 to continue filling the final sample container.
14. If the sample contains high suspended solids (or it is below freezing) the filter may clog. Replace the filter as needed to avoid needing excessive force when filtering.

When filtering water with high suspended solids down to 0.2µm, it may be beneficial to split the filtering into two phases. Using two HDPE sample containers, filter the raw water to 0.45µm from the initial HDPE container into the second HDPE container. Once a sufficient volume of raw water is filtered to 0.45µm, filter the 0.45µm filtrate down to the final 0.2µm in the final sample container.

9.4 Sample Preservation and Transport

All water samples must be preserved immediately following collection to ensure representativeness and integrity. Samples requiring a chemical preservative have the preservative added as soon as safely possible after collection. Due to environmental and personal safety, chemical preservatives may not be added directly at the sample site to avoid accidental release of hazardous materials. In this situation, preserve samples as soon as safely possible.

All samples are promptly chilled to approximately 6°C (unless otherwise specified by the analytical method) for transport to the laboratory.

Samples are transported to the project laboratory in person, generally on the same day as samples are collected, or within 24 hours of sample collection. If samples are shipped to the project laboratory (e.g. isotopes), the samples are packaged in an ice-packed cooler along with the CoC and delivered to the shipping courier within 24 hours of collection. Shipping times depend on hold times of the samples, but the minimal shipping time within project funding is preferred.

9.5 Sample Analysis

All water quality samples are analyzed by a Montana Department of Public Health and Human Services (DPHHS) certified laboratory. The three laboratories located in Helena, Montana are Alpine Analytical, DPHHS Environmental Laboratory, and Energy Labs-Helena. Samples are analyzed using the laboratory's approved methodologies for each analyte and reported using standard formats. If a specific method is required to meet detection limits or other data objectives for a project, discuss this with the laboratory prior to sample collection. Any method/reporting requirements should be noted on the CoC before sample receipt by the laboratory.

Stable isotope samples are analyzed at Isotech Labs. One or more Isotech Lab CoCs must be sent with the water samples to the lab. An additional electronic copy is emailed to the lab separately as a backup.

10.0 DATA AND RECORDS MANAGEMENT

During this procedure field personnel are required to calculate well water volume and purging rates. These data will help populate the Groundwater Purging Field Sheet (Appendix A). During the purging process, field personnel will document stabilization of water chemistry on the field sheet. During sample collection the sample collector is responsible for completing the laboratory's chain of custody documentation. At the conclusion of field work, the original field sheet and a copy of the chain of custody (original stays with the laboratory) are placed in file storage. The field sheet data are then added to a digital spreadsheet for future data processing pursuant to the overall project.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Prior to purging a well, the multi-parameter field meter must be calibrated and decontaminated according to the respective SOPs. Water quality samples are collected after all field parameters meet stabilization criteria. Stabilization criteria require a minimum of three consecutive measurements to show minimal variability. All samples are collected in new bottles provided by a state-certified laboratory or purchased directly from a vendor. For bottles procured directly from a vendor, the certificate of analysis will be kept on file documenting all background contamination.
All water samples (excluding isotope samples) have a USEPA regulated hold-time. The hold-time is the length of time between the completion of sample collection and the beginning of analysis at the laboratory. Due to the hold-time restrictions on many analytes being short (24 hours or less), samples should be collected early enough in the day so that there is sufficient time to transport/ship all samples to the laboratory the same day as collection. It is also recommended to collect samples early in the work week to avoid weekends as many laboratories increase costs or do not receive samples over the weekends.

All water samples are placed into an ice-packed cooler for transport immediately after collection. Proper chain of custody (CoC) documentation is completed at the time of collection and accompanies all samples until they are delivered to the laboratory.

Additional samples for quality control are collected alongside project samples to document the sterility, cleanliness, and reproducibility of sample results. The following quality control samples are collected at a minimum during projects. If there are concerns of contamination during sample collection, additional quality control samples may be collected to document any potential sources of contamination to the samples. The standard operating procedures for collecting quality control samples is located in Appendix C.

Sample Duplicate

A sample duplicate is an additional sample container collected at the same time and location as the original. The sample duplicate undergoes the same treatment as the original sample. The purpose of this sample is to verify the reproducibility of the sample collection. A minimum of 1 duplicate is required for each batch of 10 samples.

Table 5: The minimum number of sample duplicates is based on the number of project samples. For each batch of 10 samples, the number of duplicates increases.

Number of Unknown Samples	Number of Sample Duplicates Required
1-10	1
11-20	2
21-30…	3…

Field Blank

A field blank is a sample container that has undergone the same treatment as all other sample containers. A field blank sample is collected with each sampling event and the collection procedure is identical to all other environmental samples including triple rinsing and filtering. Field blanks typically provide a holistic view of the sample collection process, rather than individual steps. If there are concerns over individual sample collection steps introducing contamination or bias into the samples, field blanks can be collected at the field site that represents each step of the process (e.g. filter blank, pump blank, bailer blank, etc.).

Equipment Blank (Rinsate Blank)

An equipment/rinsate blank is collected to document if the equipment (pumps, tubing, filters, etc.) is properly decontaminated between samples. If any cross-contamination occurs between samples due to insufficient decontamination procedures, the equipment/rinsate blank will highlight this. Equipment blanks are collected by passing analyte-free reagent grade water through all the same sample collection steps as environmental samples. The equipment blank is collected in an appropriate sample container with the appropriate preservative. One equipment blank should be collected per 20 samples per matrix per equipment type. A minimum of one equipment per project is required. Equipment blanks are analyzed by the laboratory for the same analyte suite as the environmental samples.

Temperature Blank

Temperature blanks provide documentation that site-specific samples are adequately cooled during transport to the laboratory. A temperature blank, which consists of water, is typically provided by the project laboratory alongside the sample container. However, it can also be prepared by the sample collection personnel either before or during sample collection by adding water to an appropriate container. It is recommended to use a similar container to environmental samples in the same cooler (material and volume). The temperature blank is measured upon receipt by the laboratory staff.

Trip Blank

Trip blanks are used when collecting samples for Volatile Organic Compounds (VOCs) to ascertain if any cross-contamination of samples occurs during transport and storage. Trip blanks are provided by the analytical laboratory in a 40ml Teflon™-lined glass vial (same container as used for environmental samples) and consist of analyte-free reagent grade water. Trip blanks should be collected for each cooler used to transport VOC samples and on each day that VOC samples are collected.

12.0 WASTE DISPOSAL

All waste generated by this procedure is natural groundwater. The groundwater can be disposed of on-site through beneficial uses (watering plants). Do not allow the groundwater to flow into a surface water body (e.g. stream or pond). Groundwater can have different chemicals than surface water which could cause unforeseen changes to water quality.

13.0 REFERENCES

United States Environmental Protection Agency. 2007. Operating Procedure: Groundwater Sampling. Science and Ecosystem Support Division, Region 4. SESDPROC-301-R1.

United States Geological Survey. 2006. National Field Manual for the Collection of Water-Quality Data. Chapter A4: Collection of Water Samples. Version 2.0.

Water Quality Protection District
LEWIS AND CLARK COUNTY, MT

TOTAL DISCHARGE
STANDARD OPERATING PROCEDURE
(F02)

DATE OF ISSUE: 06/10/2026

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	Hydrogeologist	06/10/2026
PREPARED BY	TITLE	DATE
APPROVED BY	TITLE	DATE

Revision History

The following table records any and all modifications to this document. Following any modification to this document, the Water Quality Protection District Supervisor before the modifications are effective.

Date	Individual	Section(s) Modified	Comments
09/24/2024	EMERSON, NATALIE, KEGAN MCCLANAHAN	ALL	DOCUMENT CREATED
06/10/2026	KEGAN MCCLANAHAN	8.0, 9.0	REMOVED MARSH-MCBIRNEY PROCEDURE

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1.0 SCOPE AND APPLICABILITY

This procedure measures velocity and stream depth to calculate total discharge (streamflow). This procedure is applicable to surface water streams and conduit (pipe flow) with laminar flow. Surface water bodies with minimal to no flow (e.g. stagnant streams, lakes and reservoirs) are not quantifiable using this procedure.

2.0 SUMMARY OF METHOD

Discharge is the volume of water moving past a point per unit of time expressed as cubic feet per second (CFS). This procedure is adapted from the United States Geological Survey's velocity-area method from Discharge Measurements at Gaging Stations (Turnipseed and Sauer, 2010).

A cross-section of a stream or conduit is divided into a number of subsections, known as stations. At each station the water depth and average water velocity are recorded. The discharge at each station is calculated by finding the product of the depth, station width, and water velocity. The total discharge across the stream is calculated as the summation of all individual station discharges.

Discharge measurements can be correlated to a proximal staff gage. If a statistically significant number of discharge measurements and staff gage readings are collected, a rating curve can be developed across a wide range of stream conditions to statistically predict discharge based on the staff gage reading. An *in-situ* data logger can be used to collect higher temporal resolution water height data than would be logistically feasible with field personnel.

Other agencies, such as the United States Geological Survey and the Montana Bureau of Mines and Geology, share water depth (gage height) and discharge data to the public. These data, if applicable to the project objectives, can be downloaded and processed to supplement WQPD field data collection.

3.0 DEFINITIONS, ACRONYMS, AND UNITS

Definitions

ArcGIS™	Family of geographic information system technologies developed by the Environmental Systems Research Institute (ESRI).
Cross Sectional Area	Area across a stream for a subsection that extends laterally half the distance from the preceding subsection to half the distance to the next

	vertical. The area extends from the water surface to the measured depth.
Data Validation	Data validation is "an analyte and sample-specific process that extend the evaluation of data beyond method, procedural, or contractual compliance…" (U.S. EPA 2002, Section 3.1).
Data Verification	Data verification is "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements" (U.S. EPA 2002, Section 2.1).
Discharge	Volume of water passing a point in a stream per unit of time.
Eddy	Circular current of water.
Field Maps™	Online web map application within the ArcGIS platform that allows user to customize webmaps for the purposes of collecting digital field data.
Flow meter (velocity meter)	Instrument used to measure the velocity of water commonly through the use of an impeller or electromagnetism.
Geodatabase	Collection of spatially oriented data with related tabular data.
Laminar flow	Flow regime in which water particles move in straight paths and are not affected by the movement of neighboring particles.
Staff gage	Vertically mounted ruler with fine graduations to measure water depth.
Thalweg	Deepest point in a stream channel.
Top Setting Wading Rod	Device that allows a flow meter to be attached and adjusted for various depths. The device is graduated to provide direct water depth measurements.
Turbulent Flow	Flow regime in which water particles velocities are continuously changing in all directions.
Wetted Edge	Transient edge at which the water surface intersects the stream bank. As the stream changes flow, and by extension depth, the wetted edge will change as well.

