SOILS SOUTHWEST, INC.
SOILS, MATERIALS AND ENVIRONMENTAL ENGINEERING CONSULTANTS
897 VIA LATA, SUITE N • COLTON, CA 92324 • (909) 370-0474 • (909) 370-0481 • FAX (909) 370-3156

Report of Private Sewage Disposal Design

Soil Percolation Testing for Seepage Pit
Planned Truck & Trailer Facility
Waalew Road, Apple Valley, California
APN: 0440-014-11

Project No. 24019-PRC

December 9, 2024

Prepared for:

Mr. Jared Himie
c/o WEKA, Inc.
236 W. Orange Show Road, Suite 114
San Bernardino, California 92408

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Established 1984

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Mr. Jared Himie
c/o WEKA, Inc.
236 W. Orange Show Road, Suite 114
San Bernardino, California 92408

Subject: Report of Private Sewage Disposal Design
Soil Percolation Testing for Seepage Pit
Planned Truck & Trailer Facility
Waalew Road, Apple Valley, California
APN: 0440-014-11

Reference: 1. Seepage Pit Test Locations Site Plan Supplied by Bonadiman & Associates
2. Soils Percolation Report Standard Published by SBC DEHS

Dear Mr. Himie,

This report presents the results for soil percolation testing (P-1 and P-2) and recommendations for private sewage disposal systems in the form of septic tank and seepage pit(s) proposed for the planned Truck & Trailer Facility to be located at on the south side of Waalew Road between Ramona and Navajo Roads, Apple Valley, San Bernardino County, California. The approximate test locations are as delineated by Bonadiman & Associates the project engineer as shown as attached.

The soils encountered consists, in general, of dry silty fine sands with traces of clay and caliche, along with minor pebbles and scattered rock fragments overlying dense and stiff, dry to damp, silty fine sands with traces of clays and scattered pebbles and rock fragments to the depths of 50 feet at P-1 and 40 feet at P-2 explored.

No shallow-deep groundwater or bedrock was encountered within the described depths explored. Descriptions of the soils encountered are described in the attached Log of Borings.

The investigation included two (2) percolation tests (P-1 and P-2) using the Falling Head Percolation Test Procedures as described in the On-Site Wastewater Disposal System Soil Percolation (PERC) Test Report Standards Handbook (Section 3.5.2) published by the San Bernardino County Department of Environmental Health Services (DEHS). Prior to test exploration and soil percolation testing DEHS and the City of Apple Valley were notified in writing (copy attached) for their presence and observations of percolation test procedures used.

Based on the soils' percolation testing completed, it is our opinion that the observed soil percolation rates are 0.46 sf/100 gallons/day and 1.06 sf/100 gallons/day for the test locations P-1and P-2, respectively.

The observed rates may be considered in design using an appropriate Factor of Safety as selected by the project design engineer.

It is suggested that a detailed disposal system layout should be prepared to scale by the project design engineer with the septic tank capacity as determined based on the expected use of Fixture Units (FUs).

This report should be submitted to the San Bernardino County Environmental Health Department for their review and approval prior to use and construction.

Respectfully submitted,
Soils Southwest, Inc.

Malay Gupta, RCE 31708

REGISTERED PROFESSIONAL ENGINEER
MALAY K. GUPTA
No 31708
Exp. 12-31-24
CIVIL
STATE OF CALIFORNIA

John Flippin, Project Coordinator

1.0 Soil Percolation Testing using Falling Head Test Procedures

For percolation testing, considering "moderate to severe" soils conditions the exploratory test boring, P-1 and P-2 were advanced to the refusal depths of 50 and 40 respectively using an 8-inch diameter Hollow-Stem Auger (HSA) drill-rig.

During excavations, 3-inch diameter slotted PVC pipes were installed along with 6-inch crushed rocks at the excavation bottoms to prevent scouring. It is our opinion that following installation; necessary percolation testing was conducted in sufficient conformance to the requirements of the SBC DEHS Soils Percolation Test Procedure Handbook. Approximate test locations shown are where site was accessible to drilling equipment.

Site Description and Recommended Disposal System

1.1 Soil percolation testing for proposed commercial development was performed at the request and authorization from:

Mr. Jared Himie
c/o WEKA, Inc.
236 W. Orange Show Road, Suite 114
San Bernardino, California 92408

1.2 Site Location

The subject site is located at APN: 0440-014-11 South side of Waalew Road west of Navajo Road, Apple Valley, California.

1.3 Proposed Development

a. Project Type: Based on the preliminary project information supplied, it is understood that the results of soil percolation testing, P-1 and P-2 described will be to represent the entire project site areas for the planned parcel.

b. Parcel Size: The overall parcel size is 14.86 acres gross for APN: 0440-014-11 .

c. Site Preparations and Grading: Based on the available preliminary project information supplied, minor grading should be anticipated.

1.4 Description of the Site and Surroundings

a. Topography: the site is relatively flat, with sheet flow from incidental rainfall flowing towards the southeast .

b. Water Courses and Drainage: Based on site reconnaissance, it is our opinion that incidental surface water flows towards the southeast

c. Total vertical relief is estimated to be approximately 7 feet.

d. Vegetation: surface weeds and scattered desert brush.

e. Existing Structures: None

f. Existing Wells: Presence of no known active nearby water well is reported.

f. Existing Wells: Presence of no known active nearby water well is reported.

g. Existing Sewage Disposal System: No.

h. Outcropping: None detected.

i. Groundwater: None detected within the maximum depths explored. Shallow depth historical groundwater is reported at a depth in excess of 100 feet. The following table lists the historical groundwater table based on the information as supplied by the local reporting agency.

GROUNDWATER TABLE	
Reporting Agency	California Department of Water Resources Marcelo Montagna 2008 Maps http://wdl.water.ca.gov/waterdatalibrary/
Well Number	05N/03W-04B002S – Well 24 s/w of site
Well Monitoring Agency	Mojave Water Agency
Well Location: Township/Range/Section	T05N-R03W-Section 04
Well Elevation:	2929.3
Current Depth to Water (Measured in feet)	184
Current Date Water was Measured	May 1, 2010
Depth to Water (Measured in feet) (Shallowest)	178
Date Water was Measured (Shallowest)	February 1, 2000

j. Other features affecting proposed sewage disposal system: No other features are noted for the disposal system proposed. No suspected infiltration galleries or old mines and/or tunnel, excessive grading etc., are noted that may affect the disposal system planned.

2.0 EQUIPMENT USED:

A truck mounted drilling rig with 8-inch Hollow-Stem Auger (HSA) was used for the test pits excavated as described. For soil percolation testing water required was supplied by water truck and using a hose. Other used is a 100-foot measuring tape weighted at the end.

3.0 METHODOLOGY AND TEST PROCEDURES:

Considering "moderate to severe" soil conditions as described on page 20 of the San Bernardino County DEHS Percolation Test Standards and Report Guide (2019), along with the restroom for the planned 52 square foot guard shack, two (2) exploratory test borings, B-1/P-1 and B-2/P-2 were explored using an 8-inch diameter Hollow-Stem Auger (HSA) drill-rig advanced to the maximum depths within the approximate location as delineated by the project engineer as described in the percolation test boring logs.

During initial testing, since in four consecutive 30-minute readings water did not seep faster than ½ the initial wetted depth, the subject P-1 and P-2, percolation testing were made at 30 and 60-minute intervals for a minimum of six hours, or until observed rates were consistent. Considering that both tests did not seep 4 or more feet below existing grade surface, there was no refilling on the final two readings or no-refills for the final two test readings.

4.0 PERCOLATION TEST RESULTS

4.1 Soil Strata: In general, the soils encountered consists of soils encountered consists of dry silty fine sands with traces of clay and caliche, pebbles, scattered rock fragments overlying dense and stiff, dry to damp, silty fine sands with some clays, scattered pebbles and rock fragments along with isolated pockets of clayey sands to the depths of 50 and 40 feet explored. No shallow depth groundwater was encountered. Based on review of water data resources, historical groundwater is reported at a depth in excess of 100 feet below grade. **No bedrock was encountered within the maximum depth explored**.

4.2 Field Test Results: The observed percolation test results for locations P-1 to P-4 are as follows:

Test Boring No.	Test depth (feet) Initial	Final	Observed Percolation Rate, Q (gal/sf/day)	Pit MPI = 180/Q
P-1	40	39.08	0.46	391.3
P-2	30	28.50	1.06	169.8

Based on the Observed Percolation Rate (Q) (gal/sf/day), the recorded gallons per square foot per day do not meet the minimum requirements for seepage Pit (min) 1.1.

4.3 Recommended Soil Percolation Rate for Seepage Pit Design:

Based on the test results described, it is our opinion that as per the Section 5.0.3 of the DEHS Handbook, the observed percolation rates are 0.46 sf/100 gallons/day (P-1) and 1.06 sf/100 gallons/day (P-2), respectively

Sample Disposal Design Calculations:

Calculations were applied based on the San Bernardino County DEHS, "How to Calculate for Design Rates, Absorption Area, and Total Feet for Engineers and other Percolation Testing/Septic System Designers when calculating for Design Rates (June 2015).

