



# MAIN-LAND

DEVELOPMENT  
CONSULTANTS, INC.

ENGINEERS, SURVEYORS, SCIENTISTS

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August 6, 2024

Mr. Ethan Braley  
10 Willow Lane  
Arundel, ME 04046

SUBJECT: Nitrate Assessment of Proposed Septic Systems  
Proposed 3-Lot Subdivision  
Old Post Road  
Arundel, Maine

Dear Ethan,

Main-Land Development Consultants Inc. (Main-Land) is pleased to provide the following assessment of nitrate migration from proposed single- and multi-family residential septic systems on the subject project. It is understood you have requested this assessment as part of the local permitting process with the Town of Arundel, Maine.

## Assessment Input and Assumptions

You provided Main-Land with soil mapping and test pit information which has been compiled for the project by others. Main-Land reviewed the mapping and logs to determine that the site soils are generally mapped as glacial till. Soil mapping and the USDA York County Soil Survey suggest the soils are similar to the Lyman series soils which are moderately well-drained, stony fine sandy loams.

Based on a review of the soil descriptions, related gradations, and tables of *Estimated Engineering Properties* in the Soil Survey, the tills range in permeability from approximately 4 to 12 feet/day in the more friable soils above the hardpan layer. Based on this, Main-Land has used an estimated permeability,  $k$ , of 8 feet/day.

Main-Land performed a nitrate-nitrogen attenuation analysis based on the Baetsle equation for modeling migration of a substance (nitrate) dissolved in groundwater through porous media. This approach allows an estimate of nitrate plume concentrations relative to time, distance, and initial concentration from a constant point source, the proposed leachfields in this case. Ultimately, this approach allows an estimate of the distribution of steady state plume concentrations downgradient from the constant point source represented by a residential leachfield.

Other input parameters for the Baetsle equation include the following:

Based on soil type and estimated in-situ density, the effective porosity,  $n$ , of 0.33 has been assigned. The gradient of the seasonal high groundwater surface has generally been taken as similar to the ground surface

gradient. For example, a groundwater seepage velocity,  $V$ , for a site with 4% gradient,  $k = 8$  ft/day, and  $n = 0.33$  is found as:

$$V = ki/n = (8 \text{ ft/day})(0.04)/0.33 = 1 \text{ ft/day}$$

This velocity is used to determine dispersion coefficients for the x, y, and z directions downgradient of the leachfield used in the Baetsle analysis.

This analysis was made assuming 90 gallons per day per bedroom wastewater flow for the modeled leachfields (i.e., duplex of 2 bedrooms per unit = 4 bedrooms total = 360 gpd), an initial nitrate concentration of 40 mg/l in wastewater, with no dilution by coincident rainwater, and depth of flow in the soil ranging from 1 to 2 feet deep. The natural background nitrate concentration is likely to range from negligible to perhaps <0.5 mg/l (Note: these are typical parameters Main-Land uses for sites related to DEP-reviewed and approved projects).

### Assessment Results

Main-Land assessed the potential leachfield siting scenarios at each of the three proposed lots of the proposed subdivision. Assessment inputs included approximate groundwater surface gradients and inferred groundwater flow directions. The sites and input parameters to the nitrate analysis, as well as the estimated distance to the outer edge of the 10 mg/l nitrate concentration, are summarized as follows:

Lot/Test Pit	Description/GPD	Estimated gradient	Distance to edge of 10 mg/l plume
Lot 1/TP9	Gradient generally southward toward a down-gradient property line/480 gpd	5%	34 feet
Lot 2/TP15	Gradient generally northeastward toward a down-gradient property line/360 gpd	2.5%	48 feet
Lot 3/TP13	Gradient generally eastward toward a down-gradient property line/360 gpd	2.5%	48 feet

The greatest distance the 10 mg/l edge of plume extends to is approximately 48 feet from the down-gradient edge of the proposed leachfields for Lots 2 and 3. For Lot 3, the proposed leachfield location should be shifted about 10 feet southwesterly away from the nearest property line so as to maintain the nitrate setback of 48 feet and the well setback of 100 feet.

The analyses indicate that the 10 mg/l nitrate concentration would not be exceeded at a down-gradient property boundary greater than approximately 48 feet from the leachfield, or at a proposed well (which needs to be by Code at least 100 feet from the leachfield). Based on a review of the proposed lot configurations and potential leachfield locations, none of these potential leachfields will result in 10 mg/l exceedances at a project boundary. It is also noted that the estimated plumes reach a steady state by the 10-year time period modeled.

