Update of Hydrogeologic Conditions for the Lewiston-Lapwai area, Idaho 2012-2018

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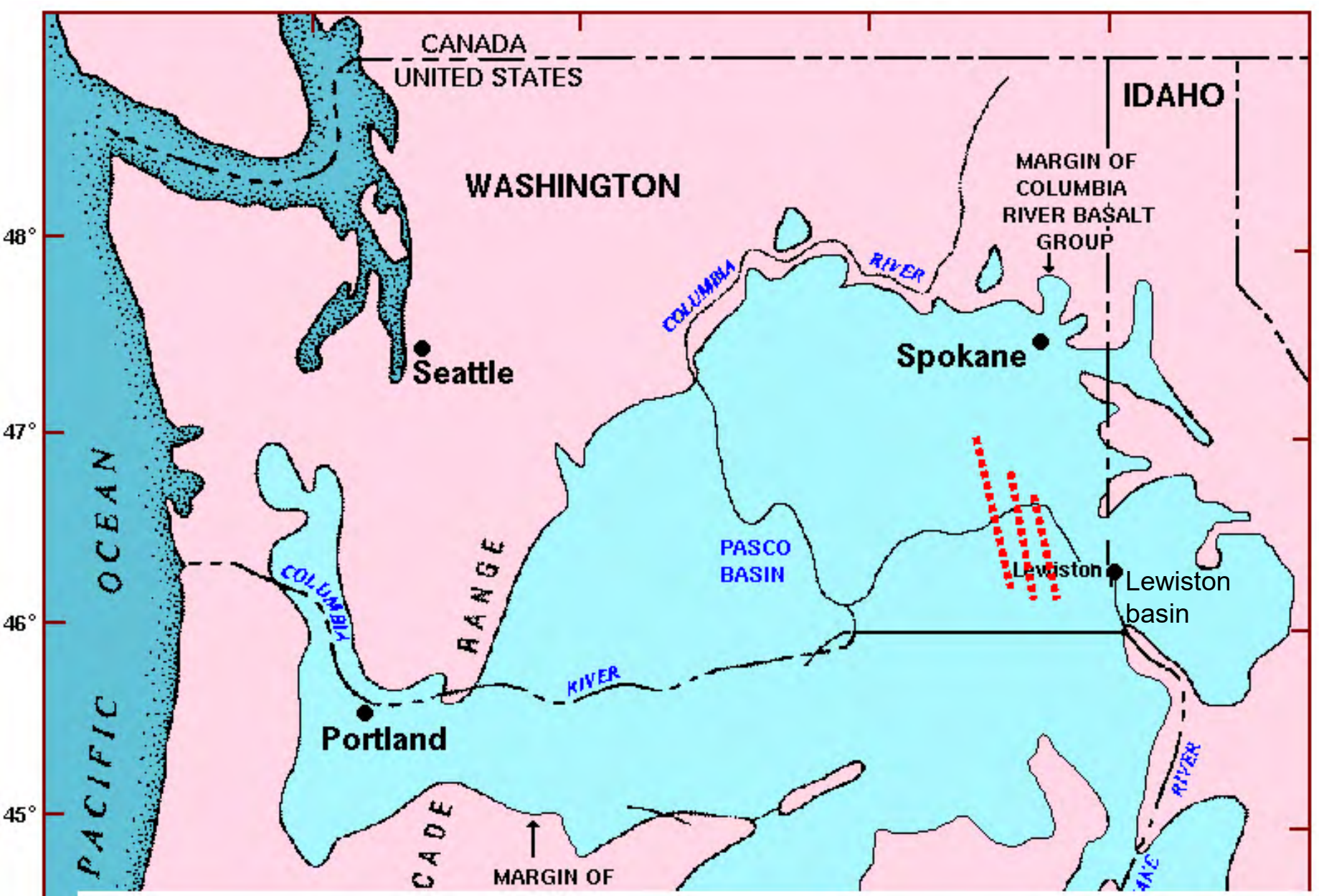
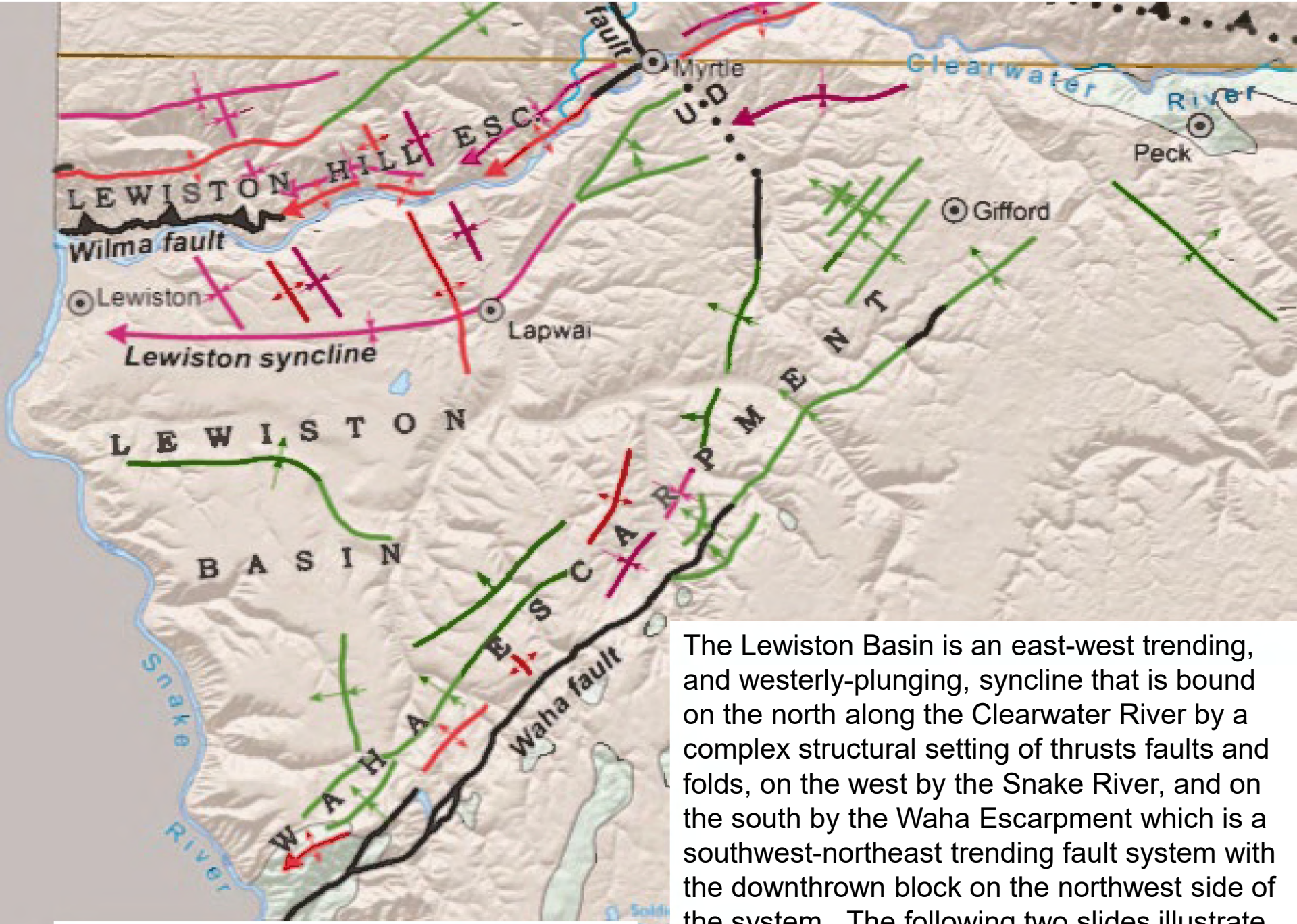
Elements of this presentation

1. Hydrogeologic setting.
2. Historic development of ground water use and the State's response to ground water supply shortages in the 1990's.
3. Ground water monitoring, 1992-2012.
4. The Lewiston Plateau Ground Water Management Area was designated in 2013.
5. Increased monitoring and studies, 2012 to 2018.
6. Current understandings of the Lewiston ground water systems.
7. Other Studies.
8. Conclusions.
9. Remaining questions.

1. Hydrogeological Setting



The Lewiston Basin is on the eastern side of the Columbia River Plateau. The Plateau is a large feature comprised of thousands of feet of basalt. (base map is from the Idaho Geological Survey)



(From Kauffman and others, 2009, IGS)

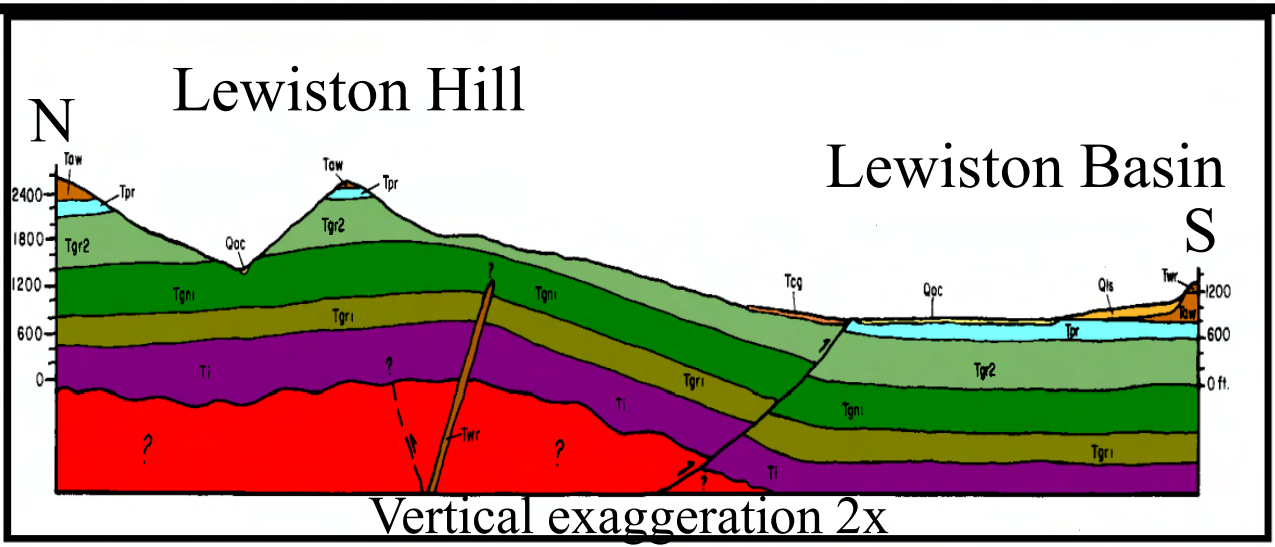
The Lewiston Basin is an east-west trending, and westerly-plunging, syncline that is bound on the north along the Clearwater River by a complex structural setting of thrusts faults and folds, on the west by the Snake River, and on the south by the Waha Escarpment which is a southwest-northeast trending fault system with the downthrown block on the northwest side of the system. The following two slides illustrate the geology and geography of the basin.

Lewiston Basin

Looking southeast from the north side of the Clearwater River

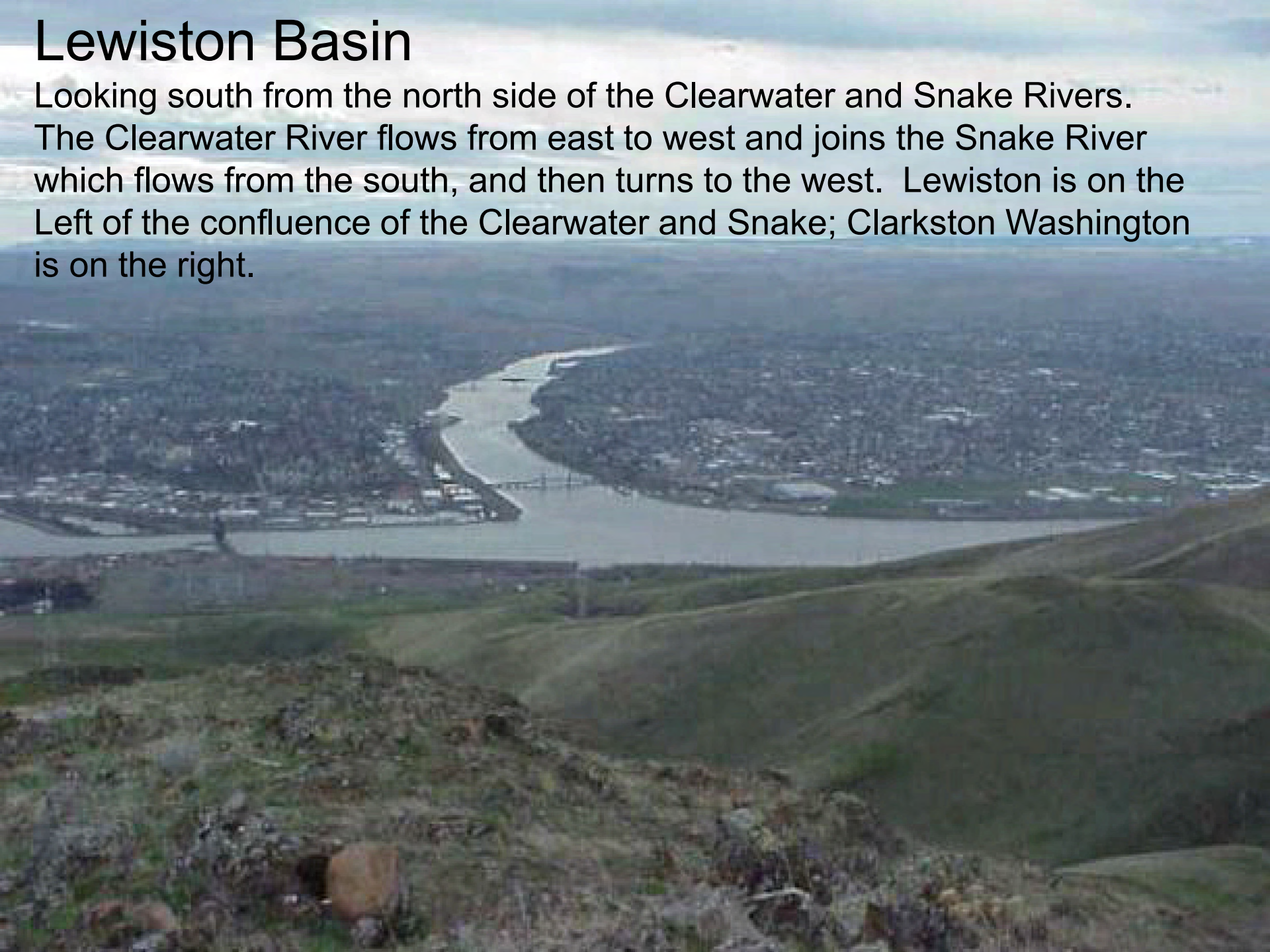
Kurt Othberg -IGS

Cross section from the Idaho Geological Survey



Lewiston Basin

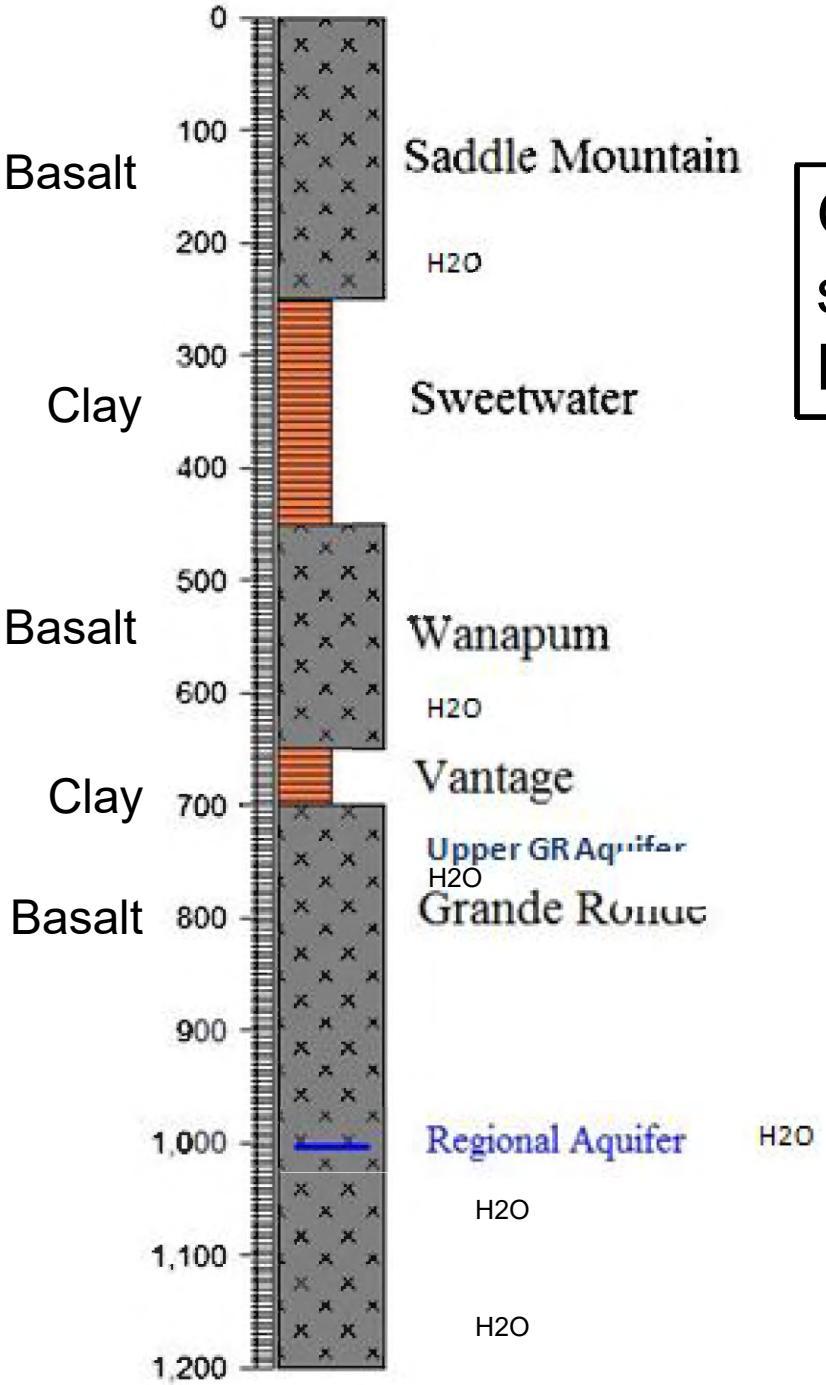
Looking south from the north side of the Clearwater and Snake Rivers. The Clearwater River flows from east to west and joins the Snake River which flows from the south, and then turns to the west. Lewiston is on the Left of the confluence of the Clearwater and Snake; Clarkston Washington is on the right.



Lewiston Aquifer Systems

Basalts with interbedded clays

1. **Saddle Mountains** (perched), 200 ft thick
   Sweetwater clay
2. **Wanapum** (perched), 200 ft thick
   Vantage clay
3. **Grande Ronde**, 3 distinct units, 1500 ft thick



Generalized lithologic section for the Lewiston Basin.


North part of
Subarea A1
Saddle Mountains
Wanapum
Sweetwater


Sweetwater clay
In Tammany Creek area

Basic hydrogeologic facts about the Lewiston Area

1. Aquifers are found in thin (5-20 feet) flow contact zones, which are overlain and underlain by thick (50-200 feet) dense basalt flows.
2. The Saddle Mountains aquifers are recharged by precipitation and irrigation percolation.
3. The Wanapum aquifers are probably recharged by water percolating from the Saddle Mountains downward through fractures.
4. The Snake River recharges the Grande Ronde aquifers in western part of the Lewiston Plateau Ground Water Management Area (LPGWMA). This recharge source is ongoing, making the aquifer sustainable.
5. Water level elevations in Grande Ronde aquifers in the northeastern and southern parts of the LPGWMA are higher than the elevations in wells in the western part. These wells are not recharged by the Snake River, but by some other sources(s).

Questions postulated since 2012

1. How far east and south is the extent of the Grande Ronde aquifer that is recharged by the Snake River?
2. To what extent, if any, does the Clearwater River recharge the Grande Ronde in Subarea A1?
3. To what extent, if any, does Lapwai Creek recharge the Grande Ronde in Subarea A1?
4. Are there other potential recharge sources for Subarea A1?
5. What are the recharge source(s) for aquifers in Subarea B?
6. Is the deep aquifer in and around the Tammany View subdivision sustainable?
7. Are the aquifers within the Grande Ronde formation hydraulically connected in vertical manners through faults and fractures?

2. Historic development of ground water use and the State's response to ground water supply shortages in the 1990's.

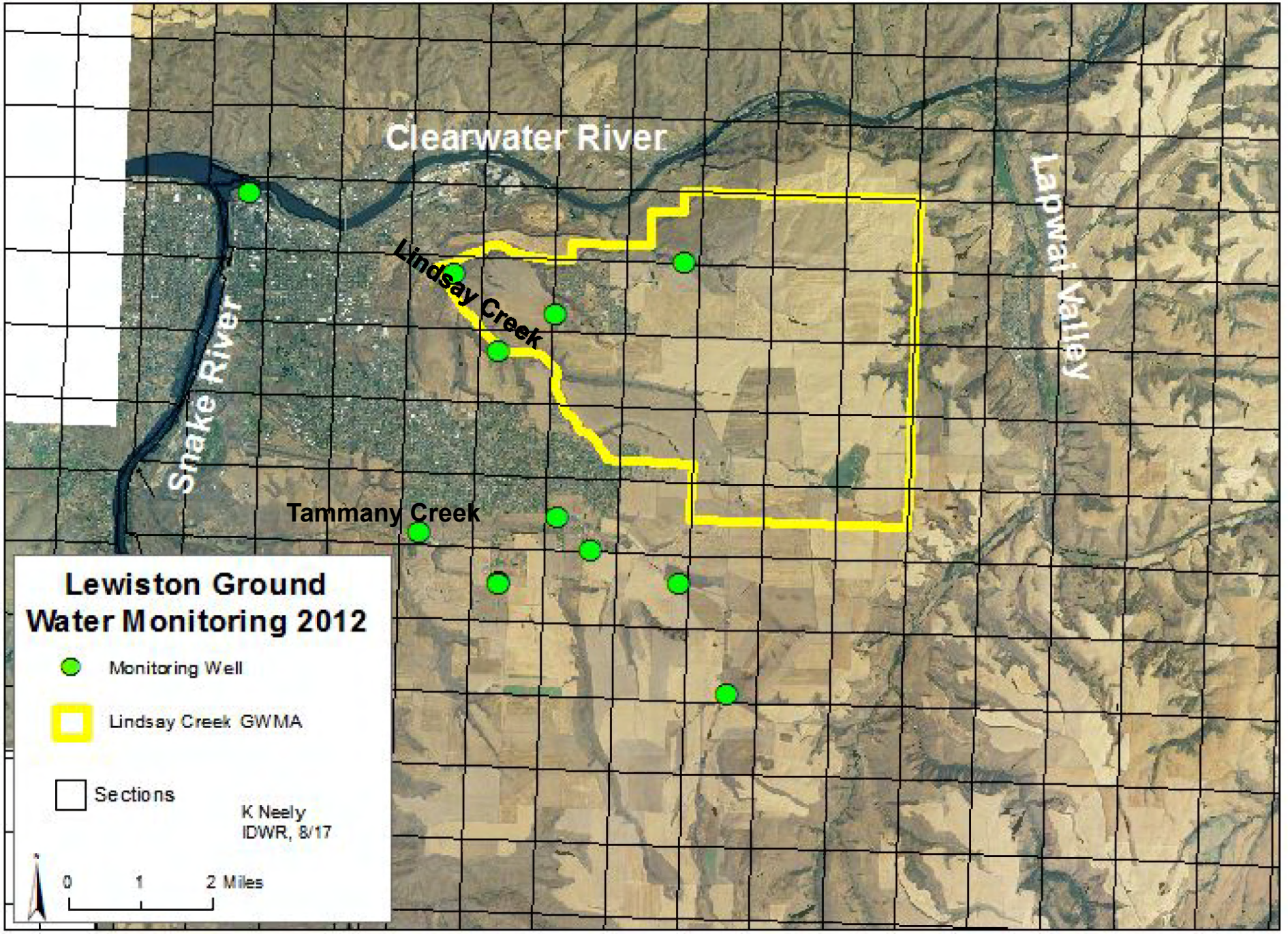
Ground Water Development and Response

1. Lewiston public supply wells beginning in 1953.

2. Lewiston Orchards Irrigation District wells beginning in 1978.

3. Domestic wells completed in the Saddle Mountains, Wanapum, and to a less extent, Grande Ronde formations over the last 50 years.

4. Ground water supply shortages in the Saddle Mountains aquifer in the Lindsay Creek area led to the Lindsay Creek GWMA in 1992. This also led to the first phase of monitoring conducted by IDWR and the US Geological Survey.

