From: **Miranda Menzies** <menzies.miranda@gmail.com>
Date: Thu, Feb 11, 2021 at 2:45 PM
Subject: Ogden Valley Ground Water Study
To: <teresawilhelmsen@utah.gov>, Eric Jones <ericjones@utah.gov>, Lucy Jordan <lucyjordan@utah.gov>

Dear Ms Wilhelmsen,
Attached are my thoughts about the Hydrogeological Study prepared by UGS for the Ogden Valley. The County and Weber Basin are now moving forward to complete regional engineering studies, so this seems timely to get these comments to you. The two documents are 1) a policy-directed set of comments including suggestions for the State Engineer, based upon the findings of the UGS studies, and some additional water sampling that I did in 2020 and 2) technical comments for UGS staff. Please let me know if you have any questions, or if you wish to convene a meeting,
best regards,
Miranda Menzies
(513) 368-4356

Policy Comments on UGS Ogden Valley Hydrogeology Report (Jordan, 2019)

E. Miranda Menzies, Eden Utah, Jan 2021

During the Ogden Valley Hydrogeology Utah Geological Survey (UGS) Geology Presentation on December 17, 2020 Theresa Wilhelmson, State Engineer, requested comments. At the same time, Weber County is partnering with Weber Basin Conservancy District on a water supply study, and simultaneously is contracting with an engineering firm (Sunrise Engineering) for a sewage management study for the Ogden Valley. I therefore offer these comments to both the report and the County's efforts.

The County and Valley appears to be headed towards some very expensive public works projects, and my primary goal in providing this information is to make those studies and projects as effective and cost-efficient as possible. From painful personal and professional experience, there is no more expensive and sometimes disastrous way to proceed than with the wrong assumptions at the beginning of an effort. Policies need to be based on verified facts, with assumptions clearly flagged and understood.

But firstly, thanks to the Utah Geological Survey team for an excellent comprehensive report, which brings together a massive amount of factual information. It is simply an outstanding effort, beautifully prepared and edited, and nothing I am stating here should in any way detract from that. These folks planned and executed a superb project, which will stand for many years as the go-to reference. However, some inconsistencies need to be checked.

While I am Chair of the Board of Trustees of Wolf Creek Water and Sewer District, and also a Director of the Wolf Creek Irrigation Company, these comments are not offered as a formal position of any organization of which I am a part. They are my personal comments as a full-time resident, advised by my background prior to retirement as an environmental consultant and geologist.

Throughout this document, I would appreciate feedback from others. Please tell me if I am wrong, based on information I am unaware of, or if I have misunderstood or misinterpreted what I have read or been told. There are a lot of people who have lived in the valley for decades who have deeply a rooted understanding of the water flows, from living, working and ranching here. Their input would help everyone, so I urge the county and its partners and consultants not to make hasty assumptions about the best way forward and to get public input throughout their deliberations.

This document is structured firstly with general comments on both water issues and sewage management and at the end there are some specific minor questions/requests for clarification related to the UGS report. Specific items and recommendations, deriving from review of the report, are summarized here for convenience:

1. Population, build out and usage data should be updated by the county's and Weber Basin's consultants, to include 2020 census data, and updated development estimates. Some usage data in the report is inconsistent, and assumptions will need to be checked.
2. Greater attention needs to be focused on secondary water supply. The county should resume the previous effort in the Planning Department to establish an ordinance for ensuring secondary water supply for developments, to make sure that there is sufficient supply for both culinary and secondary use, before approving subdivision plats. Culinary companies should be supported in their efforts to require secondary water for development.

3. The State Engineer's office should monitor for significant irrigation overuse from individual wells, and require metering in these cases, with comparison to contracts or irrigation shares held.
4. Private drinking water supply well owners should be strongly encouraged to periodically check their wells for nitrate concentrations and bacteria.
5. Geology contained in the report confirms that locations with well yields suitable for municipal supply are extremely limited. Providing individual house supply is much more widely possible, but only at low density.
6. Historical water rights are a further major limitation to expanding supply.
7. In the long term, increasing well withdrawals for irrigation will lead to slowing groundwater movement, increasing nitrate concentrations, and decreasing groundwater discharge to Pineview Reservoir.
8. High density developments should be required to connect to treatment plants, which need to be sited based both on development locations, and with attention to where high-quality treated effluent can be reused for irrigation. Low density remote developments would be more cost-effectively served with private wells and high-efficiency, well-maintained septic systems.
9. Nitrate groundwater impacts and hydrogeology in the vicinities suggests that the North Arm and Huntsville areas would not be suitable for effluent rapid infiltration basins or culinary water wells. Additional sampling confirmed the nitrate concentrations in shallow groundwater reported by UGS.

GENERAL COMMENTS

1. Population Data and Water Calculations

The report cites documents from 2014 for population and development data (Reference C Ewert, 2014). In 2016, the General Plan for Ogden Valley was approved by the County Commissioners, and clarified both the estimates of likely build-out number of houses, and population. In particular, numbers of housing units for the valley floor:

What were the maximum buildout assumptions for the Valley floor that went into this analysis?

Built Units:	3,762
Platted Vacant Parcels:	2,563
Approved Resort Units:	5,300
Total Built, Platted, Approved Units in Valley:	11,625
Unplatted, but Zoned Units on Valley Floor:	4,000
Potential Maximum Valley Floor Buildout:	15,625

Want more information on where these numbers came from? See page 14 of the Plan Study Appendix

Note that the 15,625 total includes resort units, which are not located on the valley floor.

Since 2016, approximately 300 units have been built, with on-site septic systems, mostly on the valley floor (Note 1). Roughly half were in Huntsville, and half in Liberty/Eden. The combination of these data suggests we now have approximately 4000 built units in the valley floor, and a total of approximately 4300 within the watershed. The number of approved additional "resort units" at Powder Mountain and Snowbasin is 5300, of which Summit or their landowners have constructed approximately 40 within the Summit development as of November 2020.

These data will also be updated by the 2020 Census, which is reportedly going to be available in March 2021. This population data needs to be updated in the county's ongoing studies. The assumption of 28,000 full-time residents assumed by the UGS report p. 93 appears high.

