RECORD No. 217 21 - 000436 - PLNG *For Office Use Only*

Comprehensive Plan Amendment – No Goal Exception: $5000
Comprehensive Plan Amendment – Goal Exception: $7000
Zone Map Change -M56 notice required: $5000
Zone Map Change –No M56 notice required: $2500
Zone Text Change – M56 notice required: $4000
Zone Text Change- No M56 notice required: $2500

CROOK COUNTY "Serving You" EST. 1882

Crook County Community Development/Planning Division
300 NE 3rd Street, Room 12, Prineville Oregon 97754
541-447-3211
plan@co.crook.or.us
www.co.crook.or.us

RECEIVED MAY 2 1 2021 BY:

Comprehensive Plan, Map, and Text Amendments

PROPERTY OWNER:

Last Name: Vanier First Name: Rober J. and Lani

Mailing Address: P.O. Box 326

City: Dayville State: OR Zip: 97825

Day Time Phone: (541) 462 - 3530 Cell Phone: (____) ____ - ____

Email: tricreekranch@hughes.net

AGENT/REPRESENTATIVE:

Last Name: Ropp First Name: Matt

Mailing Address: 32260 Old Hwy 34

City: Tangent State: OR Zip: 97389

Day Time Phone: (541) 918 - 5133 Cell Phone: (541) 223 - 1079

Email: matt.ropp@kniferiver.com

PROPERTY INFORMATION:

Township 14S Range 15E Section 14 Tax Lot 103

Size of property: 77.98 acres Zone: EFU -2

Physical address: 6487 NW Lamonta Road, Prinville, Oregon

Subdivision name, if applicable: ________ Lot ____ Block ____

FLOOD PLAIN:

Is the subject property located within a Flood Plain Zone? Yes ____ No X

If yes, what zone: ________

DETAILED EXPLANATION:

The subject property is a 77.98 acre parcel, currently zoned EFU-2. The subject parcel contains approximately 1.8 million tons of concrete quality aggregates. Applicant is requesting that the county amend its Comprehensive Plan to add the subject parcel to the Inventory of Significant Aggregate Sites, adopt a site specific ESEE analysis, and authorize mining, subject to approval of a conditional use permit.

IMPORTANT NOTICE: The Crook County Planning Department is required to review all applications for accuracy and to determine whether the staff and/or the Planning Commission have the information needed to make a decision. The County has 30 days to determine whether the application is complete. Within that 30-day period, the Planning Department will request additional information, if necessary. A decision on your application will be postponed until the information is received. State law requires that all information to support an application be available for public inspection at our office 20-days before a public hearing. Any information submitted after this date may require a postponement of the hearing date if necessary. Please make sure your application is complete. The burden of proof lies with the applicant.

PROPERTY OWNERS SIGNATURES:

By signing below, I/WE agree to meet the standards governing the laws as outlined in the State of Oregon's OAR, ORS, Crook County Code, and/or the Crook County Comprehensive Plan. I/We agree that all the information contained in this application is true to the best of my knowledge.

Property Owner Signature: ______________________ Date__________

Print name: ______________________

Property Owner Signature: ______________________ Date__________

Print name: ______________________

Agent/Representative Signature: Matt Ropp Date: 05.21.2021

Print name: Matt Ropp, Manager of Land Planning, Knife River Corporation - Northwest

CHECKLIST FOR COMPLETING THIS APPLICATION

1. Complete application form including the appropriate signatures
2. Include a detailed statement describing the proposal
3. Burden of Proof addressing all applicable criteria and supplemental information
4. Payment of fees
5. Submit a copy of the current "deed"

APPLICABLE CRITERIA

Title 18, Chapter 18.168 (Legislative Amendment)
Title 18, Chapter 18.170 (Quasi-Judicial Amendment)

Supplemental Information

1. **COMPREHENSIVE PLAN**:
   a. Describe in detail the proposed "Comprehensive Plan" amendment.
   b. Explain in detail how this request is in compliance with the statewide planning goals.
   c. Explain how this amendment is consistent with the Crook County – Prineville Area Comprehensive Plan.
   d. Explain how this "Comprehensive Plan" amendment would serve the public's interest.

2. **TEXT AMENDMENT**:
   a. Submit the proposed language of the proposed "Text" amendment.
   b. Explain how this request is in compliance with the Crook County – Prineville Area Comprehensive Plan and purpose of the code in effect.
   c. Explain how this "Text" amendment would serve the public's interest.

3. **MAP AMENDMENT**:
   a. Describe in detail the proposed "Map" amendment.
   b. Explain how the "Map" amendment complies with statewide planning goals, and how it is in compliance with those statewide goals.
   c. Explain how this "Map" amendment is consistent with the Crook County – Prineville Area Comprehensive Plan.

AGGREGATE RESOURCE INVESTIGATION
VANIER SITE
PRINEVILLE, OREGON
2019-2020

July 2020

By
Timothy B. Marshall
Oregon Registered Professional Geologist
G1164 Exp. 12/31/2020

Introduction

A geologic investigation was conducted on the property in Crook County, Oregon described below to determine the quantity and quality of the construction aggregates (sand and gravel) that might be reasonably recovered by mining. The evaluation was overseen by a Professional Geologist registered in the State of Oregon.

The subject property is located on the north side of Stahancyk Lane and west of Lamonta Road in the S½ Sec. 14, T. 14 S., R. 15 E., Willamette Meridian. The property consists of one tax lot, 103 (Map Lot ID 1415140000103), which is owned by Robert and Lani Vanier and will be referred to as the Vanier Site in this document. The Vanier Site comprises 77.98 acres. The location of the Vanier Site is shown northwest of Prineville on the Vicinity Map in Figure 1.

Property Description

The Vanier Site has a slight ridge crest trending northeast to southwest across the southern portion of the lot and is mostly sloping gently towards the northwest over most of the property. Just north of the Vanier Site is an unnamed drainage flowing towards the west and southwest. The unnamed drainage is a part of the irrigation system maintained by the Ochoco Irrigation District, and it carries water from the northeast towards the southwest and flows into the Rye Grass Canal system. The Vanier Site is owned and operated by the landowner for growing alfalfa and livestock grazing. There is a residence on the northeast corner of the Vanier Site on Lamonta Road. The "Mining Area" proposed for the significant aggregate inventory designation in Crook County will have setbacks from the property boundary as determined in the application process, but the quantity presented herein includes the entire Vanier Site.

Geologic Setting

The Vanier Site is located at the western edge of the Blue Mountains Physiographic Province[1] adjacent to the Deschutes-Umatilla Plateau. Published geologic surface mapping at the Vanier Site indicates that it is entirely covered with Quaternary Terrace Deposits consisting of mixed grain sediments[2]. These sediments were believed to contain the desired sand and gravel at the Vanier Site due to the proximity of several gravel mining operations that are all producing within this unit such as

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[1] Orr, Elizabeth L. and William N., 2012, *Geology of Oregon, Sixth Edition*, Oregon State University Press, Corvallis, Oregon, 304 p.

[2] Ma, Lina, Madin, Ian P., Olson, Keith V., and Watzig, Rudie J., 2009, *Oregon Geologic Data Compilation (OGDC) Release 5 (Statewide),* Oregon Department of Geology and Mineral Industries.

the adjacent Woodward Site and Grizzly Rock Products that is immediately west of the Woodward Site. The exploration confirmed this interpretation. The terrace sand and gravel deposits resulted from Quaternary backwater deposits that occurred after Newbery Lava flows erupted 1.2 million years ago[3] and dammed the Crooked River canyon[4] downstream from the site. As the Crooked River basin was filling with sediment the coarser sands and gravels advanced from the mountains that are to the north and northeast of Prineville creating the large terraces north of Prineville on which these aggregate deposits are located.

Site Investigation

The Vanier Site is shown in Figure 2 along with the marked locations of the test borings that were used to evaluate the aggregate resource. The site investigation was conducted by drilling bore holes and collecting continuous samples in order to determine aggregate resource thickness, overburden thickness, and to provide samples for resource quality analyses. The locations prefixed with 'VAN' were drilled on June 12-13, 2019. All drilling and sample collection was overseen by an Oregon Registered Professional Geologist. The topography shown with 2-foot contours on Figure 2 was obtained from publicly available Lidar data[5].

There are three basic units identified for this investigation that are described as follows –

- Overburden – This is the topsoil (Ochoco – Prineville Complex) and generally fine-grained subsoil material that overlies the aggregate resource. There are some overburden material layers interbedded within the aggregate resource.
- Aggregate Resource – This consists of sand and gravel with variable gradations over the Woodward Site. In many places the top of this unit is slightly cemented and light-colored.
- Silt – The material underlying the Aggregate Resource is fine-grained consisting of brown silts and clays with some fine sand.

The Aggregate Resource unit is the primary target of the exploration of the Vanier Site. Its location and variation across the property is documented and the volume quantified in this report along with the

[3] Smith, Gary, 1998, *Geology along U.S. Highways 197 and 97 between The Dalles and Sunriver, Oregon*, Oregon Geology, Vol. 60, Number 1, January/February 1998.

[4] McClaughry, Jason D. and Ferns, Mark L., 2006, *Field Trip Guide to the Geology of the Lower Crooked River Basin*, Oregon Geology, Vol. 67, Number 1, Fall 2006.

[5] DOGAMI, 2007 – 2010, Oregon Department of Geology and Mineral Industries Lidar Program Data, Funded by Oregon Lidar Consortium, Collected by Watershed Sciences, Inc., Vertical datum is NAVD88.

analyses for its suitability for use in Portland Cement Concrete. A fraction of the Aggregate Resource will be too coarse for use directly as concrete aggregates, but it can be crushed and assimilated into the concrete aggregates. The topsoil (uppermost 18 inches) over the mined portion of the Vanier Site will be retained on the property for use in reclaiming the top surface of the mining area within lot 103 back to its use for agricultural purposes after mining is completed. Most of the fine-grained subsoil material will be used in grading the final reclamation slopes.

The results of the drilling are shown in the table below. Water was encountered in all borings except for VAN-5.

Location	**Latitude**	**Longitude**	**Aggregate Base Depth (ft)**	**Overburden (ft)**	**Aggregate Resource (ft)**
VAN-1	44.349034	-120.887610	29	15	14
VAN-2	44.351837	-120.887410	27	18	9
VAN-3	44.351850	-120.890828	18.5	9	9.5
VAN-4	44.349004	-120.890781	29	18	11
VAN-5[6]	44.349523	-120.889380	33	12	21
VAN-6	44.352281	-120.895501	15	6	9
VAN-7	44.352805	-120.889870	23	12	11
			Average Resource Thickness		**12**

Aggregate Resource Quantity

The volume of the Aggregate Resource was determined for the Vanier Site by using the Average Resource Thickness indicated above and multiplying it times the Vanier lot acreage of 77.98 acres. This yields a potential aggregate volume of 1,509,381 cubic yards. Once the property setbacks are defined the volume of the aggregate in the Mining Area can be similarly calculated using the Average Resource Thickness.

[6] The resource layer at VAN-5 contains 8.5 feet of interbedded non-aggregate silty material that was not included in the resource thickness.

Aggregate Resource Quality

The primary target on the Woodward Site is high-quality sand and gravel suitable for use in Portland Cement Concrete ("PCC Concrete"). The cobbles larger than normally used in PCC Concrete can be crushed and added to the PCC Concrete in some instances, used as base rock or used as a component for asphaltic concrete. PCC Concrete specifications require the sand fraction to be graded within specific limits, and both the fine and coarse PCC aggregate must meet durability and other criteria. The specifications used for determining the suitability of the aggregates on the Woodward Site were obtained from the Oregon Department of Transportation ("ODOT")[7]. Some of the aggregate quality tests were performed in a Knife River Corporation – Northwest facility in Tumalo, Oregon and other tests were performed by an ODOT laboratory. All tests were performed by Certified Aggregate Technicians, and the results are presented in the Aggregate Quality Exhibits and summarized below.

Gradation

Representative samples of the aggregate collected from the test pits were used to determine the gradation (relative percentages of different sizes of aggregate) of the aggregate deposit. The sample gradations are presented in a table format in Aggregate Quality Exhibits. These measurements were made in a quality control facility operated by Knife River Corporation – Northwest in Tumalo, Oregon. The measurements were conducted by ODOT certified aggregate technicians. Specifications require that there not be greater than 4% by weight of the fine aggregates passing the No. 200 Sieve (Section 02690.30(c)). An average of 7.7% of the unwashed material passed the No. 200 sieve. Since the aggregates are to be washed during processing, it is reasonable to conclude that the processed aggregates will be able to meet this specification. Due to the variation in the gradations present, the processing system will be designed using the data collected to produce a product that complies with the aggregate gradation requirements.

The average percent of gravel that was greater than ¾" from the tested samples was 14%. This fraction is too coarse, generally, for use in PCC Concrete. It would, however, be crushed and incorporated into the concrete aggregates as has been done with the oversize coarse aggregate on the Woodward site.

Sand Equivalent

The results for the Sand Equivalent tests are also shown in Exhibit E ranging from a low of 9 to a high of 64 for unwashed samples. The specifications require that the Sand Equivalent results be greater than

[7] Oregon Department of Transportation, 2015, "Oregon Standard Specification for Construction – Section 02690 – PCC Aggregates," Salem, Oregon.

68 (Section 02690.30(f)). However, the tests were conducted on unwashed samples, and the range of results measured is indicative of being able to meet the specification once the fine aggregate is washed.

The following results are included in the Aggregate Quality Exhibits on the ODOT laboratory reports.

Sodium Sulfate Soundness

Coarse and fine aggregates to be used for PCC Concrete must be tested for Soundness using sodium sulfate salt. The weighted percentage loss for the coarse aggregates (5%) and fine aggregates (7%) do not exceed the specification thresholds of 12 percent and 10 percent by weight respectively, so they pass.

Durability – Abrasion

Coarse aggregates to be used for PCC Aggregates shall be tested for Abrasion with a maximum allowable result of 30%. The sample tested for Abrasion had a result of 17.5%. The sample passes for the Abrasion test.

Durability – Oregon Air Aggregate Degradation

Coarse aggregates to be used for PCC Aggregates shall be tested for Oregon Air Aggregate Degradation ("Degradation") with a maximum allowable amount passing the No. 20 sieve of 30% and a maximum Sediment Height of 3.0 inches. The representative sample had results of 19.9% and 1.1 inches. The sample passes the Degradation test.

Lightweight Pieces

A coarse aggregate sample was analyzed for Lightweight Pieces. The result reported in Exhibit E was 0.2%, which is less than the required 1% maximum for coarse PCC aggregates.

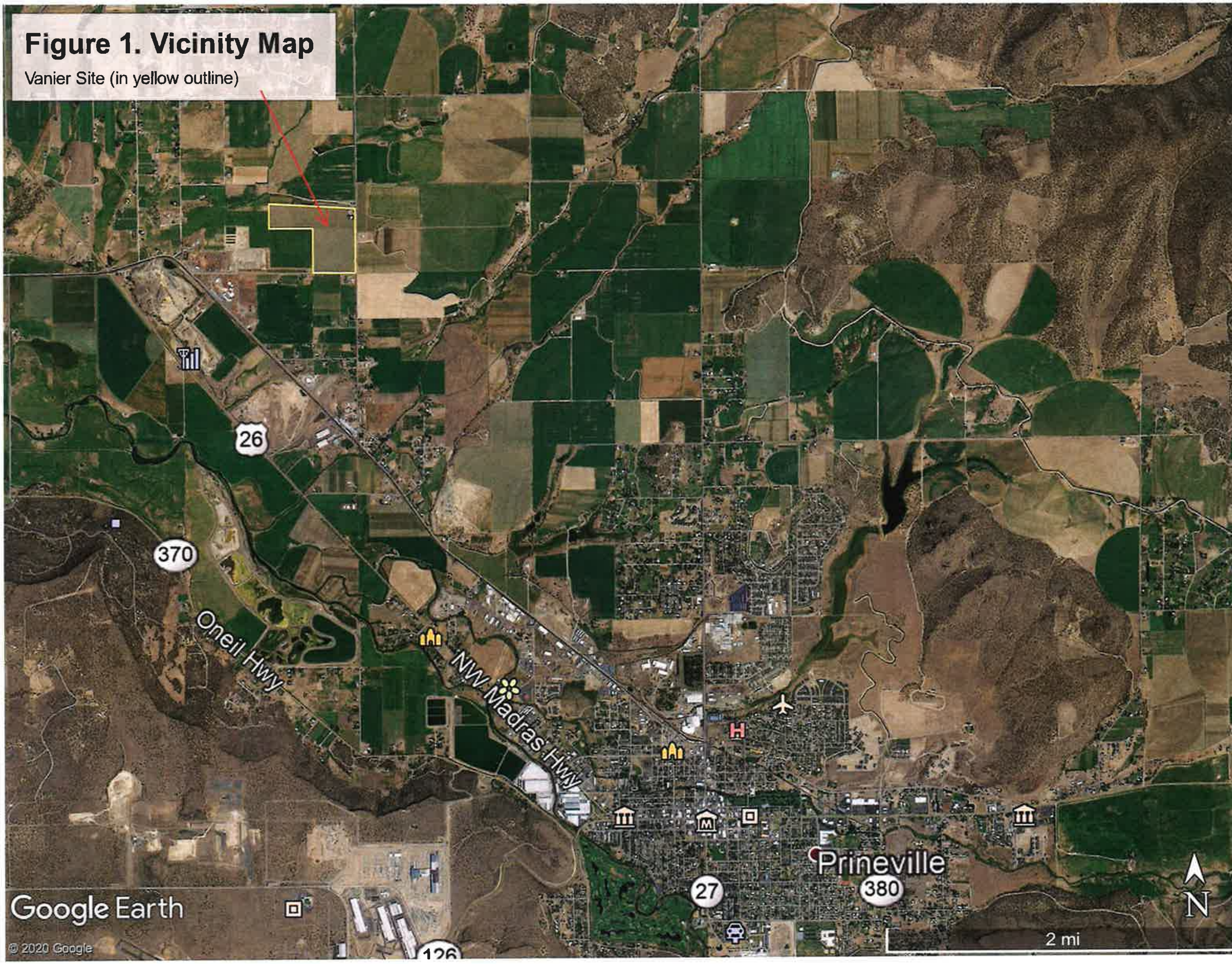
A fine aggregate sample was analyzed for Lightweight Pieces. The result reported in Exhibit E was 0.6%, which is less than the required 2% maximum.

Conclusions

Based on the data gathered in the investigation described herein, it is concluded that there is an aggregate resource consisting of sand and gravel with a potential volume of 1,509,381 Cubic Yards within the Vanier Site. This volume is expected to be reduced slightly by the anticipated setbacks from the property boundaries. The processed aggregate resource will be able to meet the ODOT specifications for PCC Concrete including the criteria for resistance to abrasion, sodium sulfate soundness, and air degradation.

Figure 1. Vicinity Map

Vanier Site (in yellow outline)



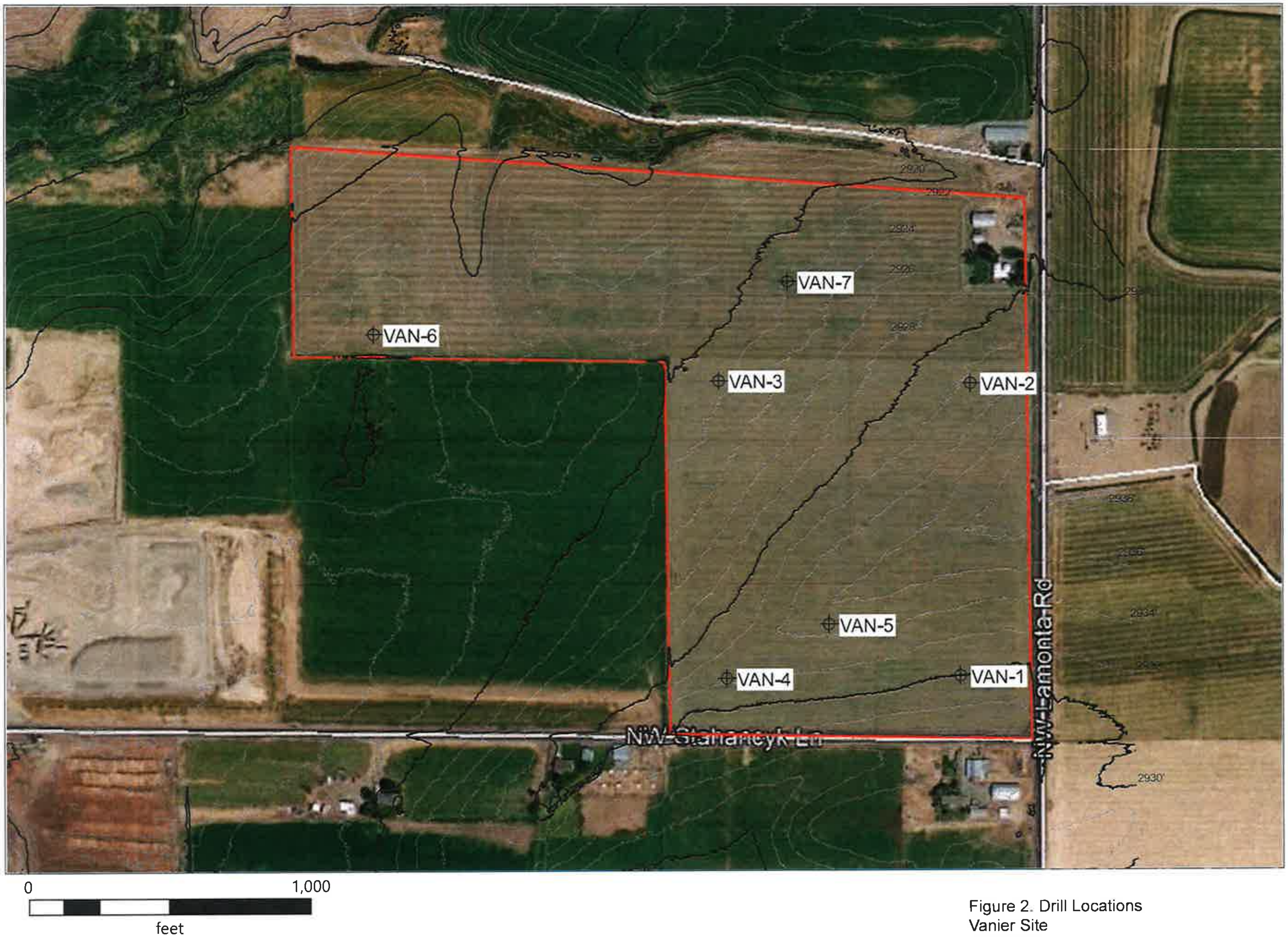


Figure 2. Drill Locations
Vanier Site
July 2020

Statistical Analysis 06/14/2019 - 06/14/2019
Knife River Corporation 250410-Woodward Agg 25024-Pit Run

