

Application for Preliminary Plat

Municipality of Anchorage
 Planning Department
 PO Box 196650
 Anchorage, AK 99519-6650

PETITIONER*		PETITIONER REPRESENTATIVE (IF ANY)	
Name (last name first) Big Country Enterprises, LLC		Name (last name first) S4 Group, LLC	
Mailing Address 4700 E 147th Ave, Anchorage, AK 99516		Mailing Address 124 E 7th Ave, Anchorage, AK 99501	
Contact Phone – Day 406-698-6969		Contact Phone – Day 907-306-8104	
Evening 		Evening 	
Fax 		Fax 	
E-mail toddbrownson@hotmail.com		E-mail tom@s4ak.com	

*Report additional petitioners or disclose other co-owners on supplemental form. Failure to divulge other beneficial interest owners may delay processing of this application.

PROPERTY INFORMATION			
Property Tax # (000-000-00-000): 017-073-06-000			
Site Street Address: 8600 Upper DeArmoun Rd, Anchorage, AK			
Current legal description: (use additional sheet if necessary) The north one-half of the southeast one-quarter (N1/2 SE1/4) of section 25, Township 12 North, Range 3 West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska. Excepting therefrom the northwest one-quarter of the northwest one-quarter of the southeast one-quarter (NW1/4 NW1/4 SE1/4) of section 25, Township 12 North, Range West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska.			
Zoning: R10SL	Acreage: 70.05 Acres	Underlying Plat #: N/A	Grid #: SW2941
# Lots: 0	# Tracts: 1	Total # parcels: 1	

PROPOSED SUBDIVISION INFORMATION		
Proposed legal description: (use additional sheet if necessary) Lots 1-19 & Tracts A&B, Lewis & Clark Subdivision		
# Lots: 19	# Tracts: 2	Total # parcels: 21

I hereby certify that (I am)(I have been authorized to act for) owner of the property described above and that I petition to subdivide it in conformance with Title 21 of the Anchorage Municipal Code of Ordinances. I understand that payment of the application fee is nonrefundable and is to cover the costs associated with processing this application, and that it does not assure approval of the subdivision. I also understand that assigned hearing dates are tentative and may have to be postponed by Planning Department staff or the Platting Authority for administrative reasons.

Signature Owner Representative Date 8/27/19
 (Representatives must provide written proof of authorization)

Print Name
 Thomas H Drayer

Accepted by: Francis Poster & Affidavit: Fee: \$8,940 Case Number: S12519 Requested Meeting Date: PB 11/06/19



Land Surveying
Land Development Consultants
Subdivision Specialists
Construction Surveying

124 E 7th Avenue, Anchorage, Alaska 99501 www.S4AK.com 907-306-8104

September 8, 2019

Lewis & Clark
Subdivision Platting Application
with Phasing Plan

Platting Application Narrative Per 21.03.200.C.9 (a thru k)

This plat conforms to the applicable dimensional standards and measurements, chapters 21.07, Development, Design Standards and 21.08, Subdivision Standard and to the maximum extent feasible:

a. Promotes the public health, safety and welfare:

Response: Lewis & Clark promotes the public health, safety, and welfare by providing roadways that provide access to each lot for police, fire apparatus, and ambulance services, and by providing utilities to each lot such as electricity, cable, natural gas, and telephone services, and by providing engineered locations on each lot for water wells and safe septic sewer systems.

b. Mitigates the effects of incompatibilities between the land uses or residential densities in the subdivision and the land uses and residential densities in the surrounding neighborhood, including but not limited to visual, noise, traffic, and environmental effects:

Response: Lewis & Clark mitigates the effects of incompatibilities between land uses and residential densities by complying with the density limitations of the underlying R-10SL zoning. With only 19 lots on 70 acres, Lewis & Clark is less dense and more spacious than most of the areas surrounding this subdivision. Two large undevelopable tracts that encompass the wetland areas are also being provided. Tract A is over 6 acres in size, and Tract B is over 2 acres in size, providing natural space for the residents to enjoy. The design of the interior road system mitigates environmental impacts by providing adequate access to each lot while being as short as possible, which helps to limit unnecessary cutting and filling of the natural terrain. All of these features of Lewis & Clark combine to limit the visual, noise, traffic & environmental effects to the surrounding neighborhood.

c. Provides for the proper arrangement of streets in relation to existing or proposed streets:

Response: Lewis & Clark has been carefully designed to provide properly arranged streets. The entrance to Lewis & Clark is aligned with the existing Jeanne Road intersection to the north along DeArmoun Road.

d. Provides for adequate and convenient open spaces:

Response: Lewis & Clark provides extra-large lots that provide adequate and convenient open spaces on each individual lot. The lots range in size from 54,592 square feet to 504,990 square feet in size. Also being provided are two large undevelopable tracts, Tract A, which is over 6 acres in size, and Tract B, which is over 2 acres in size. Below is a chart of the lot, tract, and areas dedicated to right-of-way's.

Lot number	Square footage	Acreage
1	54,592	1.25
2	55,956	1.28
3	55,562	1.28
4	85,658	1.97
5	94,777	2.18
6	125,589	2.88
7	155,284	3.56
8	147,088	3.38
9	75,246	1.73
10	73,756	1.69
11	54,491	1.25
12	504,990	11.59
13	202,419	4.65
14	334,022	7.67
15	86,131	1.98
16	77,758	1.79
17	80,488	1.85
18	63,192	1.45
19	58,772	1.35
Tract A	290,545	6.67
Tract B	117,655	2.70
Dedicated to ROW	257,439	5.91
Total	3,051,410	70.05

e. Provides for the efficient movement of vehicular and pedestrian traffic:

Response: Lewis & Clark provides efficient means of vehicular and pedestrian movement by providing roads developed as per current MOA design standards, and by connecting into De Armoun Road directly across the street from Jeanne Street. By providing direct access to DeArmoun Road from Gionet Circle, the most efficient roadway design was achieved. Only 2 lots, lot 7 & lot 8, will have access from Canyon Road.

f. Ensures adequate and properly placed utilities:

Response: Lewis & Clark provides proper and adequate utility placement by providing all utilities designed to current utility company specifications.

g. Provides access for firefighter apparatus:

Response: Lewis & Clark allows for effective access to firefighting apparatus by providing roads built per MOA regulations to support fire apparatus.

h. Provides opportunities for recreation, light and air and avoids congestion:

Response: Lewis & Clark provides opportunities for recreation, light & air by virtue of the oversized lots with only 19 lots on 70 gross acres of land.

i. Facilitates the orderly and efficient layout and use of the land:

Response: Lewis & Clark facilitates orderly layout by minimizing the length of roads, by having 17 of the 19 lots fronting on the internal road system, and by connecting into DeArmoun Road directly opposite of Jeanne Road to the north.

j. Does not create a split-zoned lot:

Response: Lewis & Clark does not create any split-zoned tracts; all properties are commonly zoned.

k. Furthers the goals and policies of the comprehensive development plan and conforms to the comprehensive development plan in the manner required by chapter 21.01.080, Comprehensive plan:

Response: Lewis & Clark Subdivision supports the comprehensive development plan. This area is classified as Large-lot Residential in the Anchorage 2040 Land Use Plan, which calls for one housing unit or less per gross acre. Our proposed Lewis & Clark Subdivision has a density of 19 lots on 70 gross acres of land, which equates to one housing unit per 3.68 gross acres.

Wetland Tracts

Tract A and Tract B as shown on the preliminary plat are parcels that encompass the two wetland areas. The wetlands will be protected in perpetuity.

Water Availability

Mr. Dan Young, certified professional geologist, of Terrasatt, Inc. has compiled a report for the Lewis & Clark development.. In summary, there is more than adequate water available for this development.

Septic & Soils Tests

Mr. Steve Eng of Northrim Engineering has provided the soils analysis and testing for this subdivision. In summary, all lots will have MOA approved septic sites before final platting can occur.

Phasing Plan

This application is for a 60-month plat approval with a phasing plan. A phasing plan is attached to this application that shows 3 phases. The phasing development schedule is for phase one to be developed between one & five years after the approval date, and phase two & three to be developed at the same time or after phase one, from between one & five years from the approval date. This phasing will allow flexibility for the developer to respond to changing market conditions and sales opportunities.

Title 21 R-10 Parameters

In Title 21.04.020.P, the purpose of the R-10 district is outlined and lists the following site design and engineering parameters, bulleted as (a.) thru (h.)

a. Protect natural features such as ponds, streams, wetlands, and springs, and incorporate such features into the development of the site design;

Response: There are two wetland areas in Lewis & Clark, each one is protected and encompassed by Tract A and Tract B as shown on the preliminary plat. The homesite lots have been designed around these important wetland features. With approval (In process.) from the MOA & the Corp of Engineers, the small stream that bisected lots 7 & 8 will be relocated to follow the north and west boundary lines of lot 7, and the west boundary of lot 8. The points that the stream enters & exits the Lewis & Clark parcel does not change. The location and water flows to and from neighboring parcels does not change.

b. Ensure the use of the site design techniques that take into consideration topographic constraints and other physical features;

Response: The design of Lewis & Clark has been carefully created considering the natural topographic constraints of the site. Cuts & fills for the interior roads have been kept to a minimum, and the road lengths have been kept to a minimum to help lessen the impact of the road while still providing adequate access to each and every lot. Safe, gentle grades along the

roadways have been paramount to the roadway design. Safe driveway grades have also each been individually evaluated and incorporated into the design of the lots and the roadway.

c. Avoid natural hazards including snow avalanche and mass wasting areas;

Response: The Lewis & Clark site is not in a snow avalanche area. There are no issues concerning mass wasting to this parcel.

d. Retain the natural flow and storage capacity on any watercourse and wetland, to minimize the possibility of flooding or alteration of water boundaries;

Response: The natural flow and storage of the two wetland areas are being retained in their existing natural configuration. The flow of water onto and from Lewis & Clark will remain as they are today. Triad Engineering has completed a drainage report for this parcel.

e. Assure that soil and subsoil conditions are suitable for excavations, site preparation, and on-site wastewater disposal;

Response: Northrim Engineering has extensively analyzed and taken soil tests on the Lewis & Clark parcel. Each and every lot will have a fully approved septic site & water well plan approved by the MOA before final platting can occur.

f. Provide adequate site drainage to avoid erosion and to control the surface runoff in compliance with the federal clean water act;

Response: The Lewis & Clark site will comply with the federal clean water act. The drainage report & plan by Triad Engineering will be required to be approved under strict guidelines by the MOA, ensuring adequate site drainage control to avoid erosion and surface runoff.

g. Assure and adequate supply of potable water for the site development;

Response: Water wells have been drilled by Terrasat, Inc. on the site and have confirmed a more than adequate supply of potable water.

h. Minimize the grading operations, including cut and fill, consistent with the retention of the natural character of the site;

Response: The interior roads in Lewis & Clark have been carefully designed to flow with the topography with minimum cuts & fills, assisting in maintain the natural character of the site.

Trail Location off of Gionet Circle

The trail location off of the end of Gionet Circle is governed by Title 21 code. Title 21.07.060.D.3.b.ii states: "Whenever cul-de-sac streets are created, at least one 10 foot wide

pedestrian access right-of-way or easement shall be provided, to the extent reasonably feasible, between each cul-de-sac head or street turnaround and the closest adjacent street or pedestrian walkway." The lot line between lots 3 & 4, where we have proposed the trail easement, is the closest to the adjacent streets. The distance, as shown on the preliminary plat, is 303.20 feet. The other lot lines such as between lots 4 & 5, and between 5 & 6 are much longer. The line between lots 4 & 5 is 441.76 feet long, and the lot line between lots 5 & 6 is 510.18 feet long. Additionally, where we have shown the trail, the average slope is only 8%, the other two possible locations are steeper, at 10% and 11% average slopes.

If you have any questions or need further clarifications, please email me at tom@s4ak.com.

Thank you,



Tom Dreyer, PLS

S4 Group

Petitioner's representative

Application for Subdivision Variance

Municipality of Anchorage
 Planning Department
 PO Box 196650
 Anchorage, AK 99519-6650



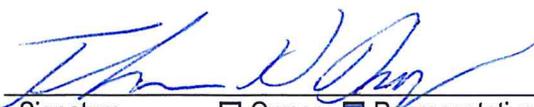
PETITIONER*		PETITIONER REPRESENTATIVE (IF ANY)	
Name (last name first)	Big Country Enterprises, LLC (Todd Brownson)	Name (last name first)	S4 Group, LLC (Tom Dreyer)
Mailing Address	4700 E 147th Ave	Mailing Address	124 E 7th Avenue
	Anchorage, AK 99516		Anchorage, AK 999501
Contact Phone – Day	907-406-0792	Contact Phone – Day	907-306-8104
Evening		Evening	907-227-1847
Fax		Fax	
E-mail	toddbrownson@hotmail.com	E-mail	tom@s4ak.com

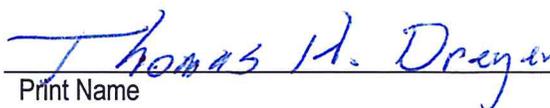
*Report additional petitioners or disclose other co-owners on supplemental form. Failure to divulge other beneficial interest owners may delay processing of this application.

PROPERTY INFORMATION
Property Tax # (000-000-00-000): 017-073-06-000
Site Street Address: 8600 Upper DeArmoun Road, Anchorage, AK
Current legal description: (use additional sheet if necessary) The north one-half of the southeast one-quarter (N1/2 SE1/4) of section 25, Township 12 North, Range 3 West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska. Excepting therefrom the northwest one-quarter of the northwest one-quarter of the southeast one-quarter (NW1/4 NW1/4 SE1/4) of section 25, Township 12 North, Range West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska.

REQUEST
The variance is for relief from the requirement to: This is a variance request from Title 21.07.060.D.3.b.ii, requiring a 10' pedestrian access from one of the two cul-de-sacs (Brownson Circle) to the nearest adjacent street.
Associated platting case number (if applicable): 5-12519

I hereby certify that (I am)(I have been authorized to act for) owner of the property described above and that I am petitioning for an subdivision variance in conformance with Title 21 of the Anchorage Municipal Code of Ordinances. I understand that payment of the application fee is nonrefundable and is to cover the costs associated with processing this application, and that it does not assure approval of the variance. I understand that the burden of evidence to show compliance with the variance standards rests with me, the applicant.

	8/28/2019
Signature <input type="checkbox"/> Owner <input checked="" type="checkbox"/> Representative <small>(Representatives must provide written proof of authorization)</small>	Date

			
Print Name			

Accepted by:	Poster & Affidavit:	Fee	Case Number
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VARIANCE(S) REQUESTED FROM (CODE CITATIONS):

AMC 21. Title 21.07.060.D.3.b.ii

AMC 21.

SUBMITTAL REQUIREMENTS

If associated with a preliminary plat application: Signed application(original) and Signed application (44 copies)

If not associated with a preliminary plat application:

1 copy required: Signed application(original)

44 copies required: Signed application (copies)
 Variance narrative, addressing:
 The need for the variance
 The effect of granting the variance
 An analysis of how the proposal meets the variance standards below
 Underlying plat
 Proposed plot plan or site plan, to scale (new construction)
 Topographic map of site
 Photographs

(Additional information may be required.)

VARIANCE STANDARDS

The Platting Board may only grant a variance if the Board finds that **all** of the following 4 standards are substantially satisfied. Each standard must have a response in as much detail as it takes to explain how your property's condition satisfies the standard. The burden of proof rests with you.

- a. There are special circumstances or conditions affecting the property such that the strict application of the provisions of the subdivision regulations would clearly be impractical, unreasonable, or undesirable to the general public;
- b. The granting of the specific variance will not be detrimental to the public welfare or injurious to other property in the area in which such property is situated;
- c. Such variance will not have the effect of nullifying the intent and purpose of the subdivision regulations or the comprehensive plan of the municipality; and
- d. Undue hardship would result from strict compliance with specific provisions or requirements of the subdivision regulations. The applicant may supplement the form with supporting documents.



Land Surveying
Land Development Consultants
Subdivision Specialists
Construction Surveying

124 E 7th Avenue, Anchorage, Alaska 99501 www.S4AK.com 907-306-8104

August 28, 2019

Subdivision Variance Narrative

from Title 21.07.060.D.3.b.ii
Lewis & Clark R-10SL Subdivision

The need for the variance:

Response: This is a variance request from Title 21.07.060.D.3.b.ii, requiring a 10' pedestrian access from the Brownson Circle cul-de-sac to the nearest adjacent street, Upper DeArmoun Road.

The effect of granting this variance:

Response: The effect of granting this variance will allow us to develop the subdivision as submitted.

The four standards required to be substantially satisfied for Platting Board approval:

A. There are special circumstances or conditions affecting the property such that the strict application of the provisions of the subdivision regulations would clearly be impractical, unreasonable, or undesirable to the general public;

Response: Lewis & Clark is unique in that it is a subdivision development according to hillside conditions. We are faced with unique considerations to this parcel as to the surrounding street system, land that needs to be accessed, and the topography.

B. The granting of the specific variance will not be detrimental to the public welfare or injurious to other property in the area in which such property is situated;

Response: This variance will not be detrimental or have any negative affect to other properties in the area. The trail from the Brownson Circle cul-de-sac to Upper DeArmoun Road would only provide an unneeded short cut through this subdivision.

C. Such variance will not have the effect of nullifying the intent and purpose of the subdivision regulations or the comprehensive plan of the municipality;

Response: The Anchorage Trails Plan designates trails along Rabbit Creek located on the property to the south of Lewis & Clark, and trails along Upper DeArmoun & Canyon Road are also shown on the Trails Plan. Providing a trail easement through Lewis & Clark off of Brownson Circle to Upper DeArmoun is unnecessary and unneeded.

C. Undue hardship would result from strict compliance with specific provisions or requirements of the subdivision regulations;

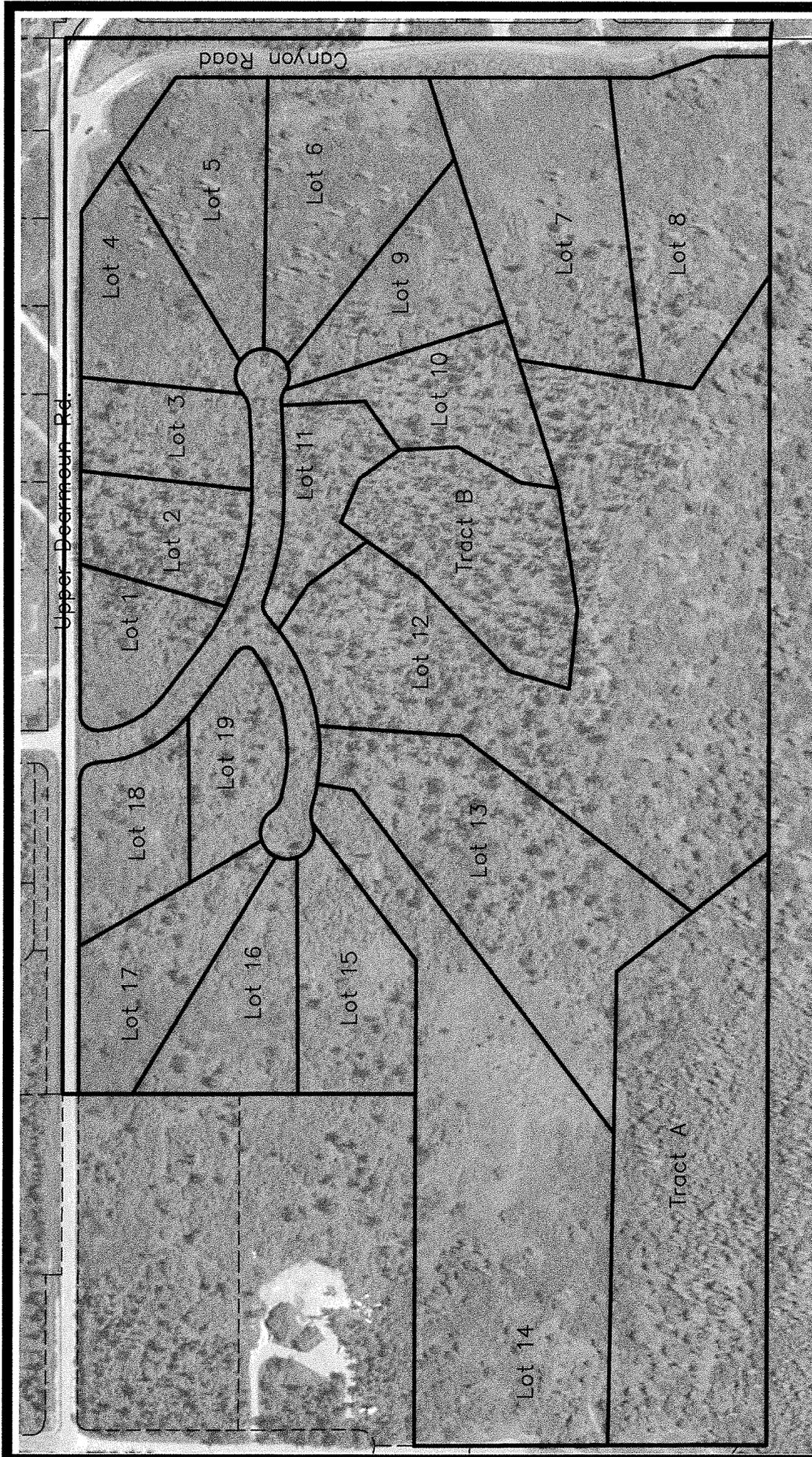
Response: Strict compliance with the regulations would result in undue hardship due to allowing pedestrian easements that would run right along the future homeowner's houses and back yards.

If you have any questions or need further clarifications, please email me at tom@s4ak.com.

Thank you,

A handwritten signature in blue ink, appearing to read "Tom Dreyer", is written over a horizontal line.