Design Percolation Rate (gal/sf/day)	Effective Sidewall Required (sf/100 gal of Septic Tank)
Q = 0.46	(1/0.46) x 100 = 217.4 ft^2/gstc

Assuming 1 restroom for the planned guard shack using a 5-foot diameter seepage pit, effective seepage pit depth:

Tank Size/(Q x diameter x 3.14) = ***750***/(0.46 x 5 x 3.14) = 750/7.22 = 103.88 (104) feet or

3 no. x 34.7 (35) (feet below inlet (BI) **or** total depth of 3 no. x 45 (35+10) feet below existing surface grade

REMARKS:

When septic tank capacity for the project is established detailed disposal system layout with required number of seepage pit(s) should be established and plotted to scale for use and submittal.

Detailed disposal system layouts with necessary setbacks are as suggested below or as selected by the design professional plotted to scale.

4.4 Typical disposal systems setback as per San Bernardino County DEHS, Appendix D, Page 35

Septic Tank to:	Feet
Water supply well	100
Buildings or structures	5
Property line adjoining private property	5
Perennial streams	50
Ephemeral streams	50
Large trees	10
Seepage pits or disposal fields	5
Private domestic water lines (building service lines)	5
Public domestic water lines (water purveyor's line)	25
Groundwater	5

Soil Absorption System	Feet
Domestic supply well-100,150, or 200 ft. depending on whether system has a: • Leaching Field • Seepage Pit • Any system discharging 5,000 gallons/day or more	100 150 200
Public Water Supply Wells-Dispersal system: • Does not exceed 10 feet • Exceeds 10 to 20 feet • Exceeds 20 feet	150 200 600
Building or structures	8
Property line adjoining private property (leach lines)	5
Property line adjoining private property (seepage pits)	8
Colorado River/Mojave River	200
Septic Tank	5
Distribution Box	5
Private domestic water lines (building service lines)	5
Public domestic water lines (water purveyor's line)	25
Seepage Pit	10
Ground Surface on sloping ground (when disposal field and/or seepage pits are installed in sloping ground, the minimum horizontal distance between any part of the leaching system and ground surface shall be 15 feet.) Also see page 29	15
Lakes, water reservoirs	200

5.0 Discussion

Uniformity/Non-Uniformity:

In general, the soils encountered consists of dry silty fine sands with traces of clay and caliche, pebbles, scattered rock fragments overlying dense and stiff, dry to damp, silty fine sands with some clays, scattered pebbles and rock fragments along with isolated pockets of clayey sands to the depths of 50 and 40 feet explored. No shallow depth groundwater was encountered, however, fine cohesive soils were encountered to the maximum depth of 50 ft. No shallow depth groundwater was encountered.

The disposal systems layouts, along with the soil percolation report, should be submitted to the local Environmental Health Agency for their review and approval.

6.0 CONCLUSIONS

Based on field explorations and soil percolation testing completed as described, it is our opinion that the site should be considered suitable for installation of a private sewage disposal system in the form of septic tank and seepage pit. 100% expansion area is available.

With historical groundwater at a depth in excess of 50 feet, it is our opinion that groundwater should not be expected within the 10 feet separation requirements below the bottom of seepage pit as currently allowable by the County and State Regulatory Agency.

Seepage pit and septic tank materials and their installation should conform to the standard requirements and specifications of the County of San Bernardino Environmental Health Department.

Detailed seepage pit layout, including primary and secondary systems, should be plotted to scale by the project civil engineer and such should be submitted to the San Bernardino County Health Department for their review and approval.

It should be noted that the soils percolation rate used are based on the field testing completed at the locations as described.

The recommended rates described may change considerably thereby causing "failure" of the installed designed systems. The designed rates described may change in the event that the seepage pits are installed at different locations, along with the change in environmental site conditions due to excessive irrigation, heavy rains, flooding or others.

Soils Southwest, Inc. assumes no responsibility in the event that the system fails in future due to incorrect installation, excessive use of grease, kitchen fat, chemical cleaners, conventional toilet papers or kitchen garbage and others.

During construction, in the event that the soils explored appear considerably different from those as described herein, it will be the responsibility of the installing contactor to notify Soils Southwest, Inc. for revised disposal system design and recommendations, as well as to verify the depth of the seepage pit bottom.

The recommendations supplied are subject to review and approval by the County of San Bernardino Environmental Health Department prior to the seepage pit installation.

PLOT PLAN AND TEST LOCATIONS
Planned Truck & Trailer Facility
Waalew Road, Apple Valley, California
APN: 0440-014-11

Legend: P-1 Approximate percolation test locations for seepage pits as delineated by the project design engineer.

Area delineated by Bonadiman and Associates

Plate 1

Attached:

- Log of Test Excavation
- Field Test Data
- *Your Septic System: A Homeowner's Guide to Septic Systems*, published by the United States Environmental Protection Agency, March 2005.

Log of Borings
Seepage Pit Test Boring Excavations

Soils Southwest, Inc.
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(909) 370-0474 Fax (909) 370-3156

LOG OF BORING P-1

Project: Weka, Inc. **Job No.:** 24019-PRC

Logged By: John F. **Boring Diam.:** 8" HSA **Date:** November 22,2024

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SM-ML			surface ground weeds
								SAND - tannish, silty, fine, pebbles, dry
							5	- color change to light brown with traces of clay, dry
								- with pebbles, scattered rock fragments, dense, dry to damp
							10	
							15	- color change to light grayish tan, silty nodules, fine, dry
								- color change to reddish light brown, silty traces of clay,fine,pebbles, dry
								- color change to gray tan, silty, fine, dense, dry
							20	- color change to gray, silty nodules, fine dense, dry
								- color change to light brown, silty nodules fine, scattered pebbles and rock fragments very dense, dry
							25	- color change to reddish brown, silty, fine scattered pebbles and rock fragments, very dense, damp
					SM-SC			- color change to brown, silty, fine with gray clayey nodules
					SM-ML		30	- color change to gray tan, silty, fine, scattered pebbles and rock fragments, dense
								- color change to light brown to tan,silty, fine, dense
					SM-SC			- color change to gray brown, silty,slightly

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: +/- 2931

Site Location

Planned Truck Parking Facility
Waalew Road
Apple Valley, California

Plate #

Soils Southwest, Inc.
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Colton, CA 92324
(909) 370-0474 Fax (909) 370-3156

LOG OF BORING P-1

Project: Weka, Inc.		Job No.: 24019-PRC
Logged By: John F.	Boring Diam.: 8" HSA	Date: November 22,2024

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SC			clayey, fine, very dense, dry to damp
								- color change to gray, clayey, tight
					SM-ML			- color change to grayish brown, silty, fine dense
							40	
							45	
							50	
								- End of percolation test boring @ 50 ft. backfill to 40 ft. - no bedrock - no groundwater - 3" perforated socked PVC pipe installed with gravel at bottom
							55	
							60	
							65	
							70	

Soils Southwest, Inc.
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LOG OF BORING P-2

Project: Weka, Inc. **Job No.:** 24019-PRC

Logged By: John F. **Boring Diam.:** 8" HSA **Date:** November 22,2024

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SM			scattered surface ground weeds
								SAND - light yellow tan, silty, and silty nodules, fine, dry
							5	
								- color change to pinkish light tan, silty nodules, fine, dry
							10	- color change to tan, silty nodules, fine, dry
								- color change to grayish brown, traces of clay, silty, fine with traces of caliches (white) specks, dense, dry to damp
							15	
							20	- color change to light brown, silty traces of clay,fine,pebbles, dense, dry
					SM-ML			- color change to light brown, silty nodules fine, scattered pebbles and rock fragments very dense, dry
							25	- color change to reddish brown, silty, traces of clay, fine, scattered small 1/2" rock
					SM-SC			- color change to reddish brown, silty, fine scattered pebbles and rock fragments, very dense, damp
					SM-ML		30	- color change to brown, silty, fine with gray clayey nodules
								- color change to gray tan, silty, fine, scattered pebbles and rock fragments, dense
					SM-SC			- color change to grayish tan, silty nodules

Groundwater: n/a
Approx. Depth of Bedrock: n/a
Datum: n/a
Elevation: +/- 2931

Site Location

Planned Truck Parking Facility
Waalew Road
Apple Valley, California

Plate #

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Colton, CA 92324
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LOG OF BORING P-2

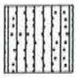
Project: Weka, Inc.		Job No.: 24019-PRC
Logged By: John F.	Boring Diam.: 8" HSA	Date: November 22,2024

Standard Penetration (Blows per Ft.)	Sample Type	Water Content in %	Dry Density in PCF	Percent Compaction	Unified Classification System	Graphic	Depth in Feet	Description and Remarks
					SC			traces of clay, fine, dense, damp. - color change to light brown to tan,silty, fine, dense
					SM-ML			- color change to gray brown, silty,slightly clayey, fine, very dense, dry to damp - color change to gray, clayey, tight - color change to grayish brown, silty, fine dense
							40	- End of percolation test boring @ 40 ft. backfill to 30 ft. - no bedrock - no groundwater - 3" perforated socked PVC pipe installed with gravel at bottom
							45	
							50	
							55	
							60	
							65	
							70	

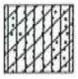
KEY TO SYMBOLS

Symbol Description

Strata symbols

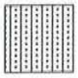


Poorly graded silty fine sand



Poorly graded clayey silty sand

Clayey sand



Silty sand

Notes:

1. Exploratory borings were drilled on November 22,2024 using a 4-inch diameter continuous flight power auger.
2. No free water was encountered at the time of drilling or when re-checked the following day.
3. Boring locations were taped from existing features and elevations extrapolated from the final design schematic plan.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.
5. Results of tests conducted on samples recovered are reported on the logs.