2. Water Use Calculations

At the same time, there is on-going development pressure, visible in the form of new homes, being built all over the valley. Many of these are second homes. However, the pandemic of 2020 brought many second-home owners to live in the valley on a semi-permanent basis, with remote working, which may continue into the future.

Occupancy

In Wolf Creek Water and Sewer Improvement District (Wolf Creek) flows to our sewage treatment plant and water demand reflect this second home ownership. We have concluded from data analysis that roughly 50% of our over 1000 culinary/wastewater connections are occupied full time, and the other half are part-time, varying from only every weekend to several months of seasonal occupancy. This is consistent with the assumptions made in the UGS report, but not with the "build-out population" value.

Secondary / Irrigation Usage in Development:

Our biggest Wolf Creek District water usage problem comes from second home owners who set clocks on their secondary water sprinkler systems at the beginning of the season, and fail to address leaks, system failures or seasonal changes. Landscape irrigation systems don't care whether the homeowner is at home, and commercial landscapers usually have little motivation to cut usage, since they don't pay the bills. Whereas culinary use stops when the home is empty, the secondary water use continues. We frequently observe use at a higher level in second homes than homes in full-time occupancy. It all depends on the style of landscaping and amount of turf installed, which is now the Wolf Creek District focus for conservation.

From more than 10 years of metering data, it is clear that the secondary water demand in Wolf Creek is very similar to that on the Wasatch Front, at 0.3 AF/single family unit, which have an average total lot size of 0.3 AC. Our secondary use is metered with tiered tariff except for parts of the golf course. The seasonal total application is approximately 20-25 inches/year, a factor of two greater than the 11.85 inches/year assumed in the UGS report (page 93). Then on page 86, 2.7 feet of irrigation water is assumed, so there is an inconsistency in the UGS report, which may affect their conclusions. The consequence of these variations and differences from metered values should be evaluated within the county's water and sewage management studies.

Culinary Usage:

Culinary use in Wolf Creek is an annual average of 0.16 AF/unit, which reflects the part-time occupancy. This is higher than the 60 gallons per capita assumed by the UGS report (page 93). Culinary water use for landscape watering is prohibited in the Wolf Creek District. These totals may be affected by our fluctuating population, large number of rental units (in the hundreds), and resulting laundry etc.

Overall Use Projections:

Secondary irrigation water demand for the larger properties being built around the valley is likely to be closer to the 3 AF/AC (i.e. 36 inches) duty standard used by Division of Water Rights (DWRi). Depending on how, and over

what area the landscaping is completed, the secondary water usage is likely to be far higher than culinary. This conclusion is supported within the UGS report in that:

- on page 93, a total culinary demand of 1880 AF/year is estimated for build out population of 28,000,
- whereas on page 94 potable water demand of 4,000 to 6,000 AF/year "including some outdoor water use" is reported for the current population of 7200, and about 4,000 dwellings.

These values suggest that if the number of dwelling units increases to the 15,625 build out estimated in the General Plan (i.e. roughly times 4 the present), overall water supply is potentially going to be insufficient, mostly due to all the factors not considered by the UGS report (see below).

- Four times present estimate (4 x 5,000 AF) = 20,000 AF.

Current total "potable" (5,000 AF) plus crop irrigation (17,000 AF from surface water) is reported as 23,000 AF (page 94). On page 93 the UGS report assumes full conversion of "*agricultural [irrigation water] to urban uses; however, water storage and waste-water treatment systems would need to be added*" hence to conclude that there is sufficient water for development. Given the various factors that are unaddressed, and the inconsistencies with actual metered data, this appears to be an extremely optimistic and perhaps overly rosy conclusion.

It is also noteworthy that 20,000 AF, if taken from groundwater, would remove more than half the estimated 35,000 AF discharge of groundwater to the reservoir, which would therefore double the assumed rate of nitrate build up in groundwater by decreasing the volume for dilution (see below). However, if much of the water comes from present surface water agricultural water, the impact to groundwater will be less.

<u>Other Water Use, Weber Basin Contracts and Development Locations:</u>

Nowhere in the UGS report is <u>any</u> allowance made for future commercial/retail use, or for use such as snowmaking, both of which use far more water per unit than domestic development. Nor is there allowance for the General Plan's goal of retaining a rural feel in the Valley, through support of agriculture. Nor is there discussion of the issue of pumping on upland areas or in the foothills, above the areas historically irrigated with surface water. And finally, the decreasing snowpack, and the increasing evapotranspiration from climate changes is also unaddressed. Each of these factors decreases the amount of available water or increases the demand for water.

Homes being built far above the original reach of valley-floor historic irrigation companies' systems, and those on the valley-floor but lacking irrigation company shares (sourced in surface water), are turning to new Weber Basin contracts and drilling wells. In other words, not only is irrigation/secondary water being provided to many areas that previously were not irrigated, but these are supplied either from private wells or new water company systems. Often, potable water is being used for landscape irrigation.

For many new homes outside of culinary water company footprints, Weber Basin contracts and State Engineer water right exchange applications are obtained for a nominal 1 or 1.25 AF of water/home, a well is drilled and as far as I can understand it, there is no monitoring of just how much water is being withdrawn.

Ultimately, this will lead to less and less groundwater reaching the Pineview Reservoir, as more is pumped and depleted through evapotranspiration during irrigation. This may well occur without any great decrease in water tables since, as documented in the UGS report, there is annual recharge of much of the aquifer system from snowmelt / surface-water. But it will take longer to 'refill the bucket' from surface water, leaving creeks dry

longer, or groundwater movement will slow, causing creeks to dry more quickly or more often. This will have further negative effects on wildlife. Increased evapotranspiration from increasing summer temperatures will exacerbate this, as will the more frequent summers with lower precipitation patterns which seem to be occurring. Slower groundwater movement will also increase nitrate accumulation, since less water flow is available for dilution.

On the DWRi website, the Valley is shown as 'closed" to further allocation. Combining this with the Developers and Landowners desire to develop beyond historically irrigated areas suggests we also have a problem around "OWNERSHIP" of the water. It is pretty obvious that water is present in the Ogden Valley, looking at a full 110,000 acre-feet of water in the Pineview Reservoir, but if it is owned by Others, then it is not available, and development will be constrained by water quantity/quality.