Tom Dreyer, PLS, petitioner's representative
S4 Group, LLC

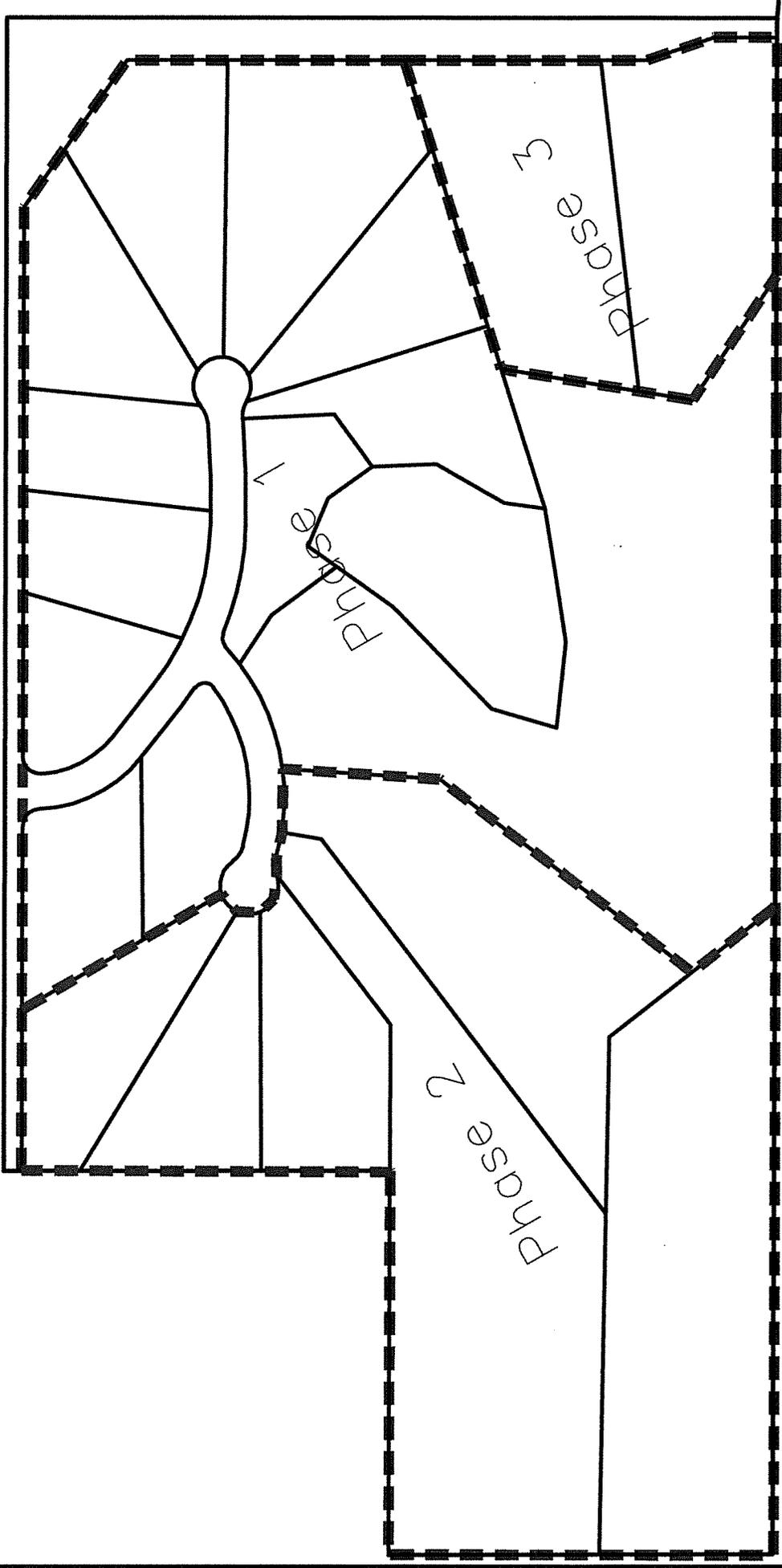


Aerial Photo of:

Lewis & Clark

Subdivision





Proposed Phase Plan of:
Lewis & Clark
Subdivision



Phasing lines may be adjusted at the time of the plat recordings based on lot sales and construction times, these lines are for conceptual reference only.



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Subdivision Specialists
Construction Surveying

124 E 7th Avenue, Anchorage, Alaska 99501 www.S4AK.com 907-306-8104

July 1 2019

Proposed Lewis & Clark R-10 Subdivision Summary of Community meeting

Ms. Michelle McNulty, MOA Planning Division Director
4700 Elmore Road
Anchorage, Ak 99507
&
Hillside Community Council

SUMMARY OF HILLSIDE COMMUNITY COUNCIL PRESENTATION:

Date: 6/26/2019

Location: 12100 Old Seward Hwy, Anchorage, AK 99515

Subject: Proposed Lewis & Clark R-10 Subdivision

119 mailings mailed on 5/31/2019 and 9 returned

Content of mailings: See Attached

Number of people that participated in the meeting: 17 community members, see attached sign in sheet. Some members did not sign in.

Presentation provided by S4 Group, LLC to provide information and take questions and comments from meeting attendees. Meeting started at 7:04 and the subdivision presentation began at approximately 7:30 PM and questioning was completed at approximately 8:04 PM. An invitation was extended for any additional questions to be sent to the S4 Group, LLC. The following is a brief summary of the questioning and discussion:

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Is this subdivision including the Jones Vergason lots?
 - Response: Jones Vergason is not part of this plat.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Why change the plat?
 - Response: After having a pre-app with the muni it was decided to change the layout.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Where are the wetlands?
 - Response: Showed the green location on the displayed plat.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: How big is lot 12 and what is the smallest
 - Response: 11 ac. and the smallest is 1.25 ac.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: How many lots are there?
 - Response: 19

- Frank Pugh– 16006 Noble Point Drive
 - Question: Asked what the muni wanted concerning roads and trails?
 - Response: The current prelim plat is showing what we have worked out with the MOA and the trail requirements are in code.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Will there be one or two drives on Canyon Road?
 - Response: Working with the MOA for the driveways as part of the Canyon Road project.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Tell us about the trail and where is it.
 - Response: Trail and Trail Easement is shown on the prelim plat.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Previous plat had a variance for trail from end of cul-de-sac to Canyon Road.
 - Response: The trail required by code is shown on the preliminary plat.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: What is the size of this parcel?
 - Response: Approximately 70ac.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Questions: What are you doing on the lot now?
 - Response: Owners are building a house.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Where is the house?
 - Response: Showed the location on the prelim plat.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: What is the process next?
 - Response: To submit a prelim application to the MOA.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: What about the subdivision road and excavators?
 - Response: There is a Fill and Grade permit for the site and there are test holes being done.

- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Who issues road/driveway permits?
 - Response: The ROW department, and the dirt work currently is under the F&G permit.

- Rob Brown - 13688 Canyon Road
 - Question: How are the wetlands delineated?

- Response: There was a wetlands study and the MOA reviewed it.
- Rob Brown - 13688 Canyon Road
 - Question: Are there conservation spaces?
 - Response: Not for this R-10 zoning.
- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Are you aware that the ordinance that gives the Platting Board authority has been appealed?
 - Response: Refer you to a lawyer to answer that.
- Rob Brown - 13688 Canyon Road
 - Question: Are there any other plans?
 - Response: This is the current plan that we are showing.
- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Will Planning approve this?
 - Response: This represents what we think the MOA would approve.
- Joan Priestly/Vern Davis – 13101 Jeanne Road
 - Question: Do you have to pay MOA fees or are you exempt?
 - Response: All fees have to be paid and are not exempt from any fees.

124 E 7th Ave
Anchorage, AK 99501



WED, JUNE 26, 2019 @ 7-9 PM

Ptarmigan Executive Conference Room
12-100 Coffee & Communitas
12100 Old Seward Hwy
Anchorage, AK 99515

Interested parties may appear at the meeting and speak on the matter. You can also submit your comments or request additional information by contacting:

Municipality of Anchorage
Planning Department
4700 Elmore Rd, Anchorage, AK 99507
(907) 343-7900

COOK FRANK E 50% & CUDNOHUFKY BONNIE A
50%
PO BOX 300067
WATERFORD, MI 48330

119 copies mailed on 05/31/2019

COMMUNITY MEETING

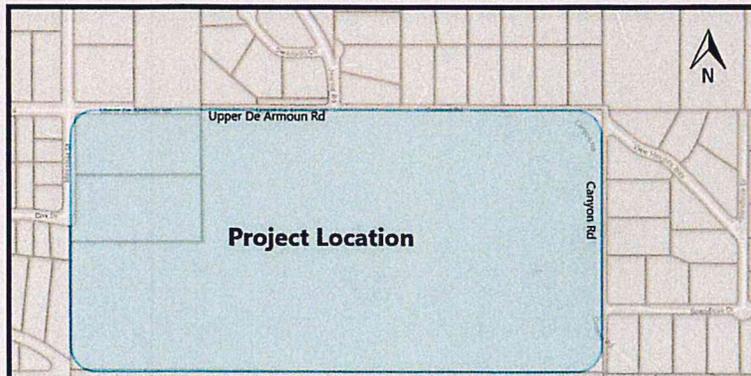
Community Meeting Notification: Lewis & Clark Subdivision Proposal

Representatives will be presenting at the Hillside Community Council meeting, being held at 12100 Old Seward Hwy, Anchorage, AK 99515 on **June 26, 2019 at 7:00 PM**, in regards to a proposal to subdivide the project location. The project location is at the corner of Upper De Armoun Rd and Canyon Rd, described as: Vergason-Jones Lots 1 & 2, T12N R3W Sec 25 S 1/2W 1/2 NW 1/4 SE 1/4 & E 1/2 NW 1/4 SE 1/4 & NE 1/4 SE 1/4. Otherwise known as Lewis & Clark.

Representatives will provide an overview of the proposal, updates, project schedule, and will be available to answer questions.

Please Note: This meeting will be held at Hillside Community Council's regularly scheduled date and time, but due to summer school availability will *not* be held at the regular location. It will be held at *12-100 Coffee & Communitas* located off of Old Seward, between Huffman Rd and E. 120th Ave.

We look forward to seeing you there!



WMS WATERCOURSE MAPPING SUMMARY

Per the requirements for watercourse verification outlined in Project Management and Engineering Operating Policy and Procedure #8 and Planning Department Operating Policy and Procedure #1 (effective June 18, 2007), MOA Watershed Management Services has inspected the following location for the presence or absence of stream channels or other watercourses, as defined in Anchorage Municipal Code (21.35).

- Project Case Number or Subdivision Name: Lewis & Clark Subd.
- Project Location, Tax ID, or Legal Description: 017-073-06-000
- Project Area (if different from the entire parcel or subdivision): _____

In accordance with the requirements and methods identified, WMS verifies that this parcel, project area, or application:

22

DOES NOT contain stream channels and/or drainageways, as identified in WMS field or archival mapping information.*

DOES contain stream channels and/or drainageways AND these are located and identified on submittal documents in general congruence with WMS field and archival mapping information.

*New or additional mapping IS NOT REQUIRED.**

_____ Contains stream channels and/or drainageways BUT one or more streams or other watercourses:

- are NOT shown on submittal documents, or
- are NOT depicted adequately on submittal documents for verification, or
- are NOT located or identified on submittal documents in general congruence with WMS field and archival mapping information.

*New or additional mapping IS REQUIRED and must be re-submitted for further review and verification.**

_____ Presence of stream channels and/or drainageways is unknown AND field verification is not possible at this time. WMS will verify as soon as conditions and prioritized resources allow.

* Streams omitted in error by WMS or others remain subject to MOA Code and must be shown in new mapping upon identification of the error.

ADDITIONAL INFORMATION:

- Y N WMS written drainage recommendations are available. Preliminary Final
- Y N WMS written field inspection report or map is available. Preliminary Final
- Y N Field flagging and/or map-grade GPS data is available.

Inspection Certified By: [Signature]

Date: 8-27-19



Land Surveying
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Subdivision Specialists
Construction Surveying

124 E 7th Avenue, Anchorage, Alaska 99501 www.S4AK.com 907-306-8104

August 27, 2019

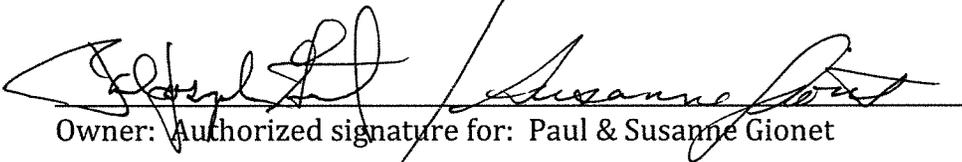
MOA Planning Department
4700 Elmore Road
Anchorage, Ak 99519

Letter of Authorization
for
Lewis & Clark R-10SL Subdivision

The owners of the below listed parcels, do, hereby authorize the S4 Group to represent them before the MOA for the subdivision platting of the parcel listed below:

The N 1/2 of the SE 1/4, Section 25, T12N, R3W, S.M., Alaska, excepting the NW 1/4 of the NW 1/4 of the SE 1/4 of Section 25, T12N, R3W, S.M., Alaska, approx. 70 acres.


Owner: Authorized signature for Elisha & Todd Brownson


Owner: Authorized signature for: Paul & Susanne Gionet

Municipal Clerk's Office
Amended and Approved

Date: March 5, 2019

Immediate Reconsideration Failed

Date: March 5, 2019

Submitted by: Chair Croft at the
Request of the Mayor
Prepared by: Planning Department
For reading: January 29, 2019

ANCHORAGE, ALASKA
AO No. 2019-20, As Amended

1 AN ORDINANCE AMENDING THE ZONING MAP AND APPROVING THE REZONING OF
2 APPROXIMATELY 77 ACRES FROM R-8 (LOW DENSITY RESIDENTIAL 4 ACRE
3 DISTRICT) TO R-10 SL (LOW DENSITY RESIDENTIAL, ALPINE/SLOPE DISTRICT)
4 WITH SPECIAL LIMITATIONS FOR N½ OF THE SE¼ OF SECTION 25, T12N, R3W,
5 S.M., ALASKA EXCEPTING THE NW¼ OF THE NW¼ OF THE SE¼ OF SECTION 25,
6 T12N, R3W, S.M., ALASKA, AND LOTS 1 AND 2 OF VERGASON-JONES SUBDIVISION
7 PER PLAT 98-178; GENERALLY LOCATED SOUTH OF UPPER DEARMOUN ROAD,
8 WEST OF CANYON ROAD, AND EAST~~[WEST]~~ OF MESSINIA STREET, IN
9 ANCHORAGE.

10
11 (Hillside Community Council) (Planning and Zoning Commission Case 2018-0052)

12
13 THE ANCHORAGE ASSEMBLY ORDAINS:

14
15 **Section 1.** The zoning map shall be amended by designating the N½ of the SE¼ of
16 Section 25, T12N, R3W, S.M., Alaska excepting the NW¼ of the NW¼ of the SE¼ of
17 Section 25, T12N, R3W, S.M., Alaska, and Lots 1 and 2 of Vergason-Jones Subdivision per
18 Plat 98-178, as R-10 SL, low density residential, alpine/slope district, with special
19 limitations.

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21 The property described above is shown on Exhibit "A," attached.

22
23 **Section 2.** This zoning map amendment is subject to the following special limitation: "The
24 district is limited to 23 lots. The platting authority shall require a note on the final plat stating
25 the lot number restrictions of this section. If Title 21 is amended to create Hillside
26 Conservation Subdivisions, as described in the 2010 Hillside District Plan, then a Hillside
27 Conservation Subdivision of the property may allow up to two additional lots for a total of 25
28 lots. Future subdivisions shall place wetlands, designated by the U.S. Army Corp of
29 Engineers, in [reserve]open-space tracts."

30
31 **Section 3.** In support of its approval of this zoning map amendment, based on the
32 information received in the record, the Assembly makes the following findings:

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34 **FINDING #1:** The rezone is consistent with the land use designation in the Hillside
35 District Plan (HDP) and Anchorage 2040 Land Use Plan (LUP) that this area be
36 zoned residential with a 0-1 dwelling unit per acre (DUA) density.

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38 **FINDING #2:** R-10 is an[the] appropriate zoning for parcel like this.

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40 **FINDING #3:** The special limitation on the number of lots to 23 allows for a
41 subdivision development that is respectful to the surrounding neighborhood by
42 providing for less than one-third the maximum DUA for the land use designation.
43 This density is far less than currently in the surrounding neighborhood.

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45 **FINDING #4:** This rezone meets the intent statement of AMC section 21.03.160
46 regarding rezones. This rezone was not easily changed. Changed conditions are

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the adoption of the Anchorage 2040 LUP in 2017 and amendments to the HDP in 2015. The benefit to the general welfare is our need for housing of all types.

FINDING #5: The rezone is consistent with the HDP.

FINDING # 6: The subdivision is within the Glenn Alps Service Area (GASA) and any developed lots will be subject to tax levy for road maintenance and improvements for this road service area. Assuming 22 more homes valued \$750,000, this will generate approximately \$33,000 more per year for much needed road maintenance in the area.

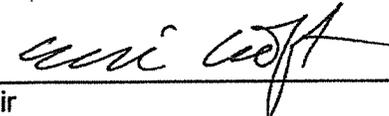
FINDING #7: ~~The rezone process followed all proper procedures. The required Community Meeting met the requirements of Code. At least three subsequent open meetings with the community allowed further discourse.~~ The public notification requirements in Title 21 were met. The Title 21 required Community Meeting was properly noticed, as shown on page 69 of the packet. The Community Meeting was held at the preferred location, which is in the vicinity of the petition site and at the regularly scheduled Hillside Community Council Meeting.

FINDING #8: The rezone with the special limitation was approved and recommended by the Planning and Zoning Commission by a vote of 7-0, and the Assembly accepts their findings.

FINDING #9: The Assembly finds the cap on the number of lots in the district to reflect important community considerations regarding the character of the neighborhood and development constraints. An increase to the cap on the number of lots would require a Hillside Conservation Subdivision if allowed by Code or a new rezoning application to change the Special Limitation.

~~Section 3.~~ Section 4. This ordinance shall become effective 10 days after the Director of the Planning Department has received the written consent of at least 51 percent of the owners of the property within the area described in Section 1 above to any special limitations contained herein. The rezone approval contained herein shall automatically expire, and be null and void, if the written consent is not received within 120 days after the date on which this ordinance is passed and approved. In the event no special limitations are contained herein, this ordinance is effective immediately upon passage and approval. The Director of the Planning Department shall change the zoning map accordingly.

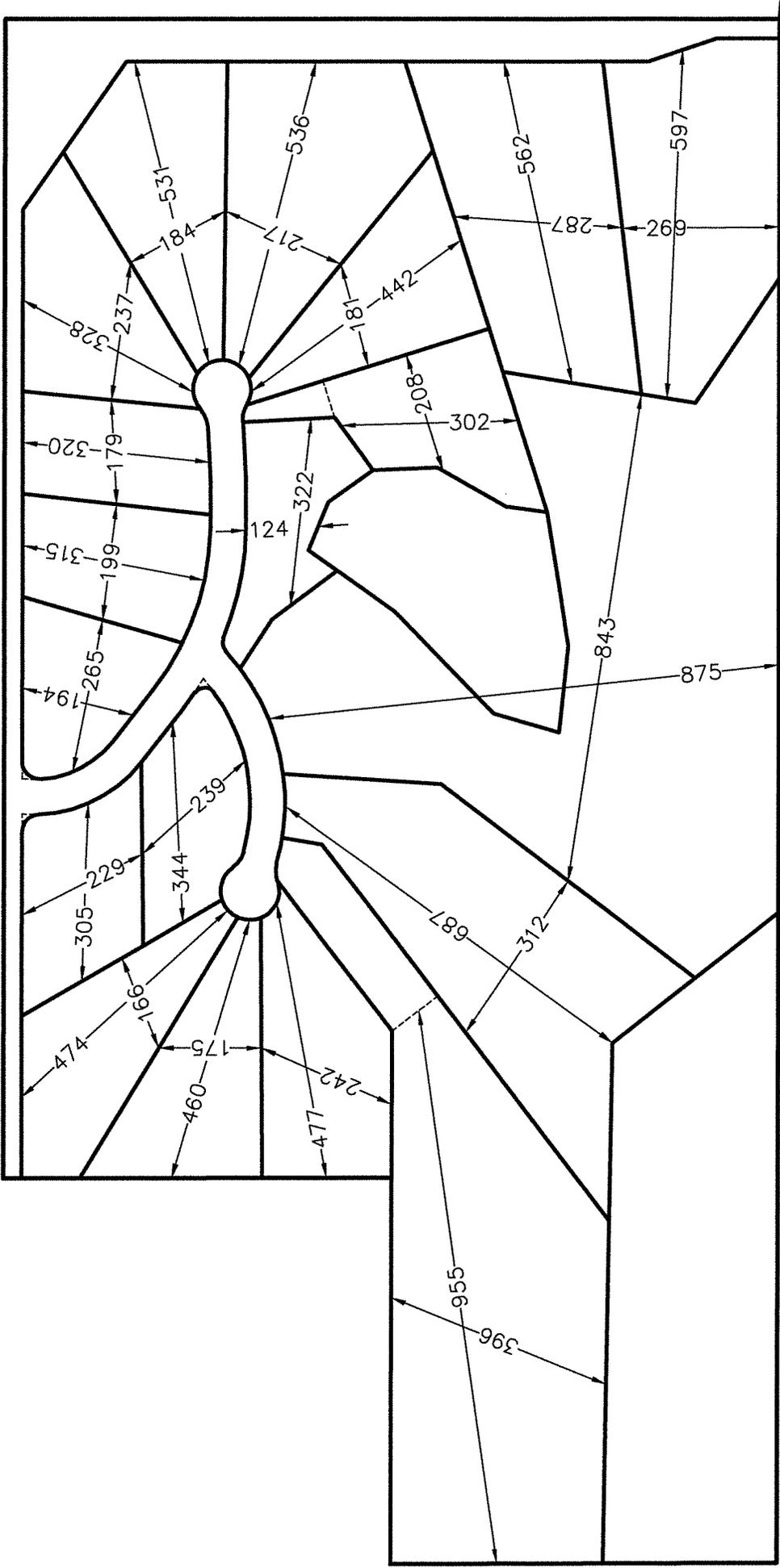
PASSED AND APPROVED by the Anchorage Assembly this 5th day of March, 2019.



Chair

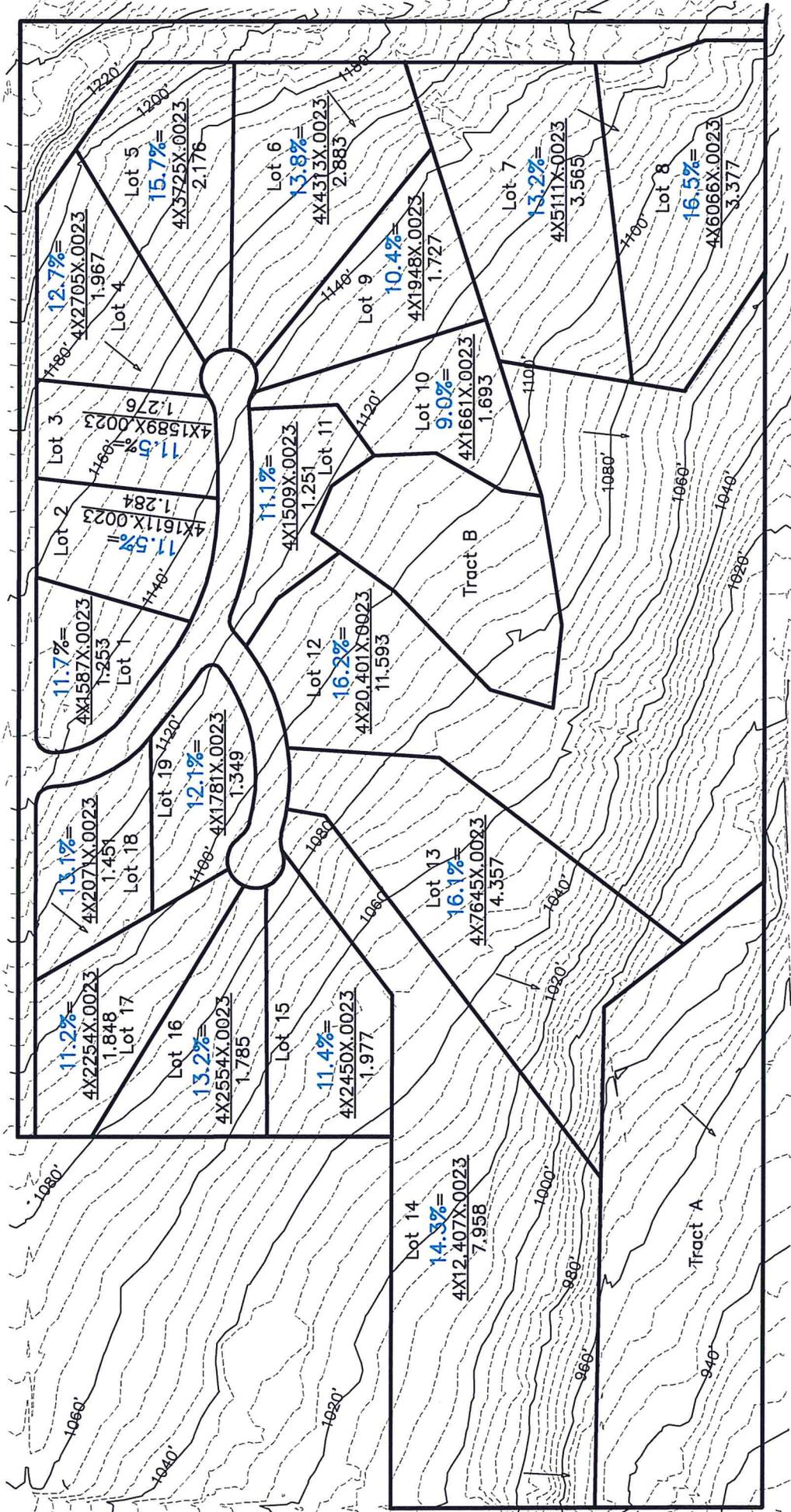
ATTEST:


Municipal Clerk



Lot Width & Depth:
Lewis & Clark
 Subdivision





Topographic Map with Average slopes & Drainage:
Lewis & Clark
 Subdivision



Alyeska Title Guaranty Agency

CERTIFICATE TO PLAT

1. Effective Date: **October 24, 2017 at 8:00 A.M.**
Order No. 57046

2. Certificate to be issued:

(a) (Fee \$250.00)

Liability: \$250.00

Assured:

Big Country Enterprises, LLC and Municipality of Anchorage

3. The Fee Simple interest in the land described in this Certificate is owned, at the Effective Date, by

Big Country Enterprises, LLC, an Alaska limited liability company

4. The land referred to in this Certificate is described as follows:

The North one-half of the Southeast one-quarter (N1/2 SE1/4) of Section 25, Township 12 North, Range 3 West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska.