Field Data Results
Grain size Analyses (ASTM D422)
San Bernardino County Public Health Percolation Test Notification Form & Response

SEEPAGE PIT
FIELD DATA SHEET

Boring No: B-1 **Percolation No:** P-1 **Job No:** 24019-PRC
Hole Diameter (ft): 0.66 **Gravel Pack:** N/A **APN:** 0440-014-11

Soil Description: SP-SM

Depth Below Grade:
Initial (FT): 50
After Backfill (FT): 40

Presaturation Pre-Soaking: HRS. 24
Tested By: JF&JG
Date of Test: 12/2 and 12/3/2024

$d_{b\,(ft)}$	$t_{i\ hr:min}$	$t_{f\ hr:min}$	Δt	$d_{i\,(ft)}$	$d_{f\,(ft)}$	$F = d_f - d_i$	$L_{ave} = d_b - ((d_i+d_f)/2)$	$Q = (\Delta t \times f)/l_{ave}$	
39.92	8:18	8:48	11.80	0	6.50	6.50	36.67	2.09	Presoak
39.00	8:49	9:19	11.80	0	2.83	2.83	37.59	0.89	
39.42	9:21	9:51	11.80	0	2.17	2.17	38.34	0.67	
39.33	9:54	10:24	11.80	0	1.75	1.75	38.46	0.54	
39.25	10:25	11:25	5.94	0	2.92	2.92	37.79	0.46	
39.17	11:27	12:27	5.94	0	2.92	2.92	37.71	0.46	
39.08	12:28	1:28	5.94	0	2.92	2.92	37.62	0.46	

Symbol Definitions

d_b Depth to bottom

t_i Time @ start of test cycle

t_f Time @ end of test cycle

Δt Duration of test cycle — Enter values listed below for the time period used

10 min: 35.7 | 30 min: 11.8 | 90 min: 3.96
20 min: 18 | 60 min: 5.94

d_i Depth to water @ start of test cycle

d_f Depth to water @ end of test cycle

Q Gallons/ft^2/day

F Change in water level during time of test

SEEPAGE PIT
FIELD DATA SHEET

Boring No: B-2 **Percolation No:** P-2 **Job No:** 24019-PRC
Hole Diameter (ft): 0.66 **Gravel Pack:** N/A **APN:** 0440-014-11

Soil Description: SP-SM

Depth Below Grade:
Initial (FT): 40
After Backfill (FT): 30

Presaturation Pre-Soaking: HRS. 24
Tested By: JF&JG
Date of Test: 12/2 and 12/3/2024

$d_{b\ (ft)}$	$t_{i\ hr:min}$	$t_{f\ hr:min}$	Δt	$d_{i\ (ft)}$	$d_{f\ (ft)}$	$F = d_f - d_i$	$L_{ave} = d_b - ((d_i+d_f)/2)$	$Q = (\Delta t \times f)/l_{ave}$	
29.42	8:12	8:42	11.80	0	8.25	8.25	25.30	3.85	Presoak
29.25	8:45	9:15	11.80	0	4.58	4.58	26.96	2.00	
29.00	9:16	9:46	11.80	0	3.75	3.75	27.13	1.63	
28.83	9:49	10:19	11.80	0	3.17	3.17	27.25	1.37	
28.67	11:42	12:12	5.94	0	4.75	4.75	26.30	1.07	
28.50	12:18	12:48	5.94	0	4.67	4.67	26.17	1.06	
28.50	12:54	1:24	5.94	0	4.67	4.67	26.17	1.06	

Symbol Definitions

d_b Depth to bottom

t_i Time @ start of test cycle

t_f Time @ end of test cycle

Δt Duration of test cycle

10 min: 35.7
20 min: 18

Enter values listed below for the time period use

30 mir 11.8 90 min: 3.96
60 mir 5.94

d_i Depth to water @ start of test cycle

d_f Depth to water @ end of test cycle

Q Gallons/ft^2/day

F Change in water level during time of test

How to Calculate for Design Rates, Absorption Area and Total Feet for Engineers and other Percolation Testing / Septic System Designers

When calculating for Design Rates using Perc Rates and Absorption Area:

LL → Take most conservative MPI and use the EPA's LL graph to find Perc rate (sf/ gal/ day) → Perc rate x flow (gallons) = **Absorption Area** →

- Absorption Area / (tank size / 100 gal.) = **Design Rate:** LL # sf/100 gstc*
- Absorption Area / (trench area) = **Total Lineal Feet**

Credit

SP → (gal/ sf/ day) 1.1 < Q** < 4 →

- 1 / (Q x 100 gal.) = **Design Rate:** Pits # sf/100 gstc*
- Absorption Area / (diameter x 3.14) or Tank size / (Q x diameter x 3.14) = **Total Depth Feet**

LL: (min.) 1.0 < 60 (max.); (min.) 0.6 < Perc rate < 2.26 (max.)
SP: (min.) 1.1 < Q < 4 (max.) [if caving occurred: Q < 3 (max.)]
MPI < 30 (max.) → For Lahontan SP only

LL → Perc rate **x** flow (gallons) **/** (tank size / 100 gal.) **=** **Design Rate:** LL # sf/100 gstc*

* County of San Bernardino Design Rates are expressed in units of square feet (sf) per 100 gallons septic tank capacity (gstc).

** For leach lines, you can use the result of the average MPI subtracted from the most conservative MPI. For seepage pits, it is suggested that you used the most conservative Q that falls within the range of 1.1 to 4. If there are Q values greater than 4, then a Q of 4 gallons per square feet (g/sq) is the fastest value that can be chosen to design your septic system.

When calculating for Absorption Area and Total Feet using Design Rates:

LL → **Design Rate:** sf/100 gstc* **x** Gallon Tank Size → **Absorption Area (sf)** → Absorption Area / (trench area) = **Total Lineal Feet**

Credit

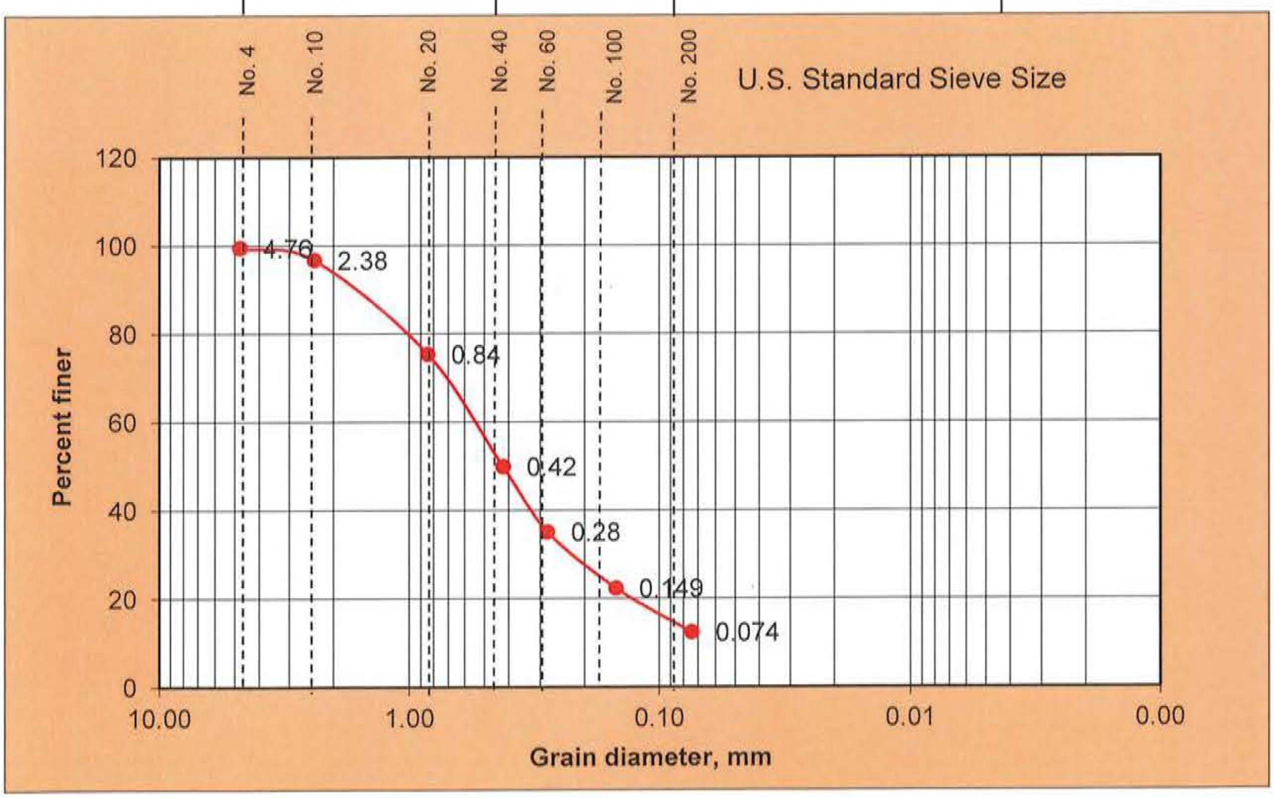
SP → **Design Rate:** sf/100 gstc* **x** Gallon Tank Size → **Absorption Area (sf)** → Absorption Area / (diameter x 3.14) = **Total Depth Feet**