In particular, the Exchange Application process, by which users downstream of Pineview Dam are made whole by release from storage, does not help the folks who are the Meat in the Sandwich, below the Point of Diversion (POD), but not mitigated by Pineview or other release from storage. This is particularly the case when groundwater pumping occurs at PODs high in the system, removing water from surface-water baseflow. The State Engineer is urged to consider the advantages of allowing additional storage above Pineview, with due consideration of dam safety requirements.

All of the above issues suggest that there should be increased focus on secondary water supply, and the overall total demand. In order to address this issue, I recommend strongly that five steps be taken:

- The county should resume its effort to establish an ordinance for ensuring secondary water supply for developments, to make sure that there is sufficient supply, supported by water rights and source, for both culinary and secondary use, before approving the plat.
- The State Engineer's office should monitor for egregious irrigation overuse from individual wells, or from surface water, and require metering in these cases, with comparison to contracts or irrigation shares held.
- The State Engineer is urged to consider the advantages of allowing/encouraging additional storage above Pineview Reservoir.
- The culinary water distribution systems in the Valley commonly require secondary water to be available before providing culinary connection. This should be reinforced where possible with separate secondary systems being installed for landscape irrigation in all areas where higher density development and wastewater treatment plants are considered.
- Reuse of high-quality treated effluent for irrigation should be encouraged, and should be supported by legislative changes where needed.

3. Influence of Geology

The greatest strength of the UGS report is its comprehensive presentation of geology/hydrogeology. In the UGS report and her presentation Dec 17, 2020, Ms. Jordon effectively and fluently describes the formation of the valley, and presents the detailed mapping and interpretation that has been generated by a generation of field scientists.

It is important for policymakers to understand that there are remarkably few locations in the valley where water can be sourced in quantity/quality suitable for municipal type supply. A single house can be supplied by a 3 to 5 gpm well or permanent spring in otherwise unpromising aquifers, so long as the quality is suitable, and it is supported by storage. That is how the more remote cabins/houses are supplied.

For municipal supply we are typically looking for water in amounts of 50-200 gpm or more, with high transmissivity. The only locations where this appears to be possible (see UGS report page 25-26 and figures 13 and 19) are:

- 1) in the valley fill aquifer, which is limited in extent – basically in parts of the southern valley floor, with some additional key locations along the major rivers – e.g. the Eden Water Works Clarke East Well;
- 2) other specific areas such as alluvial fans where there are coarse soils, without too much clay; or
- 3) in a very few of the bedrock formations.

These areas are precious, and preventing contamination by infiltrating septic flows or other contamination sources is critical, i.e. septic systems must stay clear of drinking water protection zones of municipal wells/springs. The drilling of wells through the protective confining layer is a further quality risk, if those wells are not fully sealed, or when they become disused are not properly abandoned, and pressures in the confined aquifer are lower than in the upper zone, either due to location or pumping.

The possible water municipal development sites are further constrained by historic water rights ownership, which is a property right we need to respect.

It may be helpful to think of it from this perspective: Away from the current water systems footprint and Village centers, it may be far more cost-efficient overall to use private water wells and enhanced efficiency septic systems in very low-density development (6 to 10 acre or greater lot size) rather than installing miles of water-supply piping and sewers. This is doubly true for second homes.

- Sewer lines and water lines both leak, and ultimately need repair. These costs would be avoided through distributed low-density development of water resources in the form of private wells on large lots, which are only partially irrigated, or not irrigated.

4. Nitrate in Groundwater

The UGS report contains the results (Appendix D) of sampling of 31 private and municipal wells for nitrate. Also included are the nine monitoring well sets of nitrate results from Reuben (2013) which range up to 47 mg/l. The UGS report states that the geometric mean nitrate concentration from UGS samples was 0.45 mg/l, and the arithmetic mean was 1.04 mg/L.

The report and these present comments assume that nitrate in groundwater does not degrade, and is conservative. It is also important to remember that nitrate is also applied to valley soils in agricultural and lawn fertilizers and from livestock manure. These sources may be greater in magnitude than from septic systems.

Sampling of discharging groundwater that I performed in 2020 (February and September) along the margins of Pineview Reservoir confirmed the typical groundwater values reported in the UGS report. (Full results have been provided to UGS and Forest Service, landowner). The shallow unconfined aquifer discharges in multiple locations around the North Arm, along the west side of the Stringtown Road peninsular, on both sides of the Huntsville peninsular, and some other channel discharges at Gertsen Bay and Middle Fork. This appears to be because the confining unit approaches the ground surface in these areas, encouraging discharge.

Sampling of all major discharges around the lake, in particular springs differentiated by field temperature, resulted in two datasets with a geometric mean concentration of nitrate in ground water samples of 0.43 mg/l and 0.48 mg/l (arithmetic mean 0.58 mg/l and 0.72 mg/l). Several locations that were downgradient of areas of homes with septic systems contained nitrate above 1 mg/l.

Points to note:

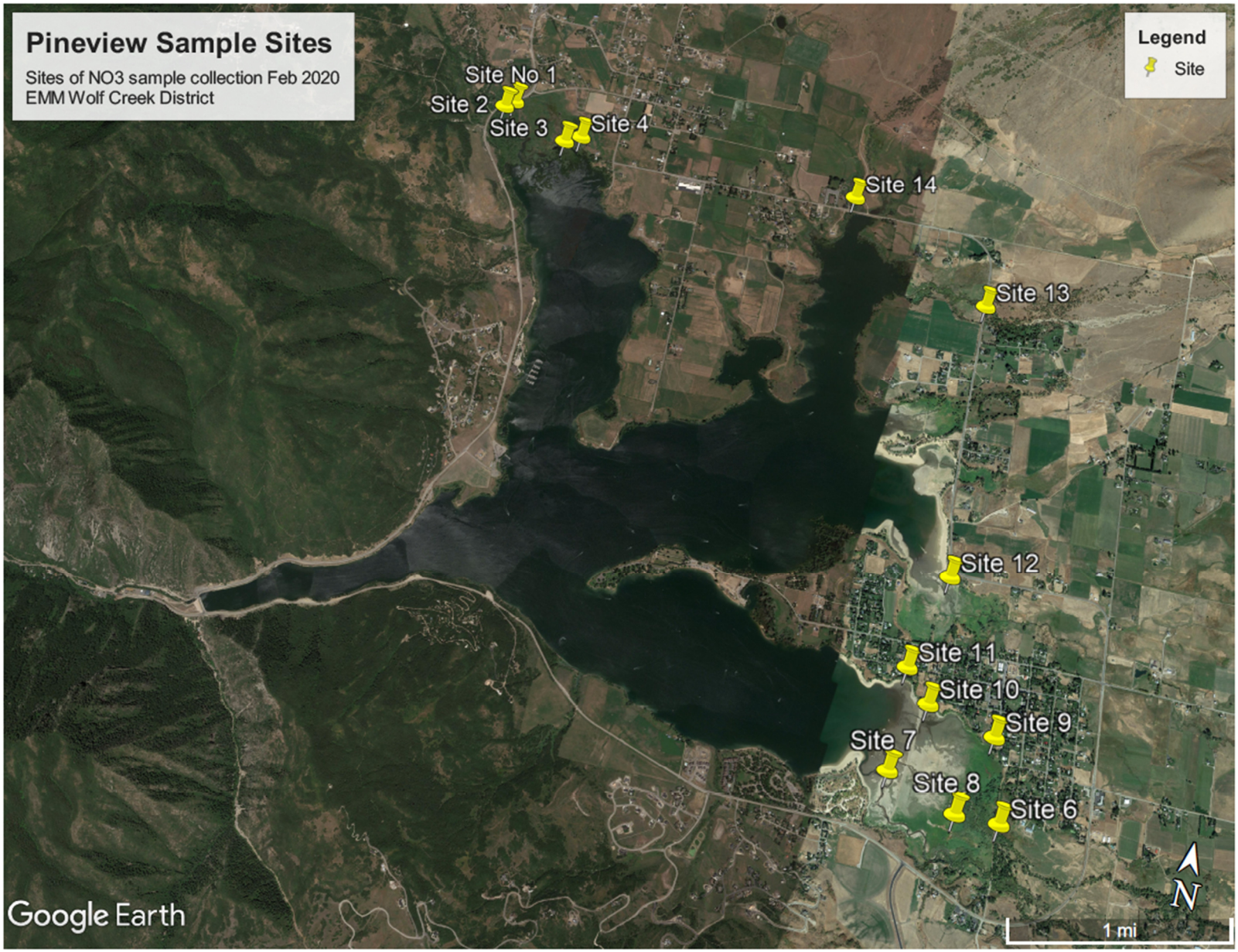
- This completely independent approach confirmed the UGS results for the typical concentrations in the shallow groundwater. These concentrations are well below the primary drinking water standard of 10 mg/l.
- The nitrate concentration of the North Arm East Spring sample was 1.24 mg/l in February 2020 and 0.85 mg/l in September 2020. This spring was nearest to the monitoring well No 1 sampled by Reuben and appears generally downgradient of it. This suggests that the groundwater Reuben (2013) sampled, which was reported to have a mean of 14.1 mg/l and range of 2.5 to 47 mg/L, is either diluted by other groundwater flows prior to discharge, or discharges elsewhere.
- The Pineview reservoir concentrations seem to be close to “background” concentrations (0.1 to 0.2 mg/l). Ogden Valley/Causey Canal and Middle Fork water were also at background levels.
- Comparing the averages to the concentration reported in the UGS Report from the Ogden City well in the confined aquifer (1.43 mg/l) suggests there is another factor(s) involved with this well.

Table 1
Results of Nitrate Sampling 2020

EM Menzies		Feb data	Feb data	Feb data	Feb data	Sept/Oct data	Sept/Oct data	Sept/Oct data
Inflow points	Sample point	Temp deg C	Observed flow (cfs)	NO3 N concn mg/l (ppm)	Ortho phosphate -P (mg/L)	Temp deg C	Observed approx flow (cfs)	NO3 N concn mg/l (ppm)
North Fork river	Site 2	3	13.5	1.005				
Modified N Fork discharge pt	2B					16	5	0.597
N Arm West Springs (nr Parking lot)	Site 1	7	14.9	1.004		12	0.04	0.982
N Arm Middle springs	Site 3	8	3.5	0.995		9	2	1.149
N Arm East Springs	Site 4	7	5.9	1.239		10	1.5	0.849
**Bulk lake (Yacht Club)	Site 5	Assume 0 a	n/a	0.197				
**Bulk lake (Port Ramp)						15	n/a	0.138
N Branch S Fork	Site 6	4	70	0.234	0	13	12	0.164
S Branch S Fork	Site 7	4	20	0.325	0.003	12	10	0.252
S Fork Spring (btwn branches)	Site 8	8	0.33	0.1	0.001	13	0.375	0.137
Creek SE Huntsville	Site 9	6	1.1	0.622	0.077	12	0.022	1.944
**Old Road S of Huntsville	Site 10	2	0	0.131	0			not sampled
Pool next to Huntsville shore	Site 11	9	9	0.677	0.011	12	0.02	1.798
Spring Creek	Site12	4	20	0.481	0.013	17	4.5	0.454
Middle Fork River	Site 13	6	3	0.115	0	13	0.1	0.138
Gertsen Bay W Branch	Site 14	1	1.5	0.161	0.009	12	0.05	0.216
**Middle Fork WMA	MF-1					12		0.135
**Causey Canal	C-1					14		0.137
			Geometric mean	0.43			Geometric mean	0.48
			Springs only	0.59			Springs only	0.80
			Avg NO3	0.58			Avg NO3	0.72
			(Not inc MF and C)				(Not inc MF and C)	

Springs
Lake
Possibly near sources

**Data from Pineview, Middle Fork and Causey (Ogden Valley Canal) not included in calculation of means


Pineview Sample Sites
Sites of NO3 sample collection Feb 2020
EMM Wolf Creek District
Legend
Site
Site No 1
Site 2
Site 3
Site 4
Site 14
Site 13
Site 12
Site 11
Site 10
Site 9
Site 7
Site 8
Site 6
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Google Earth

5. Wastewater Management and Policy Issues

From a wastewater and water supply policy perspective I would make the following comments and statements of my personal opinion.