Acronyms

AGOL	ArcGIS Online
GWIC	Groundwater Information Center
MBMG	Montana Bureau of Mines and Geology
MCL	Maximum contaminant level
MDL	Minimum detection limit
PWS	Public Water Supply
QA	Quality assurance
QC	Quality control
RL	Reporting limit
SMCL	Secondary maximum contaminant level
SAP	Sampling and Analysis Plan
SWL	Static Water Level
WQPD	Water Quality Protection District

Units

<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to
a_i	cross-section area for the *i*th segment of the *n* segments of which the channel is divided
CFS	cubic feet per second
ft	feet
Q	discharge, in cubic feet per second
s	second (time)
v_i	mean velocity of flow normal to the *i*th segment
δ	lowercase Greek delta. Used to denote stable isotopes.

4.0 HEALTH AND SAFETY

Working in and around streams involves inherent dangers associated with the natural environment. Conditions may include, but are not limited to, uneven terrain, inclement weather, extreme heat and cold, electrical hazards, and potentially dangerous wildlife. Snakes, spiders, and insects commonly inhabit the vegetation surrounding bodies of water and the fields used to access the streams. If anyone is bitten, scratched, or stung by wildlife, seek medical attention immediately.

Weather conditions range from extreme heat in the summer to extreme cold in the winter. Field personnel must dress appropriately for the weather. Summer conditions can expose field personnel to sunburn and heat exhaustion / heat stroke while winter conditions can cause hypothermia and frostbite. High winds are also common in the WQPD. Personnel must be cautious of airborne debris that could cause bodily harm.

Accessing a stream may require personnel to traverse fences. Be aware of electrified fencing and if the fencing is energized. Do not assume it is de-energized even if it was recently crossed. When in doubt always request the property owner provide an alternative route to the well or confirm the fencing is de-energized. Electrical shock can cause serious and life-threatening bodily harm. Electrical current causes muscle contractions which can cause a person’s hand to grip the source of electricity, preventing the person from letting go which severely increases the exposure and likelihood of fatal effects.

While the streams in the Helena valley are not as large as those in other parts of the country, flash flooding is always a possibility. Storm systems commonly move through the area rapidly and only impact certain areas of the valley or surrounding mountains. This means that field personnel may not experience any precipitation, but upstream reaches may. This can lead to flash floods. Field personnel should always be cognizant of the surrounding weather conditions and stream flow. If stream flow begins to rapidly increase, evacuate the area immediately and seek high ground. Do not enter a stream if the depth and/or flow velocity are too high to do so safely.

When working in and around streams, personnel may encounter unstable rocks or substrate. This can cause a person’s balance to be compromised resulting in a fall. Streambeds often include cobbles and boulders that can cause serious physical injury during a fall. Additionally, the wide range of temperature conditions means the water temperature can be dangerously cold even during warm days. If personnel are exposed to cold water, especially if clothing becomes wet, halt field activities and seek warm dry clothes immediately. Do not underestimate the impact of cold water on the human body.

Personal Protective Equipment

- Waterproof footwear (waders or tall boots depending on stream depth)
- Life Jacket
- Hat
- Sunscreen

5.0 CAUTIONS

Personnel must avoid causing damage to landowner property while accessing streams. It is common to cross fields, fences, and gates to access streams. Vehicles can cause ruts during muddy or snowy conditions and can lead to fires if driven over extremely dry vegetation. When crossing fences and gates, avoid damaging wire strand fencing, loose fence posts, or gate hinges.

When performing work in streams, many pieces of instrumentation are not rated for water immersion (not waterproof). Personnel must ensure all instrumentation is secured in such a way to avoid accidental contact with water. Additionally, the instrumentation should be covered to minimize exposure to precipitation. Water damage can affect the internals of the instruments causing inaccurate measurements or other failures.

6.0 INTERFERENCES

Accurate measurements of stream width, depth, and velocity require many considerations. Stream width measurements can be impacted by thick vegetation and debris along the bank or by undercut banks. When selecting a site to measure discharge, field personnel should look to minimize these factors. Stream depth measurements can be influenced by debris such as logs that do not represent long-term controls on stream discharge (i.e. obstructions that are temporary).

Velocity measurements can be influenced by turbulent flow, stagnant or minimal flow, eddies, bends in the channel, vegetation, and nearby downstream obstructions. Obstructions such as rocks, tree roots, bridge infrastructure, staff gages, and people can cause turbulent flow and can create localized zones of lower velocity directly upstream. These localized low velocity zones are especially problematic for the individual holding the wading rod and measuring velocity. The individual must stand as far from the wading rod as possible to minimize this interference. Section 10.1 Site Selection includes additional guidance on avoiding interferences.

7.0 PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

Field personnel conducting this procedure must be familiar with basics of stream hydrology (braided vs meandering stream channels, recharge, turbulent vs laminar flow, pools vs rapids, stream velocity profile). Before conducting this procedure solo, all personnel must be trained by the Hydrogeologist. If new equipment is purchased, online or in person training must be completed before implementing new equipment.

8.0 EQUIPMENT AND SUPPLIES

The following equipment, supplies, and personal protective equipment are the minimum recommendations to use.

Equipment

- OTT MF Pro flow meter
- Top setting wading rod
- Fiberglass measuring tape, measured in tenths of feet
- 2 Metal bank pins
- Charge cable (if using OTT MF Pro)
- Phillips screwdriver (to replace batteries in Marsh McBirney)
- Surface water field sheet

Supplies

- 2 D-cell batteries (if using Marsh McBirney)

Personal Protective Equipment

- Waterproof footwear (waders or tall boots depending on stream depth)
- Life Jacket
- Hat
- Sunscreen

9.0 PROCEDURE

Each project or monitoring program details the specific location(s) and methods for collecting discharge data in the respective Sampling and Analysis Plan (SAP).

9.1 Workflow and Method Overview

The LCCWQPD routinely collects streamflow data using the velocity-area method. This method divides a cross section of the stream into a number of segments. Within each segment the depth and average velocity are measured. The width of the segment is multiplied by the depth to give the cross-sectional area of that segment, in square feet. The velocity (feet per second) is multiplied by the segment's cross-sectional area to yield the discharge, in cubic feet per second, in each segment. The discharge measurements in each segment are added together to give the total discharge.

The two velocity meters used by the WQPD are the OTT MF Pro and the Marsh McBirney Model 2000. The primary difference in workflow between the two instruments is the OTT records all data internally to the instrument, whereas the Marsh McBirney relies on field personnel to manually record all data in a field sheet and manually calculate the total discharge.

9.2 One-, Two- and Three-Point Methods

The velocity of water in a natural stream channel is not uniformly distributed. Water velocity slows as it approaches the banks and bed of the stream channel due to friction forces. This means that the specific depth at which velocity is measured has a significant impact on the representativeness of that measurement. Figure 1 shows the generalized velocity profile for a natural stream channel.

When setting the depth on the wading rods, the calculated depth is measured from the top of the water column. In other words, 0.6 of the depth means 0.6 from the top, or 0.4 from the bottom (Figure 2)

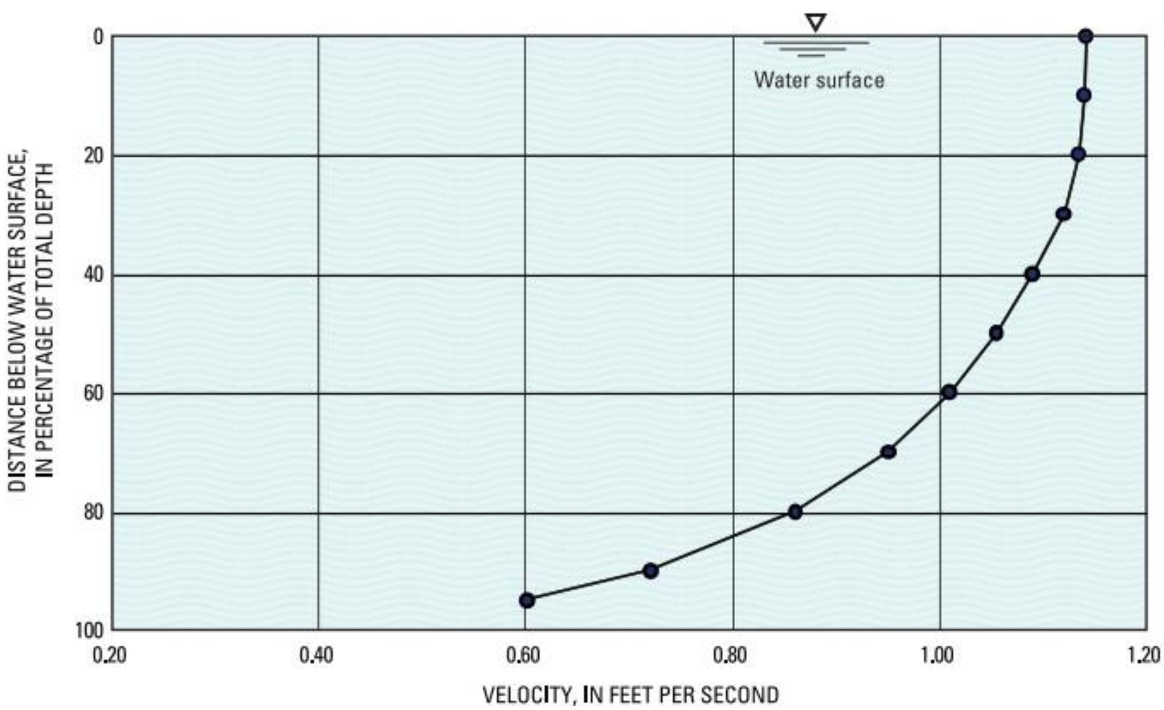

Figure 1: Average vertical-velocity curve of an open channel stream. The frictional forces along the bottom of a stream decrease the stream velocity. Source: Turnipseed and Sauer, 2010.

1 Point Method / 0.6 Method

In streams with a depth of less than 2.5 feet, a single velocity measurement at 0.6 of the depth (measured from the top), has been found to be representative of the average velocity. In shallow water the velocity meter sensor is too close to the bottom to accurately measure velocity and the proximity to the stream bed poses a risk of physical damage to the sensor. Discharge is not taken if depth is less than 0.2 ft due to the meters not being able to measure velocity at depths shallower than 0.2 feet.