GRAIN SIZE DISTRIBUTION

Project: Weka, Inc. **Job #** 24019-PRC
Location: Waalew Rd. w/o Navajo Rd, Apple Valley **Boring No:** P-1 @ 50' **Sample No:** 1
Description of Soil: SP-SM
Date of Sample: 11/22/2024
Tested By: JF **Date of Testing:** 12/2/2024

Sieve No.	Sieve Openings in mm	Percent Finer	Grain Size	% Retained
4	4.76	99.52	Gravel	0.5
10	2.38	96.76	Med. to Crs	47.5
20	0.84	75.40	Fines	38
40	0.42	49.94	Silts/Clays	14
60	0.28	35.14	Insitu MC %	20.8
100	0.149	22.34		
200	0.074	12.40		

Gravel	Sand		Silt	Clay
	Coarse to Medium	Fine		



Visual Soil Description : SAND - slightly silty grayish brown, fine to medium, pebbles, widely scattered gravels

Soil Classification: SP-SM

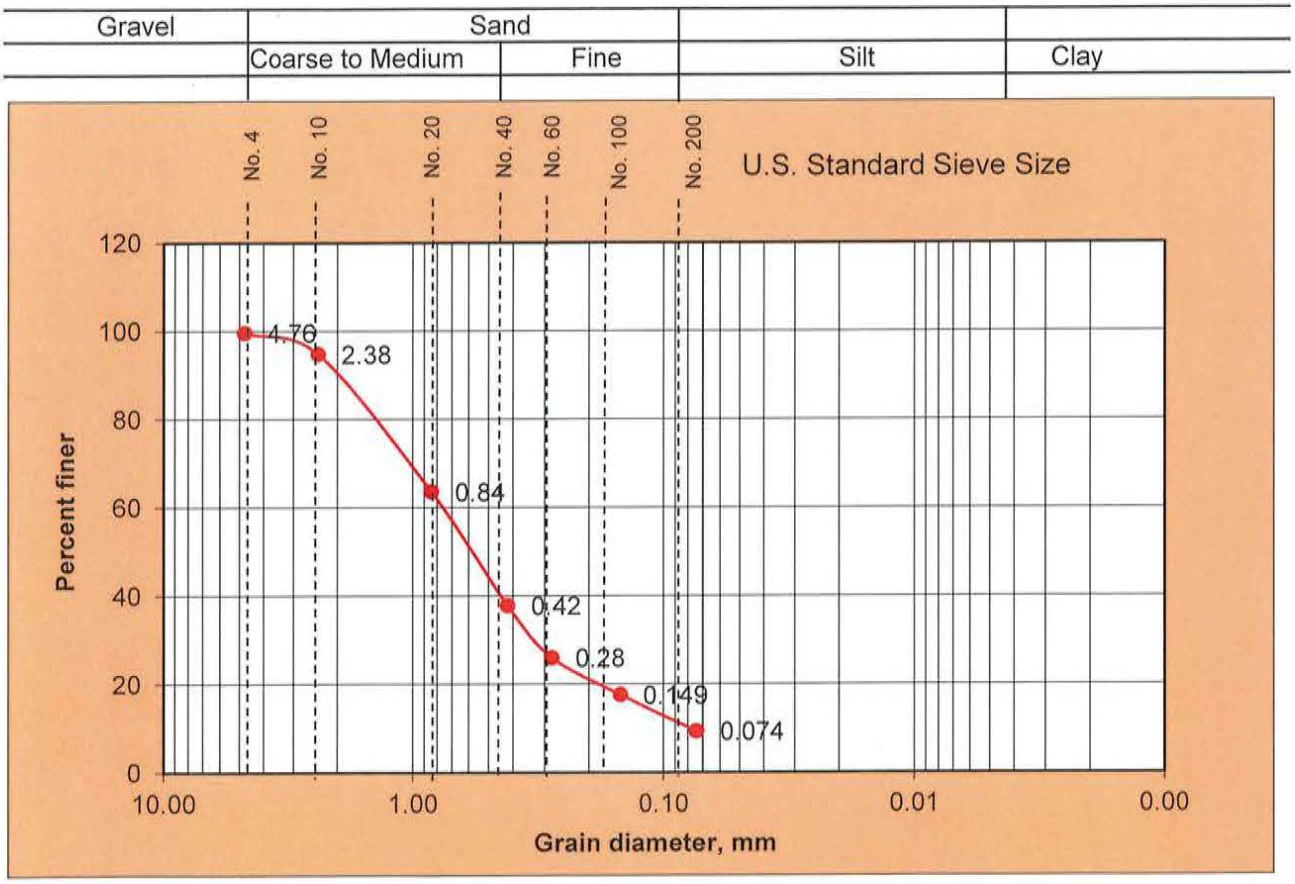
System: USC

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

GRAIN SIZE DISTRIBUTION

Project: Weka, Inc. **Job #** 24019-PRC
Location: Waalew Rd. w/o Navajo Rd, Apple Valley **Boring No:** P-2 @ 30' **Sample No:** 2
Description of Soil: SP-SM
Date of Sample: 11/22/2024
Tested By: JF **Date of Testing:** 12/2/2024

Sieve No.	Sieve Openings in mm	Percent Finer	Grain Size	% Retained
4	4.76	99.62	Gravel	0.5
10	2.38	94.82	Med. to Crs	58.5
20	0.84	63.62	Fines	30
40	0.42	37.82	Silts/Clays	11
60	0.28	26.00	Insitu M.C.%	25.9
100	0.149	17.60		
200	0.074	9.36		



Visual Soil Description : SAND - slightly silty grayish brown, fine to medium, pebbles, widely scattered gravels

Soil Classification: SP-SM

System: USC

SOILS SOUTHWEST INC.
Consulting Foundation Engineers

BMP
EAST Boundary

Expansion Index

ASTM D 4829

Machine No: 1
Project No: 24019-BMP
Depth (ft): 5 ft.
Location: Waalew Road, Apple Valley
Date: 5-13-24

Project Name: Weka Inc.
Lot/Boring/Trench: P2
Tract No:
Technician: JF

TEST DATA		Load: 144 lb	Ring = 1" x 4"
	Dial Reading	Time (h:m)	Date
Dry / 10 min	0	2:55	5/13/2024
Inundate	0	3:05	5/13/2024
Reading	16	3:15	5/13/2024
Reading	41.0	4:15	5/13/2024
Reading	45.0	4:35	5/13/2024
EI (measured)	52.0	8:22	5/14/2024

DEGREE OF SATURATION DATA	Test A	Test B
A. Initial Moisture Content (%)	17.14%	13.44%
B. Weight of wet soil + Ring (g)	609.20	590.40
C. Weight of Ring (g)	188.70	188.70
D. Weight of Wet Soil (g) (B-C)	420.50	401.70
E. Weight of Dry Soil (g) (D/(1 + A))	358.97	354.11
F. Wet Density (pcf) D g/cubic cm/207 cubic cm convert to pcf (x 62.4) (1gram/cubic cm = 62.4 lbs cubic foot)	126.76	121.09
G. Dry Density (pcf) E g/cubic cm/207 cubic cm convert to pcf (x 62.4)	108.21	106.75
H. Weight of Water (pcf) (A/100 x G)	18.55	14.35
I. Volume of Solids (cubic ft) (G/(2.7 sp. Gravity x 62.4))	0.64	0.63
J. Volume of Voids (cubic ft) (1-I)	0.36	0.37
Degree of saturation (%) Volume of water/volume of void x 100 H/62.4/J (%)	83.09	62.75

Expansion Potential			
	Test A	Test B	
0 - 20	N/A	↔	VERY LOW
21 - 50	N/A	↔	LOW
51 - 90	N/A	↔	MEDIUM
91 - 130	N/A	N/A	HIGH
>130	N/A	N/A	VERY HIGH

FINAL RESULTS		
Expansion Index (EI60) (A)		Final Moisture Content (%) 26.5
Expansion Index (EI60) (B)	61.00	← Note: Disregard Test (B) if Degree of Saturation is 0.0

CORRECTION FOR DEGREE OF SATURATION

EI60 = EI measured - (50-S measured) x ((65 + EI measured) / (220 - S measured))

SAN BERNARDINO COUNTY
Public Health
Environmental Health Services

385 N. Arrowhead Ave., 2nd floor, San Bernardino, CA 92415
Email: EHS.CustomerService@dph.sbcounty.gov
Website: ehs.sbcounty.gov
Text/Call: 800.442.2283
Fax: 909.387.4323

PERCOLATION TEST NOTIFICATION

Submit the form via fax, email or in person at least two working days before testing.