These are based on the Non-Discharge Requirement for treated wastewater under Utah current regulations – i.e. treated effluent must be evaporated (lagoon systems), or infiltrated into the ground, either on-site (e.g. septic systems) or through Rapid Infiltration Basins (RIB). Due to the importance of Pineview Reservoir for drinking water, and the demonstrated interchange between groundwater and surface water in Ogden Valley this non-discharge policy should be continued in Ogden Valley to protect groundwater and the Reservoir.

High quality effluent (tertiary treatment to 10 mg/L or less – i.e. below drinking water standard) can be reused/disposed by irrigation.

Treatment Locations and Siting:

- The nitrate groundwater results presented in the UGS report and the additional data reported in this document support the county commissioners' broad goals of providing wastewater management/treatment for areas of dense development in the Valley – the "Village Areas". Both Eden and Huntsville are relatively close to Pineview Reservoir, so disposal of treated effluent may be difficult.
- Storage and reuse of high-quality treated effluent for summer irrigation should be considered, or alternatively pumping treated effluent to RIB that are 1) upgradient of areas where homes have municipal drinking water supply; and 2) suitable geology and water table level where the effluent can be infiltrated; and preferably 3) recovered for summer irrigation by shallow downgradient wells. (Take a look at the system in Vernon, British Columbia, (pop 36,000) where the whole town's treated effluent is stored in an upper Mackay Reservoir for irrigation use)
- Given the overall limitations on groundwater available for water supply, it would be very unwise to allow wastewater transfer out of the valley down the canyon, as was suggested in the 1990s. Local treatment to irrigation water standards, and use for irrigation, is now technologically straightforward and a better, and more cost-efficient solution.
- The North Arm area groundwater is already above background with respect to nitrate concentrations, and is discharging to the lake. In addition, the water table is clearly near the surface (or probably above it in some areas). Consequently, placing a culinary supply well or RIB for disposal of wastewater here is probably not wise. The flow distance to discharge in Pineview is extremely short preventing any degradation/dilution.
- Huntsville area shallow groundwater is also above background with respect to nitrate, likely due to a combination of livestock sources, septic systems and fertilizer use (both agricultural and lawns). This is true both on the Spring Creek side north of town, and South Fork Arm south of the peninsula. As discussed above, these may not be good sites for RIB or culinary wells.

Approach to Residential Development:

- It would be wise to encourage all private drinking water supply well owners to periodically check their wells for nitrate and bacteria. In particular, older shallow wells downgradient of areas of older on-site treatment or community septic systems, may be at risk of pumping contaminated groundwater.
- If property owners wish to build individual homes on sites with a density of less than 3 acres/unit the rate of degradation of groundwater quality projected by the UGS report suggests that connection to

Village-focused treatment plants or enhanced treatment on-site systems should be required by the county/health department.

- Personally, I would support the use of a 6-acre average minimum lot size for areas of the valley with low density development (i.e. single family homes on large lots). This reduces the nitrate loadings and risk of future issues, particularly if enhanced on-site systems are used.
- Consistent with previous studies and efforts, attention needs to be given to secondary (irrigation) water supply from private wells. Developments in all new developments should have confirmed sources able to support the area that is (or will be) irrigated. With 700 wells already existing in the valley, unmetered over-pumping beyond water rights has the potential to cause depletion.
- The culinary water distribution systems in the Valley commonly require secondary water to be available before providing culinary connection. This should be reinforced where possible with separate secondary systems being installed for landscape irrigation in areas where higher density development and treatment plants are considered.
- Reuse of high-quality treated water for irrigation can then be encouraged, and should be supported by legislative changes where needed.

6. Specific Comments:

- On page 93 it is stated that installation of treatment plants would lead to discharge to surface water. This is not correct under the current operating rules, which consider the Valley as “non-discharge”, which requires treated water to be discharged via Rapid Infiltration Basins or retained and evaporated in lagoons.
- The Wolf Creek Water and Sewer Improvement District does not have a sewage ‘Lagoon’, but rather a tertiary-standard treatment plant, and RIB. The plant was built in 2008. See Figure 6, which was then repeated in the Sunrise Engineering technical proposal 2020.
- On page 95 the typical transmissivities stated appear to be incorrect compared to those shown on Figure 18. On the figure the values appear likely to be 490 ft2/d and 270 ft2/d. Missing decimal points?
- On Figure 19 the water supply well locations and data in Wolf Creek were incorrectly mapped. No high transmissivity ground water supply area has been identified to the northwest of the Upper Branch Willard Thrust fault. It is mapped as underlain by Kelly Canyon argillite and phyllite (Plate 2), which is an aquitard.
- Inconsistency: Page 93: The seasonal total irrigation application reported as 11.85 inches/year. On page 86, 2.7 feet of irrigation water is assumed. Approximately 20-25 inches/year, has been typical metered value in Wolf Creek.

References and Notes:

Note 1: Septic system data provided by Summer Day in response to GRAMA request to Weber-Morgan Health Department.

Reuben, T.N. 2013, Nutrient contribution of the shallow unconfined aquifer to Pineview Reservoir: Logan, Utah State University, Ph.D. dissertation, 159p.

Jordan, J. Lucy et al 2019 Characterization of the Groundwater System in Ogden Valley, Weber County, Utah, with Emphasis on Groundwater-Surface Water Interaction and the Groundwater Budget: Salt Lake City Utah Division of Natural Resources (Utah Geological Survey), Special Study 165 106p with Appendices.

Comments on UGS Ogden Valley Hydrogeology Report

E. Miranda Menzies

Eden, Utah 84310 February 2021

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Thanks to the Utah Geological Survey team for an excellent comprehensive report, which brings together a massive amount of factual information. It is simply an outstanding effort, beautifully prepared and edited, and nothing I am stating here should in any way detract from that. These folks planned and executed a superb project, which will stand for many years as the go-to reference. The few corrections I provide in these comments simply indicate that no database can be 100% complete or fully accurate, especially when collected for multiple unrelated reasons, over a long period of time.