How to set the wading rod:

1. Measure the total depth of the stream using the tick marks on the hexagonal main shaft.
2. Line up the number on the smaller shaft, which measures feet, to the corresponding decimal number on the top of the wading rod.

   Example: if the total depth was 1.8 feet, the smaller shaft would slide up until the 1-foot mark lines up with the 0.8 mark on the decimal scale.

2 Point Method / 0.2 – 0.8 Method

When the water depth at a particular station is greater than 2.5 feet, two measurements are made: one at 0.2 of total depth and one at 0.8 of total depth. The arithmetic average is then found between the two velocities for the final velocity at that station.

How to set the wading rod for the 0.2 measurement:

1. Measure the total depth of the stream using the tick marks on the hexagonal main shaft.
2. Multiply the total depth by 2.
3. Using the depth x 2 result, line up the number on the smaller shaft, which measures feet, to the corresponding decimal number on the top of the wading rod.

   Example: The water depth is 2.7 feet (see figure 2 below). Multiple 2.7 by 2 which yields 5.4. Slide the foot scale up until the 5 foot mark is lined up with 0.4 on the decimal scale.

How to set the wading rod for the 0.8 measurement:

1. Measure the total depth of the stream using the tick marks on the hexagonal main shaft.
2. Divide the total depth by 2.

3. Using the depth ÷ 2 result, line up the number on the smaller shaft, which measures feet, to the corresponding decimal number on the top of the wading rod.

   Example: The water depth is 2.7 feet (see figure 2 below). Divide 2.7 by 2 which yields 1.35. Slide the foot scale up until the 1-foot mark is lined up between 0.3 and 0.4 on the decimal scale.

3 Point Method / 0.2, 0.6, 0.8 Method
The three-point method is employed in water deeper than 2.5 feet when the vertical-velocity profile is abnormal. The normal profile (Figure 1) has slower velocities near the stream bed due to the additional frictional forces. This can be caused by severe turbulence or friction from obstructions in the stream. Abnormal velocity profiles include:

- The 0.2 velocity (top) is more than double the 0.8 (bottom) velocity
- The 0.8 velocity (bottom) is greater than the 0.2 (top) velocity.

Using the methodology described above, measure the velocities at 0.2, 0.6 and 0.8 at the station. The arithmetic average of the 0.2 and 0.8 velocities is found before averaging this with the 0.6 velocity.

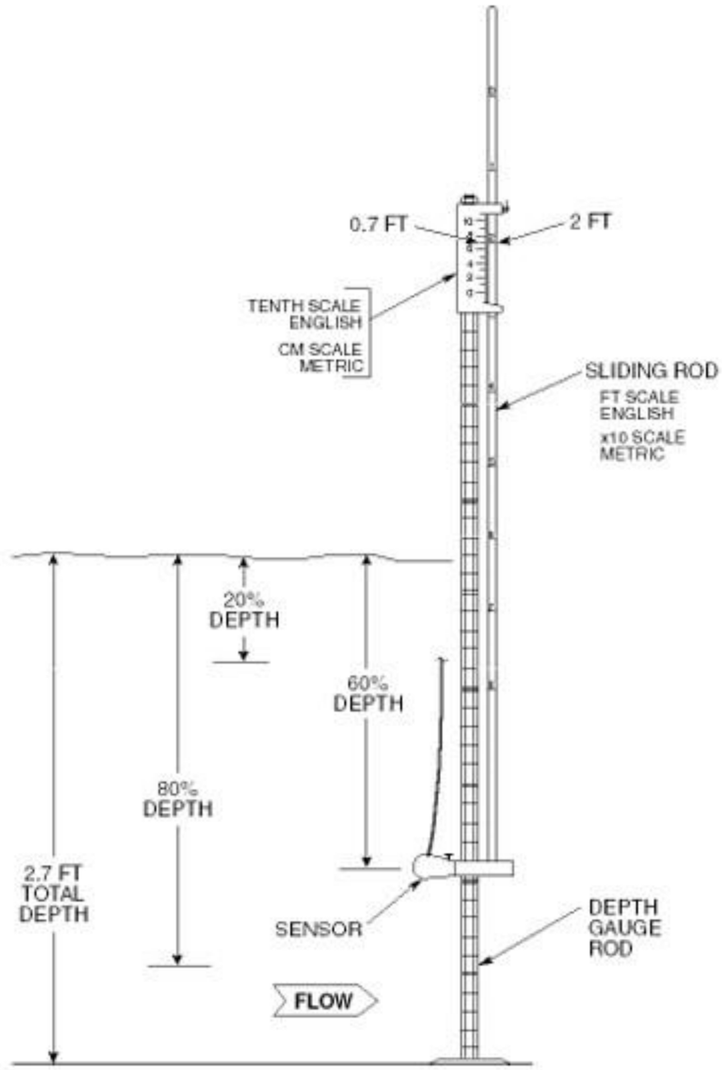

Figure 2: How to set the wading rod depth. Image source: Marsh McBirney Inc. Flo-Mate Model 2000 instruction manual.

9.3 Measuring Water Depth

The wading rod's stationary main shaft is hexagonal and graduated to measure water depth. When placed upright on the bottom of a stream, each single tick mark on the shaft refers to 0.1 feet. The double tick marks refer to 0.5 feet increments. The triple tick marks refer to 1.0 feet increments (Figure 2).

When measuring depth in flowing water, the water surface will ride up the side of the wading rod proportional to the velocity. When measuring the depth, this artificial increase in water depth must be ignored.

9.4 Site Selection

Collecting representative discharge data requires certain stream conditions and characteristics. Ideally, the stream displays consistent laminar flow through a straight channel with a smooth channel bed and no obstructions. This, unfortunately, is rarely the case. Field personnel should follow the guidance below when selecting a site.

It is also important to remember that stream channels change over time. Changes in water depth may add or remove obstructions to the same location. These changes may necessitate small changes in location along a stream. Generally, discharge measurements should remain within 50 feet of the same location. As distance increases between measurement locations considerations must be made for baseflow hydrology and storage.

When selecting a site for measuring discharge look for:

- A site free from large obstructions such as rocks or tree roots in the stream channel.
- Banks that are not undercut. Changes in water depth may expose or remove undercut banks from a site.
- Consistent laminar flow that does not have stagnant water or eddies. Stagnant water and eddies may bias velocity measurements.
- A straight channel between a pool and rapids.

9.5 Establish the Cross Section

Once the site has been chosen, the cross section needs to be established using the fiberglass tape measure. The tape measure should be installed perpendicular to the channel, close to the water surface, and as level as possible. This ensures that the segment widths are accurate, and that each velocity measurement is parallel to the flow direction.

1. Insert one of the bank pins securely into the ground and attach the end of the tape measure.
2. Extend the tape measure to the other side of the channel. It is helpful to orient the tape measure such that the tenths of feet side is facing up.
3. Insert the other bank pin securely into the ground on the other bank.
4. Keeping the tape measure taught such that it is not dragging in the water, secure the tape measure to the second bank pin.
5. The tape measure should be parallel with the ground and as close to the stream as feasible to ensure accurate placement of the wading rod along the tape measure.

9.6 Establish the Number of Segments

The number of segments to measure in a cross section is based on the total width of the stream and the distribution of flow in the channel. The width of the stream is measured from the intersection of the water surface and the bank, known as the wetted edge. As the stream depth changes the wetted edges move resulting in different stream widths over time. When measuring discharge using the velocity-area method, it is ideal to have no more than 5% of the total flow within a single segment. The maximum percentage of discharge through a single segment cannot exceed 10% of the total.

To achieve less than 5% of total flow through each segment, the number of segments must be positively correlated with the stream width. For streams in the WQPD, there are two classifications of stream widths: narrow and wide.

- Narrow streams (≤15 feet wide)
- Wide streams (>15 feet wide).

To help meet the 5% goal, segments may also be distributed non-uniformly. Stream channel flow is biased toward the deepest point in the channel (thalweg) while the shallower parts of the channel see correspondingly less flow. If field personnel visually observe a higher percentage of flow through the thalweg, that portion of the stream should be divided into more segments. If discharge visually appears to be evenly spread across the channel the segments may be spread equidistant from one another.

Because streams are dynamic systems, completing a discharge measurement with no stations greater than 5% can be difficult at time, especially as surface water flows drop throughout the summer and fall. For this reason, a certain number of stations representing greater than 5% of the total discharge are allowed for narrow and wide streams:

- Narrow streams may include up to 6 stations
- Wide streams may include up to 4 stations

If the discharge measurement exceeds the allowed number of stations exceeding 5%, additional stations must be added. If any stations represent more than 10% of the total discharge, additional stations must be added.

9.7 Measuring Discharge

The velocity-area method is the standard USGS method for measuring discharge in open channel flows with water depths ≥0.2 feet. The procedure is separated by the instrument used to measure velocity due to the difference in data recording. The OTT MF Pro records all data internally while the Marsh McBirney relies on field personnel to manually record all data on the Discharge Measurement Form.

The OTT MF Pro is an electromagnetic velocity meter with built in data storage. The instrument incorporates all data entry and has a streamlined workflow. The OTT has approximately 18 hours of battery life when fully charged and when the OTT loses all battery it takes roughly 8 hours to fully charge. When the OTT is not in use do not store in direct sunlight as it can cause the battery to overheat. While using the OTT the backlight will go dim after 30 seconds of no activity and enters sleep mode after 60 seconds of no activity. These actions do not occur if meter is in real-time mode or while meter is measuring. After 30 minutes in sleep mode the meter will power off. To get out of sleep mode (any time before 30 minutes) push any key on the display and it will return to normal brightness and functions.

Before heading out in the field check the following:

- Batteries are fully charged
- Review the settings below in Table 1 to confirm they match the OTT

Table 1: Instrument settings on the OTT MF Pro to review before operation. If settings are to be changed, it is the responsibility of the technician to review the manufacturer's manual before implementing any changes.