THIS SECTION TO BE COMPLETED BY A QUALIFIED PROFESSIONAL

QUALIFIED PROFESSIONAL'S INFORMATION

Firm Name: Soils Southwest, Inc.		Date: November 20,2024	
Firm Address: 897 Via Lata, Suite N	City: Colton	State: CA	Zip: 92324
Firm Contact Person: John Flippin	Email: soilsouthwest@aol.com	Phone Number: 909-370-0474	

SITE INFORMATION

Owner's Name: WEKA, Inc.	Assessor's Parcel Number (APN): 0440-014-11		
Site Address: Waalew Road	City: Apple Valley	State: CA	Zip: 92307
Email: wekainc@gmail.com		Phone Number: (909) 425-8700	

BILLING INFORMATION

Environmental Health Services (EHS) may need to be onsite to observe percolation testing. This will be billed at the current hourly professional rate. Provide billing information below or check one of the following if the information is the:

☐ Same as Qualified Professional's Information ☑ Same as Site Information

Billing Name:			
Billing Address:	City:	State:	Zip:
Email:		Phone Number:	

PROJECT INFORMATION

Disposal field	☐ Leach Lines	☑ Seepage Pits	☐ Alternative Treatment System	
Exploratory Boring(s)	Boring Date(s): 11-22-24	Boring Time: 8:00	Number of Borings: 3	Depth of Boring(s) in ft: 30 & 40
Testing	Test Date(s): 11-23-24	Test Time: 8:00	Number of Tests: 2	Depth of Test Hole(s) in ft: 30&4
Project Type	☐ Single Family Residence	☐ Multi-Family Residential		☑ Commercial
	Lot Size (ft²/acres): 14.86 acrs	Number of Units: n/a		Lot Size (ft²/acres): 14.86
		Lot Size (ft²/acres): 14.86		Estimated Flow: <5% to South
	Select one of the following:			
	☐ Tentative Tract (TT) #:		☐ Tentative Parcel Map (TPM) #:	
	Number of Proposed Lots:	Original Lot Size (ft²/acres): 14.86 ac	Average New Lot Size (ft²/acres): +/- 14.86 ac	

A sewer connection will be required if a sewer is available within 200 ft. of the nearest property line (add 100 ft. for each additional lot). A "Sewer Will Not Serve" letter may be required prior to submittal of the percolation report.

Site Conditions	Historic groundwater level in feet: 178	Slope in disposal area (%): +/- 5 % to south
	Source of Water: ☐ Private Well ☐ Water Purveyor	
	☐ Check box if the parcel is on Forest Service land	
	☐ Check box if the lot is within 100 feet of a river/stream	

Indemnification: The Contractor agrees to indemnify, defend (with counsel reasonably approved by County) and hold harmless the County and its authorized officers, employees, agents and volunteers from any and all claims, actions, losses, damages, and/or liability arising out of this contract from any cause whatsoever, including the acts, errors or omissions of any person and for any costs or expenses incurred by the County on account of any claim except where such indemnification is prohibited by law. This indemnification provision shall apply regardless of the existence or degree of fault of indemnities. The Contractor's indemnification obligation applies to the County's "active" as well as "passive" negligence but does not apply to the County's "sole negligence" or "willful misconduct" within the meaning of Civil Code Section 2782.

By initialing and submitting this form, you acknowledge that you have read and understand the above statement.
Initials: soilssouthwest

For Office Use Only				
Fee:	FA Number:	Record ID:		PE Number:
Late Fee: ☐ Y ☐ N	Designated Employee:		Received By:	Date:
Check One: ☐ New	☐ Transfer ☐ Reactivate	Changes (please specify):		

Automatic reply: Percolation Test Notification Form

From: EHSCustomerService (ehs.customerservice@dph.sbcounty.gov)

To: soilssouthwest@aol.com

Date: Wednesday, November 20, 2024 at 11:24 AM PST

Hello,

Thank you for your e-mail; we will respond to your request as soon as possible. In the meantime, visit our website at ehs.sbcounty.gov for more information. If your request is urgent, give us a call at 800.442.2283.

Please be aware this mailbox only accepts attachments under 25MB. Anything above that will not be received and you will not be notified of its rejection.

Thank you,

Department of Public Health
Environmental Health Services
Phone: 800.442.2283
385 N. Arrowhead Ave, 2nd Floor
San Bernardino, CA 92415

Our job is to create a county in which those who reside and invest can prosper and achieve well-being.
www.SBCounty.gov

Town of Apple Valley
Engineering

Town of Apple Valley
Engineering Department
PERCOLATION TEST NOTIFICATION

Please email form to rpedersen@applevalley.org or call (760) 240-7000 ext 7352 at least two (2) working days before testing.

THIS SECTION TO BE COMPLETED BY QUALIFIED PROFESSIONAL

QUALIFIED PROFESSIONAL INFORMATION

Firm Name: Soils Southwest, Inc.			Date: 11/20/24	
Firm Address: 897 Via Lata, Suite N		City: Colton	State: CA	Zip: 92324
Firm Contact Person: John Flippin	Email(s): soilssouthwest@aol.com		Phone Number: (909) 370-0474	

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Site Address: Waalew Road between Ramona Road and Navajo Road	City: Apple Valley	State: CA	Zip: 92307
Email(s): wekainc@gmail.com		Phone Number: (909) 425-8700	

BILLING INFORMATION

Engineering staff may need to be onsite to observe percolation testing. This will be billed at the current hourly professional rate. Provide billing information below or check one of the following:

☐ Same as Qualified Professional Information ☒ Same as Site Information

Billing Name:			
Billing Address:	City:	State:	Zip:
Email(s):		Phone Number:	

PROJECT INFORMATION

Disposal field	☒ Leach Lines	☒ Seepage Pits	☐ Alternative Treatment System	
Exploratory Boring(s)	Boring Date(s): 11-22-2024	Boring Time: 8:00 A.M.	Number of Borings: 2	Depth of Boring(s) in ft.: 40 ft and 30ft
Testing	Test Date(s): 11-23-2023	Test Time: 8:00	Number of Tests: 2	Depth of Test Hole(s) in ft.: 40ft. and 30 ft.
Project Type	☐ Single Family Residence	☐ Multi Family Residential		☒ Commercial
	Lot Size (ft²/acres): 14.86	Number of Units: n/a		Lot Size (ft²/acres): 647,297 sqft
		Lot Size (ft²/acres): 14.86		Estimated Flow: +/- 5% south
	Please select one of the following			
	☐ Tentative Tract (TT) #		☐ Tentative Parcel Map (TPM) #	
	Number of Proposed Lots: 1	Original Lot Size (ft²/acres):	Average New Lot Size (ft²/acres): 14.86	

A sewer connection will be required if a sewer is available within 200 ft. of the nearest property line (add 100 ft. for each additional lot). A "sewer will not serve" letter may be required prior to submittal of the percolation report.

Site Conditions	Historic groundwater level in feet	Slope in disposal area (%) 5% south
	Source of Water	
	☐ Private Well	☐ Water Purveyor
	☐ Check box if parcel is on Forest Service Land	
	☐ Check box if lot is within 100 feet of a river/stream	

For Office Use Only For Office Use Only For Office Use Only For Office Use Only For Office Use Only

Fee:	FA Number:	Record ID:	PE Number:
Late Fee: ☐ Y ☐ N	Designated Employee:	Received By:	Date:
Check One: ☐ New ☐ Transfer ☐ Reactivate		Changes (please specify):	

Septic Tank Maintenance Guide

Summer 2013
Vol 24, No. 1

Pipeline

Small Community Wastewater Issues Explained to the Public

Phosphorus and Onsite Wastewater Systems

In the previous Pipeline *we discussed the role of nitrogen in onsite wastewater systems, its effect on the environment, and how to reduce nitrogen discharges. In this issue of* Pipeline *we discuss phosphorus, the other major nutrient of concern found in residential wastewater, and what happens to phosphorus in the environment and in onsite wastewater systems. Phosphorus has not generally been considered to be a major problem for onsite systems. However, because of the site-specific nature of onsite wastewater treatment, in some cases it does create problems. This* Pipeline *discusses situations where and why it may be a problem and what the options are for controlling phosphorus.*

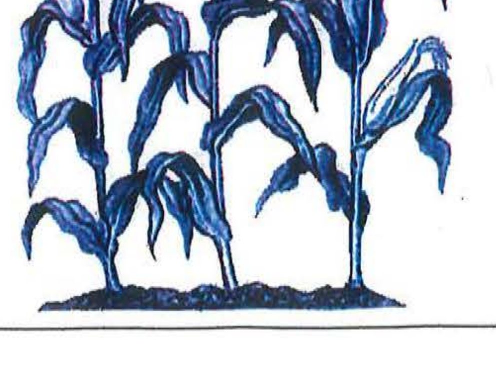
Phosphorus and the environment: The back story

Phosphorus is an essential nutrient for sustaining all life and is present in every cell in every living organism. It is an indispensable part of the important, but generally underappreciated, adenosine triphosphate molecule, which stores energy and releases it as needed for cellular activity. Phosphorus is also a key component in the structure of DNA. In vertebrates phosphorus is found in teeth and bones. It is one of the major nutrients necessary for healthy plant growth, where it plays key roles in photosynthesis and a variety of other functions such as healthy root development and seed formation.