Summaries of the Baetsle analysis for the three cases above modeling the 10 mg/l concentration limit of the nitrate plume are attached. Main-Land has attached a sketch based on a provided proposed site plan. This

sketch depicts interpreted groundwater flow directions (blue arrows) from the proposed leachfields and the estimated shape of the 10 mg/l concentration limit (red dashed lines).

## Closure

Based on a review of the proposed lot configurations and potential leachfield locations, none of these potential leachfields will result in 10 mg/l exceedances at a project boundary or proposed well location. Please do not hesitate to contact Main-Land with any questions or if we be of further service to you on this project.

Sincerely,

Main-Land Development Consultants, Inc.



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Scott R. Dixon, P.E., C.G., L.S.E.  
Senior Chief Scientist

Attachments: Detailed calculations for Lots 1-3 concept leachfield locations

## REFERENCES

Chang, Tan-yueh "Philip", et. al., *Utilizing Baetsle's Equation to Model the Fate and Transport of MTBE in Groundwater*, Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water Prevention, Detection, and Remediation Conference, 1998, Houston, Texas.

Freeze, R. Allan, and Cherry, John A., 1979, *Groundwater*, Prentice-Hall publisher, Englewood Cliffs, New Jersey.

United States Dept. of Agriculture, Soil Conservation Service, *Soil Survey of York County, Maine*, issued June 1982.



Spreadsheet for Nitrate attenuation after Baetsle and Chang: Lot 1/TP9 10 mg/l isograd  
 Proposed 3-Lot subdivision for E. Braley, Arundel, ME

$$C(x,y,z,t) = [CoVo/8(\pi t)^{1.5}((DxDyDz)^{-5}) e^{-((x-vt)^2/4Dxt)-(y^2/4Dyt)-(z^2/4Dzt)}]$$

Co = nitrate initial concentration

Vo = daily volume

T = time in days

Dxyt = Dispersion coefficient in x,y,z directions

x = distance of interest from source, parallel to g.w. flow

v = g.w. velocity

n = porosity 0.33

D = av

ax = dispersivity in x direction = (0.83)[(log<sub>10</sub>(Lp))<sup>2.414</sup>

Lp = vt

k=hydr. Cond 8 ft/day

i=gradient 0.05 ft/ft

Variables:

g.w. velocity 1.21 ft/day

time 3650 days

x, from source 34 feet

10.10301 mg/l

AFTER

10.0 years

y, from source cl 0 feet

z, from source cl 2 feet

Volume 480 gal/day

64.171123 cubic feet

Lp, plume length

to center of mass 4424.242424 feet

ax 42.77443363

ay 14.25814454

az 2.138721682

Dx 51.84779834

Dy 17.28259945

Dz 2.592389917

Initial concen 40

Spreadsheet for Nitrate attenuation after Baetsle and Chang: Lot 2/TP15 10 mg/l isograd  
 Proposed 3-Lot subdivision for E. Braley, Arundel, ME

$$C(x,y,z,t) = [CoVo/8(\pi t)^{1.5}((DxDyDz)^{-5}) e^{-((x-vt)^2/4Dxt)-(y^2/4Dyt)-(z^2/4Dzt)}]$$

Co = nitrate initial concentration

Vo = daily volume

T = time in days

Dxyt = Dispersion coefficient in x,y,z directions

x = distance of interest from source, parallel to g.w. flow

v = g.w. velocity

n = porosity 0.33

D = av

ax = dispersivity in x direction = (0.83)[(log<sub>10</sub>(Lp))<sup>2.414</sup>

Lp = vt

k=hydr. Cond 8 ft/day

i=gradient 0.025 ft/ft

Variables:

g.w. velocity 0.61 ft/day

time 3650 days

x, from source 48 feet

10.00813 mg/l

AFTER

10.0 years

y, from source cl 0 feet

z, from source cl 1 feet

Volume 360 gal/day

48.1283422 cubic feet

Lp, plume length

to center of mass 2212.121212 feet

ax 33.50964379

ay 11.16988126

az 1.675482189

Dx 20.30887502

Dy 6.769625008

Dz 1.015443751

Initial concen 40

Spreadsheet for Nitrate attenuation after Baetsle and Chang: Lot 3/TP13 10 mg/l isograd  
 Proposed 3-Lot subdivision for E. Braley, Arundel, ME

$$C(x,y,z,t) = [CoVo/8(\pi t)^{1.5}((DxDyDz)^{-5}) e^{-((x-vt)^2/4Dxt)-(y^2/4Dyt)-(z^2/4Dzt)}]$$