Menu Options	**Selection/ Description**
Velocity Calibration	Zero checks the velocity follow manual for instructions.
Filter Parameters	Main filter: Fixed Period Averaging set to 30seconds (default).
Wet/Dry Threshold	Default (20%) This allows the meter to know when it is in or out of the water.
Auto Zero Depth	Set to On: The meter will automatically zero calibrate if sensor is taken out of water if this is turned off the user will have to manually zero sensor after 30 minutes of measurements.
EMI	Default (50Hz.) This sets the local line frequency for noise rejection.
Clock	Set Date and Time to 24-hour format.
USB	For computer use: Mass Storage (default) this mode operates similar to reading a hard drive on the computer. CDC mode is used to update firmware.
Language	English
Units	Set all units to English for velocity, flow, depth, and area.
Beeper	On (default) or Off
Flow Calculation	Mid-Section Calculation (default) This method divides the cross-section into individual flow sections.

Station Entry	Station non-fixed (default) The operator chooses proper spacing between station verticals.
Measurement Resolution	0.01 feet per second

Setting Up the Measurement

Before each discharge measurement, the OTT requests to know who is operating the instrument and the site name. These data are included in the final readout for future reference.

1. Press the power button on the handheld for 1 second to turn the unit on.
2. The handheld will automatically perform a Self-Test on all systems.
3. Once the Sensor Status reads, "Communicating" and the Sensor Voltage reads 7.9 – 8.0 volts, the Self-Test is complete (Figure 3).

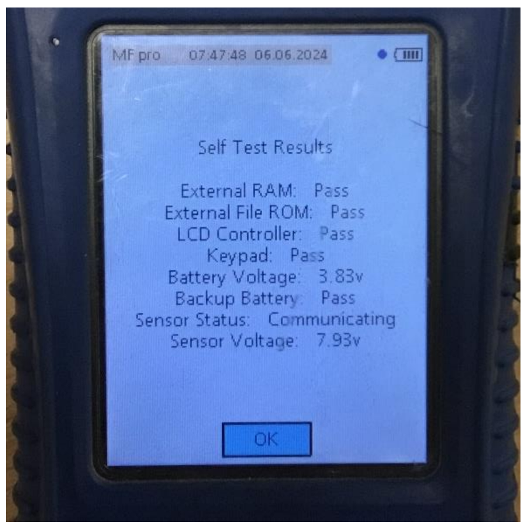

Figure 3: OTT Self-Test screen on start-up.

4. Select OK.
5. From the Main Menu, select "Profiler."
6. Select "Stream"
7. Enter the operator's name as LAST NAME_FIRST INITIAL (e.g John Doe would be DOE_J). Press OK.
8. Enter the site name as SITE ID_YYYYMMDD (e.g. T7_20240826). Press OK.
9. The meter is now set up for the site and ready to begin collecting data.

Establishing the Starting Edge

The OTT needs to know which side of the stream the operator begins/ends on and where the edges are relative to the tape measure.

1. The meter is now displaying the measurement menu. At the top of the screen Station 1 is displayed along with the depth (once it is measured).
2. Select Edge/Obstruction.
3. While looking downstream, select Right/Left Edge based on where you will begin measuring (Figure 4).

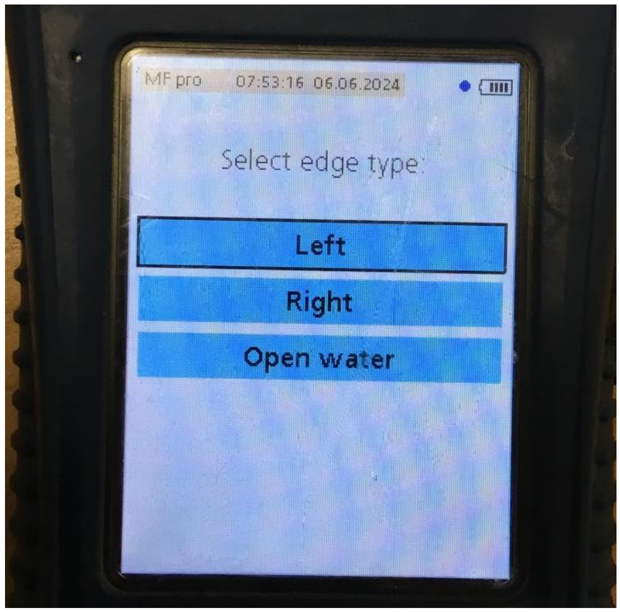

Figure 4: Selecting the edge from which the measurements will begin.

4. Enter the tape measure reading for the starting edge to one decimal point (#.#). Select OK (Figure 5).

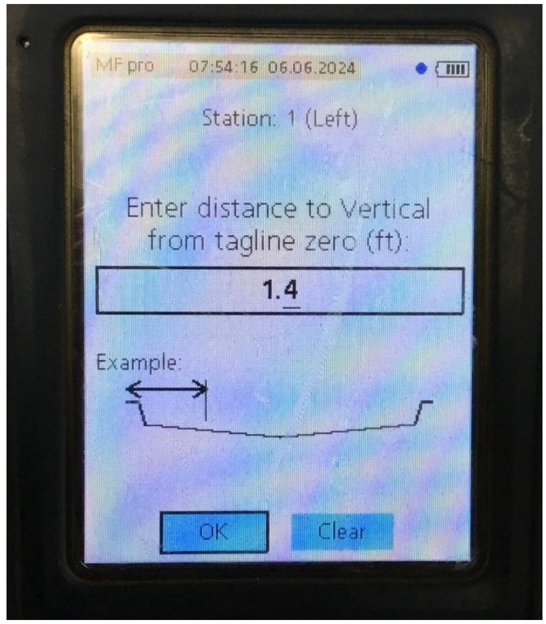

Figure 5: The location on the tape measure that marks the wetted edge must be noted.

5. Select "Set Depth".
6. The OTT automatically sets the depth to 0.0 at the edges. This is accurate in most cases, however if the bank is sufficiently steep enough that there is a measurable depth (≥0.2ft) along the edge, enter that depth. Select OK (Figure 6).

a. When the depth is set to >0.0 feet, the meter asks for the roughness coefficient:

Table 2: Roughness coefficients for edge calculations

Coefficient	Description	Examples
1.0	Smooth	Smooth edge with no vegetation (concrete, steel)
0.9		
0.8		
0.7		Brick with vegetation
0.6		Rough walls with heavy vegetation
0.5	Very Rough	

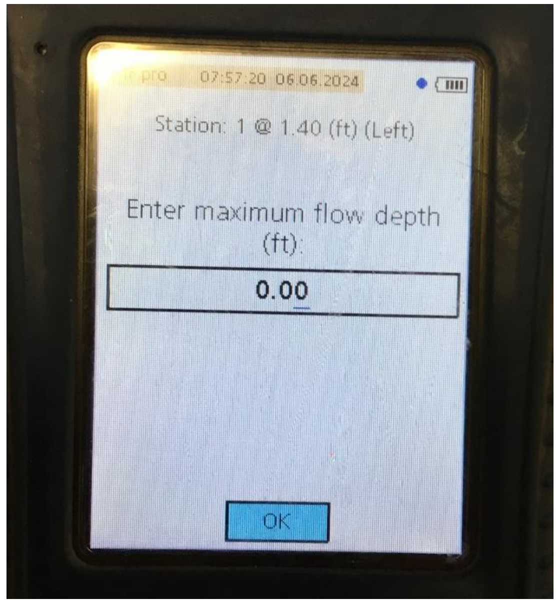

Figure 6: Setting the depth at each station.

7. Enter the current stage reference from a nearby staff gage using the format #.##.
8. The meter automatically sets the velocity to 0.00 ft/sec at the edges.
9. Select next to proceed to the next station.

Measuring Stream Segments

Now that the beginning edge is established, it is time to begin collecting data from each segment. This process will be repeated at each segment until the other side of the stream is reached.

At each station along the tape, position the base of the wading rod on the bottom of the stream. The operator must stand downstream of the wading rod and at least 18" off to the side of the wading rod. The wading rod must be held upright at approximately arm's length. This position is held to avoid interfering with the velocity measurement (Figure 7).

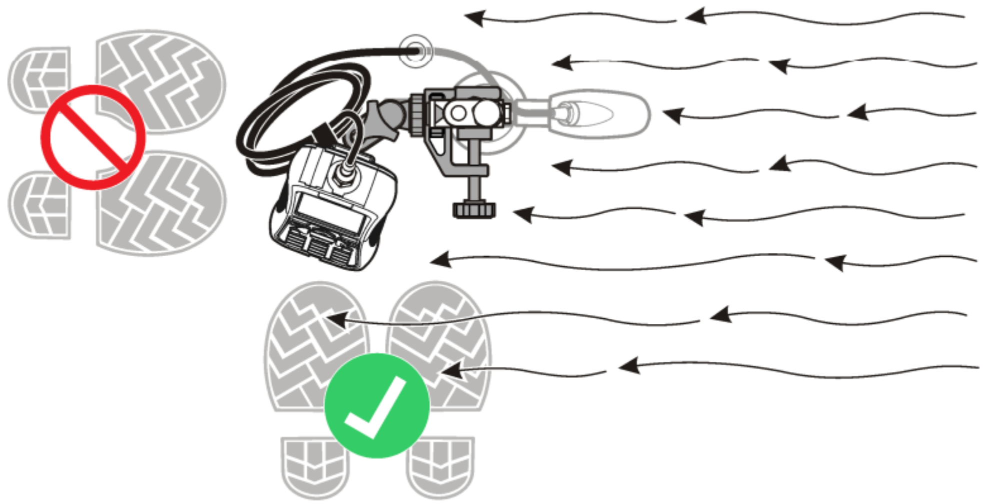

Figure 7: Position of operator while measuring velocity in relation to the wading rod and current direction. The goal is to minimize any impact of a person's legs on water velocity.

***Note**: If the stream bed is soft, avoid pushing the base of the wading rod into the substrate.

1. The top of the measurement menu screen should read Station 2 # ___ (ft).
2. Select Dist. to Vertical.
3. Enter the tape measure reading in tenths of feet (#.#).
4. Select OK
5. Enter the total depth as #.#. Select OK.
6. The Stage Reference is prefilled based on the previous station. Unless the stream flow is rapidly changing, this value will not change over the course of the discharge measurement (Figure 8). Select OK.