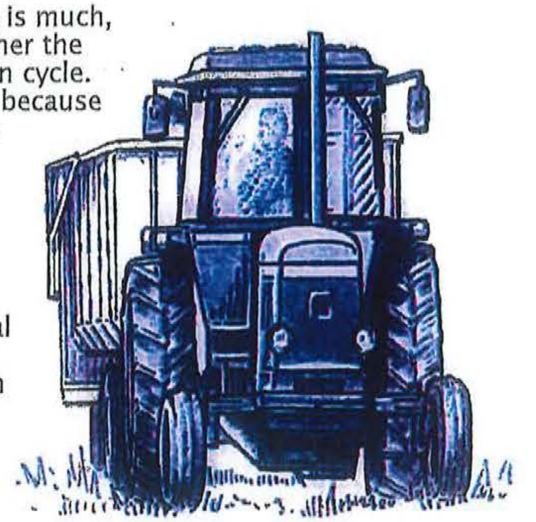
Because of its high chemical reactivity, phosphorus is rarely found in its elemental state in nature. Phosphorus atoms frequently combine with three oxygen atoms to form a composite phosphate ion with a negative three charge. The phosphate ion can then combine with other atoms and molecules to form a variety of compounds. We often use the terms phosphorus and phosphate interchangeably but a phosphorus atom is a part of the phosphate ion.

As with carbon and nitrogen, phosphorus has a natural cycle in the environment. It is present in rocks and in the soil. As rocks weather, phosphorus is released that becomes available for incorporation into soil and for uptake by plants. Phosphorus in soil that is not taken up by plants is subject to erosion by both wind and rain, and eventually finds its way into streams and rivers in a dissolved form or as components of suspended sediment. Considerable biological recycling of phosphorus occurs both in terrestrial and aquatic environments—animals consume plants containing phosphorus and excrete wastes containing phosphorus that then becomes available for use by other plants, animals, and microbes.

Ultimately, phosphorus ends up in the oceans where, after more biological



recycling by marine plankton and other organisms, it is deposited on the ocean floor. Over periods of millions of years ocean sediments become compressed and consolidated into layers of rock. These ocean-floor rock layers eventually are subject to geologic uplift into above-sea-level mountains that are again subject to weathering and erosion, completing the cycle. Because we are talking about geologic time scales, the phosphorus cycle is much, much slower than either the carbon or the nitrogen cycle. This is at least partly because phosphorus does not naturally exist in a gaseous state to any significant extent. As a result there is no atmospheric cycling of phosphorus between the terrestrial and marine environments as there is with carbon and nitrogen.



The key role of phosphorus in enhancing plant growth was scientifically verified less than 200 years ago. Before that farmers, without knowing exactly how or why it helped, had learned to add substances that contained phosphorus to croplands. Historically these were mainly animal manures, plant residues, or human waste products. Within the last 100 years, however, the mining of phosphate-bearing rock deposits that are then industrially processed has been the main source of agricultural phosphorus fertilizers. About 80 to 90 percent of the mined phosphate rock is made into fertilizer with the remainder being used in food and beverages, detergents, industrial processes, and animal feeds. The availability of mass amounts of phosphate fertilizer contributed to the "Green Revolution" that dramatically increased global food production, in turn allowing global population to increase from about 1.6 billion people in 1900 to more than seven billion people today.

However, because phosphate rock deposits are formed only over long geologic time periods, from the human perspective, phosphorus is a finite resource that is being rapidly consumed. Accelerated mining and consumption of phosphate rock have essentially turned the phosphorus cycle into a one-way transfer of phosphorus from the land to the ocean bottoms. The phosphorus is not destroyed, but it is dispersed to the ocean floor where recovery is economically not feasible.

Because the easily accessible, high-quality phosphate rock deposits are being depleted there have been discussions in the past 10 years of phosphorus production peaking and declining, which raises concerns about the ability to keep the world fed. Others believe that new deposits of phosphorus will be discovered and made available averting any potential global food security crisis. It is likely, however, that newly discovered deposits will require more energy to mine, process, and purify. As a result, regardless of it relative availability, phosphorus is expected to become a more expensive resource in the near future.

As with nitrogen, the dramatic increase in the agricultural use of phosphorus during the past 100 years has brought some unintended, negative consequences. Phosphorus is not a selective fertilizer. When soil that contains phosphorus is eroded by wind or rain, phosphorus ends up in streams

National Environmental Services Center
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Joyce Taylor, RUS Loan Specialist and Project Officer
U.S. Department of Agriculture's
Rural Development Rural Utilities Service

Office of Wastewater Management

National Enviromental Services Center
West Virginia University, Morgantown, WV

Dr. Gerald Iwan — Executive Director
Mark Kemp — Communications Manager / Editor
Craig Mains — Author/Technical Advisor
Zane Satterfield — Technical Advisor
John Fekete — Senior Project Coordinator

and lakes where it can stimulate biological activity beyond normal levels, a condition referred to as eutrophication. This often results in the overabundant growth of undesirable algae, referred to as a harmful algal bloom.

The frequency and severity of harmful algal blooms in lakes and rivers is increasing globally.

Undesirable or harmful algal blooms create a number of problems besides being unsightly. Individual algae are short-lived and as they die and decompose they consume dissolved oxygen. Low-oxygen conditions, referred to as hypoxia, can lead to fish kills, loss of other aquatic life, and noxious conditions. Algal blooms can also shade out native rooted aquatic plants and negatively shift the ecological balance in aquatic environments.

Certain types of algae called cyanobacteria, also referred to as blue-green algae, produce potent toxins that are harmful to humans and aquatic life. Blooms of cyanobacteria have become increasingly more frequent in freshwater lakes in the U.S. in the last 20 years. Because cyanobacteria can fix nitrogen from the atmosphere, they can bloom in water bodies that are low in nitrogen if sufficient phosphorus is present. The toxins can be ingested by swimmers and boaters who are in direct contact with the water. However, under certain conditions the toxins can also become aerosolized and inhaled by others at a distance from their source. The toxins can be removed from drinking water sources but at an added cost.

It is generally accepted that phosphorus is usually the limiting nutrient when it comes to eutrophication of freshwater resources and nitrogen is usually the limiting nutrient in offshore waters and estuaries. The limiting nutrient is the nutrient in least supply relative to its demand and controls the amount of biological growth taking place. Concentrations of total phosphorus in the range of 0.02 to 0.03 mg/l have been shown to stimulate algal growth in many North American freshwater lakes.

In the 1960s, widespread eutrophication of lakes and rivers attributed to phosphate pollution became a public concern leading to 27 states passing full or partial bans on laundry detergents containing phosphate. Detergent manufacturers voluntarily phased out the use of phosphates in laundry detergents nationally in 1994. More recently, attention has focused on dishwasher detergents containing phosphates. Because automatic dishwashers were not as common in the 1960s, dishwasher detergents were not included in the initial bans. In response to 16 states passing bans limiting phosphates in dishwashing detergents, in 2010 the detergent industry greatly reduced the use of phosphates in domestic dishwasher detergents nationally from 8.7 percent to no more than 0.5 percent. Phosphates are still present in consumer products such as some hair dyes, toothpastes, mouth washes, liquid hand soaps, and shampoos.

Although phosphate bans and other actions taken to control phosphate have helped, the continued application of phosphate fertilizers and animal manures along with population growth means that phosphate contamination continues to be an issue. Currently, the U.S. Environmental Protection Agency estimates more than 100,000 miles of streams; about 2.5 million acres of lakes, reservoirs, and ponds; and 800 square miles of bays and estuaries have poor water quality due to excess nutrients including phosphorus.

This satellite image shows the extent of a blue-green algae bloom in the western section of Lake Erie in 2011. An unusually wet spring, which generated high levels of nutrients in runoff, followed by warmer weather contributed to the worst algal bloom in Lake Erie since the 1960s.

Photo credit: MERIS/NASA; processed by NOAA/NOS/NCCOS

Phosphorus in Wastewater

Phosphorus in wastewater is categorized as either inorganic or organic phosphorus. Inorganic phosphorus includes relatively simple forms of phosphates referred to as reactive or ortho-phosphates consisting of one phosphate ion and zero to three hydrogen ions, depending on the pH level. Condensed phosphates or polyphosphates, also categorized as inorganic, are somewhat more complex chemical structures with more than one phosphorus atom linked together in each molecule. Most polyphosphates originate in detergents and other cleaning products and eventually decompose into ortho-phosphates. Organic phosphorus includes phosphorus incorporated into undigested food residue and dead and living bacteria that are present in feces. Some organic phosphorus is also present in uneaten food scraps that are part of the wastewater stream.