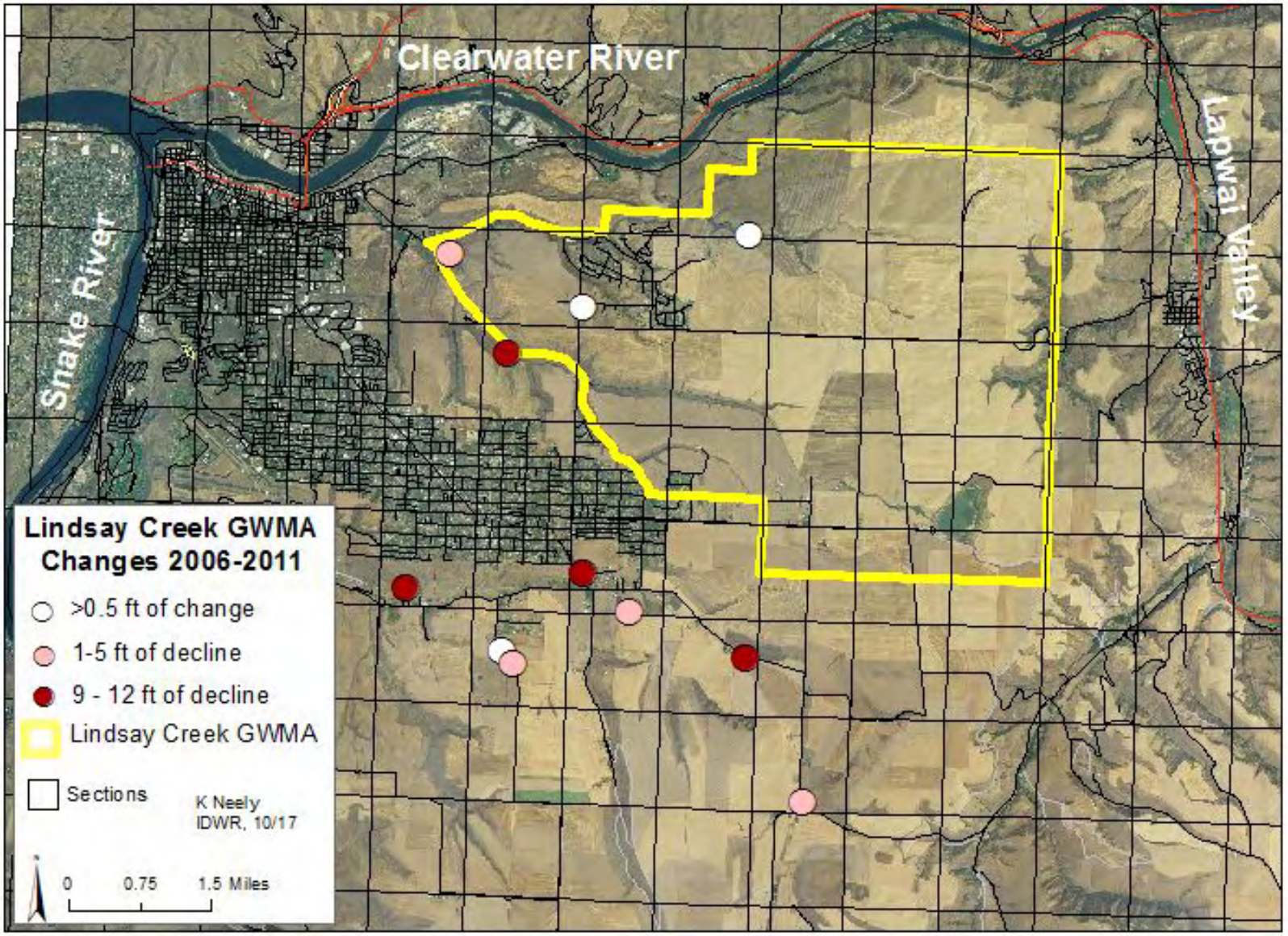

Clearwater River
Lapwai Valley
Lindsay Creek
Snake River
Tammany Creek
Lewiston Ground Water Monitoring 2012
Monitoring Well
Lindsay Creek GWMA
Sections
K Neely
IDWR, 8/17
0
1
2 Miles

3. Ground water monitoring, 1992-2012.

From 1992-2012, IDWR measured ground water levels using E tapes.

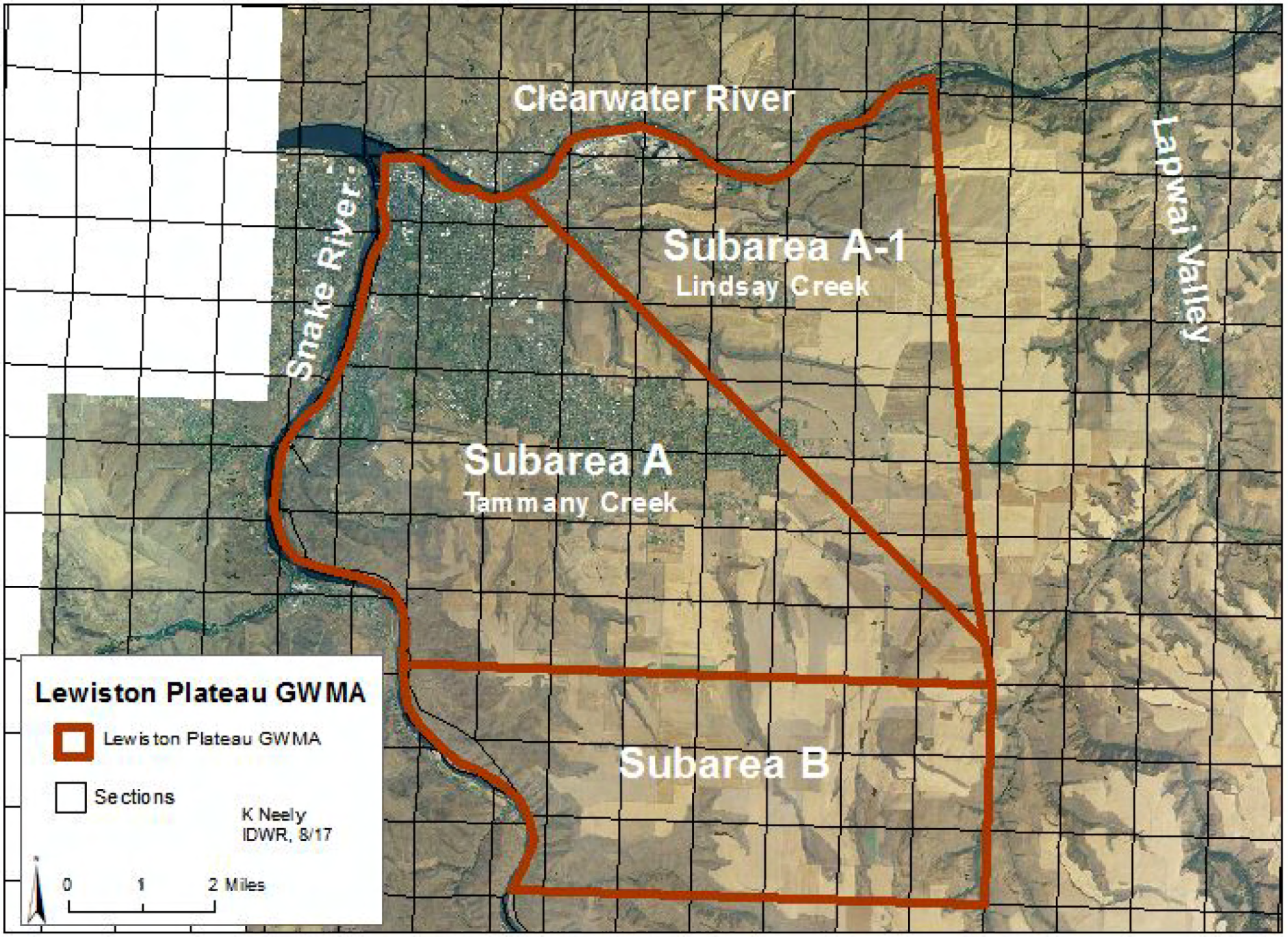
In 2012, IDWR published a report documenting that 9 of the 12 monitoring wells had water level declines ranging from 0.1 to 3.4 ft/yr. Nine of the wells were completed in the Saddle Mountains and Wanapum formations; 3 wells were completed in the Grande Ronde formation.

Water level changes from 2006 to 2011



4. The Lewiston Plateau GWMA was created in 2013.

In 2013, the Lindsay Creek GWMA was rescinded and the much-larger Lewiston Plateau GWMA was created. The Lewiston Plateau GWMA is approximately 10 miles by 9 miles in size, with boundaries of the Clearwater River on the north, the Snake River on the west, the Nez Perce Tribe Reservation boundary on the east, and an arbitrary boundary on the south. The Lewiston Plateau GWMA is the first GWMA in Idaho that has been subdivided into subareas. The GWMA has 3 subareas named A, A1, and B.


Clearwater River
Snake River
Lapwai Valley
Subarea A-1
Lindsay Creek
Subarea A
Tammany Creek
Subarea B
Lewiston Plateau GWMA
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 8/17
0
1
2 Miles

5. Increase in monitoring and studies, 2012 to 2018

In 2012, IDWR began installing pressure transducers in wells for continuous ground water level and water temperature data collections.

Highlights of work conducted from 2012 to 2018:

1. Number of monitoring wells in the GWMA quadrupled.
2. Monitoring began in the Lapwai Valley.
3. IDWR drilled 5 wells.
4. Rock chemistry samples were collected and analyzed.
5. Water chemistry samples were collected and analyzed.
6. Water level elevations in wells were correlated with potential surface water sources.
7. IDWR hired Daniel Sturgis, hydrogeologist, in 2016 to conduct monitoring and studies in northern Idaho.
8. Ralston Hydrologic Services Inc was contracted for a two year study which resulted in two technical reports.
9. Current monitoring network consists of 55 wells (42 in GWMA, 1 south of GWMA, and 12 in Lapwai Valley. 34 wells have transducers. Six other wells were in the network for a while, but have gone inactive.
10. Much knowledge has been gained about the Lewiston ground water resources. Results are presented in upcoming slides.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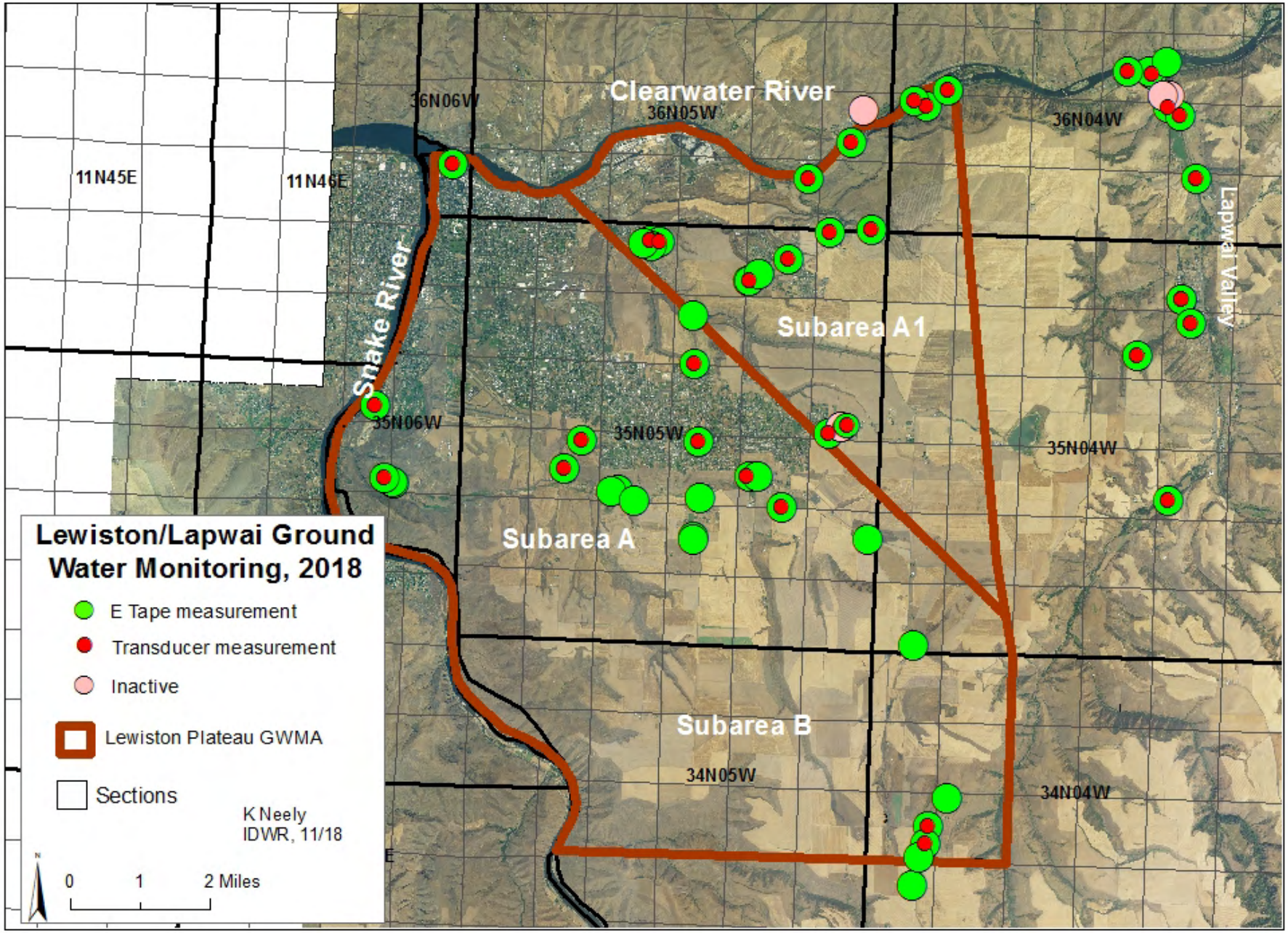
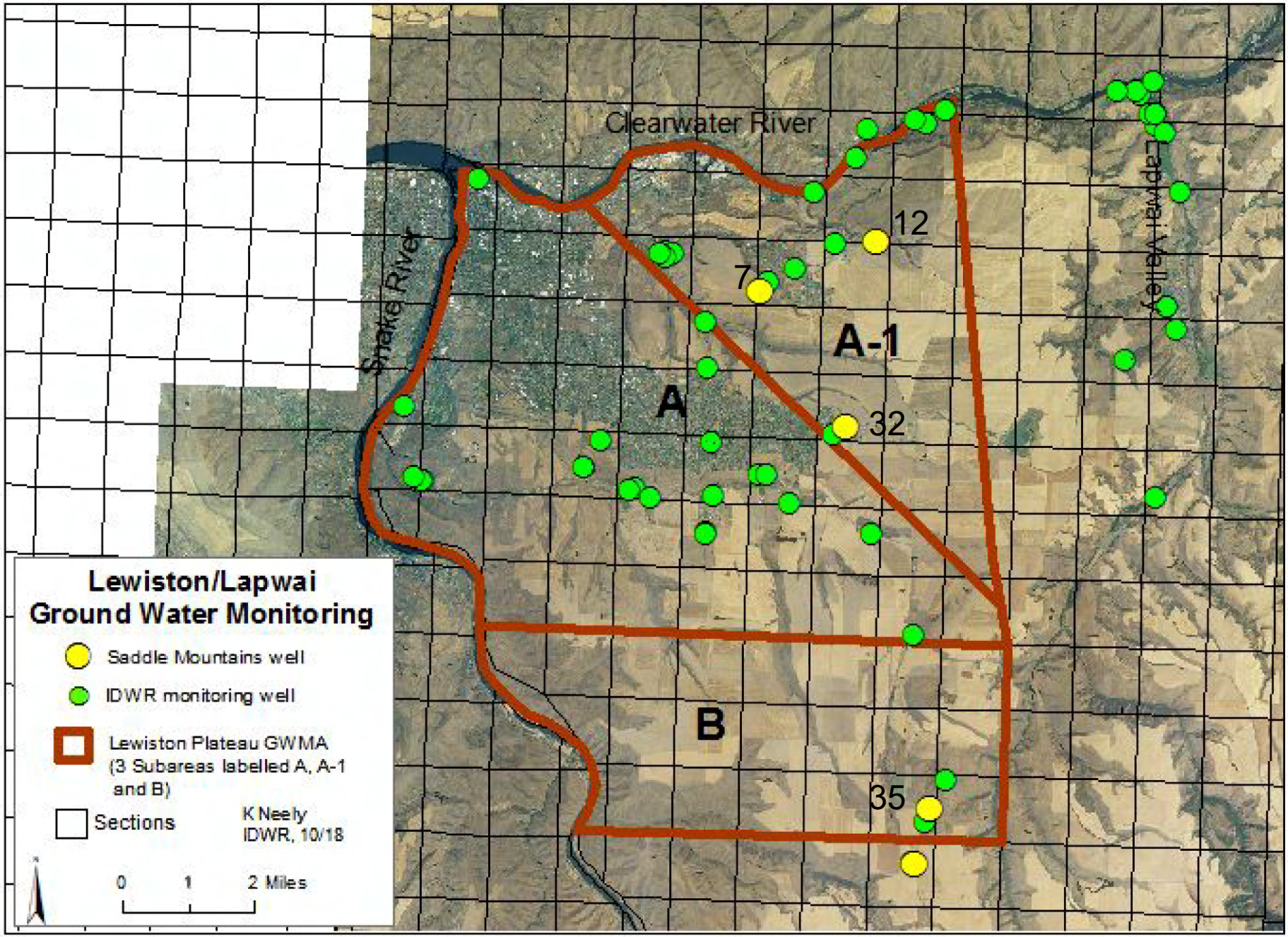

Clearwater River
36N06W
36N05W
36N04W
11N45E
11N46E
Snake River
Lapwai Valley
Subarea A1
35N06W
35N05W
35N04W
Subarea A
Subarea B
34N05W
34N04W
Lewiston/Lapwai Ground Water Monitoring, 2018
E Tape measurement
Transducer measurement
Inactive
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 11/18
0
1
2 Miles

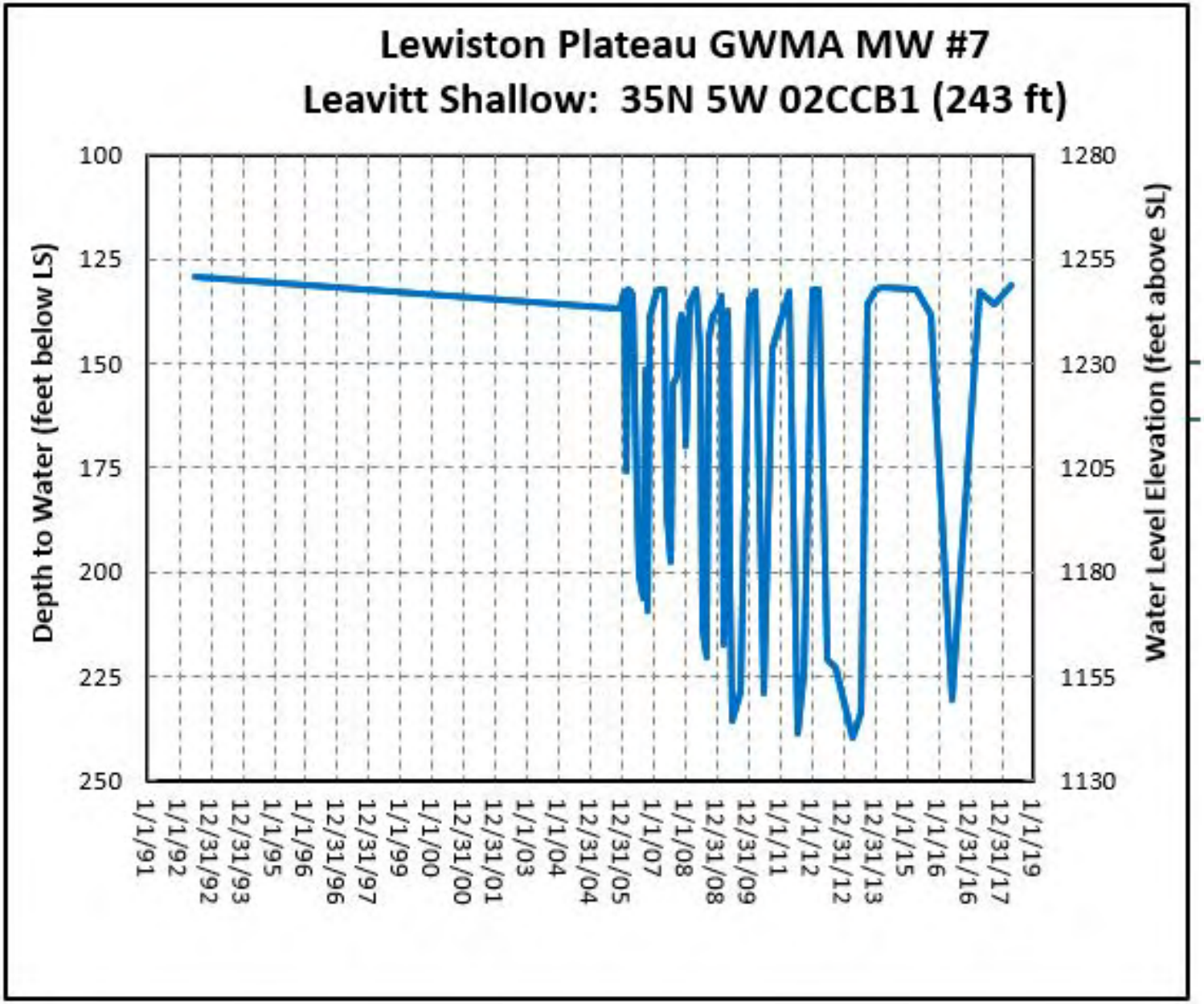
6. Current understandings of the Lewiston and Lapwai ground water systems.

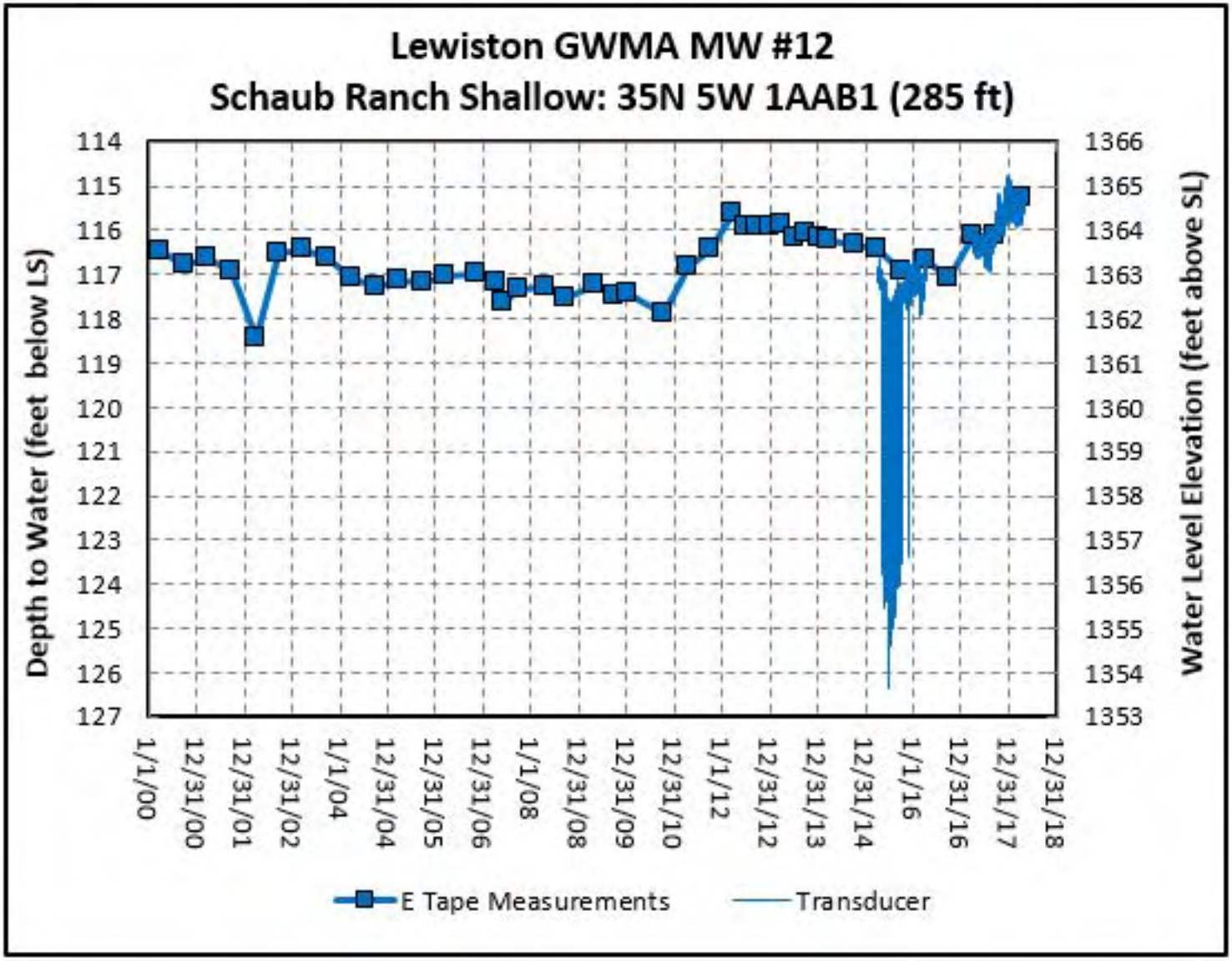
The following slides contain data and interpretations for these elements:

A. Aquifers in the Saddle Mountains Formation
B. Aquifers in the Wanapum Formation
C. Aquifers in the Grande Ronde Formation
D. Rock chemistry analyses
E. Stratigraphic relationships illustrated by cross sections
F. Subarea B Analyses
G. Lapwai Valley Analyses

A. Saddle Mountains


Clearwater River
Snake River
Lapwai Valley
12
7
A-1
A
32
B
35
Lewiston/Lapwai
Ground Water Monitoring
Saddle Mountains well
IDWR monitoring well
Lewiston Plateau GWMA
(3 Subareas labelled A, A-1
and B)
Sections
K Neely
IDWR, 10/18
0
1
2 Miles