Co = nitrate initial concentration

Vo = daily volume

T = time in days

Dxyt = Dispersion coefficient in x,y,z directions

x = distance of interest from source, parallel to g.w. flow

v = g.w. velocity

n = porosity 0.33

D = av

ax = dispersivity in x direction = (0.83)[(log<sub>10</sub>(Lp))<sup>2.414</sup>

Lp = vt

k=hydr. Cond 8 ft/day

i=gradient 0.025 ft/ft

Variables:

g.w. velocity 0.61 ft/day

time 3650 days

x, from source 48 feet

10.00813 mg/l

AFTER

10.0 years

y, from source cl 0 feet

z, from source cl 1 feet

Volume 360 gal/day

48.1283422 cubic feet

Lp, plume length

to center of mass 2212.121212 feet

ax 33.50964379

ay 11.16988126

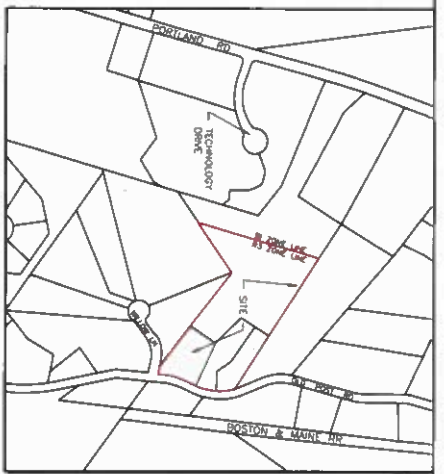
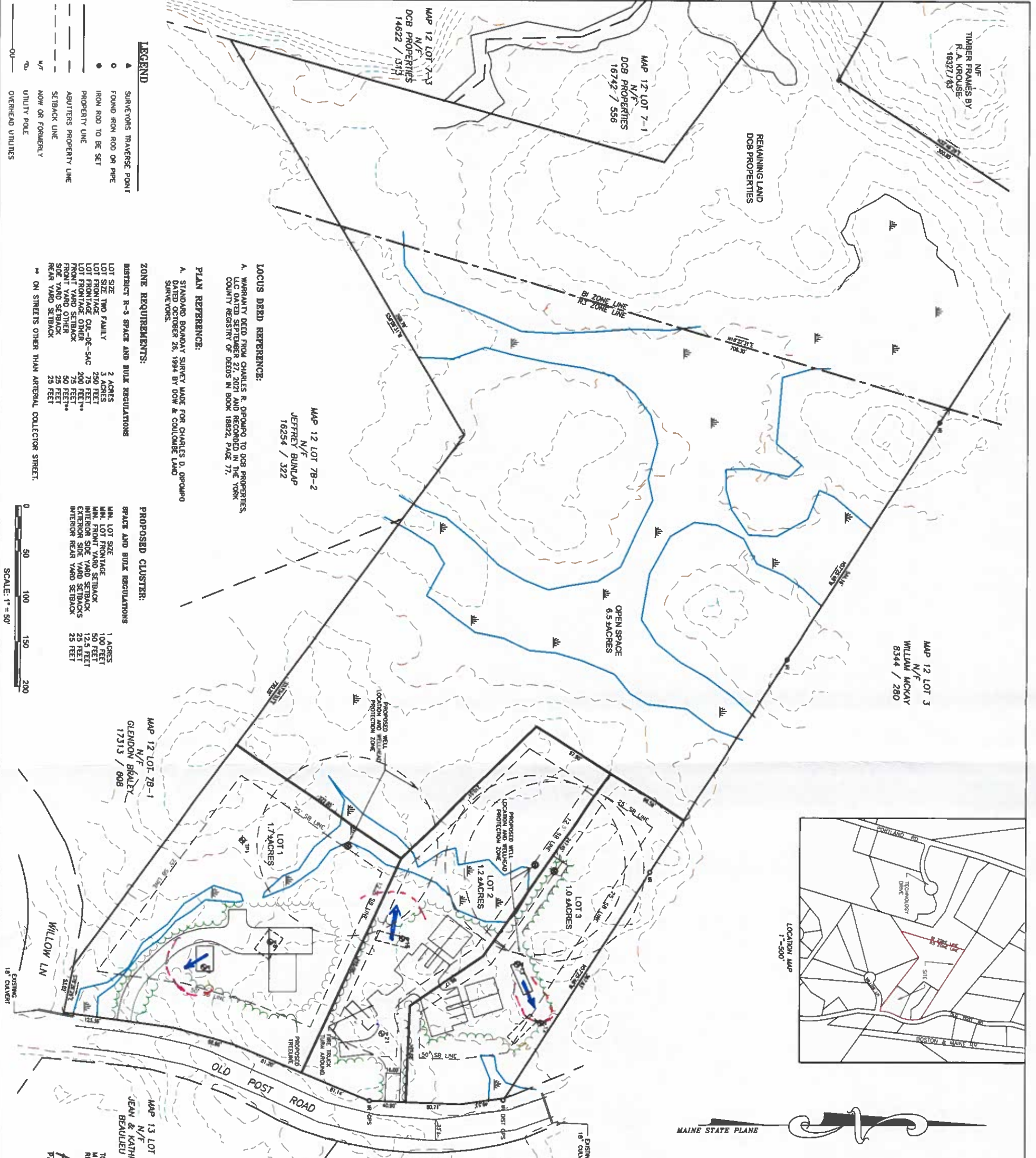
az 1.675482189