Vanier Site
Aggregate Quality Exhibit

Date Sampled	Type	Note	3" %	1 1/2" %	1" %	3/4" %	1/2" %	3/8" %	1/4" %	#4 %	#8 %	#16 %	#30 %	#50 %	#100 %	#200 %	PAN %	FM	SE-Wet %
06/14/2019 14:30	Investigative	VAN-05 30' - 33'	100.00	89.00	76.00	70.00	59.00	53.00	45.00	40.00	33.00	28.00	22.00	14.00	7.00	3.9	0.0	5.43	40.00
06/14/2019 14:30	Investigative	VAN-04 22' - 25'	100.00	98.00	94.00	85.00	74.00	68.00	60.00	55.00	47.00	40.00	31.00	15.00	8.00	4.6	0.0	4.52	61.00
06/14/2019 14:30	Investigative	VAN-07 20' - 23'	100.00	100.00	95.00	90.00	77.00	70.00	60.00	54.00	45.00	37.00	27.00	11.00	4.00	2.8	0.0	4.61	
06/14/2019 14:30	Investigative	VAN-03 15' - 18.5'	100.00	100.00	97.00	94.00	88.00	84.00	77.00	72.00	62.00	51.00	35.00	16.00	8.00	4.9	0.0	3.78	46.00
06/14/2019 14:30	Investigative	VAN-06 10' - 15'	100.00	94.00	86.00	80.00	68.00	62.00	54.00	48.00	39.00	32.00	24.00	15.00	10.00	7.0	0.0	4.96	23.00
06/14/2019 14:30	Investigative	VAN-07 12' - 15'	100.00	89.00	81.00	74.00	61.00	53.00	44.00	40.00	32.00	27.00	19.00	8.00	4.00	2.3	0.0	5.55	57.00
06/14/2019 14:30	Investigative	VAN-05 25' - 30'	100.00	96.00	86.00	82.00	73.00	68.00	61.00	56.00	45.00	37.00	30.00	21.00	16.00	12.8	0.0	4.48	20.00
06/14/2019 14:30	Investigative	VAN-02 18' - 20'	100.00	100.00	94.00	89.00	76.00	69.00	58.00	52.00	43.00	36.00	28.00	13.00	7.00	5.2	0.0	4.63	57.00
06/14/2019 14:30	Investigative	VAN-01 7' - 10'	100.00	100.00	100.00	99.00	95.00	90.00	82.00	75.00	60.00	47.00	39.00	31.00	23.00	17.1	0.0	3.34	27.00
06/14/2019 14:30	Investigative	VAN-03 9' - 13'	100.00	100.00	90.00	85.00	74.00	68.00	59.00	54.00	44.00	38.00	31.00	19.00	11.00	8.2	0.0	4.51	38.00
06/14/2019 14:30	Investigative	VAN-01 25' - 29'	100.00	94.00	82.00	72.00	60.00	53.00	44.00	38.00	29.00	23.00	17.00	8.00	4.00	2.6	0.0	5.63	62.00
06/14/2019 14:30	Investigative	VAN-03 13' - 15'	100.00	98.00	91.00	82.00	69.00	61.00	51.00	46.00	35.00	28.00	22.00	11.00	5.00	2.8	0.0	5.12	62.00
06/14/2019 14:30	Investigative	VAN-02 25' - 27'	100.00	100.00	89.00	81.00	68.00	60.00	50.00	43.00	33.00	25.00	19.00	12.00	6.00	4.1	0.0	5.20	61.00
06/14/2019 14:30	Investigative	VAN-01 20' - 25'	100.00	99.00	85.00	76.00	60.00	52.00	42.00	37.00	28.00	22.00	14.00	7.00	3.00	2.2	0.0	5.62	58.00
06/14/2019 14:30	Investigative	VAN-01 15' - 20'	100.00	100.00	97.00	94.00	87.00	82.00	73.00	67.00	55.00	47.00	38.00	25.00	16.00	11.8	0.0	3.75	26.00
06/14/2019 14:30	Investigative	VAN-02 20' - 25'	100.00	85.00	74.00	68.00	57.00	51.00	42.00	37.00	27.00	22.00	17.00	8.00	4.00	2.5	0.0	5.81	57.00
06/14/2019 14:30	Investigative	VAN-05 20' - 23'	100.00	100.00	100.00	98.00	97.00	95.00	92.00	90.00	85.00	79.00	68.00	40.00	20.00	12.1	0.0	2.24	31.00
06/14/2019 14:30	Investigative	VAN-04 25' - 29'	100.00	96.00	89.00	83.00	72.00	65.00	55.00	49.00	38.00	27.00	18.00	10.00	6.00	4.4	0.0	5.07	42.00
06/14/2019 14:30	Investigative	VAN-05 8' - 12'	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.00	97.00	92.00	87.00	77.00	61.00	40.7	0.0	0.87	9.00
06/14/2019 14:30	Investigative	VAN-05 3.5' - 7'	100.00	100.00	100.00	100.00	99.00	99.00	98.00	98.00	96.00	94.00	90.00	70.00	35.00	7.5	0.0	1.19	38.00
06/14/2019 14:30	Investigative	VAN-07 15' - 20'	100.00	95.00	88.00	82.00	71.00	64.00	56.00	51.00	43.00	36.00	26.00	11.00	5.00	3.4	0.0	4.87	36.00
06/14/2019 14:30	Investigative	VAN-04 18' - 22'	100.00	100.00	99.00	97.00	94.00	90.00	85.00	82.00	74.00	65.00	48.00	21.00	9.00	5.7	0.0	3.14	64.00
06/14/2019 14:30	Investigative	VAN-06 6' - 10'	100.00	100.00	100.00	97.00	92.00	88.00	81.00	77.00	69.00	61.00	46.00	25.00	14.00	8.4	0.0	3.22	28.00
Count			23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	22
Min			100	85	74	68	57	51	42	37	27	22	14	7	3	2.2	0	0.87	9
Max			100	100	100	100	100	100	100	99	97	94	90	77	61	40.7	0	5.81	64
Mean			100	97	91	86	77	72	64	59	50	43	35	21	12	7.7	0	4.24	43
SD			0	4.3	7.9	10.1	14.1	16	18.3	19.5	21.1	21.4	21	18.4	13.1	8.22	0	1.372	16.5
CV			0	4.4	8.7	11.8	18.3	22.4	28.7	33	41.9	49.6	60.8	86.7	105	106.79		32.348	38.6
Pay Factor																			
Targets																			
Specification																			

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4792
(503)986-3000
FAX(503)986-3096

Contract No.: PRIVATE   EA No.: PRIVATE TESTING   Lab No.: 20-000161
Project: PRIVATE AGGREGATE TESTING - KNIFE RIVER WOODWARD PIT (07-
Highway: County: **Data Sheet No.: F49910 030**
Contractor: KNIFE RIVER - BEND   FA No.:
Project Manager: Org Unit: Bid Item No.:
Submitted By: JOSHUA MORGAN   Org Unit: KRB   Sample No.:
Material Source: 07-097-4 Woodward Aggregate   Qty Represented:
Sampled At: VANIER FIELD SAMPLE   Sampled By: Witnessed By:
DATE-Sampled: 20/ 1/17   Received: 20/ 1/17   Tested: 20/ 2/ 6   Date Reported: 20/ 2/ 6
Class/Type: COMPLIANCE   **Use: FINE PCC AGGR**

Q or G: GRAVEL   **AGGREGATE LABORATORY REPORT - FPCCAG**   **Size: SAND**

Test	Field	Lab
T 176 S.E.		
T 89 L.L.		
T 90 P.I.		
Fineness Modulus		
TM 226 Dust/Clay		
TM 227 Cleanness		
TM 229 Elong pcs		
308 Incin/Ga A/C		
Total A/C		
Retention		
T 329 Moisture		
T 27/11 Sieve	Passing	Passing
2.5		
2		
1.5		
1		
3/4		
1/2		
3/8		
1/4		
# 4		
# 8		
# 10		
# 16		
# 30		
# 40		
# 50		
#100		
#200		

T 84 F. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

T 85 C. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

T 104 Soundness
C A: F A: 7%
1.5-3/4:   <10%
3/4-3/8:
3/8- #4:
#4- #8: 10.9 %
#8-#16: 6.5 %
#16-#30: 5.9 %
#30-#50: 5.1 %

TM 208 Degrade
Crse Ht:
P20:
Fine Ht:
P20:

T 96 Abrasion

T 21 Impurity
Plate #: 1

T 335 Fracture
3/4:
1/2:
3/8:
1/4:
#10:

T 112 Friables
Wt'd Avg :
1.5-3/4:
3/4-3/8:
3/8- #4:
#4-#16:

T 113 Lightweight
Coarse:
Fine: 0.6 %   <2.0%

TM 225 Woodwaste
Lab:
Field:

AASHTO T 288/289
Resist: Ω
pH:

AASHTO T 267
Organic:

AASHTO T 291
Chloride:

AASHTO T 290
Sulfate:

T 327 Micro Deval ===> Grading: Loss: %

1 @ t21	=$	21.00
5 @ t104	=	38.00
1 @ t113	=	44.00

NSM = Not Sufficient Material

TOTAL CHARGES: $ 255.00

REMARKS:
INFORMATION ONLY

KEVIN BROPHY - LABORATORY SERVICES MANAGER

C: FILES ; KNIFE RIVER - BEND ; A JOHNSON - CONCRETE QUALITY ; J CIESLAK - AGGREGATE

Vanier Site
Aggregate Quality Exhibit
Page 2 of 3

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
800 AIRPORT RD. SE SALEM, OR 97301-4792
(503)986-3000
FAX(503)986-3096

Contract No.: PRIVATE EA No.: PRIVATE TESTING Lab No.: 20-000160
Project: PRIVATE AGGREGATE TESTING - KNIFE RIVER WOODWARD PIT (07-
Highway: County: Data Sheet No.: F49910 030
Contractor: KNIFE RIVER - BEND FA No.:
Project Manager: Org Unit: Bid Item No.:
Submitted By: JOSHUA MORGAN Org Unit: KRB Sample No.:
Material Source: 07-097-4 Woodward Aggregate Qty Represented:
Sampled At: Sampled By: Witnessed By:
DATE-Sampled: 20/ 1/17 Received: 20/ 1/17 Tested: 20/ 2/ 6 Date Reported: 20/ 2/ 6
Class/Type: COMPLIANCE Use: COARSE PCC AGGR

Q or G: GRAVEL AGGREGATE LABORATORY REPORT - CPCCAG Size: 3/4"-#4

Test	Field	Lab
T 176 S.E.		
T 89 L.L.		
T 90 P.I.		
T 335 Ttl Frac.		
TM 226 Dust/Clay		
TM 227 Cleanness		
TM 229 Elong pcs		
308 Incin/Ga A/C		
Total A/C		
Retention		
T 329 Moisture		

T 27/11 Sieve	Field Passing	Lab Passing
2.5		
2		
1.5		
1		
3/4		
1/2		
3/8		
1/4		
# 4		
# 8		
# 10		
# 16		
# 30		
# 40		
# 50		
#100		
#200		

T 84 F. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

T 104 Soundness
C A: 5% <12% F A:
1.5-3/4: 4.6 %
3/4-3/8: 4.8 %
3/8- #4: 6.8 %
#4- #8:
#8-#16:
#16-#30:
#30-#50:

T 96 Abrasion
<30.0% 17.5 %
Type B

T 335 Fracture
3/4:
1/2:
3/8:
1/4:
#10:

T 113 Lightweight
Coarse: 0.2 % <1.0%
Fine:

AASHTO T 288/289
Resist: Ω
pH:

AASHTO T 291
Chloride:

T 85 C. Grav.
Bulk:
S.S.D.:
Appar.:
Absorp.:

TM 208 Degrade
Crse Ht: 1.1 in
P20: 19.9 %
Fine Ht: <3.0"
P20: <30.0%

T 21 Impurity
Plate #:

T 112 Friables
Wt'd Avg :
1.5-3/4:
3/4-3/8:
3/8- #4:
#4-#16:

TM 225 Woodwaste
Lab:
Field:

AASHTO T 267
Organic:

AASHTO T 290
Sulfate:

| T 327 Micro Deval ===> Grading: Loss: % |

1 @ t96	=	$125.00
4 @ t104	=	38.00
1 @ t113	=	44.00
1 @ tm208	=	96.00

NSM = Not Sufficient Material

TOTAL CHARGES: $ 417.00

REMARKS:
INFORMATION ONLY

KEVIN BROPHY - LABORATORY SERVICES MANAGER

C: FILES ; KNIFE RIVER - BEND ; A JOHNSON - CONCRETE QUALITY ; J CIESLAK - AGGREGATE

Vanier Site
Aggregate Quality Exhibit

Woodward/Vanier Aggregate Mine Hydrogeologic Characterization

March 2021

Prepared for:

Prepared for: Knife River Corporation
32260 Highway 34
Tangent, OR 97389

Prepared by:

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WOODWARD/VANIER AGGREGATE MINE HYDROGEOLOGIC CHARACTERIZATION
MARCH 2021
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APPENDICES

1.0 INTRODUCTION

Wenck, now part of Stantec (Wenck) has completed a hydrogeologic investigation and groundwater inflow analysis at the Woodward and Vanier properties located near Prineville, Oregon, for the Knife River Corporation (Knife River). Both properties are located on the north side of Stahancyk Lane and east of Elliot Lane in the southern ½ of Section 14 Township 14 South, Range 15 East along the Crooked River in Crook County. Comprised of 112 acres, the Woodward property (Woodward) lies within two tax lots, 702 and 703, and are owned by Woodward Land & Timber. Comprised of 77.98 acres, the Vanier property (Vanier) lies just east of Woodward in tax lot 103 and is owned by Robert J. Vanier Jr. and Lani Vanier. Knife River is currently mining the sand and gravel resources at Woodward and expects to finish mining the remaining cells at Woodward by the end of 2021. Knife River anticipates mining will continue into Vanier in 2022. Wenck understands Knife River is in the process of preparing a Goal V application to submit to Crook County and will also submit an Operating Permit application to the Oregon Department of Geology and Mineral Industries (DOGAMI) for Vanier.

As mining has progressed to the east across Woodward, Knife River has encountered increasing amounts of groundwater near the eastern boundary between Woodward and Vanier. While this water has not adversely affected mining efforts, it has hindered reclamation in the blocks that have been mined out. Wenck understands the landowners want these properties reclaimed to farm fields or hay meadows and supplemental imported materials are prohibited for reclamation efforts. The groundwater encountered in the area is making it difficult to meet this reclamation objective. The water was not expected nor in the quantities observed. Knife River's permit to mine at Woodward includes a mining depth limitation of only 20 feet below ground surface (bgs) and prohibits dewatering. In addition to addressing the groundwater issues at Woodward, this report will address the local area groundwater setting, groundwater handling at Vanier and a proposed mine and reclamation plan that will allow maximum resource recovery with no impact to area groundwater rights. The data and technical discussions of this report can be submitted as part of the Goal V application to Crook County and the permit application to DOGAMI.

The purpose of our work has been to answer the following questions and provide solutions:

- Can we reduce or eliminate the presence of groundwater during backfill and reclamation?
- Can we meet the landowner's proposed and desired final land use: pasture and hay meadow?
- If we dewater (pump and discharge), can we do so with no impact to surrounding water rights and resources?
- Are there alternative means to pump and discharge that will protect area wells and water rights?
- Can we develop a backfill plan that will allow successful farm field reclamation?

To address these questions, Wenck completed a multi-phased scope of work which included evaluating geologic and hydrogeologic literature; locating water rights in the surrounding areas; drilling of test wells at Woodward and aquifer testing; evaluating water management strategies; estimating potential groundwater inflows; and evaluating reclamation plans and options.

2.0 REGIONAL GEOLOGICAL AND HYDROGEOLOGICAL SETTING

Woodward and Vanier are located near the intersection of the High Cascades, High Lava Plains, and Blue Mountains geologic provinces in central Oregon (McClaughry & Ferns, 2006). The property lies within the Lower Crooked River Basin which formed due to regional explosive volcanism and basalt lava flows. The present basin is centered on the Crooked River Caldera, a semi-elliptical, northwest-southeast elongated depression consisting of a large vent complex that collapsed and filled with a rhyolitic ash-flow tuff (McClaughry et al., 2009). Broadly speaking, the rocks comprising the Prineville area consist of a succession of Tertiary volcanic and sedimentary strata and including lava flows of the Clarno Formation; rhyolite, tuff, and sedimentary rocks of the John Day Formation; basalt flows of the Prineville Basalt; sediments and lava flows of the Deschutes Formation; and Quaternary surficial and valley fill deposits.

As shown on **Figure 1**, geologic mapping of the area indicates that Woodward and Vanier are entirely covered with Quaternary Terrace Deposits. The deposits resulted from backwater deposition occurring after lava flows dammed the Crooked River Canyon downstream of the site. As the Crooked River Basin filled with sediment, the coarser sands and gravels prograded out from the Ochoco Mountains to the northeast creating large terraces north of Prineville on which Woodward and Vanier are located. Surficial sediments near the site mainly consist of stream alluvium (Qal) deposited in active stream channels and flood plains underlain by terrace deposits (Qs) consisting of abandoned terraces of the Crooked River (Swanson, 1968) and fluviolacustrine deposits. Alluvial sediments are deposits of recent geologic age underlying the present flood plains of the Crooked River consisting of unconsolidated gravel, sand, and silt, generally less than 40 feet thick. The gravel and sand in the alluvium yield small to moderate amounts of water to wells in the area. (Robinson and Price, 1968). The underlying terrace and fluviolacustrine deposits are described as thick beds of silt and clay alternating with thin beds of sand and fine gravel. These units have been observed as thick as 300 feet near Prineville (Swanson, 1968). A stratum of sand and gravel, ranging in thickness between 10 and 30 feet, constitutes the most productive aquifer in the Prineville area (Robinson and Price, 1968). This aquifer unit yields moderate to large amounts of water to the wells and is described as confined with artesian pressures. The terrace and fluviolacustrine units were deposited on an eroded surface of the Madras Formation, though the contact between these two units is difficult to distinguish in well logs (Robinson and Price, 1968).

3.0 LOCAL GEOLOGIC AND HYDROGEOLOGICAL SETTING

To assess the geologic resources of Woodward, Knife River conducted two investigations using test pit excavation methods. In October 2014, Knife River conducted an aggregate resource investigation of the sand and gravel (construction aggregates) at Woodward that could reasonably be recovered through mining. The site investigation was performed by digging test pits with an excavator to determine aggregate resource and overburden thicknesses and collect samples for materials testing. A total of 27 test pits were dug between October 20 and October 27, 2014. The locations of these test pits are noted on **Figure 2**.

Knife River identified three basic units from this investigation:

- Overburden – topsoil and generally fine-grained subsoil material that overlie the aggregate resource. The overburden unit varied in thickness between 1 and 16 feet at the site with thicknesses generally increasing to the east.
- Aggregate Resource – sand and gravel, the primary target of the exploration at the Woodward site. The aggregate resource was thickest at TP-21 in the center of the site and was not present at TP-16 and XP-5 located at the north-northwest and south-southwest ends of the property, respectively. There is no observable correlation between the location of the test pit and aggregate resource thickness.
- Silt – silts and clays underlying the aggregate resource. The silt unit described above was encountered below the aggregate resource in all cases where the exploration pit was dug to a depth below the target sand and gravel unit. The silt was observed as shallow as 2 feet bgs at TP-18 approximately 700 feet north of the property boundary and as deep as 18 feet bgs at TP-21 in the center of the site. There is no strong correlation between the depth at which the silt unit was observed and its location, though, the depth tended to be deeper in the center of the site.

After groundwater was encountered in mine blocks (Areas 7 and 8) to the east at Woodward, Knife River conducted an additional investigation to assess conditions by excavating four test holes. The purpose of this investigation was to quantify groundwater at the eastern Woodward/western Vanier boundary for the remainder of the mining efforts at Woodward. The data could provide initial information for future mining considerations at Vanier. The test holes were dug on December 1, 2020 and logged by Bill Gibson of Knife River. The locations of these test holes are also noted on **Figure 2.** Overburden was observed to a depth of 8, 5, and 10 feet at Test Holes 1 through 3, respectively. Below this unit, 7 to 8 feet of sand was observed at Test Holes 1 and 2 but was not present at Test Hole 3. Seven feet of gravel was noted at Test Hole 1, 1 foot at Test Hole 2, and 6 feet at Test Hole 3. However, Test Hole 2 was not excavated to the bottom of the gravel unit, suggesting a greater gravel thickness could be present. Test Hole 1 was likely dug deeper than the gravel unit but was difficult to observe due to groundwater flow through the unit. Test Hole 3 was dug past the gravel unit and encountered a silt unit at 16 feet.

During Knife River's 2014 test pit investigation, groundwater was noted in seven of the 27 test pits. Groundwater flow was not quantified during logging, though units that appeared to be wet or water yielding were recorded. Water bearing units consisted primarily of gravel with varying amounts of sand. Water was encountered as shallow as 9 feet at TP-5 on the northeastern edge of the property and as deep as 17 feet bgs at TP-13 located centrally towards the eastern side of the property. All test pits which encountered water were located on the eastern half of the property. This observation is consistent with the locations where Knife River began encountering water during mining. During Knife River's test hole investigation in 2020, groundwater was encountered in all three test holes at depths ranging from 7 to 15 feet bgs. The most water was present at Test Hole 1 where Knife River visually estimated nearly 100 gallons per minute (gpm) of inflow between 15 and 22 feet bgs. Similarly Knife River estimated approximately 25 gpm of inflow at Test Hole 2 between 13 and 14 feet. Since Test Hole 2 was not dug entirely through the gravel unit, it is possible that a greater flow rate is present. Knife River noted less than 5 gpm at Test Hole 3, where water was flowing through the gravel unit between 15 and 19 feet. Based on the test hole logs, groundwater flow appears to increase moving from west to east.

To assess the aggregate resources at Vanier, Knife River conducted a site investigation in June 2019. Seven soil borings were drilled to depths between 30 and 35 feet to assess the lateral continuity of the sand and gravel resources. The locations of these borings are noted on **Figure 2**. The overburden unit consists of topsoil and silt which transitions into silty fine to medium grained sand with occasional gravel. Overburden depths varied from 6 to 18 feet. The aggregate resource consisted primarily of sand and gravel with occasional silt and varied in thickness between 9 and 21 feet. Aggregate resource thickness tended to be slightly greater in the southern portion of Vanier. A silt unit similar to that encountered at Woodward was encountered below the aggregate resource unit. This unit generally consisted of silt and clay with occasional fine sand and was found at depths between 15 and 33 feet bgs. The silt unit appears to be found deeper toward the southern end of the site. Groundwater flow was not quantified during this site investigation, though the depths and intervals at which sediments appeared to be wet were reported. Water was typically present in the sand and gravel unit in all soil borings found at depths between 6 and 33 feet, apart from soil boring VAN-05. The sand and gravel unit in soil boring VAN-06 was dry at the time of drilling but became wet overnight.

Based on these investigations and local water well records, Wenck prepared a water table map. Wenck prepared this map by plotting groundwater elevations measured at nearby shallow wells drilled or screened to a maximum depth of 40 feet. This distinction in shallow well depth was made based on the thickness of alluvial deposits specified by Robinson and Price in *Ground Water in the Prineville Area, Oregon* (1968). Groundwater was found to flow generally from the northeast towards the southwest. Groundwater elevations were also plotted based on water level observations made by Tim Marshall during test pit logging at both the Woodward and Vanier property. Only water level measurements recorded between June and October were considered in part to reduce error caused by seasonal fluctuations in the water table and an abundant amount of available data recorded during these months. Water level observations made by Knife River during their test hole investigation at the Woodward property were omitted due to this investigation occurring in December. Groundwater contours were generated based on reported groundwater elevations measured at each well and water levels noted during each site investigations. The location of these shallow wells and test pits, their groundwater elevations, and water table contours are noted in **Figure 3**. Based on the configuration of the groundwater table, Wenck anticipates that Knife River will continue to encounter groundwater as it mines into Vanier. This map was also prepared to estimate the saturated thickness of sand and gravel that would potentially need to be dewatered at the Vanier property.

4.0 TEST WELL DRILLING AND GROUNWATER CONDITIONS

In collaboration with Yellow Jacket Drilling (Yellow Jacket), Wenck completed three test wells: WW-1A, WW-2A, and WW-3A. These wells were drilled and installed between January 18 and 20, 2021, along the southeastern edge of the Woodward property, bordering the southwestern edge of Vanier, as shown on **Figure 2.** The objective of this aspect of the investigation was to obtain the hydrogeologic properties of the shallow aquifer. Knife River was particularly interested in the volume of groundwater that might be encountered as they mine the remaining two Woodward cells: Areas 9 and 10. The test wells were also drilled to provide Knife River with insight regarding potential groundwater conditions at Vanier, east of the wells.

Wenck observed the drilling, completion, and development for each test well. The wells were drilled using sonic drilling methods. Sonic drilling uses high-frequency vibrations to advance a core barrel into the subsurface formations, allowing for continuous coring. Wenck logged the continuous 8-inch core sample during drilling at each hole. All three wells fully penetrate the surficial aquifer and were completed to the top of the silt/clay unit below the sands and gravels. Based on water level data collected at the site, groundwater encountered during mining operations at Woodward is transmitted through the alluvial sands and gravels. The clay unit was encountered at 30 feet bgs at WW-2A and WW-3A, and 32 feet bgs at WW-1A. Because of this, the wells were completed to 30, 25, and 28 feet at WW-1A, WW-2A, and WW-3A, respectively. Test wells WW-1A through 3A were developed and completed as 4-inch diameter PVC wells. Well construction details are included in **Appendix A.**

Geologic drill log data for WW-1A through 3A indicated that shallow subsurface sediments consist of both fine- and coarse-grained sediments overlying the John Day Formation. The upper 15 feet at each well generally consisted of tan to brown silty sand and sandy clay with varying amounts of carbonaceous material. Below that layer, 0.5 to 2-inch diameter subrounded gravel with medium grained sand with varying amounts of silt is generally present between 15 and 27 feet bgs. This gravel laden unit is the source of mineable rock at the site. The silty sand and sandy clay unit above the sand and gravel resource is overburden. The upper 2 to 4 feet is topsoil. A silty sand unit that transitions into a lean clay underlies the sand and gravel and was the completion depth of each well. The top of the silty sand unit (base of the sand and gravel resource) was encountered at 29, 26, and 28 feet at WW-1A, WW-2A, and WW-3A, respectively.