Lewiston Plateau GWMA MW #7
Leavitt Shallow: 35N 5W 02CCB1 (243 ft)
Depth to Water (feet below LS)
Water Level Elevation (feet above SL)
100
125
150
175
200
225
250
1280
1255
1230
1205
1180
1155
1130
1/1/91
1/1/92
12/31/92
12/31/93
1/1/95
1/1/96
12/31/96
12/31/97
1/1/99
1/1/00
12/31/00
12/31/01
1/1/03
1/1/04
12/31/04
12/31/05
1/1/07
1/1/08
12/31/08
12/31/09
1/1/11
1/1/12
12/31/12
12/31/13
1/1/15
1/1/16
12/31/16
12/31/17
1/1/19


Lewiston GWMA MW #12
Schaub Ranch Shallow: 35N 5W 1AAB1 (285 ft)
Depth to Water (feet below LS)
Water Level Elevation (feet above SL)
114
115
116
117
118
119
120
121
122
123
124
125
126
127
1366
1365
1364
1363
1362
1361
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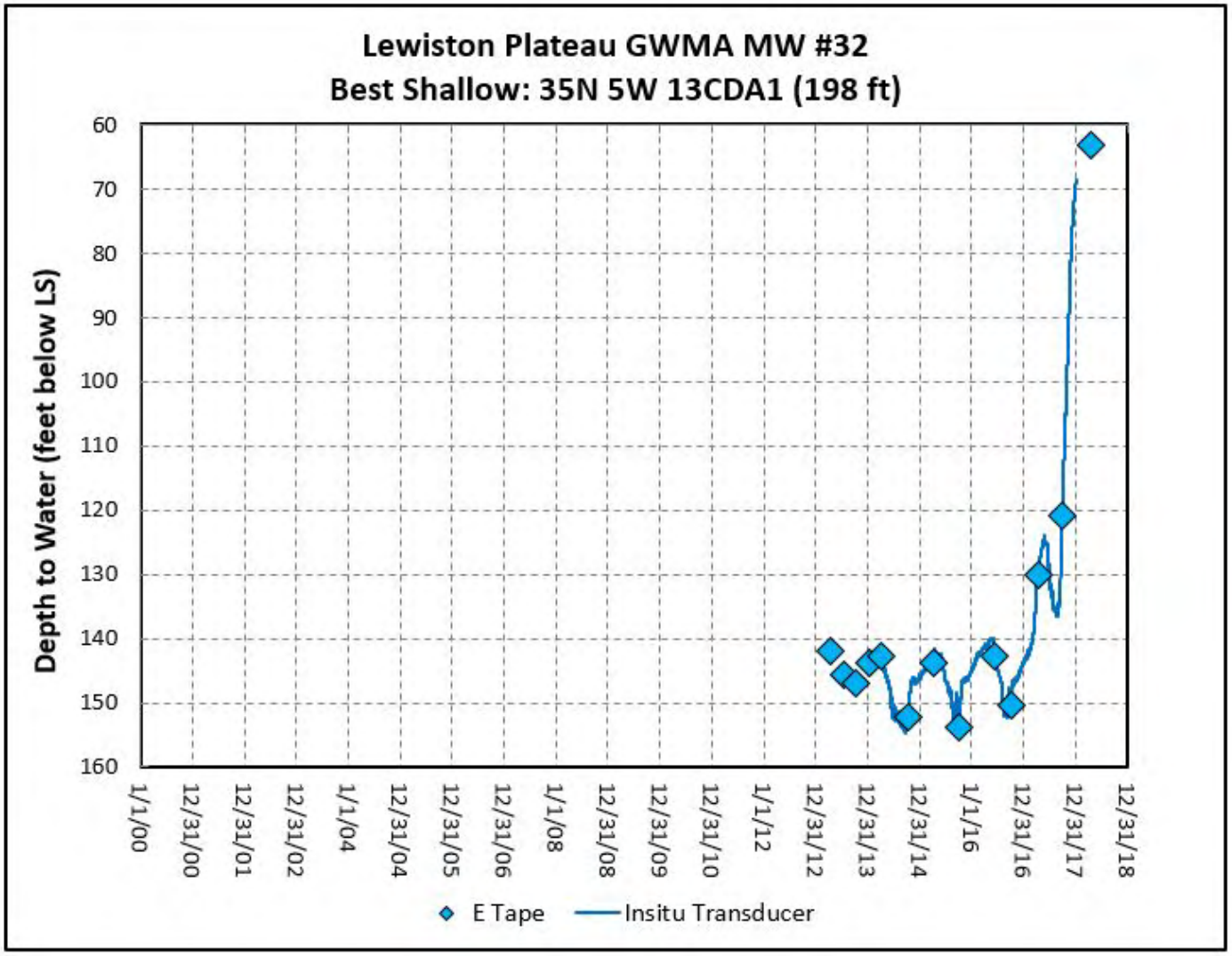
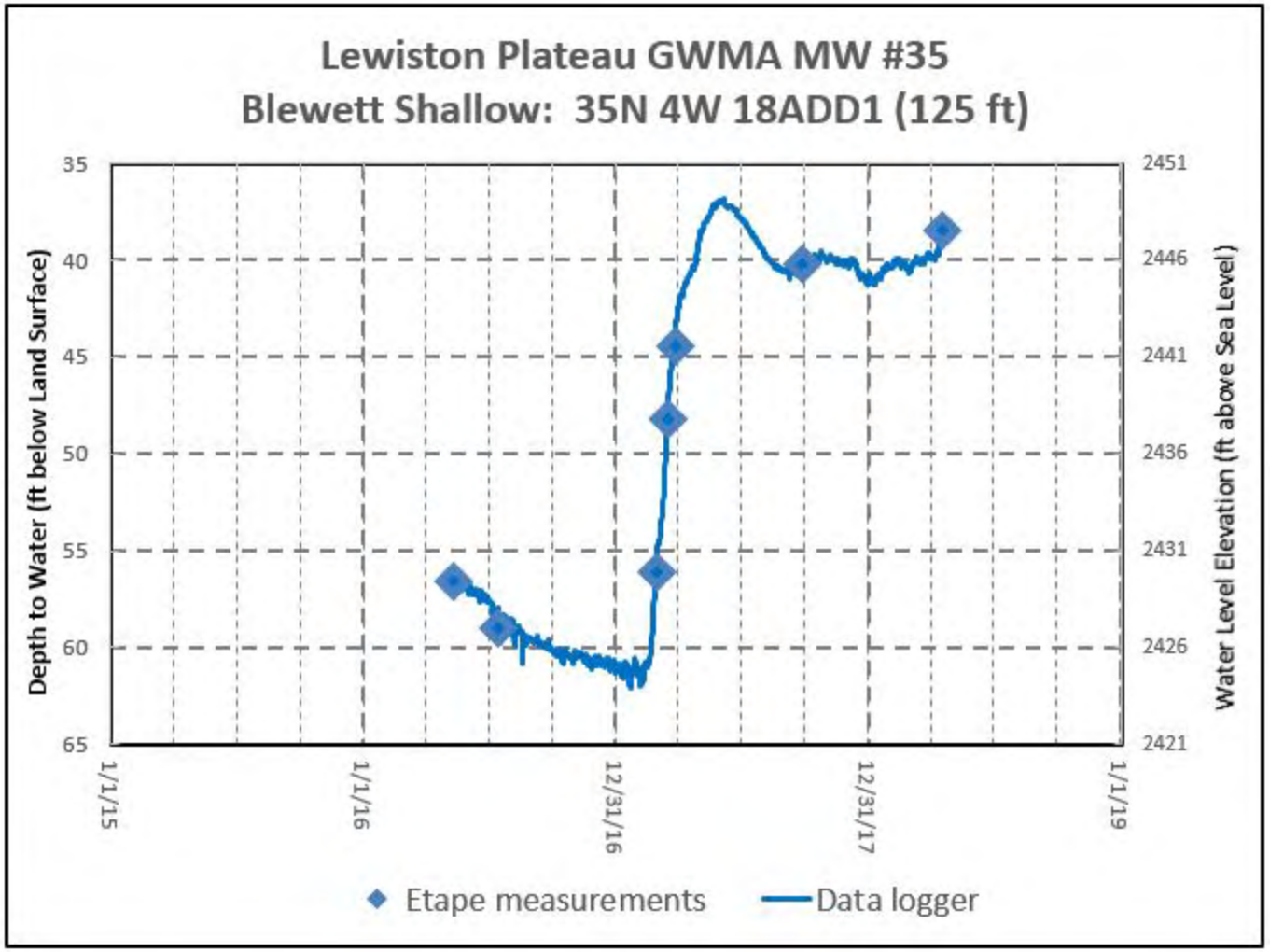
1357
1356
1355
1354
1353
1/1/00
12/31/00
12/31/01
12/31/02
1/1/04
12/31/04
12/31/05
12/31/06
1/1/08
12/31/08
12/31/09
12/31/10
1/1/12
12/31/12
12/31/13
12/31/14
1/1/16
12/31/16
12/31/17
12/31/18
E Tape Measurements
Transducer



Precipitation from Fall 2016 thru Spring 2017 was 60% higher than average.



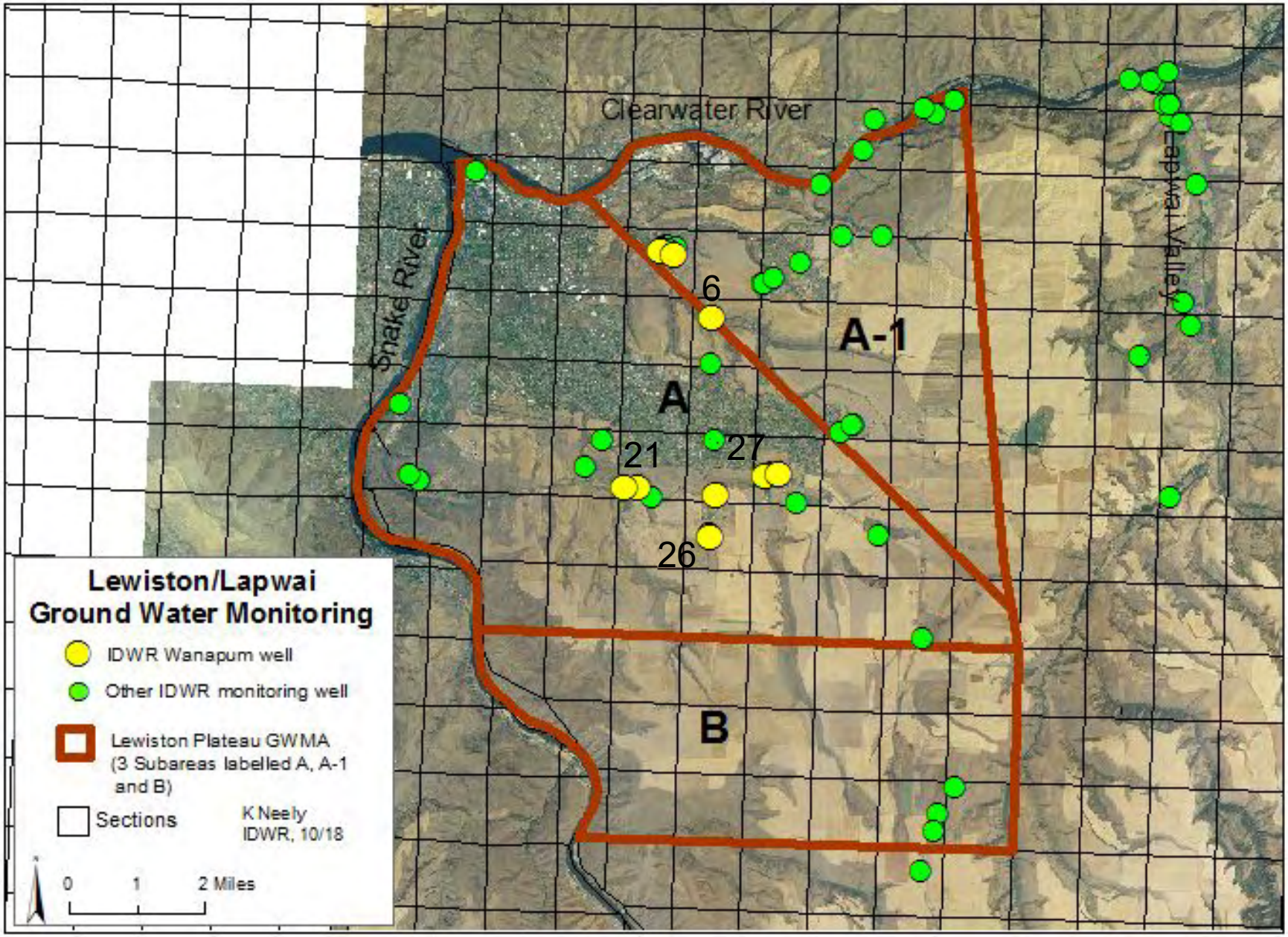
Precipitation from Fall 2016 thru Spring 2017 was 60% higher than average.

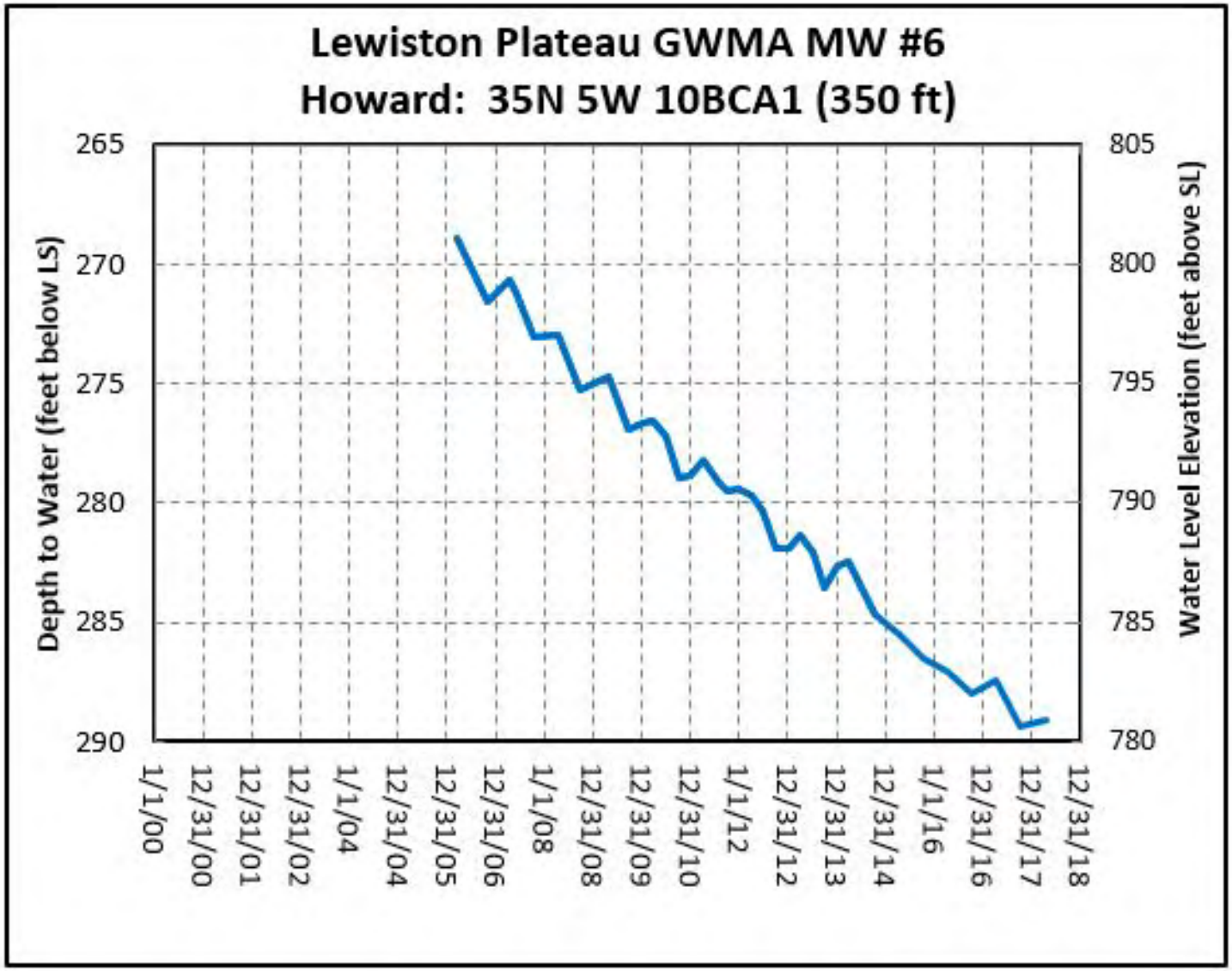
Saddle Mountains Summary

3 wells with long-term data (> 5 yrs); 1 well with short-term data (2.5 yrs). Two of the wells had dramatic water level increases following the wet winter of 2017. Two wells had moderate increases.

2 new wells were added to the network in 2018, one in the southeast corner of Subarea B and one just south of Subarea B. The well south of Subarea B had a much higher water level in 2018 than in 1999 (well driller's report).

B. Wanapum


Clearwater River
Snake River
Lapwai Valley
6
A-1
A
21
27
26
B
Lewiston/Lapwai
Ground Water Monitoring
IDWR Wanapum well
Other IDWR monitoring well
Lewiston Plateau GWMA
(3 Subareas labelled A, A-1
and B)
Sections
K Neely
IDWR, 10/18
0
1
2 Miles


Lewiston Plateau GWMA MW #6
Howard: 35N 5W 10BCA1 (350 ft)
Depth to Water (feet below LS)
265
270
275
280
285
290
Water Level Elevation (feet above SL)
805
800
795
790
785
780
1/1/00
12/31/00
12/31/01
12/31/02
1/1/04
12/31/04
12/31/05
12/31/06
1/1/08
12/31/08
12/31/09
12/31/10
1/1/12
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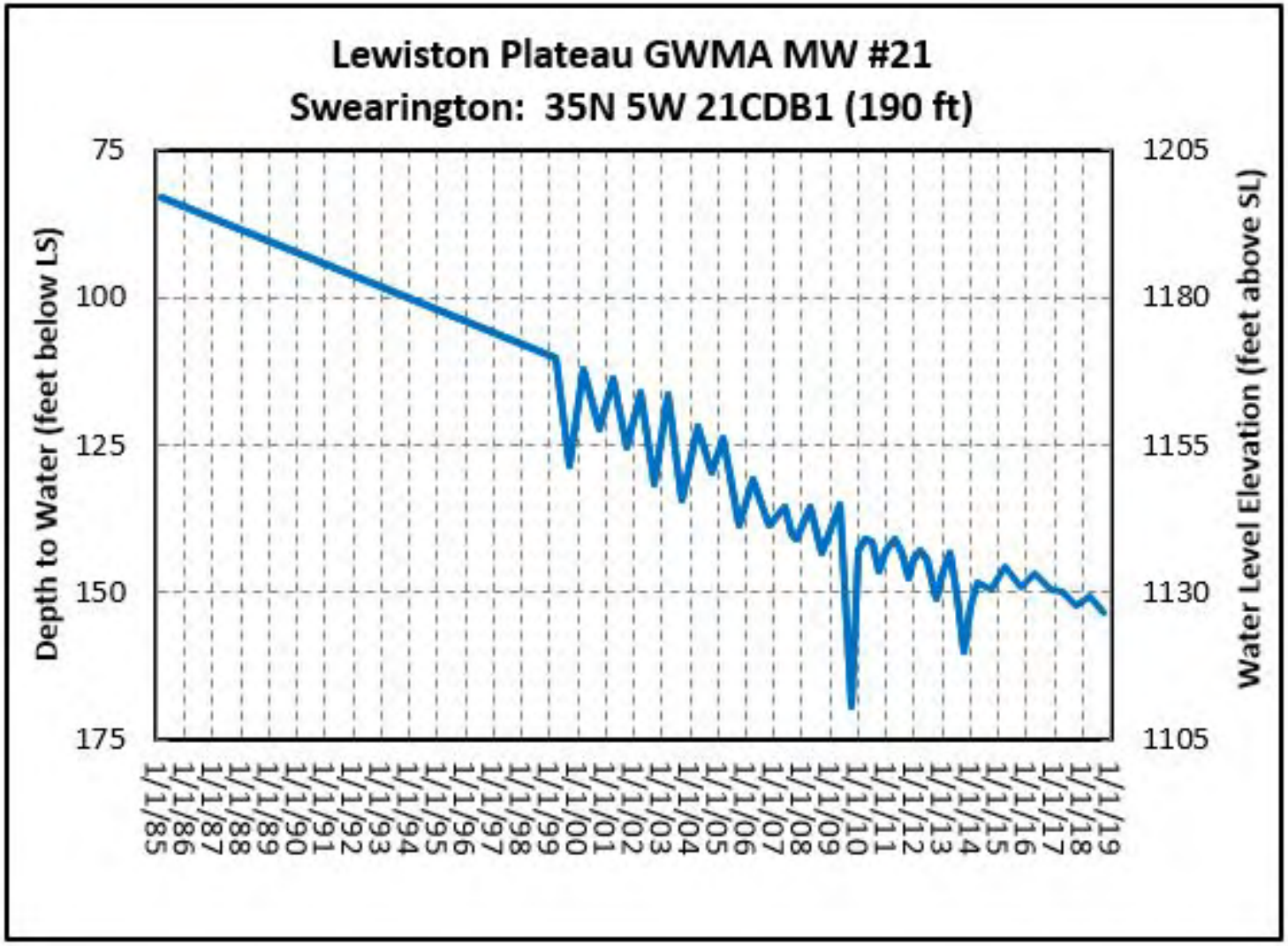
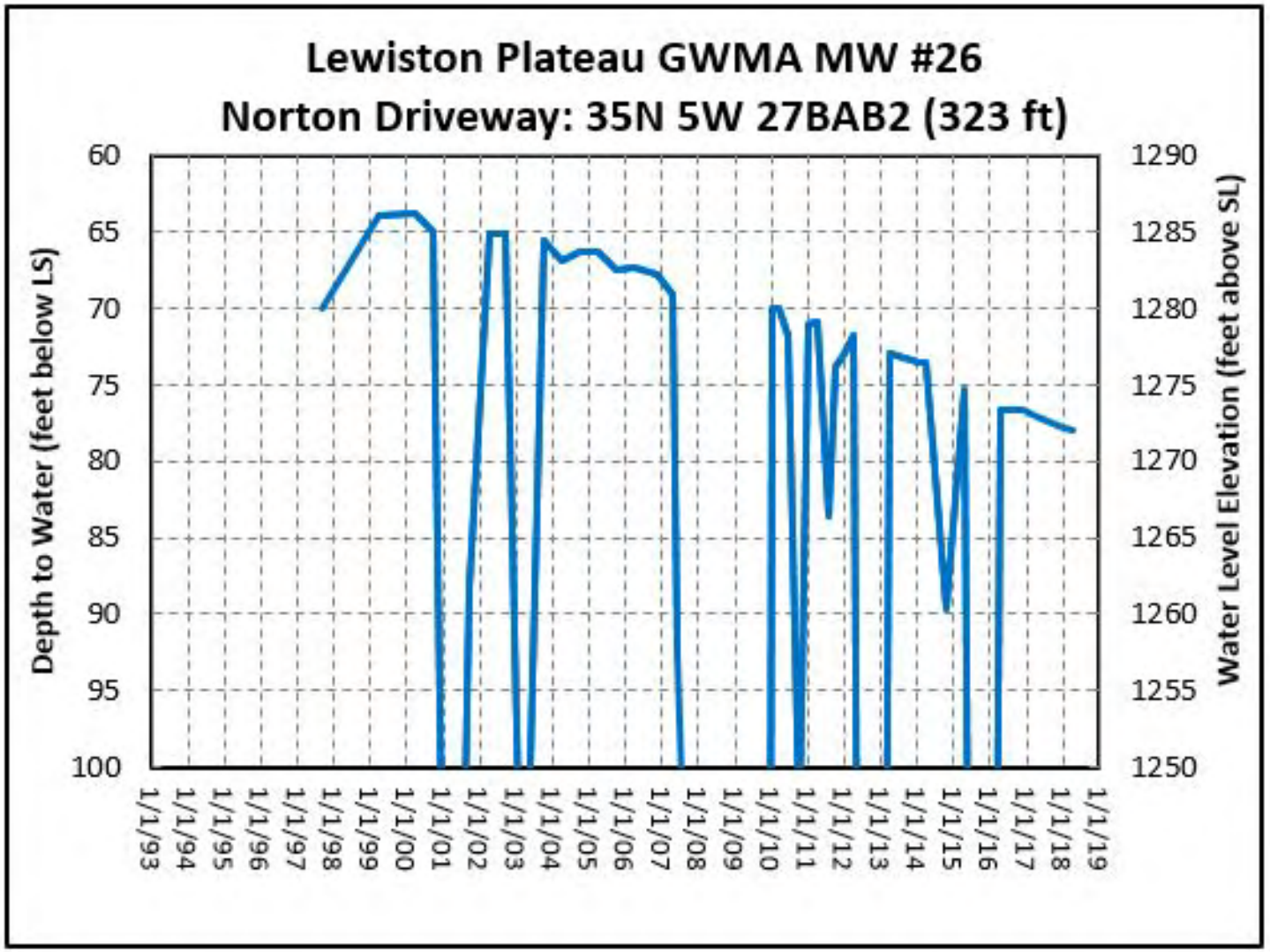
12/31/14
1/1/16
12/31/16
12/31/17
12/31/18