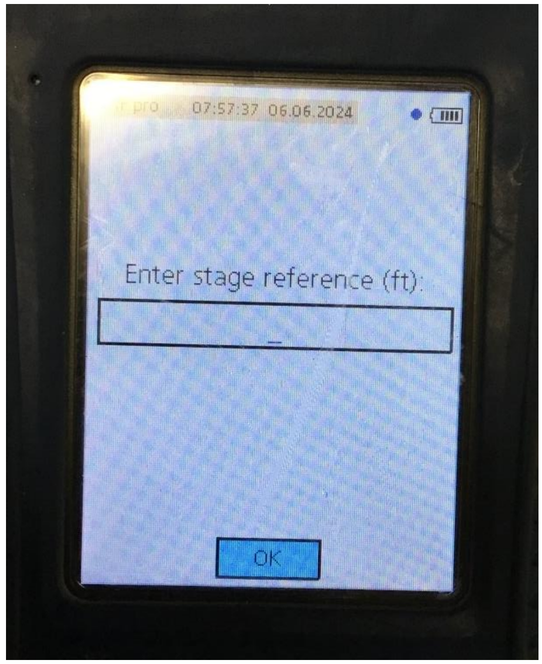

Figure 8: The stage reference is entered from a nearby staff gage. This reading should not change from station to station during a discharge measurement unless the discharge is changing rapidly from flood waters.

7. Select Measure Velocity.
8. Based on the total depth, select the appropriate number of points to measure at this station. Refer to Section 10.2 for more information on how many points to measure.
9. Based on how many points were selected on the previous screen, the meter will display the appropriate points to measure. Select the first measurement point.
10. Adjust the depth of the sensor on the wading rod to the correct depth from top of the stream. *The recommended depth displayed on the OTT is based on measuring from the bottom of the stream, not the top.*
11. Verify the meter is straight up and down and the sensor is pointed upstream and parallel with the flow direction. Select Capture.

The meter must be held as still as possible while the meter collects velocity data. The duration of data collection is 30 seconds.

12. Once the velocity data collection is complete, select OK to accept the velocity unless the measured velocity does not appear representative or if the meter was not stable and oriented correctly. If the velocity measurement needs to be repeated, select Repeat.

13. If a two or three point measurement was selected for this station, select the next depth to measure, otherwise select Main.
14. Select Next to proceed to the next station.
15. Repeat this procedure for each station until the far edge is reached.

Establishing the Final Edge

Once the other side of the channel is reached, the final station will be located on the wetted edge.

1. Select Edge/Obstruction.
2. While looking downstream, select Right/Left Edge based on where you will end measuring.
3. Enter the tape measure reading for the ending wetted edge to one decimal point (#.#). Select OK.
4. Select “Set Depth.”
5. The OTT automatically sets the dept to 0.0 at the edges. This is accurate in most cases, however if the bank is sufficiently steep enough that there is a measurable depth (≥0.2ft) along the edge, enter that depth. Select OK.
6. When the depth is set to >0.0 feet, the meter asks for the roughness coefficient. Use table # to select the appropriate coefficient.
7. Enter the current stage reference from nearby staff gage using the format #.##.
8. The meter automatically sets the velocity to 0.00 ft/sec at the edges if the depth is set to 0.0. If there is a non-zero depth entered, measure the velocity just as the previous segments.
9. Do NOT select “Save Data and Exit.”

Review Station Measurements

Before finalizing the discharge measurement, the data must be reviewed to verify enough segments were measured. If this reveals that more segments are needed, proceed to “Inserting Additional Stations.”

1. Select “Channel Summary.”
2. Review the depth and velocity profiles for any abnormal readings that might indicate an incorrect depth or velocity was entered. Refer to the “Correcting Depth and Velocity Measurements” section to address any errors.
3. On the third screen, the meter automatically calculates each station’s percentage of the total discharge. Review the stations to determine if additional stations are needed.
4. If no additional stations are needed, record the number of stations exceeding 5% and 10% on the field sheet.
5. If additional stations are needed, proceed to “Inserting Additional Stations”.

Correcting Depth and Velocity Measurements

If the review of velocity and depth readings reveals any erroneous measurements, the stations can be re-measured.

1. Count the number of bars (stations) to determine which station(s) needs to be re-measured.
2. Use the Prev and Next buttons at the bottom of the menu to navigate back through the stations.
3. Re-enter the depth and/or re-measure the velocity as needed.
4. Review the Channel Summary to verify the depth and velocity measurements are correct.

Inserting Additional Stations

If the operator needs to add more stations to the stream to meet the 5% guidance, visually review the channel flow distribution. More channels are needed where there is more depth/flow.

1. Use the Prev and Next buttons at the bottom of the menu to navigate back through the stations.
2. Where another station is needed, select Ins (insert) to create a new station. For example, to insert a new station between stations 3 and 4, navigate back to Station 3 then select Ins. A new station titled Station 4 will be created and the existing stations will be automatically given new sequential numbers.
3. Measure the velocity using the procedure in "Measuring Stream Segments" above.
4. Repeat this wherever additional stations are needed.
5. Review the Channel Summary to verify a sufficient number of stations have been measured to accurately the flow. Refer to section 9.6 for guidance on the number of stations and the acceptance criteria.
6. Record the number of stations exceeding 5% and 10% on the field sheet.

Record Discharge

The OTT records the total discharge in the Files menu which can be accessed from the main menu.

1. Select "Save Data and Exit".
2. Verify the file name is correct.
3. From the main menu select Profiler.
4. Select Files from the Profiler menu (Figure 9).

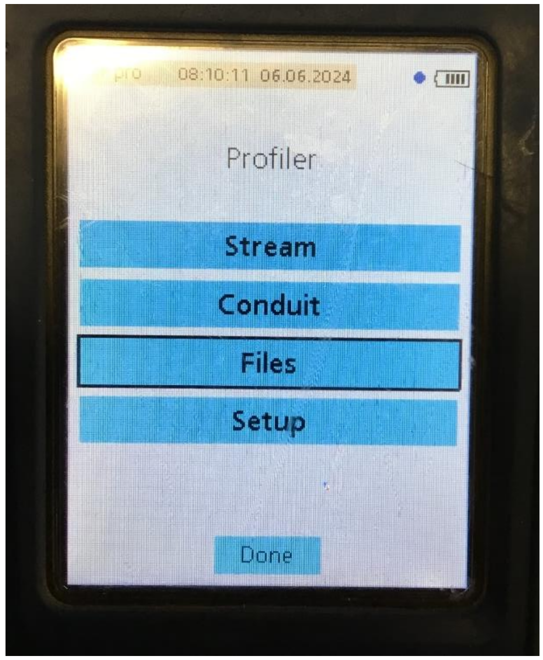

Figure 9: The Profiler menu allows the user to access the files save from previous measurements.

5. Use the Next and Prev. options at the bottom of the page to navigate to the measurement of interest. Tip: selecting Prev. displays the last page of measurements with the most recent measurement.
6. Using the arrow buttons, select the measurement of interest (Figure 10).

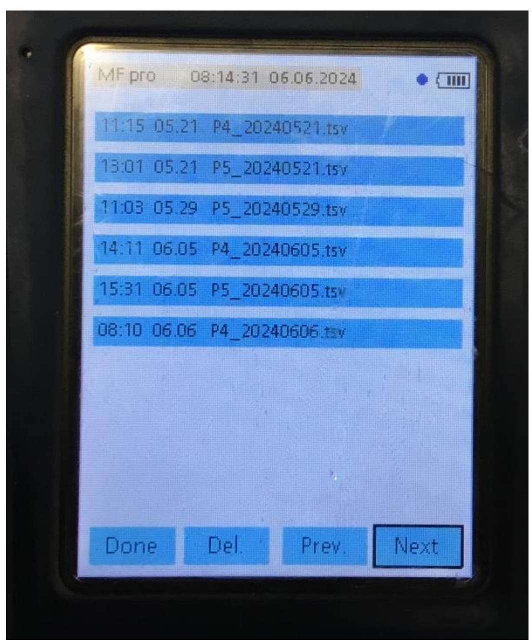

Figure 10: All previous profiles are stored in the OTT. The summary data of each profile can be accessed by the user.

7. A summary of the measurement will display, including the stream's total width and discharge.
8. Record the stream width and discharge on the field sheet.

10.0 DATA AND RECORDS MANAGEMENT.

All paper forms including discharge and SVF will be kept in Surface Water file folder (SWSVFYY). All paper forms will also be scanned to be stored in proper project folder within the LCCWQPD database along with any electronic forms. If OTT was used discharge data will be downloaded and stored in proper project folder.

***Note**: As long as paper copies have been scanned and saved in LCWQ database after one year paper copies may be discarded.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

When erratic velocity readings are observed, the sensor is cleaned with a mild detergent to remove oils and other contaminants.

At the conclusion of each discharge measurement the percent of total discharge for each station is calculated. If a narrow channel exceeds 6 stations with >5% of the total discharge, or a wide channel exceeds 4 stations with >5% of the total discharge, additional stations must be measured. If it is not feasible to add stations (at baseflow some streams require measurements at 0.2ft increments that do not provide room for additional stations), a note must be provided on the field sheet explaining why more stations were not added.

If any stations represent >10% of the total discharge, additional stations must be measured.

12.0 WASTE DISPOSAL

This procedure does not generate any waste materials.

13.0 REFERENCES

Department of Environmental Quality. 2020. DEQ Standard Operating Procedure for Total Discharge (WQDWQPBFM-03 V1). Helena, MT.

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United States Geological Survey. 2018. How Streamflow is measured.

United States Geological Survey.2019. National Field Manual for the Collection of Water-Quality Data.

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Water Quality Protection District
LEWIS AND CLARK COUNTY, MT

GROUNDWATER STATIC WATER LEVEL MEASUREMENTS STANDARD OPERATING PROCEDURE

(F01)

DATE OF ISSUE: 05/29/2026

REVISION: 1.1

	Hydrogeologist	05/29/2026
PREPARED BY	TITLE	DATE
APPROVED BY	TITLE	DATE

Revision History

The following table records any and all modifications to this document. Following any modification to this document, the Supervisor will have to approve before the modifications are effective.

Date	Individual	Section(s) Modified	Comments
08/26/2024	MCCLANAHAN, KEGAN	ALL	DOCUMENT CREATED
05/29/2026	MCCLANAHAN, KEGAN	2.0, 9.0	REVISED PROCEDURE TO REFLECT CURRENT PROTOCOLS.

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1.0 SCOPE AND APPLICABILITY

This procedure measures groundwater levels for non-regulatory research. This procedure is applicable to potable water source wells, irrigation wells, and monitoring wells.

2.0 SUMMARY OF METHOD

The user measures the depth to groundwater in a well using one of two instruments: a graduated water level meter (sounder) or a sonic water level meter (sonic). The user conducts two to three measurements at each well, waiting a minimum of two minutes between measurements to check for water table movement indicating non-static conditions. Once the depth to water is confirmed the measurement is recorded on physical field sheets and electronically through the ArcGIS Field Maps mobile application.