EXCEPTING THEREFROM the Northwest one-quarter of the Northwest one-quarter of the Southeast one-quarter (NW1/4 NW1/4 SE1/4) of Section 25, Township 12 North, Range 3 West, Seward Meridian, located in the Anchorage Recording District, Third Judicial District, State of Alaska

Alyeska Title Guaranty Agency

CERTIFICATE TO PLAT

We find the following exceptions to title to be addressed on any Plat or Re-Plat:

1. Minerals of whatsoever kind, subsurface and surface substances, including but not limited to coal, lignite, oil, gas, uranium, clay, rock, sand and gravel in, on, under and that may be produced from the Land, together with all rights, privileges, and immunities relating thereto, whether or not appearing in the Public Records or listed in Schedule B. The Company makes no representation as to the present ownership of any such interests. There may be leases, grants, exceptions or reservations of interests that are not listed.
2. Reservations and exceptions as contained in U.S. Patent Numbers 1204212 and 1143325 and/or in Acts authorizing the issuance thereof.
3. Taxes and/or assessments, including penalties and interest, if any, owing the Municipality of Anchorage.
4. Rights of the public and governmental agencies in and to any portion of said land included within the boundaries of any street, road and/or highway.
5. Right-of-Way Easement, including terms and provisions thereof, granted to CHUGACH ELECTRIC ASSOCIATION, INC., and its assigns and/or successors in interest, to construct, operate and maintain an electric transmission and/or telephone distribution line or system by instrument recorded August 17, 1987 in Book 1640 at Page 122. (Affects see document for area affected)
6. Public Use Easement for a public street, highway, walkway, trail, and corridor for utilities of every kind and nature and appurtenances thereto, including the terms and provisions thereof, granted to Anchorage, a municipal corporation as set forth in Final Order of Condemnation/Judgment recorded February 16, 1990 in Book 2000 at Page 641. (Affects See document for area affected)
7. Any right, title or interest of Rodney Spendlove, or those claiming by, through or under that person or entity, as disclosed by Patent Number 1204212, and Warranty Deed recorded May 8, 2000 in Book 3629 at Page 903.
8. Subject to the Articles of Organization according to A.S. 10.50.090, and Operating Agreement, (and any amendments thereto) for Big Country Enterprises, LLC and interests disclosed thereby.

NOTE: Submission for our review of a copy of the preliminary or proposed plat is required. Such review will determine the effect of the exceptions as set out herein.

NOTE: This report is to be used for the purposes herein stated, and is not to be used for the basis for the closing of any transaction affecting title to the herein subject property. Liability herein is limited to the compensation received therefore.

NHN NSN, AK

Sincerely,

A handwritten signature in cursive script that reads "Susan R. Calhoun".

Susan R Calhoun
Authorized Signer for
Alyeska Title Guaranty Agency

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2018-025612-0

Recording Dist: 301 - Anchorage
7/12/2018 08:22 AM Pages: 1 of 6



Please return to:
Municipality of Anchorage
Project Management & Engineering
P.O. Box 196650
Anchorage, Alaska 99519-6650
Attn: Fran Murphy

MOA/PM&E/ROW
Canyon Road Improvements
Upper DeArmoun Rd. to Chugach State Park
Project No.13-56, ROW File No. C-13-14
Tax #017-073-06
Parcel #4

PUBLIC USE EASEMENT

The GRANTOR, **BIG COUNTRY ENTERPRISES, LLC**, whose mailing address is 4700 E. 147TH Avenue, Anchorage, AK 99516, for good and valuable consideration, conveys and warrants to **MUNICIPALITY OF ANCHORAGE**, an Alaska municipal corporation whose address is P.O. Box 196650, Anchorage, Alaska, 99519-6650, GRANTEE, and to its successors and assigns, an easement in perpetuity pertaining to the following described real estate:

A Public Use Easement lying over a portion of the North 1/2 of the Southeast 1/4, excepting therefrom the Northwest 1/4 of the Northwest 1/4 of the Southeast 1/4, Section 25, Township 12 North, Range 3 West, Seward Meridian, Alaska, as described in warranty deed recorded on September 12, 2014 filed under Serial No. 2014-036617-0 in the Anchorage Recording District, Third Judicial District, State of Alaska. Said easement being more particularly described by metes and bounds as follows:

Commencing at the 1/4 corner common to common to said Section 25, Township 12 North, Range 3 West, and Section 30, Township 12 North, Range 2 West, Seward Meridian, Alaska, also being the True Point of Beginning;

Thence, S 00° 21' 55" E, along the Section line common to said Sections 25 and 30, a distance of 1318.81 feet to the South 1/16th corner;

Thence, S 89° 40' 50" W, along the South 1/16th line of said Section 25, a distance of 33.00 feet;

Thence N 00° 21' 55" W, a distance of 109.00 feet;

Thence N 19° 20' 35" W, a distance of 123.00 feet;

MOA/PM&E/ROW
Canyon Road Improvements
Upper DeArmoun Rd. to Chugach State Park
Project No. 13-56, ROW File No. C-13-14
Tax #017-073-06
Parcel #4

Thence N 00° 21' 55" W, a distance of 888.52 feet;
Thence N 55° 31' 12" W, a distance of 307.05 feet to a point being
30.00 feet south of the E-W 1/4 section line of said section 25;
Thence S 89° 43' 15" W and parallel with said E-W 1/4 section line, a
distance of 958.66 feet to the southeasterly terminus of that 30-foot
wide Public Use Easement described in Book 2000, Page 641 of the
Anchorage Recording District, Third Judicial District, State of Alaska;
Thence N 00° 16' 45" W, along the easterly line of the said 30-foot wide
Public Use Easement, a distance of 30.00 feet to a point on the E-W
1/4 section line of said Section 25;
Thence N 89° 43' 15" E, along said E-W 1/4 section line, a distance of
1283.61 feet to the True Point of Beginning.

Containing 147,966 Square Feet, more or less.

The Basis of Bearings for the above description is Bowl 2000
Coordinate System.

for a public street, highway, walkway, trail, public transportation facility and appurtenances and corridor for utilities of every kind and nature including, but not limited to, the right to construct, reconstruct, maintain, repair, operate and improve a public street, highway, walkway, trail, public transportation facility, drainage, drainage facility and/or electric, telephone or telecommunications, gas, water, sewer, or other utility transmission or distribution facilities together with the right to license, permit or otherwise agree to the exercise of these rights by any other person, or entity.

All improvements are the property of Anchorage, removable at its option. The failure of the GRANTEE to exercise any of its rights granted herein shall not be construed as a waiver or abandonment of the right.



MOA/PM&E/ROW
Canyon Road Improvements
Upper DeArmoun Rd. to Chugach State Park
Project No. 13-56, ROW File No. C-13-14
Tax #017-073-06
Parcel #4

GRANTOR:
BIG COUNTRY ENTERPRISES, LLC

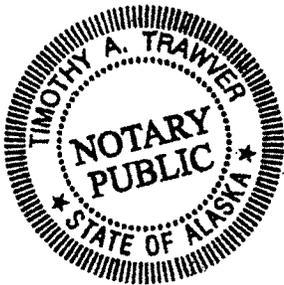
BY: Todd Brownson Date: 6/21/2018

ITS: MANAGING MEMBER

STATE OF ALASKA)
THIRD JUDICIAL DISTRICT) ss:

The foregoing instrument was acknowledged before me this 21st day of June,
2018, by Todd Brownson the managing member of
BIG COUNTRY ENTERPRISES, LLC.

Timothy A. Trawer
Notary Public for the State of Alaska
My Commission Expires: Feb 14, 2022

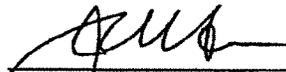


MOA/PM&E/ROW
Canyon Road Improvements
Upper DeArmoun Rd. to Chugach State Park
Project No. 13-56, ROW File No. C-13-14
Tax #017-073-06
Parcel #4

CERTIFICATE OF ACCEPTANCE

This is to certify that the Municipality of Anchorage, Project Management and Engineering Department, Grantee herein, acting by and through its Director, hereby accepts for public purposes the real property, or interest therein, described in this instrument and consents to the recordation thereof.

Municipality of Anchorage

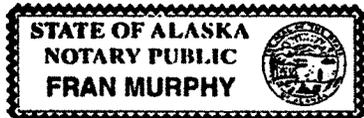


By: J. W. Hansen
Director
Project Management & Engineering Department

Date: 6/21/18

STATE OF ALASKA)
) ss.
THIRD JUDICIAL DISTRICT)

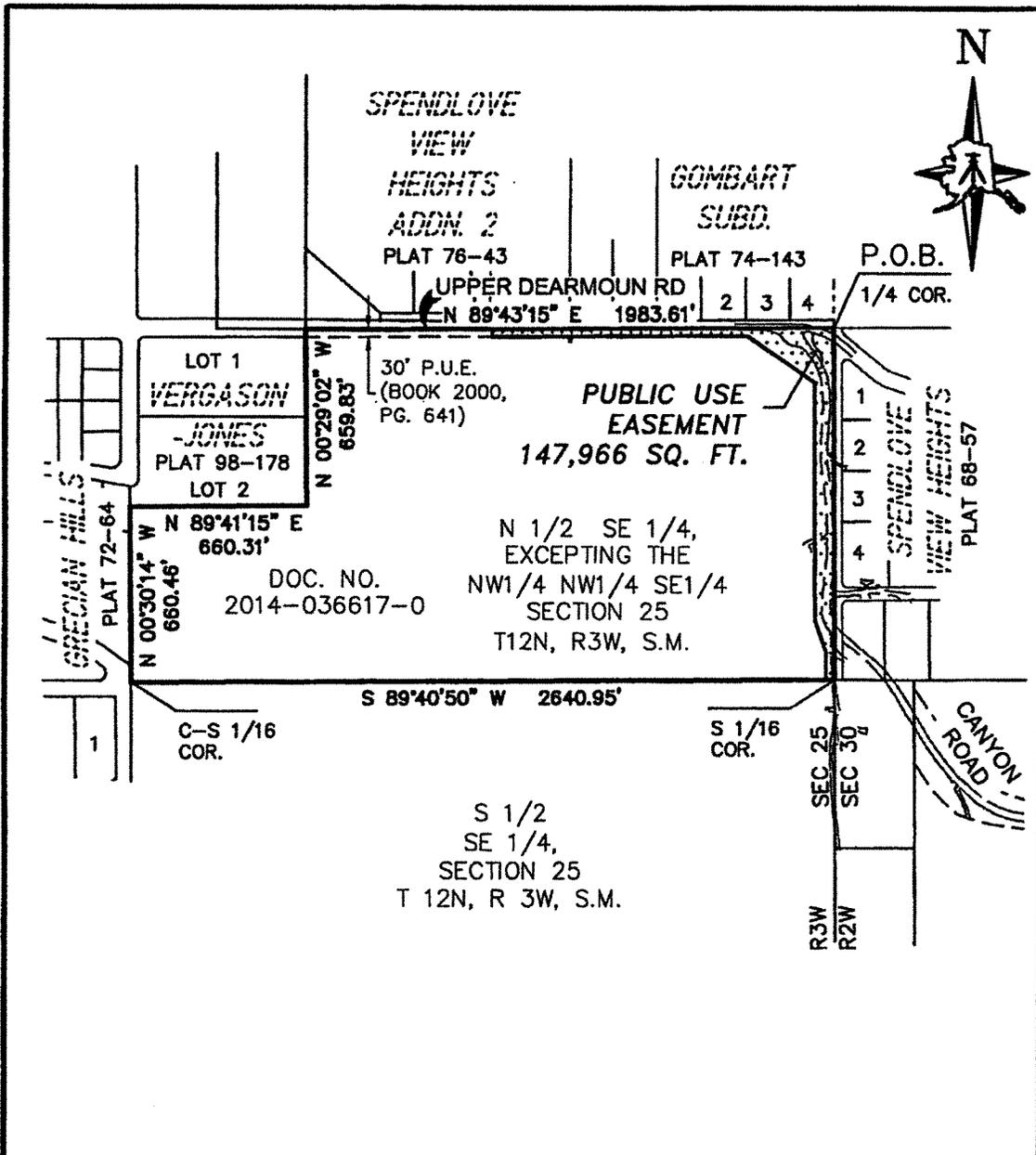
The foregoing instrument was acknowledged before me this 21st day of June, 2018 by J. W. Hansen, the Director of the Municipality of Anchorage, Project Management & Engineering Department on behalf of the corporation.





Notary Public in and for Alaska
My Commission Expires: 5-22-2021



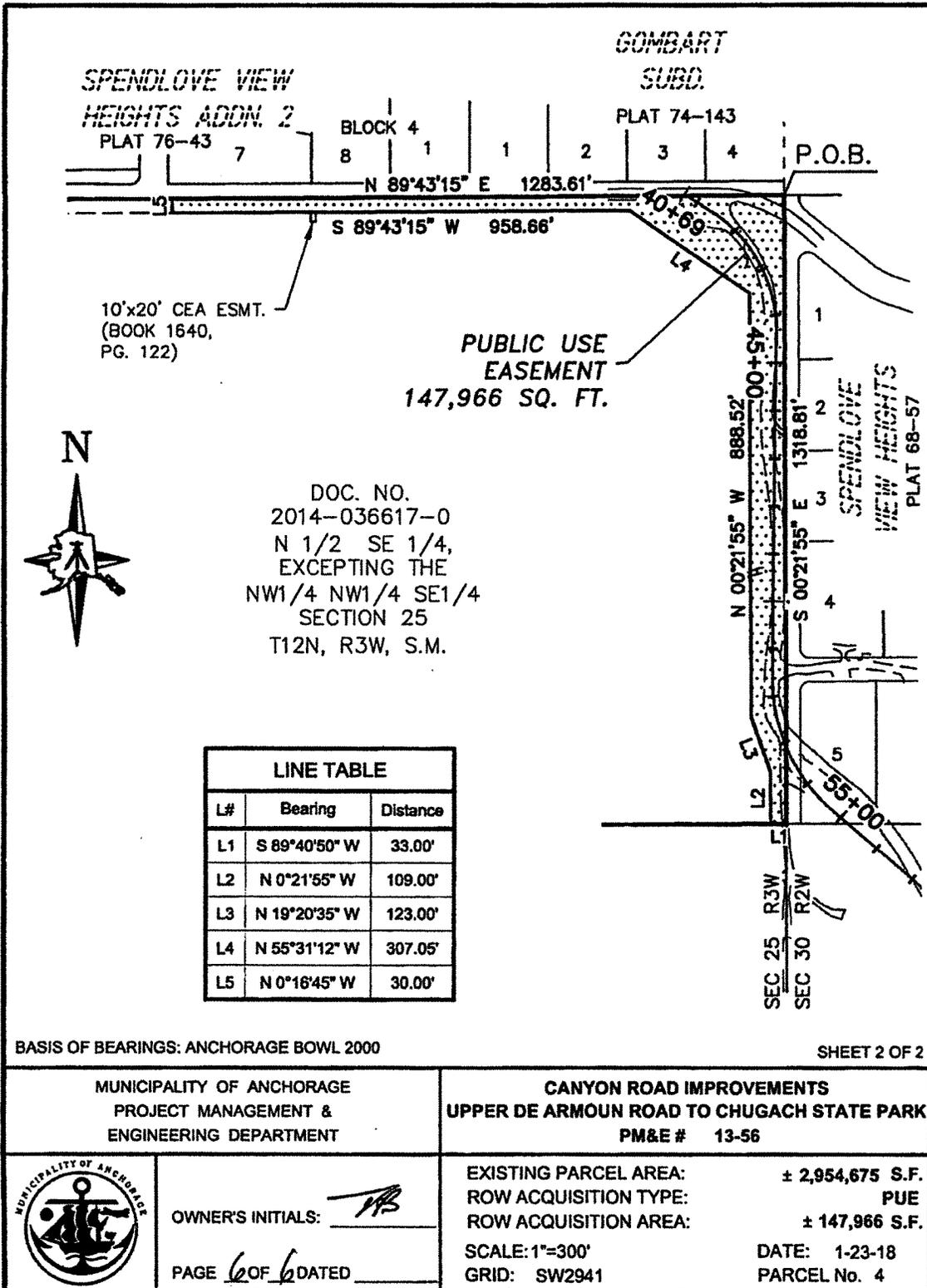


BASIS OF BEARINGS: ANCHORAGE BOWL 2000

SHEET 1 OF 2

MUNICIPALITY OF ANCHORAGE PROJECT MANAGEMENT & ENGINEERING DEPARTMENT		CANYON ROAD IMPROVEMENTS UPPER DE ARMOUN ROAD TO CHUGACH STATE PARK PM&E # 13-56	
	OWNER'S INITIALS: <i>JB</i>	EXISTING PARCEL AREA: ± 2,954,675 S.F. ROW ACQUISITION TYPE: PUE ROW ACQUISITION AREA: ± 147,966 S.F.	DATE: 1-23-18 PARCEL No. 4
	PAGE 5 OF 6 DATED _____	SCALE: 1"=600' GRID: SW2941	





**ACCESSORY DWELLING UNIT
AFFIDAVIT OF OWNER-OCCUPANCY
MUNICIPALITY OF ANCHORAGE**

I, **PAUL GIONET**, am over the age of 18 years, and make the statements herein of actual knowledge.

1. The legal description of my property is **T12N R3W SEC 25 S2 W2 NW4 SE4 Seward Meridian** parcel ID # **017-073-06-000** located in the Anchorage Recording District, Third Judicial District, State of Alaska, and there is an existing or proposed accessory dwelling unit (ADU) at this address.
2. I understand that in order to maintain an ADU in the Municipality of Anchorage, the property owner must reside in either the principal dwelling unit or the ADU for more than six months of each year. In other words, the property must be owner-occupied, per Section 21.05.070D.1.b.iii.(C)(4)(b) of the Anchorage Municipal Code.
3. I own this property, and this property is my legal residence for more than six months of each year.
4. I understand that the ADU permit is not transferable, and I certify that prospective purchasers will be notified of the requirements of the Municipality of Anchorage's ADU regulations.
5. A building or land use permit has been obtained in accordance with AMC 21.05.070D.1.b.ii.(A). Reference permit #**R18-2360**. I will notify the Municipal Planning Department, Land Use Review Division, if the ADU is modified from the plans approved by the Building Safety Division, or if the ADU is removed from this property.
6. I understand that the Municipality may subject me to a civil penalty per AMC 14.60.030 and/or require the removal of the ADU if any of the requirements at AMC 21.05.070D. are violated.
7. I agree that this document will be recorded as a deed restriction with the Anchorage Recording District.

8. This ADU is: (check one)

- New Construction Attached
- New Construction Detached
- Existing Structure Conversion Attached
- Existing Structure Conversion Detached
- Existing ADU Transfer of Ownership

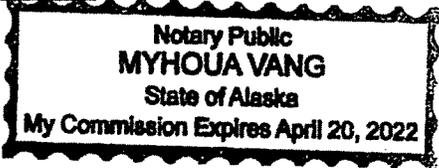
I declare under penalty of perjury that the foregoing is true and correct.

OWNER
 Signature: *Paul Gionet*
 Name: PAUL GIONET
 Date: 08-12-2018

OWNER
 Signature: _____
 Name: _____
 Date: _____

On this 12 day of August, 2018, before me, the undersigned Notary Public in and for the State of Alaska, Paul Joseph Gionet personally appeared and is to me known to be the individual described in the foregoing instrument, and acknowledged that he or she signed the same as his or her free and voluntary act and deed, for the uses and purposes therein mentioned.

GIVEN under my hand and official seal this 18 day of August, 2018.



My Houa Vang
 NOTARY PUBLIC in and for the State of Alaska
 My commission expires: April 20, 2022

Anchorage Recording District

Return original recorded document to:
 Municipality of Anchorage, Planning Department
 Land Use Review Section
 Attn: Sonnet Calhoun
 PO Box 196650
 Anchorage, AK 99519-6650

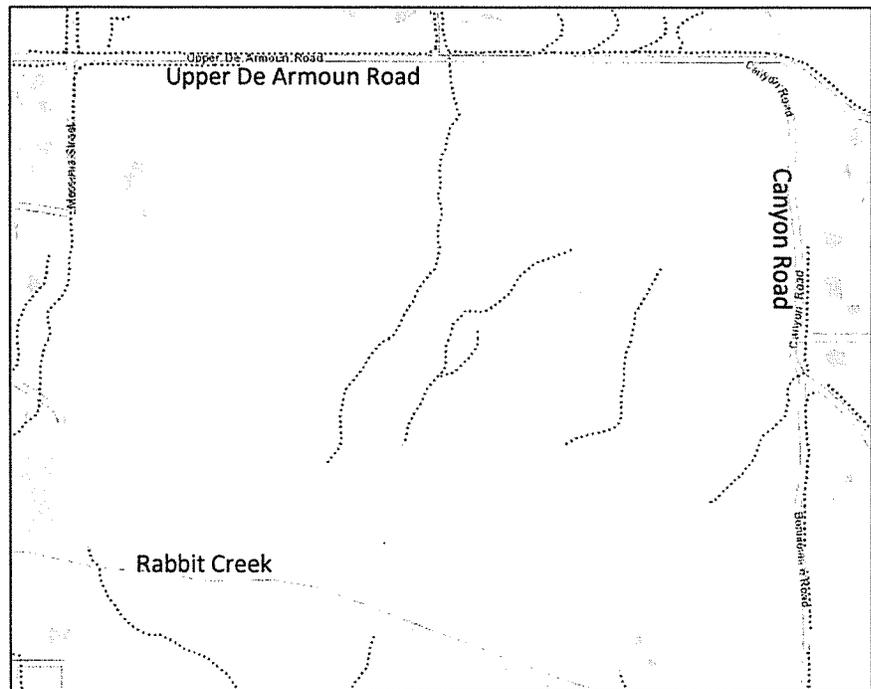


LEWIS & CLARK SUBDIVISION - LOTS 1-19, TRACTS A & B PRELIMINARY DRAINAGE IMPACT ANALYSIS 8-20-19

The following preliminary drainage impact analysis is associated with the proposed Lewis and Clark Subdivision, a large lot residential development located south of Upper De Armoun Road and west of Canyon Road in Anchorage Alaska. The preliminary plat creates nineteen R-10 zoned lots and two tracts within the 64.14-acre parcel. The project site is located within the Rabbit Creek watershed with the primary creek channel traversing along and outside of the southerly boundary of the preliminary plat. Proposed improvements will include publicly maintained, twenty-foot wide strip paved roads with drainage swales along with individual on-site wells and septic systems constructed on each individual lot at the time of home construction.