Lewiston Plateau GWMA MW #21
Swearington: 35N 5W 21CDB1 (190 ft)
Depth to Water (feet below LS)
75
100
125
150
175
Water Level Elevation (feet above SL)
1205
1180
1155
1130
1105
1/1/85
1/1/86
1/1/87
1/1/88
1/1/89
1/1/90
1/1/91
1/1/92
1/1/93
1/1/94
1/1/95
1/1/96
1/1/97
1/1/98
1/1/99
1/1/00
1/1/01
1/1/02
1/1/03
1/1/04
1/1/05
1/1/06
1/1/07
1/1/08
1/1/09
1/1/10
1/1/11
1/1/12
1/1/13
1/1/14
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19


Lewiston Plateau GWMA MW #26
Norton Driveway: 35N 5W 27BAB2 (323 ft)
Depth to Water (feet below LS)
Water Level Elevation (feet above SL)
60
65
70
75
80
85
90
95
100
1290
1285
1280
1275
1270
1265
1260
1255
1250
1/1/93
1/1/94
1/1/95
1/1/96
1/1/97
1/1/98
1/1/99
1/1/00
1/1/01
1/1/02
1/1/03
1/1/04
1/1/05
1/1/06
1/1/07
1/1/08
1/1/09
1/1/10
1/1/11
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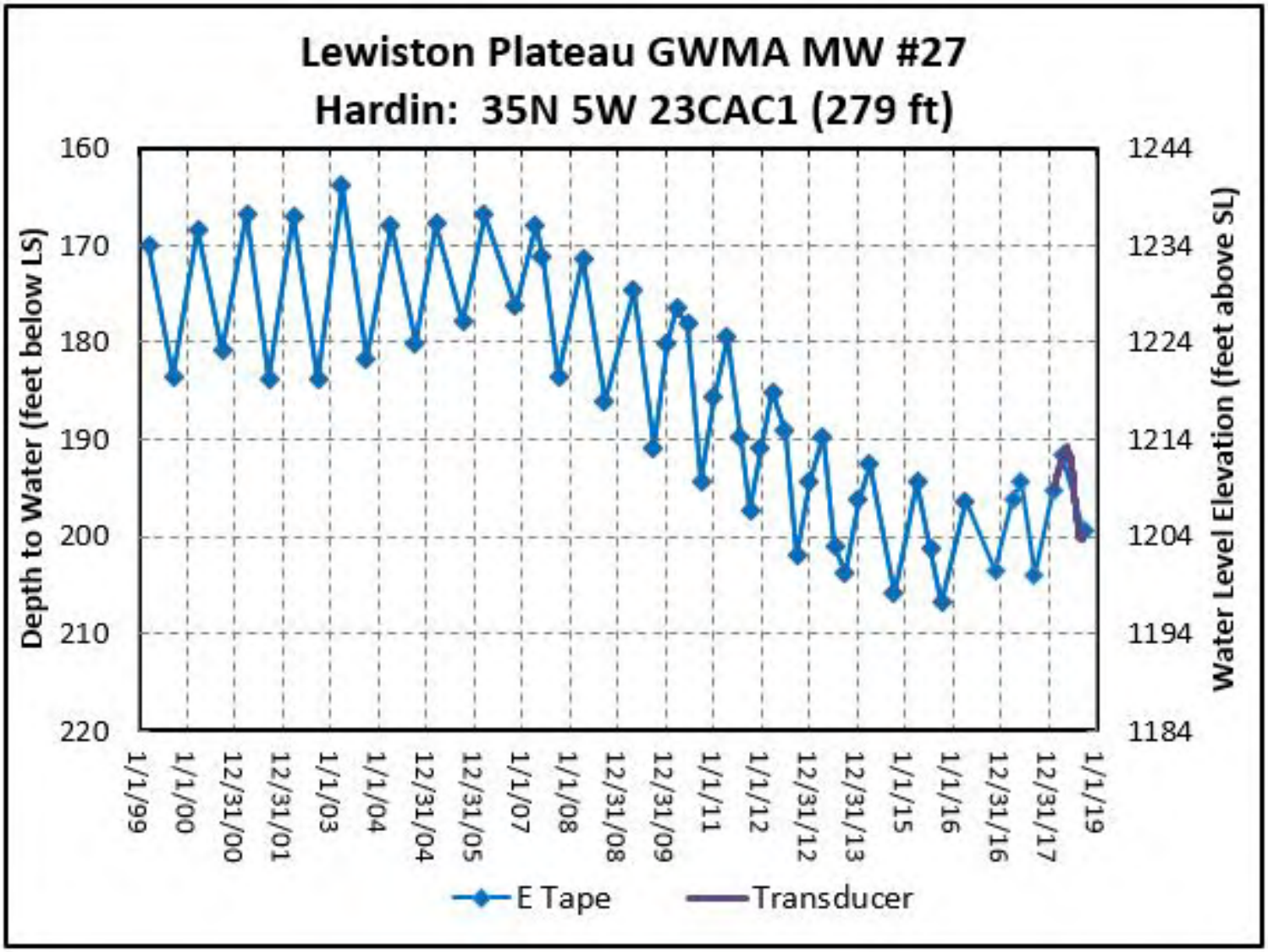
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19


Lewiston Plateau GWMA MW #27
Hardin: 35N 5W 23CAC1 (279 ft)
Depth to Water (feet below LS)
160
170
180
190
200
210
220
Water Level Elevation (feet above SL)
1244
1234
1224
1214
1204
1194
1184
1/1/99
1/1/00
12/31/00
12/31/01
1/1/03
1/1/04
12/31/04
12/31/05
1/1/07
1/1/08
12/31/08
12/31/09
1/1/11
1/1/12
12/31/12
12/31/13
1/1/15
1/1/16
12/31/16
12/31/17
1/1/19
E Tape
Transducer

Wanapum Summary

9 monitoring wells. Only 4 of the wells have long-term monitoring data. The other 5 wells were added to the network within the last 4 years.

3 of the 4 long-term wells have shown continual water level declines, with no apparent positive response to the wet winter of 2017.

1 well has a unique pattern showing stable conditions until 2007, followed by significant declines until 2016, then recovery in 2017 and 2018.

C. Grande Ronde Aquifers

1. Tgr2 (Upper GR). Primarily found in Subareas A and A1.

2. Tgn1 (Middle GR). Primarily found in Subareas A and B

3. Tgr1 (Lower GR). The few wells drilled deep enough to encounter this unit are in Subareas A and A1

Analyses of Grande Ronde Aquifers

1. Geographic distributions of wells with similar water level elevations
2. Correlations between water level elevations in wells and elevations of surface water recharge sources
3. Responses to the LOID 5 well test of 2017
4. Rock chip chemical analyses
5. Cross sections using rock chip analyses, stratigraphic correlations, and water level elevation data

Geographic distributions of wells with similar water level patterns and/or elevations

There are 4 distinct groupings of wells that have similar water level elevations and/or trends.

Group 1. 9 monitoring wells with spring time water level elevations ranging from 710 to 735 feet above Sea Level (ft asl); 8 are in Subarea A and 1 is in Subarea A1. These wells are hydraulically connected to the Snake River.

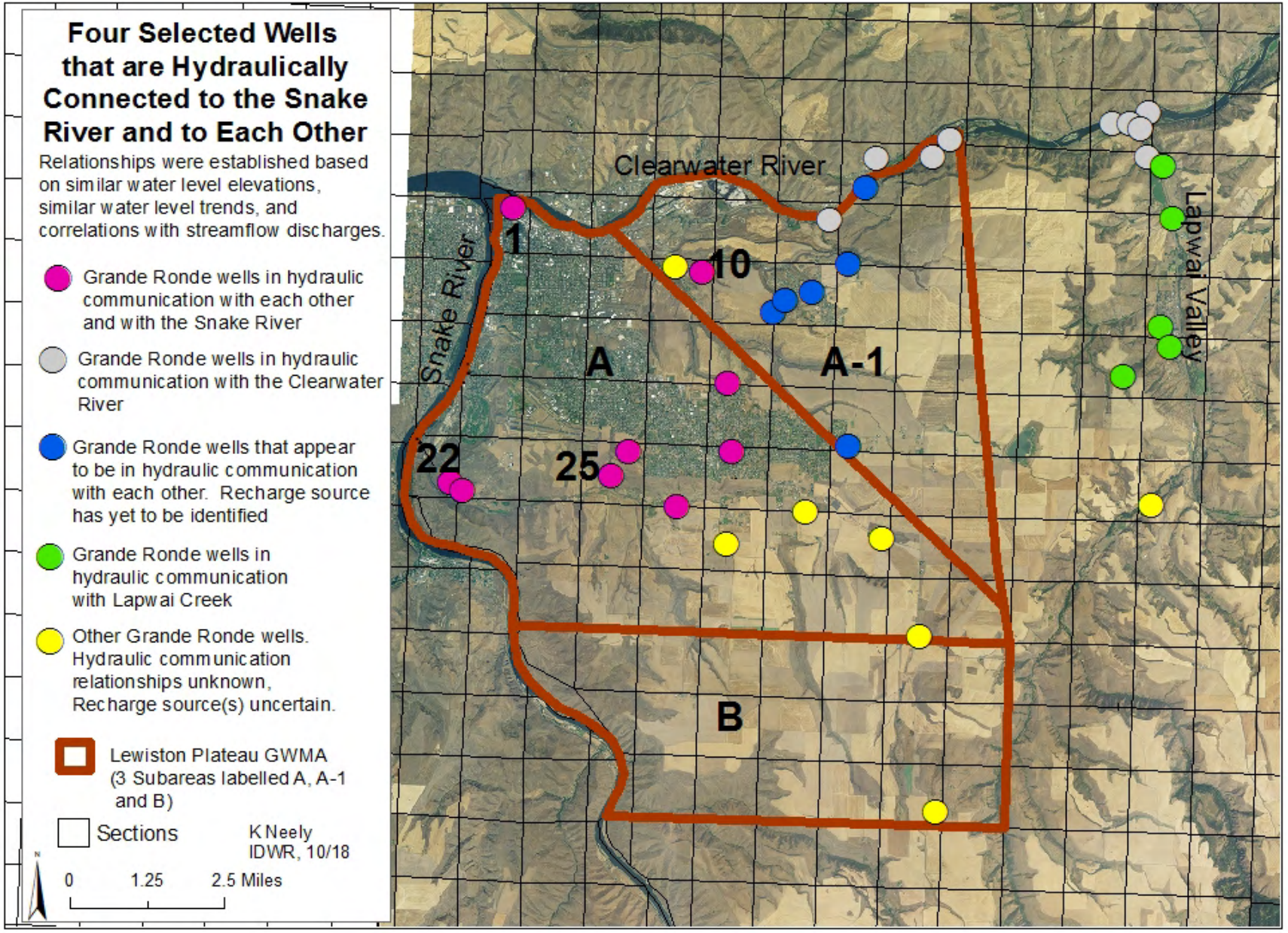
Group 2. 9 wells with water level elevations around 750-800 ft asl found along the Clearwater River in the northern part of Subarea A1 and in the Spaulding area of the Lapwai Valley. These wells are hydraulically connected to the Clearwater River.

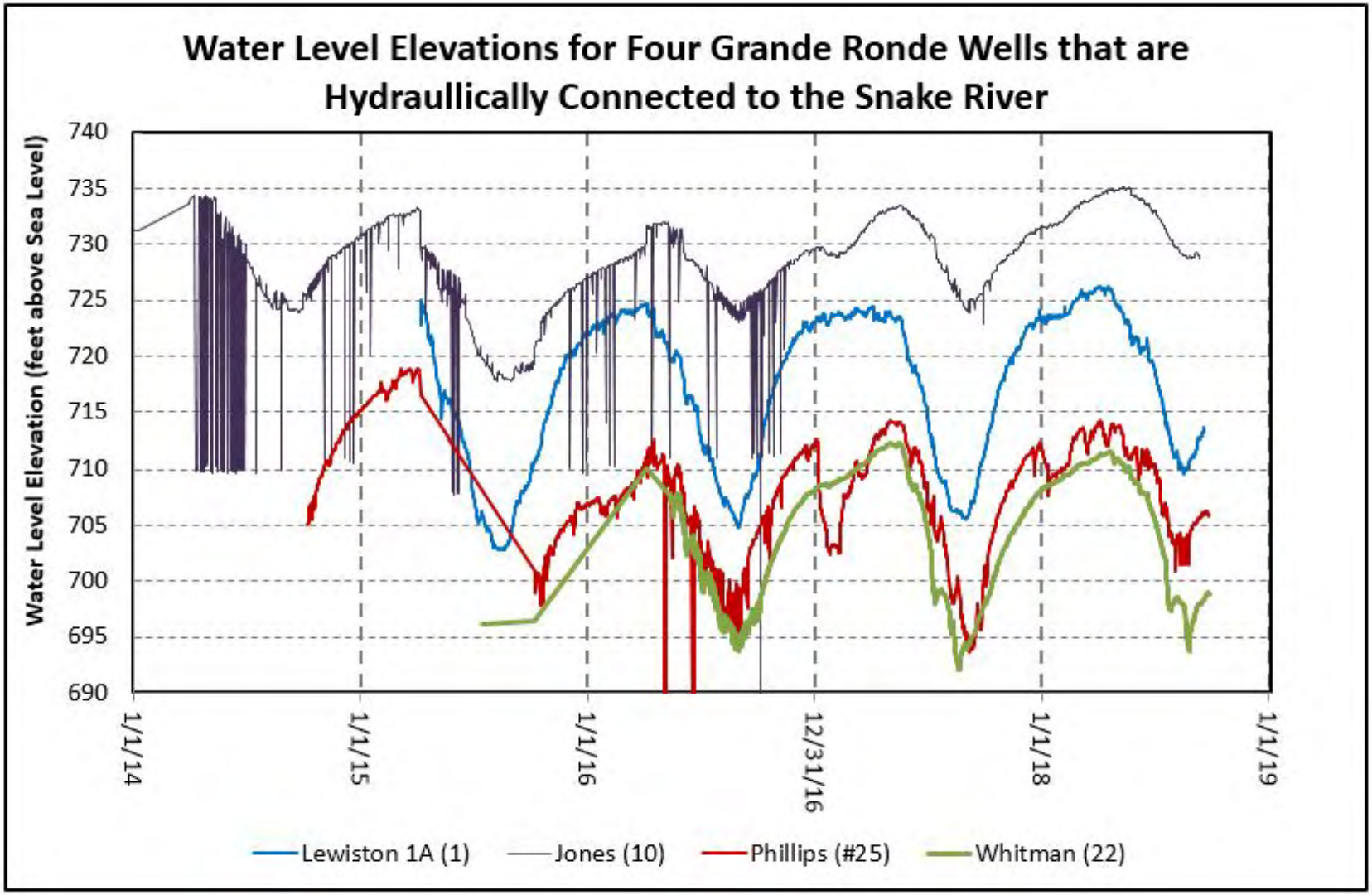
Group 3. 6 wells with water level elevations around 790 to 820 ft asl found in Subarea A1. Hydraulic connection with a surface water source has not been identified.

Group 4. 5 wells in northern and central Lapwai Valley. Although the wells in the southern area have much higher water level elevations than the wells in the northern area, all of the wells appear to be hydraulically connected to Lapwai Creek.

There are 5 wells in the southern part of Subarea A and in Subarea B that have water level elevations greater than 1000 ft asl, but the elevations differ significantly between the wells. It is unknown if they are hydraulically connected to each other, and the recharge source(s) for these wells are currently undetermined.

The following slides illustrate the observations for the four groups with similar water level elevations and/or trends.

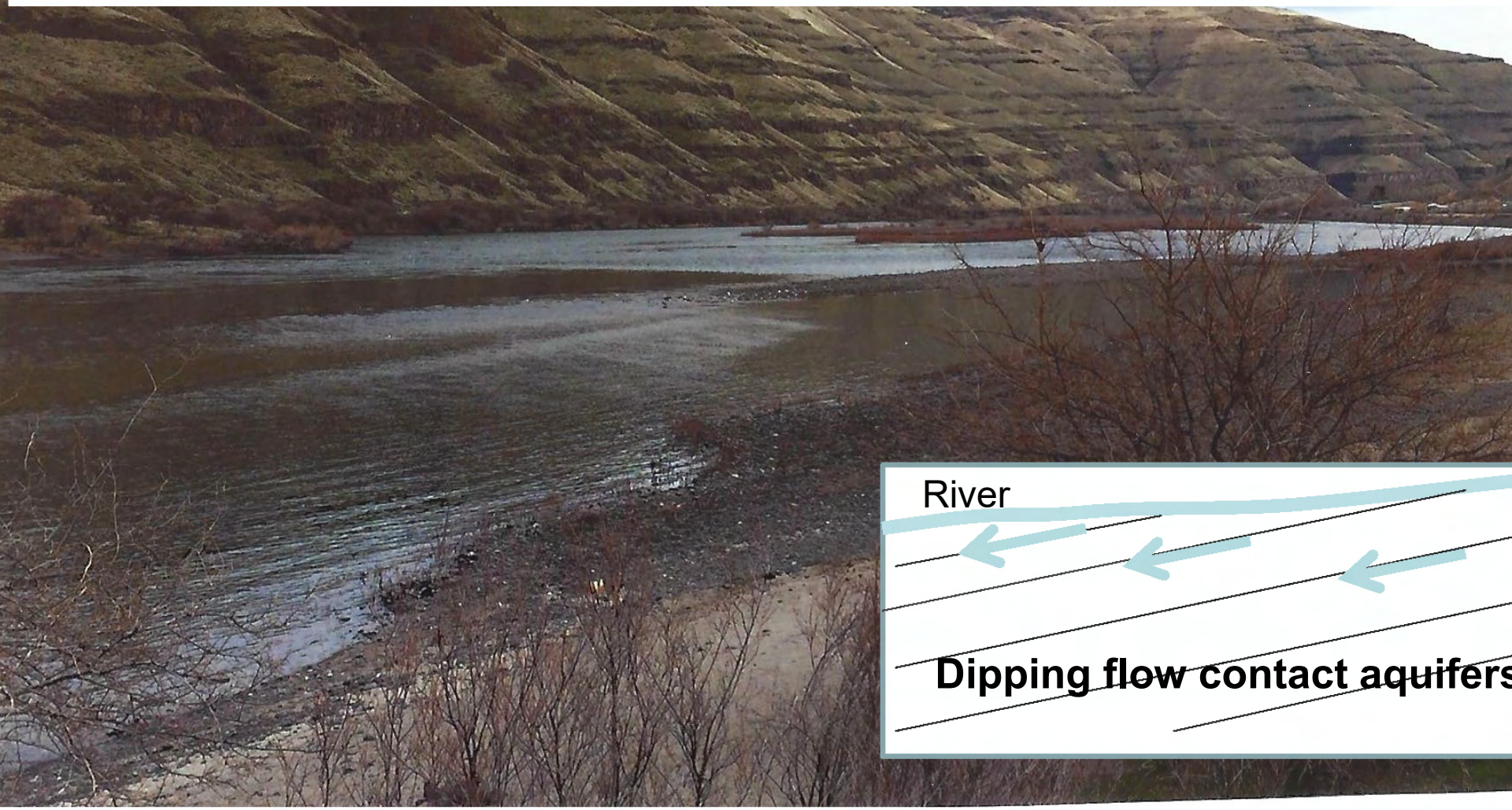

Four Selected Wells that are Hydraulically Connected to the Snake River and to Each Other
Relationships were established based on similar water level elevations, similar water level trends, and correlations with streamflow discharges.
Grande Ronde wells in hydraulic communication with each other and with the Snake River
Grande Ronde wells in hydraulic communication with the Clearwater River
Grande Ronde wells that appear to be in hydraulic communication with each other. Recharge source has yet to be identified
Grande Ronde wells in hydraulic communication with Lapwai Creek
Other Grande Ronde wells. Hydraulic communication relationships unknown, Recharge source(s) uncertain.
Lewiston Plateau GWMA (3 Subareas labelled A, A-1 and B)
Sections
K Neely IDWR, 10/18
0
1.25
2.5 Miles
Clearwater River
Snake River
Lapwai Valley
1
10
22
25
A
A-1
B


Water Level Elevations for Four Grande Ronde Wells that are Hydraullically Connected to the Snake River
Water Level Elevation (feet above Sea Level)
740
735
730
725
720
715
710
705
700
695
690
1/1/14
1/1/15
1/1/16
12/31/16
1/1/18
1/1/19
Lewiston 1A (1)
Jones (10)
Phillips (#25)
Whitman (22)

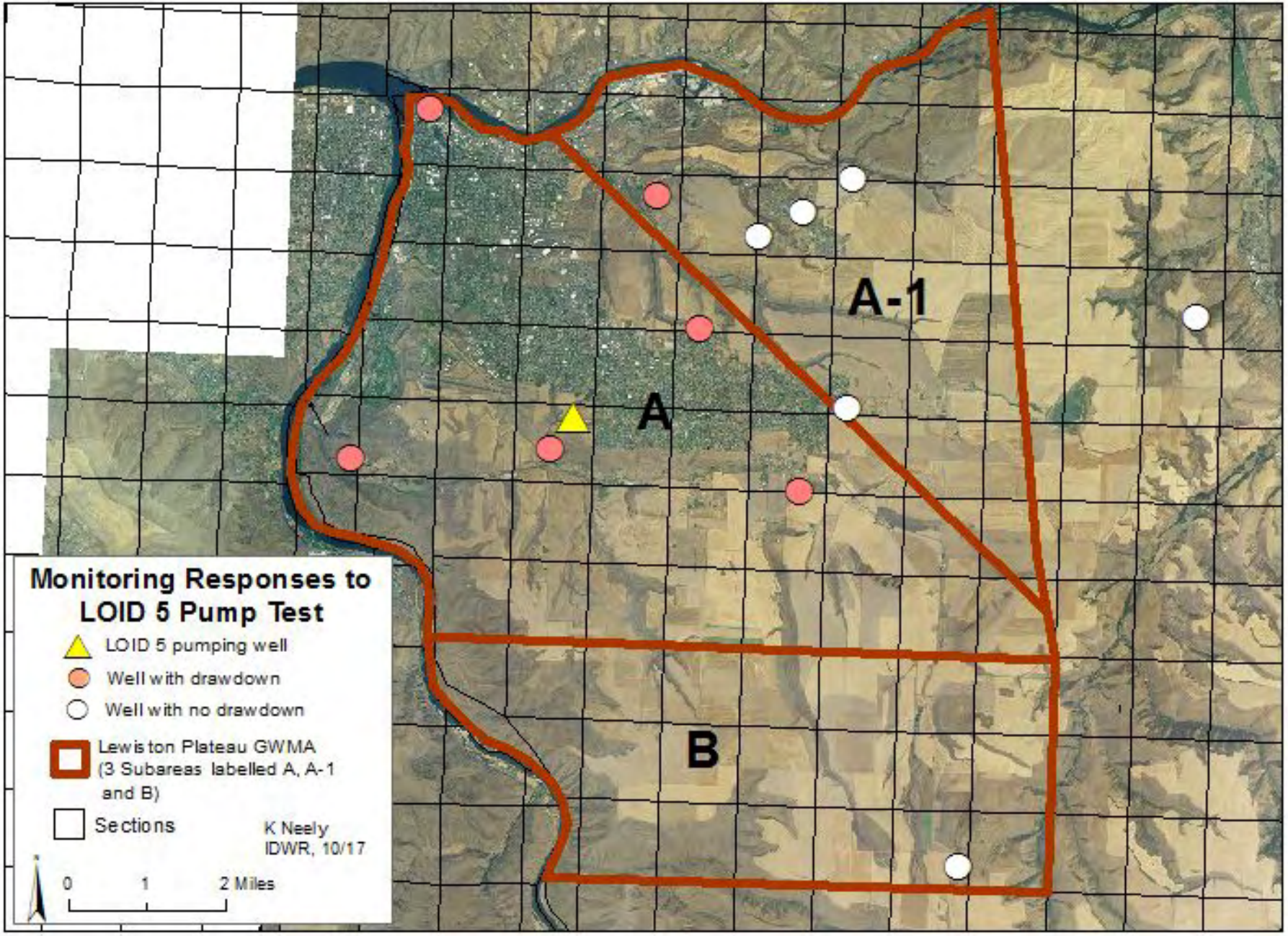
Well (Map Number)	Well Depth (ft)	Bottom Hole Elevation (ft above SL)	Water Level Elevation (ft above SL)
Lewiston 1A (1)	735	-5	724
Jones (10)	1200	-5	730
LOID 3 (18)	2617	-1198	724
Whitman (22)	475	495	712
LOID 5 (26)	1900	-583	723
LOID 4 (30)	1625	-59	719

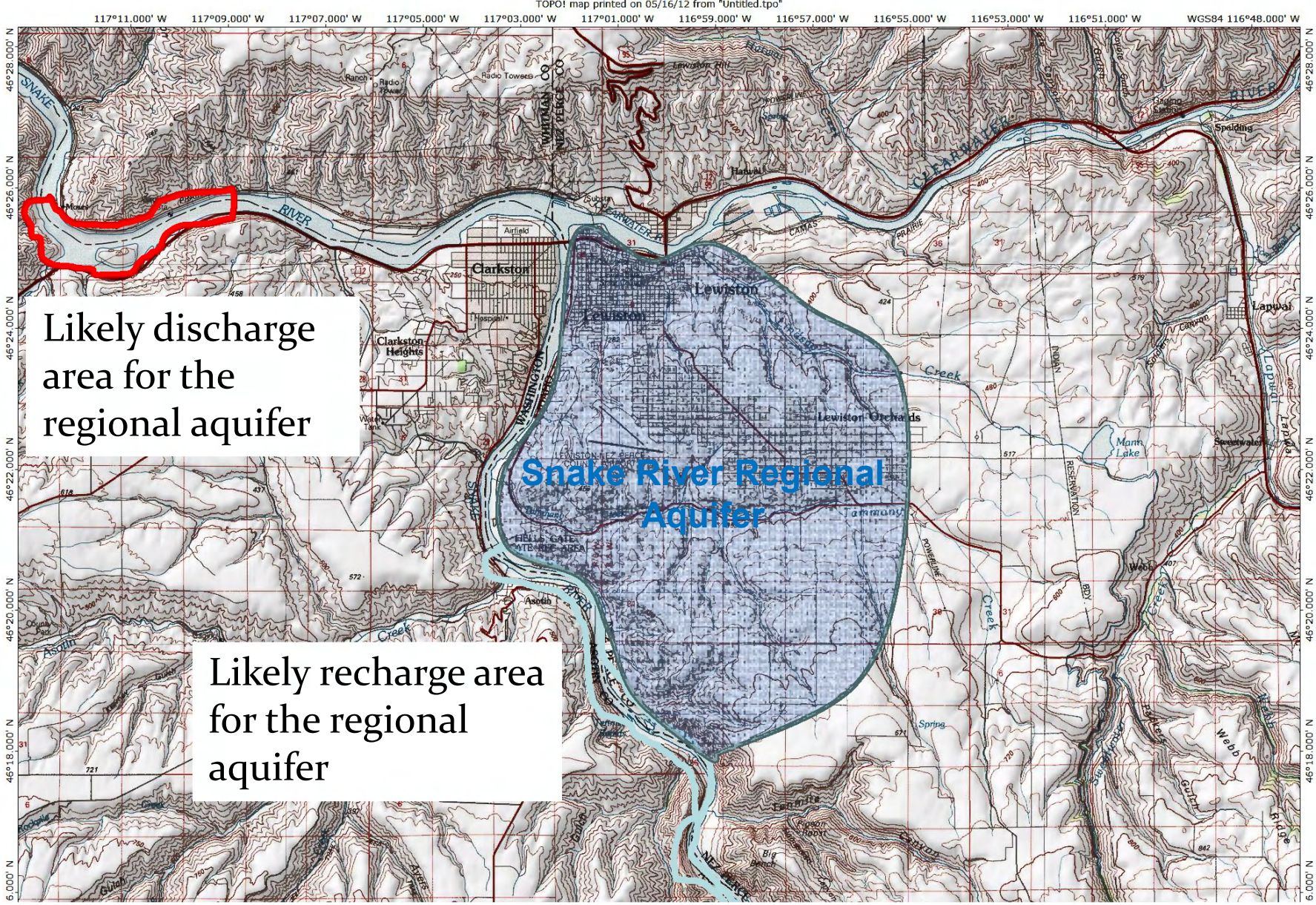
Selected wells showing that the water level elevations in the wells that are hydraulically connected to the Snake River are independent of well depths and bottom hole elevations. (Credit: Ralston Hydrologic Services).