Dx 20.30887502

Dy 6.769625008

Dz 1.015443751

Initial concen 40



- NOTES:**
1. RECORD OWNER: DCB PROPERTIES LLC  
388 BOOM ROAD  
SACO, MAINE
  2. NAME OF APPLICANT: ETHAN BRALEY  
WILLOW MAINE  
ARUNDEL, MAINE
  3. MAP / LOT: 12 / 6
  4. TOTAL AREA OF PROPERTY 21.80 ACRES.
  5. PROPERTY IS LOCATED IN THE R1 AND R3 ZONES.
  6. PROJECT TO BE SERVICED BY ON LOT DRILLED WELLS AND SEPTIC.
  7. WETLAND DELINEATION, SOIL LOGS AND HIGH INTENSITY SOIL MAPPING BY CORPI ENVIRONMENTAL, LLC.
  8. THE PROPERTY IS NOT LOCATED IN A FEMA FLOOD ZONE.
  9. THE PROJECT HORIZONTAL DATUM: MAINE STATE PLANE COORDINATE SYSTEM, MAINE ZONE. PROJECT VERTICAL DATUM: NORTH AMERICAN DATUM 1988 (NAVD88). ALL DATA WAS DERIVED USING LEICA GS14 REAL TIME KINEMATIC GPS.
  10. WETLANDS SHOWN ON THIS PLAN WERE LOCATED USING GLOBAL POSITIONING SYSTEMS (GPS) TECHNOLOGY. ALL GPS LOCATED POINTS HAVE A VARYING DEGREE OF ACCURACY AND MAY NOT REPRESENT THE ACTUAL FIELD LOCATION, THEREFORE WETLAND FLAGS WITHIN THE DEVELOPMENT AREA MAY NEED TO BE SURVEY LOCATED PRIOR TO ENGINEERING / ARCHITECTURAL DESIGN TO DETERMINE ALL APPLICABLE SETBACKS.
  11. TOPOGRAPHIC INFORMATION WAS DERIVED FROM THE MAINE GIS WEBSITE.
  12. UTILITY INFORMATION DERIVED HEREON IS COMPILED USING PHYSICAL EVIDENCE LOCATED IN THE FIELD. UTILITIES DEPICTED HEREON MAY NOT NECESSARILY REPRESENT ALL EXISTING UTILITIES. CONTRACTOR AND / OR DESIGNERS NEED TO CONTACT ONE-SAFE SYSTEMS, INC. (1-888-ONE-SAFE) AND FIELD VERIFY EXISTING UTILITIES PRIOR TO BUILDING DESIGN, CONSTRUCTION AND/OR EXCAVATION.