Phosphorus in water and wastewater is typically measured as total phosphorus, which includes both inorganic and organic forms of phosphorus. The concentration of total phosphorus in raw wastewater is quite variable from household to household. A 2008 survey of 17 residences in three regions of the U.S. found total phosphorus concentrations ranging from 0.2 to 32 mg P/l with a median value of 10.4 mg/l. A 1991 study estimated that the average person in the US generates about 2.7 grams of phosphorus per day with approximately 59 percent of the phosphorus coming from toilets; 37 percent from sinks, showers, and appliances; and four percent from kitchen garbage disposals. Due to the 1994 ban on phosphates in laundry detergents and the 2010 ban affecting dishwashing detergents the average amount generated per person has decreased and it has been estimated that as much as 75 percent of phosphorus may now be contained in toilet wastewater.

For toilet wastes, approximately two-thirds of the phosphorus is contained in urine, with the remainder found in feces. The total amount of phosphorus excreted varies from person to person depending on diet and other factors. The approximately two-to-one ratio between the amount of phosphorus found in urine to that in feces, however, is fairly consistent.

On a national basis the majority of phosphorus released to the environment by human activity comes from agriculture. Current data are not available. However, a 1984 study estimated that 72 percent came from agriculture, split evenly between fertilizer application and manure application. Five percent came from wastewater treatment plants and the remaining 22 percent came from all other non-point sources, including onsite wastewater systems.

Agriculture and domestic wastewater are closely connected when it comes to phosphorus. Phosphorus applied by farmers ends up in the foods we eat. Any excess phosphorus our bodies don't need is excreted and ends up in our wastewater. Our wastewater is now being viewed by many as a potential source of phosphate and other nutrients to be recycled for agricultural use. As the availability of easily mined, high-quality rock phosphate declines and the need to make agriculture more sustainable becomes more apparent, wastewater will increasingly be seen more as a resource and less as a waste product.

What happens to phosphorus in onsite wastewater systems?

The concern with phosphorus in onsite systems is that the concentration of phosphorus in wastewater is usually hundreds of times higher than that needed to stimulate algal growth in surface water. Fortunately, compared to other wastewater constituents, phosphorus is not very mobile. In most cases, phosphorus is effectively retained in the soils below drainfields (or soil absorption systems), preventing much phosphorus from being released to streams and lakes. As a result phosphorus from onsite wastewater systems has historically been lightly regulated and added treatment for phosphorus reduction is still rare. The science underlying how phosphorus is retained by soils, however, is complex and varies with soil types.

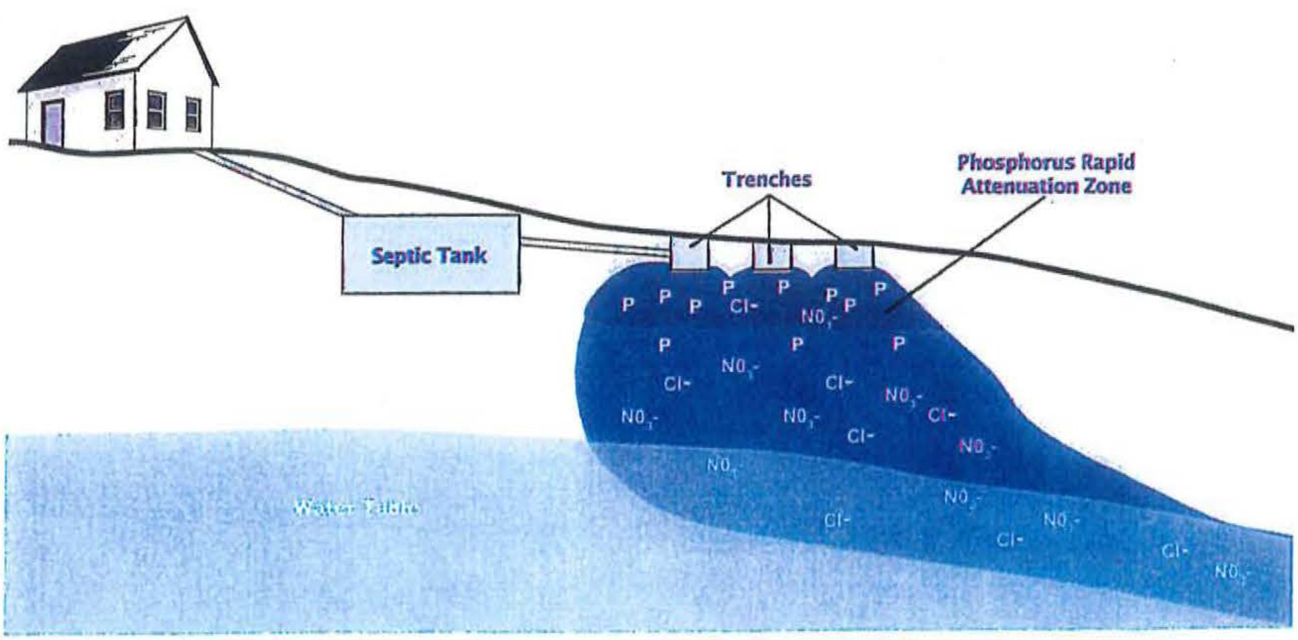
Some phosphorus is removed as the wastewater flows through the septic tank. Some studies have estimated that as much as 20 to 30 percent of phosphorus becomes part of the settled solids in the septic tank. A 2008 study indicated less than six percent removal of phosphorus occurs in septic tanks, however. The concentration of total phosphorus in septic tank effluent, the liquid exiting the septic tank, varies widely from household to household but the median value is approximately 10 mg/l.

As the wastewater leaves the septic tank and is dispersed to the unsaturated soil beneath the drainfield, phosphorus is retained due to two chemical processes: precipitation and adsorption. Precipitation occurs when negatively charged phosphate anions react chemically with positively charged cations to form a solid mineral that is immobilized in the soil. Common cations that react with phosphate to form minerals are iron (both Fe^{+2} and Fe^{+3}), aluminum (Al^{+3}), and calcium (Ca^{+2}). Phosphate also reacts with oxides of iron, aluminum, and calcium to form stable phosphate-metal complexes.

The extent to which precipitation occurs in soil depends on a number of factors including soil pH, the oxidation/reduction status of the soil, the relative availability of cations to react with phosphate, and whether a soil is calcareous or non-calcareous. Calcareous soils are soils of marine origin that have a significant calcium carbonate content and tend to be alkaline in nature. Non-calcareous soils tend to be acidic rather than alkaline. Cations such as iron and aluminum that can react effectively with phosphate are generally more available in non-calcareous soils. Although phosphate reacts with calcium in calcareous soils, it is more effectively immobilized by iron and aluminum in non-calcareous soils.

The other way phosphate is immobilized is through adsorption. Adsorption occurs when phosphate anions are attracted to and bind to positively charged mineral particle surfaces. Binding by adsorption is not as strong as precipitation reactions and is considered more reversible. Adsorption is limited by the number of adsorption sites available. The capacity for precipitation is also finite but can continue as long as cations are available and there is space in the soil for the precipitating solid.

As with precipitation, adsorption is more effective in acidic environments than alkaline environments. Adsorption



In many onsite wastewater systems, phosphorus (P) is effectively immobilized within the first two or three feet of soil below drainfield trenches. This area has been referred to as the Phosphorus Rapid Attenuation Zone or Phosphorus Enrichment Zone. This is in contrast to the plume associated with other more mobile wastewater constituents such as nitrate (NO_3^-) and chloride (Cl^-). The extent of movement of phosphorus varies from system to system but is almost always less than that of NO_3^- and Cl^-.

relies on negatively charged phosphate anions being attracted to positively charged surfaces including aluminum and iron oxides and hydroxides and clay minerals. The surface charge of the minerals can vary under different conditions. In alkaline conditions, such as in calcareous soils, the net surface charge is more likely to be negative in which case little or no adsorption is likely to occur.

Precipitation and adsorption quickly and effectively retard the movement of phosphorus in many drainfield soils to the extent that there is a zone of phosphorus enrichment or accumulation within the first meter below the drainfield lines. This zone, which includes the biomat, has been referred to as the Phosphorus Rapid Attenuation Zone.

Precipitation and adsorption are less effective once any remaining phosphorus reaches groundwater. The movement of phosphorus in groundwater is still slower however than the movement of more mobile, less reactive anions such as nitrate and chloride. Studies that have plotted the movement of groundwater plumes of septic system contaminants almost always show a considerably longer plume for nitrates and chlorides compared to phosphate, even in situations where conditions for phosphate immobilization may not be ideal. The extent to which phosphorus migration is retarded is variable and site-specific.

Nevertheless, there are circumstances where phosphorus from onsite wastewater systems can contribute to pollution of lakes or streams. Some of the factors that contribute to problem sites include:

- Calcareous soils;
- Coarse-grained soils such as sandy and gravelly soils that allow rapid flow rates;
- Households that generate more wastewater than their septic systems were designed to handle;
- Drainfields with thin soils, shallow bedrock, or high water tables;
- Systems with drainfields close to lakes or streams;
- Areas where onsite systems are densely sited;
- Systems where the septic tank effluent is not uniformly distributed across the drainfield; or
- Older or substandard systems such as cesspools, which may be in direct contact with groundwater during part of the year.