Recharge mechanism for the wells that are hydraulically connected to the Snake River. The dip of Grande Ronde flows are steeper than the gradient of the Snake River, allowing for recharge to occur in places where flow contact zones outcrop under the river (credit: Ralston Hydrologic Services).

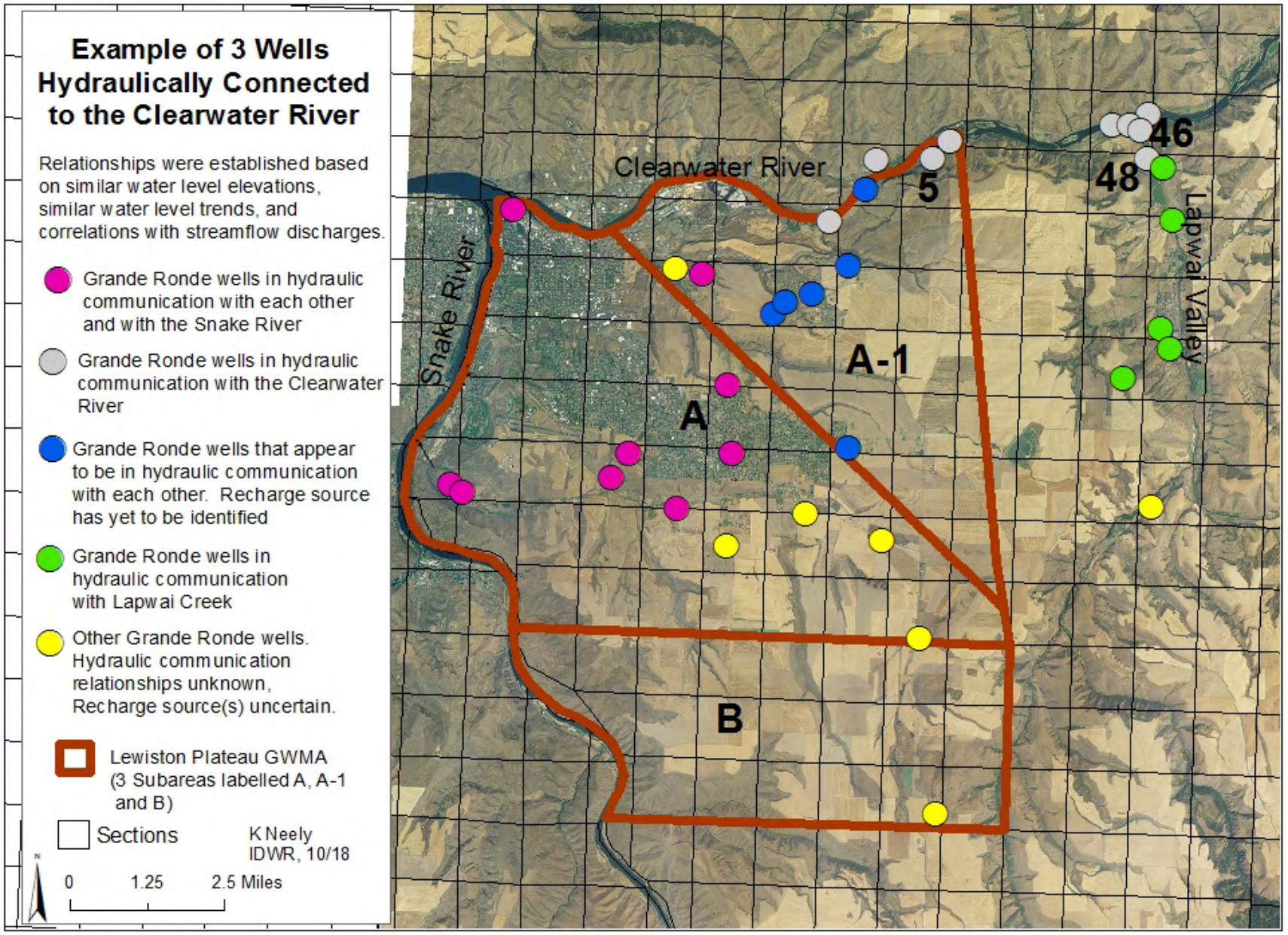


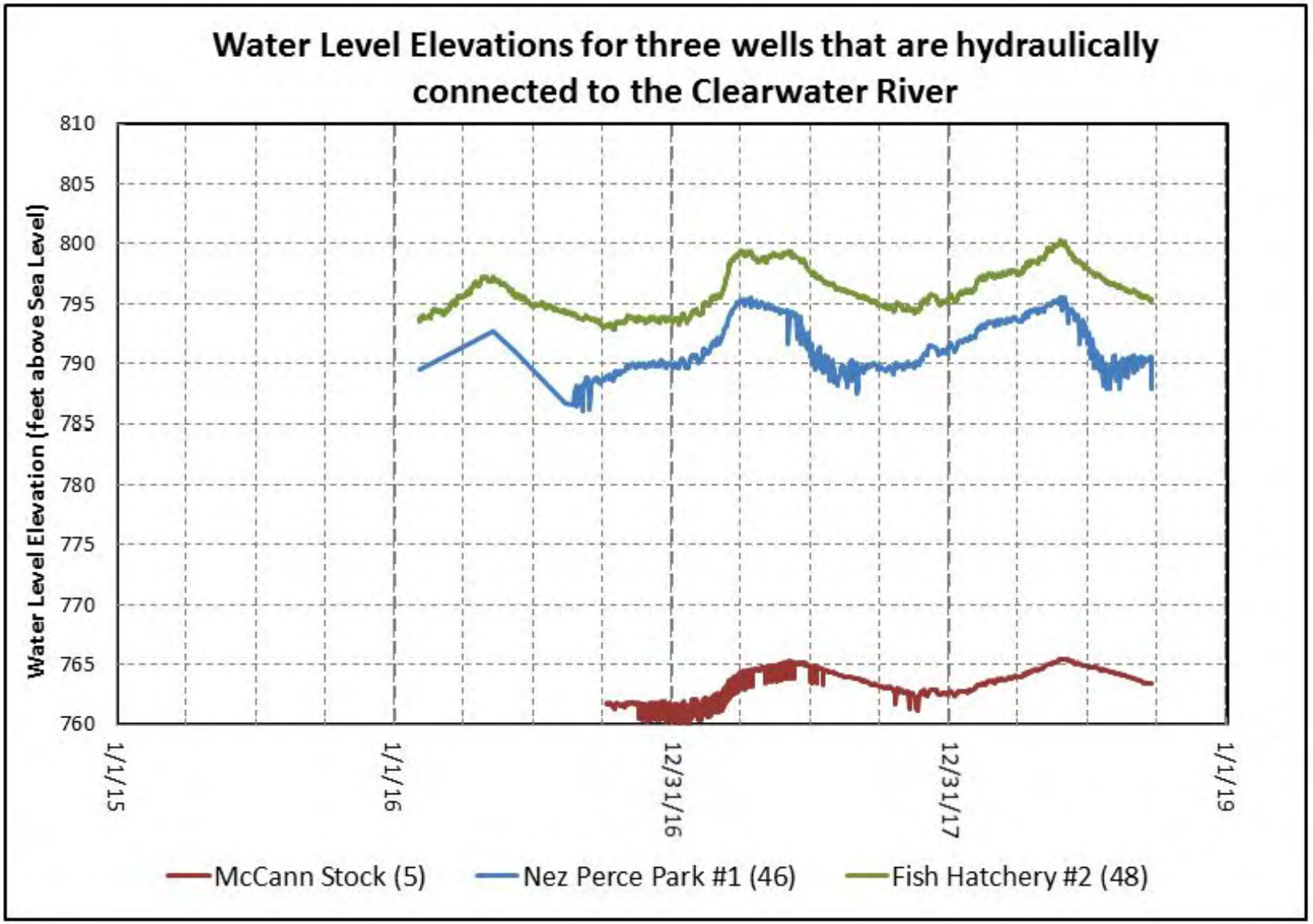
Responses to LOID 5 Pump Test (Sturgis)

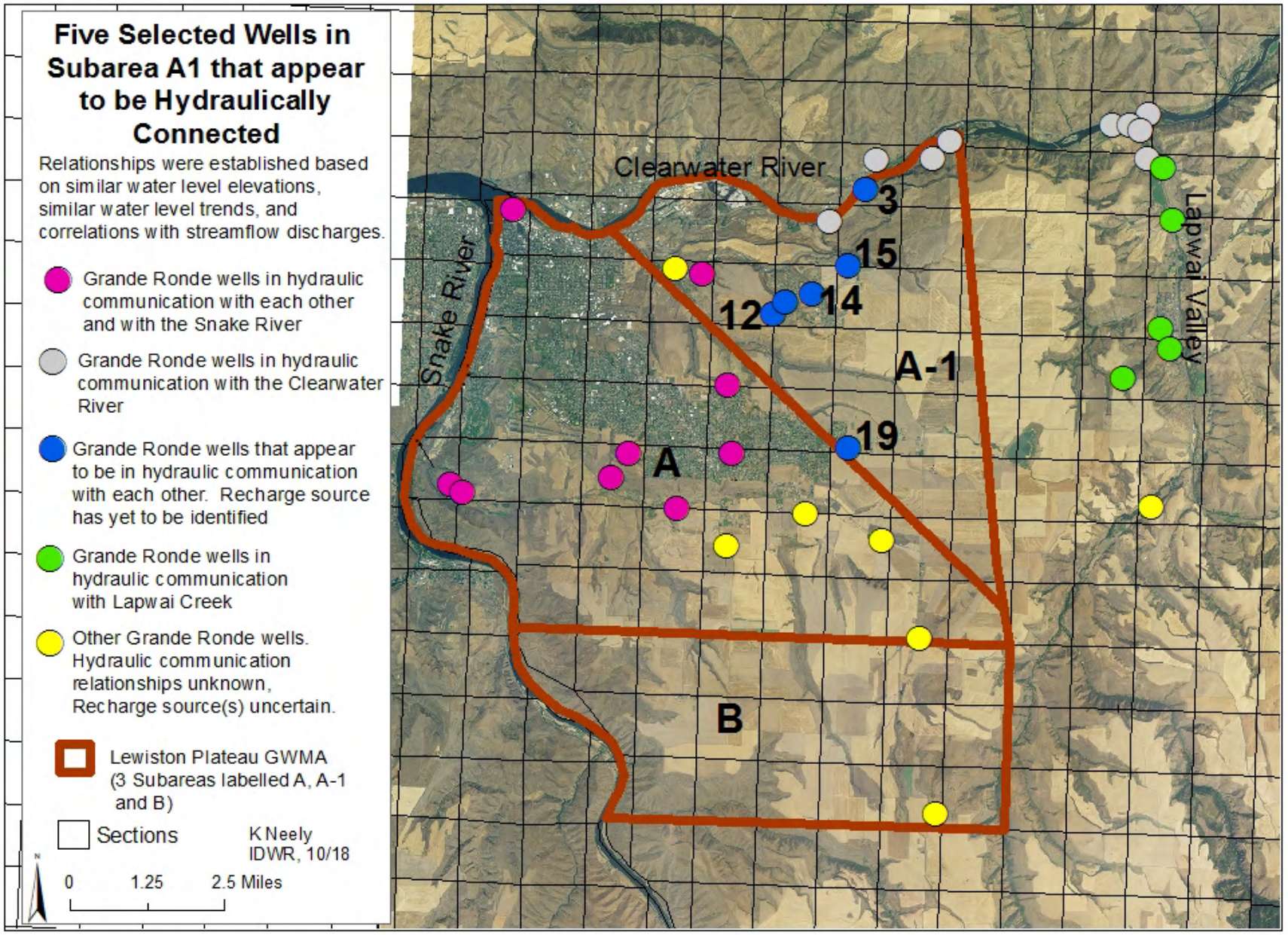


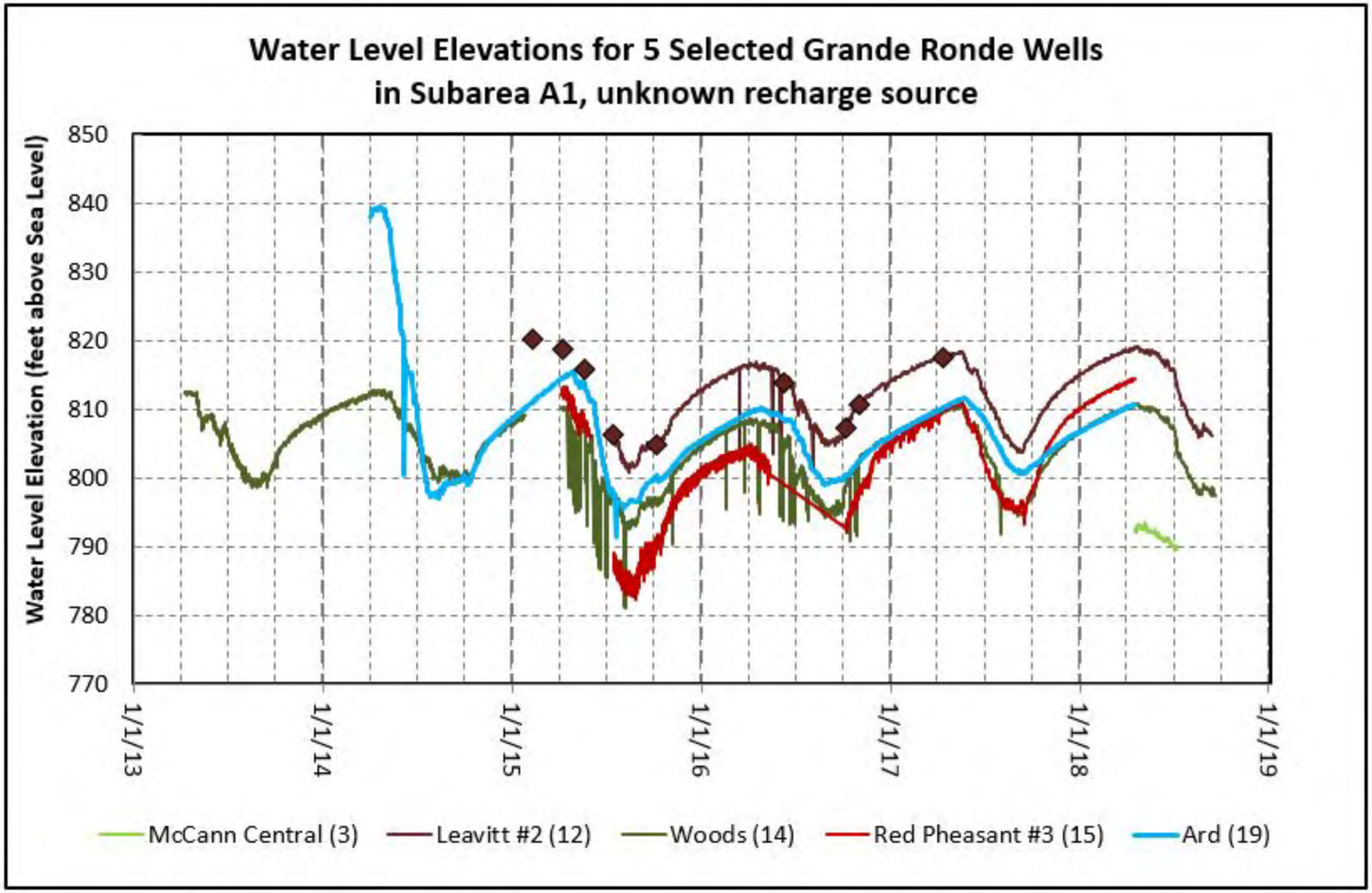


Probable areal extension of the Grande Ronde aquifers that are hydraulically connected to the Snake River.

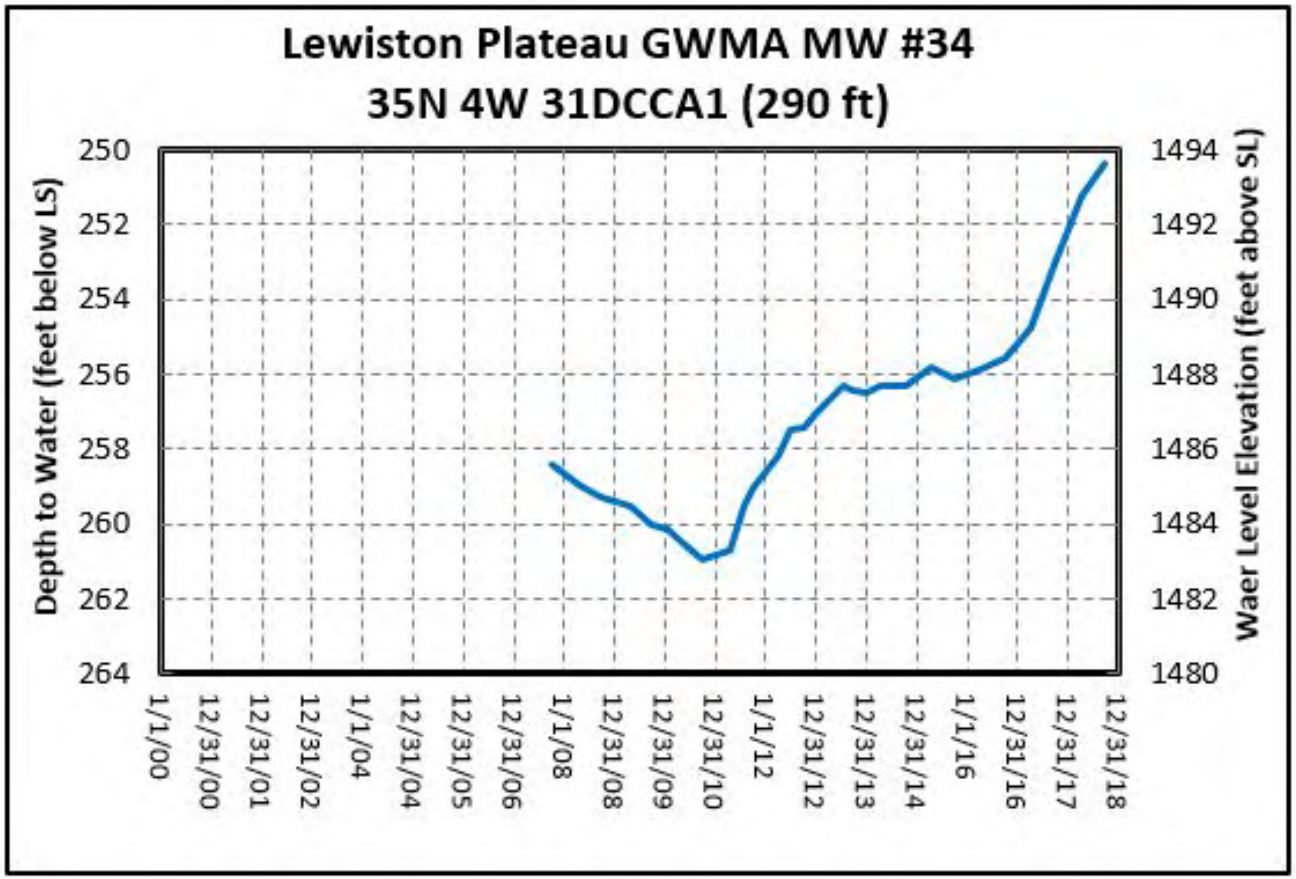

Example of 3 Wells Hydraulically Connected to the Clearwater River
Relationships were established based on similar water level elevations, similar water level trends, and correlations with streamflow discharges.
Grande Ronde wells in hydraulic communication with each other and with the Snake River
Grande Ronde wells in hydraulic communication with the Clearwater River
Grande Ronde wells that appear to be in hydraulic communication with each other. Recharge source has yet to be identified
Grande Ronde wells in hydraulic communication with Lapwai Creek
Other Grande Ronde wells. Hydraulic communication relationships unknown, Recharge source(s) uncertain.
Lewiston Plateau GWMA (3 Subareas labelled A, A-1 and B)
Sections
K Neely IDWR, 10/18
0 1.25 2.5 Miles
Clearwater River
Snake River
Lapwai Valley
A
A-1
B
5
46
48


Water Level Elevations for three wells that are hydraulically connected to the Clearwater River
Water Level Elevation (feet above Sea Level)
810
805
800
795
790
785
780
775
770
765
760
1/1/15
1/1/16
12/31/16
12/31/17
1/1/19
McCann Stock (5)
Nez Perce Park #1 (46)
Fish Hatchery #2 (48)


Five Selected Wells in Subarea A1 that appear to be Hydraulically Connected
Relationships were established based on similar water level elevations, similar water level trends, and correlations with streamflow discharges.
Grande Ronde wells in hydraulic communication with each other and with the Snake River
Grande Ronde wells in hydraulic communication with the Clearwater River
Grande Ronde wells that appear to be in hydraulic communication with each other. Recharge source has yet to be identified
Grande Ronde wells in hydraulic communication with Lapwai Creek
Other Grande Ronde wells. Hydraulic communication relationships unknown, Recharge source(s) uncertain.
Lewiston Plateau GWMA (3 Subareas labelled A, A-1 and B)
Sections
K Neely IDWR, 10/18
0
1.25
2.5 Miles
Clearwater River
Snake River
Lapwai Valley
3
15
14
12
19
A-1
A
B


Water Level Elevations for 5 Selected Grande Ronde Wells
in Subarea A1, unknown recharge source
Water Level Elevation (feet above Sea Level)
850
840
830
820
810
800
790
780
770
1/1/13
1/1/14
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19
McCann Central (3)
Leavitt #2 (12)
Woods (14)
Red Pheasant #3 (15)
Ard (19)

There are five wells with water level elevations much higher than the previous 3 groups described. These wells occur in the southern part of Subarea A and the southeast part of Subarea B. Based on significant differences in water level elevations, water level trend patterns, the Grande Ronde units that the wells are thought to be completed in, and the distance between the wells, the degree of hydraulic connection between the wells, if any, is unknown. The next slide shows an example of one of these wells.