This procedure is adapted from the United States Geological Survey's Office of Groundwater: Groundwater Technical Procedures of the U.S. Geological Survey: GWPD 4 – Measuring water levels by use of an electric tape (Cunningham and Schalk, 2011).

3.0 DEFINITIONS

Definitions

ArcGIS™	Family of geographic information system technologies developed by the Environmental Systems Research Institute (ESRI).
Data Validation	Data validation is "an analyte and sample-specific process that extend the evaluation of data beyond method, procedural, or contractual compliance…" (U.S. EPA 2002, Section 3.1).
Data Verification	Data verification is "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements" (U.S. EPA 2002, Section 2.1).
Field Maps™	Online web map application within the ArcGIS platform that allows user to customize webmaps for the purposes of collecting digital field data.
Geodatabase	Collection of spatially oriented data with related tabular data.
Monitoring Tube	A small vertical pipe installed down the inside of a well casing (commonly made of polyvinylchloride, PVC). The pipe allows for a datalogger or water level meter to be safely deployed inside a well where the built-in pump infrastructure commonly interferes.

Saturated Zone	Vertical space below the unsaturated zone in which all void spaces are water filled. This zone is characterized by horizontal water movement. Also known as the Phreatic Zone.
Sonic	Water level meter that emits an acoustic signal down a well. By measuring the time delay before the echo is heard, the instrument is able to calculate the depth to groundwater. The instrument includes two depth settings and is temperature adjustable based on the average temperature inside the well column.
Sounder	Water level meter with graduated cable connecting a probe to the cable reel. The probe is lowered into a well until the probe contacts groundwater. At which time a buzzer/light is activated informing the operator that groundwater has been reached. The graduated cable allows the operator to measure the depth to groundwater.
Unsaturated Zone	Vertical space between the ground surface and the top of the water table. This zone is characterized by vertical groundwater movement, biological activity, and contaminant transport. Also known as the Vadose Zone.

Acronyms

AGOL	ArcGIS Online
GWIC	Groundwater Information Center
MBMG	Montana Bureau of Mines and Geology
PWS	Public Water Supply
QA	Quality assurance
QC	Quality control
SWL	Static Water Level

Units

<	less than
>	greater than
±	plus or minus
≤	less than or equal to
≥	greater than or equal to

4.0 HEALTH AND SAFETY

This procedure involves working in the natural environment. Conditions may include uneven terrain, inclement weather, extreme heat and cold, electrical hazards, and potentially dangerous wildlife. Wells are commonly inhabited with spiders and insects that must be approached with care. Accessing wells also commonly involves traversing fields with tall grass that are common habitats for snakes. If anyone is bitten, scratched, or stung by wildlife, seek medical attention immediately.

Weather conditions range from extreme heat in the summer to extreme cold in the winter. Field personnel must dress appropriately for the weather. Summer conditions can expose field personnel to sunburn and heat exhaustion / heat stroke while winter conditions can cause hypothermia and frostbite. High winds are also common in the LCCWQPD. Personnel must be cautious of airborne debris that could cause bodily harm.

Accessing a well commonly requires personnel to traverse fences. Be aware of electrified fencing and if the fencing is energized. Do not assume it is de-energized even if it was recently crossed. When in doubt always request the property owner provide an alternative route to the well or confirm the fencing is de-energized. Electrical shock can cause serious and life-threatening bodily harm. Electrical current causes muscle contractions which can cause a person's hand to grip the source of electricity, preventing the person from letting go which severely increases the exposure and likelihood of fatal effects.

Personal Protection Equipment:

- Close-toed footwear with ankle support
- Hat
- Long pants
- Leather gloves
- Sunscreen
- Winter clothing (when applicable)

5.0 CAUTIONS

Potable water source wells have multiple components that can interfere with water level measurements. Inside of the well casing is a wiring harness that extends from the well cap down to the well pump. Lowering a sounder into the casing can allow the sounder's probe to be entangled with the wires. If this occurs, pulling on the sounder's cable may cause damage to the sounder and/or the pump wiring. To extract the sounder, a well driller may be required to remove the pump assembly from the well.

The sonic water level meter is a robust piece of instrumentation with the exception of the nozzle. The nozzle is exposed to potential damage if the instrument is dropped. Keep the instrument in the protective hard case unless actively performing a measurement.

The acts of opening a well cap and introducing either a sounder or sonic to the well can introduce contaminants to the well. Contaminants can include, but are not limited to, bacteria, sediment, insects, and spiders. After every well measurement is complete and recorded, the instrument used must be decontaminated. This applies to wells on the same property as many contaminants may be isolated to a single well and not the local groundwater. Failure to decontaminate between wells can contaminate an otherwise clean well.

6.0 INTERFERENCES

This procedure measures the natural static groundwater level which requires the local groundwater to not be disturbed (pumped) recently. The majority of wells in the LCCWQPD that are monitored are used for residential potable water. Therefore, it is common for local groundwater levels to be lowered due to recent pumping (laundry, showering, irrigation, etc.). In most cases the effects of recent pumping are minimal, and the groundwater returns to its natural static condition over the course of several minutes. If a property has been irrigating for an extended period of time, the local groundwater level may be substantially depressed and require a significant length of time to recover to its natural position. In these situations, it is best to coordinate with the property owner to find the best time to measure the well.

The sounder employs a simple electrical circuit to detect water. Depending on the sensitivity of the meter, small amounts of moisture on the well casing, unrelated to the groundwater table, can complete the circuit and trip the buzzer. This gives a false-positive that can yield an incorrect SWL measurement. Commonly this situation does not give a strong, constant buzzer as there is insufficient moisture to fully complete the circuit. A strong indication this interference is occurring is an intermittent buzzer. Field personnel must always review recent measurements to help discern false-positive measurements from true SWL measurements.

The sonic water level meter can give false depth readings due to physical obstructions in the well casing. Pump equipment, wiring, and pipes, and pitless adaptors inside the well casing can impede the sound waves generated by the sonic water level meter. This is evidenced by either extremely deep or extremely shallow measurements. Field personnel must always review recent measurements to help discern these extreme measurements from true SWL measurements.

7.0 PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

Field personnel must be familiar with basic hand tools (wrenches) and ArcGIS Field Maps. All new field personnel must be trained by the Hydrogeologist before performing field work without supervision.

8.0 EQUIPMENT AND SUPPLIES

Equipment

- Water level meter (sounder)
- Sonic water level meter (sonic)
- iPad
- iPad vehicle charge cord
- Field sheets
- Pencils / pens (indelible ink only)
- Assorted wrenches (7/16", 1/2", 9/16")
- Allen wrench set
- 3/8" drive socket wrench
- 14mm socket for 3/8" drive socket wrench
- Cordless drill with 3/8" drive socket adaptor (optional)
- Hammer

Supplies

- 70% isopropyl alcohol in spray bottle
- Alconox solution in spray bottle
- Paper towels
- Nitrile gloves

Personal Protection Equipment

- Close-toed footwear with ankle support
- Hat
- Long pants
- Leather gloves
- Sunscreen

9.0 PROCEDURE

The procedure includes a general background on groundwater flow patterns in the saturated and unsaturated zones and background on the common types of well caps. Procedures for using both a graduated water level meter and a sonic water level meter are included. Procedures are adapted from Cunningham and Schalk (2011).

9.1 Background

Groundwater flows downward through the unsaturated (vadose) zone towards the saturated (phreatic) zone. The natural process of groundwater flowing downward comes into equilibrium with the rate at which the groundwater flows to the regional base level (Lake Helena). This equilibrium creates a long-term, relatively stable, surface at the top of the phreatic zone known as the water table (Figure 1). The water table fluctuates over daily and seasonal cycles due to snow melt, precipitation, residential water use, irrigation, and flooding.

The depth at which the water table is stable is known as the static water level (SWL). Due to the slow rate at which natural groundwater levels fluctuate, stability across several minutes implies that no anthropogenic forces are affecting the water table, so any changes are due to long-term natural forces. Natural forces can then be extrapolated across larger areas to better assess the water resources dynamics. SWL measurements require multiple measurements spread out over time to evaluate if local anthropogenic forces have affected the SWL measurement.

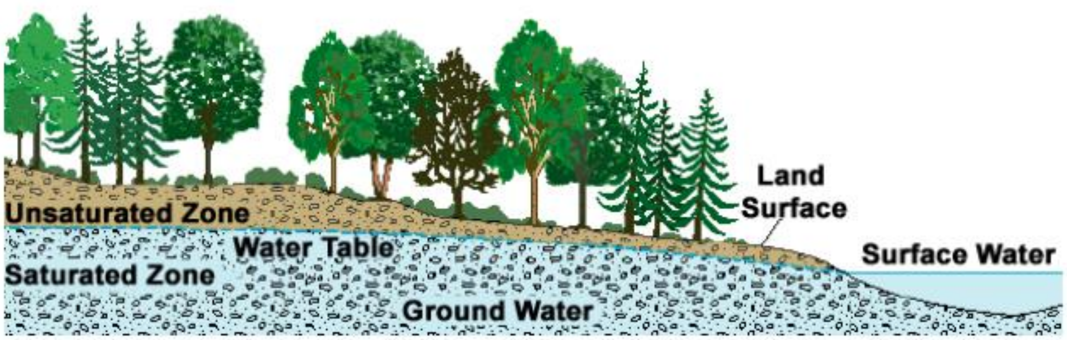

Figure 1: Generalized diagram of the water table following the topography. Source: Unites States Geological Survey (https://wwwrcamnl.wr.usgs.gov/uzf/unsatflow/unsatflow.html)

9.2 Workflow

When arriving at a well, personnel will remove the cap off the top of the well. Each well is measured by either lowering a sounder into the well column or using a sonic at the top of the casing. An initial measurement is collected as a reference point. In case the local groundwater level is not in a static condition due to recent water usage (e.g. showering, laundry, irrigation, etc), a second measurement is collected after waiting a minimum of two minutes following the initial measurement. If the second measurement is ±0.1 feet of the original measurement, measurement is considered static and is recorded. If the second measurement is not in agreement with the initial measurement, a third measurement is collected after an additional 2-minute waiting period. If this third measurement is ±0.1 feet from one of the previous measurements, the third measurement is considered the SWL. If the third measurement is not ±0.1 feet from the second measurement, the third measurement is recorded, however, it is documented the water level was nonstatic.