Problem areas often occur due to the combination of multiple factors. For example, numerous lake-front communities with closely sited homes, with drainfields in sandy or gravelly soils close to the lake shore have experienced problems with noxious algal blooms. In cases such as these, where drainfield soils are not capable of immobilizing phosphorus, some additional action may be necessary in order to restore lake water quality.

Phosphorus Reduction Options

A number of options can be used in situations where phosphorus from onsite wastewater systems has been identified as a problem. These options can be categorized as source diversion, advanced treatment, and drainfield modifications. Because concern with phosphorus from onsite wastewater systems is fairly recent treatment approaches are continuing to evolve.

Source Diversion

Because 60 to 75 percent of phosphorus is contained in toilet wastewater, referred to as blackwater, removing the blackwater from the wastewater stream can greatly reduce the amount of phosphorus discharged from an onsite system. This has been achieved through the use of composting toilets, urine-diverting toilets, and holding tanks. The remaining wastewater in the household from other fixtures goes to the septic system or a grey water system.

Composting toilets collect toilet waste in a chamber below the toilet. The system is designed so that the contents compost or decompose biologically into a humus-like material that needs to be removed periodically. There are a wide variety of models of composting toilets available including ones that use a small amount of flush water and are able to evaporate off any excess liquid that might interfere with the composting process. Because most composting toilets capture all of the blackwater they can potentially remove as much as 75 percent of the phosphorus,

The fully composted material must occasionally be removed by a service provider or the homeowner. Some states have rules regarding the acceptable disposal of the composted material. Appropriate use or disposal of the compost is necessary so that the phosphorus problem is not simply transferred from one location to another.

Urine-diverting toilets remove urine from the wastewater stream to then be disposed of separately. These toilets are constructed with a barrier in the bowl that separates urine from solid toilet waste.

Urine is deposited in the front chamber and feces and toilet paper in the rear chamber. The front chamber has a separate line that allows urine to be collected in a storage tank. The urine can be processed for use as either a liquid or a solid fertilizer. Because urine contains about two-thirds of the phosphorus in blackwater, urine diversion has the potential to remove 35 to 50 percent of phosphorus from residential wastewater. The effectiveness of the toilet at diverting urine depends upon the correct use of the toilet by the users.

Urine-diverting toilets are not common in the U.S. at this time. However, they have been successfully used in other countries, particularly in planned communities in Europe. Their use in the U.S. has been limited by their unfamiliarity and the lack of a well-established system to collect, process, and reuse the urine agriculturally. However, urine harvesting is beginning to draw more interest in the U.S. and this is expected to increase as the benefits of capturing the nutrients in urine for agricultural use becomes more evident.

In some cases, households may be permitted to divert their toilet waste to a holding tank. The contents of the tank must be periodically pumped and transported to a wastewater treatment plant. Many health departments view holding tanks as a last-resort option and because of the cost of regular pumping this is an expensive option. With the use of a micro-flush toilet the intervals between pumping can be extended helping to reduce costs.

Advanced Treatment

Although advanced treatment systems for phosphorus reduction in onsite systems are still uncommon in the U.S., a number of units are available commercially. A variety of approaches to phosphorus reduction have been made but the most common method has been through the use of reactive media filters. These are modular units that are installed between the septic tank and the drainfield.

Media filters, such as sand or gravel filters, have been used for decades to provide an additional level of wastewater treatment for onsite systems. The difference with phosphorus removal systems is that a medium or combination of media are added that react specifically to immobilize phosphorus. Typically, the media contain some combination of iron, aluminum, or calcium compounds and the reactions are similar to the adsorption and precipitation reactions that occur in soil. The goal is to enhance and maximize the reactions in a more controlled environment.

The types of media used have been categorized as natural, manufactured, and industrial by-products. Natural media include iron-rich soils and peat, which may be supplemented with additional materials to increase their affinity for phosphorus. Other natural materials that have been tested include limestone, bauxite (aluminum ore), bentonite (a type of clay), and lignocellulose fibers, among others.

Manufactured materials include light-weight clay aggregates, which have been processed to expand the clay structure to provide greater surface area. Phosphorus removal for systems using light-weight aggregates have achieved greater than 90 percent phosphorus removal in test facilities. Filtralite® and Utelite® are two brands of manufactured clay aggregates that have been used for phosphorus removal media.

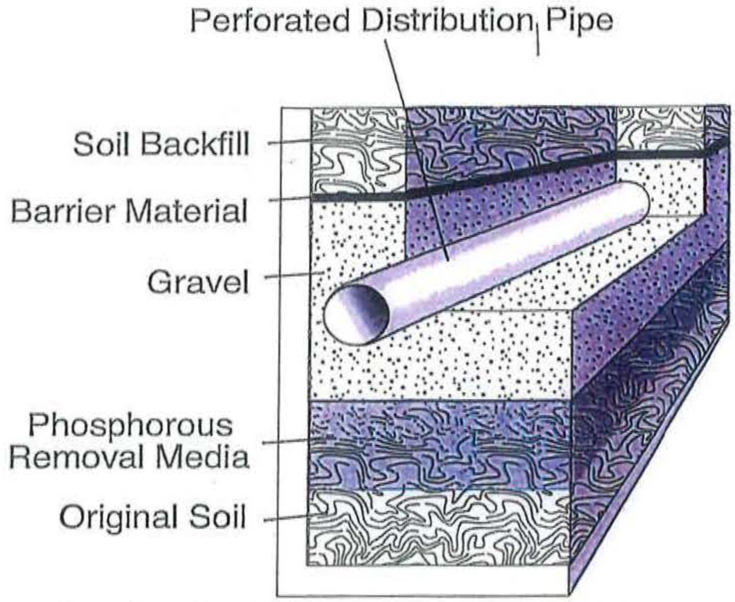
Separating urine from the wastewater of residences or public facilities through the use of urine-diverting toilets or urinals can potentially reduce phosphorus loading to onsite wastewater systems by as much as 50 percent.

A wide variety of industrial by-products have been investigated for use in reactive media filters including different types of blast furnace or steel furnace slags and alkaline fly ash from coal-fired power plants. The composition of industrial slags varies depending on the type of industrial process that generated the slag. A high rate of phosphorus removal has been documented using some slags. However, a drawback with some slags is that they generate a high pH in the water exiting the filter, which means an extra treatment step may be needed to neutralize the pH before final dispersal.

Recently there has been much interest in the use of nanomaterials for phosphorus removal. As the overall surface area of a medium increases the number of attachment sites for phosphorus also increases. Because of the extremely small size of nanoparticles, the total surface area exposed is greatly increased, potentially giving these materials a much higher capacity for phosphorus removal than other media. Iron-based nano-materials have been coated onto base media and have also been incorporated into resins that can be regenerated once their phosphorus removal capacity has been reached. As with other media, because the demand for phosphorus removal is fairly recent, research and knowledge of the effectiveness and economic practicality of different media are continually developing.

Drainfield Modifications

Because phosphorus related problems from septic systems have been perceived as rare, proposed sites for septic systems are seldom evaluated for their capacity to immobilize phosphorus. However, in the future, especially in sensitive watersheds or in the vicinity of an impaired water body, it is likely that soils may be evaluated more frequently for their ability to capture phosphorus.



A number of media have been suggested for use in drainfield trenches to capture phosphorus. The medium is added between the bottom of the drainfield line and the trench bottom. A suitable medium must have a high capacity to immobilize phosphorus and sufficient permeability. Since it will eventually need to be replaced it should have as long a lifespan as possible.

In soils that are determined to have an inadequate or marginal capacity, in addition to advanced treatment, modification of the drainfield may also be considered.

One modification that has been suggested for marginal soils is timed, pressurized dosing of septic tank effluent to equalize flow over the entire drainfield. This eliminates the localized, saturated flow conditions that often occur after surge flows in conventional gravity-flow systems. Another suggestion has been the use of shallow dispersal options, especially the use of drip distribution systems in which the effluent is dispersed within the root zone of plants, which can then biologically take up phosphorus and incorporate it into plant tissue. These are more effective if any resulting non-woody plants are occasionally harvested to prevent localized phosphorus accumulation.

Research is also being conducted on adding a layer of material with a high capacity for immobilizing phosphorus to the drainfield. These materials would be added to the drainfield trenches between the drainlines and the original soil. Numerous materials have been considered including replacing gravel used in drainfields with limestone or tire chips. The effectiveness of tire chips comes from exposure of the iron present in steel belts. Many of the media that have been suggested for use in reactive media filters such as imported iron or aluminum-rich soils, industrial slag, or clay aggregates may also be candidates for incorporation into drainfield trenches.

The criteria for these types of drainfield amendments include a sufficient capacity to immobilize phosphorus and a texture that allows flow that is slow enough to provide adequate contact time but not so slow as to cause excessive ponding. Because the material will eventually need to be replaced it is important that the material have a long lifespan so the need for replacement is infrequent. It is preferable if the spent material can be reused for horticultural or agricultural purposes. Cost considerations are, as always, a factor as well.

Because the need for better control of phosphorus from onsite wastewater systems is a slowly emerging issue, the options for dealing with it are also continuing to develop. As the need to better protect water resources and rehabilitate nutrient-impaired water bodies becomes more necessary it is likely that additional options for phosphorus control will also become available in the future.

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