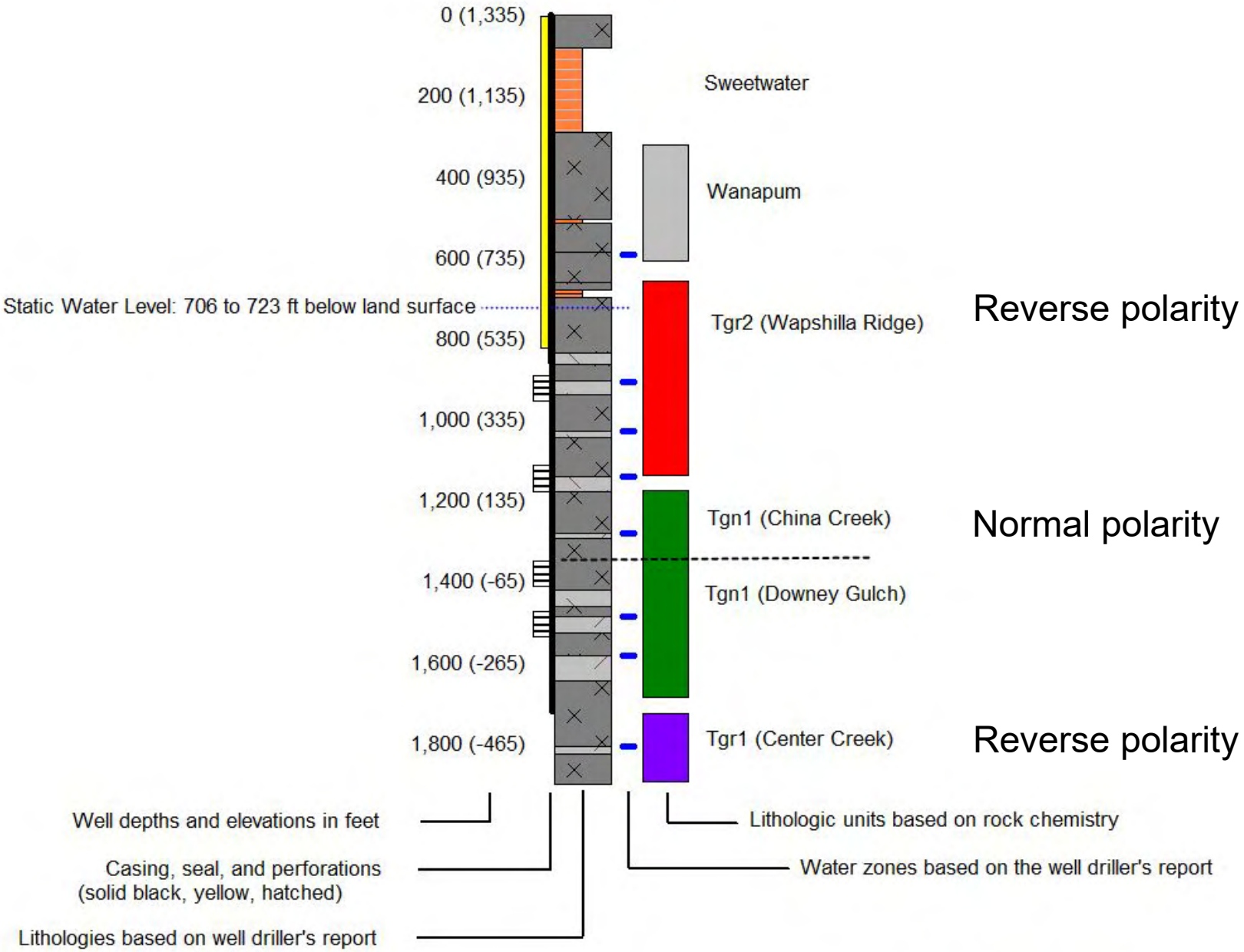
Well 34 is located in the southeast corner of Subarea A. The water level elevation is 600-700 feet higher than the wells in the three groups to the north and northwest. This well has a water elevation that is very similar to a Grande Ronde well about three miles to the south at the Tammany View subdivision. However, this well produces from Tgr2 and the Tammany View well produces from Tgn1. It is unknown if the two wells are in hydraulic communication.

The Lapwai wells (group 4) are discussed in a separate section later in this presentation.

D. Rock Chemistry

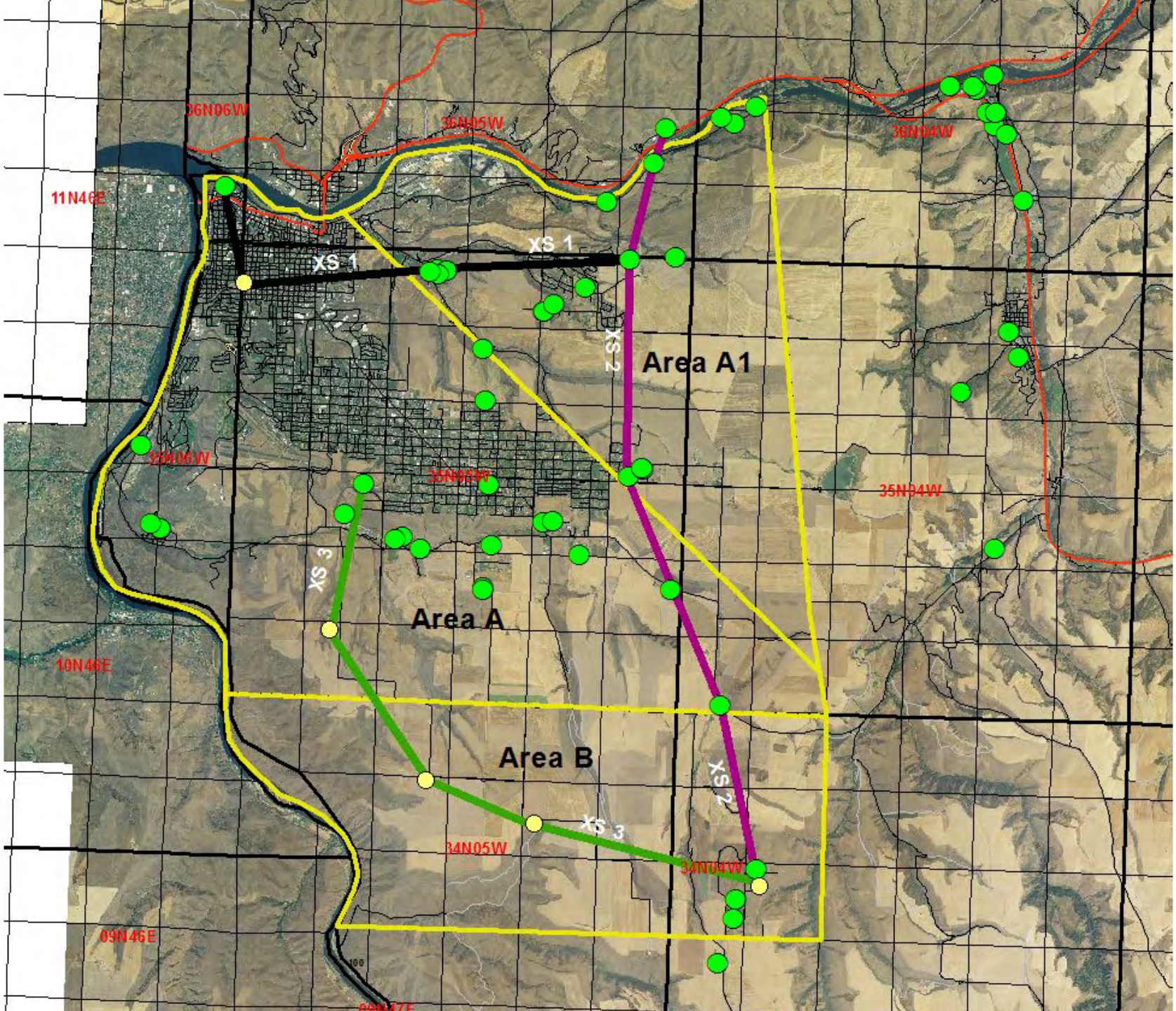
Samples of rock chips have been collected at 7 wells in the Lewiston Plateau GWMA, and at 5 wells in the Lapwai Valley. The next slide shows a log of the LOID 5 well which has the most complete record of rock chemistry analyses in the Lewiston-Lapwai area.

LOID #5



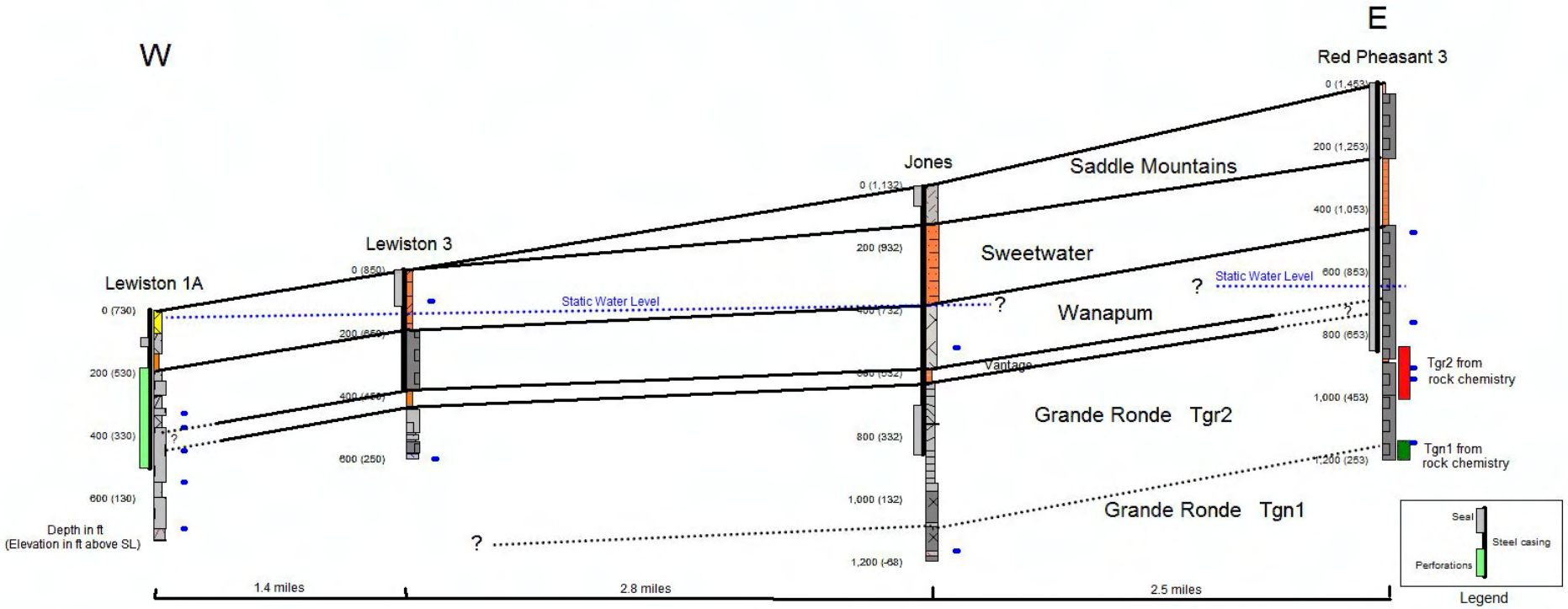
Ken Neely, IDWR, Oct 2017

E. Hydrogeologic Cross Sections


36N06W
36N05W
36N04W
11N46E
XS 1
XS 1
XS 2
Area A1
35N06W
35N05W
35N04W
XS 3
Area A
10N46E
Area B
XS 2
XS 3
34N05W
34N04W
09N46E

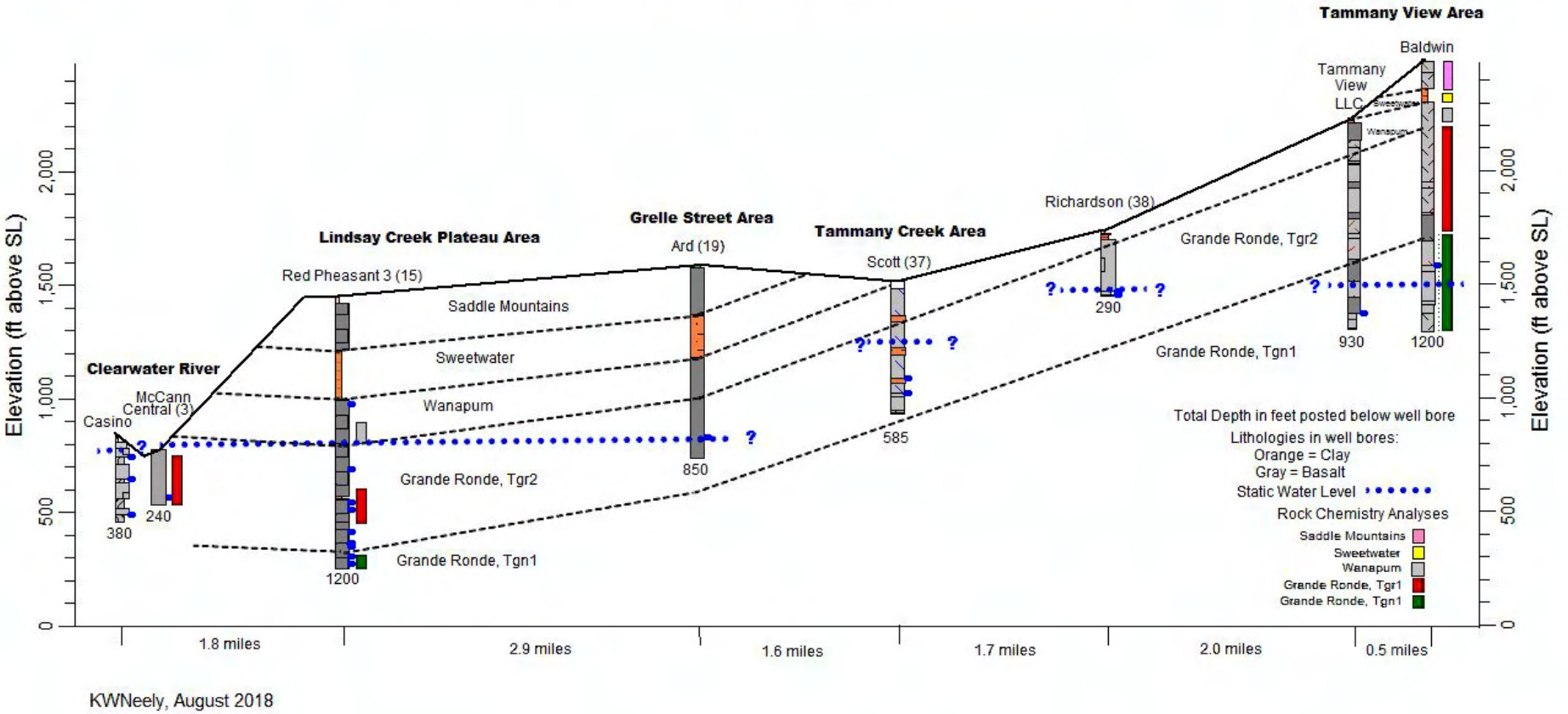
XS 1

Lewiston 1A to Red Pheasant 3



XS 2

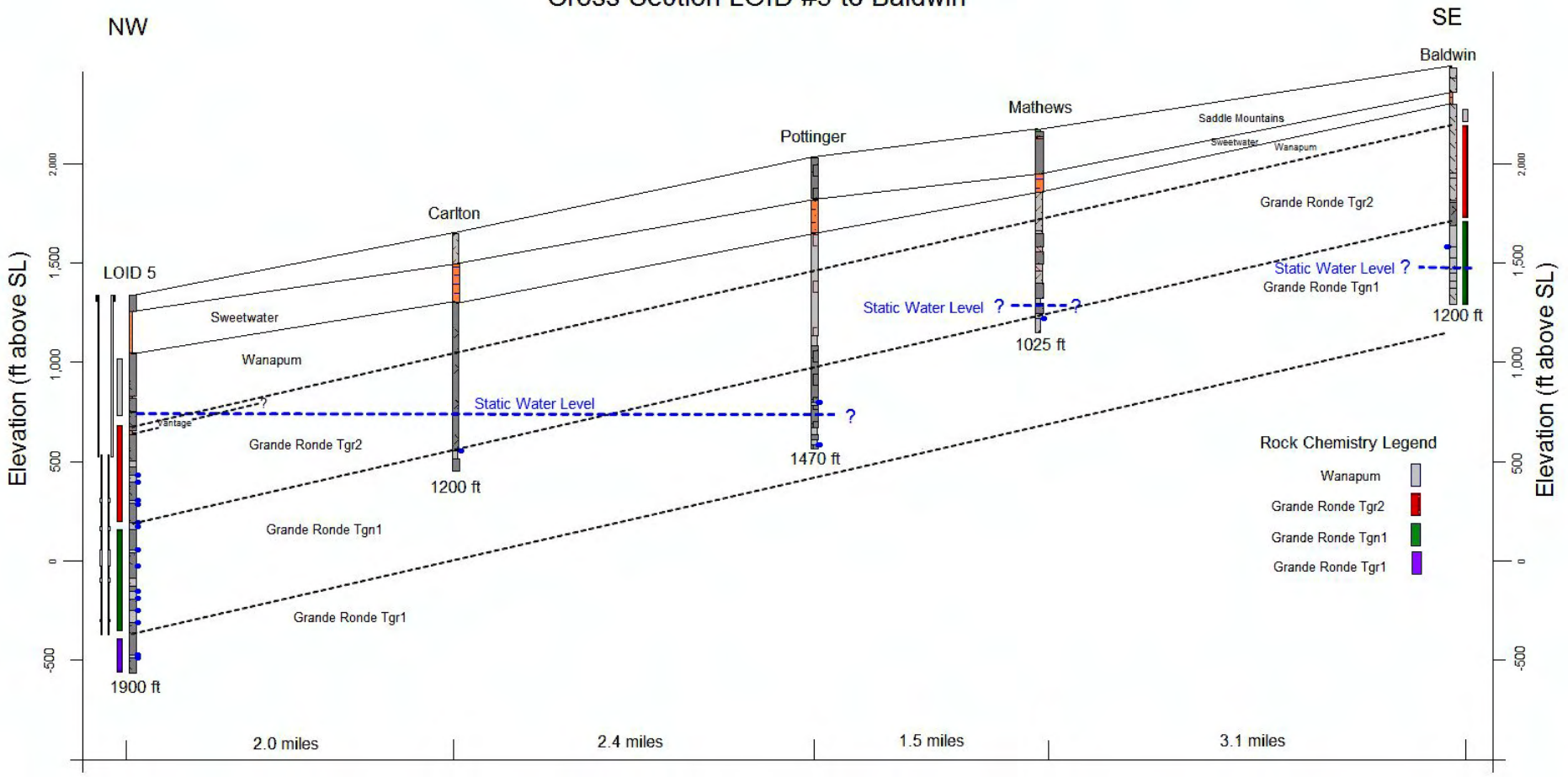
Clearwater River to Tammany View Cross-Section



KWNeely, August 2018

XS 3

Cross-Section LOID #5 to Baldwin

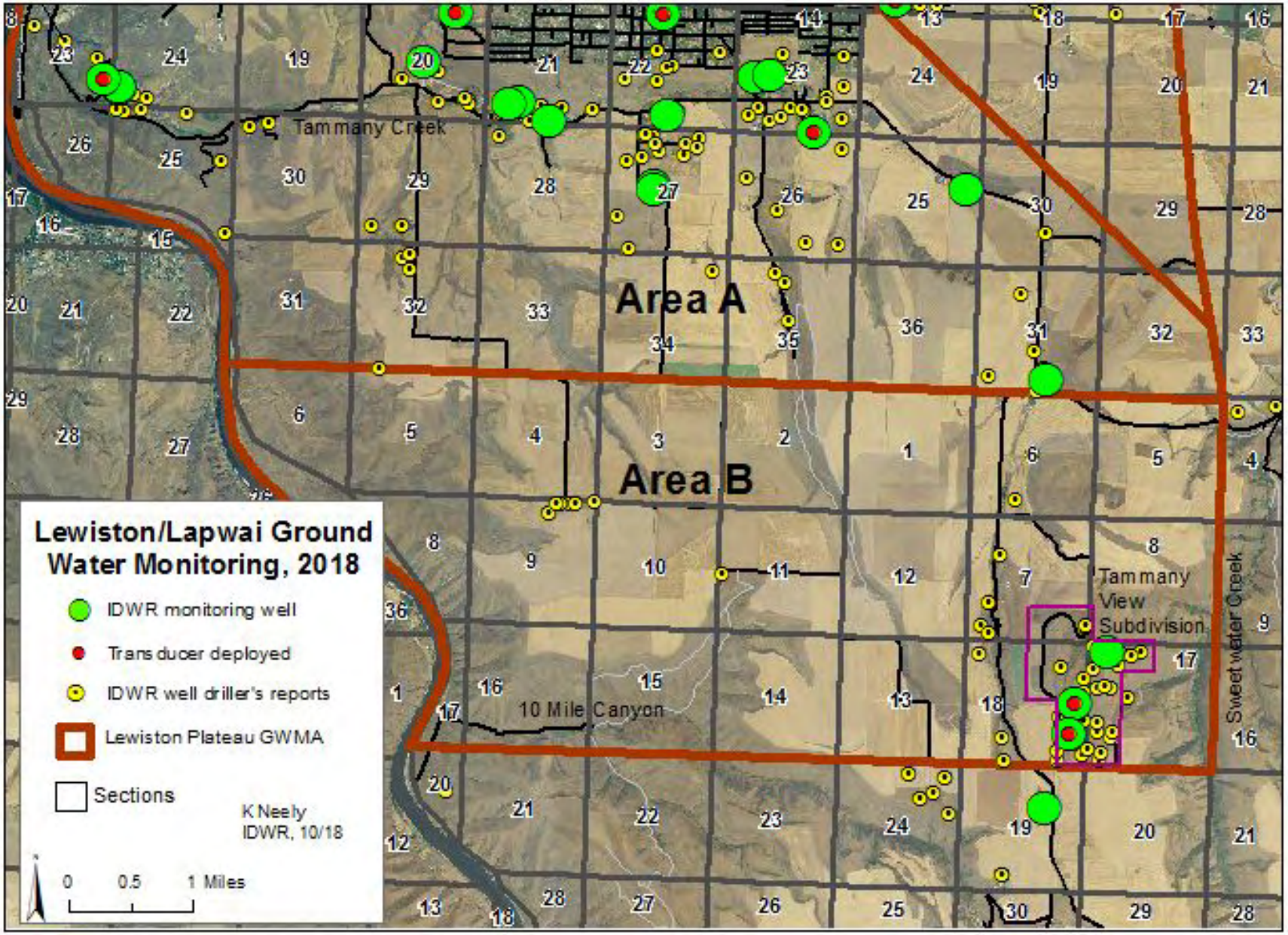


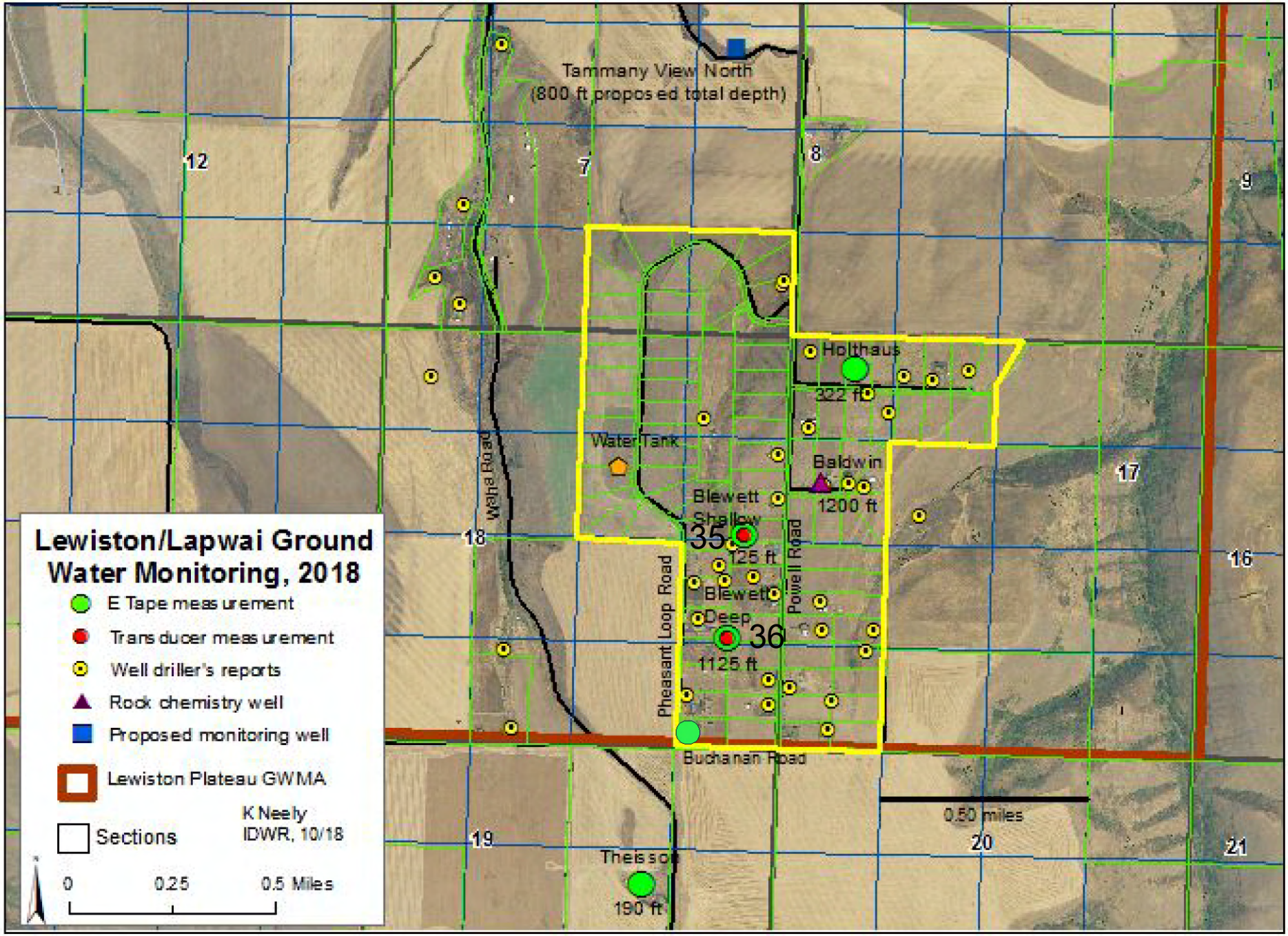
The 3 previous cross sections reveal the following:

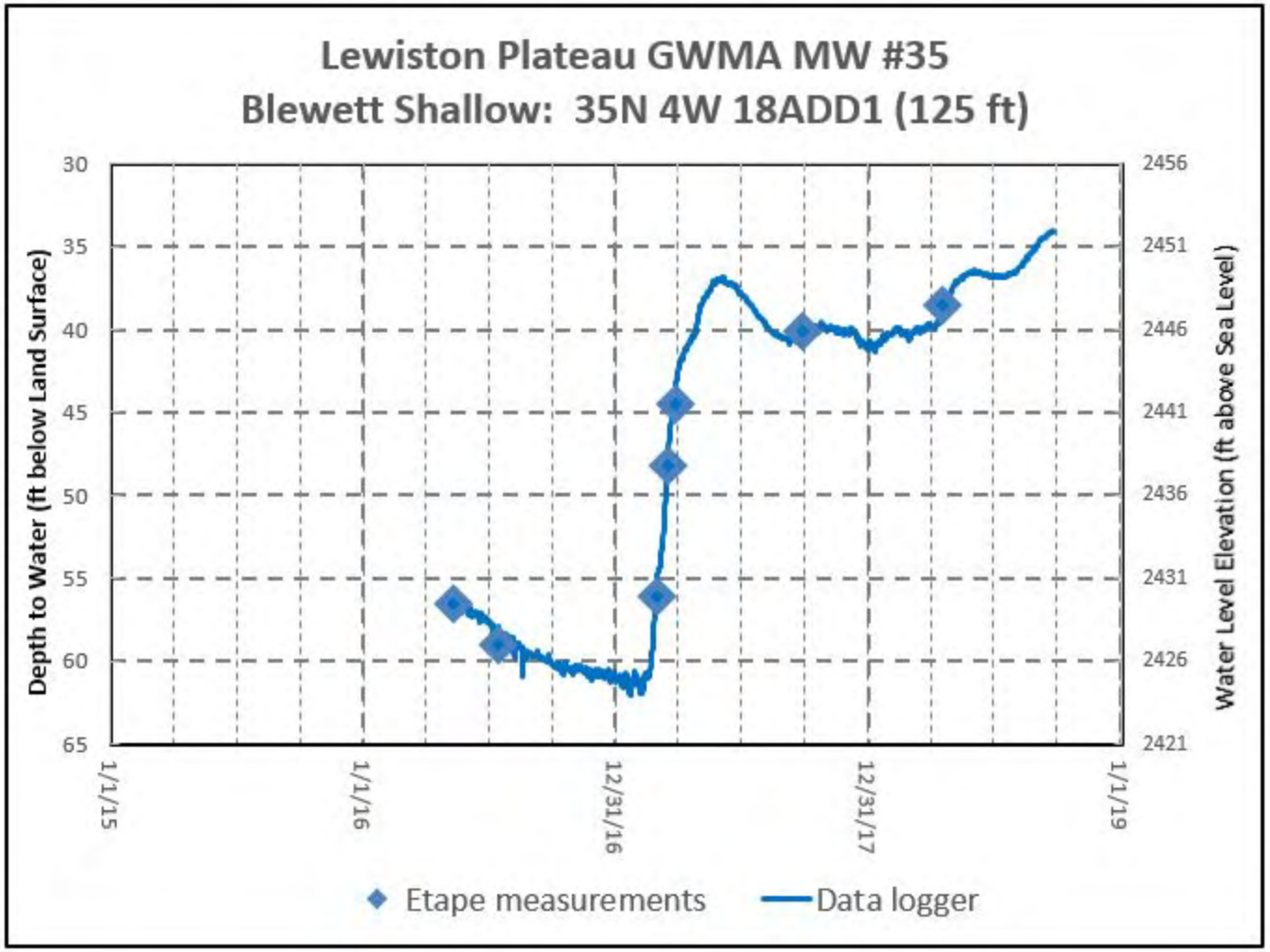
1. The Sweetwater Clay is thickest in the northern part of the GWMA (over 200 feet) and thins to 100 feet or less to the south in Subarea B.
2. The Vantage Clay is also thickest in the north (up to 50 feet), but thins to the south and is not recognized in drill cuttings in most of the wells in the southern part of Subarea A and Subarea B.
3. Where rock chemistry exists, there is a high degree of correlation for the Grande Ronde units between wells throughout the GWMA.
4. Water level elevations for Grande Ronde wells are highest in the Tammany View area of Subarea B, but are much lower just a few miles to the north and northwest in the Grelle Street and Tammany Creek areas of Subareas A and A1.

F. Subarea B and south to the Waha Escarpment

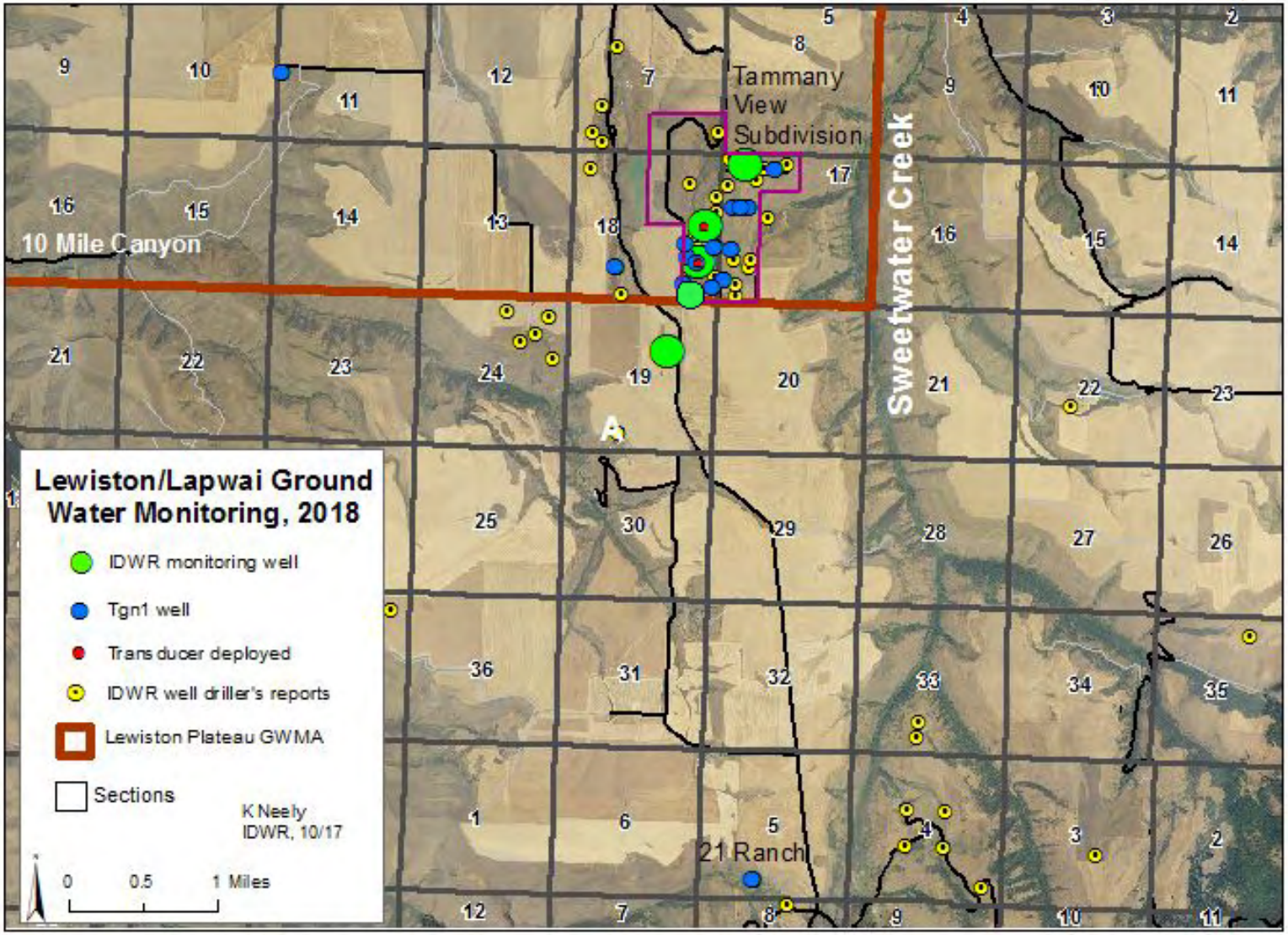
1. High density of wells in and around the Tammany View subdivision in the southeast part of the Subarea B. Very few wells in the western and central part of the subarea.
2. IDWR has five monitoring wells in or near the Tammany View subdivision. Three wells are completed in the Saddle Mountains; one well is completed either in the Wanapum or Grande Ronde Tgr2; one well is completed in the Grande Ronde Tgn1.
3. Monitoring data have been collected since 2016 at two wells. Both wells have transducers deployed in them.
4. Aquifers exist in the Saddle Mountains, Wanapum, and Grande Ronde in the Tammany View subdivision area. Water level elevations range from 2400 ft asl to 1400 ft asl.
5. The primary aquifer in the Tammany View subdivision area is the Tgn1, with a water level elevation of about 1400 ft asl (drill depth is 1000-1100 feet below the land surface). Thirteen wells are drilled to this aquifer.
6. A deep (>1000 ft) well 3 miles south of the Tammany View subdivision appears to be also completed in Tgn1.
7. A deep (>1400 ft) well in the western part of Subarea B has a water level elevation of 730 ft asl (well driller's report), which is consistent with monitoring wells to the north that are hydraulically connected to the Snake River.


Lewiston/Lapwai Ground Water Monitoring, 2018
IDWR monitoring well
Transducer deployed
IDWR well driller's reports
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 10/18
0 0.5 1 Miles
Area A
Area B
Tammany Creek
10 Mile Canyon
Tammany View Subdivision
Sweetwater Creek

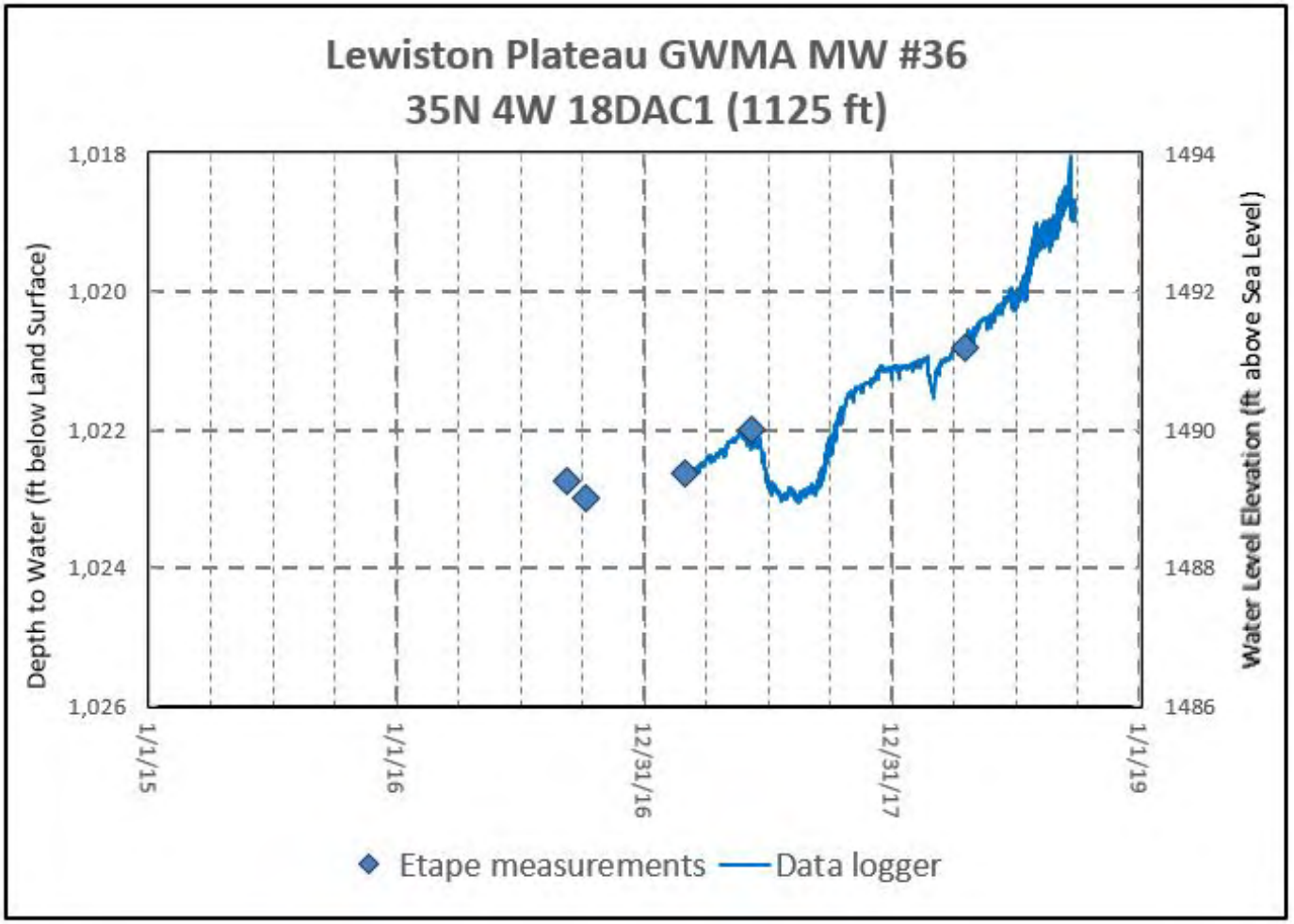

Tammany View North
(800 ft proposed total depth)
12
7
8
9
Holthaus
322 ft
Water Tank
Baldwin
1200 ft
17
Blewett
Shallow
35
125 ft
18
16
Blewett
Deep
36
1125 ft
Wahl Road
Pheasant Loop Road
Powell Road
Buchanan Road
0.50 miles
19
20
21
Theisson
190 ft
Lewiston/Lapwai Ground Water Monitoring, 2018
E Tape measurement
Transducer measurement
Well driller's reports
Rock chemistry well
Proposed monitoring well
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 10/18
0
0.25
0.5 Miles



This well is completed in the Saddle Mountains formation.



13 wells in the Tammany View subdivision and 3 wells west and south of the subdivision appear to be completed in the Tgn1 unit of the Grande Ronde formation.

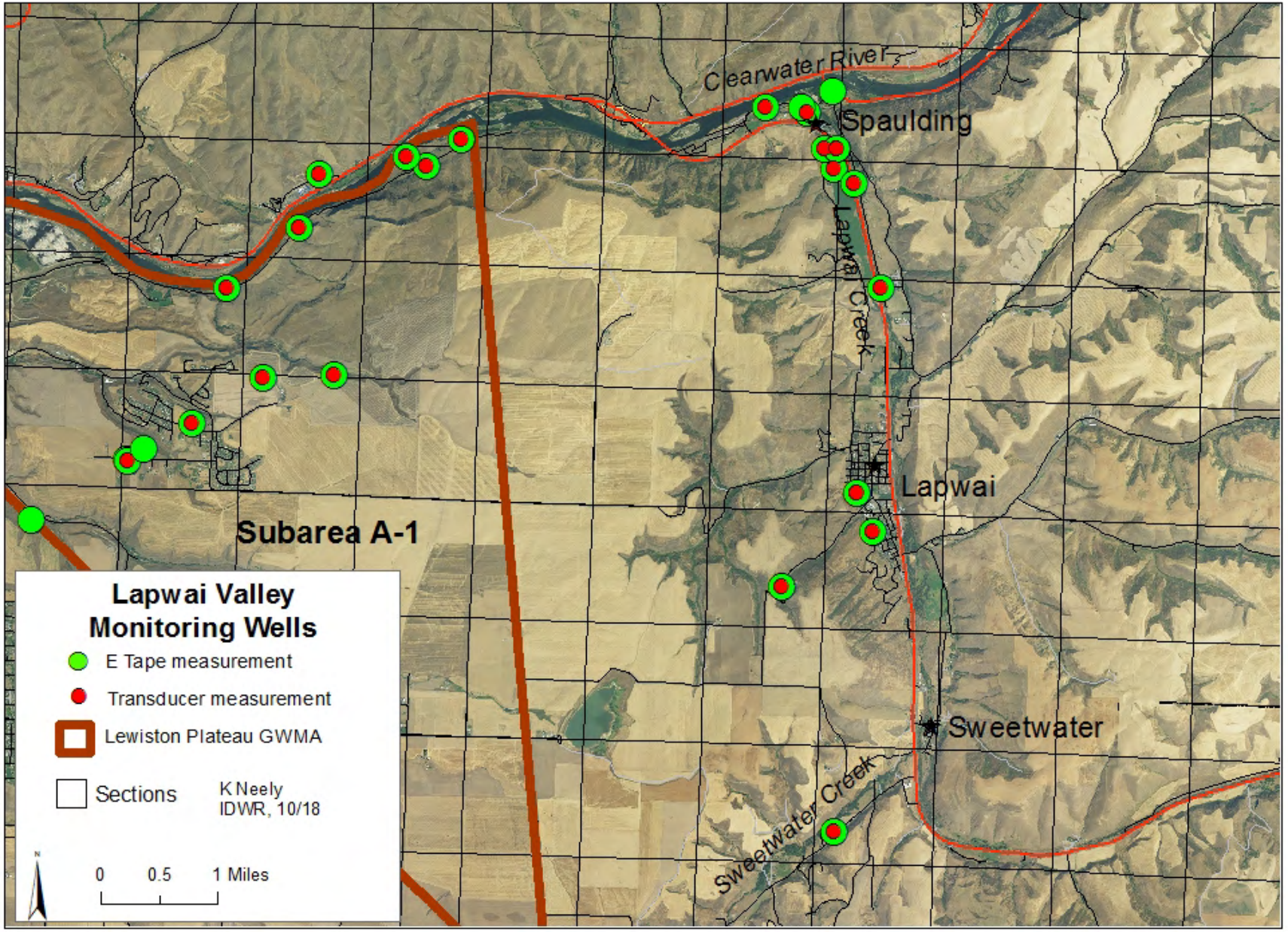


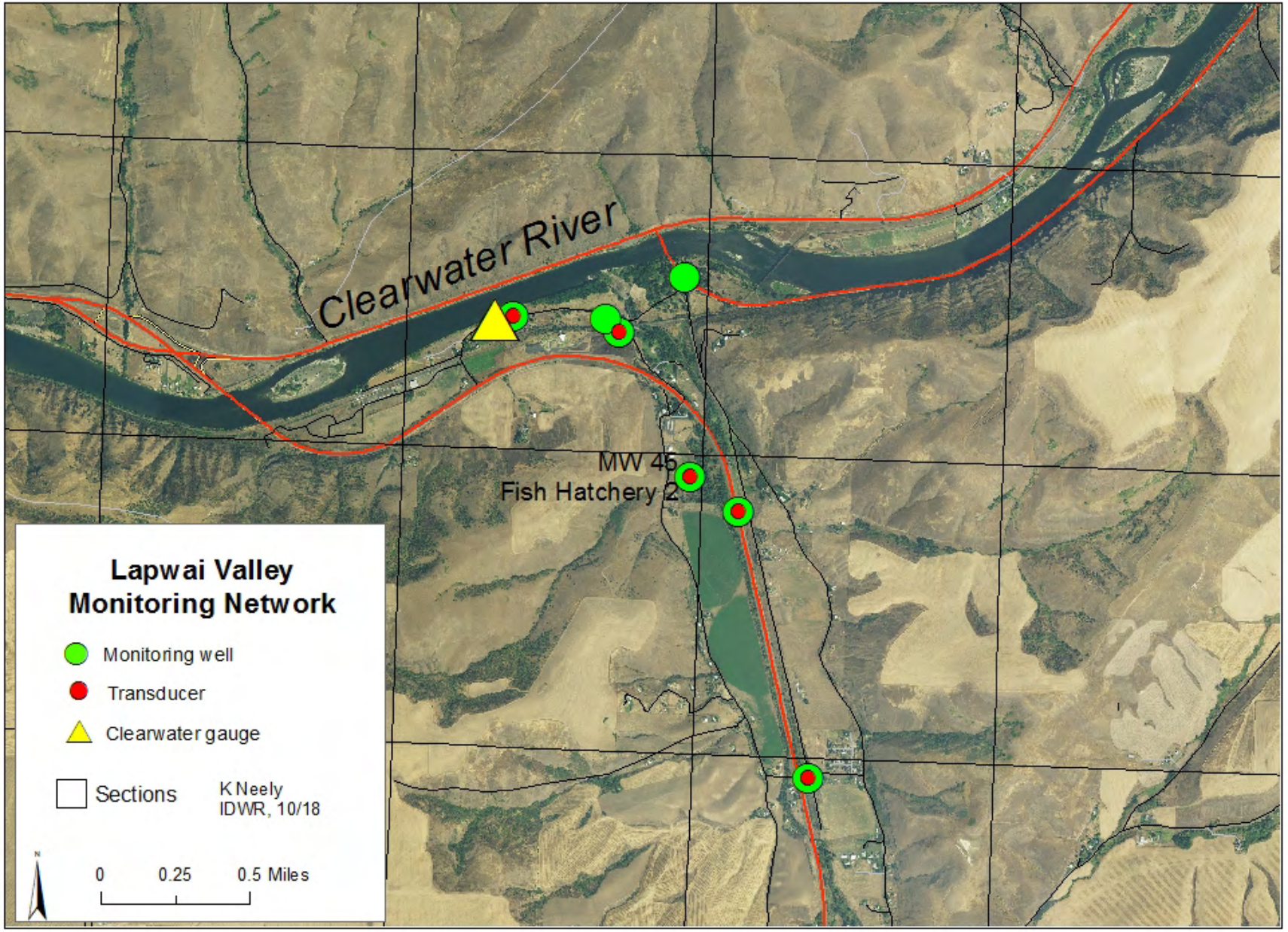
This well, known as Blewett Deep, is completed in Tgn1 unit of the Grande Ronde formation.