Current Development

The undeveloped site is currently well vegetated with mature trees and thick brush. The site drains generally from the northeast to the southwest towards Rabbit Creek. Slopes range from 9% to 16% across the property. There are two identified wetland areas on the parcel which account for approximately 9.4 acres of the total site. Both wetlands are anticipated to be preserved within Tracts as part of the final recorded plat. There are four drainage ways and one unnamed stream that have been identified by Watershed Management as shown to the right.



Existing Drainage Ways

The identified drainage ways collect onsite runoff as well as runoff from the upstream drainage area north of Upper De Armoun Road. Two 24" cross culverts exist at the intersection of Upper De Armoun Road and Jeanne Road intersection. These culverts drain surface water from the north side of De Armoun Road to the south and through the site. No municipally maintained storm drain systems exists within the proposed development. Additional drainage enters the property from the east through a

recently upgraded culvert across Canyon Road. This 36" culvert was recently installed as part of the Municipalities Canyon Road upgrade project.

Future Development

The proposed development will not alter the incoming flows from the north and east. The easterly flows will be routed around/through lots 7 and 8 before out falling to Rabbit Creek to the south. Likewise, runoff from the north will be routed through the development via the proposed road side swales. The swales will direct this concentrated flow towards established drainageways that eventually outfall to Rabbit Creek. An overlay of the preliminary plat with the existing drainageways is attached with this analysis.

After removing Tracts A and B from the total subdivided area the average lot size for the proposed subdivision is approximately 2.9 acres. Based on published tables for Runoff Curve Tables of Urban Areas, the average impervious area for 3 acre lots is anticipated to be roughly 8 to 10%. Note that the attached table provided by the United States Department of Agriculture (USDA) lists 12% as the average impervious area for lots 2 acres in size. Actual impervious area is anticipated to be closer to 8%. Roughly 1,650 lineal feet of strip paved road will further increase impervious area by an additional 1.5% resulting in a total estimated impervious area of roughly 9 to 11% of the overall area of the proposed subdivision. While many components impact the actual runoff generated from a development, increase to impervious area generally has the greatest impact to increased flow rates.

To address the increase in flow rates, a series of rock infiltration trenches will be installed within the swales to capture and infiltrate a portion of the runoff. The swales will outfall into either an identified drainage way, wetland or stream which eventually connects to Rabbit Creek located directly south of the property. Drainage easements will be created for all of these features and will be shown on the recorded plat. Increase in the quantity of runoff due to the development of the parcel will be minimal due to the low density and relatively small amount of impervious area anticipated. The current pattern of off-site drainage that enters the site from the north through existing culverts will remain unchanged and will be addressed in the civil design plans for the required subdivision improvements. The Autodesk Storm and Sanitary Analysis 2018 computer program, which utilizes the SCS TR-55 methodology, will be used to analyze and model the project drainage in both the present and future conditions as required by the Anchorage Stormwater Manual, Version 1.0, December 2017.

As is common within hillside developments in the Anchorage area glaciation concerns will need to be addressed within the site. While generally hard to predict, glaciation tends to occur at locations of shallow subsurface water flow which can vary seasonally. This shallow flow can be drawn to the surface by cold temperatures during the winter months. As the shallow subsurface water daylights it freezes and causes glaciation. To address this issue, locations of shallow groundwater flow discovered during the installation of the roadway improvements will be over excavated and backfilled with rock. This process further insulates the subsurface water from cold weather by keeping it below ground and in a thawed state.

August 20th, 2019

Subject: Lewis & Clark Subdivision Preliminary DIA

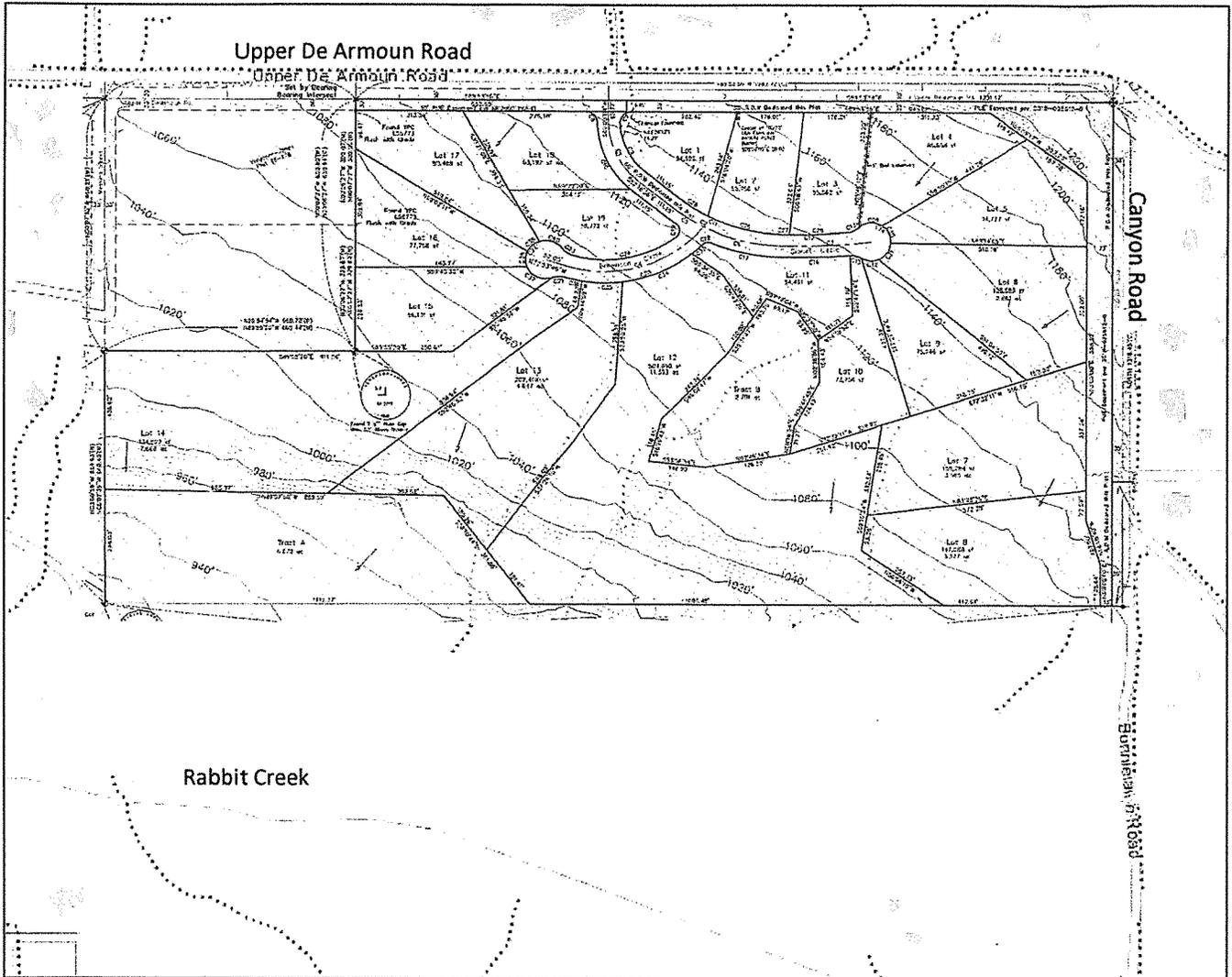
Page 3 of 5

Summary

Based on the initial review of the site, the existing conditions and known concerns from the public as well as the relatively low increase in impervious areas by the proposed development, the municipal drainage requirements appear to be attainable with no adverse impact to adjacent properties or Rabbit Creek. The preliminary plat and proposed site engineering concepts will; protect natural features such as wetlands and streams by incorporating them into the development of the site design, retain the natural flow and storage capacity of any watercourse and wetland to minimize the possibility of flooding or alteration of water boundaries, and provide adequate site drainage features to avoid erosion and to control the surface runoff in compliance with the federal clean water act.

Submitted by:

Brandon Marcott, P.E.



Existing Drainage Ways with Preliminary Plat

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description	Average percent impervious area ^{2/}	Curve numbers for hydrologic soil group			
		A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/} :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ^{4/}		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Developing urban areas

Newly graded areas (pervious areas only, no vegetation) ^{5/} 77 86 91 94

Idle lands (CN's are determined using cover types similar to those in table 2-2c).

^{1/} Average runoff condition, and $I_a = 0.2S$.
^{2/} The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
^{3/} CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
^{4/} Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
^{5/} Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

TERRASAT, INC.

4203 Iowa Drive, Anchorage, Alaska 99517

(907) 344-9370

Fax: (907) 243-7870

Geological Consulting • Environmental Restoration • Regulatory Compliance

April 8, 2016

Tom Dreyer
1427 W. 8th Ave.
Anchorage, Alaska 99501

RE: Findings of Groundwater and Nitrate Fate and Transport Investigations in the Area of the Lewis & Clark Subdivision

Mr. Dreyer,

TERRASAT Inc. is a professional hydrogeological consulting firm. We have been providing expert opinions about hydrogeology in Alaska since 1983. Dan Young, the principal hydrogeologist, is licensed by the State of Alaska and has been qualified as an expert by the Alaska Superior Court on many occasions since 1984. This report provides expert opinions based on facts and extensive experience working in the Anchorage basin as hydrogeologists.

GROUNDWATER AND WATER WELL CONDITIONS

TERRASAT conducted a comprehensive groundwater investigation of the area in and around the proposed Lewis & Clark Subdivision using well logs from the MOA and from the ADNRS WELTS databases that were between 1/2 to 3/4 miles from the property of interest. Twenty-five wells were evaluated and we reviewed and compared percolation rates and other data, previously obtained by S4 for the property of interest. Attached are three figures that depict relevant findings of the groundwater investigation. Specific concerns are addressed as follows:

Concern: A general concern that off-site groundwater quality will be affected by development of Lewis & Clark subdivision.

1. Of the twenty-five area water wells surrounding the development, twenty-two are bedrock wells and three are unconsolidated, as seen in Figure 1. The data clearly shows that the upper unconsolidated aquifer, in which septic systems are installed, does not produce sufficient water and therefore is not being utilized for drinking water in the area between 1/2 to 3/4 miles distance from the property of interest.
2. The static water level elevations of most of the surrounding water wells are higher than the water table within the property of interest (Figure 2). The elevated static water levels of the surrounding wells means that the

primary recharge to the bedrock aquifers is from farther up in the Chugach Mountains. Thus, development of the Lewis and Clark subdivision will not impact water quality of the surrounding water users.

3. Figure 2 shows four distinct bedrock aquifers surrounding the proposed Lewis and Clark subdivision. Septic systems and leach fields within the Lewis and Clark subdivision will be installed above a shallow unconsolidated water table aquifer. The shallow water table aquifer is distinctly different from the four bedrock aquifers. The shallow water table aquifer is likely recharged in part from bedrock fractures. The shallow water table is not a source of potable water for the surrounding community. Because the water table aquifer is recharged from bedrock, the water quality in the water table will have no effect on the four bedrock aquifers.

Concern: Groundwater extracted for use in the Lewis & Clark subdivision will reduce the available drinking water of off-site for adjacent land users.

4. Figure 3 shows that most of the wells in the study area produce greater than 3 gpm of water with some producing up to 20 gpm. The volume of water expected to be extracted for use in the Lewis & Clark development is unlikely to have a significant impact to existing water quantity production. Most homes use approximately 450 gallons per day and the bedrock aquifer wells are capable of producing up to 28,000 gallons per day (20 gallons per minute).

FATE AND TRANSPORT OF NITRATES AND BACTERIA

Concern: Does adequate separation exist from septic systems to potential receptors?

Nitrogen and Nitrates

TERRASAT evaluated existing percolation test results, surface topography, water well logs, and distances to property boundaries and distances to active drainages. Sixteen well logs from surrounding subdivisions provided the basis to determine the thickness of the shallow water table aquifer. We created two appropriate mathematical models to evaluate the fate and transport of nitrogen from the proposed advanced nitrate reducing septic systems. We modeled total nitrogen, which includes nitrates. We found that nitrogen, at the local creek, 430 feet away from the nearest lot, would be less than 0.2 mg / liter. The ADEC drinking water standard is 10 mg/ liter. ADEC requires nitrogen concentrations from septic systems to be less than 5 mg per liter at the nearest receptor, either the property boundary or a point designated by the Agency, like a creek. We also modeled concentrations at a downgradient property boundary 200 feet from a proposed leach field. The result was 0.3 mg per liter.

In conclusion, nitrates and nitrogen levels from a single family advanced septic system will comply with current regulations and will protect down gradient receptors. Our calculations, results and references are appended to this report.

Bacteria

TERRASAT considered the potential migration of five different pathogenic bacteria from a proposed leach field. The bacteria are:

- *E. Coli* bacteria
- *Enterococci* bacteria
- Fecal *streptococci* bacteria
- *Salmonella* bacteria
- *Shingella* bacteria

We found that *E. coli* is the most persistent of these five bacteria. We calculated that the maximum distance the *E. coli* could travel before achieving 99.99% deactivation is 110 feet from the source. Our calculations and references are appended to this report. Please note, 110 feet is extremely conservative because these bacteria travel as colonies and colonies travel slowly. We calculated as if the bacteria colonies travel at the seepage velocity, even though they travel much slower. The other bacteria will travel much less before 99.99% deactivation.

In conclusion, the MOA separation distance of 100 feet from a leach field to domestic water well is adequate in this subdivision and the local stream is also protected. Most lots are at least 1,000 feet from the stream and the closest lot is more than 430 feet (leach field) to the stream.

Summary and Conclusions

- Four distinct bedrock aquifers and one unconsolidated aquifer provide drinking water to the surrounding subdivisions.
- Static water elevations in most of the surrounding subdivisions are higher than the surface topography in the proposed Lewis and Clark Subdivision. That means development of this subdivision will have no impact to drinking water quality for the surrounding subdivisions.
- Water well logs from the surrounding subdivisions show that most of the wells produce more than 3 gallons per minute and up to 20 gallons per minute. Therefore, adequate to abundant groundwater quantiles are likely to exist in the Lewis and Clark Subdivision.
- Fate and transport modeling show that nitrogen from advanced nitrate reducing septic systems will comply with MOA and ADEC regulations.
- Fate and transport modeling for pathogenic bacterial show that the most persistent pathogenic bacteria will travel less than 110 feet before 99.99% deactivation. In reality, none of the bacteria are expected to travel more than 30 feet from the leach fields.

Please contact us if you have questions or require further information regarding our investigations.

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Attachments:

Figure 1: Aquifer Types for Water Wells in the Project Area
Figure 2: Static Water Elevations of Area Water Wells and Aquifers
Figure 3: Well Yields in GPM for Area Water Wells

Appendices:

1 - Three Dimensional Mass Solute Analytical Solution (5 pages)
1 - Deactivation of Pathogenic Organisms (1 page)
1 - Maximum Travel Distance to Achieve 99.99% Deactivation of Coliform Bacteria

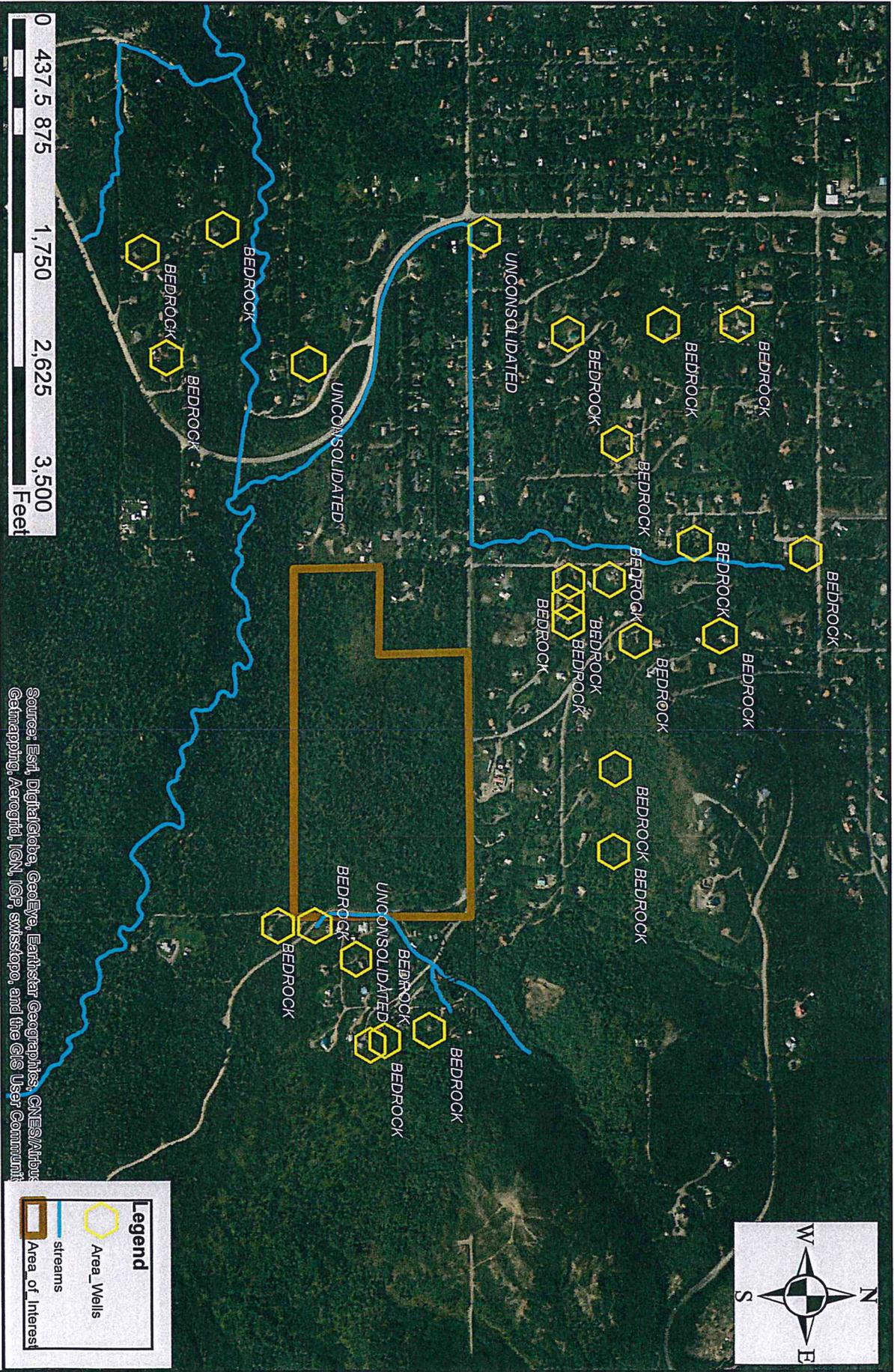
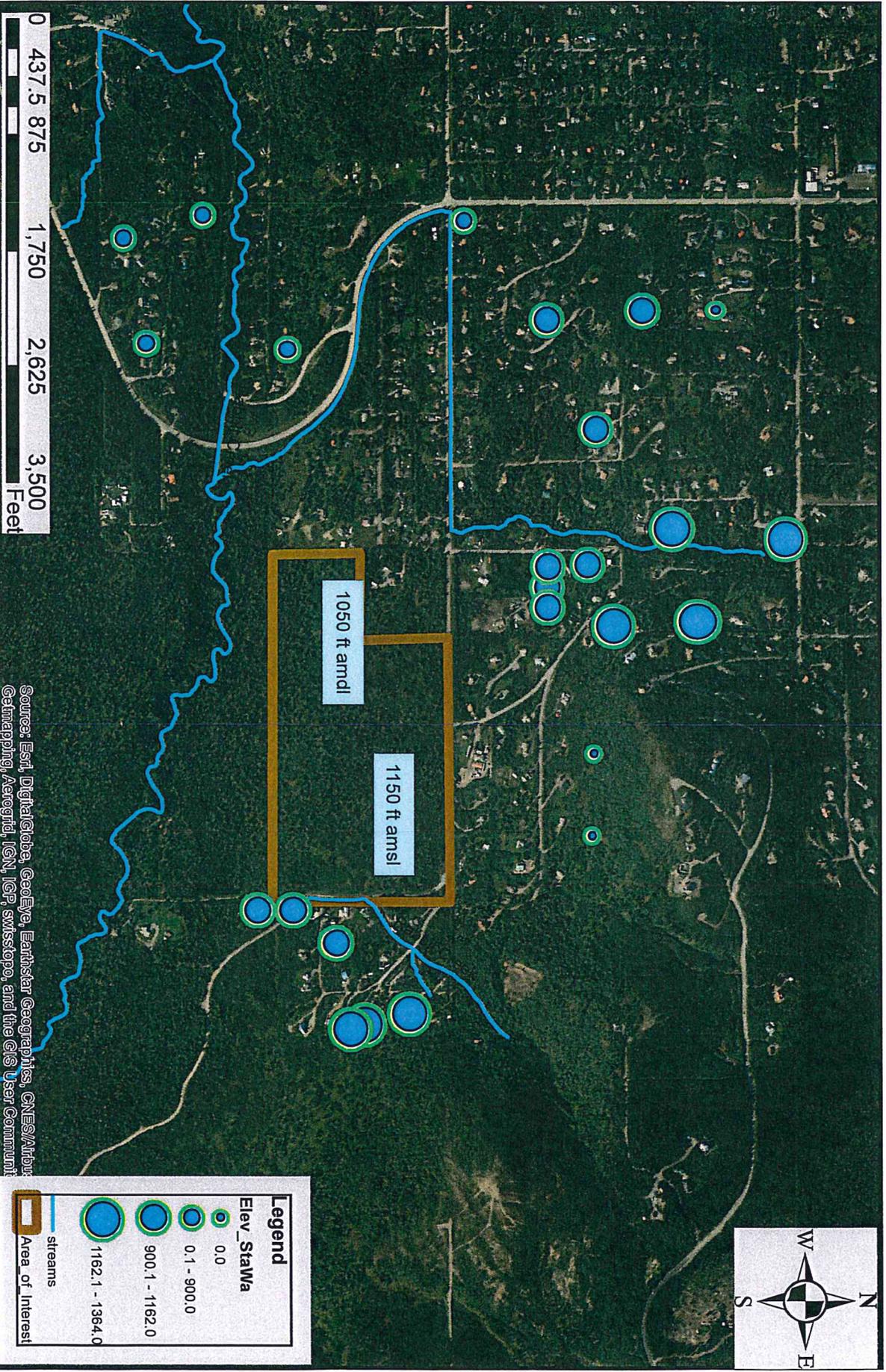


Figure 1
Aquifer Types for Water Wells in Project Area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
 @tmapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