While I am Chair of the Board of Trustees of Wolf Creek Water and Sewer District, and also a Director of the Wolf Creek Irrigation Company, these comments are not offered as a formal position of any organization of which I am a part. They are my personal comments as a full-time resident, advised by my background prior to retirement as an environmental consultant and geologist.

Throughout this document, I would appreciate feedback from others. Please tell me if I am wrong, based on information I am unaware of, or if I have misunderstood or misinterpreted what I have read or been told.

GENERAL COMMENTS

1. Population Data and Water Calculations

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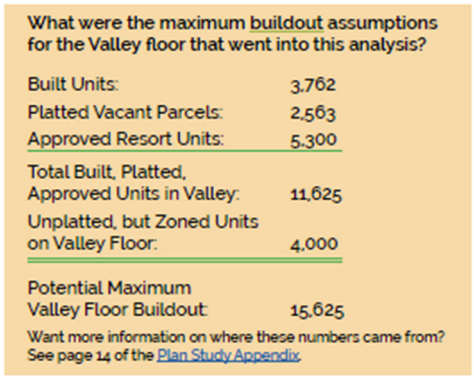

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Unplatted, but Zoned Units on Valley Floor:	4,000
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Want more information on where these numbers came from? See page 14 of the Plan Study Appendix.

Note that the 15,625 includes 5,300 resort units, which are not located on the valley floor.

Since 2016, approximately 300 units have been built on the valley floor with on-site septic systems (Note 1). The combination of these data suggests we now have approximately 4000 built units in the valley floor, and a total of approximately 4300 within the watershed. The number of approved additional "resort units" at Powder Mountain and Snowbasin is 5300, of which Summit or their landowners have constructed approximately 40 within the Summit development as of November 2020.

These data will also be updated by the 2020 Census, which is reportedly going to be available in March 2020. This population data needs to be updated in the county's ongoing studies. The assumption of 28,000 full-time residents at build out assumed by the UGS report p. 93 appears high.

2. Water Use Calculations

Occupancy:

In Wolf Creek Water and Sewer Improvement District (Wolf Creek) our sewage flows and water demand reflect this second home ownership. We have concluded from data analysis that roughly 50% of our over 1000 culinary/wastewater connections are occupied full time, and the other half are part-time, varying from occasional weekends to several months of seasonal occupancy. This is consistent with the UGS report.

Secondary / Irrigation Usage in Development:

From more than 10 years of metering data in Wolf Creek, it is clear that the secondary water demand in Wolf Creek is very similar to that on the Wasatch Front, at 0.3 acre-feet(AF)/single family unit, which have an average total lot size of 0.3 AC. Not all of every occupied lot is landscaped or irrigated. Our secondary water use is metered with tiered tariff except for parts of the golf course. The seasonal total application is approximately 20-25 inches/year, a factor of two greater than the 11.85 inches/year assumed in the UGS report (page 93). The source and consequences of this large difference should be evaluated.

Culinary Usage:

Culinary use in Wolf Creek is an annual average of 0.16 AF/unit, which reflects the part-time occupancy. This is higher than the 60 gallons per capita assumed by the UGS report (page 93). Culinary water use for landscape watering is prohibited in the Wolf Creek District. These totals may be affected by our large number of rental units (in the hundreds) and resulting laundry etc, and the difficulty of estimating the number of "residents".

Overall Use Projections:

Secondary irrigation water demand for the larger properties being built around the valley is likely to be closer to the 3 AF/AC (i.e. 36 inches seasonal total depth) duty standard used by Division of Water Rights (DWRi). Depending on how, and over what area the landscaping is completed, the secondary water usage is likely to be far higher than culinary. This conclusion is supported within the UGS report in that:

- on page 93, a total culinary demand of 1880 AF/year is estimated for build out population of 28,000;
- whereas on page 94 potable water demand of 4,000 to 6,000 AF/year "including some outdoor water use" is reported for the current population of 7200, and about 4,000 dwellings. I.E 1.5 AF/dwelling

These values suggest that if the number of dwelling units increases to the 15,625 build out estimated in the General Plan (i.e. roughly times 4 the present), overall water supply is going to be tight or insufficient, as follows:

- Four times present estimate (4 x 5,000 AF) = 20,000 to 23,500 AF/year.

Current total "potable" (5,000 AF) plus crop irrigation (17,000 AF from surface water) is reported as 23,000 AF (page 94). Hence the UGS reaches the conclusion that ALL the crop irrigation water from surface water will need to be converted to landscape irrigation. A further probable source of error is that current landscape irrigation by surface water has not been estimated. Some irrigation company shares are currently owned by residential users. A further source of error is the low value used for consumptive irrigation use in the water budget (11.85 inches/year. Page 93)

It is also noteworthy that 20,000 AF, if taken from groundwater, would remove more than half the estimated 35,000 AF discharge of groundwater to the reservoir, which in the absence of wastewater treatment systems would therefore double the assumed rate of nitrate build up in groundwater by decreasing the volume for dilution (see below).

It is also worth noting that the groundwater flow is apparently back-calculated by subtraction, so that errors in evapotranspiration, which is a huge component of the budget, would adversely affect the accuracy of the groundwater discharge value.

Nowhere in the UGS report is any allowance made for commercial/retail use, or use such as snowmaking, which use far more water per unit than domestic development. Nor is there allowance for the Ogden Valley General Plan's goal of retaining a rural feel in the Valley, through support of agriculture. There is effort being made to establish agricultural conservation easements which will require water. Nor is there discussion of the issue of pumping on upland areas or in the foothills, above the areas historically irrigated with surface water. And finally, the decreasing snowpack and increasing evapotranspiration from climate changes is also unaddressed.

On page 93 the UGS report assumes full conversion of "*agricultural [irrigation water] to urban uses; however, water storage and waste-water treatment systems would need to be added*" hence to conclude that there is sufficient water for development.

Given the various factors that are unaddressed, and the inconsistencies with actual metered data, this appears to be an extremely optimistic and perhaps overly rosy conclusion.