Moist sediments were observed at the time of drilling between 9 and 11 feet bgs at each well. A PVC monitor/test well was completed at each site (WW-1A, WW-2A, and WW-3A) and static water levels were measured to be 20.6, 21.4 and 17.5 feet bgs, respectively, on January 21, 2021. These data suggest that localized groundwater flow is from WW-3A to WW-1A, or from north to south. The water table map on **Figure 3** presents a broader picture of the local area groundwater flow.

5.0 AQUIFER TESTING AND HYDROGEOLOGICAL DATA

Wenck collaborated with Yellow Jacket to conduct aquifer testing of the surficial aquifer. Stepped Rate and Constant Rate tests were conducted using submersible pumping equipment. Stepped Rate testing was conducted at WW-1A and WW-3A. Constant rate testing was conducted at WW-1A in conjunction with WW-2A and WW-3A acting as observation wells. During the pumping and recovery portions of these tests, Wenck acquired water level data using both downhole pressure transducers and water level tapes. Discharge measurements were collected using a calibrated bucket and a stopwatch. The aquifer testing graphs, and associated analysis are included in **Appendix B**.

Stepped and Constant Rate tests were completed on WW-1A on January 19, 2021. Prior to the initiation of pumping, the static water level at the well was recorded to be 21.06 feet bgs. The Stepped Rate test was completed at discharge rates of 2 and 2.5 gpm. A third step was not completed due to the well's water yield limitations. Discharge rates were increased at the end of the first step without allowing water level recovery between steps. The maximum drawdown from the initiation of pumping through the second step was 8.92 feet. Following the second step, the pump was shut off and the well recovered to pre-pumping water levels after approximately 25 minutes. Following the Stepped Rate test, Constant Rate testing was conducted at WW-1A on January 20, 2021. Prior to testing, the static water level was recorded to be 21.13 feet bgs. Based on stepped rate testing, a target flow rate of 2 gpm was selected given pump and well capabilities. The constant rate test was conducted for 12 hours at an average flow rate of 2.2 gpm. At the end of this constant rate test, drawdown was 8.43 feet.

Due to lower than expected well yields observed at WW-1A and WW-2A, a third well, WW-3A, was drilled to assess the lateral continuity of the surficial aquifer and to see if a well completed further north and towards Kinfe River Test Hole 1 may yield more water. Knife River's Test Hole 1 is described further in Section 3 yielded large water inflow rates (+/- 100gpm). Prior to the initiation of pumping, the static water level was recorded at 17.58 feet bgs. Stepped rate testing on WW-3A was completed on January 21, 2021 and yielded discharge rates of 1 and 2 gpm. A third step was not performed due to the well's limited water yield capabilities. The maximum drawdown from the initiation of pumping through the second step was 9.27 feet. Following the second step, the pump was shut off and the well recovered to pre-pumping water levels after approximately 15 minutes.

A second Constant Rate test (January 22, 2021) was conducted on WW-1A to observe pumping impacts to water levels in the observation wells (WW-2A and WW-3A). WW-3A is located approximately 144 feet to the north of WW-2A. WW-2A is approximately 18 feet north of WW-1A. Prior to testing, water levels were recorded to be 21.16, 20.67, and 17.52 feet bgs at WW-1A, WW-2A, and WW-3A, respectively. A target flow rate of 2 gpm was originally selected, though, the target flow rate was increased to 3 gpm halfway through the test to ensure the opportunity to impact (observe drawdown) nearby observation wells. The Constant Rate test was conducted for 11 hours at an average flow rate 2.5 gpm. At the end of constant rate pumping, drawdown was measured to be 8.13 and 0.04 feet at WW-1A and WW-2A, respectively. No observable change in water levels was noted at WW-3A.

Based on data collected during stepped rate testing at WW-1A and WW-3A and constant rate testing at WW-1A, the following conclusions were made:

- Aquifer test analyses using Waterloo's AquiferTest Pro 10.0 revealed a range in transmissivity values between 2,215 and 9,195 gallons per day per foot (gpd/ft).

- Hydraulic conductivity values varied between 218 and 903 gallons per day per square foot (gpd/ft^2). Hydraulic conductivity values in this range are typical of silty sand or fine to medium grained clean sand (Heath, 1983).
- The storage coefficient was estimated to be 0.285 which is typical of an unconfined aquifer (Lohman, 1972).

6.0 GROUNDWATER INFLOW ANALYSIS - WOODWARD

Based on the data acquired from monitoring well drilling and aquifer test analysis, Wenck estimated the groundwater inflow volumes that could be produced from Area 10 as Knife River continues mining to the east toward Vanier. Only Area 10 was considered for this inflow analysis because minimal groundwater is expected in Area 9. It is to Wenck's knowledge that Knife River reported minimal groundwater influence when Area 6 and 7 (mining cells directly north of Area 9) were mined. Areas 9 and 10 are located at the southeastern edge of the property and are illustrated in **Figure 4** along with other, previously mined cells.

Mine plan drawings provided by Knife River were used to identify the remaining two cells to be mined at Woodward and were used in this analysis. Areas 9 and 10, 7.3 and 9.3 acres respectively, are the remaining mining cells expected to be mined during the summer of 2021. Knife River's 2014 test pit investigation indicates minimal groundwater will be present within Area 9 based on a series of nearby test holes yielding no water. Area 10 was analytically modeled under three mining approaches, extracting the resource from (1) the mine block as a whole; (2) from ten individual 66-foot-wide mining cells, which are mined from west to east and backfilled in a contemporaneous fashion; and (3) ten 55-foot-wide mining cells, which are mined from north to south and backfilled in a contemporaneous fashion. Each mining approach is illustrated on **Figure 5**. These mining approaches were chosen for the purpose of providing Knife River alternatives for extracting the remaining aggregate resources at Woodward with the least potential groundwater production. Analytical groundwater equations (modified Theim equations for unconfined aquifer conditions (Driscoll, 1986)) were applied to the individual mine cells under each mining approach. Groundwater inflow equations describing inflows to a rectangle were used for the first mining approach assuming the entire mine block is being mined and is open to groundwater inflow. Groundwater inflow equations describing inflow to a trench were used to describe inflows under mining Approaches 2 and 3. The distinction between a rectangle and a trench depends on the ratio between the length and the width of a particular mining cell. A summary of the model's results is presented in **Table 1**.

Because the analytical flow results are sensitive to the radius of influence or R-value, Wenck considered two scenarios for each mining approach to estimate the groundwater inflows to Area 10. Scenario 1 uses an R-value of 1,000-feet and assumes both a low and high hydraulic conductivity generated from aquifer testing. Scenario 2 uses an R-value of 4,000-feet and similarly assumes a low and high hydraulic conductivity value. By using different hydraulic conductivity values, Wenck was able to estimate the range in groundwater inflows that could be encountered given varying hydrogeologic conditions across the site. Modeled values produced by evaluating mining approach 1, which considers mining cell Area 10 in its entirety, estimated a range of inflows between 19.9 and 189.2 gpm. For mining approach 2, which considers a series of individual trenches mined from east to west, the model estimated inflow values between 15.7 and 99.9 gpm. For mining approach 3, which similarly considers a series of trenches but mined from north to south, did not produce significantly different results compared to mining approach 2. The model predicted a range in inflows between 15.7 and 100.2 gpm. All scenarios assume the individual mining cells were open. Although, in the case of mining approaches 2 and 3, the previously mined trenches are expected to be backfilled. For mine planning purposes, the higher inflow estimates should be used. Although modeled inflow values for mining approaches 2 and 3 do not significantly differ, Wenck anticipates mining approach 2 (mining cells mined from east to west) would be the most favorable mining strategy for reducing the impacts of groundwater. Due to a general groundwater flow from northeast towards the southwest (**Figure 3**), Knife River could mine the aggregate resource and backfill with low permeability material to the east effectively sealing off/rerouting the flow of groundwater. This strategy is explained in greater detail in section 9.0.

7.0 GROUNDWATER INFLOW ANALYSIS - VANIER

Based on the aquifer testing results and using the same equations used on Woodward, Wenck estimated the groundwater inflows that could be produced as Knife River continues mining at Vanier. Wenck utilized several values for the aquifer hydraulic conductivity as well as different extents of dewatering influence. These scenarios were selected to assess groundwater inflow variations due to changes in local aquifer characteristics, pumping rates, and associated dewatering requirements for individual cells. Mine plan drawings initially provided by Knife River and later modified by Wenck were used to identify the 14 areas that might be at Vanier. Mining cells used in this analysis vary in size between 5 and 6.5 acres and are shown on **Figure 4**.

Only one mining approach was considered at Vanier. Each mining area was analyzed as a whole, rather than separating each mining cell into a series of trenches as discussed for the Woodward property. Contemporaneous reclamation (backfill of the previously mined cell) was assumed. Analytical groundwater equations (modified Theim equations for unconfined aquifer conditions (Driscoll, 1986)) were applied to the individual mine cells and used to estimate groundwater inflows to a rectangular mine block. Two scenarios were considered for this mining approach. Scenario 1 used an R-value of 1,000 feet and used a low and high hydraulic conductivity. Scenario 2 uses an R-value of 4,000 feet and similarly used a low and high hydraulic conductivity value. By using different hydraulic conductivity values, Wenck was able to estimate the range in groundwater inflows that could be encountered given varying hydrogeologic conditions across the site. The results of our analysis are summarized in **Table 2**. Of the 14 mining cells analyzed, the modeling effort predicted a maximum inflow value of 288 gpm within Area 8, located in the northwest portion of the site. As shown by groundwater contours on **Figure 3**, increasing amounts of groundwater can be expected from southwest to northeast. The lowest inflow estimates were predicted by the model to be present within mining cell Area 11 with a range between 1.6 and 14.5 gpm. Inflow values are expected to be low in this area since it is the most westerly mining cell and groundwater increases towards the east. Knife River did encounter minimal inflows as they were mining Area 6 at Woodward. For mine planning purposes, these estimates do not consider the mitigative effects of backfilling to predicted inflow values and are reflective of worst-case scenarios.

8.0 WATER RIGHTS IMPACT ANALYSIS

Wenck researched, mapped, and analyzed water rights in the areas surrounding Woodward and Vanier for the purposes of assessing potential impacts of dewatering to nearby shallow wells. Based on data available information from the Oregon Water Resources Department's Well Report query tool, the results of this search were separated into two categories: (1) wells located within a one-half mile buffer of the Woodward/Vanier boundary and (2) wells located within a 1,000-foot buffer. Details on these wells are presented in **Table 3**, and both deep and shallow well locations are shown on **Figure 6.** Wells were categorized as 'shallow' if drilled or perforated above 40 feet, all other wells were considered 'deep'. Wells drilled and completed to a depth of 40 feet or shallower are of particular interest because they are completed in the same aquifer and similar depth as that being mined. Knife River's proposed mine plan includes resource extraction to a depth of 20 feet at Woodward and potentially 35 feet at Vanier. The distinction between shallow and deep wells was made based on the reported thickness of alluvial deposits by Robinson and Price in *Groundwater in the Prineville Area, Oregon* (1968). These alluvial deposits are separated from underlying sediments by thick layers of clay and silt (Robinson and Price, 1968) which are detected at the site by a low permeability, brown sandy clay unit. The presence of this unit is evidenced by well logs CROO-50140 (located in the Woodward plant area, **Figure 6**), CROO-53661, and the three test wells drilled at the southeastern edge of the Woodward property, to name a few. Water extraction from the overlying aquifer is expected to have little hydrogeologic impact on the underlying units.

To assess the potential effects of water mitigation to nearby shallow wells, Wenck used AquiferTest Pro 10.0 to conduct a simplified Theis analysis. Based on these modeling efforts, there is a possibility that nearby water rights could be affected. However, this analysis does not consider any mitigative actions taken by Knife River. In the section below, Wenck presents several mitigation approaches with the goal of protecting water rights in the vicinity of the mine. Furthermore, Wenck proposes an approach where Knife River will implement continuous monitoring strategies to assess the efficacy of their mitigation efforts.

9.0 RECOMMENDED WATER MANAGEMENT TO MITIGATE IMPACT TO ADJACENT WATER RESOURCES

Wenck, in conjunction with Knife River, proposes an adjustment to the Mine and Reclamation plan at both the Woodward and Vanier property. Currently the DOGAMI permit, and Crook County land use do not allow dewatering at the Woodward property.

Wenck believes the best approach to mining the final mining cells at Woodward will be to mine Area 9 as historically done, but to mine discrete cells within Area 10. The discrete mine cells should be oriented in a north-south direction. Once mining is completed, the overburden will be stripped from the new mine cell and used for backfilling at the adjacent mined out cell. The mine direction should start with the easternmost cell in Area 10 and progress west towards Area 9. This mining and backfilling approach will effectively "cut off" the upgradient inflow and divert groundwater flow to the south and north around the backfill. It may not "cut off" all groundwater but will significantly reduce groundwater inflow and the impact related to a dewatering approach as discussed in Section 8.0.

At the Vanier property, Wenck recommends Knife River request an increased depth of mining and the ability to dewater in their Goal V application to Crook County. The increased depth of mining will be required to completely mine the available resource. Wenck believes that pit dewatering and injection into a "recharge trench" will eliminate any impact to area groundwater resources. This protocol has been successfully implemented at numerous floodplain mines throughout Oregon and is a viable solution at Vanier. Wenck recommends that Knife River commence mining in the northeast corner of the Vanier Property (**Figure 4**, Area 1) and construct a recharge trench within Areas 4-7. Backfilling along the eastern property boundary is again recommended to seal off water and divert it to the south. A recharge trench is a linear feature that effectively pre-strips the overburden within these mine cells to the top of gravels. All dewatering from Areas 1-3 is pumped to this recharge trench. Two observation wells would be drilled within Areas 4-7 (**Figure 4**), which will include continuous monitoring using a downhole pressure transducer. These data would establish the efficacy of the recharge trench and its ability to balance dewatering with aquifer recharge. After mining is completed in Areas 1-3, a new recharge trench would be constructed south of Areas 4, 5 and 6 (**Figure 4**). Mining would continue throughout Areas 4-11 and a new observation well within Area 14 would characterize the efficacy of the approach.

In conclusion, dewatering of the mine cells at the Vanier property can be accomplished with minimal impact to nearby water rights. The use of recharge trenches is a proven method, and the installation of observation wells will minimize and/or eliminate the negative impacts of dewatering.

10.0 RECLAMATION CONSIDERATIONS

Wenck addressed post mining land use emphasizing the impacts of a high post mining water table on overlying soil and vegetative growth. Where alkaline and/or sodic soils are subjected to a high-water table, capillary rise will leach salts from below and transfer them to the rooting zone of plants. From an agronomic perspective, this leaching can have an adverse impact on crops. On January 18, 2021 Wenck collected three overburden samples from test hole WW-1A and one composite overburden sample from WW-2A. Sample analyses were completed by Pace Analytical in Sheridan, Wyoming. Parameters tested included grain size analysis, soil pH, Saturation Percentage, Sodium Absorption Ratio (SAR) and Exchangeable Sodium Percentage. Results from the chemical analysis performed on the soil samples were used to characterize the overburden, which would be used as reclamation backfill and placed below the salvaged topsoil. The results of these laboratory analyses are presented in **Appendix C**.

Sieve analysis data indicate the overburden material contains a mixture of silt and sand with some clay intermixed. The clay content ranged from 3 to 13% and silt generally averaged nearly 50%. Samples collected at WW-1A during drilling were separated into three intervals: 4 to 6 feet, 6 to 8 feet, and 10 to 12 feet bgs. The sample collected at WW-2A was composted 2 to 10 feet. Texture tended to increase (become finer) with depth. Sieve data collected at WW-2A can be summarized as follows: a median (D50) particle size of 0.071 mm or very fine sand. Forty six percent (46%) of the sample consisted of sand sized grains (the majority of which were fine grained) and 54% was dominated by silt and clay fraction material.

The agronomic suitability tests were generally favorable. While SAR increased with depth, all materials were suitable as a growth medium. SAR ranged from 1.06 at the surface to 2.09 at depth. Agronomic suitability ranged from 0 to 10. Soil pH were slightly alkaline and averaged 7.8 su. Electrical conductivity (EC), like SAR increased with depth. Again, EC met all suitability criteria (0-8) and there were no marginal characteristics of the overburden. It is important to note that the composite sample from WW-2A reflected the fact that the overburden could be composited with no detrimental change in agronomic suitability.

Based on the seven test pit logs at Vanier, Knife River will be removing approximately 15 feet of combined topsoil and overburden. Although the test pit logs do not differentiate between topsoil and silt (overburden), our field observations during the drilling of test wells at Woodward suggest topsoil may range from 2 to 4 feet. Reclamation will be vastly improved if Knife River were to strip and separately stockpile the topsoil from the overburden. For simplicity, Wenck recommends stripping 2 feet of topsoil. Overburden depth below the topsoil is variable and ranges from 6 to 18 feet. Overburden depths become shallower near the northwestern edge of the property, evidenced by VAN-3 and VAN-6, 9 and 6 feet, respectively. The anticipated pit floor elevation at the Vanier property is predicted to be relatively consistent with an average elevation of 2,900 feet. This suggests that the groundwater recovery elevation will average 2,910 to 2,915 feet across the site. Generally speaking, the water table will recover close to and within 5 feet of the reclaimed surface.

Assuming dewatering takes place as discussed in this report, mine cell backfill should take place in reverse order: overburden first and topsoil second. Selective handling of the overburden is not required and can be placed directly in the floor of the mine pit. Dewatering during backfilling is likely required, though less dewatering may be required as mining approaches the westernmost cell blocks. Once the overburden is placed, the uppermost overburden lift should be ripped and perhaps disked before placement of the topsoil. Topsoil can be placed directly on the overburden. Because sodium and SAR levels are reasonably low, Wenck is not concerned with the upward movement of salts. The final ground surface will be close to the recovery elevation of the groundwater and should be acceptable for growing hay and similar forage crops.

11.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our hydrogeologic investigation of the Woodward and Vanier properties, Wenck has the following conclusions and recommendations:

1. Knife River will continue to encounter groundwater in Area 10 at Woodward and throughout the Vanier property. Given the water table configuration and groundwater flow to the southwest, Knife River will find additional water is present in varying quantities to the east and depend upon local permeabilities and preferred groundwater flow paths.

2. Although the test wells did not yield significant volumes of groundwater, aquifer testing of these wells indicated the shallow aquifer has a relatively high permeability. Transmissivity values range from 2,215 and 9,195 gpd/ft, hydraulic conductivity values varied between 218 and 903 gpd/ft^2, and the storage coefficient was estimated to be 0.285. These values and water level recovery immediately following cessation of pumping suggest that the saturated sand and gravel beds are capable of yielding significant volumes of groundwater to individual mine blocks during dewatering operations. The amount of groundwater encountered will also vary with the saturated thickness of local sand and gravel deposits.

3. Potential groundwater inflows to Area 10 at Woodward range up to approximately 190 gpm for the whole mine block and 100 gpm for individual mine cells within this area. Lesser flows may be encountered, and modeling suggests these lesser flows may range from 15 to 50 gpm.

4. Potential groundwater inflows to Vanier range up to approximately 290 gpm on the eastern edge of the property and diminish to the west. Lesser flows may be encountered, and modeling suggests these lesser flows may range from 13 to 60 gpm.

5. In order to avoid dewatering at the Woodward property, Wenck recommends Knife River mine Area 10 using a backfill and plug method in north-south oriented mine blocks. This approach will minimize impact on area water rights.

6. To minimize the potential impacts to local water resources and water rights by mining the Vanier property, Wenck recommends Knife River establish recharge trenches and observation wells between the mine area and adjacent water rights. Assuming Crook County and DOGAMI approve mine dewatering at Vanier, reinjection should take place in a downgradient direction. Knife River can likely mine this area in the wet but dewatering for reclamation will likely be an ongoing need.

7. Should Knife River proceed with dewatering as described in this report, Wenck suggests backfilling mine cells by placing overburden first followed by topsoil. Overburden can be placed directly on the mine floor with negligible impacts to the soil as suggested by its favorable agronomic characteristics. Wenck recommends ripping and or/discing the surface of the overburden once it is placed to encourage root development post-reclamation. Stockpiled topsoil should be distributed across the reclaimed surface to best mimic pre-mining surface elevations. The final ground surface will be close to the recovery elevation of the groundwater but should be acceptable for growing hay and similar forage crops.