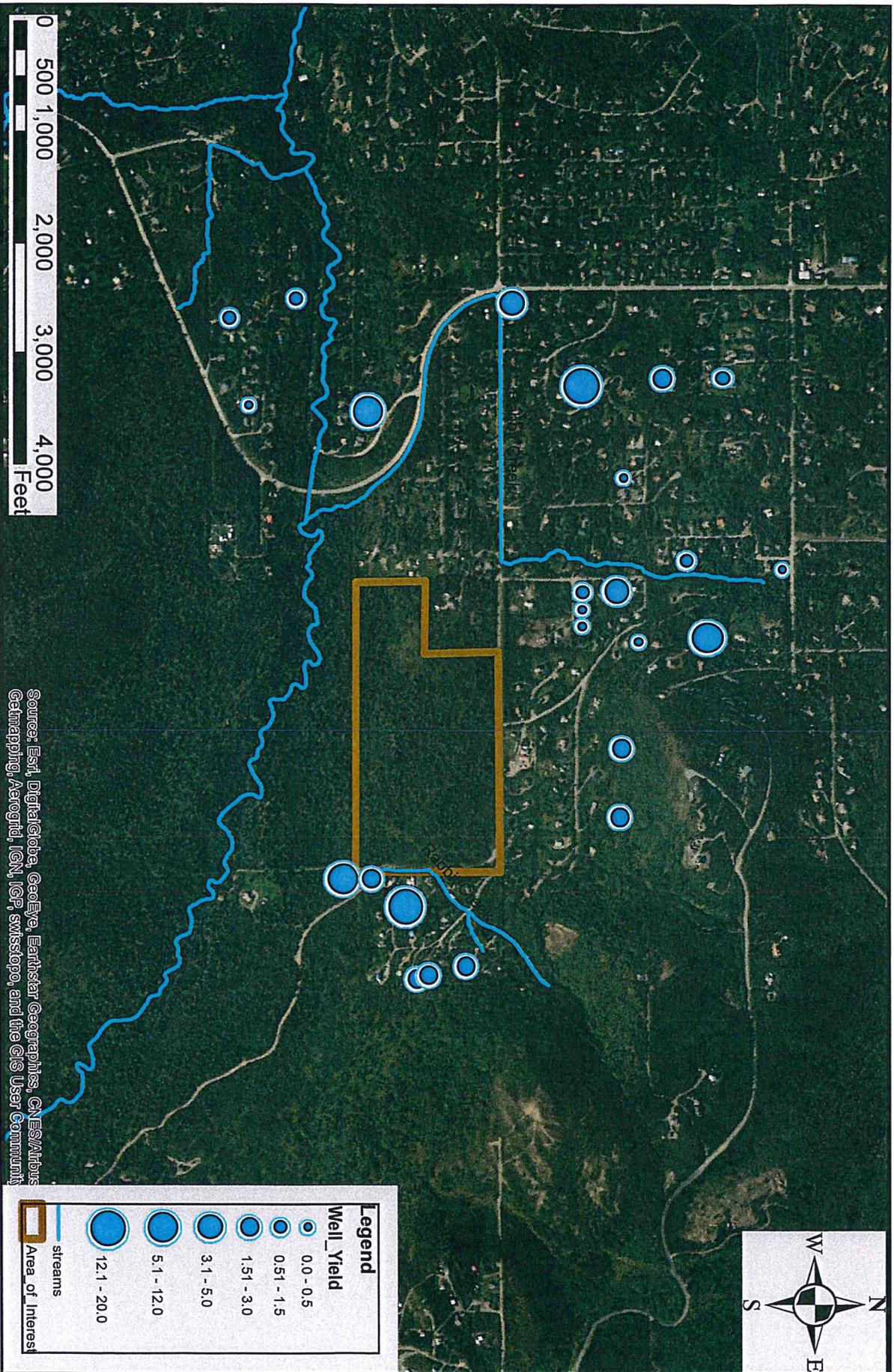
By: Terrasat, Inc.
Date: 4/7/16



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 2
Static Water Elevations of Area Water Wells

By: Terrasat, Inc.
Date: 4/7/16



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
 Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 3

**Well Yields in GPM for Area Water Wells
 Obtained from Drillers Well Logs**

**By: Terrasat, Inc.
 Date: 4/7/16**

Lewis and Clark Subdivision-- Nitrogen Migration in Groundwater from a Sanitary Leach Field that is Designed to Serve a Single Family House

Three Dimensional Mass Solute Analytical Solution

Introduction

Mass solute can be modeled with 1-, 2-, and 3-dimensional analytical groundwater models, as well as with a mass balance equation. Numerical models are much more complex and are used when multiple sources, multiple sinks and variable site conditions exist. Numerical models are appropriate when much more information is available, such as the horizontal and vertical distribution of hydraulic conductivities and porosity. This information is seldom known across the domain of a leach field to a down gradient receptor in Alaska.

We choose a 3-dimensional analytical model because it provides a good understanding of what occurs down gradient of a leach field. Analytical models have proven to be powerful tools to evaluate solute transport and are abundant in the hydrogeological literature. The 3-D model considers longitudinal dispersion, transverse dispersion and vertical dispersion, three important transport processes that are only approximately accounted for in a mass balance model.

This 3-dimensional analytical model ignores molecular diffusion because diffusion is so small compared with mechanical dispersion in a flowing aquifer that diffusion becomes trivial. The 3-D model ignores precipitation entering the aquifer. Based on a sensitivity analysis with the mass balance model, precipitation in South Central Alaska is small enough, over the model domain, that it will not influence the final concentration at the compliance point.

This 3-D model considers aquifer thickness and appropriately restricts vertical dispersion to the maximum depth of the aquifer.

Nitrate is biodegradable as it migrates down gradient from its source. Biodegradation rates are not available so the process is eliminated from this model. The results are likely biased high at the compliance point.

Assumptions

The aquifer is uniform thickness. This is a limitation of the analytical model. We therefore assume that the aquifer is uniformly 8 feet thick, based on soil borings and water well logs. The average aquifer thickness, from available water well logs, is 14 feet. The aquifer could be as thick as 24 feet in places, which means significant dilution will likely occur before water reaches the compliance point. We selected 14 feet thick as a minimum, based on available water well logs from adjacent subdivisions.

We assume that the aquifer is infinite laterally and down gradient. This is likely true, within the domain of the model. Water well logs from surrounding subdivisions support this assumption.

We assume that mechanical dispersion is much greater than molecular diffusion. We assume molecular diffusion is trivial in this model and is therefore omitted. This is a safe assumption when hydraulic conductivities are moderate or higher. If molecular diffusion was significant, the final concentration at the compliance point would be decreased.

We assume that nitrogen, as it migrates, does not react with minerals or elements in the aquifer. This assumption is likely valid for nitrogen, as most models with nitrogen assume nitrogen travels at the same rate of groundwater flow.

We assume sorption does not occur for nitrogen. Nitrogen is generally known as a conservative solute, traveling at the same velocity as groundwater. If conditions exist where nitrogen does adsorb to soil particles, these models would predict higher concentrations at the compliance point than are actually likely to occur.

We assume that we have a continuous flow of both groundwater and nitrogen input from the source. Even though nitrogen is episodically discharged throughout a day, an average value is sufficient to evaluate the hydrogeologic model.

Inputs

Source conditions

$$C_0 := 15.6 \cdot \frac{mg}{L}$$

Concentration at the source

$$R := 1.$$

Retardation, 1 for no retardation

$$Y := 30 \cdot ft$$

Width of leach field above aquifer

$$Z := 1 \cdot ft$$

Depth of leachate penetration into top of aquifer, likely <1 foot

Receptor

$$x := 430 \cdot ft$$

Distance to receptor, lot closest to creek

$$t := 0.5 \cdot yr$$

Time since source began leaching into aquifer

Aquifer conditions

$$i := 0.15$$

hydraulic gradient (measured MOA 10-foot contour data of land surface)

$$k := 0.003 \cdot \frac{cm}{s} = 8.5 \frac{ft}{day}$$

hydraulic conductivity (based on percolation tests results)

$$\eta_e := 0.3$$

Effective porosity (assumed, text book range for sand)

$$b := 11.5 \cdot ft$$

aquifer thickness (minimum, based on existing water well logs)

$$v := \frac{k \cdot i}{\eta_e} = 4.252 \frac{ft}{day} \quad \text{Aquifer velocity}$$

$$\alpha_x := 0.83 \cdot \left(\log \left(\frac{x}{ft} \right) \right)^{2.414} \cdot ft \quad \text{Longitudinal dispersivity, parallel to x-axis}$$

$$\alpha_y := .1 \cdot \alpha_x = 0.86 \text{ ft} \quad \text{Transverse dispersivity, perpendicular to x-axis, typically 10% of longitudinal dispersivity}$$

$$\alpha_z := .1 \cdot \alpha_y = 0.09 \text{ ft} \quad \text{Vertical dispersivity, typically 10% of transverse dispersivity}$$

Function Definitions

$$y := 1 \cdot ft \quad \text{offset from x axis at downgradient compliance point}$$

$$z := 1 \cdot ft \quad \text{vertical offset from x axis at downgradient compliance point}$$

$$x' := \frac{(b-Z)^2}{\alpha_z} \quad x' \text{ is used in the Z component to limit vertical dispersion to the thickness of the aquifer}$$

$$y_{component} := \text{erf} \left(\frac{y + \frac{Y}{2}}{4 \cdot (\alpha_y \cdot x)^{0.5}} \right) - \text{erf} \left(\frac{y - \frac{Y}{2}}{4 \cdot (\alpha_y \cdot x)^{0.5}} \right)$$

$$Z_{component} := \text{erf} \left(\frac{z + Z}{2 \cdot (\alpha_z \cdot x')^{0.5}} \right) - \text{erf} \left(\frac{z - Z}{2 \cdot (\alpha_z \cdot x')^{0.5}} \right)$$

$$t := 10 \cdot yr \quad \text{This is a guess value for time to reach steady state}$$

$$\beta := -2 \quad \text{when } \beta = -2 \text{ concentration is at steady state conditions}$$

$$\beta = \frac{x - \frac{v \cdot t}{R}}{2 \cdot \left(\alpha_x \cdot \frac{v \cdot t}{R} \right)^{0.5}}$$

$$\text{steady_state_time} := \text{find}(t) = 0.48 \text{ yr}$$

Solve for time to reach steady state concentrations at distance from source $x = 430 \text{ ft}$

$$\beta := \frac{x - \frac{v \cdot t}{R}}{2 \cdot \left(\alpha_x \cdot \frac{v \cdot t}{R} \right)^{0.5}} = -2.121$$

When $\beta < -2$, aquifer is at steady state conditions at $x = 430 \text{ ft}$ from source

Analysis

$$x := 430 \cdot ft$$

$$y = 1 \cdot ft$$

$$z = 1 \cdot ft$$

$$t := steady_{state_time} = 0.48 \cdot yr$$

$$C_{xyz} := \frac{C_0}{8} \cdot \operatorname{erfc} \left(\frac{x - v \cdot t}{2 \cdot (\alpha_x \cdot v \cdot t)^{0.5}} \right) \cdot y_{component} \cdot Z_{component}$$

Results

$$C_{xyz} = 0.18 \frac{mg}{l}$$

Maximum nitrogen concentration in aquifer at $x = 430 \cdot ft$ from source and aquifer has reached steady state concentrations.

Conclusions

This three-dimensional analytical mass transport equation is an appropriate model to evaluate leachate in a septic system drainfield with essentially continuous source release. The model is widely used and accepted throughout the groundwater industry. The model assumes groundwater velocity in one direction with mechanical dispersion downgradient, transverse to the gradient, and vertical to the flow direction.

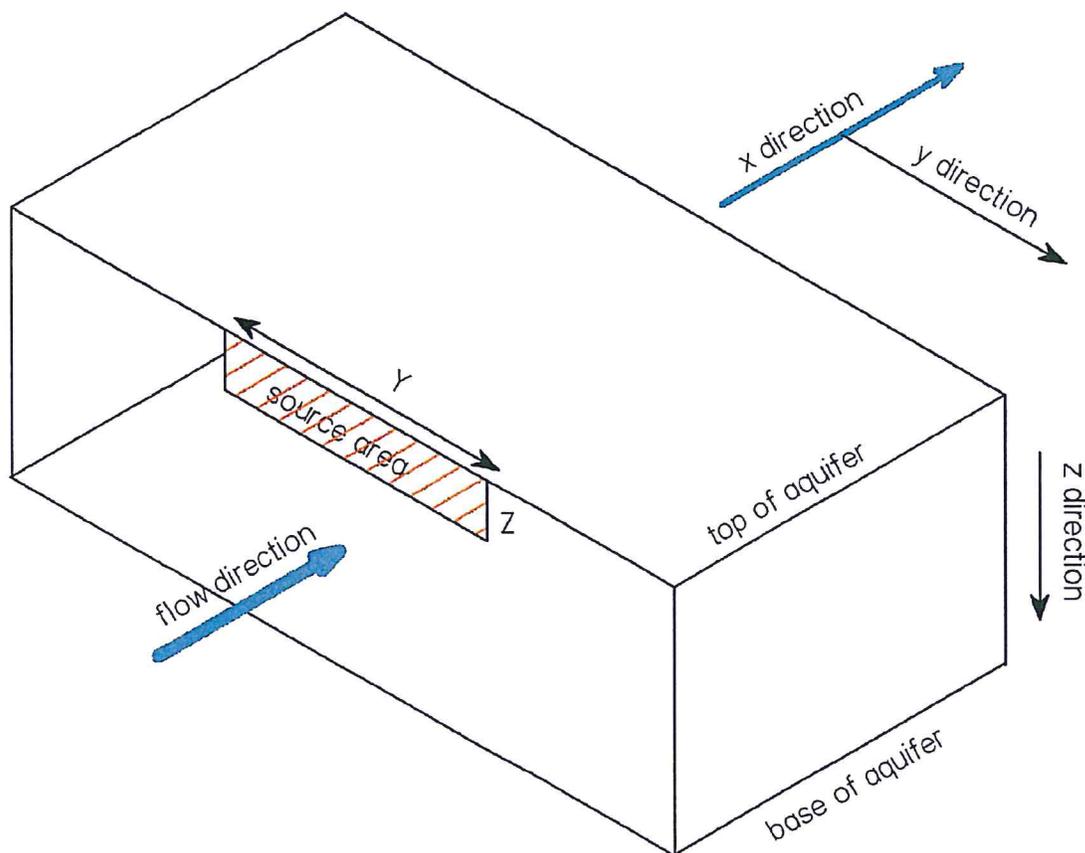
Results from these evaluations show that after the flow field reaches steady state, the highest concentration directly downgradient at $x = 430 \cdot ft$ will be $C_{xyz} = 0.18 \frac{mg}{l}$.

source: Domenico, P., and Schwartz, F., 1990, Physical and Chemical Hydrogeology, John Wiley and Sons, Inc. 504 pps.

Domenico, P.A., and Robbins, G.A., 1985, A New Method of Contaminant Plume Analysis, Ground Water, Vol 23.

Alvarez, J.J. and Illman, W.A., 2006. Bioremediation and Natural Attenuation, John Wiley and Sons, Inc., p. 177.

Mass Transport Conceptual Model



Deactivation of Pathogenic Organisms

$N_1 := 1$	Number of colonies or viruses at well location
$N_2 := 10000$	Number of initial colonies or viruses
$log_{reduction} := \log\left(\frac{N_2}{N_1}\right) = 4$	log reduction in bacteria or viruses
$\tau = \frac{t}{\log\left(\frac{N_2}{N_1}\right)}$	τ is the inactivation rate, t is time to deactivate with $log_{reduction} = 4$
$t = \tau \cdot log_{reduction}$	Rearrange and solve for t = time to deactivate

Average days to achieve 90% deactivation for groundwater less than 59 degrees F.	Time to achieve deactivation for $log_{reduction} = 4$
--	--

$\tau_{Coliform_bacteria} := 6.6 \cdot \text{day}$	$t := \tau_{Coliform_bacteria} \cdot log_{reduction} = 26.4 \text{ day}$
$\tau_{Enterocci_bacteria} := 3.5 \cdot \text{day}$	$t := \tau_{Enterocci_bacteria} \cdot log_{reduction} = 14 \text{ day}$
$\tau_{Fecal_streptococci} := 3.5 \cdot \text{day}$	$t := \tau_{Fecal_streptococci} \cdot log_{reduction} = 14 \text{ day}$
$\tau_{Salmonella} := 2.0 \cdot \text{day}$	$t := \tau_{Salmonella} \cdot log_{reduction} = 8 \text{ day}$
$\tau_{Shigella} := 3.5 \cdot \text{day}$	$t := \tau_{Shigella} \cdot log_{reduction} = 14 \text{ day}$

Pyne, David, 2005, Aquifer Storage Recovery, 2nd Ed., p 272, ASR Systems, LLC.
 and Maliva, R., and Missimer, T., 2010, Aquifer Storage and Recovery and managed Aquifer Recharge Using Wells: Planning, Hydrogeology, Design and Operation, Pg. 385. Published by Schlumberger Marketing Communications.

Maximum travel distance to achieve 99.99% deactivation of coliform bacteria

$$\text{Darcy Velocity } V = K i$$

i is gradient

$$\text{Seepage Velocity is } V_s = K \cdot i / \phi$$

K is hydraulic conductivity

$$\phi := .30$$

Porosity is ϕ

$$i := 0.15$$

gradient measured from source to creek

$$K := \frac{1 \text{ in}}{14.4 \text{ min}} = 8.33 \frac{\text{ft}}{\text{day}}$$

Hydraulic conductivity

$$\text{Distance} := 110 \cdot \text{ft}$$

Distance from source to 99.99% deactivation of coliform bacteria

$$V := K \cdot i$$

$$V_s := \frac{V}{\phi} = 4.2 \frac{\text{ft}}{\text{day}}$$

Seepage Velocity

$$\text{time}_{\text{seep}} := \frac{\text{Distance}}{V_s} = 26.4 \text{ day}$$

Seepage time

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Ground Water Resource Evaluation for the Proposed Lewis and Clark Subdivision

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February 16, 2017

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1.0 SUMMARY

(Big Country Enterprises, LLC. (Big Country) contracted TERRASAT, Inc. (TERRASAT) to conduct an investigation of hydrogeological conditions at the proposed Lewis and Clark Subdivision (see Figures 1 & 2). In addition, TERRASAT supervised the installation of three new wells and conducted aquifer testing and evaluation as part of the overall study objectives.

The proposed Lewis and Clark subdivision is comprised of approximately 80 acres of undeveloped land on the Hillside area of Anchorage, Alaska. Ten acres of the land in the northwest corner of the parcel may be not included in the final plat for the development. The parcel is bordered on the north by Upper DeArmoun Road, on the east by Canyon Road, on the west by Messinia Street on the south by undeveloped land that lies 500 to 1000 feet up gradient of a segment of Rabbit Creek. Figure 1 shows the site general location and Figure 2 shows the specific site location.

Our investigation of the area water budget concluded that sufficient sustainable ground water is available to supply the proposed Lewis and Clark subdivision land development. An evaluation of area well data suggests at least five separate aquifers exist in the local area. TERRASAT proposes that at least two aquifers will likely be used to extract groundwater for the various lots in the Lewis and Clark development.

Average yield per well for 124 residential wells in an approximate 1/2 mile area around Lewis and Clark subdivision that were evaluated in this study is 5.09 gallons/minute. Aquifer test results suggest that the average well in the Lewis and Clark subdivision may produce between 7 to as much as 135 gallons/minute. Hydrogeological modeling of the new wells show that the largest impact to a property 200 feet away ranges between 0.0 and 3.08 feet when a well is pumped for up to three hours at 2 gallons per minute, a typical rate. Most of the neighboring wells have more than 200 feet of available static water level in their wells. Therefore, the neighboring wells will continue to function without a significant impact.

2.0 METHODS

TERRASAT conducted a comprehensive groundwater investigation of the area in and around the proposed Lewis & Clark Subdivision using available well logs from the MOA and from the ADNR WELTS databases that were within 1/2 to 3/4 miles from the property of interest. Figure 3 shows the locations of 124 private residential wells whose records were analyzed during the site evaluation conducted by TERRASAT for the proposed Lewis and Clark subdivision.

3.0 GEOLOGY

3.1 Background Information

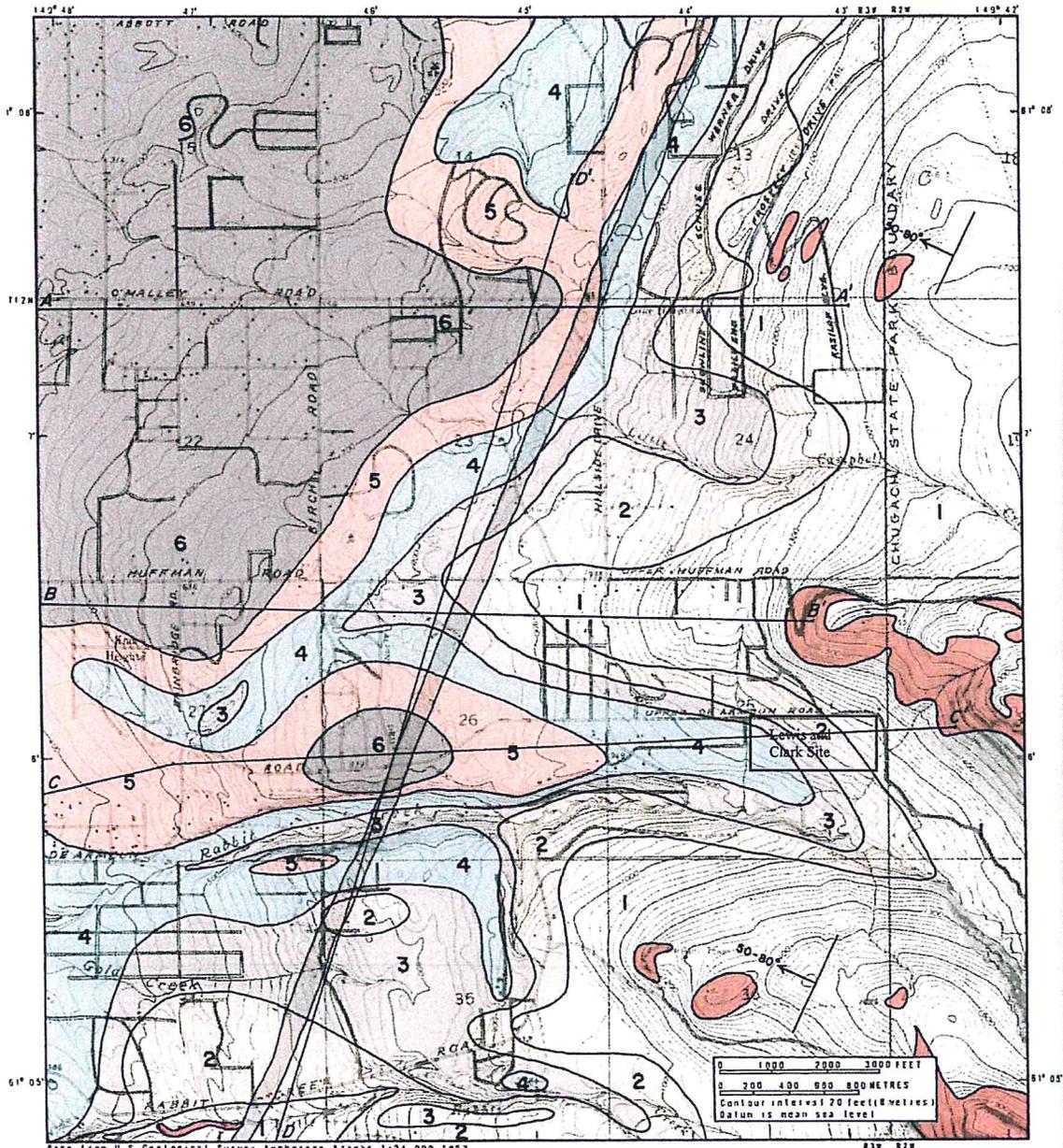
Several State and Federal reports have documented the generalized geology of the area around and including the proposed Lewis and Clark subdivision. Much of the Upper Hillside area of Anchorage is part of the Chugach State Park and the boundary lies one mile east of the eastern boundary of the Lewis and Clark subdivision. A USGS map report "Generalized Geologic Map of Anchorage and Vicinity, Alaska" by Henry R. Schmoll and Ernest Dobrovolny 1972, shows the surficial geology types, not including a thin layer of organics that is found in many areas, include the following:

- Colluvium (c): Slope deposits on mountain sides and valley walls in lowlands. Consisting of diamicton and poorly sorted to well sorted gravel with some sand, silt or clay. Usually, and in this location, it is found downslope of bedrock.
- Lake and Pond Sediment (l): Near mountains it is chiefly silt and clay with some fine sand, and sand and gravel: it is accumulated in former ice-dammed lakes. In this case, from ice-dammed water flowing down the modern Rabbit Creek channel as seen in Figure 4 south of the property of interest.
- Alluvial Fan Deposits (af): Deposits in alluvial fans or alluvial cones. In this case they are likely from alluvial fan or cone deposits that came down from mountain sides in the area. Consisting dominantly of gravel and may contain some silt and clay. Often, as here, they are found next to and grade into colluvium (c).
- Morainal Deposits (m): Deposits found generally in long ridges marking the merging of former glaciers. Chiefly till.