The final measurement is then recorded on a physical field sheet and electronically in the ArcGIS Field Maps application.

All equipment is decontaminated following each well measurement is completed to prevent cross-contamination between wells.

9.3 Well Head Construction

Groundwater wells are constructed with one of several types of well heads at the top of the casing. Well casings are terminated either at the ground surface or above the ground surface. The location of the top of the well defines the types of well caps that can be installed. Below is a general guide to the common types of well caps within the LCCWQPD.

Above Ground Well Caps

Above ground well caps are the most common styles of well caps. The well casings typically extend 18-24 inches above the ground surface.

Non-Sealing Well Cap

Most residential wells are terminated with a standard non-sealed well cap (Figure 2). These caps do not include a sealing surface such as a gasket, however they are also easy to remove. They are typically kept in place by 3-4 bolts which go through the sides of the cap and pinch against the well casing. Field personnel must be cautious of re-installing the caps to avoid tightening a bolt into any electrical wires – this can cause damage to a pump and presents a substantial electrical shock hazard to people.

Figure 2: Standard non-sealing well cap on a well.

PWS Style Well Cap

Public water supplies (PWS) are required to have a sealed well cap to prevent the intrusion of any contaminants (e.g. insects) into the well column (Figure 3). These caps consist of two parts: a collar and cap. The collar is mounted onto the well casing below the cap. The cap is then secured onto the collar with multiple bolts. The caps are removed by first removing the bolts around the perimeter of the cap then lifting up on the cap itself. Care should be taken when removing and reinstalling the caps to prevent damage to the gasket.

Figure 3: PWS style sealed well cap. The vertical bolts around the perimeter secure

the upper cap to the lower collar. A padlock has been installed for additional security.

Split Well Cap

The last style of above ground well caps are split caps (Figure 4). These caps, as the name implies, come in two pieces held together by a large gasket. The cap is installed into the top of a well before the 4 bolts on the top are tightened. As the bolts are tightened the gasket is compressed and forced outward into the well casing. This act seals the well casing very well; however the cap is not easily removed. For this reason, these caps are often installed with plumbing coming out of them for irrigation systems or other permanent uses. To access these wells, there is often a small port on the top of the well (see the top half of the cap in Figure 4). If an access port is not present, the well is considered unmeasureable by the LCCWQPD as we do not remove permanently installed well caps.

Figure 4: Split well caps are often used with irrigation systems or other permanent plumbing does not require frequent removal of the cap.

Below Ground Well Caps (Flush Mount)

Monitoring wells are commonly installed below ground level and have a protective plate installed flush with the ground surface (Figure 5). The well casing is commonly constructed of polyvinylchloride (PVC) and include a separate well cap underneath the main protective plate. The plate is secured using up to four bolts around the perimeter that must be fully removed. Once the cover plate is removed the well cap can be removed (Figure 6). The center pin in the cap can be turned counterclockwise to loosen the cap.

Figure 5: A flush mount well is protected by a steel cover plate that is similar to a sewer manhole cover.

Figure 6: Once the cover plate of a flush mount well is removed the actual PVC well casing and cap are visible. Be cautious of spiders and insects underneath the cover plate.

9.4 Preparing to Collect Measurement

Before arriving on site, field personnel must review the well to verify how to access the well property and if the property owner must be notified ahead of time.

1. On the iPad, open the ArcGIS Field Maps application.
2. Open the LCCWQPD DATABASE: WELL NETWORK map.
3. Navigate to the well and select it on the map.
4. Two layers will pop-up:
    a. Well Locations: this layer includes all background data on the well (property owners, contact information, well construction, monitoring frequency, and which instrument to use). **This layer has all well measurements related to it based on each well's unique ID.**
    b. Month of Last Collection: This layer tracks when the well was last measured to coordinate field work across the team.
5. Select the Well Location layer.
6. Review the following fields at a minimum:

Table 1: Minimum fields to review before arriving to a property.

Field	Description
Site Name	The site name indicates who owns the well (private citizen, Lewis and Clark County, etc).
Well Address	Physical location of the well that can be used for driving directions.

Contact Residents?	Certain residents require the WQPD to notify them before arriving on site. This is commonly due to aggressive pets that need to be contained or gate access.
Report SWL	Certain residents have requested that the WQPD report the water level immediately after collecting the measurement via a door hanger or by email.
Access Notes	Most properties include notes to describe how to enter the property, where to park, which gate(s) to enter through, etc.
Remarks	This field can include additional information on property access, or if the well requires special considerations.
Tools Required	Which size wrenches and keys are required to access the well cap.
SWL Equipment	Which instrument is commonly used at this well.
Monitoring Tube	Is a monitoring tube installed in the well. See 3.0 Definitions for more information on a monitoring tube.
Monitoring Frequency	How often is the well monitored.
Status	Is the well active (currently monitored) or inactive (no longer monitored). Wells can be changed to inactive if a property owner no longer wants the WQPD on the property. This can also happen if the well goes dry, equipment will not read etc.

7. Locate the GWIC on the Field Sheet. Review the past SWL measurements.

Note the past SWL measurements on the Field Sheet have been corrected for the stick-up height of the well casing meaning the past measurements are showing SWL from ground level. New measurements are collected from the top of the casing which can add up to 1-2 feet to the measurement. This effect can be noticeable with very shallow SWLs.

8. Based on the SWL Equipment field, follow the procedure in 9.5 for either the Sounder or Sonic.

9.5 Collecting the Water Level Measurement

Each well has a designated instrument to use based on past measurements. Field personnel may deviate from the designated instrument if measurements are not possible with the designated instrument due to interference. **Be cautious of lowering the sounder into a well that does not normally use a sounder as there could be obstructions in the well that could become entangled with the sounder.** Removing a stuck sounder requires a well driller to remove the well pump; this costs the LCCWQPD money and the property owner to not have potable water for several hours.

9.5.1 Water Level Meter (Sounder)

The sounder is an instrument with a long, graduated cable protecting two wires that is lowered into the well. The wires terminate in a probe that isolates the two wires, normally maintaining an open circuit. The wires are exposed to a small electrical current via a battery. When the end of the wires comes into contact with water, the electrical circuit is completed by the water which triggers a buzzer and light on the instrument.

Initial Measurement

1. Remove the well cap to gain access to the well.
2. Turn the sensitivity dial on the sounder to the 4-5 position. The sensitivity may need to be adjusted to account for moisture on the well casing itself. If intermittent water is detected as the probe descends, consider decreasing the sensitivity.
3. Test the sounder using the “Test” button on the face of the reel. If the sounder fails to emit a noise and/or activate the light, replace the batteries.
4. Each well has a marking around the top edge of the casing to indicate where the probe should be lowered to avoid obstructions.
5. Slowly lower the probe into the well.

As the probe is lowered, keep an eye on the increasing weight. If the probe appears lighter, it is likely caught on something. If this happens, slowly raise the probe until the weight is felt again and try lowering the probe again.

6. The sounder’s light and buzzer will activate when the probe contacts water.
7. Measure the depth from the top of the casing (Figure 7). Flush mount wells are measured from the top of the steel plate (Figure 8).

Figure 7: Wells that stick up above the ground surface (stick-up height) are measured from the top of the casing (red circle).

Figure 8: Wells that terminate flush with the ground surface (flush mount) are measured from the steel collar built into the concrete (red circle).

8. Check this measurement against the most recent SWL measurements.
9. If this measurement is consistent with past measurements, this is considered the initial measurement.
10. If this measurement is inconsistent, review historical measurements in Field Maps and consult colleagues to determine if this measurement is consistent with historical records. Some wells fluctuate substantially throughout each year.

Second Measurement

11. Pull 2-3 feet of cable up to reset the measurement.
12. To verify the water level is not moving (indicating the water level is not static), wait a minimum of two minutes before recording another measurement.
13. Repeat the measurement.

14. If the second measurement is less than ±0.1 feet of the initial measurement, the second measurement is accepted. Document the date/time of the second measurement. Proceed to Section 9.6 Data Entry.
15. If the second measurement is greater than ±0.1 feet of the initial measurement, conduct a third measurement.

Third Measurement

1. Wait a minimum of two minutes before recording another measurement.
2. Repeat the measurement.
3. If this measurement is less than ±0.1 feet from the second measurement, the groundwater is considered static, and the third measurement is accepted. Proceed to Section 9.6 Data Entry.
4. If the third measurement is greater than ±0.1 feet from the second measurement, the groundwater is considered nonstatic, and the third measurement is accepted. Document the date/time of the third measurement.

9.5.2 Sonic Water Level Meter (Sonic)

Whereas the graduated Sounder relies on inserting a probe into the well casing, the Sonic instrument sits atop the well casing and does not enter the casing. The Sounder emits an acoustic pulse down the well casing. The instrument then detects the echo of the pulse off the water table surface. Based on the timing of the echo, the sonic then calculates the depth to the water table. The speed of sound is temperature dependent, so the Sonic allows the user to adjust the temperature setting in increments of 1°F.

Initial Measurement

5. Remove the well cap to gain access to the well.
6. Place either the round white isolator or the yellow rectangular isolator across the top of the well casing.
7. Insert the nozzle of the Sonic through the central hole in the isolator.
8. While aiming the nozzle straight down, press the red POWER ON button on the Sonic. This starts the instrument and simultaneously initiates a reading (Figure 9).

Figure 9: Control interface for the Sonic. The RED Power ON button also triggers a measurement from the instrument.

9. The instrument will send three acoustic pulses down the well. As each pulse echoes back to the Sonic, the instrument will refine the measurement on the screen.

Note the temperature setting. By default, the air columns in the groundwater wells averages 46°F. Adjust the temperature up/down using the switch on the top of the Sonic.

10. The instrument has two depth settings. The Normal (Nml) setting is for SWL from 10 to 500 feet (fast pulses). The Deep setting is for SWL from 200 to 1200 feet (slow pulses).
11. For wells with SWL measurements over 200 feet, consider using the top switch to change to the Deep setting. All other measurements are conducted in Normal setting.
12. The instrument defaults to the depth setting that was last used. If the first measurement was conducted using the incorrect depth setting, repeat the initial measurement with the correct depth setting. Pressing the red button again triggers a new measurement.
13. Check this measurement against the most recent SWL measurements.
16. If this measurement is consistent with past measurements, this is considered the initial measurement.
17. If this measurement is inconsistent, review historical measurements in Field Maps and consult colleagues to determine if this measurement is consistent with historical records. Some wells fluctuate substantially throughout each year.