12.0 REFERENCES

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TABLES

Table 1. Groundwater Inflow Scenario at MiningCcell Area 10 for the Woodward Property

Mining Approach	Scenario	Hydraulic Conductivity (gpd/ft^2)	Radius of Influence (ft)	Estimated Inflow (gpm)
1, entire cell	1	218	1000	45.58
		903	1000	189.20
	2	218	4000	19.95
		903	4000	82.83
2, east-west, 66-foot-wide trenches	1	218	1000	30.57
		903	1000	99.97
	2	218	4000	15.73
		903	4000	58.55
3, north-south, 55-foot-wide trenches	1	218	1000	30.63
		903	1000	100.22
	2	218	4000	15.75
		903	4000	58.64

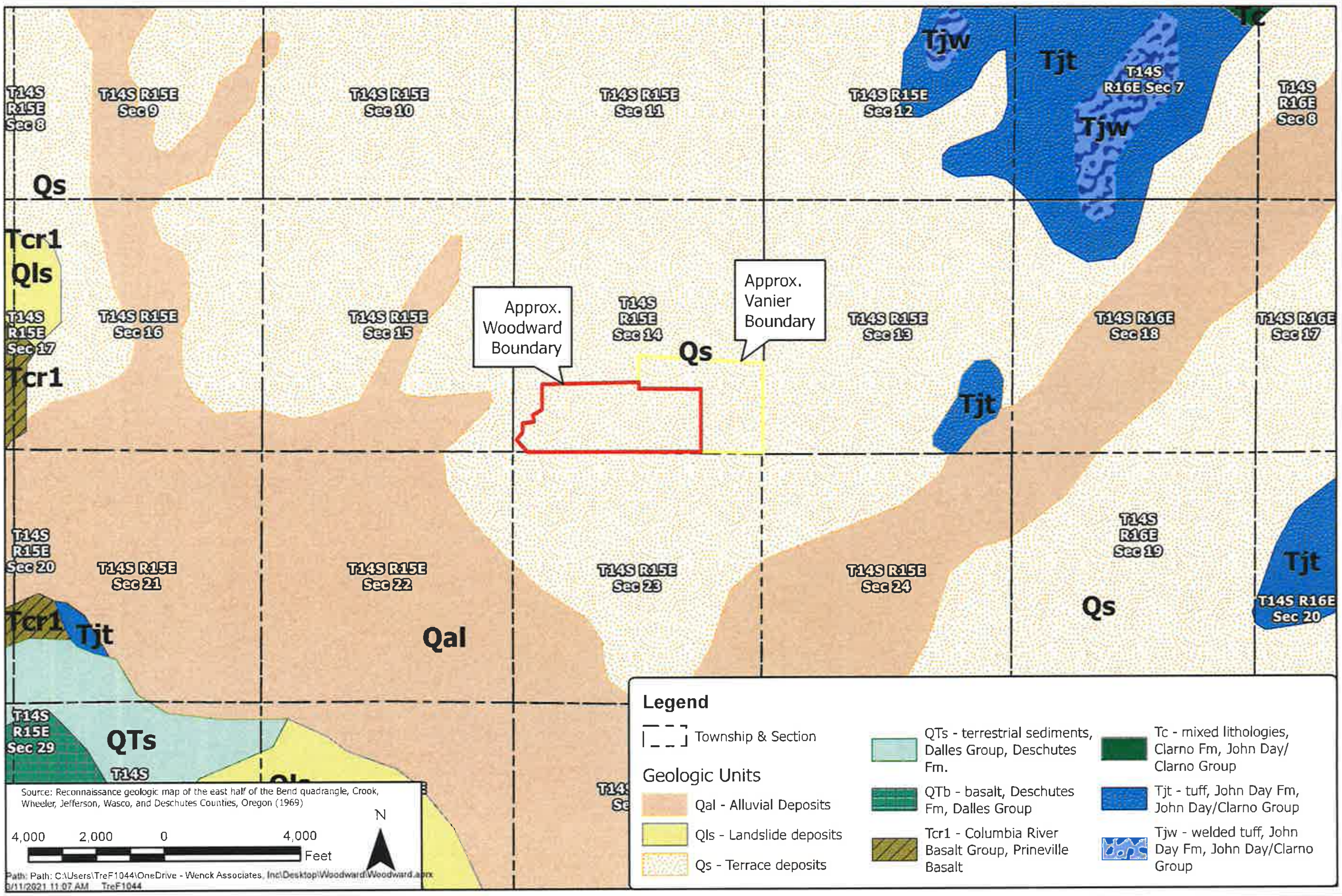
Table 2. Groundwater Inflow Scenario at the Vanier Property

Mining Cell	Scenario	Hydraulic Conductivity (gpd/ft²)	Radius of Influence (ft)	Estimated Inflow (gpm)	Mining Cell	Scenario	Hydraulic Conductivity (gpd/ft²)	Radius of Influence (ft)	Estimated Inflow (gpm)
Area 1	1	218	1000	54.9	Area 8	1	218	1000	69.4
		903	1000	228.2			903	1000	288.4
	2	218	4000	26.3		2	218	4000	33.9
		903	4000	109.5			903	4000	141
Area 2	1	218	1000	39.2	Area 9	1	218	1000	29.9
		903	1000	162.7			903	1000	124.4
	2	218	4000	20.4		2	218	4000	13.9
		903	4000	84.7			903	4000	58.1
Area 3	1	218	1000	43.2	Area 10	1	218	1000	33.19
		903	1000	179.5			903	1000	137.7
	2	218	4000	21.1		2	218	4000	15.5
		903	4000	87.64			903	4000	64.3
Area 4	1	218	1000	18.1	Area 11	1	218	1000	3.5
		903	1000	75.1			903	1000	14.5
	2	218	4000	9.4		2	218	4000	1.6
		903	4000	39.3			903	4000	6.8
Area 5	1	218	1000	65.1	Area 12	1	218	1000	35.5
		903	1000	270.2			903	1000	147.6
	2	218	4000	31.8		2	218	4000	17.4
		903	4000	132.3			903	4000	72.2
Area 6	1	218	1000	46.3	Area 13	1	218	1000	16.8
		903	1000	192.3			903	1000	70.1
	2	218	4000	22.7		2	218	4000	8.27
		903	4000	94.2			903	4000	34.33
Area 7	1	218	1000	15.4	Area 14	1	218	1000	51.34
		903	1000	63.9			903	1000	213.09
	2	218	4000	7.5		2	218	4000	25.15
		903	4000	31.2			903	4000	104.41

Table 3. Wells Within a One-Half Mile and 1000-foot Buffer of the Woodward and Vanier Property

Buffer from Woodward/Vanier Property Boundary	Well #	Owner Name	Primary Use	Tax Lot	Top of Perforations (ft bgs)	Completed Depth (ft bgs)	Township & Range	Section	Potential Adverse Impacts
1000-foot buffer	86	MRS WILLIS STAFFORD	Domestic	115	35	50	T14S R15E	23	Possible
	951	BEN KOOPS	Domestic	801	20	40	T14S R15E	15	Possible
	953	CARL SHUMWAY	Domestic	801	30	50	T14S R15E	15	Possible
	970	RAY FOX	Domestic	801	20	40	T14S R15E	15	Possible
	972	WILLIS STAFFORD	Domestic	801	35	50	T14S R15E	15	Possible
	977	ELMER SELF	Domestic	108	30	50	T14S R15E	23	Possible
	329	RON WILKINSON	Domestic	116	255	260	T14S R15E	23	Not Likely
	907	L M DAIRY	Domestic	--	235	257	T14S R15E	14	Not Likely
	915	ED HUNT	Domestic	103	220	220	T14S R15E	14	Not Likely
	931	LESLIE PAYNE	Domestic	602	225	235	T14S R15E	15	Not Likely
	946	RAY MCLAMB	Domestic	600	210	220	T14S R15E	15	Not Likely
	50140		Industrial	702	250	255	T14S R15E	14	Not Likely
	50577		Irrigation	112	175	275	T14S R15E	23	Not Likely
	53568	JOHN WOERNER	Domestic	102	200	300	T14S R15E	23	Not Likely
	53661	SCOTT PROFILEY	Domestic	701	240	260	T14S R15E	14	Not Likely
	54339	ADAM MIKULSKI	Domestic	114	100	281	T14S R15E	23	Not Likely
	54660	TAUNDY BYRD	Domestic	600	140	220	T14S R15E	15	Not Likely
	54787		Domestic	200	245	255	T14S R15E	23	Not Likely
One-half Mile	81	JOHN COLLIN	Domestic	202	30	45	T14S R15E	13	Possible
	82	JOHN MITTS	Domestic	1000	30	60	T14S R15E	15	Possible
	83	N L MATHEWS	Domestic	1200	31	50	T14S R15E	15	Possible
	86	MRS WILLIS STAFFORD	Domestic	115	35	50	T14S R15E	23	Possible
	900	ARNOLD EVANS	Domestic	202	40	60	T14S R15E	13	Possible
	903	JACK BRIGGS	<Null>	104	18	34	T14S R15E	14	Possible
	904	CECIL HARNDEN	Domestic	503	30	50	T14S R15E	14	Possible
	906	JOHN DEMERITT	Domestic	503	30	50	T14S R15E	14	Possible
	909	VIRGIL W SHARP	Domestic	809	30	50	T14S R15E	15	Possible
	912	JACK BRIGGS	UNKNOWN	1300	20	50	T14S R15E	15	Possible
	916	JOHN MITTS	Domestic	1000	40	60	T14S R15E	15	Possible
	918	DALE BANNON	Domestic	2500	40	60	T14S R15E	15	Possible
	923	JIM HALSEY	Domestic	1100	20	55	T14S R15E	15	Possible
	924	TIM COOLEY	Domestic	802	40	60	T14S R15E	15	Possible
	926	PHILLIP R POWELL	UNKNOWN	800	34	54	T14S R15E	15	Possible
	927	IRA O FINLEY	Domestic	804	40	60	T14S R15E	15	Possible
	934	JOHN G PRUNER	Domestic	2400	21	42	T14S R15E	15	Possible
	939	JERRY PAYNE	Domestic	600	31	51	T14S R15E	15	Possible
	940	LARRY CHAMBERLAIN	Domestic	900	35	50	T14S R15E	15	Possible
	941	LLOYD DYMOND	Domestic	500	34	50	T14S R15E	15	Possible
	942	BASAL TURNER	Domestic	802	40	60	T14S R15E	15	Possible
	945	DAVE TURNER	Domestic	200	35	55	T14S R15E	15	Possible
	951	BEN KOOPS	Domestic	400	20	40	T14S R15E	15	Possible
	952	RICHARD FULTON	Domestic	807	36	48	T14S R15E	15	Possible
	953	CARL SHUMWAY	Domestic	601	30	50	T14S R15E	15	Possible
	970	RAY FOX	Domestic	102	20	40	T14S R15E	23	Possible
	972	WILLIS STAFFORD	Domestic	116	35	50	T14S R15E	23	Possible
	977	ELMER SELF	Domestic	111	30	50	T14S R15E	23	Possible
	980	TOM PAYNE	Domestic	110	30	42	T14S R15E	23	Possible
	983	AL BUSTILLIO	Domestic	113	30	50	T14S R15E	23	Possible
	1001	CAL CATLETT	UNKNOWN	504	30	50	T14S R15E	24	Possible
	1002	GLENN A CHEEK	Domestic	501	34	48	T14S R15E	24	Possible
	51597	MARK FLEMING	Domestic	1900	40	60	T14S R15E	23	Possible
	51786	RHETT SHULTZ	Domestic	807	32	52	T14S R15E	15	Possible
	54367	MARK FLEMING	Domestic	1900	40	80	T14S R15E	23	Possible
	55017	--	Unknown	703	10	30	T14S R15E	14	Possible
	55018	--	Unknown	703	10	25	T14S R15E	14	Possible
	55019	--	Unknown	703	10	28	T14S R15E	14	Possible
	329	RON WILKINSON	Domestic	116	255	260	T14S R15E	23	Not Likely
	416	CARROL RICE	Domestic	503	60	82	T14S R15E	24	Not Likely
	438	GERALD L WHALEY	Domestic	809	196	206	T14S R15E	15	Not Likely
	458	WAYNE ROBISON	Domestic	700	192	200	T14S R15E	15	Not Likely
	460	W K TICHENOR	Domestic	1100	193	204	T14S R15E	15	Not Likely
	530	JERRY HILL	Domestic	300	220	230	T14S R15E	15	Not Likely
	548	CHARLES MERIDITH	Domestic	800	207	215	T14S R15E	15	Not Likely
	907	L M DAIRY	Domestic	--	235	257	T14S R15E	14	Not Likely
	910	BEN OWENS	Domestic	100	196	206	T14S R15E	15	Not Likely
	915	ED HUNT	Domestic	103	220	220	T14S R15E	14	Not Likely
	925	BIFFLY TURNER	Domestic	803	240	250	T14S R15E	15	Not Likely
	931	LESLIE PAYNE	Domestic	602	225	235	T14S R15E	15	Not Likely
	932	COLE STILL	Domestic	805	250	260	T14S R15E	15	Not Likely
	946	RAY MCLAMB	Domestic	600	210	220	T14S R15E	15	Not Likely
	947	--	Domestic	809	50	70	T14S R15E	15	Not Likely
	948	TERRY HILD	Domestic	801	55	75	T14S R15E	15	Not Likely
	955	M D COLAHAN	Domestic	801	210	210	T14S R15E	15	Not Likely
	974	FLOYD FITCH	Domestic	108	45	60	T14S R15E	23	Not Likely
	985	ERNEST E FORTNER	Irrigation	103	45	80	T14S R15E	23	Not Likely
	988	CLAUDE F WILLIAMS	Irrigation	405	298	320	T14S R15E	23	Not Likely
	993	CALVIN CATLETT	Domestic	502	50	62	T14S R15E	24	Not Likely
	3154	ROY PAZK	Domestic	808	180	210	T14S R15E	15	Not Likely
	3177	KEITH TAYLOR	Domestic	503	222	230	T14S R15E	14	Not Likely
	3252	GLEN HOPFER	Domestic	810	225	235	T14S R15E	15	Not Likely
	50140	--	Industrial	702	250	255	T14S R15E	14	Not Likely
	50576	--	Irrigation	200	250	<Null>	T14S R15E	23	Not Likely
	50577	--	Irrigation	112	175	275	T14S R15E	23	Not Likely
	50830	DONALD SHELTON	Domestic	900	220	230	T14S R15E	15	Not Likely
	50851	LEONARD CHANDLER	Domestic	200	235	<Null>	T14S R15E	15	Not Likely
	52281	ELSIE M SIMMONS	Domestic	402	220	325	T14S R15E	24	Not Likely
	52344	LAWRENCE E ADAMSON	Domestic	504	41	240	T14S R15E	24	Not Likely
	52453	KERMIT MCGREW	Domestic	100	65	335	T14S R15E	23	Not Likely
	53206	JULIE THOMPSON	Domestic	809	200	240	T14S R15E	15	Not Likely
	53346	DON WORTHING	Domestic	2400	232	232	T14S R15E	15	Not Likely
	53457	ILOMAE ZEHNER	Domestic	1100	190	260	T14S R15E	23	Not Likely
	53568	JOHN WOERNER	Domestic	102	200	300	T14S R15E	23	Not Likely
	53661	SCOTT PROFILEY	Domestic	701	240	260	T14S R15E	14	Not Likely
	54339	ADAM MIKULSKI	Domestic	114	100	281	T14S R15E	23	Not Likely
	54660	TAUNDY BYRD	Domestic	600	140	220	T14S R15E	15	Not Likely
	54787	--	Domestic	200	245	255	T14S R15E	23	Not Likely

FIGURES



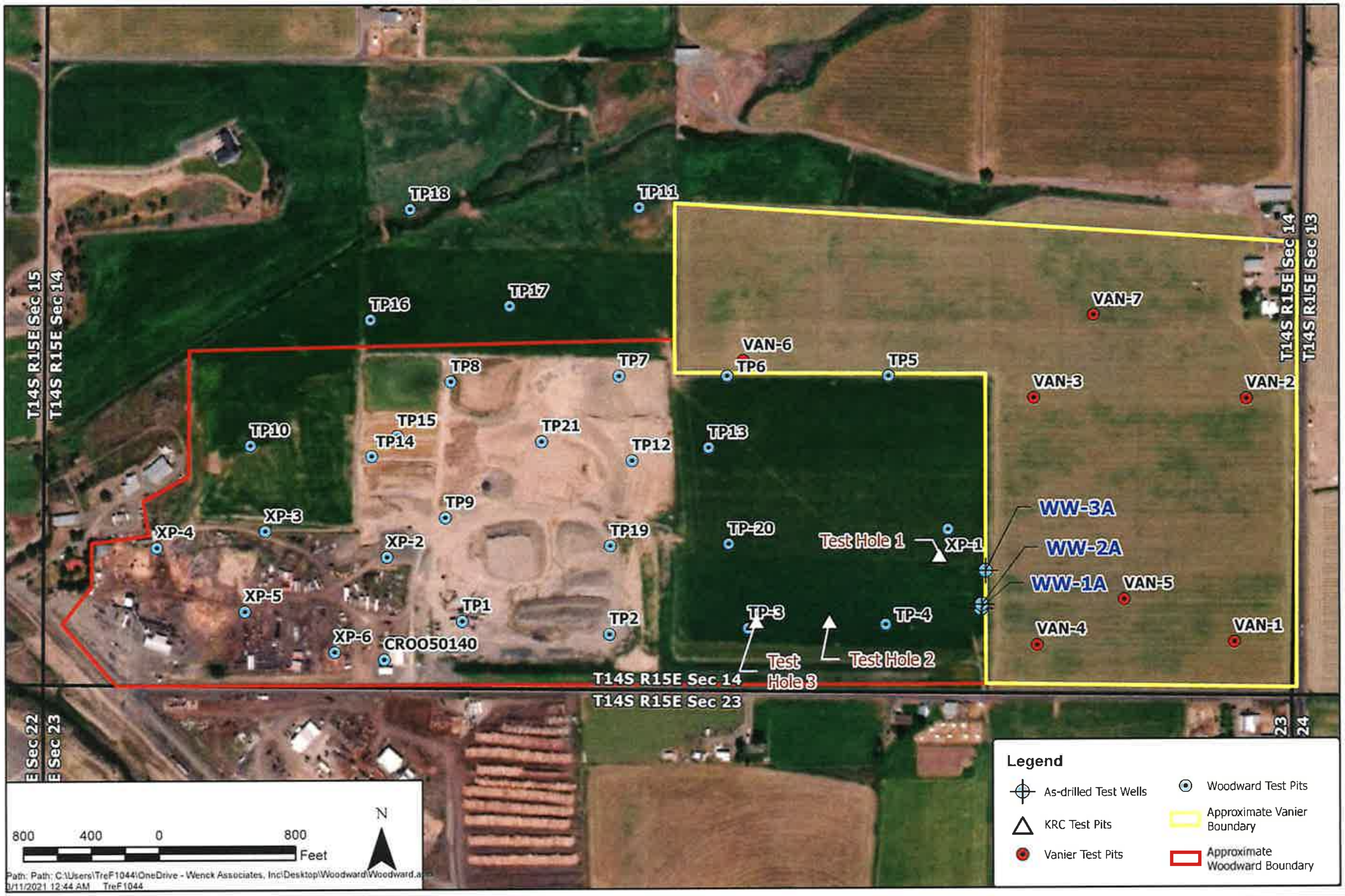
KNIFE RIVER

Geology near the Woodward and Vanier Property

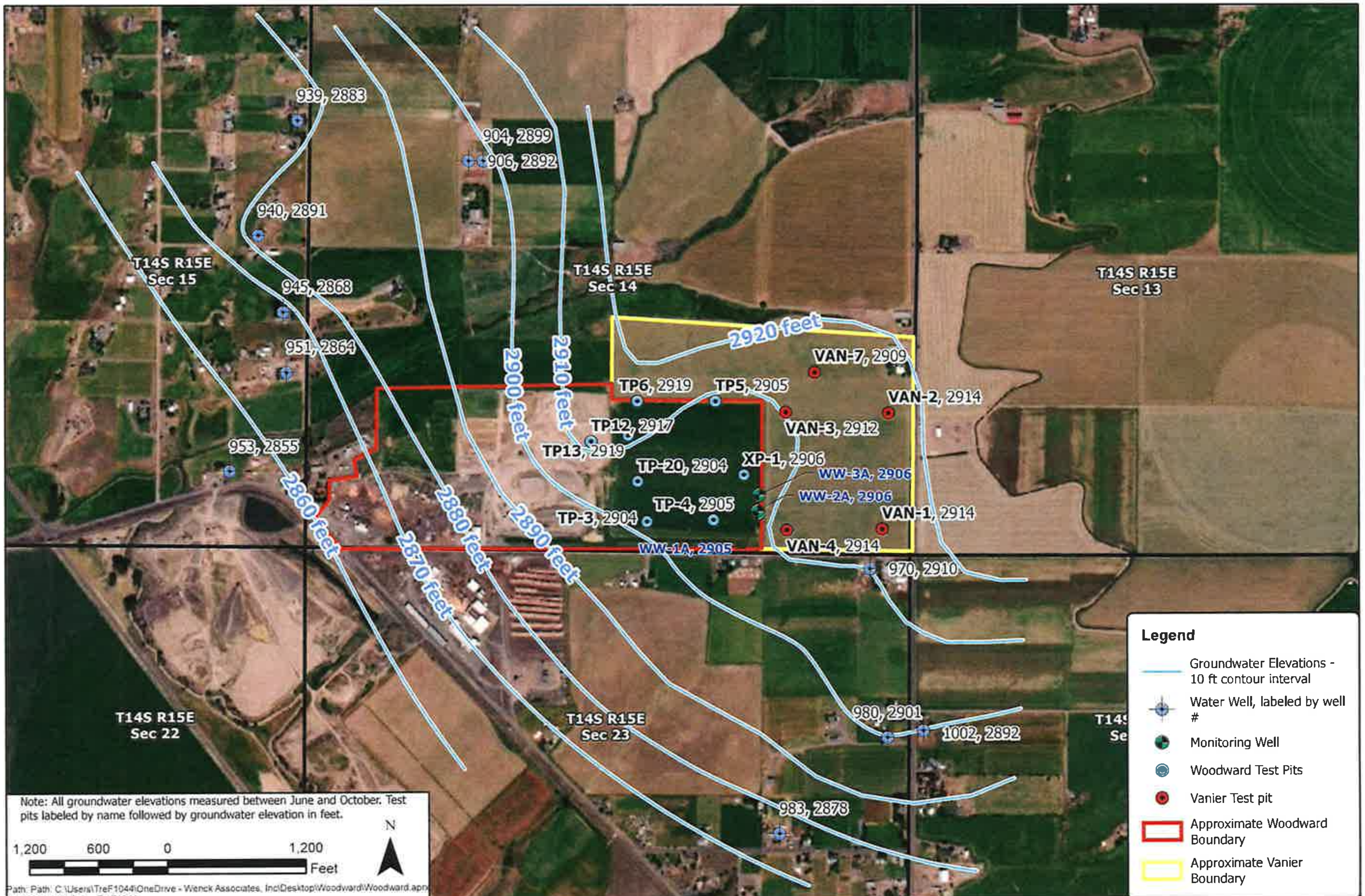
WENCK now part of Stantec

MAR 2021

Figure 1



KNIFE RIVER	WENCK now part of Stantec	MAR 2021
As-drilled Test Wells and Test Pits		Figure 2



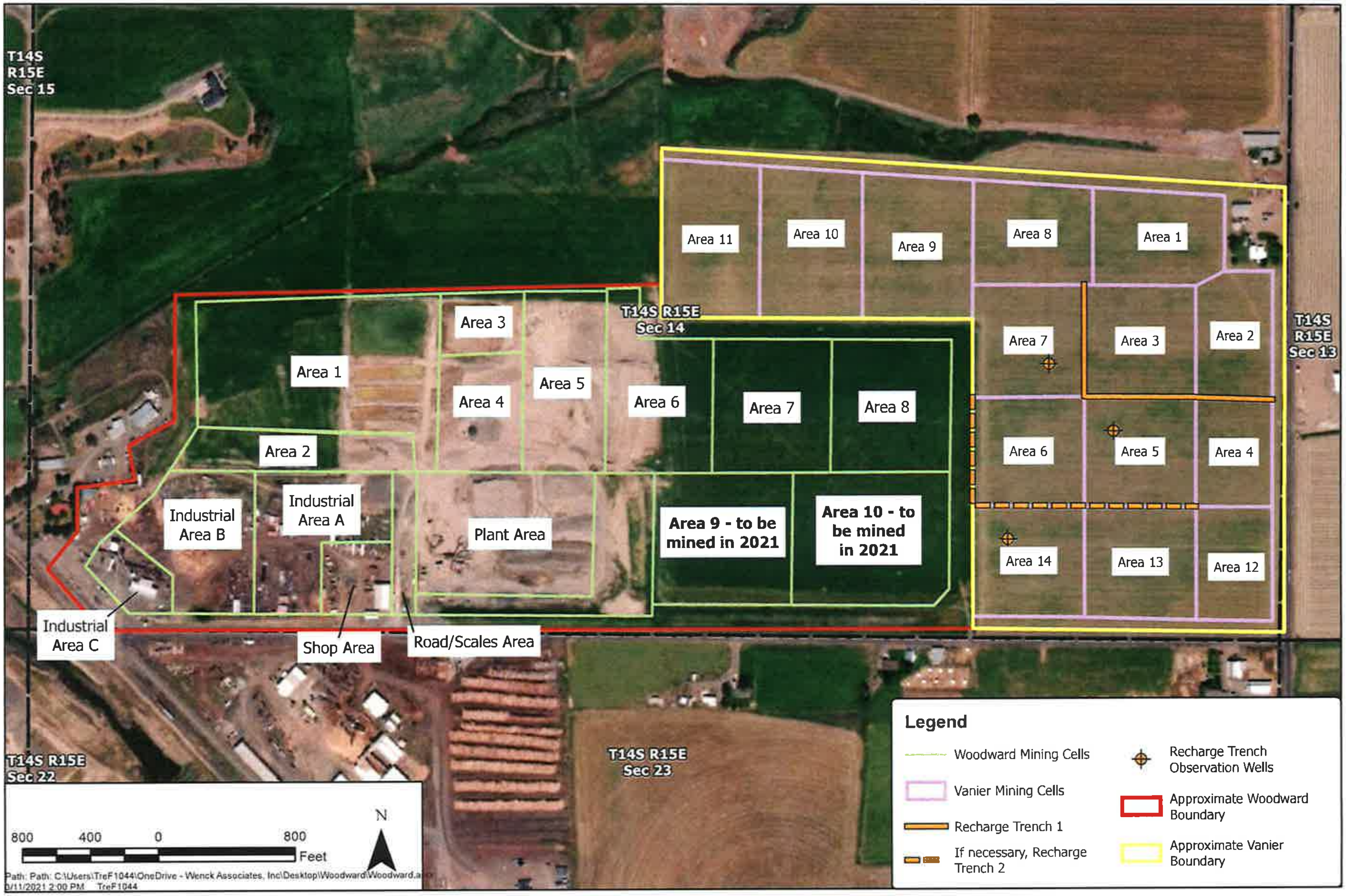
KNIFE RIVER

Groundwater Elevations - based on local well and test pit data

WENCK now part of Stantec

MAR 2021

Figure 3



KNIFE RIVER	WENCK now part of Stantec	MAR 2021
Woodward and Vanier Mining Cells		Figure 4