While beneath the surface, any of the above type deposits may also be found, ultimately at some depth bedrock will be located:

- Bedrock (b): Metamorphic rock, principally McHugh Complex metamorphosed siltstone, greywacke, arkose, conglomerate sandstone, and greenstone. Chert and argillite are often associated with these deposits. This type rock is surely to be found at the Lewis and Clark site, likely at depths no greater than 250 feet bgs.

Figure 4 is a map display of the information contained in the USGS geology map of the area. Figure 5 shows the topographic location of the site and includes the location of a drainage basin divide in the area. Figure 6 below, from Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105 in cooperation with the Greater Anchorage Area Borough shows likely bedrock depths of the Hillside area including the Lewis and Clark site.



EXPLANATION

Unit thickness in Feet (metres)		Unit thickness in Feet (metres)			
	Bedrock at surface		150-200 (46-61)		Line of section (fig 5)
	Less than 50 (15)		50-100 (15-30)		Info/rad subsurface location of Knik Fault zone (Clark, 1973).
	50-100 (15-30)		100-150 (30-46)		Symbol indicates general orientation of strike and dip of major bedrock fractures.
	100-150 (30-46)		More than 250 (75)		

Figure 6. Hillside bedrock depths. (from Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105 in Cooperation with the Greater Anchorage Area Borough)

Note in Figure 6 that bedrock depths across the Lewis and Clark site range from 50 to 200 feet (below ground surface) bgs. This compares favorably to a statistical modeling evaluation by TERRASAT, based on well log data from area wells, that showed depths to bedrock likely will range from between 0 to 158 feet bgs for the up-gradient 2/3 of the property, with greater depths downgradient in a southwestern direction. Insufficient data was available to model the lower 1/3 of the Lewis and Clark site.

Subsequent data collected from the installation of the three new wells (see following sections) in December 2016 has compared favorably to the TERRASAT and USGS bedrock modeling of that specific area of the Lewis and Clark subdivision and confirms the actual bedrock depth at those locations ranges from 43 to 92 feet below ground surface.

3.2 Subsurface Investigations

3.2.1 Pre-Drilling Evaluations

Figure 4 shows the geology of in the area of interest consists of colluvium in the south and in the north, lake and pond sediments that run in the center of the property, and alluvial fan deposits on the east of the property. Percolation test hole logs show peat in the upper 1 to 2 feet, with silty or gravelly fine sands (colluvium or lake and pond sediments) predominant for several feet beneath the upper layers.

Wells in the area are known to be in bedrock in most locations, however to the west of Lewis and Clark several private wells in the Grecian Hills Subdivision are installed in unconsolidated material as is a private well (within the project area) located on the east side of Messina Street. These wells are likely located in the alluvial fan or morainal deposits that are shown in Figure 4, indicating that either or both of those type of deposits may extend further south than the generalized USGS map indicates. This is inferred from the fact that the residential wells directly north of the Lewis and Clark subdivision, which are located in colluvium, are bedrock wells according to well logs, while wells directly west of the Lewis and Clark subdivision are located in unconsolidated material. As one moves from higher to lower elevations in the Hillside area, bedrock is generally found deeper and the percentage of wells in unconsolidated material becomes greater. This effect may become evident within the Lewis and Clark parcel because the land there grades gently downward toward the Rabbit Creek valley which lies south of it.

TERRASAT reviewed the water well data from 124 local wells and reviewed static water levels and elevations, lithology, depths to bedrock, well aquifer type, and other available information including water quality. Appendix A contains much of that information.

3.2.2 Post Well-Drilling Geological Results

Three drinking water well boreholes were drilled in December 2016 through January 2017 . Well logs (Appendix D) show that fractures in bedrock aquifers exist at several depths in the Lewis and Clark Subdivision at those specific locations. These water bearing fractures-zone aquifers are protected from surface activities by at least 100 feet of bedrock aquitard. Bedrock was initially encountered at depths of 43, 51 and 92 feet below ground surface in the three exploratory wells. Those wells were drilled to depths of 398, 256, and 236 feet below ground surface respectively. All three wells were completed in bedrock with water producing fracture zones encountered at several depth intervals. The bedrock was predominately greywacke with numerous hydrothermal veins of quartz and other minerals at various depths. Section 4.2 describes the results of aquifer testing at the three wells.

4.0 HYDROGEOLOGY

4.1 Subsurface and Previous Investigations

Several prior studies describe various aspects of the geology and hydrogeology of the area. TERRASAT used “Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105” in cooperation with the Greater Anchorage Area Borough, to help define the water budget for the area. Another study that was referenced was “Emanuel and Cowing, USGS Open File Report 82-86, Hydrogeology for land-use planning; the Potter Creek Area, 1982, Anchorage, Alaska” in cooperation with the Greater Anchorage Area Borough.

Static water levels at the time of drilling from available well logs were converted to static water elevations above sea level for the area well logs used in TERRASAT’s investigation. The static water elevations were then statistically evaluated to differentiate aquifers in the communities surrounding the Lewis and Clark subdivision. Five separate aquifers were delineated for the area.

The western area of the Lewis and Clark subdivision likely contains a thicker section of unconsolidated material above bedrock. At least one confined aquifer likely exists in this unconsolidated material that either does not exist further to the east, or if it exists, is too thin to produce sustainable water supplies. The one water well that currently exists in that area confirms this likelihood.

TERRASAT’s investigation found that ancient channels of Rabbit Creek once crossed two locations within or very near the property of interest. Figure 7 shows the locations of these former stream channels. These ancient channels will have altered the subsurface and surface geology in those specific areas, likely creating deposits of alluvium that still exist. These will likely be encountered during development of the area and have a potential to serve as a high yield aquifer.

4.1.1 Local Aquifers and Availability of Water

According to the report; Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105, the groundwater budget for the Anchorage Upper Hillside area containing the Lewis and Clark project area is approximately 10-16 Mgal/day. Figure 8, below depicts the general study area of that Hillside report which closely correlates with the 99516 area code area. Figure 9 shows the water budget in that area.

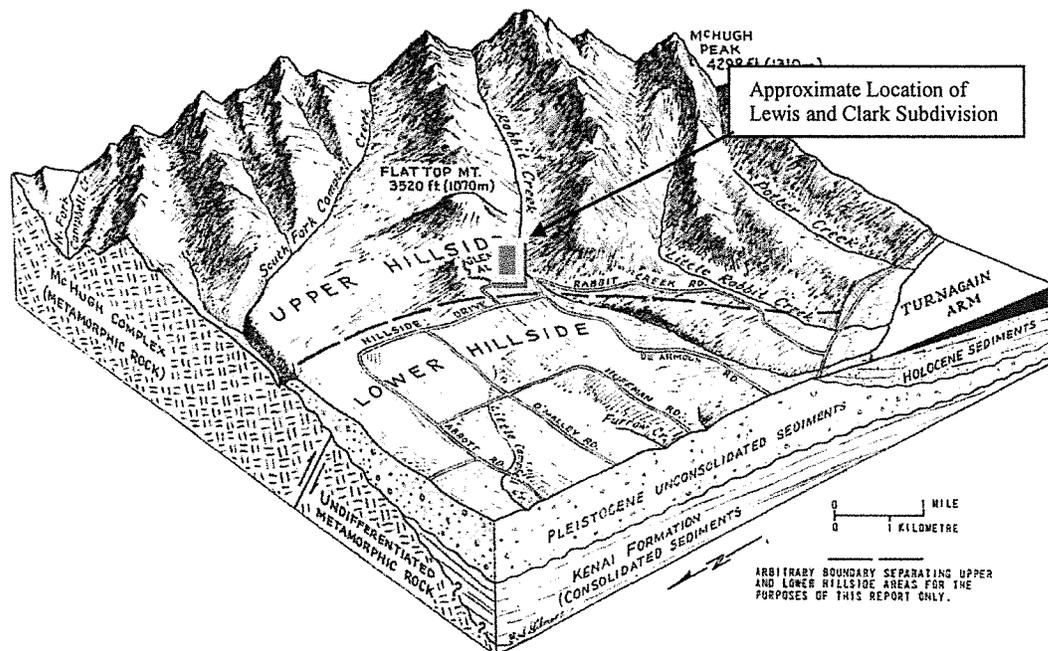


Figure 8. Upper Hillside Area (from Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105 in Cooperation with the Greater Anchorage Area Borough.)

An average home in Anchorage uses approximately 450 gallons per day of water. The MOA census data from 2013 for the Upper Hillside, the area code 99516 area, lists a population of 20,781. If we are to assume that an average house contains four people, then we can assume that the area contains approximately 5195 houses. If 5195 homes use 450 gallons per day then the Upper Hillside area would use 2,337,750 gallons per days of the available 10-16 million gallons. This shows that availability of groundwater is not, at this time, an issue for the Upper Hillside area. The Lewis and Clark subdivision will have approximately 30 houses

or less. The daily water consumption for 30 houses at 450 gallons per house equals 13,500 gallons per day. This is a fraction of the 10-16 million gallons per day of available groundwater shown in Figure 9. We conclude that groundwater recharge is abundant for the Lewis and Clark subdivision and surrounding subdivisions.

One-hundred seventeen wells had available data regarding aquifer type for each well. Figure 10 shows the most current static water elevations measured for each well. Some are the measurement taken at the time of drilling and some are taken at a later date, often when the property ownership was being transferred. The results show that five separate aquifers likely exist in the area.

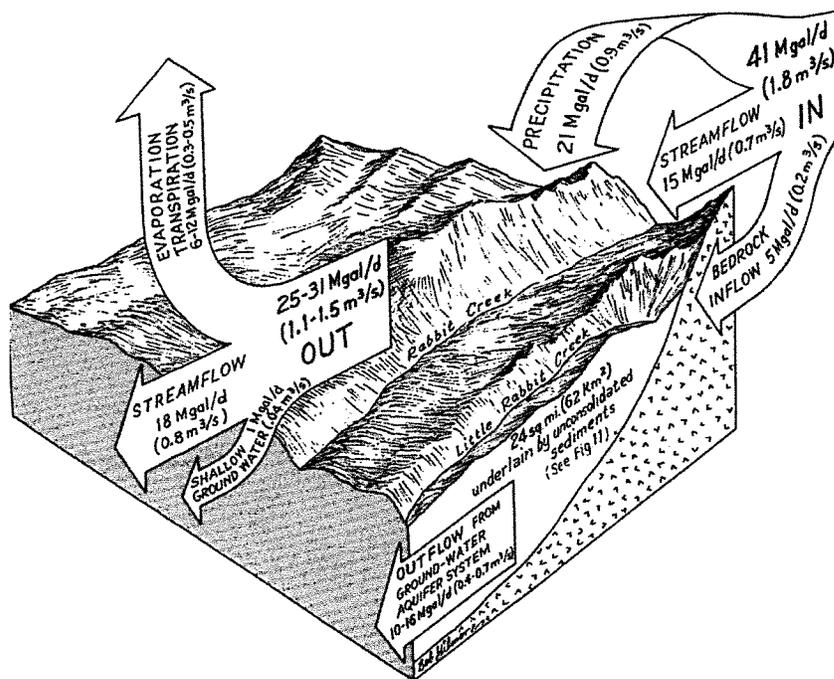


Figure 9. Water Budget of the Upper Hillside area containing the Lewis and Clark project site. (from Hydrology For Land-Use Planning: The Hillside Area, Anchorage, Alaska, Larry L. Dearborn and William W. Barnwell, USGS Open File Report 75-105)

Available well logs show 92 water wells are completed in consolidated rock (bedrock) and twenty-five are completed in unconsolidated (sand and gravel) aquifers. Figure 11 shows static water elevations at the time of drilling. These water levels differentiate aquifers.

Well yields for the 124 area wells show that 92 wells completed in bedrock have a mean yield of 2.7 gpm (see Figure 12). More than 97.5% of the consolidated rock wells produced more than 0.33 gallons per minute at the time of drilling. Figure 12 shows the well yield of all 124 wells, including the wells completed in unconsolidated material. Average yield per well for 124 residential wells in an approximate 1/2 mile area around Lewis and Clark subdivision that were evaluated in this study is 5.1 gallons/minute.

A four bedroom house requires about a third of a gallon per minute without the need for a holding tank. We conclude that adequate groundwater resources are available for the Lewis and Clark Subdivision with a planned density of R-6 lots.

Most homes use less than 450 gallons per day, or 0.3 gallons per minute, while most area wells produce more than 3 gallons per minute and, as Figure 12 shows, the area bedrock aquifer is capable of producing as much as 20 gallons per minute.

4.2 Well Installation and Aquifer Test Results at Lewis & Clark

Three wells were drilled on three contiguous lots in December of 2016 and January of 2017. The contiguous lots were selected so that aquifer tests could determine likely impacts to nearby wells. Well were spaced approximately 180 feet apart. These lots are typical of lots within the subdivision. Wells were drilled to depths of 393, 256, and 236 feet below ground surface. These wells were completed in bedrock. Figure 13 shows the locations of three wells installed at Lewis and Clark. Initially, step tests were performed at each well to determine the maximum rate at which each could be pumped for the 24 or 6 hour tests, without causing rapid or significant drawdown to the observations wells. These observation wells acted as proxy wells for neighboring wells.

The wells were also monitored for diurnal-antecedent water level fluctuations. Well LCW-1 is an artesian flowing well and was constantly flowing during manual observations taken several times during the January to February well drilling and aquifer testing program. Only during pump testing of LCW-2 did the water level fall temporarily below the top of the casing. Wells LCW-2 and LCW-3 were instrumented with pressure transducers for one 24 hour period. Well LCW-2 showed 0.137 ft. (1.64 inches) of water level fluctuation while well LCW-3 showed 0.8 ft. (9.6 inches) of fluctuation. From past experience, these results were not deemed great enough to affect the AqteSolv data evaluation of the aquifer pump testing, and the dataset was therefore not modified before evaluating the results.

Aquifers were tested following ASTM standards. Two wells were tested with a 24-hour continuous discharge test and one well was tested with a 6-hour continuous discharge test. Each well was allowed to recover for the same duration as the drawdown testing. Aquifer test results show that each well is capable of providing adequate water supplies and that the impact to wells on adjacent lots will be

insignificant. The basic well and aquifer test results and information for each well are listed below.

LCW-1

- Total Depth (ft. top of casing) : 393
- Depth of Casing (ft. bgs) : 65
- Depth to Bedrock (ft. bgs) :43 fractured/weathered – 62 fully consolidated
- Static Water Level (ft. top of casing) : Flowing
- Static Water Level Elevation (ft AMSL) :
- Diurnal Antecedent Water Fluctuation (ft.): 0
- Casing Height Above Ground Surface (ft.) : 2.0
- Maximum Potential Yield (gpm) : 135
- Drawdown at 200 Radial Feet (@3gpm/2Hrs.) (ft.) : 0
- Recovery After 6 Hours (ft.): 100%

LCW-2

- Total Depth (ft. top of casing) : 256
- Depth of Casing (ft. bgs) : 53
- Depth to Bedrock (ft. bgs): 52
- Static Water Level (ft. top of casing): 18.5
- Static Water Level Elevation (ft. AMSL) :
- Diurnal Antecedent Water Fluctuation (ft.) : 0.137
- Casing Height Above Ground Surface (ft.) : 2.6
- Maximum Potential Yield (gpm) : 34
- Drawdown at 200 Radial Feet (@3gpm/2Hrs.) (ft.) : 5.1
- Recovery After 24 Hours (ft.): 100%

LCW-3

- Total Depth (ft. top of casing) : 236
- Depth of Casing (ft. bgs) :100
- Depth to Bedrock (ft. bgs) : 92
- Static Water Level (ft. top of casing) : 55
- Static Water Level Elevation (ft. AMSL)
- Diurnal Antecedent Water Fluctuation (ft.) : 0.8
- Casing Height Above Ground Surface (ft.) : 2.0
- Maximum Potential Yield (gpm) : 9.5
- Drawdown at 200 Radial Feet (@3gpm/2Hrs.) (ft.) : 0
- Recovery After 24 Hours (ft.) : 96%

The maximum potential yields listed above refers to the rate at which the well could be continuously pumped before 100% of the available drawdown would be reached. These test data show that abundant water is available for planned wells in the Lewis and Clark subdivision. The average Anchorage household well would need to be pumped at a rate of 0.31 gpm continuously, when equilibrating this rate to the average daily household usage of 450 gallons/day. The maximum rates listed for the wells above are therefore far above the range of expected normal rates. They indicate that much more water is available than will ever normally be used.

For the Lewis and Clark subdivision, 200 lateral feet is the approximate distance between planned wells on separate lots. That hydrogeological modeling of the new wells show that the largest drawdown impact to a property 200 feet away ranges between 0 and 3.08 feet when a well is pumped for up to three hours at 2 gallons per minute, a typical rate. The individual well data are listed below:

- Based on the aquifer test data for well LCW-1, pumping at 3 gpm for 2 hours will result in drawdown of 0.0 feet at a distance of 200 ft.
- Based on the aquifer test data for well LCW-2 pumping at 3 gpm for 2 hours will results in drawdown 3.08 ft. at a distance of 200 feet.
- Based on the aquifer test data for well LCW-3 pumping at 3 gpm for 2 hours will results in drawdown of 0.0 ft. at a distance of 200 feet.

Most wells in the Lewis and Clark Hillside area contain at least 200 feet of available drawdown. A well 200 feet away from well LCW-2 would draw down 3.08 feet, which leaves 98.46% of the available water. The drawdown is temporary and recharge begins as soon as pumping is discontinued. Pumping of the other two wells would have no drawdown effect for wells 200 feet away.

Recharge rates as listed above show that all three wells attain 96% to 100% recharge in the same amount of time or less time than they were pumped during aquifer testing. Well LCW-3 (96%) is the only well that did not achieve 100% recharge in the same time period as the pump test, and it is also the well with the highest (0.8 feet) amount of normal daily water level fluctuation.

Based on static water level elevations of the three new wells and laboratory water chemistry results (see Table 1), we conclude that at least two bedrock aquifers exist beneath the Lewis and Clark subdivision. Further, based on observations made during the aquifer testing procedures we conclude that partial connectivity exists between all three wells. Wells LCW-2 and LCW-3 exhibit a higher degree of connectivity than does LCW-1 to either of the other two wells.

5.0 ENVIRONMENTAL CONSIDERATIONS

5.1 Existing Contaminants

The proposed Lewis and Clark subdivision is an undeveloped forested parcel. Site inspections by TERRASAT have found no potential contaminants or environmental concerns that currently exist on the property. Potential contaminants and environmental considerations that are commonly associated with development are discussed below. A discussion of the potential for the Lewis and Clark development to affect adjoining or nearby properties is included for each topic of concern. The potential effect of potential contaminants on aquifers that supply drinking water is discussed in section 5.2.5.

5.1.1 Water Quality at Lewis and Clark

Water samples were collected from the three new wells drilled in January of 2017. The samples were analyzed for Calcium, Iron, Manganese, Total Dissolved Solids (TDS), and total Nitrogen by Nitrate-Nitrite. Table 1 lists the results of the water sampling. Water quality from the three wells complies with primary drinking water standards for the parameters tested. Iron and manganese exceeds the secondary drinking water standards in some wells, based on desirability of drinking water. Iron or manganese treatment could be employed to reduce these metals from the water supply.

Table 1. Results of Water Sampling in January 2017

	Sample Collection Date	Calcium (ug/L)	Iron (ug/L)	Manganese (ug/L)	TDS (mg/L)	Nitrate-Nitrite-N (mg/L)
Drinking Water Standard		NA	NA	NA	NA	10
Secondary Drinking Water Standard		NA	300	50	500	NA
Well ID						
LCW-1	1/31/17	27000	1330	57.3	246	1.12
LCW-2	1/25/17	54900	ND (DL=78.0)	4.67	286	1.83
LCW-3	1/30/17	43300	ND (DL=78.0)	59.0	291	0.0378

NA refers to non-applicable items. ND refers to an analyte that was analyzed for but was not detected at a level above the detection limit. Calcium is not a regulated or secondary parameter of water quality in Alaska. Secondary Standards are not regulated by law but are used to suggest good or desirable water quality. DL=Detection Limit

5.2 Potential Contaminants

TERRASAT, Inc. considered potential contaminants that could be introduced to the property as a result of development. Contaminants typically associated with residential development include pesticides and herbicides, automotive wastes, de-icing chemicals, nutrients, and bacteria and viruses.

5.2.1 Pesticides and Herbicides

Pesticides and herbicides are likely to be used in small quantities in residential developments. Pesticide use in Anchorage is even less than other parts of the country because we have fewer pests and a short growing season. Both pesticides and herbicides have an affinity for carbon and, therefore, are not mobile in carbon-rich environments. This reduces their capability for overland flow and soil infiltration. This means that pesticides and herbicides will likely remain in root mass, leaf mass, or within the root zone, where they will be trapped and naturally degraded. In the Lewis and Clark development, large lawns or garden areas are not likely to be created by the new owners as the large lot concept that is planned retains most of the currently existing vegetation and trees. This will

result in even lower amounts of pesticides and herbicides than an average Anchorage home that is located in the bowl area.

5.2.2 Automotive Wastes

Several types of contaminants are commonly associated with automotive waste. These include hydrocarbons (gasoline or diesel fuels, oils, grease etc.), metals (lead, copper zinc, and cadmium), and antifreeze. These contaminants are typically released to driveways and roadways and are transported in storm water. Storm water in this development will be treated using grassy swales and bio-filtering, will follow Best Management Practices, and will follow the Municipality of Anchorage Storm Water Treatment Plan Review Guidance Manual. This type of treatment is common in other Upper Hillside subdivisions, where the Municipality of Anchorage's Municipal Separate Storm Sewer System (MS4) does not reach at this time.

The treated storm water will then be discharged into Rabbit Creek and eventually to Cook Inlet as does all of Anchorage's storm water. Stormwater monitoring in other, higher-density subdivisions within the Municipality of Anchorage show that contaminants from automotive waste seldom if ever reach major conveyances. The amount of automotive waste transported in storm water is expected to be minimal and insignificant.

5.2.3 De-Icing Chemicals

The Municipality of Anchorage uses Magnesium Chloride as an anti-icing and de-icing agent on some roadways in Anchorage. Common de-icing chemicals used by residents on walkways and driveways are sodium chloride and calcium chloride. These chemicals may be applied in small quantities and would be significantly diluted by melting snow and rainwater prior to entering the storm water outflow. Low concentrations of de-icing chemicals will be removed with bio filtration.