3. Nitrate in Groundwater – An Alternate Approach

The UGS report contains the results (Appendix D) of sampling of 31 private and municipal wells for nitrate. Also included are the nine monitoring well sets of nitrate results from Reuben (2013) which range up to 47 mg/l. The

UGS report states that the geometric mean nitrate concentration from UGS samples was 0.45 mg/l, and the arithmetic mean was 1.04 mg/L. The UGS report and these comments assume that nitrate in groundwater does not degrade, and is conservative. Sources include septic systems, fertilizers on crops and lawns and livestock. As described below, these overall results were confirmed by sampling discharging groundwater (Table 1 and Figure A)

The geology of the valley is described in detail in the UGS report, and the depth and thickness of the confining unit is described on report Figure 16. It is interesting that around the margins of the Pineview Reservoir, the clay confining unit is projected as being close to or at the ground surface. i.e. That the shallow unconfined aquifer is extremely thin at these locations. This includes the Eden North Arm area, and on both sides of Huntsville, including the discharge area of the South Fork River. On page 70 and Figure 61, the flow in the principal aquifer is described, and it is concluded that the shallow unconfined aquifer is one of the primary routes of groundwater discharge to Pineview Reservoir.

Given the geology and conservative behavior of nitrate, this would imply that water entering Pineview during baseflow should be generally reflective of the sum of overall nitrate impact, minus that removed by local pumping for irrigation from shallow wells. However, there is no discussion whether other contaminants in sewage (e.g. pharmaceuticals and metabolites), for which the nitrate is merely an indicator, may be present in groundwater.

During the winter of 2020, I watched the North Arm area, and noted that certain areas of the shore were consistently open water throughout the winter, apparently due to warm water discharge, i.e. groundwater. Ice fishermen confirmed that some areas of the lake shoreline never freeze. These locations approximately coincide with the locations where the confining unit approaches ground surface. In several cases, there are areas of multiple springheads, with channel flow down to the lake.

In February 2-9, 2020, on snowshoes, and from the ice in several places, I sampled these spring groundwater discharge areas, and flowing surface water in North Arm and later around Huntsville, Middle Fork and one of the discharges to Gertsen Bay. Samples were collected directly from a spring head, or from channels. No open water areas were noted on the western shore of the lake; the Pineview Yacht Club has open water due to use of bubblers. A sample was also collected from the reservoir itself. The sampling was repeated at the end of September/early October, though at this time some sample points were dry and Causey Canal and Middle Fork at the MFWA trailhead were added as background locations. The October lake sample was from Port Ramp.

The samples were collected using a rinsed bucket, stored under standard Chain of Custody in a cooler with ice/refrigeration, and analyzed at the Weber Basin Conservancy District certified laboratory for nitrate and in some cases orthophosphate. Sample field temperature was used as an approximate guide to the source of the water, and flow rate was estimated based upon channel dimensions and flow velocity. The results are shown on Table 1. Sample locations from February 2020 are shown on Figure A.

Points to note:

- The geometric mean of ground water samples in both datasets (0.43 mg/l and 0.48 mg/l) are similar to the geometric mean in the UGS report (UGS report geometric mean of 0.45 mg/l). Arithmetic mean for all samples which include ‘surface water’ was slightly lower but similar in magnitude (0.58 mg/l and 0.72 mg/l compared with 1.04 mg/l in the UGS report). Much of this surface water likely is groundwater discharge given the sampling dates.

- In other words, a completely independent approach confirmed the UGS results for the typical concentrations in the shallow groundwater. It is worth pointing out again, that the concentrations are well below the primary drinking water standard of 10 mg/l.
- The nitrate concentration of the North Arm East Spring sample was 1.24 mg/l in February 2020 and 0.85 mg/l in September 2020. This spring was nearest to the monitoring well No 1 sampled by Reuben and generally downgradient of it. This suggests that the groundwater Reuben (2013) sampled, which was reported to have a mean of 14.1 mg/l and range of 2.5 to 47 mg/L, is either diluted by other groundwater flows prior to discharge, or discharges elsewhere.
- The Pineview reservoir concentrations seem to be close to "background" 0.1 to 0.2 mg/l. Ogden Valley/Causey Canal and Middle Fork water were also at background levels.
- Comparing the averages to the concentration reported in the UGS Report from the Ogden City well in the confined aquifer (1.43 mg/l) suggests there is another factor involved with this well.

4. <u>Specific Comments and Corrections:</u>

- On page 93 it is stated that installation of treatment plants would lead to discharge to surface water. This is not correct under the current operating rules, which consider the Valley as "non-discharge", which requires treated water to be discharged via Rapid Infiltration Basins (RIB) or retained and evaporated in lagoons.
- The Wolf Creek Water and Sewer Improvement District does not have a sewage 'Lagoon', but rather a sewer collection system, tertiary-standard treatment plant, and RIB. The plant was built in 2008. See Figure 6, which was then repeated in the Sunrise Engineering technical proposal to Weber County July 2020.
- On page 95 the typical transmissivities stated appear to be incorrect compared to those shown on Figure 18. On the figure the values appear likely to be 490 ft2/d and 270 ft2/d. Are decimal points missing?
- On Figure 19 the water supply well locations and data in Wolf Creek were incorrectly mapped. No high transmissivity ground water supply area has been identified to the northwest of the Upper Branch Willard Thrust fault. It is mapped as underlain by Maple Canyon Lower Arkose member (Plate 2), which is described as "deeply weathered to clay" and an aquitard.
- Inconsistency: Page 93: The seasonal total irrigation application reported as 11.85 inches/year. On page 86, 2.7 feet of irrigation water is assumed. Approximately 20-25 inches/year, has been typical metered value in Wolf Creek.