Mining Approach 1: Total Mine Block

Mining Approach 2: Trenches mined from East to West

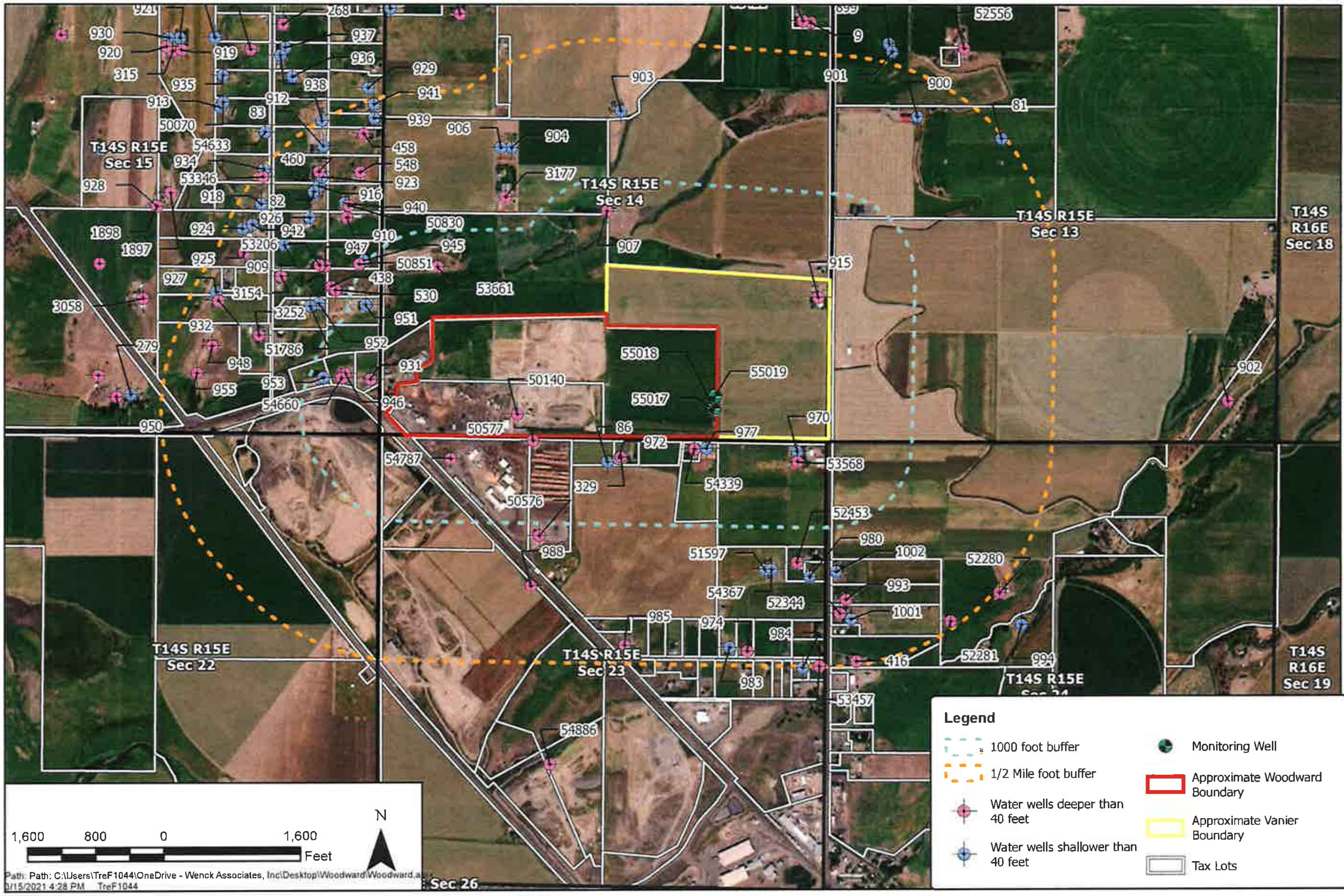
Mining Approach 3: Trenches mined from North to South

250 125 0 250 Feet N

Legend

- Woodward Mining Cells
- Approximate Woodward Boundary
- Approximate Vanier Boundary
- Vanier Mining Cells
- Township & Section

KNIFE RIVER	WENCK now part of Stantec	MAR 2021
Proposed Mining Approach - Inflow Analysis		Figure 5



KNIFE RIVER

Water Rights Within 1000- and 2,640-feet

WENCK now part of Stantec

MAR 2021

Figure 6

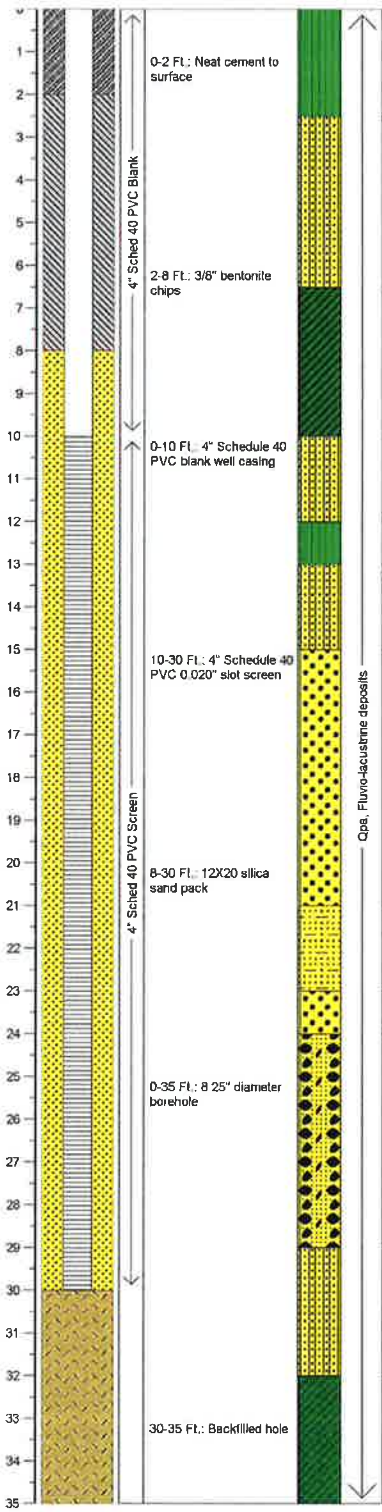
APPENDIX A

Well Completion Reports

Project:	Woodward	Well Name:	WW-1A
Location:	44.34941°, -120.89169°	Drilling Method:	Sonic
Drilled by:	Yellow Jacket Drilling Services	Logged by:	F. Tremblay
Date started:	1/18/2021	Total depth:	35 Ft.
Date completed:	1/18/2021	Elevation:	2928 Ft.

WENCK now part of Stantec

Depth (feet)	Well Construction	Lithology	Remarks



0-3 Ft.: **SILT W/ SAND (ML)**: dark brown, rooted and moist with some organic content to 1.5', dries out below, fine sand well graded sand, low plasticity, somewhat cohesive, carbonate concretions at 3', silt is very carbonaceous, trace amounts of gravel at 4'

3-7 Ft.: **SILTY SAND (SM):** brown, medium to low plasticity, dry, fine sand in a carbonaceous silt, massive, carbonaceous concretions, sand is well sorted, poorly graded, platy structure and consolidated at 5', slightly to very carbonaceous, 0.25-0.5" bedding

7-10 Ft.: **FAT CLAY (CH):** brown, high plasticity, little to no coarse sediments, platy, medium to dense, cohesive, thinly bedded, non to slightly carbonaceous, 12" layer of medium grained poorly sorted sand at 8.5', some trace gravel, subrounded, back to clay at 9.5'

10-12 Ft.: **SILTY SAND (SM):** loose, moist, fine to medium grained sand, non plastic, noncohesive, blocky and semiconsolidated to 11', granular and unconcolidated below that, trace gravel ~1 cm in diameter

Remarks: Water level measured at 20.73 feet bgs on 1/19/2021.

12-13 Ft.: **SILT W/ SAND (ML):** brown, fine sand in a calcareous silt, loose, low to medium plasticity, cohesive, granular, brittle carbonaceous concretions, very carbonaceous

13-15 Ft.: **SILTY SAND (SM)**: noncalcareous, similar to 10-12' interval, moist, silt content decreases below 14', medium sorted, medium grained, sub rounded, noncalcareous, trace amounts of gravel ~1cm diameter

15-21 Ft.: **WELL GRADED SAND W/ SAND (SW):** brown, loose to medium dense, moist, nonplastic, noncohesive, granular, gravel between 0.5-1.5" in diameter, subrounded, 20-30%, gravel content decreases below 18', silty sand dominates below 19', noncalcareous

21-23 Ft.: **WELL GRADED SAND W/ SILT & GRAVEL (SW-SM):** loose, dry, fine sand in a calcareous silt, low plasticity, granular, gravel conetent 15-20%, 0.5-2" diameter

23-24 Ft.: **WELL GRADED SAND W/ GRAVEL (SW):** loose, moist, medium grained sand, nonplastic, noncohesive, granular

24-29 Ft.: **WELL GRADED GRAVEL W/ SAND (GW):** some silt and medium grained sand, gravel between 0.5-3" in diameter, well rounded, wet, sand and silt below 27', mostly gravel, sharp contact with clay layer below

29-32 Ft.: **SILTY SAND (SM):** wet, fine sand in a noncalcareous silt, gravel is gone, low to medium plasticity, massive, silt sontent increases significantly below 30', blocky, sand gone below 32'

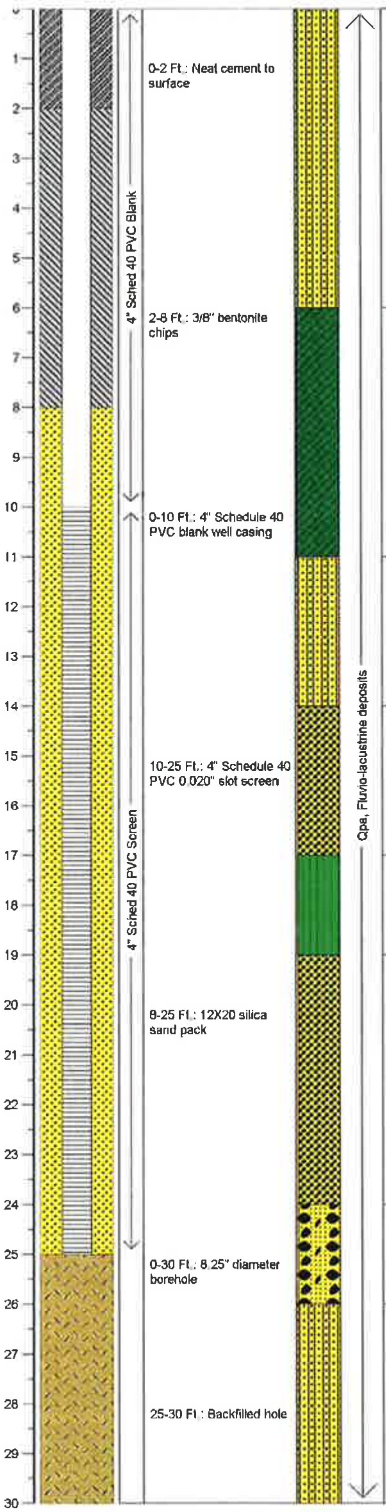
32-35 Ft.: **LEAN CLAY (CL):** wet, medium plasticity, little to no coarse sediments

Notes: This figure presents the as-built details for WW-1A located near Knife River's ISR Woodward Property in the SESW of Section 14 of T14S, R15E. This well was drilled and completed by Yellow Jacket Drilling Services of Sandy, OR using sonic drilling methods to assess shallow subsurface alluvial groundwater. Upon completion, the well was developed for three hours via surge block and pumping techniques. Water quality parameters at the end of development were as follows: pH=7.63; EC=571 uS; and T= 11.7 degrees Celsius.

WENCK now part of Stantec

Project:	Woodward	Well Name:	WW-2A
Location:	44.349494°, -120.891692°	Drilling Method:	Sonic
Drilled by:	Yellow Jacket Drilling Services	Logged by:	F. Tremblay
Date started:	1/18/2021	Total depth:	30 Ft.
Date completed:	1/18/2021	Elevation:	2930 Ft.

Depth (feet) | Well Construction | Lithology | Remarks



Lithology:

0-6 Ft.: **SILTY SAND (SM)**: rooted from 0-1', moist form surface moisture, fine well sorted sand, medium plasticity, carbonate concretions at 2', silt is calcareous from 2-5', clay content increases below 2-5'

6-11 Ft.: **LEAN CLAY W/ SAND (CL)**: moist at 6', platy, medium plasticity, carbonate leaching, trace fine sand, calcite content decreases below 5', coincides with fine sand increase between 5-7', increases again between 10-11', platy carbonate concretions

11-14 Ft.: **SILTY SAND (SM)**: low plasticity, non calcareous, granular, moist, fine to medium grained sand, silt between 12-13', decreases below 13'

14-17 Ft.: **POORLY GRADED SAND W/ GRAVEL (SP)** moist, granular, nonplastic, noncohesive, medium grained sand, gravel content 10-15% between 14-15', 0.5-1" diameter, gravel decreases from 15-16'

17-19 Ft.: **SANDY SILT (ML)**: moist, calcareous, medium plasticity, cohesive, some trace gravel, trace roots, massive

19-24 Ft.: **POORLY GRADE SAND W/ GRAVEL (SP)**: D.O. as 14-17', gravel content low from 20-21.5', noncalcareous

24-26 Ft.: **WELL GRADED GRAVEL W/ SAND (GW)**: medium to coarse sand, trace silts, gravel betwene 0.5-3" in diameter, well rounded, wet, sharp contact with unit below

26-30 Ft.: **SILTY SAND (SM)**: wet, medium to low plasticity, cohesive, noncalcareous, clay content increases with depth, prismatic, sand is fine grained and well sorted

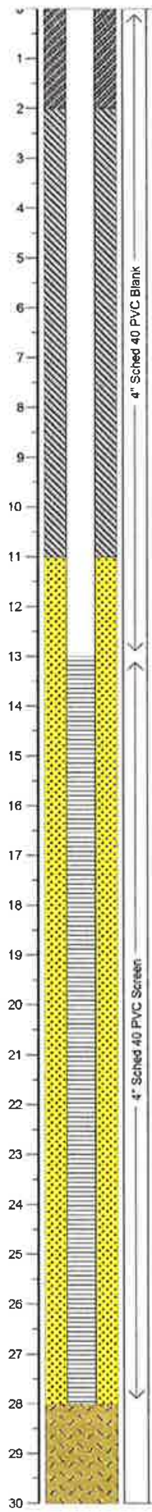
Remarks: Water level measured at 21.35 feet bgs on 1/21/2021.

Notes: This figure presents the as-built details for WW-2A located near Knife River's Woodward Property in the SESE of Section 14 of T14S, R15E. This well was drilled and completed by Yellow Jacket Drilling Services of Sandy, OR using sonic drilling methods to assess shallow subsurface alluvial groundwater. Upon completion, the well was developed for two hours via surge block and pumping techniques. Water quality parameters at the end of development were as follows: pH=7.58; EC=598 uS; and T= 13.1 degrees Celsius.

WENCK now part of Stantec

Project:	Woodward	Well Name:	WW-3A
Location:	44.349629°, -120.891684°	Drilling Method:	Sonic
Drilled by:	Yellow Jacket Drilling Services	Logged by:	F. Tremblay
Date started:	1/20/2021	Total depth:	30 Ft.
Date completed:	1/20/2021	Elevation:	2929 Ft.

Depth (feet)	Well Construction	Lithology	Remarks



0-2 Ft.: Neat cement to surface

2-11 Ft.: 3/8" bentonite chips

0-13 Ft.: 4" Schedule 40 PVC blank well casing

11-28 Ft.: 12X20 silica sand pack

13-28 Ft.: 4" Schedule 40 PVC 0.020" slot screen

0-30 Ft.: 8.25" diameter borehole

28-30 Ft.: Backfilled hole

0-11 Ft.: **SILT W/ SAND (ML):** overburden, rooted and moist with some organic content to 1.5', fine well sorted sand, clay content increases below 6', moist at contact

11-14 Ft.: **SILTY SAND (SM)**: fine to medium grained sand with occasionally calcareous silt, semiconsolidate, trace amounts of gravel <1cm in diameter, some carbonate concretions

14-24 Ft.: **POORLY GRADED SAND W/ GRAVEL (SP):** moist, granular, coarsens with depth, nonplastic and noncohesive, medium grained well sorted sand, gravel is 0.5-1" in diameter, some medium plasticity sandy silt zones from 19-20'

24-28 Ft.: **WELL GRADED GRAVEL W/ SAND (GW):** medium to coarse grained sand, trace silt, well rounded poorly sorted gravel, 0.5-3.5" in diameter

28-30 Ft.: **SILY SAND (SM):** fine grained well sorted sand in silt, wet, blocky, well consolidated, noncalcareous, clay content increases with depth

Remarks: Water level measured at 17.5 feet bgs on 1/21/2021.

Notes: This figure presents the as-built details for WW-3A located near Knife River's Woodward Property in the SESE of Section 14 of T14S, R15E. This well was drilled and completed by Yellow Jacket Drilling Services of Sandy, OR using sonic drilling methods to assess shallow subsurface alluvial groundwater. Upon completion, the well was developed for 3 hours via surge block and pumping techniques. Water quality parameters at the end of development were as follows: pH=7.62; EC=338 uS; and T= 12.1 degrees Celsius.

APPENDIX B

Aquifer Testing Results

WENCK now part of Stantec

Site Plan	
Project:	Woodward/Vanier
Number:	ORKRC131
Client:	Knife River

Location: Prineville, OR | Scale 1:15000 | Origin [ft] X: -44158581.68 Y: 18105011.59

WENCK now part of Stantec

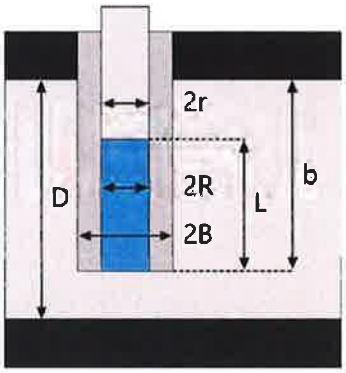
Wells

Project: Woodward/Vanier

Number: ORKRC131

Client: Knife River

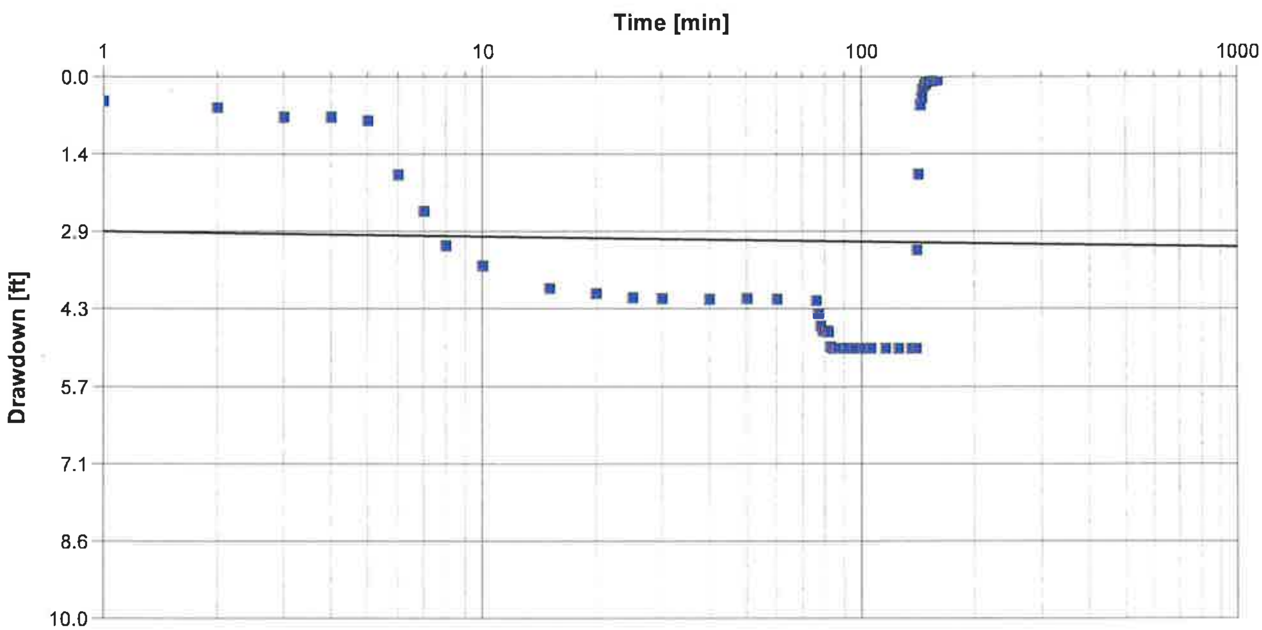
Location: Prineville, OR



	Name	X [ft]	Y [ft]	Penetration	L [ft]	B [ft]
1	WW-1A	-44152234.44	18109169.95	Fully	9.44	0.1875
2	WW-2A	-44152222.87	18109192.92	Fully	3.65	0.1875
3	WW-3A	-44152207.21	18109393.05	Fully	10.5	0.1875
4	Model Well 1	-44152940.6	18109415.6	Fully		
5	Model Well 2	-44152475.59	18109412.52	Fully		
6	Model Well 3	-44152934.42	18109027.72	Fully		
7	Model Well 4	-44152474.64	18109026.03	Fully		
8	Model Well 1v	-44151324.5808825	18110899.7479265	Fully		
9	Model Well 2v	-44150921.9945013	18111157.9736089	Fully		
10	Model Well 3v	-44151307.7736089	18111183.1804331	Fully		
11	Model Well 4v	-44150950.5867802	18110893.3731714	Fully		

WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Step Test	Pumping Well: WW-1A
Test Conducted by: FT		Test Date: 1/19/2021
Analysis Performed by: FT	WW-1A Step 1: Cooper-Jacob	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.8821 [U.S. gal/min]	

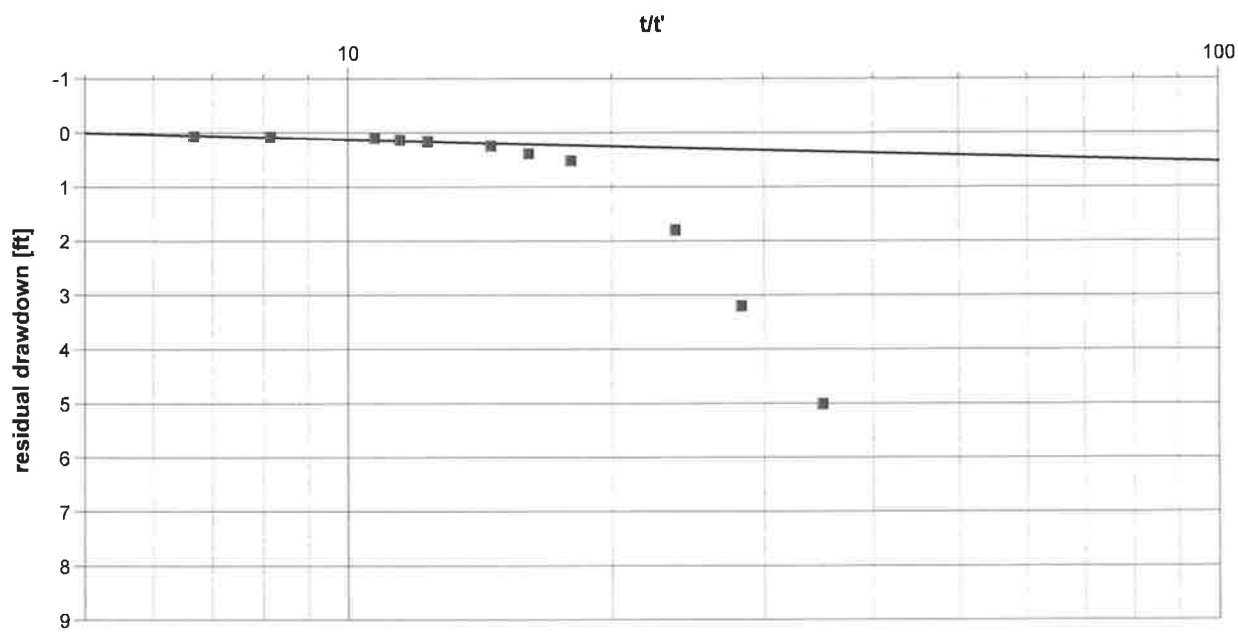


Calculation using COOPER & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Storage coefficient	Radial Distance to PW [ft]	
WW-1A	5.33×10^{3}	5.23×10^{2}	1.00×10^{-29}	0.17	