5.2.4 Nutrients

Based on the ADEC Guidance Manual for Class A Public Water Systems and the development plan for Lewis and Clark, we determined that the most likely sources for nutrients would be leaking septic systems, lawn fertilizer, and animal waste. The nutrients that could have the greatest impact on water quality are nitrogen and phosphorus. The fate and transport of nitrogen is described in section 5.3.2 below. Phosphorus, and phosphates, complex with calcium in soil and become insoluble, thus they are less mobile than nitrates. Likewise, nutrients will be filtered by soil or used by the lawns and will be taken up by plants or immobilized within the root zone.

5.2.4.1 *Septic Systems*

Although there is little evidence of the water table aquifer being used to supply drinking water in the general area, one does exist throughout the area. Septic

systems and leach fields within the Lewis and Clark subdivision will be installed above the shallow unconsolidated water table aquifer that exists there. The shallow water table aquifer is distinctly different from the confined unconsolidated or confined bedrock aquifers. The shallow water table aquifer is likely recharged in part from bedrock fractures. The shallow water table is not a known source of potable water for the surrounding community. Septic systems within the Lewis and Clark subdivision will use advanced treatment systems. The results are discussed in section 5.3. In summary, the shallow water table will be protected from microorganisms and nitrates.

5.2.4.2 *Lawn Fertilizer*

The Lewis and Clark development includes large lots that are likely to remain mostly forested with the original vegetation and small lawn space. Because of this, we expect that the nitrate loading to the water table aquifer due to leachate from lawn fertilizer and animal waste will be below laboratory detection limits. The process of fertilizer fate and transport in soil explains why ground water in the Upper Hillside area is not susceptible to nitrate contamination from lawn fertilizer.

The lawn fertilizer often contains a soluble form of nitrogen known urea. Urea is composed of carbon, oxygen, nitrogen and hydrogen. The urea is converted to ammonia and carbon dioxide. Some of the ammonia is lost as gas to the atmosphere. The remaining ammonia is converted to positively charged ions that attach to negatively charged soil grains. Soil bacteria then convert the ions into nitrate through a process called nitrification. The nitrogen, as nitrate, is now in a form that is useable by plants and soil microbes. Four main processes remove nitrogen from the soil. Most nitrogen is bound in organic matter, is used by plants, or is used by bacteria and released to the atmosphere as nitrogen gas. The remaining nitrogen, as nitrate, that escapes the root and humic zones is available to leach through the soil. The amount of nitrate available to leach through the soil is reduced further as some of it is immobilized by organic sources below the root zone. Tight soils that slow or prevent the infiltrations of water also prevent the vertical migration of nitrate to the aquifer.

The minimum uptake of nitrogen by nine common grass species is 125 pounds/acre/year (Croste, 1997). The minimum uptake of nitrogen by the most popular grass seed mix sold by Alaska Mill and Feed (Fescue and bluegrass) has a minimum uptake of 158 pounds/acre/year and an average uptake rate of 211 pounds/acre/year. According to several university extension services, typical nitrate application rates for urban lawn range from 43 to 174 pounds/acre/year. Hillside Lawn and Snow, an Anchorage lawn maintenance company, reported their normal nitrate application rate to be less than 70 pounds/acre/year. Alaska Mill and Feed recommends applying nitrogen at a rate of 194 pounds/acre/year. The average uptake rate is greater than the expected application rate of nitrate in lawn fertilizer for a typical Anchorage lawn. Furthermore, some nitrate will be immobilized by organic matter and some will be denitrified. This suggests that no

nitrate added during lawn fertilization will be able to reach the water table aquifer by leaching through soil in the root zone.

Several researchers have looked at nitrate leaching beneath urban lawns under various conditions. Gold *et al* (1990) looked at nitrate leaching from residential and agricultural land uses. He found that with an application rate of 218 pounds/acre/year only 4% of the applied nitrate leached in the first year of the study. The second year of the study less than 1% leached through the top 8 inches of the soil profile. Geron *et al.* (1993) looked at nitrogen leaching from seeded and sodded turf-grass under different a fertilizer programs. Using an application rate of 194.5 pounds/acre/year, he found that in the first year after establishment 26% and 28% leaches from seeded and sodded plots respectively. By the second year of the study, leaching decreased to 3.5% and 11% respectively. He concluded that “the results for the second year are more representative of a stable turf-grass environment”. These studies demonstrate that even exceeding the recommended/average application rate, nitrate leaching from lawn fertilizer decreases rapidly as the sod/roots develop. A judiciously managed phased approach to fertilization during lawn establishment will greatly reduce first year nitrogen leaching.

5.2.5 Effect of Surface Contaminants on Water Supply Aquifers

The above descriptions of surface contaminant fate and transport show that most contaminants will not reach the water table. Lawns and the use of fertilizers are minimal on Anchorage R-6 zoned lots on most of the Upper Hillside. Pesticide and herbicide use on R-6 zoned lots will likely be minimal and completely insignificant. Thus, the limited use of these types of contaminants reduces the risks of water table contamination to nearly zero. Natural vegetation and soil microbes will further protect the upper water table aquifer.

Available well logs and data show that 92 water wells are completed in consolidated rock (bedrock) and twenty-five are competed in unconsolidated (sand and gravel) aquifers. Based on well static water elevations, at least five separate aquifers are being used to supply water to area wells. These do not include the water table aquifer. High static water levels in the surrounding subdivisions suggest the dominant recharge of the water table aquifer is from water migrating upward from rock fractures.

5.3 Nitrate Fate and Transport Modeling

5.3.1 ATS Systems

The Lewis and Clark development plans to use Advanced Treatment Systems (ATS) for the septic systems on all lots. These systems significantly reduce nitrate effluent using a filter media and biodegradation processes. The filter media reduces virus and bacteria outflow by 99% more than conventional systems. The likelihood of leachate migrating offsite is extremely low to non-existent. The

more relevant concern is migration within the Lewis and Clark development, specifically to water well aquifers on downgradient lots.

Nitrates from septic systems, as with other compounds, have distinct migration characteristics depending on the media and physical conditions through which it passes. TERRASAT used analytical mathematical modeling techniques to determine the distances and rates at which nitrates are likely to move through the soils at the proposed sites. Of particular concern are water well distances from nitrate sources. Surface water, such as Rabbit Creek, were also considered in the modeling process.

5.3.2 Nitrate Fate and Transport

TERRASAT evaluated existing percolation test results, surface topography, water well logs, distances to property boundaries, and distances to active drainages. Sixteen water well logs from surrounding subdivisions provided the basis to determine the thickness of the shallow water table aquifer. We created two appropriate mathematical models to evaluate the fate and transport of nitrogen from the proposed advanced nitrate reducing septic systems. We modeled total nitrogen, which includes nitrates. We found that nitrogen, at the local creek, 430 feet away from the nearest lot, would be less than 0.07 mg / liter. This model assumes that no biological processes denitrify the nitrate between the source and the receptor, in this case Rabbit Creek. Denitrification does occur in aquifers, breaking down the nitrate molecule into nitrogen gas and oxygen. Denitrification by heterotrophic bacteria will occur, with published removal rates in excess of 0.01 mg per liter per day and as much as 0.44 m/l per day. Travel time from the nearest leach field to Rabbit Creek is over 112 days. That means at least 1 milligram/liter of nitrogen will be denitrified, converted to nitrogen gas, before it reached the creek. Therefore, we conclude that measurable nitrates will not reach Rabbit Creek from septic systems within the Lewis and Clark subdivision. Appendix B contains the worksheets and results of the nitrate fate and transport model.

TERRASAT concludes that septic nitrate migration to other properties or to Rabbit Creek is highly unlikely, based on modeling results, the use of ATS systems, and taking into consideration the topographic slopes of the Lewis and Clark property.

5.4 Bacteria and Pathogen Removal Modeling

TERRASAT considered the potential migration of five different pathogenic bacteria from a proposed leach field. The bacteria are:

- *E. Coli* bacteria
- *Enterococci* bacteria
- Fecal *streptococci* bacteria
- *Salmonella* bacteria

- *Shingella* bacteria

Bacteria and viruses are primarily removed from ground water by the process of attachment and deactivation, where attachment (think straining) is the dominant process. The Manual of Design for Slow Sand Filtration (1999) states that 97% of coliform bacteria are removed within the first meter (approximately 3 feet) of sand filtration beneath a leach field. More recent studies (Morales, et al, 2014) found removal rates of 99.99% removal of bacteria and 99.99% removal of viruses for drinking water (Predicting Attenuation of Viruses During Percolation in Soils, August, 2002)

These studies suggest that more than 99.99% pathogenic organism are removed from septic leachate before the effluent reaches groundwater. Ignoring the primary attachment process, we calculate that 99% *E. Coli* bacteria that could reach groundwater will be deactivated within 51 feet of the leach field. We conclude that the MOA separation distance of 100 feet from a leach field to a domestic water well is much more than adequate. We also conclude that pathogenic organisms will be deactivated before they can reach a lot boundary.

In conclusion, the MOA separation distance of 100 feet from a leach field to domestic water well is adequate in this subdivision and the local stream is also protected. Most lots are at least 1,000 feet from the stream and the closest lot is more than 430 feet (leach field) to the stream. Appendix B contains the deactivation models for bacteria and pathogens.

6.0 AERIAL PHOTOGRAPHIC EVALUATION OF TERRAIN

TERRASAT evaluated aerial photographs of the area to interpret site drainage and topography.

6.1 Surface Drainage

Surface drainage of the Lewis and Clark parcel is currently overland in an approximate southwestern direction as is moves downgradient toward one of the branches of Rabbit Creek. This was also verified by onsite inspections. A historic segment of Rabbit Creek was discovered that existed along the eastern border area of the parcel. Figure 7 shows this segment. This was verified by investigating older maps and documents and TERRASAT found that this segment was likely changed when Canyon Road was constructed.

6.2 Site Topography

Lewis and Clark subdivision is situated in a low point topographically compared to properties northeast and east of it. Some properties to the northwest lie cross gradient (on the approximate same elevations) as portions of Lewis and Clark. A very small portions of land to the southwest lies downgradient of the property of interest. Finally, while no land is developed in that area, the land directly south of

Lewis and Clark is downgradient of the development. Rabbit Creek prevents surface flow from moving south beyond Rabbit Creek as it accepts any runoff from up-gradient areas.

Figure 5 shows this relationship.

7.0 CONCLUSIONS

TERRASAT was concerned about the sufficiency of groundwater to support the Lewis and Clark subdivision. We were also concerned about what impact water wells would have on the new subdivision and on the surrounding neighboring water wells. We found that more than 10 million gallons per day of groundwater flows through this area of the south Anchorage hillside, far in excess of what the existing community uses. We found that groundwater recharge is from several watersheds south and east of this proposed development. TERRASAT concludes that *recharge* is expected to remain abundant and far in excess of the demands of residential use.

Available water well logs and a statistical analysis show that the community within a half mile of the Lewis and Clark subdivision exploits groundwater from at least five different aquifers. Recharge for these aquifers are up-gradient from the Lewis and Clark subdivision. Therefore, TERRASAT also concludes that, drinking water *quality* is expected to remain unaffected by the new land development.

Based on static water level elevations of the three new wells and water chemistry laboratory results we conclude that at least two bedrock aquifers exist beneath the Lewis and Clark subdivision. Further, based on observations made during the aquifer testing procedures we conclude that partial connectivity exists between the three wells. Wells LCW-2 and LCW-3 exhibit a higher degree of connectivity than does LCW-1 to either of the other two wells.

Test data shows that maximum well yield is in the range of 7.4 gpm to 135 gpm for the three water wells recently completed. Wells in this subdivision are expected to use an average of 0.31 gallons per minute. We predict that the drawdown 200 feet away will be up to 3.08 feet, an insufficient amount to impact the neighboring lots. Recharge is expected to be complete within minutes to several hours after the pumps are off, meaning the small, insignificant impact will only last for several minutes. Therefore, we conclude that impact to wells on adjacent lots will be insignificant.

TERRASAT evaluated the concern that other nearby subdivisions have a significant nitrate problem in their aquifers. Two reports about nitrates exist for this area. Both reports state that nitrate levels are low and are not concerning. TERRASAT evaluated newer data from the Municipality of Anchorage. We found low levels of nitrate exist and conclude that the newer data is consistent with the previous reports. We found that nitrate concentrations increased in some

subdivisions and decreased in others. We further conclude that rates of increase are low and consistent with past information.

TERRASAT also evaluated the vulnerability of Rabbit Creek from development of the subdivision. Several community members expressed concern that nitrates from septic systems could have a negative impact to the water quality of the creek. We conducted mathematical modeling to evaluate the fate and transport of nitrates from proposed septic systems. Specifically, we modeled the septic system that would be closest to the creek. The results show that in a worst-case scenario, nitrate would reach the creek at a concentration of 0.07 milligrams per liter. However, this assumes that no denitrification occurs. Denitrification by heterotrophic bacteria will occur, with published removal rates¹ in excess of 0.01 mg per liter per day and as much as 0.44 mg/l. Travel time from the nearest leach field to Rabbit Creek is over 112 days. That means at least 1 milligram/liter of nitrogen will be denitrified, converted to nitrogen gas, before it reaches the creek. Therefore, we conclude that measurable nitrates will not reach Rabbit Creek from septic systems within the Lewis and Clark subdivision.

TERRASAT investigated the concern of several community members that nitrates from the Lewis and Clark subdivision could impact their water supply. Soils within the Lewis and Clark subdivision will, for the most part, support conventional septic systems. However, as good citizens and protectors of the environment, the developers are proposing to use advanced nitrate reducing septic treatment systems, reducing nitrate output by a factor of three from conventional systems. The ultimate fate of the nitrates after leaving the leach field is that they will ultimately reach the upper water table. In the upper water table, heterotrophic bacteria will denitrify the nitrates into nitrogen gas and nitrous oxide gas. We modeled nitrate migration to the nearest lot line in the water table. Nitrate concentrations will be less than 0.1 mg per liter at the lot boundary, minus the amount removed by denitrification, which could easily be 0.5 mg per liter. TERRASAT concludes therefore that nitrates will not likely reach an adjacent lot.

TERRASAT examined other potential impacts to the environment, such as stormwater runoff towards Rabbit Creek, pesticide use and the existence of wetlands. This low-density land development is expected to protect the natural resources and surrounding communities. We conclude that the preservation of the existing wetlands will allow the distinct existing biological communities to continue their function of treating stormwater and protecting Rabbit Creek water quality.

¹ Morales Parra, Ivan, "Modeling Onsite Wastewater Treatment System Contaminants in Current and Climate Changing Conditions" (2015). *Open Access Dissertations*. Paper 376. pg118.

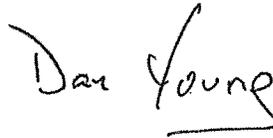
Please contact us at (907) 344-9370 if you have any questions or would like further information.

Prepared By:

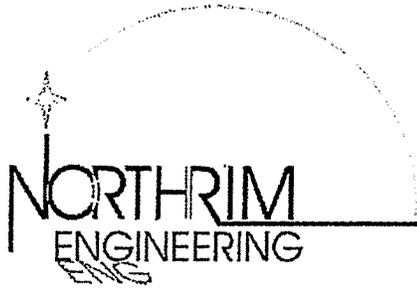


Cali Swatowski (for Steven Smith)
Project Environmental Scientist

Approved By:



Dan Young
Principal,
CPG, #7811



GEOTECHNICAL SOILS REPORT

FOR

LEWIS & CLARK SUBDIVISION

FOR S4 GROUP

ANCHORAGE, ALASKA

Submitted by:

NorthRim Engineering
P.O. Box 770724
Eagle River, AK 99577-0724
(907) 694-7028

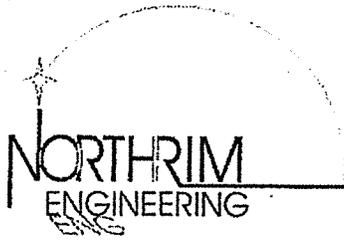
Steve Eng, PE, PH
SteveEng.com

September, 2019

CIVIL

ENVIRONMENTAL

HYDROLOGY



SteveEng.com

Lewis & Clark Subdivision, August, 2019

SOILS SUMMARY

Lewis & Clark Subdivision is planned for the Upper De Armoun area. The proposed subdivision is surrounded by developed subdivisions. These surrounding subdivisions utilize on-site water wells and septic systems. Lewis and Clark Subdivision will also utilize on-site systems.

At least four major Quaternary glaciations are recognized in the Upper Cook Inlet area. The bordering mountains still retain extensive icecaps and alpine glaciers. The proposed Lewis & Clark Subdivision soil was derived from these glacial moraines. The soil for this general area was deposited by these glacial events. The surrounding subdivisions have similar soil. The Lewis & Clark Subdivision will have the largest lots in the area; the least density.

A large number of test holes have been completed the past several years within the proposed subdivision. Test holes were completed in the fall of 2016. Recent test hole logs are included in this soils report, as well as previous test holes. A location map for these test holes is included at the end of the report.

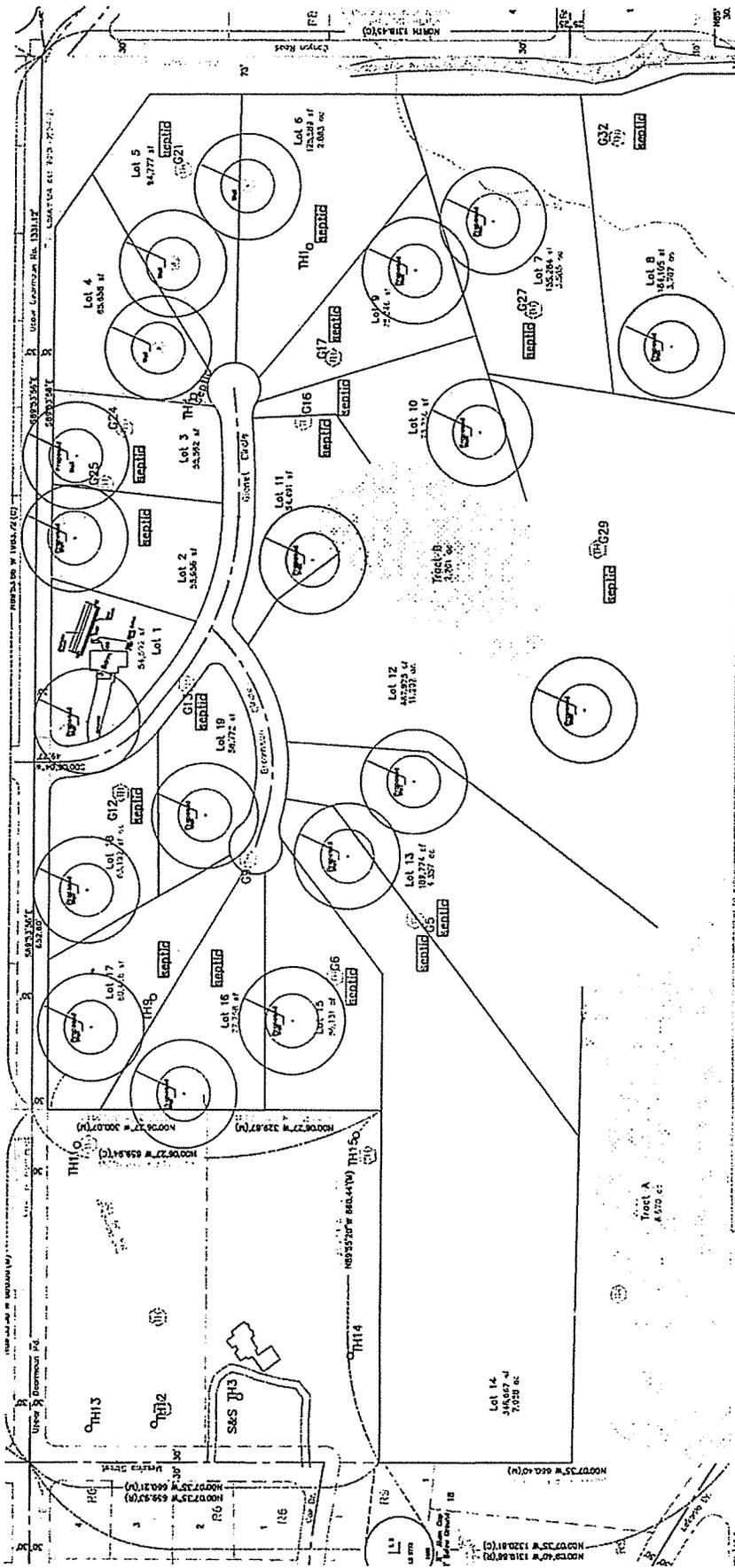
The soils in Lewis & Clark Subdivision have generally been found to be consistent with the soils in the surrounding subdivisions. The soils were placed as glacial till, and are predominately sand, silty sand, silts, and gravel. Bedrock was not encountered in the test holes. Groundwater is not an issue; all the test holes have adequate separation to groundwater. Most test holes exhibited no groundwater.

Drainages have been mapped for the subdivision. Drainages consist of small rills and seeps, associated with riparian vegetation. Several test holes required relocation after interference from these surface seeps.

The soils logs in this report have been found to be consistent with MOA requirements for on-site systems. We are prepared to complete additional drawings demonstrating that each lot has the prescribed area for on-site systems.

In order to satisfy the requirements set forth in MOA 21.04.b, a soil boring or tests pit has been provided to a minimum depth of 16 feet for each lot. A summary is provided in the table below.

Lot No.	Boring / Test Pit No.	Depth	Depth to Bedrock
1	B-2 (NGE)	16'-0"	Not Encountered
2	TH-25 (GEG)	16'-0"	Not Encountered
3	TH-24 (GEG)	16'-0"	Not Encountered
4	W-3 (MWD)	233'-0"	100 ft BGS
5	W-2 (MWD)	257'-0"	55 ft BGS (Fractured)
6	W-1 (MWD)	407'-0"	60 ft BGS (Fractured)
7	TH-27 (GEG)	16'-0"	Not Encountered
8	TH-32 (GEG)	16'-0"	Not Encountered
9	TH-17 (GEG)	16'-0"	Not Encountered
10	B-4 (NGE)	16'-6"	Not Encountered
11	TH-16 (GEG)	16'-0"	Not Encountered
12	B-8 (NGE)	30'-9"	Not Encountered
13	B-7 (NGE)	31'-3"	Not Encountered
14	TH-5 (GEG)	16'-0"	Not Encountered
15	TH-6 (GEG)	16'-0"	Not Encountered
16	B-6 (NGE)	16'-0"	Not Encountered
17	TH-9 (NE)	16'-0"	Not Encountered
18	TH-12 (GEG)	16'-0"	Not Encountered
19	TH-13 (GEG)	16'-0"	Not Encountered



1" = 200'

REVISED
LAYOUT

Date: 9/10/19

LEWIS & CLARK S/D

T12NR3WSEC25S2WNW4SE4&NE4SE4

WASTEWATER LAYOUT

WATER WELL LAYOUT



NORTHTRIM ENGINEERING
 SteveEng.com
 PO Box 770724
 Eagle River, Alaska 99577
 907.694.7028



Northern Geotechnical Engineering Inc.
 d.b.a. Terra Firma Testing
 11301 Olive Lane
 Anchorage, AK 99515
 Telephone: 907-344-5934
 Fax: 907-344-5993

EXPLORATION B-2

R-10 LOT 1

NGE-TFT PROJECT NAME: Lewis & Clark Subdivision NGE-TFT PROJECT NUMBER: 4865-17

PROJECT LOCATION: Anchorage, AK EXPLORATION CONTRACTOR: Discovery Drilling, Inc.