Second Measurement

14. To verify the water level is not moving (indicating the water level is not static), wait a minimum of two minutes before recording another measurement.
15. Repeat the measurement.
16. If the second measurement is less than ±0.1 inches of the initial measurement, the second measurement is accepted. Document the date/time of the second measurement. Proceed to Section 9.6 Data Entry.
17. If the second measurement is greater than ±0.1 inches of the initial measurement, conduct a third measurement.

Third Measurement

18. Wait a minimum of two minutes before recording another measurement.
19. Place either the round white isolator or the yellow rectangular isolator across the top of the well casing.
20. Insert the nozzle of the Sonic into the central hole in the isolator.
21. While aiming the nozzle straight down, press the red POWER ON button on the Sonic to initiate a third reading.
22. If this measurement is less than ±0.1 feet from the second measurement, the groundwater is considered static, and the third measurement is accepted. Proceed to Section 9.6 Data Entry.
23. If the third measurement is greater than ±0.1 feet from the second measurement, the groundwater is considered nonstatic, and the third measurement is accepted. Document the date/time of the third measurement. Proceed to Section 9.6 Data Entry.

9.6 Data Entry

Once the SWL has been confirmed by either a second or third measurement, the data must be recorded. All SWL measurements are recorded on a physical field sheet and electronically in the ArcGIS Field Maps application. The Well Quantity table in the Field Maps application contains all SWL measurements in the LCWQPD Geodatabase and is related to the Well Locations feature layer. This allows for easy association of a new SWL measurement to a specific well.

Field Sheet

1. Locate the well's GWIC identifier on the field sheet.
2. Record the confirmed measurement.
    a. Measurements with the Sounder are recorded to one decimal place.

   b. Measurements with the Sonic are recorded to one decimal place.
3. Record the date and time of the confirmation measurement (second or third measurement).
4. If the SWL was nonstatic (moving), note this in the Remarks field.
5. Add any remarks pertaining to current site conditions or the measurement.

ArcGIS Field Maps Application

1. On the iPad, open the ArcGIS Field Maps application.
2. Open the *LCCWQPD DATABASE: WELL NETWORK* map.
3. Navigate to the well and select it on the map.
4. Select the Well Location layer.
5. Select the Related Records icon in the bottom-left corner of the window (Figure 10).

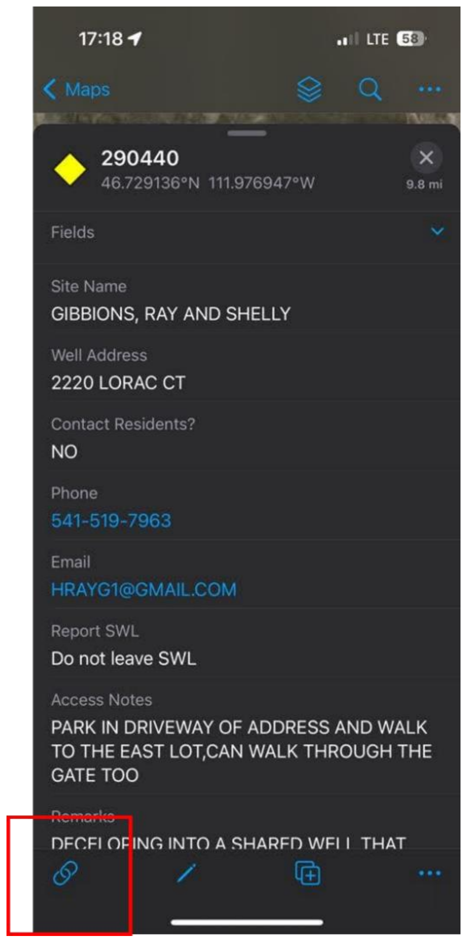

Figure 10: The Related Records icon in the lower left-hand corner of the screen automatically shows all records from related tables that pertain to the selected well.

6. In the list of related tables, select “Well Quantity”.
7. Select “Add”.
8. Select the date_measured field. The current date and time will auto-populate. Change the time to reflect the time of the measurement as needed.
9. In the swl_toc (SWL from Top of Casing) field enter the confirmed measurement to 1 decimal place.
10. The “dry” and “nonstatic” fields auto-populate with NO. Modify these as needed.
11. In the “method” field select the instrument used to collect the measurement.
12. If the Sonic instrument is selected in Step 11, an additional field will appear requesting the temperature setting of the Sonic. Enter the temperature as it was set on the Sonic during the confirmed measurement.
13. Select the “measured_by” field and choose the individual who collected the measurement.
14. Add any remarks pertaining to current site conditions or the measurement.
15. Select “Submit” in the top-right corner of the window.

9.7 Updating Month of Last Measurement

To track which wells have been measured throughout each month and quarter, the “Month of Last Well Measurement” feature layer needs to be manually updated.

1. On the iPad, open the ArcGIS Field Maps application.
2. Open the *LCCWQPD DATABASE: WELL NETWORK* map.
3. Navigate to the well and select it on the map.
4. Select the “Month of Last Measurement” feature layer.
5. Select Edit (Figure 11).

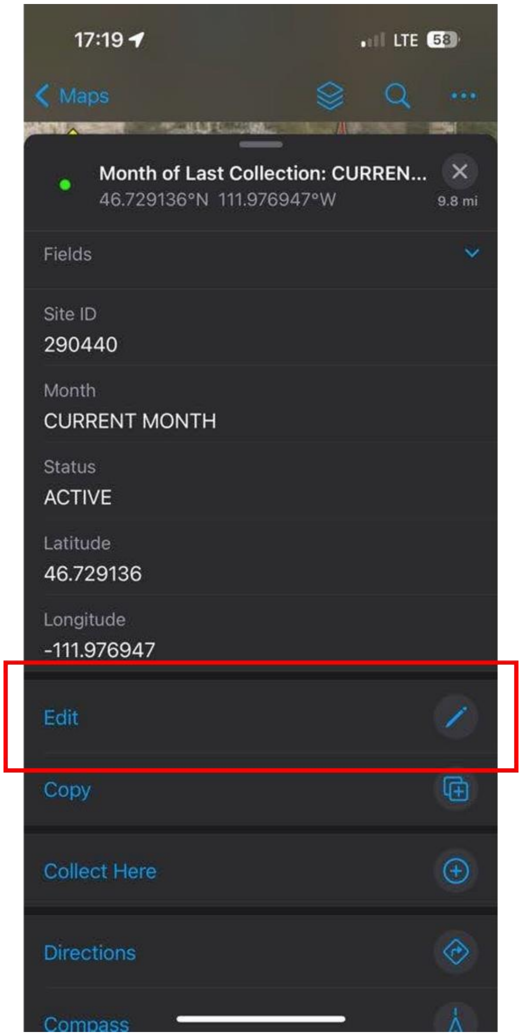

Figure 11: Field personnel may edit existing features (red rectangle). Edits can include updating the record with new data, such as the month of collection, or the location of the feature.

6. Select and change the field to either "Current Month" or Current Quarter"(Figure 12).

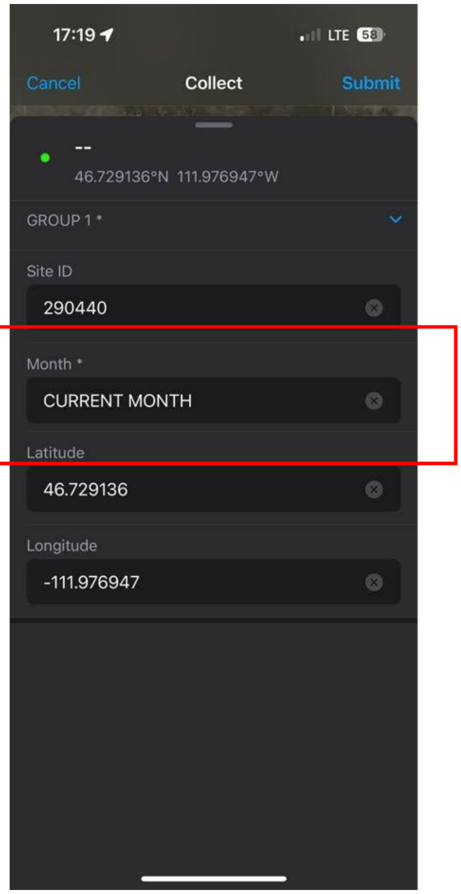

Figure 12: Using the drop-down menu, select the most appropriate month/quarter after completing a measurement (red rectangle).

7. Select Submit.
8. The color symbology in the center of the well icon will change to reflect the change in month/quarter. This allows easy tracking between field personnel of which well measurements are outstanding each month/quarter.

The new measurement has been completed and recorded. Once the "Month of Last Well Measurement" table has been updated in Section 9.7 field personnel may proceed to decontaminating the field equipment. Decontamination procedures are found in the Decontamination of Field Equipment (F08) standard operating procedure.

10.0 DATA AND RECORDS MANAGEMENT

Field personnel document raw measurements in the field. No processed/calculated data are recorded in this procedure. Data entry occurs on physical field sheets and an electronic form built into the ArcGIS Field Maps application. At the end of each month, field personnel deliver the physical field sheets to the Hydrogeologist for data processing. The Hydrogeologist references the electronic record vs the physical field sheet record during the quality control evaluation of the data.

Physical field sheets are stored in the YYYY Well Level Field Sheets folder in the office. All field sheet are scanned and digitally stored at Lewis & Clark County\LCWQPD - Documents_Projects\00_Routine Monitoring\Groundwater Monitoring\Scanned Field Sheets\YYYY. After one year the physical field sheets are verified to be electronically backed up and can be destroyed.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL

All field measurements consist of an initial review of past SWL data. The first SWL measurement is collected before waiting a minimum of two minutes before collecting a second measurement. The second measurement (and third measurement if needed) ensure the water level is static and representative of the water table. New measurements are recorded on physical field sheets and electronically in the geodatabase. Dual recording can highlight any typographical errors created during data recording.

All new measurements are processed through a quality control Jupyter Notebook script to compare new measurements against historic trends. Any measurements that exhibit a significant change in SWL or are outside historic margins are flagged and reviewed by the Hydrogeologist. New measurements may be collected to reconcile any quality control flags.

12.0 WASTE DISPOSAL

This procedure does not generate nor consume any hazardous waste.

13.0 REFERENCES

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p.