WENCK now part of Stantec	**Pumping Test Analysis Report**
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Step Test	Pumping Well: WW-1A
Test Conducted by: FT		Test Date: 1/19/2021
Analysis Performed by: FT	WW-1A Step Test Theis Recovery	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.8821 [U.S. gal/min]	

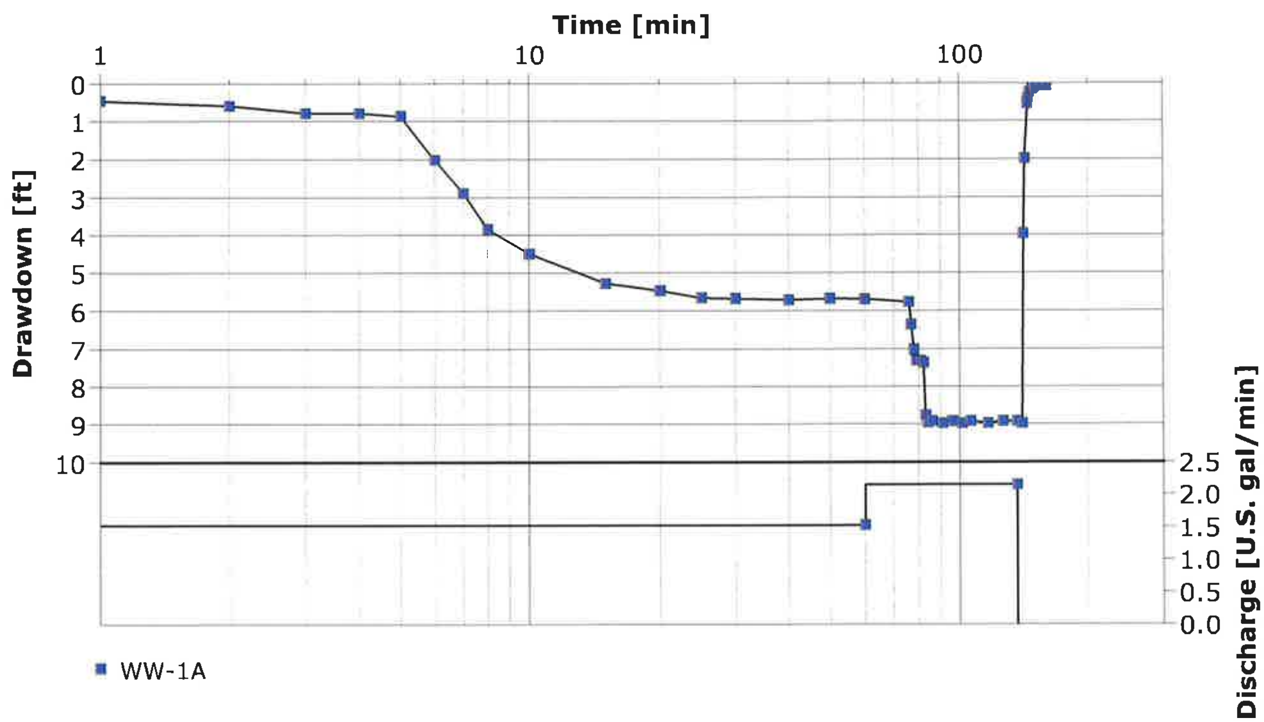


Calculation using THEIS & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Radial Distance to PW [ft]	
WW-1A	1.22×10^3	1.20×10^2	0.17	

WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Step Test	Pumping Well: WW-1A
Test Conducted by: FT		Test Date: 1/19/2021
Analysis Performed by: FT	WW-1A Step Test Time-Drawdown	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.8821 [U.S. gal/min]	



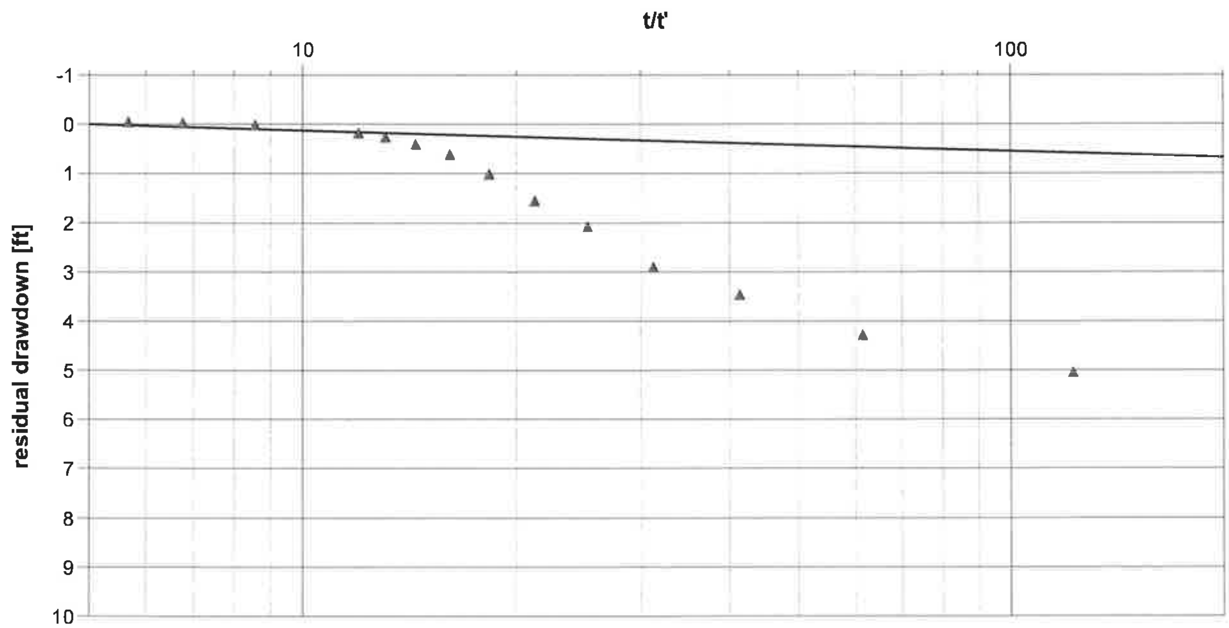
WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Step Test	Pumping Well: WW-1A
Test Conducted by: FT		Test Date: 1/19/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.8821 [U.S. gal/min]	

	Analysis Name	Method name	Well	T [U.S. gal/d-ft]	K [U.S. gal/d-ft²]	S
1	WW-1A Step 1: Cooper-Jaco	Cooper & Jacob I	WW-1A	5.33×10^{3}	5.23×10^{2}	1.00×10^{-29}
2	WW-1A Step Test Theis Rec	Theis Recovery	WW-1A	1.22×10^{3}	1.20×10^{2}	

WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-3A Step Test	Pumping Well: WW-3A
Test Conducted by: FT		Test Date: 1/21/2021
Analysis Performed by: FT	WW-3A Step Test Theis Recovery	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.4911 [U.S. gal/min]	

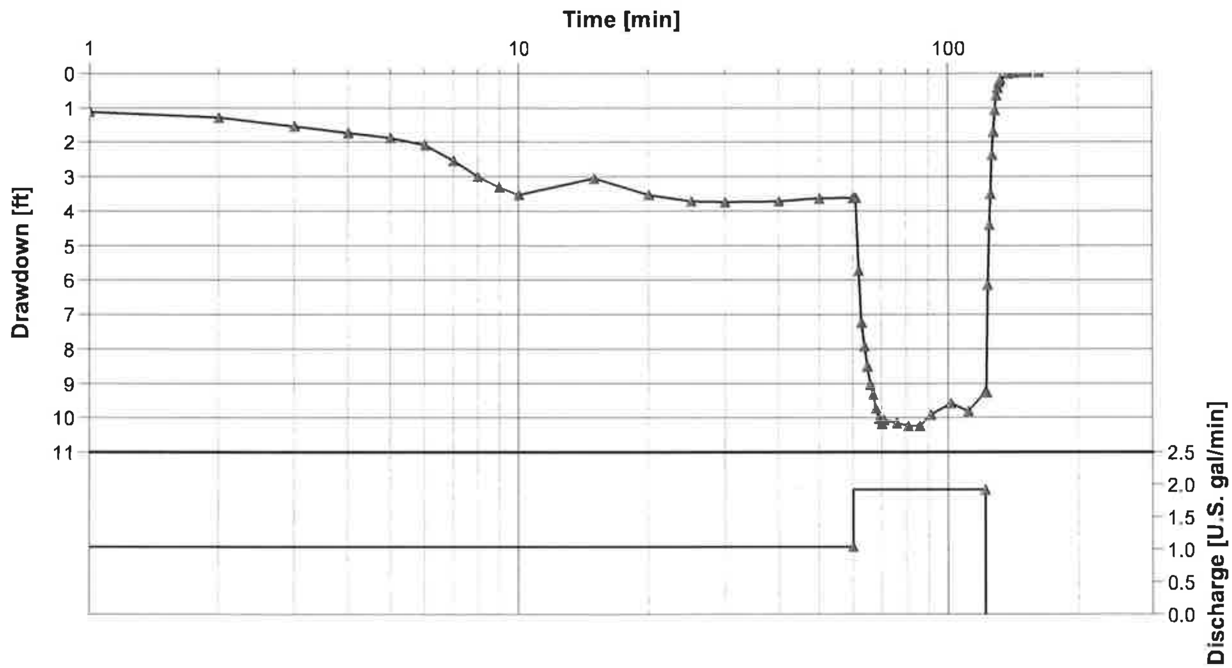


Calculation using THEIS & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Radial Distance to PW [ft]	
WW-3A	9.34×10^{2}	9.17×10^{1}	0.17	

WENCK now part of Stantec	**Pumping Test Analysis Report**
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-3A Step Test	Pumping Well: WW-3A
Test Conducted by: FT		Test Date: 1/21/2021
Analysis Performed by: FT	WW-3A Step Test Time-Drawdown	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.4911 [U.S. gal/min]	



WENCK

now part of

Stantec

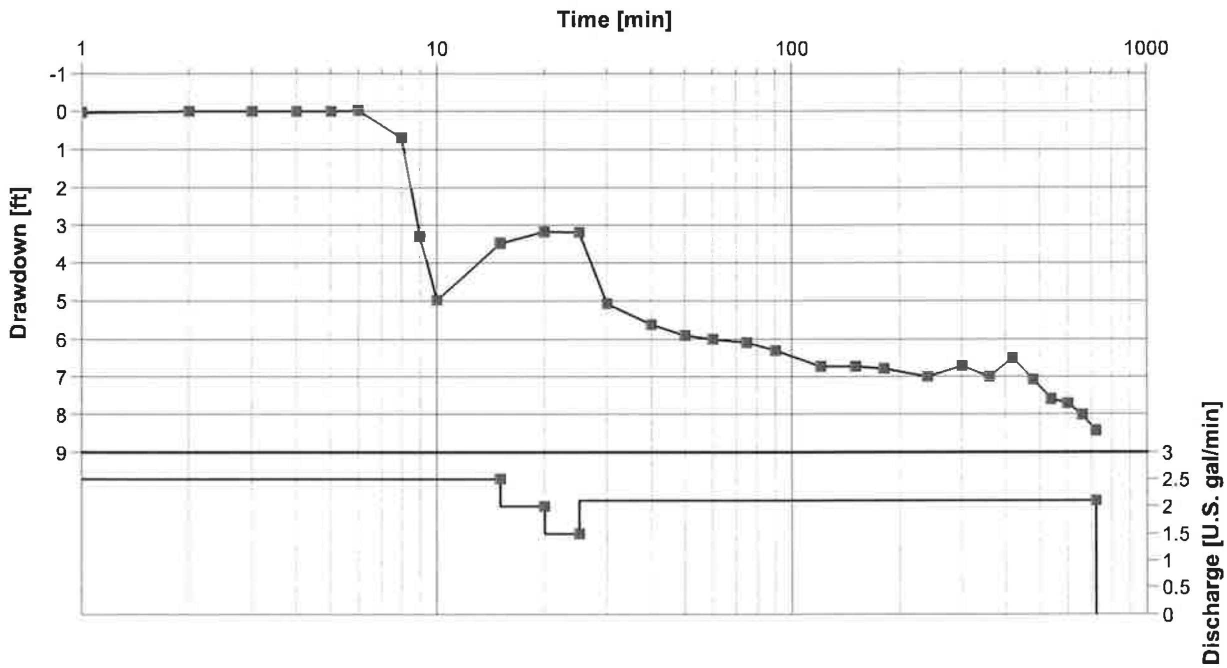
Pumping Test Analysis Report	
Project: Woodward/Vanier	
Number: ORKRC131	
Client: Knife River	

Location: Prineville, OR	Pumping Test: WW-3A Step Test	Pumping Well: WW-3A
Test Conducted by: FT		Test Date: 1/21/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 1.4911 [U.S. gal/min]	

	Analysis Name	Method name	Well	T [U.S. gal/d-ft]	K [U.S. gal/d-ft²]	S
1	WW-3A Step Test Theis Rec	Theis Recovery	WW-3A	9.34×10^2	9.17×10^1	

WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

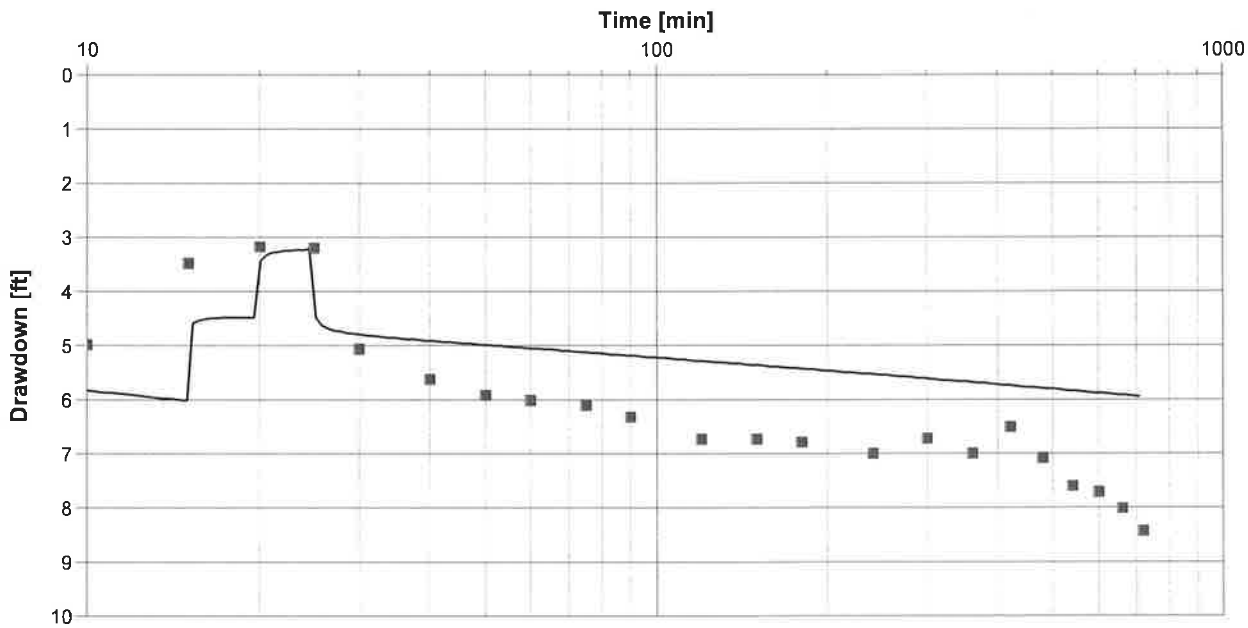
Location: Prineville, OR	Pumping Test: WW-1A Constant Rate	Pumping Well: WW-1A
Test Conducted by:		Test Date: 1/20/2021
Analysis Performed by: FT	WW-1A Constant Rate Time-drawdown	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.1035 [U.S. gal/min]	



WENCK now part of Stantec

Pumping Test Analysis Report	
Project:	Woodward/Vanier
Number:	ORKRC131
Client:	Knife River

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate	Pumping Well: WW-1A
Test Conducted by:		Test Date: 1/20/2021
Analysis Performed by: FT	WW-1A Constant Rate: Theis w/ Jacob Correction	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.1035 [U.S. gal/min]	



Calculation using Theis with Jacob Correction

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Storage coefficient	Radial Distance to PW [ft]	
WW-1A	1.43×10^{3}	1.41×10^{2}	1.00×10^{-7}	0.17	

WENCK
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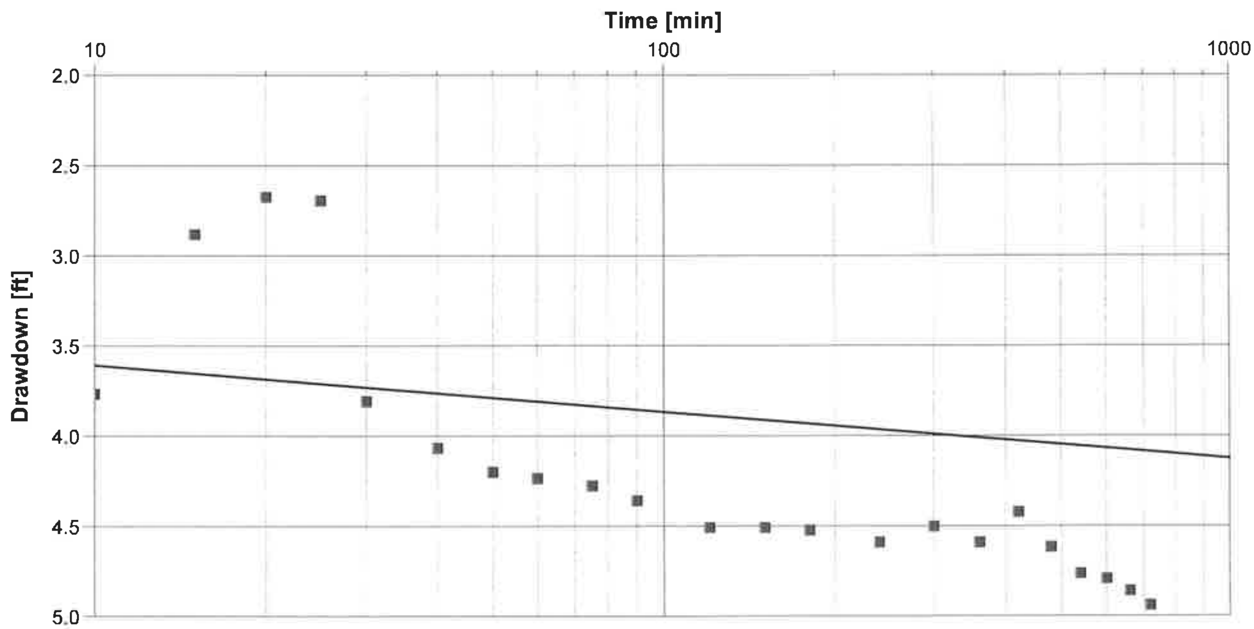
Stantec

	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate	Pumping Well: WW-1A
Test Conducted by:		Test Date: 1/20/2021
Analysis Performed by: FT	WW-1A Constant Rate: Cooper-Jacob	Analysis Date: 2/9/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.1035 [U.S. gal/min]	



Calculation using COOPER & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Storage coefficient	Radial Distance to PW [ft]	
WW-1A	2.16×10^{3}	2.12×10^{2}	1.52×10^{-12}	0.17	

WENCK

now part of

Stantec

Pumping Test Analysis Report		
Project: Woodward/Vanier		
Number: ORKRC131		
Client: Knife River		
Location: Prineville, OR	Pumping Test: WW-1A Constant Rate	Pumping Well: WW-1A
Test Conducted by:		Test Date: 1/20/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.1035 [U.S. gal/min]	

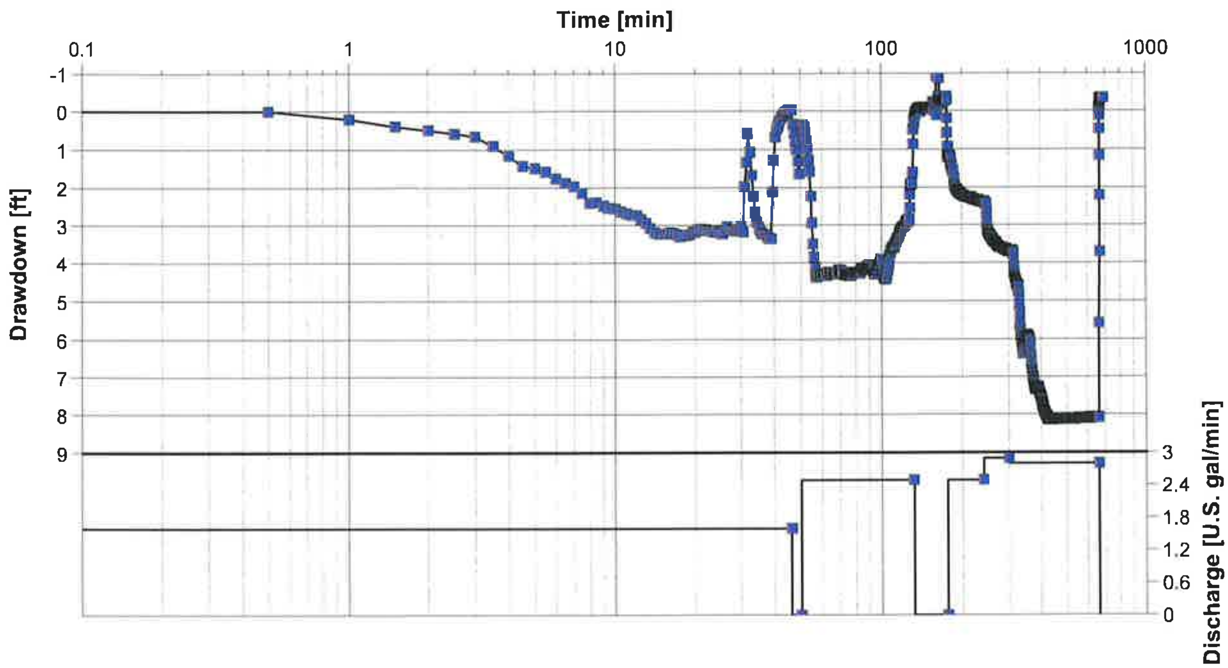
	Analysis Name	Method name	Well	T [U.S. gal/d-ft]	K [U.S. gal/d-ft²]	S
1	WW-1A Constant Rate: The	sTheis with Jacob Correction	WW-1A	1.43×10^{3}	1.41×10^{2}	1.00×10^{-7}
2	WW-1A Constant Rate: Coo	pCooper & Jacob I	WW-1A	2.16×10^{3}	2.12×10^{2}	1.52×10^{-12}