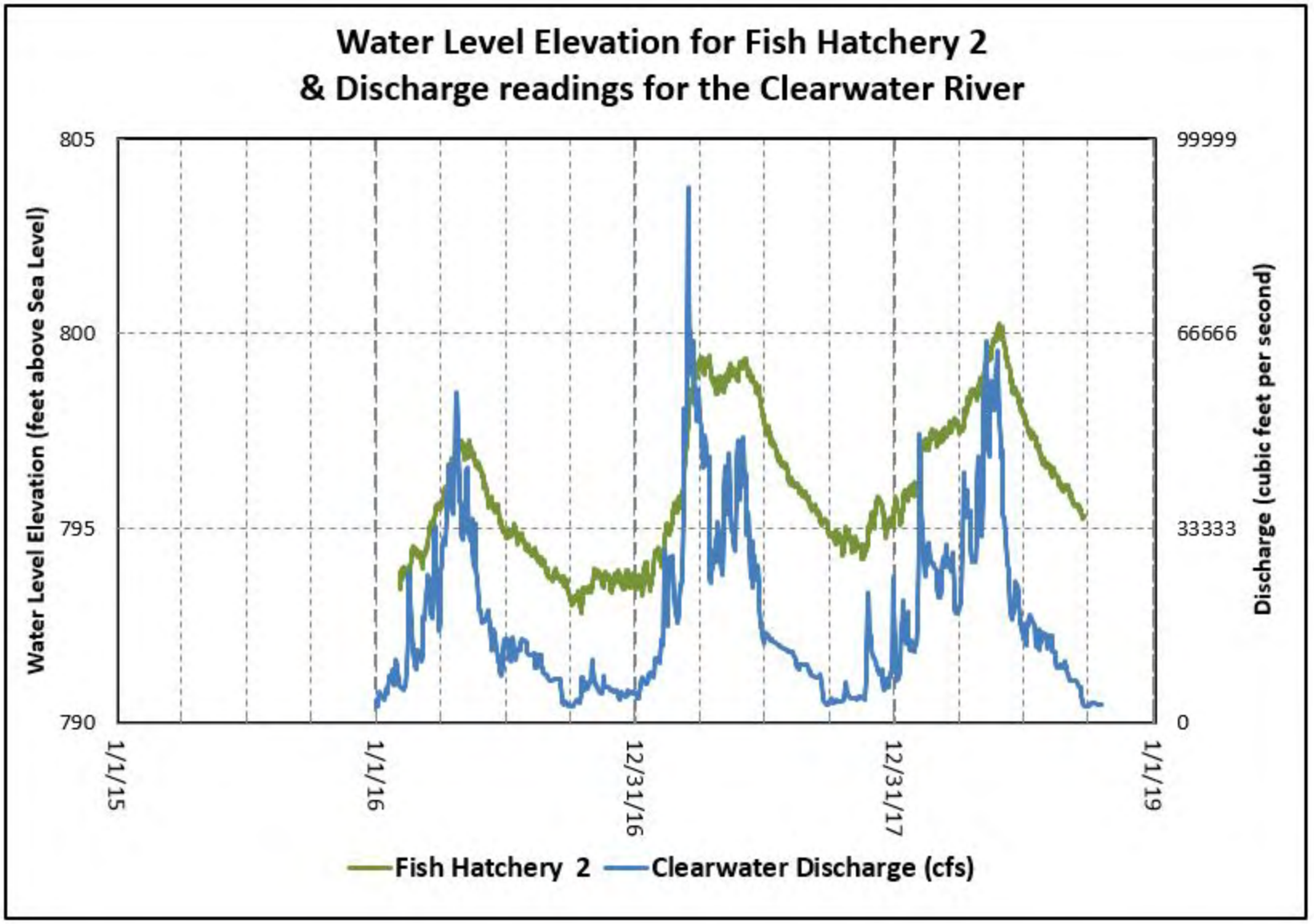
G. Lapwai Valley

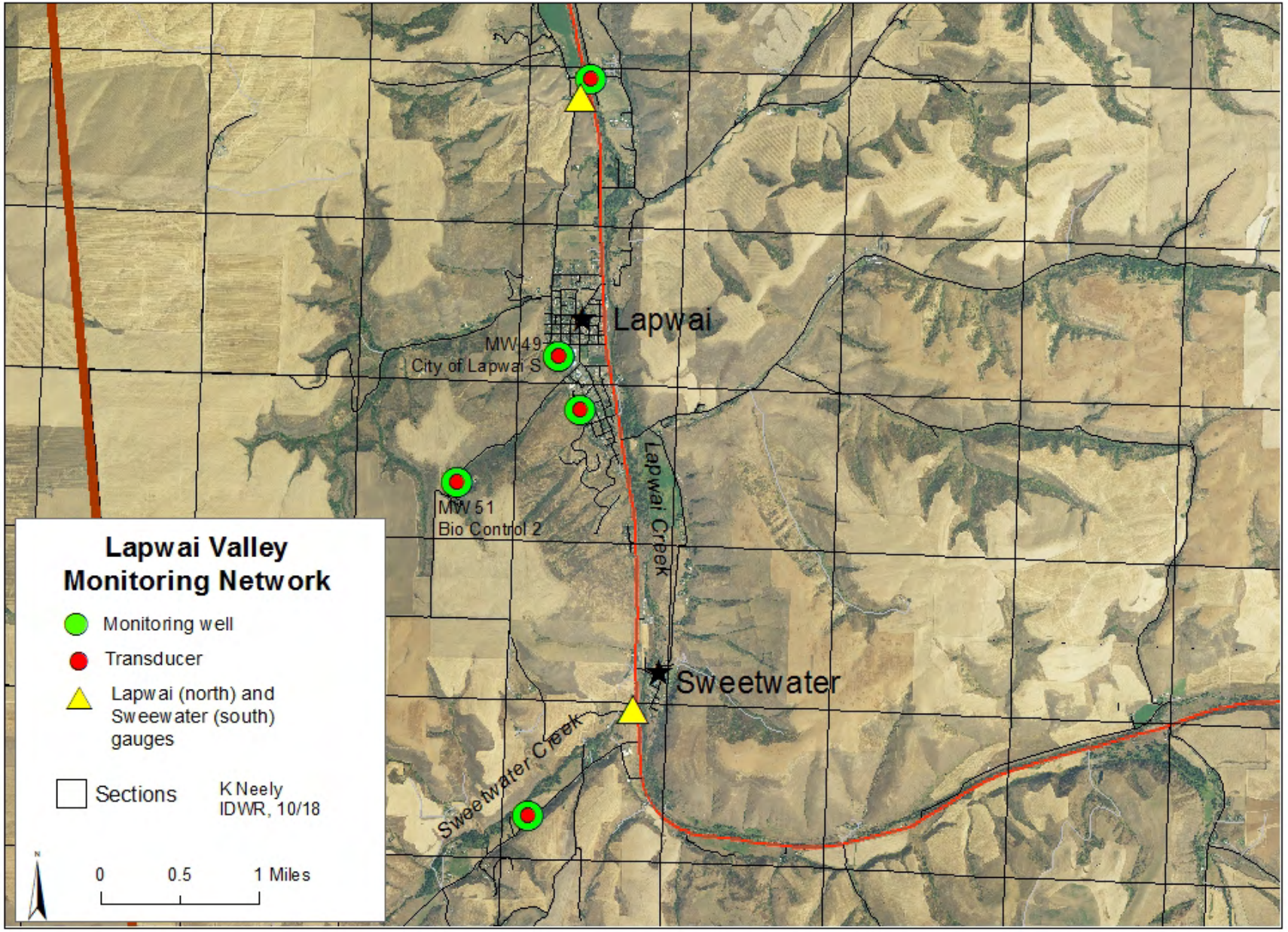
Monitoring Network and Results

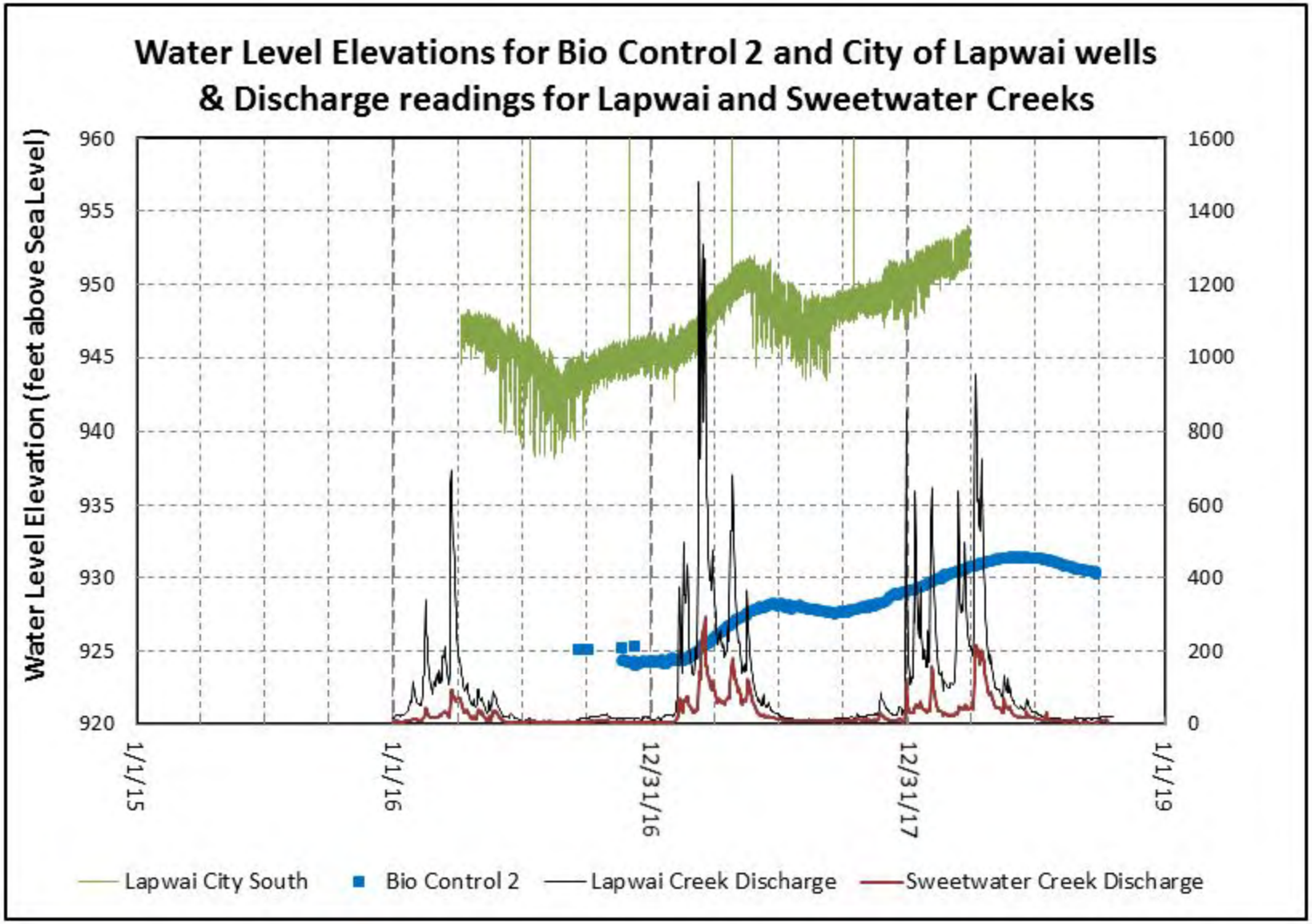
1. 12 active monitoring wells. 3 inactive wells.
2. Fairly short-term data records; water level measurements started in early 2016.
3. 5 wells with rock chemistry data. However 2 of those wells have single samples.
4. Wells along the Clearwater River and up to about 0.5 miles south of the river in the Lapwai Valley are hydraulically connected to the Clearwater River.
5. Wells in the segment of the valley from just south of the city of Lapwai north to about 0.75 miles south of the Clearwater River are hydraulically connected to Lapwai Creek.
6. The southern most well has just over one year of data and the relationship of that well to nearby surface water sources (Lapwai and Sweetwater creeks) is currently unknown.

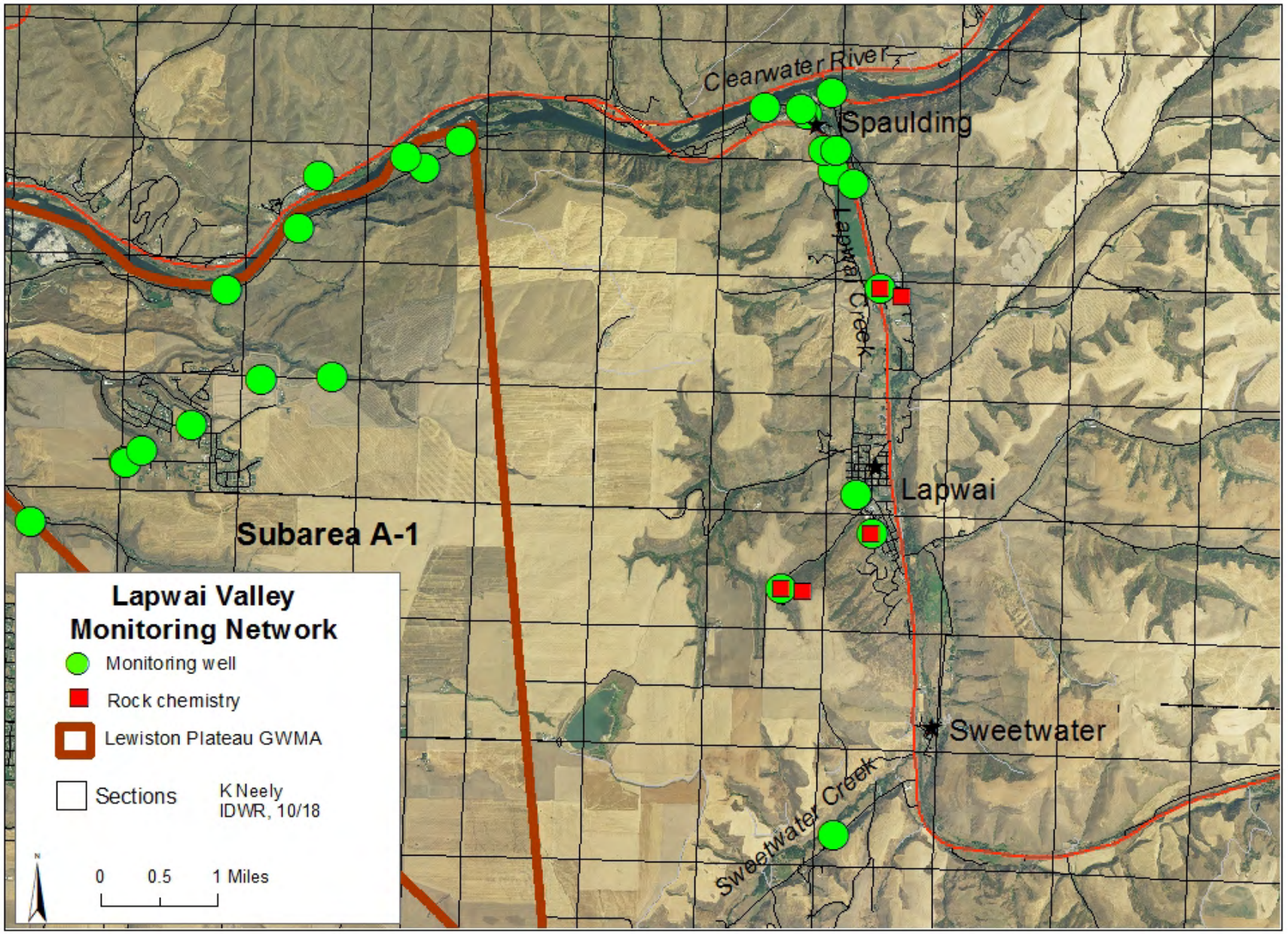

Clearwater River
Spaulding
Lapwai Creek
Lapwai
Subarea A-1
Sweetwater
Sweetwater Creek
Lapwai Valley
Monitoring Wells
E Tape measurement
Transducer measurement
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 10/18
0
0.5
1 Miles


Clearwater River
MW 45
Fish Hatchery 2
Lapwai Valley
Monitoring Network
Monitoring well
Transducer
Clearwater gauge
Sections
K Neely
IDWR, 10/18
0
0.25
0.5 Miles

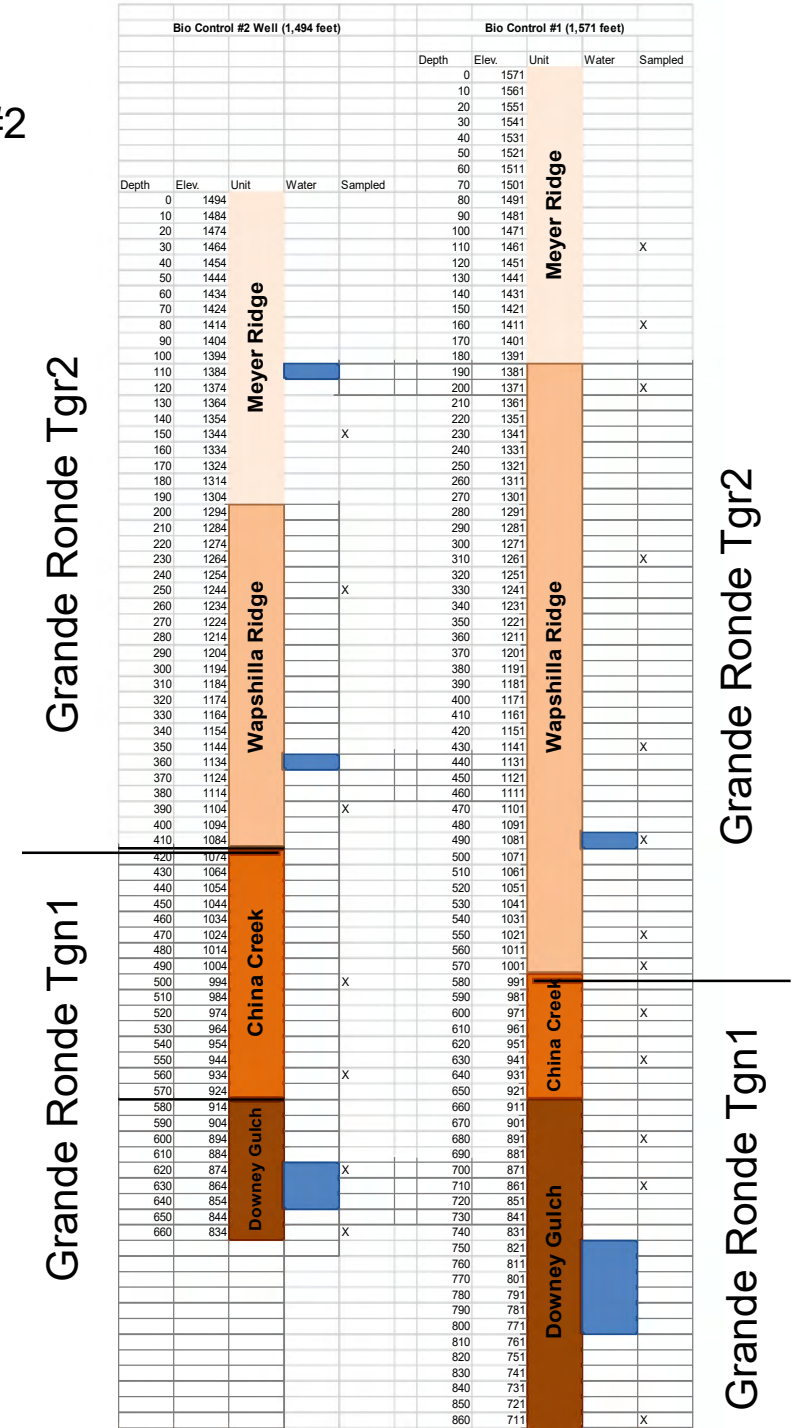

Water Level Elevation for Fish Hatchery 2
& Discharge readings for the Clearwater River
Water Level Elevation (feet above Sea Level)
805
800
795
790
Discharge (cubic feet per second)
99999
66666
33333
0
1/1/15
1/1/16
12/31/16
12/31/17
1/1/19
Fish Hatchery 2
Clearwater Discharge (cfs)


Lapwai
MW 49
City of Lapwai S
MW 51
Bio Control 2
Lapwai Creek
Sweetwater
Sweetwater Creek
Lapwai Valley
Monitoring Network
Monitoring well
Transducer
Lapwai (north) and
Sweewater (south)
gauges
Sections
K Neely
IDWR, 10/18
0
0.5
1 Miles


Water Level Elevations for Bio Control 2 and City of Lapwai wells & Discharge readings for Lapwai and Sweetwater Creeks
Water Level Elevation (feet above Sea Level)
960
955
950
945
940
935
930
925
920
1600
1400
1200
1000
800
600
400
200
0
1/1/15
1/1/16
12/31/16
12/31/17
1/1/19
Lapwai City South
Bio Control 2
Lapwai Creek Discharge
Sweetwater Creek Discharge


Clearwater River
Spaulding
Lapwai Creek
Lapwai
Subarea A-1
Sweetwater
Sweetwater Creek
Lapwai Valley
Monitoring Network
Monitoring well
Rock chemistry
Lewiston Plateau GWMA
Sections
K Neely
IDWR, 10/18
0
0.5
1 Miles

Rock chemistry results
From Bio Control #1 and #2



From Garwood, 2018

Lapwai Monitoring Results

1. Wells along the Clearwater River and up to 0.5 miles south of the river (general Spaulding area) are hydraulically connected to the river, with very rapid respond in ground water levels to changes in discharge.
2. Water levels in two wells near the city of Lapwai were higher in 2017 and 2018 than in 2016. The rises coincide with higher flows in Sweetwater and Lapwai creeks in 2017 and 2018. The wells appear to be hydraulically connected to Lapwai Creek and/or Sweetwater Creek. However, there appears to be a lag time of 3-4 months between the peak discharges in the creek and the maximum water levels in the wells.
3. The maximum water level elevation in wells near Spaulding is about 800 feet above sea level (ft asl); the maximum water level elevation near Lapwai is about 930 ft asl.
4. Rock chemistry results from five wells indicate that Lapwai Valley is underlain by the Tgn1 unit, at least from 1.5 miles north of city of Lapwai to 0.5 miles south of Lapwai.
5. Additional rock chemistry is needed in the northern and southern parts of the valley to determine.

7. Other Studies

Other Recent Studies

1. Ralston Hydrologic Services Inc., conducted a two-year study from 2016 to 2018. Two technical reports were produced and are posted at: http://www.idwr.idaho.gov/water-rights/groundwater-management-areas/designated.html

2. Daniel Sturgis, IDWR hydrogeologist, began conducting water quality sampling in 2017. Samples have been collected and analyzed for common ions and isotopes. Daniel presented some of the findings to the Lewiston Ground Water Advisory Committee in October 2018.

3. IDWR contracted with Dean Garwood, geologist, in 2018 to perform specific hydrogeological tasks (rock chemistry analyses and stratigraphic relationships).

8. Conclusions

1. 3 basalt formations, each having one or more aquifers.

2. **Saddle Mountains aquifers.** Occur in Subareas A-1 and B. IDWR monitors 6 wells completed in the Saddle Mountains. Following the wet winter of 2017, water levels rose slightly in two wells and dramatically in three wells. No further development allowed under the GWMA.

3. **Wanapum aquifers**. Occur in all three subareas. IDWR monitors 9 wells completed in the Wanapum. Four of the wells have long-term (> 4 years) data records. The overall trend is water level decline. However water levels rose in 3 wells following the wet winter of 2017. No further development allowed.

Grande Ronde Aquifers

4. Occur in all 3 subareas. Development is allowed.

5. Proven recharge sources are the Snake and Clearwater Rivers. Probable recharge sources are Lapwai Creek and precipitation. Possible recharge sources are 1) the lower end of Sweetwater Creek and 2) downward transmission of surface water along the faults of the Waha Escarpment (water originating from Lake Waha and upper Sweetwater Creek).

6. Many of the wells completed in the Grande Ronde in Subarea A have similar water level elevations despite being completed in different units (Tgr1, Tgn1, and Tgr2), and having large differences in total depth. These wells are hydraulically connected to the Snake River. Water level elevations range from about 700-730 feet above sea level in these wells. Water levels are stable in these wells.

7. IDWR has no monitoring wells south of Tammany Creek with water level elevations indicative of hydraulic connection to the Snake River. However, based on the drillers' water levels reported for two wells (one in the southwestern part of Subarea A and one in the western part of Subarea B) the aquifer that is hydraulically connected to the Snake River may extend south of Tammany Creek into Subarea B.

8. The estimated areal extent of the Grande Ronnde aquifer that is hydraulically connected to the Snake River is from the northwestern part of Subarea B, throughout the western and central parts of Subarea A, and slightly into the northwestern part of Subarea A-1.

9. Water level elevations in several Grande Ronde wells in Subarea A-1 are significantly higher (70-80 feet) than the elevations in Subarea A. Water levels declined slightly in Subarea A-1 from 2014 to 2016, and have increased slightly since then. These wells are not hydraulically connected to the Snake River and most likely not connected to the Clearwater River. Possible recharge sources are Lapwai Creek, infiltration along the Waha Escarpment, infiltration along canyon slopes where the Grande Ronde units are exposed, and precipitation. In Subarea A-1, additional development is anticipated in the near future.

Subarea B – Tammany View Subdivision and surrounding areas

10. High density of wells in a small geographic area (Tammany View subdivision). Much lower density of wells in the areas outside of the subdivision.

11. Wells in the subdivision are completed in the Saddle Mountains, Grande Ronde (Tgr2 and Tgn1) and possibly the Wanapum.

12. Well yields are typically low ranging from 1-10 gallons per minute.

13. Aquifers in Saddle Mountains, Wanapum, and Grande Ronde Tgr2 do not appear to be laterally extensive. It is unknown if the wells are hydraulically connected.

14. Twelve wells in the Tammany View subdivision, and one well just west of the subdivision, are completed in the Tgn1, with well depths ranging from 1000 to 1200 ft. It is postulated that these 13 wells are hydraulically connected. Based on two years of monitoring data for one well completed in the Tgn1, it appears that the Tgn1 aquifer received recharge in 2017-2018. However, the well has cascading water, probably from the Saddle Mountains formation, which may influence the water level trend.

15. The Tgn1 aquifer under Tammany View may extend 4 miles to the south and 3 miles to the northwest based on correlations with well driller's reports.

16. Potential recharge sources are infiltration from local precipitation, infiltration along the faults associated with the Waha Escarpment, and infiltration in the upper reach of 10 Mile Canyon.

17. IDWR plans to drill an 800-ft monitoring well about ½ mile north of the Tammany View subdivision in 2018 or 2019. The well is to be completed in the Tgn1 aquifer, which may help determine if the Tgn1 aquifer under Tammany View extends to the north.

Lapwai Valley

18. Twelve active monitoring wells.

19. Ground water level monitoring is in the beginning stage, with only short term records available. Monitoring commenced at 6 wells in 2016 and 6 wells in 2017.

20. Five monitoring wells in the northern-most part of the valley appear to be hydraulically connected to the Clearwater River.

21. Five wells in the central part of the Valley appear to be hydraulically connected to Lapwai Creek.

22. One well in the central part of the valley has an unusual water level trend which does not match nearby wells.

23. One well in the southern part of the valley is along Sweetwater Creek. The water level trend in 2017-2018 is different than the trends in the monitoring wells to the north.

24. Rock chip chemistry from 5 wells indicates that the central part of the valley is underlain by the Tgn1 unit. It is unknown which unit(s) underlie the north and south parts of Lapwai Valley.

25. IDWR plans to drill a borehole in the north part of the valley in 2018 or 2019 in order to collect rock chips and possibly as a ground water level monitoring well.

9. Remaining Questions

1. Does the Grande Ronde aquifer that is hydraulically connected to the Snake River extend south of Tammany Creek?
2. Does the Grande Ronde aquifer that is hydraulically connected to the Snake River extend east into Subarea A1?
3. What is the recharge source for the wells in Subarea A1 that do not appear to be hydraulically connected to the Snake or Clearwater Rivers? Can this source sustain additional development in Subarea A1?
4. What is the recharge source for the wells completed in the Tgn1 aquifer in the Tammany View?
5. What are the hydrogeologic relationships from the Tammany View subdivision in Subarea B, north to the Grelle Street area in Subarea A1, and west to LOID wells in Subarea A?