**NET DENSITY CALCULATIONS:**

TOTAL AREA OF PROPERTY	454,628 SF
LESS WETLANDS	97,316 SF
LESS SHARED DRIVE	3,112 SF
NET DENSITY	354,200 SF (8.13 ACRES)
REQUIRED AREA:	
2-DUPLEX LOTS	6 ACRES
1-SINGLE FAMILY	6 ACRES

**KEY TO MAIN-LAND EDITS \***

Estimated groundwater flow direction

Estimated edge of 10' water table

\* for letter dated 8/6/24

BETTY BRICKKITES

MAP 13 LOT 2 N/F

Received \_\_\_\_\_ m \_\_\_\_\_ M. and \_\_\_\_\_

Filed in Plan Book \_\_\_\_\_ Page \_\_\_\_\_

ATTEST: \_\_\_\_\_ Register

**APPROVAL**

**TOWN OF ARUNDEL**

**PLANNING BOARD**

DATE \_\_\_\_\_

CHAMBERLAIN

MAP 13 LOT 2A N/F

JEAN & KATHRYN BEAULIEU

TO THE BEST OF MY KNOWLEDGE AND BELIEF, THIS SURVEY CONFORMS TO THE MAINE BOARD OF LICENSED PROFESSIONAL LAND SURVEYORS' RULES AND REGULATIONS, WITH THE EXCEPTION THAT NO SURVEY REPORT WAS WRITTEN.

*Paul P. Gadbois*

PAUL P. GADBOIS, PLS 2104 DATE \_\_\_\_\_

- LEGEND**
- ▲ SURVEYORS TRAVERSE POINT
  - FOUND IRON ROD OR PIPE
  - IRON ROD TO BE SET
  - PROPERTY LINE
  - - - ADJUTERS PROPERTY LINE
  - - - SETBACK LINE
  - - - NOW OR FORMERLY
  - UTILITY POLE
  - - - OVERHEAD UTILITIES

- ZONE REQUIREMENTS:**
- DISTRICT R-3 SPACE AND BULK REGULATIONS
- LOT SIZE TWO FAMILY 2 ACRES
  - LOT SIZE SINGLE FAMILY 3 ACRES
  - LOT FRONTAGE 75 FEET
  - LOT FRONTAGE QU-DE-SAC 200 FEET
  - LOT FRONTAGE OTHER 75 FEET
  - FRONT YARD SETBACK 50 FEET\*\*
  - REAR YARD SETBACK 25 FEET
  - REAR YARD SETBACK 25 FEET
- \*\* ON STREETS OTHER THAN ARTERIAL COLLECTOR STREET.

- PROPOSED CLUSTER:**
- SPACE AND BULK REGULATIONS
- MIN. LOT SIZE 1 ACRES
  - MIN. FRONT YARD SETBACK 50 FEET
  - MIN. INTERIOR SIDE YARD SETBACK 12.5 FEET
  - MIN. EXTERIOR SIDE YARD SETBACK 25 FEET
  - MIN. INTERIOR REAR YARD SETBACK 25 FEET

- MAP 12 LOT 7B-1 N/F
- GLENDON BEAULIEU
- 17313 / 808
- WILLOW LN
- EXISTING 18' DRIVEWAY

- MAP 12 LOT 7B-2 N/F
- JEFFREY BUNLAP
- 16254 / 322
- OPEN SPACE 6.5 ACRES

- MAP 12 LOT 7-1 N/F
- DCB PROPERTIES
- 16742 / 556
- REMAINING LAND DCB PROPERTIES
- MAP 12 LOT 7-3 N/F
- DCB PROPERTIES
- 14622 / 317
- TIMBER FRAMERS BY R.A. KROUSE 18327/83
- MAP 12 LOT 3 N/F
- WILLIAM MCKAY
- 8344 / 280

<p><b>PAUL P. GADBOIS</b></p> <p>ENGINEERING SURVEYING LAND PLANNING</p> <p>P.O. BOX 327, SACO, MAINE 04072 (207) 283-3980</p>	<p><b>PRELIMINARY CLUSTER PLAN</b></p> <p>ETHAN BRALEY</p> <p>OLD POST ROAD</p> <p>ARUNDEL, MAINE</p>	<p><b>RECORD OWNER</b></p> <p>DCB PROPERTIES</p> <p>368 BOOM ROAD</p> <p>SACO, MAINE</p>	<p>DRAWN: P.P.G.</p>	<p>REVISIONS:</p>
			<p>CHECKED: P.P.G.</p> <p>SCALE: 1" = 50'</p> <p>FIELD BOOK:</p> <p>DATE: 06-03-2024</p> <p>JOB NO. 1821</p> <p>SHEET 1 OF 1</p>	