WENCK

now part of

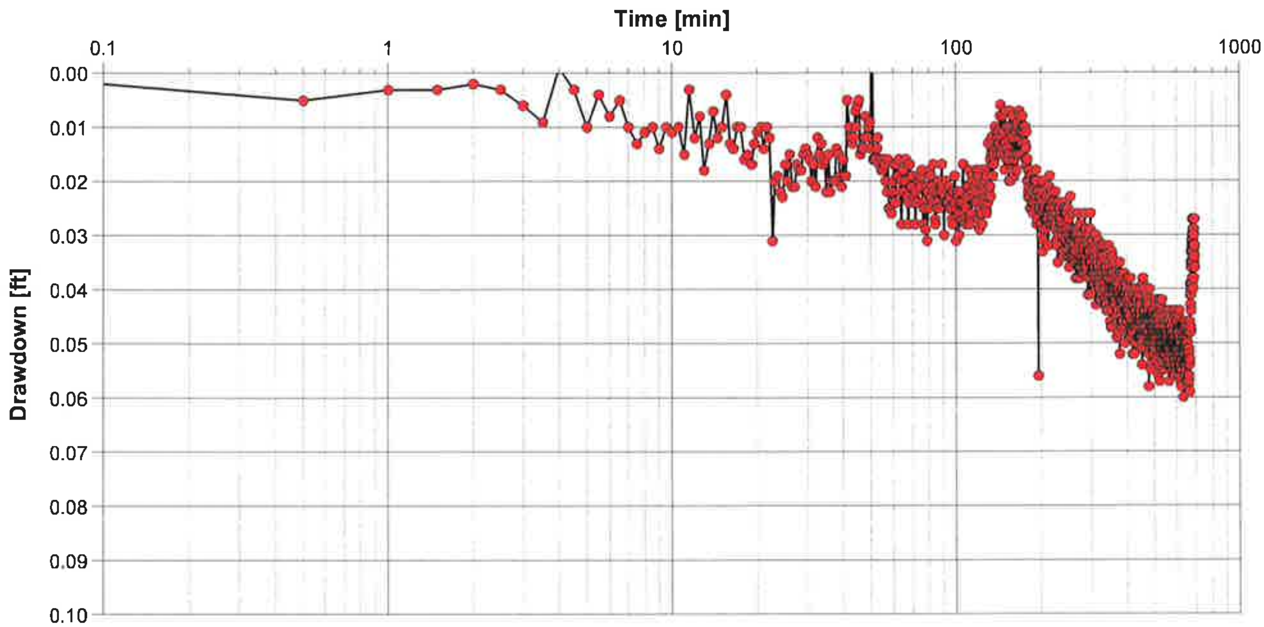
Stantec

Pumping Test Analysis Report		
Project: Woodward/Vanier		
Number: ORKRC131		
Client: Knife River		
Location: Prineville, OR	Pumping Test: WW-1A Constant Rate Re-Test	Pumping Well: WW-1A
Test Conducted by: F. Tremblay		Test Date: 1/22/2021
Analysis Performed by: FT	WW-1A Constant Rate Re-Test Time-drawdown	Analysis Date: 2/15/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.4538 [U.S. gal/min]	



WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate Re-Test	Pumping Well: WW-1A
Test Conducted by: F. Tremblay		Test Date: 1/22/2021
Analysis Performed by: FT	WW-2A Constant Rate Re-Test Time-Drawdown	Analysis Date: 2/15/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.4538 [U.S. gal/min]	



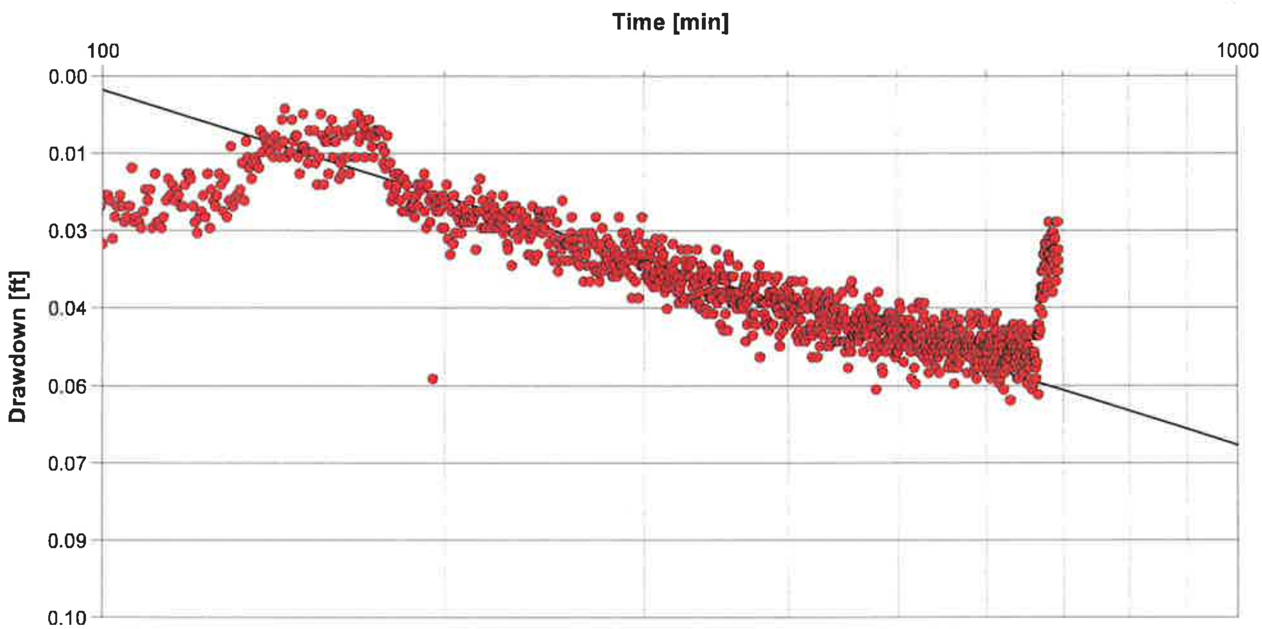
WENCK

now part of

Stantec

Pumping Test Analysis Report	
Project: Woodward/Vanier	
Number: ORKRC131	
Client: Knife River	

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate Re-Test	Pumping Well: WW-1A
Test Conducted by: F. Tremblay		Test Date: 1/22/2021
Analysis Performed by: FT	WW-2A Cooper-Jacob 2	Analysis Date: 2/15/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.4538 [U.S. gal/min]	

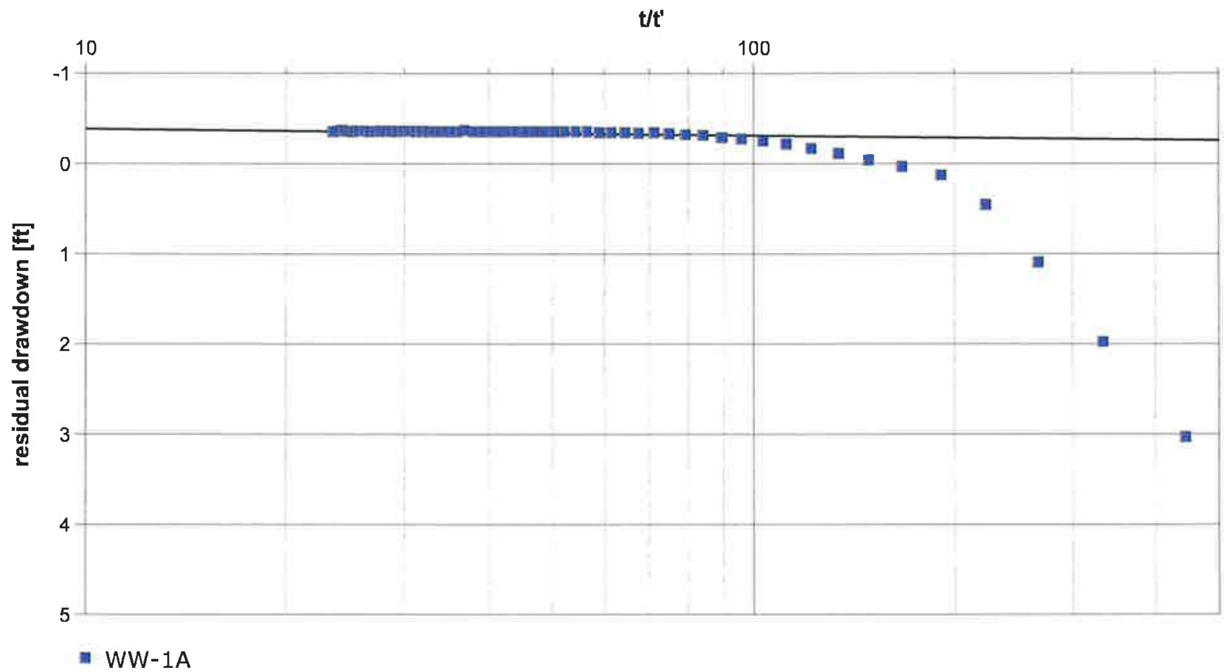


Calculation using COOPER & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Storage coefficient	Radial Distance to PW [ft]	
WW-2A	9.84×10^{3}	9.67×10^{2}	2.85×10^{-1}	25.72	

WENCK now part of Stantec	Pumping Test Analysis Report
	Project: Woodward/Vanier
	Number: ORKRC131
	Client: Knife River

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate Re-Test	Pumping Well: WW-1A
Test Conducted by: F. Tremblay		Test Date: 1/22/2021
Analysis Performed by: FT	WW-1A Theis Recovery	Analysis Date: 2/22/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.4538 [U.S. gal/min]	



Calculation using THEIS & JACOB

Observation Well	Transmissivity [U.S. gal/d-ft]	Hydraulic Conductivity [U.S. gal/d-ft²]	Radial Distance to PW [ft]	
WW-1A	8.55×10^{3}	8.39×10^{2}	0.17	

WENCK

now part of

Stantec

Pumping Test Analysis Report	
Project: Woodward/Vanier	
Number: ORKRC131	
Client: Knife River	

Location: Prineville, OR	Pumping Test: WW-1A Constant Rate Re-Test	Pumping Well: WW-1A
Test Conducted by: F. Tremblay		Test Date: 1/22/2021
Aquifer Thickness: 10.18 ft	Discharge: variable, average rate 2.4538 [U.S. gal/min]	

	Analysis Name	Method name	Well	T [U.S. gal/d-ft]	K [U.S. gal/d-ft²]	S
1	WW-2A Cooper-Jacob 2	Cooper & Jacob I	WW-2A	9.84×10^{3}	9.67×10^{2}	2.85×10^{-1}
2	WW-1A Theis Recovery	Theis Recovery	WW-1A	8.55×10^{3}	8.39×10^{2}	

APPENDIX C

Soil Testing Results

Pace Analytical® Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Date: 2/24/2021

CLIENT: Wenck Associates
Project: ORKRC131
Lab Order: S2102046

CASE NARRATIVE

Report ID: S2102046001

Samples WW1A and WW2A were received on February 2, 2021.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978
American Society of Agronomy, Number 9, Part 2, 1982
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994
State of Nevada Modified Sobek Procedure
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Pace Analytical (Formerly Inter-Mountain Laboratories) except as indicated in this case narrative.

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Wenck Associates
4025 Automation Way
Bldg E
Fort Collins, CO 80525

Date Reported: 2/24/2021
Report ID: S2102046001

Work Order: S2102046
Collection Date: 1/18/2021 10:00:00 AM
Date Received: 2/2/2021 10:15:00 AM
Sampler: FT
Matrix: Soil
COC:

Project: ORKRC131
Lab ID: S2102046-001
Client Sample ID: WW1A
Depths: 4 - 6 Feet

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters-Soil						
pH	7.8	0.1		s.u.	02/17/2021 09:11 CH	USDA 60-21a
Saturation Percent	36.8	0.1		%	02/17/2021 08:57 NLG	USDA 60-27a
Electrical Conductivity	0.42	0.01		dS/m	02/18/2021 13:27 CH	USDA 60-4
Saturated Paste Cations						
Calcium	2.20	0.05		meq/L	02/23/2021 19:32 DG	EPA 200.7
Magnesium	0.99	0.05		meq/L	02/23/2021 19:32 DG	EPA 200.7
Sodium	1.34	0.05		meq/L	02/23/2021 19:32 DG	EPA 200.7
Sodium Adsorption Ratio	1.06	0.05			02/24/2021 11:00 KS	Calculation
Exchangeable Cations						
Cation Exchange Capacity	34.2	0.1		meq/100g	02/23/2021 20:11 DG	EPA 9081
Available Sodium	0.72	0.16		meq/100g	02/22/2021 18:46 DG	ASA9 9-3.1
Exchangeable Sodium	0.67	0.05		meq/100g	02/24/2021 11:00 KS	USDA 60-18
Exchangeable Sodium % (ESP)	1.96	0.05		%	02/24/2021 11:00 KS	USDA 60-20

These results apply only to the samples tested. **RL - Reporting Limit**

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
D	Report limit raised due to dilution	E	Value above quantitation range
G	Analyzed at IML Gillette laboratory	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
U	Analyte below method detection limit	X	Matrix Effect

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Wenck Associates
4025 Automation Way
Bldg E
Fort Collins, CO 80525

Date Reported: 2/24/2021
Report ID: S2102046001

Work Order: S2102046
Collection Date: 1/18/2021 10:15:00 AM
Date Received: 2/2/2021 10:15:00 AM
Sampler: FT
Matrix: Soil
COC:

Project: ORKRC131
Lab ID: S2102046-002
Client Sample ID: WW1A
Depths: 6 - 8 Feet

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters-Soil						
pH	7.8	0.1		s.u.	02/17/2021 09:12 CH	USDA 60-21a
Saturation Percent	37.5	0.1		%	02/17/2021 08:58 NLG	USDA 60-27a
Electrical Conductivity	0.36	0.01		dS/m	02/18/2021 13:28 CH	USDA 60-4
Saturated Paste Cations						
Calcium	1.40	0.05		meq/L	02/23/2021 19:35 DG	EPA 200.7
Magnesium	0.69	0.05		meq/L	02/23/2021 19:35 DG	EPA 200.7
Sodium	1.05	0.05		meq/L	02/23/2021 19:35 DG	EPA 200.7
Sodium Adsorption Ratio	1.02	0.05			02/24/2021 11:00 KS	Calculation
Exchangeable Cations						
Cation Exchange Capacity	39.2	0.1		meq/100g	02/23/2021 20:13 DG	EPA 9081
Available Sodium	0.81	0.16		meq/100g	02/22/2021 18:48 DG	ASA9 9-3.1
Exchangeable Sodium	0.78	0.05		meq/100g	02/24/2021 11:00 KS	USDA 60-18
Exchangeable Sodium % (ESP)	1.98	0.05		%	02/24/2021 11:00 KS	USDA 60-20

These results apply only to the samples tested. **RL - Reporting Limit**

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
D	Report limit raised due to dilution	E	Value above quantitation range
G	Analyzed at IML Gillette laboratory	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
U	Analyte below method detection limit	X	Matrix Effect

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Wenck Associates
4025 Automation Way
Bldg E
Fort Collins, CO 80525

Date Reported: 2/24/2021
Report ID: S2102046001

Work Order: S2102046
Collection Date: 1/18/2021 10:30:00 AM
Date Received: 2/2/2021 10:15:00 AM
Sampler: FT
Matrix: Soil
COC:

Project: ORKRC131
Lab ID: S2102046-003
Client Sample ID: WW1A
Depths: 10 - 12 Feet

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters-Soil						
pH	7.6	0.1		s.u.	02/17/2021 09:13 CH	USDA 60-21a
Saturation Percent	22.9	0.1		%	02/17/2021 08:59 NLG	USDA 60-27a
Electrical Conductivity	0.82	0.01		dS/m	02/18/2021 13:29 CH	USDA 60-4
Saturated Paste Cations						
Calcium	1.55	0.05		meq/L	02/23/2021 19:37 DG	EPA 200.7
Magnesium	3.25	0.05		meq/L	02/23/2021 19:37 DG	EPA 200.7
Sodium	3.24	0.05		meq/L	02/23/2021 19:37 DG	EPA 200.7
Sodium Adsorption Ratio	2.09	0.05			02/24/2021 11:00 KS	Calculation
Exchangeable Cations						
Cation Exchange Capacity	23.5	0.1		meq/100g	02/23/2021 20:20 DG	EPA 9081
Available Sodium	0.63	0.16		meq/100g	02/22/2021 18:51 DG	ASA9 9-3.1
Exchangeable Sodium	0.56	0.05		meq/100g	02/24/2021 11:00 KS	USDA 60-18
Exchangeable Sodium % (ESP)	2.37	0.05		%	02/24/2021 11:00 KS	USDA 60-20

These results apply only to the samples tested. **RL - Reporting Limit**

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
D	Report limit raised due to dilution	E	Value above quantitation range
G	Analyzed at IML Gillette laboratory	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
U	Analyte below method detection limit	X	Matrix Effect

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Wenck Associates
4025 Automation Way
Bldg E
Fort Collins, CO 80525

Date Reported: 2/24/2021
Report ID: S2102046001

Work Order: S2102046
Collection Date: 1/18/2021 11:30:00 AM
Date Received: 2/2/2021 10:15:00 AM
Sampler: FT
Matrix: Soil
COC:

Project: ORKRC131
Lab ID: S2102046-004
Client Sample ID: WW2A
Depths: 2 - 10 Feet

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters-Soil						
pH	7.8	0.1		s.u.	02/17/2021 09:14 CH	USDA 60-21a
Saturation Percent	36.1	0.1		%	02/17/2021 09:00 NLG	USDA 60-27a
Electrical Conductivity	0.34	0.01		dS/m	02/18/2021 13:30 CH	USDA 60-4
Saturated Paste Cations						
Calcium	1.64	0.05		meq/L	02/23/2021 19:39 DG	EPA 200.7
Magnesium	0.91	0.05		meq/L	02/23/2021 19:39 DG	EPA 200.7
Sodium	0.84	0.05		meq/L	02/23/2021 19:39 DG	EPA 200.7
Sodium Adsorption Ratio	0.74	0.05			02/24/2021 11:00 KS	Calculation
Exchangeable Cations						
Cation Exchange Capacity	34.9	0.1		meq/100g	02/23/2021 20:22 DG	EPA 9081
Available Sodium	0.70	0.16		meq/100g	02/22/2021 18:53 DG	ASA9 9-3.1
Exchangeable Sodium	0.67	0.05		meq/100g	02/24/2021 11:00 KS	USDA 60-18
Exchangeable Sodium % (ESP)	1.92	0.05		%	02/24/2021 11:00 KS	USDA 60-20

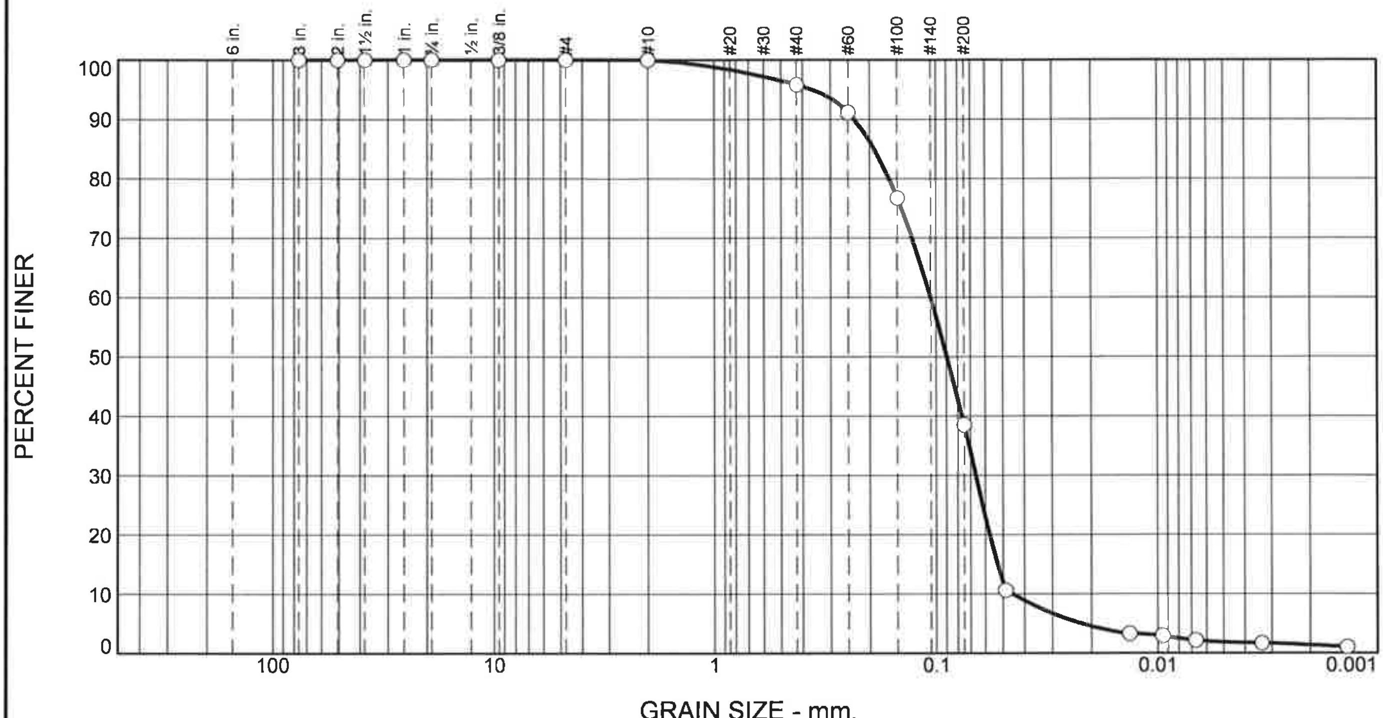
These results apply only to the samples tested. **RL - Reporting Limit**

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
D	Report limit raised due to dilution	E	Value above quantitation range
G	Analyzed at IML Gillette laboratory	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
U	Analyte below method detection limit	X	Matrix Effect

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	4	57	37	2

TEST RESULTS (ASTM D 422)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100		
2	100		
1.5	100		
1	100		
.75	100		
.375	100		
#4	100		
#10	100		
#40	96		
#60	91		
#100	77		
#200	39		
0.0486 mm.	11		
0.0134 mm.	3.3		
0.0095 mm.	3.0		
0.0067 mm.	2.2		
0.0033 mm.	1.7		
0.0014 mm.	1.1		

* (no specification provided)

Material Description

WW1A Silty Sand

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients

D_{90}= 0.2349 D_{85}= 0.1910 D_{60}= 0.1060
D_{50}= 0.0894 D_{30}= 0.0663 D_{15}= 0.0527
D_{10}= 0.0455 C_u= 2.33 C_c= 0.91

Remarks

Date Received: 2/2/2021 **Date Tested:** 2/16/2021

Tested By: Karen Secor

Checked By:

Title:

Sample Number: S2102046-001 **Depth:** 4-6ft **Date Sampled:** 1/18/2021

Pace Analytical Services, Inc.