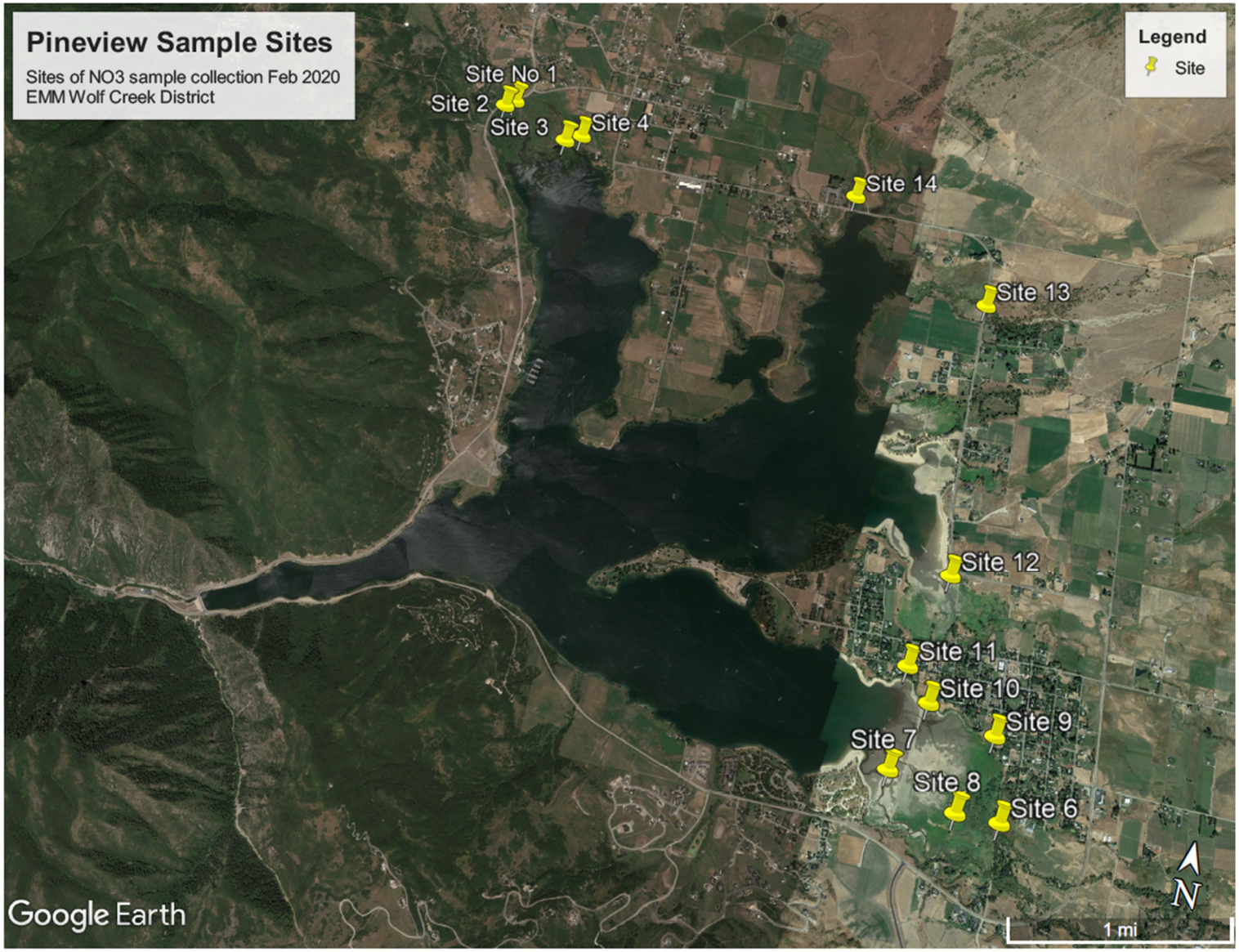
Table 1
Results of Nitrate Sampling 2020

EM Menzies		Feb data	Feb data	Feb data	Feb data	Sept/Oct data	Sept/Oct data	Sept/Oct data
Inflow points	Sample point	Temp deg C	Observed flow (cfs)	NO3 N concn mg/l (ppm)	Ortho phosphate -P (mg/L)	Temp deg C	Observed approx flow (cfs)	NO3 N concn mg/l (ppm)
North Fork river	Site 2	3	13.5	1.005				
Modified N Fork discharge pt	2B					16	5	0.597
N Arm West Springs (nr Parking lot)	Site 1	7	14.9	1.004		12	0.04	0.982
N Arm Middle springs	Site 3	8	3.5	0.995		9	2	1.149
N Arm East Springs	Site 4	7	5.9	1.239		10	1.5	0.849
**Bulk lake (Yacht Club)	Site 5	Assume 0 a	n/a	0.197				
**Bulk lake (Port Ramp)						15	n/a	0.138
N Branch S Fork	Site 6	4	70	0.234	0	13	12	0.164
S Branch S Fork	Site 7	4	20	0.325	0.003	12	10	0.252
S Fork Spring (btwn branches)	Site 8	8	0.33	0.1	0.001	13	0.375	0.137
Creek SE Huntsville	Site 9	6	1.1	0.622	0.077	12	0.022	1.944
**Old Road S of Huntsville	Site 10	2	0	0.131	0			not sampled
Pool next to Huntsville shore	Site 11	9	9	0.677	0.011	12	0.02	1.798
Spring Creek	Site12	4	20	0.481	0.013	17	4.5	0.454
Middle Fork River	Site 13	6	3	0.115	0	13	0.1	0.138
Gertsen Bay W Branch	Site 14	1	1.5	0.161	0.009	12	0.05	0.216
**Middle Fork WMA	MF-1					12		0.135
**Causey Canal	C-1					14		0.137
			Geometric mean	0.43			Geometric mean	0.48
			Springs only	0.59			Springs only	0.80
			Avg NO3	0.58			Avg NO3	0.72
			(Not inc MF and C)				(Not inc MF and C)	

Springs
Lake
Possibly near sources

**Data from Pineview, Middle Fork and Causey (Ogden Valley Canal) not included in calculation of means

Figure A


Pineview Sample Sites
Sites of NO3 sample collection Feb 2020
EMM Wolf Creek District
Legend
Site
Site No 1
Site 2
Site 3
Site 4
Site 14
Site 13
Site 12
Site 11
Site 10
Site 9
Site 7
Site 8
Site 6
N
1 mi
Google Earth

References and Notes:

Note 1: Septic system data provided by Summer Day in response to GRAMA request to Weber-Morgan Health Department.

Reuben, T.N. 2013, Nutrient contribution of the shallow unconfined aquifer to Pineview Reservoir: Logan, Utah State University, Ph.D. dissertation, 159p.