Sheridan, Wyoming

Client: Wenck Associates, Inc.
Project: ORKRC131
Project No: S2102046 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

2/24/2021

Client: Wenck Associates, Inc.
Project: ORKRC131
Project Number: S2102046
Depth: 4-6ft **Sample Number:** S2102046-001
Material Description: WW1A Silty Sand
Sample Date: 1/18/2021
Date Received: 2/2/2021 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SM **AASHTO Classification:** A-4(0)
Grain Size Test Method: ASTM D 422
Tested By: Karen Secor **Test Date:** 2/16/2021

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
240.00	0.00	3	0.00	0.00	100
		2	0.00	0.00	100
		1.5	0.00	0.00	100
		1	0.00	0.00	100
		.75	0.00	0.00	100
		.375	0.00	0.00	100
		#4	0.00	0.00	100
		#10	0.00	0.00	100
60.53	0.00	#40	2.56	0.00	96
		#60	2.81	0.00	91
		#100	8.75	0.00	77
		#200	23.07	0.00	39

Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 39
Weight of hydrometer sample =60.53
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -3.5
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	21.0	20.0	16.7	0.0135	20.0	13.0	0.0486	10.6
15.00	21.0	8.5	5.2	0.0135	8.5	14.9	0.0134	3.3
30.00	21.0	8.0	4.7	0.0135	8.0	15.0	0.0095	3.0
60.00	22.0	6.5	3.4	0.0133	6.5	15.2	0.0067	2.2
240.00	23.0	5.5	2.7	0.0132	5.5	15.4	0.0033	1.7
1440.00	23.0	4.5	1.7	0.0132	4.5	15.6	0.0014	1.1

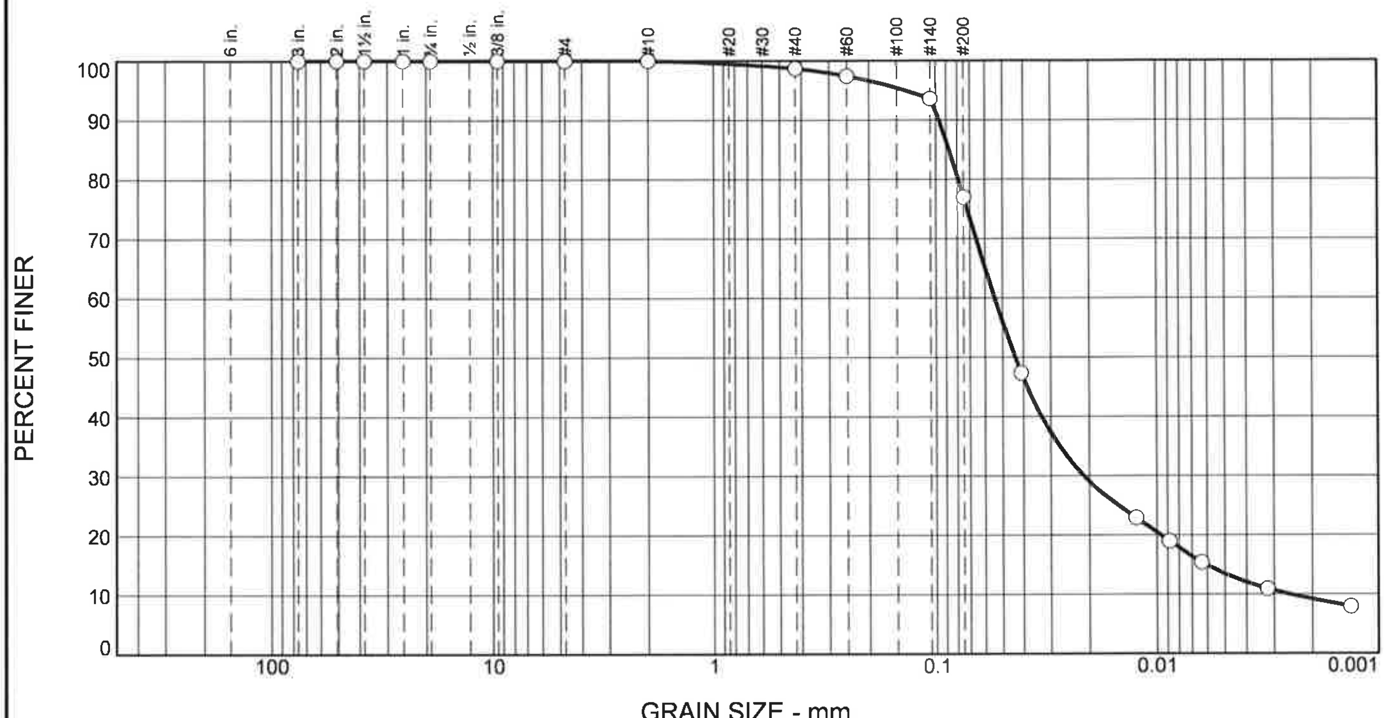
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0	0	0	0	0	4	57	61	37	2	39

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0222	0.0455	0.0527	0.0572	0.0663	0.0766	0.0894	0.1060	0.1637	0.1910	0.2349	0.3639

Fineness Modulus	C_u	C_c
0.33	2.33	0.91

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	1	22	64	13

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100		
2	100		
1.5	100		
1	100		
.75	100		
.375	100		
#4	100		
#10	100		
#40	99		
#60	97		
#140	94		
#200	77		
0.0410 mm.	47		
0.0124 mm.	23		
0.0088 mm.	19		
0.0064 mm.	15		
0.0032 mm.	11		
0.0013 mm.	8.0		

* (no specification provided)

Material Description

WW1A Silt with Sand

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(0)

Coefficients

D_{90}= 0.0968 D_{85}= 0.0871 D_{60}= 0.0543
D_{50}= 0.0437 D_{30}= 0.0213 D_{15}= 0.0061
D_{10}= 0.0025 C_u= 21.30 C_c= 3.27

Remarks

Date Received: 2/2/2021 **Date Tested:** 2/16/2021

Tested By: Karen Secor

Checked By:

Title:

Sample Number: S2102046-002 **Depth:** 6-8ft **Date Sampled:** 1/18/2021

Pace Analytical Services, Inc.

Sheridan, Wyoming

Client: Wenck Associates, Inc.
Project: ORKRC131

Project No: S2102046 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

2/24/2021

Client: Wenck Associates, Inc.
Project: ORKRC131
Project Number: S2102046
Depth: 6-8ft
Sample Number: S2102046-002
Material Description: WW1A Silt with Sand
Sample Date: 1/18/2021
Date Received: 2/2/2021 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML
AASHTO Classification: A-4(0)
Grain Size Test Method: ASTM D 422
Tested By: Karen Secor
Test Date: 2/16/2021

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
225.71	0.00	3	0.00	0.00	100
		2	0.00	0.00	100
		1.5	0.00	0.00	100
		1	0.00	0.00	100
		.75	0.00	0.00	100
		.375	0.00	0.00	100
		#4	0.00	0.00	100
		#10	0.00	0.00	100
64.52	0.00	#40	0.82	0.00	99
		#60	0.83	0.00	97
		#140	2.50	0.00	94
		#200	10.68	0.00	77

Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 77
Weight of hydrometer sample =64.52
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -3.5
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	21.0	43.0	39.7	0.0135	43.0	9.2	0.0410	47.4
15.00	21.0	22.5	19.2	0.0135	22.5	12.6	0.0124	22.9
30.00	22.0	19.0	15.9	0.0133	19.0	13.2	0.0088	19.0
60.00	22.0	16.0	12.9	0.0133	16.0	13.7	0.0064	15.4
240.00	23.0	12.0	9.2	0.0132	12.0	14.3	0.0032	10.9
1440.00	23.0	9.5	6.7	0.0132	9.5	14.7	0.0013	8.0

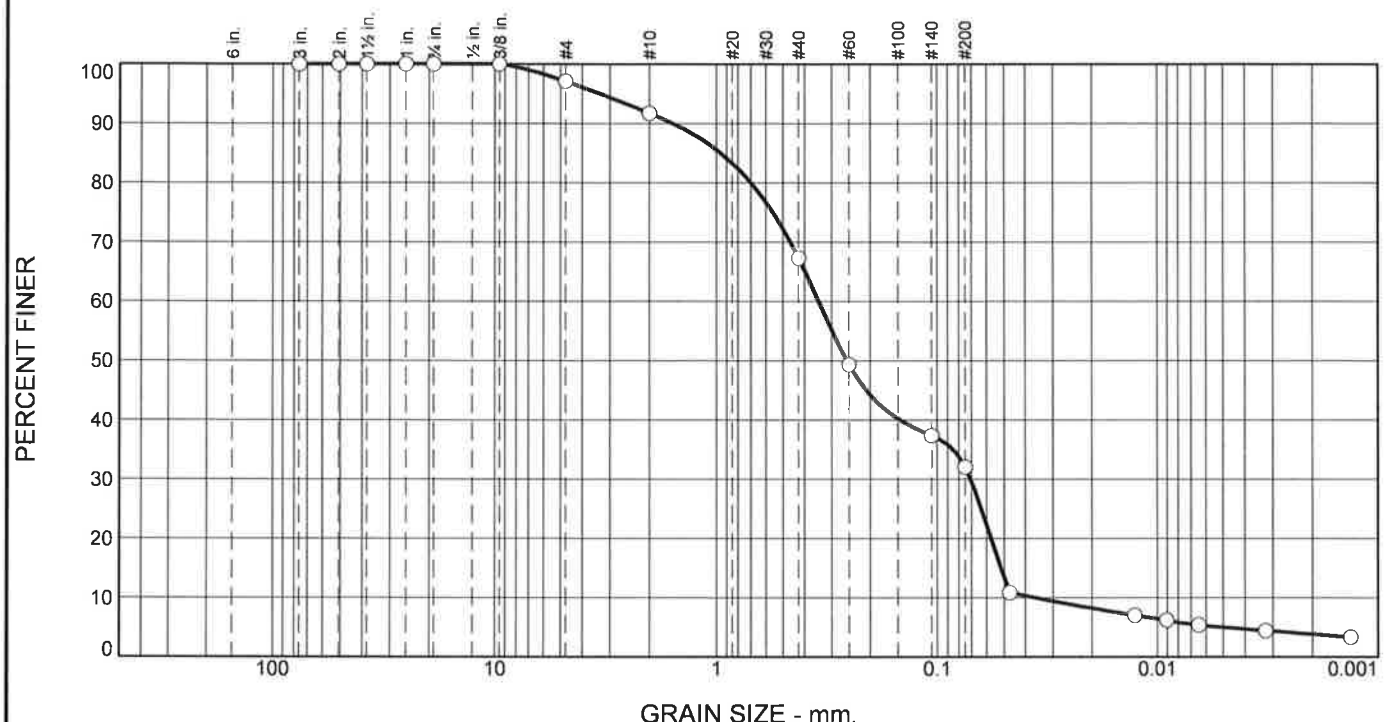
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0	0	0	0	0	1	22	23	64	13	77

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0025	0.0061	0.0096	0.0213	0.0331	0.0437	0.0543	0.0792	0.0871	0.0968	0.1381

Fineness Modulus	C_u	C_c
0.08	21.30	3.27

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	3	5	25	35	27	5

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100		
2	100		
1.5	100		
1	100		
.75	100		
.375	100		
#4	97		
#10	92		
#40	67		
#60	49		
#140	37		
#200	32		
0.0471 mm.	11		
0.0127 mm.	7.0		
0.0091 mm.	6.2		
0.0065 mm.	5.4		
0.0032 mm.	4.4		
0.0013 mm.	3.4		

* (no specification provided)

Material Description

WW1A Silty Sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 1.5749 D_{85}= 0.9589 D_{60}= 0.3446
D_{50}= 0.2557 D_{30}= 0.0708 D_{15}= 0.0517
D_{10}= 0.0362 C_u= 9.52 C_c= 0.40

Remarks

Date Received: 2/2/2021 **Date Tested:** 2/16/2021

Tested By: Karen Secor

Checked By:

Title:

Sample Number: S2102046-003 **Depth:** 10-12ft **Date Sampled:** 1/18/2021

Pace Analytical Services, Inc.

Sheridan, Wyoming

Client: Wenck Associates, Inc.
Project: ORKRC131
Project No: S2102046 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

2/24/2021

Client: Wenck Associates, Inc.
Project: ORKRC131
Project Number: S2102046
Depth: 10-12ft **Sample Number:** S2102046-003
Material Description: WW1A Silty Sand
Sample Date: 1/18/2021
Date Received: 2/2/2021 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SM **AASHTO Classification:** A-2-4(0)
Grain Size Test Method: ASTM D 422
Tested By: Karen Secor **Test Date:** 2/16/2021

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
338.09	0.00	3	0.00	0.00	100
		2	0.00	0.00	100
		1.5	0.00	0.00	100
		1	0.00	0.00	100
		.75	0.00	0.00	100
		.375	0.00	0.00	100
		#4	9.83	0.00	97
		#10	18.16	0.00	92
58.80	0.00	#40	15.67	0.00	67
		#60	11.49	0.00	49
		#140	7.69	0.00	37
		#200	3.41	0.00	32

Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 32
Weight of hydrometer sample =58.8
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -3.5
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.0	23.0	19.9	0.0133	23.0	12.5	0.0471	10.8
15.00	22.0	16.0	12.9	0.0133	16.0	13.7	0.0127	7.0
30.00	22.0	14.5	11.4	0.0133	14.5	13.9	0.0091	6.2
60.00	22.0	13.0	9.9	0.0133	13.0	14.2	0.0065	5.4
240.00	23.0	11.0	8.2	0.0132	11.0	14.5	0.0032	4.4
1440.00	23.0	9.0	6.2	0.0132	9.0	14.8	0.0013	3.4

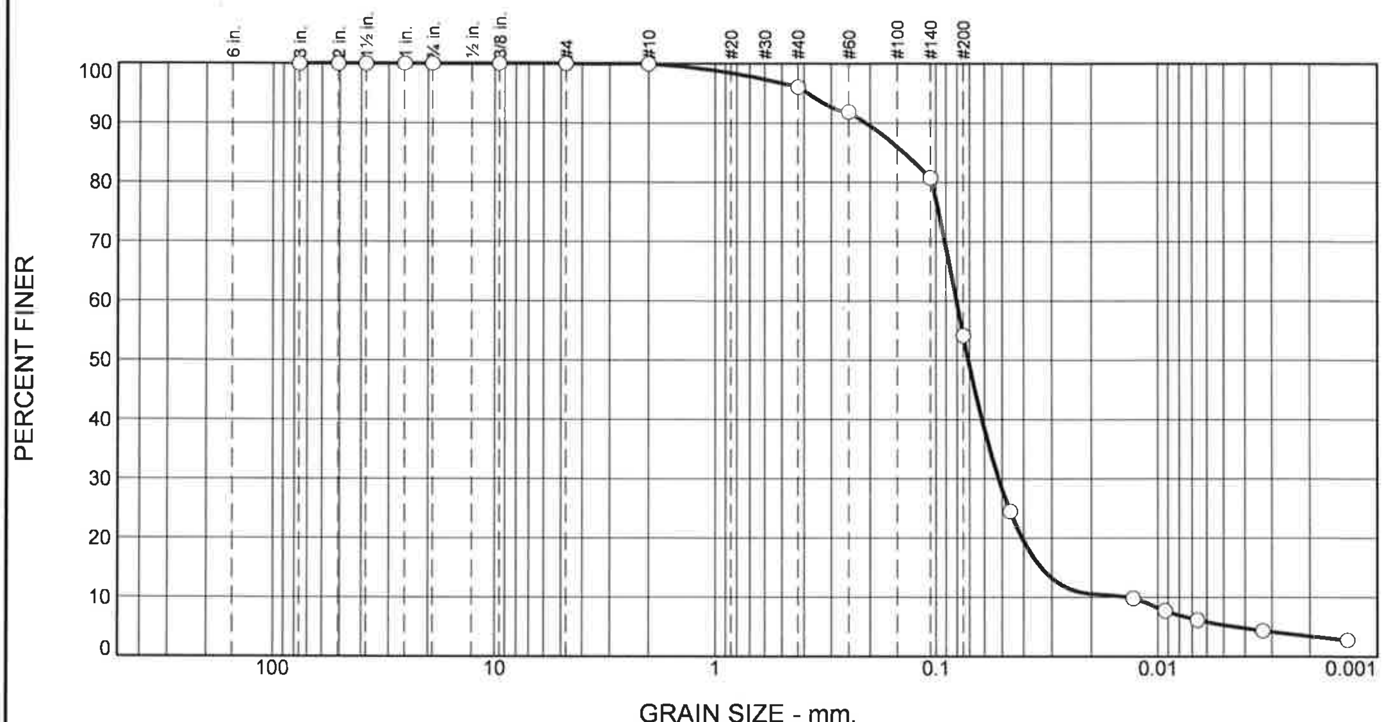
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0	0	3	3	5	25	35	65	27	5	32

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0050	0.0362	0.0517	0.0572	0.0708	0.1470	0.2557	0.3446	0.7014	0.9589	1.5749	3.3213

Fineness Modulus	C_u	C_c
1.51	9.52	0.40

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	4	42	49	5

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3	100		
2	100		
1.5	100		
1	100		
.75	100		
.375	100		
#4	100		
#10	100		
#40	96		
#60	92		
#140	81		
#200	54		
0.0460 mm.	24		
0.0130 mm.	9.8		
0.0093 mm.	7.7		
0.0066 mm.	6.2		
0.0033 mm.	4.4		
0.0014 mm.	2.8		

* (no specification provided)

Material Description

WW2A Sandy Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.2092 D_{85}= 0.1407 D_{60}= 0.0806
D_{50}= 0.0711 D_{30}= 0.0519 D_{15}= 0.0334
D_{10}= 0.0136 C_u= 5.94 C_c= 2.46

Remarks

Date Received: 2/2/2021 **Date Tested:** 2/16/2021

Tested By: Karen Secor

Checked By:

Title:

Sample Number: S2102046-004 **Depth:** 2-10ft **Date Sampled:** 1/18/2021

Pace Analytical Services, Inc.

Sheridan, Wyoming

Client: Wenck Associates, Inc.
Project: ORKRC131
Project No: S2102046 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

2/24/2021

Client: Wenck Associates, Inc.
Project: ORKRC131
Project Number: S2102046
Depth: 2-10ft
Sample Number: S2102046-004
Material Description: WW2A Sandy Silt
Sample Date: 1/18/2021
Date Received: 2/2/2021 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: ML **AASHTO Classification:** A-4(0)
Grain Size Test Method: ASTM D 422
Tested By: Karen Secor **Test Date:** 2/16/2021

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
364.16	0.00	3	0.00	0.00	100
		2	0.00	0.00	100
		1.5	0.00	0.00	100
		1	0.00	0.00	100
		.75	0.00	0.00	100
		.375	0.00	0.00	100
		#4	0.00	0.00	100
		#10	0.09	0.00	100
51.81	0.00	#40	2.03	0.00	96
		#60	2.17	0.00	92
		#140	5.78	0.00	81
		#200	13.76	0.00	54

Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 54
Weight of hydrometer sample =51.81
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -3.5
Meniscus correction only = 0.0
Specific gravity of solids = 2.65
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
1.00	22.0	26.5	23.4	0.0133	26.5	11.9	0.0460	24.5
15.00	22.0	12.5	9.4	0.0133	12.5	14.2	0.0130	9.8
30.00	22.0	10.5	7.4	0.0133	10.5	14.6	0.0093	7.7
60.00	22.0	9.0	5.9	0.0133	9.0	14.8	0.0066	6.2
240.00	23.0	7.0	4.2	0.0132	7.0	15.1	0.0033	4.4
1440.00	23.0	5.5	2.7	0.0132	5.5	15.4	0.0014	2.8

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0	0	0	0	0	4	42	46	49	5	54

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0044	0.0136	0.0334	0.0407	0.0519	0.0616	0.0711	0.0806	0.1047	0.1407	0.2092	0.3832

Fineness Modulus	C_u	C_c
0.25	5.94	2.46

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

ANALYTICAL QC SUMMARY REPORT

CLIENT: Wenck Associates **Date:** 2/24/2021
Work Order: S2102046 **Report ID:** S2102046001
Project: ORKRC131

Available Metals - meq Sample Type **MBLK** Units: meq/100g

AVA BLK (02/22/21 19:20) RunNo: 186947

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Available Sodium	ND	0.16					

Available Metals - meq Sample Type **LCS** Units: meq/100g

AVA QC (02/22/21 19:18) RunNo: 186947

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Available Sodium	1.73	0.16	2.36		73.4	70 - 130	

Cation Exchange Capacity Sample Type **MBLK** Units: meq/100g

CEC BLK (02/23/21 20:31) RunNo: 186999

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Cation Exchange Capacity	ND	0.1					

Cation Exchange Capacity Sample Type **LCS** Units: meq/100g

CEC QC (02/23/21 20:29) RunNo: 186999

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Cation Exchange Capacity	16.4	0.1	20.6		80.0	80 - 120	

Electrical Conductivity - Soil Sample Type **LCS** Units: dS/m

CONTROL (02/18/21 13:39) RunNo: 186882

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Electrical Conductivity	4.30	0.01	4.05		106	80 - 120	

pH-Soil Sample Type **LCS** Units: s.u.

CONTROL (02/17/21 09:23) RunNo: 186837

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
pH	7.3	0.1	7.1		103	96 - 104	

Saturated Paste Cations by EPA 200.7 Sample Type **MBLK** Units: meq/L

SAR BLK (02/23/21 20:06) RunNo: 186998

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Calcium	ND	0.05					
Magnesium	ND	0.05					
Sodium	ND	0.05					

Saturated Paste Cations by EPA 200.7 Sample Type **LCS** Units: meq/L

SAR QC (02/23/21 20:04) RunNo: 186998

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Calcium	27.6	0.05	26		106	80 - 120	
Magnesium	14.0	0.05	13.4		104	80 - 120	
Sodium	16.5	0.05	17.2		96.1	80 - 120	

Qualifiers:

B	Analyte detected in the associated Method Blank	D	Report limit raised due to dilution
E	Value above quantitation range	G	Analyzed at IML Gillette laboratory
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
L	Analyzed by another laboratory	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	R	RPD outside accepted recovery limits
S	Spike Recovery outside accepted recovery limits	X	Matrix Effect

Pace Analytical Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

ANALYTICAL QC SUMMARY REPORT

CLIENT: Wenck Associates **Date:** 2/24/2021
Work Order: S2102046 **Report ID:** S2102046001
Project: ORKRC131

Saturation Percent Sample Type **LCS** Units: %

CONTROL (02/17/21 09:09) RunNo: 186865

Analyte	Result	RL	Spike	Ref Samp	%REC	% Rec Limits	Qual
Saturation Percent	43.1	0.1	51		84.5	80 - 120	

Qualifiers:

B	Analyte detected in the associated Method Blank	D	Report limit raised due to dilution
E	Value above quantitation range	G	Analyzed at IML Gillette laboratory
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
L	Analyzed by another laboratory	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	R	RPD outside accepted recovery limits
S	Spike Recovery outside accepted recovery limits	X	Matrix Effect

Pace Analytical

CHAIN-OF-CUSTODY Analytical Request Document

Submitting a sample via this chain of custody constitutes acknowledgment and acceptance of the Pace Terms and Conditions found at: https://info.pacelabs.com/hubfs/pas-standard-terms.pdf

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevant fields

LAB USE ONLY- Affix Workorder/Login Label Here or List Pace Workorder Number or MTJL Log-in Number Here

ALL BOLD OUTLINED AREAS are for LAB USE ONLY

Company: Wenck Associates, Inc.
Address: 4025 Automation Way, Bldg. E
Billing Information: Same
Report To: Mark Stacy
Email To: mstacy@wenck.com
Copy To:
Site Collection Info/Address: Prineville, Oregon
Customer Project Name/Number: ORKRC131
State: OR / County/City: Crook
Time Zone Collected: [x]PT [ ]MT [ ]CT [ ]ET
Phone: 970-893-4812
Email: mstacy@wenck.com
Site/Facility ID #: None
Compliance Monitoring? [ ] Yes [x] No
Collected By (print): Freddy Tremblay
Purchase Order #:
Quote #: 89196
DW PWS ID #:
DW Location Code:
Collected By (signature): Freddy Tremblay
Turnaround Date Required: Standard TAT
Immediately Packed on Ice: [ ] Yes [x] No
Sample Disposal: [X] Dispose as appropriate [ ] Return [ ] Archive: ______ [ ] Hold:
Rush: (Expedite Charges Apply) [ ] Same Day [ ] Next Day [ ] 2 Day [ ] 3 Day [ ] 4 Day [ ] 5 Day
Field Filtered (if applicable): [ ] Yes [ ] No
Analysis: ______

Container Preservative Type **: U

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) hydrochloric acid, (4) sodium hydroxide, (5) zinc acetate, (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, (9) hexane, (A) ascorbic acid, (B) ammonium sulfate, (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other ______

Lab Project Manager:

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Analyses: Analyze each sample bag per quote

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start) Date	Collected (or Composite Start) Time	Composite End Date	Composite End Time	Res Cl	# of Ctns	Container Type: Plastic (P) or Glass (G)	Analyze each sample bag per quote	LAB USE ONLY: Lab Sample # / Comments:
WW1A-4-6 feet	SL	Grab	1/18/21	1000				1		x	52102046-001
WW1A-6-8 feet	SL	Grab	1/18/21	1015				1		x	-002
WW1A-10-12 feet	SL	Grab	1/18/21	1032				1		x	-003
WW2A-2-10 feet	SL	Grab	1/18/21	1130				1		x	-004

Lab Profile/Line:

Lab Sample Receipt Checklist:
Custody Seals Present/Intact Y N NA
Custody Signatures Present Y N NA
Collector Signature Present Y N NA
Bottles Intact Y N NA
Correct Bottles Y N NA
Sufficient Volume Y N NA
Samples Received on Ice Y N NA
VOA - Headspace Acceptable Y N NA
USDA Regulated Soils Y N NA
Samples in Holding Time Y N NA
Residual Chlorine Present Y N NA
Cl Strips:
Sample pH Acceptable Y N NA
pH Strips:
Sulfide Present Y N NA
Lead Acetate Strips:

Customer Remarks / Special Conditions / Possible Hazards: None

Type of Ice Used: Wet Blue Dry None
Packing Material Used:
Radchem sample(s) screened (<500 cpm): Y N NA
SHORT HOLDS PRESENT (<72 hours): Y N N/A
Lab Tracking #:
Samples received via: FEDEX UPS Client Courier Pace Courier

LAB Sample Temperature Info:
Temp Blank Received: Y N NA
Therm ID#:
Cooler 1 Temp Upon Receipt: ___oC
Cooler 1 Therm Corr. Factor: ___oC
Cooler 1 Corrected Temp: ___oC
Comments:

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Mark Stacy/Wenck	1/29/21 1400	Kara Sea Pace	2/2/21 1015

MTJL LAB USE ONLY
Table #:
Acctnum:
Template:
Prelogin:
PM:
PB:

Trip Blank Received: Y N NA
HCL MeOH TSP Other

Non Conformance(s): YES / NO
Page: ____ of: ____