EXPLORATION EQUIPMENT: Track-mounted CME 75 EXPLORATION METHOD: Hollow Stem Auger w/ NWJ Rods

SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer LOGGED BY: A. Smith

DATE/TIME STARTED: 11/1/2017 @ 1:15:00 PM DATE/TIME COMPLETED: 11/1/2017 @ 2:45:00 PM

EXPLORATION LOCATION: N/A GROUND ELEVATION: Approx. 1126 ft above msl

GROUNDWATER (ATD): None observed GROUNDWATER (11/3/2017): 15.1 ft bgs (May not be representative)

EXPLORATION COMPLETION: See comments below WEATHER CONDITIONS: Sunny, calm, 36°F

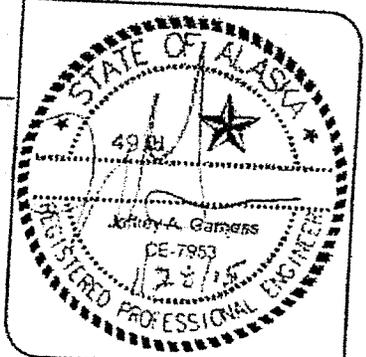
DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (in)	FIELD BLOWS	(N) ₁₀₀	LAB RESULTS	REMARKS/NOTES	WELL DIAGRAM
0			<p>SURFICIAL ORGANIC DEPOSITS, consist of a mixture of grasses, leaf litter, root masses, peat, and organic silt</p> <p>COLLUVIAL DEPOSITS, SILTY SAND WITH GRAVEL (SM), loose, tannish gray, damp, gravel up to 2" in diameter</p>		S1	20	1 4 6	17	S1 MC = 11.9% 22.2% gravel, 42.1% sand, 35.7% silt		
			<p>GLACIAL TILL DEPOSITS, SILTY GRAVEL WITH SAND (GM), very stiff, tannish gray, damp</p>		S2	15	4 6 7	11	S2 MC = 10.7%		
5					S3	15	4 10 9	16	S3 MC = 9.0% 41.0% gravel, 28.5% sand, 30.8% silt P _{0.02} = 25.4%		
					S4	16	4 9 10	16	FC = F3 S4 MC = 19.5%		
10					S5	11	9 50 3"	N/A	S5 MC = 20.9%	Sampler refusal on cobble boulder at approx. 10.75 ft bgs. Increased drill chatter from approx. 10.75-11.5 ft bgs.	
15					S6	16	26 50	N/A	S6 MC = 8.7%	Sampler refusal on cobble boulder at approx. 16 ft bgs.	
<p>Bottom of borehole at 16.0 ft bgs. Set 1" PVC casing to BOH. Hand slotted casing from 11-16 ft bgs. Backfilled annulus with pea gravel from 11-16 ft bgs, cuttings to 3 ft bgs, then bentonite chips to ground surface. Hydrated chips to form seal.</p>											

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS



SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK SD (PROPOSED - LOT 25) R-10 LOT 2
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / S4 GROUP DATE: SEE PAGE 1 OF 2

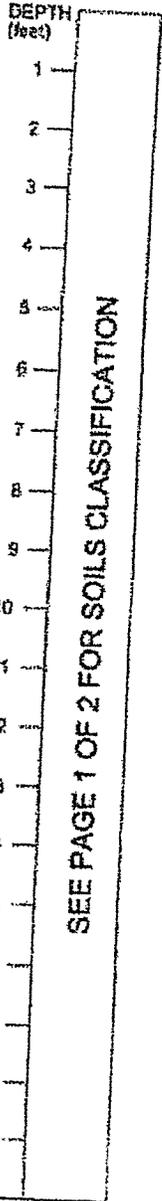
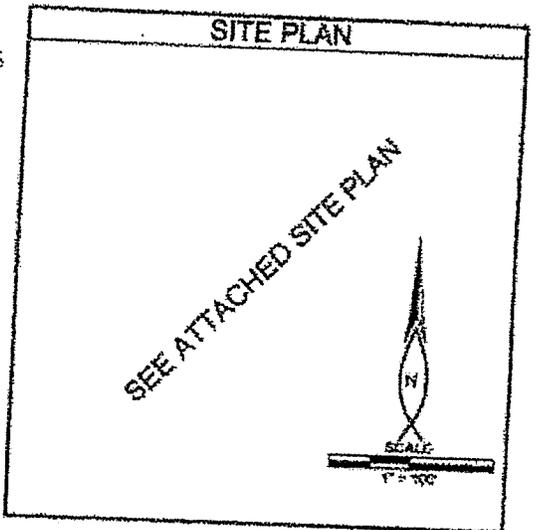
TEST HOLE #25

PAGE 2 OF 2

SOIL CLASSIFICATIONS

	GW		GRC
	GP		ML
	GM		CL
	GC		OL
	SW		MR
	SP		CH
	SM		OH
	SC		

DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	



	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/15/2015	1	3:20	-	6"	-
		2	3:50	30	5-1/8"	7/8"
		3	3:50	-	6"	-
		4	4:20	30	5-1/8"	7/8"
		5	4:20	-	6"	-
		6	4:50	30	5-1/8"	7/8"

PERCOLATION RATE 34.3 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)

TEST RUN BETWEEN 2 FT. AND 3 FT.

A FOUR HOUR PRESSURE WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ANDREW GRAY

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/20/15

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

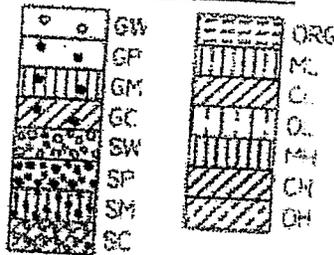


SOIL LOG - PERCOLATION TEST

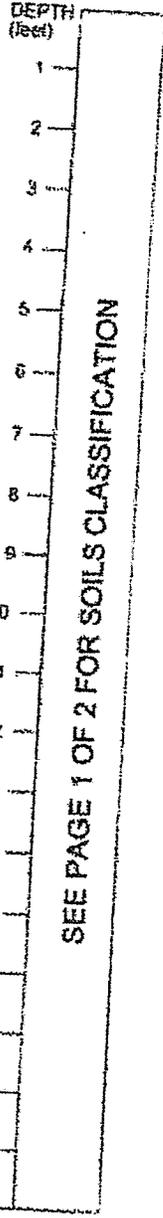
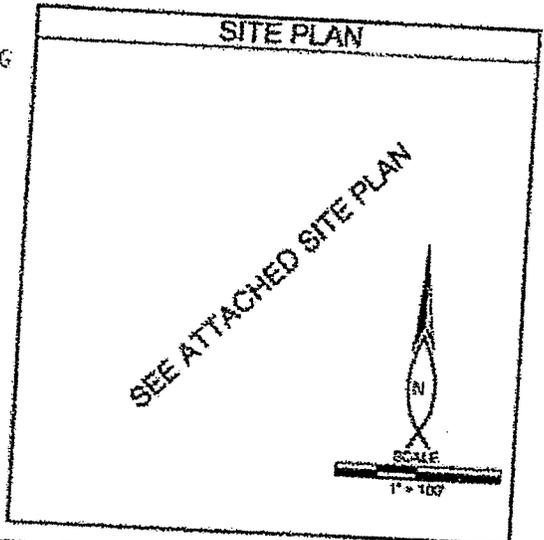
LEGAL DESCRIPTION: LEWIS AND CLARK SID (PROPOSED) - LOT 24; R-10 LOT 3
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC (S4 GROUP) DATE: SEE PAGE 1 OF 2

TEST HOLE #24
PAGE 2 OF 2

SOIL CLASSIFICATIONS



DEPTH TO GROUNDWATER	DATE
<i>SEE PAGE 1 OF 2</i>	



	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/15/2015	1	3:25	-	6"	-
		2	3:55	30	0"	6"
		3	3:55	-	6"	-
		4	4:25	30	0"	6"
		5	4:25	-	6"	-
		6	4:55	30	0"	6"

PERCOLATION RATE 8 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 2 FT AND 9 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ANDREW GRAY

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

PERFORMED BY GEG, LTD. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/28/15

M-W Drilling, Inc.

♦ P.O. Box 110389 ♦ Anchorage, AK 99511 ♦
 ♦ 907-345-4000 ♦ 907-345-3287 Fax ♦

Job No. 16-127

GROUNDWATER WELL LOG

Well Owner: Big Country Enterprises, LLC Use of Well: Domestic Exploration
 Legal Description: Lewis & Clark Subdivision, Upper De Arnoun Road, Anchorage, Alaska
LCW-3: 149° 43' 4.66" W - 61° 6' 2.63" N Elevation : 1187' S.L

W-3, R-10 LOT

CONSTRUCTION

Drill Method: Air Rotary Hole Size: 6" Hole Depth: 233'
 Casing Size: 6" Cased to: 100' Material: A53B Steel Wall: 0.250"
 Well Completion: Open end Screen Perforated Method: _____
 Screen/Perforation description: None
 Grout Notes: (2) Sack(s) of Bentonite
 Well Development: Air Surge - 3 HRS
 Well Disinfected: N Method: _____
 Yield test at 5 GPM for 24 hour(s) with 70" of drawdown (DD) from static level (SWL).
 Method: Submersible Pump Static Water Level (SWL): 57'
 Start Date: 12-06-16 Completion Date: 12-09-16
 Test Pump Date: 1/28 - 1/29/17 Final Pump Install Date: _____

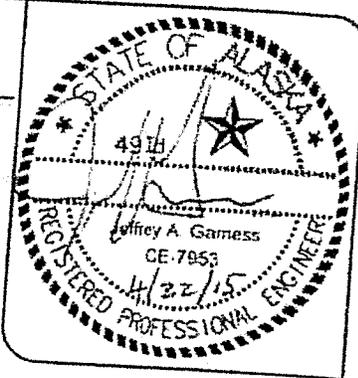
WELL LOG

Depth in feet from top of casing.	Details of formations penetrated, size of material, color and miscellaneous details.
0 TO 2	Casing Stick Up
2 TO 4	Top Organics Frozen
4 TO 52	Small Gravel: Silty, Sandy, Inter
52 TO 72	Gravelly Sand: Damp
72 TO 100	Sandy Silt: Gravelly
100 TO 150	Bedrock: Grey to Black, Siltstone/Mudstone Argillite
150 TO 207	Water Seaps in Sporadic Fractures
207 TO 213	Water Seaps = 5 GPM
213 TO 233	Bedrock; A/A
TO	

WAYNE E. WESTBERG
 President, M-W Drilling, Inc.
 VGWA Certified (MS) of Groundwater Contactor
 Lic. Gen. Serv. Lic. No. 11000

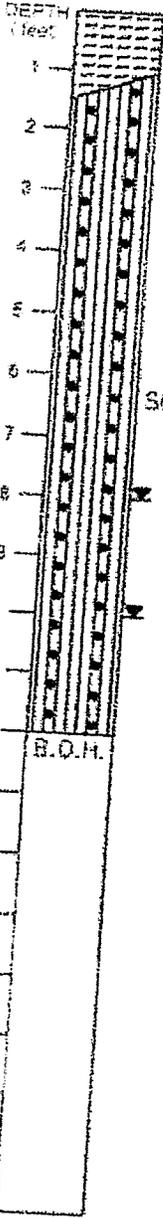
GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS



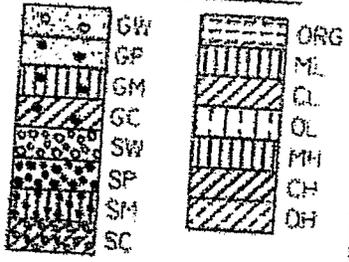
SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK S/D (PROPOSED LOT 21) R-10 LOT 5
 PERFORMED FOR: BIG COUNTRY ENTERPRISES LLC / SA GROUP DATE: 1/5/2015



TEST HOLE #21

SOIL CLASSIFICATIONS



DEPTH TO GROUNDWATER	DATE
10'	1/5/2015
8'	1/16/2015
8.5'	4/17/2015

SITE PLAN

SEE ATTACHED SITE PLAN

DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
1/6/2015	1	2:38	-	6"	-
	2	3:08	30	2"	4"
	3	3:08	-	6"	-
	4	3:38	30	2"	4"
	5	3:38	-	6"	-
	6	4:08	30	2"	4"

PERCOLATION RATE 7.5 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 4 FT. AND 5 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

LOGGED BY: JODY MAUS PERCOLATION TEST PERFORMED BY: ROB CAMPBELL

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH
 PERFORMED BY GEG, LTD. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 4/22/15

M-W Drilling, Inc.

♦ P.O. Box 110389 ♦ Anchorage, AK 99511 ♦
 ♦ 907-345-4000 ♦ 907-345-3287 Fax ♦

Job No. 16-127

GROUNDWATER WELL LOG

Well Owner: Big Country Enterprises, LLC Use of Well: Domestic Exploration
 Legal Description: Lewis & Clark Subdivision, Upper De Armoun Road, Anchorage, Alaska
LCW-2: 149° 43' 0.82" W - 61° 6' 2.72" N Elevation: 1202' S.L.

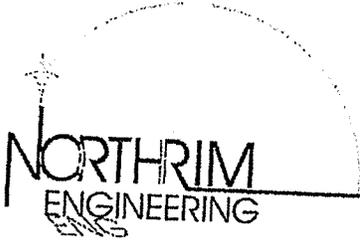
W-2, R-10 LOT

CONSTRUCTION

Drill Method: Air Rotary
 Casing Size: 6" Cased to: 55.9' Hole Size: 6' Hole Depth: 257'
 Material: A53B Steel Well: 0.250"
 Well Completion: Open end Screen Perforated
 Screen/Perforation description: None Method: _____
 Grout Notes: (3) Sack(s) of Bentonite
 Well Development: Air Surge - 5 HRS
 Well Disinfected: N Method: _____
 Yield test at 10 GPM for 24 hour(s) with 51.4' of drawdown (DD) from static level (SWL).
 Method: Submersible Pump Static Water Level (SWL): 13.3'
 Start Date: 12-12-16 Completion Date: 12-16-16
 Test Pump Date: 1/24 - 25/17 Final Pump Install Date: _____

WELL LOG

Depth in feet from top of casing.	Details of formations penetrated, size of material, color and miscellaneous details.	
0 TO 3	Casing Stick Up	
2 TO 4	Top Organics = Frozen	
4 TO 10	Sandy Gravel	
10 TO 55	Small Gravel: Silty Sandy, Hardpan	
55 TO 100	Bedrock: Grey Black, Siltstone Argillite, Small Seap in Sporadic Fractures	
100 TO 178	Fractures - 4GPM	
178 TO 257	Bedrock: A/A	
TO		
TO		
TO		
TO	WAYNE E. WESTBERG President, M-W Drilling, Inc. NGWA Certified Master Groundwater Contractor Ak Gen Contr Lic No. 1000	
TO		



SOILS LOG - PERCOLATION TEST

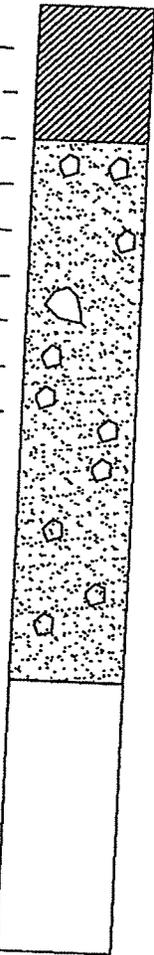
Date Performed: 9/14/16

Performed For: Todd Brownson

Legal Description: Lewis & Clark S/D, Lot 6- Revised R-10 Lot 6

T.H. Location: See Location Map

DEPTH (FEET)
 1 -
 2 -
 3 -
 4 -
 5 -
 6 -
 7 -
 8 -
 9 -
 10 -
 11 -
 12 -
 13 -
 14 -
 15 -
 16 -
 17 -
 18 -
 19 -
 20 -
 21 -



Organic
 SM/ML
 Silty Sand & Silt
 w/Gravel

Denser

Groundwater? No
 Depth ---
 Water Depth ---

After Monitoring: None Date: 10/14/16

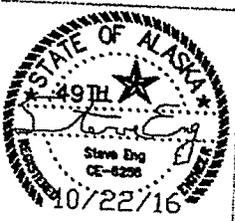
#	Date	Gross Time	Net Time	Depth	Net Drop
1	9/14	0	--	2"	--
2	9/14	30	30 min.	4.5"	2.5"
3	9/14	32	--	2"	--
4	9/14	62	30 min.	4.5"	2.5"
5	9/14	65	--	2"	--
6	9/14	95	30 min.	4.5"	2.5"

Percolation Rate 12 min./Inch Perc Hole Diameter 6"
 Test Run Between 4' and 5'

Comments: Presoaked

Performed By NorthRim Eng. I SEE CERTIFY THAT THIS TEST WAS
 Performed in Accordance with All State/Municipal Guidelines in Effect
 ON THIS DATE. DATE: 10/22/16

NORTHRIM ENGINEERING
 PO Box 770724
 Eagle River, Alaska 99577
 907.694.7028



TESTHOLE LOG
 GEOTECHNICAL

LEWIS & CLARK S/D
 LOT 6

TH1

Date: 10/22/16 SHEET: 1 of 26

M-W Drilling, Inc.

♦ P.O. Box 110389 ♦ Anchorage, AK 99511 ♦
 ♦ 907-345-4000 ♦ 907-345-3287 Fax ♦

Job No. 16-127

GROUNDWATER WELL LOG

Well Owner: Big Country Enterprises, LLC Use of Well: Domestic Exploration
 Legal Description: Lewis & Clark Subdivision, Upper De Armoun Road, Anchorage, Alaska
LCW-1: 149° 42' 58.98" W - 61° 6' 1.20" N Elevation: 1190' S.L. W-1, R-10 LOT

CONSTRUCTION

Drill Method: Air Rotary Hole Size: 6' Hole Depth: 407'
 Casing Size: 6" Cased to: 65.4' Material: A53B Steel Wall: 0.250"
 Well Completion: Open end Screen Perforated Method: _____
 Screen/Perforation description: _____

Grout Notes: (3) Sack(s) of Bentonite
 Well Development: Air Surge - 7.5 HRS
 Well Disinfected: N Method: _____
 Yield test at 2 GPM for 6 hour(s) with 2' of drawdown (DD) from static level (SWL).
 Method: Submersible Pump Static Water Level (SWL): + = Flowing
12-16-16 1-04-17 - Christmas
 Start Date: _____ Completion Date: Shutdown
 Test Pump Date: 1-31-17 Final Pump Install Date: _____

WELL LOG

Depth in feet from top of casing.	Details of formations penetrated, size of material, color and miscellaneous details.
0 TO 2	Casing Stick Up
2 TO 5	Gravelly Sand; Silty
5 TO 25	Silty with Hardpan
25 TO 30	Medium Gravel: Damp, Sandy
30 TO 60	Silty, Gravel, Hardpan
60 TO 62	Weathered, Fractured Bedrock
62 TO 407	Bedrock: Grey, Black Siltstone/Mudstone Argillite, Few Seaps in Fractures
TO	

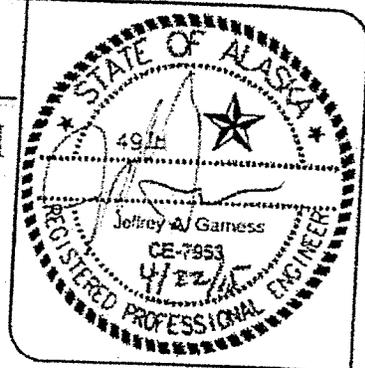
WAYNE E. WESTBERG
 PRESIDENT, M-W DRILLING, INC.
 NSWA Certified Master Groundwater Contractor
 AA 001 Cont' Lic No 1000

GARNNESS ENGINEERING GROUP, Ltd

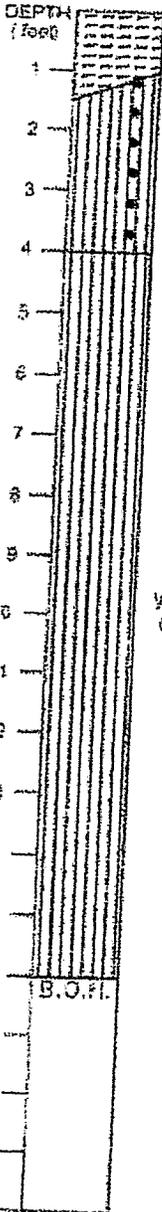
CIVIL & ENVIRONMENTAL ENGINEERS

SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK SQ (PROPOSED - LOT 32) R-10 LOT 8
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / SA GROUP DATE: 1/22/2015



TEST HOLE #32
 PAGE 1 OF 2



SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		

SITE PLAN

SEE ATTACHED SITE PLAN

DEPTH TO GROUNDWATER	DATE
DRY	1/7/2015
DRY	1/15/2015
DRY	4/17/2015

DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
1/7/2015	1	3:15	-	8"	-
	2	3:45	30	5-15/16"	1/16"
STOPPED READINGS					

PERCOLATION RATE >120 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 5 FT AND 6 FT

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

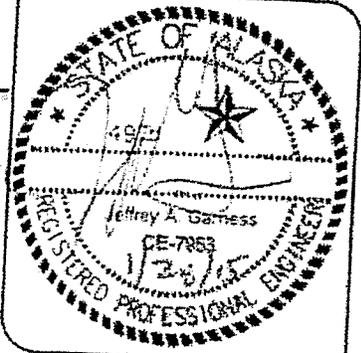
SOIL LOGGED BY: JODY MAUS PERCOLATION TEST PERFORMED BY: ROB CAMPBELL

REMARKS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH
 PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 4/22/15

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

1011 F TUTTAWAY DRIVE, SUITE 101, RICHMOND, ALABAMA 36821 PHONE (205) 331-8777 FAX (205) 331-8777 WEBSITE: www.garnessengineering.com



SOIL LOG - PERCOLATION TEST

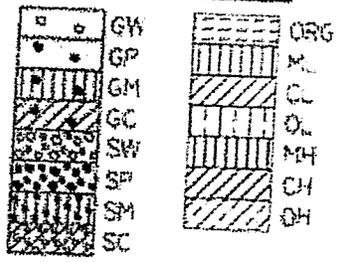
LEGAL DESCRIPTION: LEWIS AND CLARK S/D (PROPOSED - LOT 17) R-10 LOT 9
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / S4 GROUP DATE: SEE PAGE 1 OF 2

TEST HOLE #17
PAGE 2 OF 2

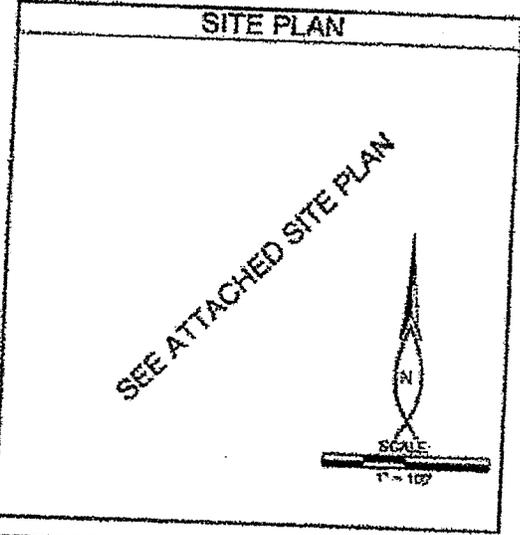
DEPTH (feet)
 1
 2
 3
 4
 5
 6
 7
 8
 9
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20

SEE PAGE 1 OF 2 FOR SOILS CLASSIFICATION

SOIL CLASSIFICATIONS



DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	



	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
	1/14/2015	1	3:39	-	6"	-
		2	4:09	30	2"	4"
		3	4:09	-	6"	-
		4	4:39	30	2"	4"
		5	4:39	-	6"	-
		6	5:09	30	2"	4"

PERCOLATION RATE 7.5 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 2 FT. AND 3 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ROD CAMPBELL

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.
 PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/20/15



Northern Geotechnical Engineering Inc.
 d.b.a. Terra Firma Testing
 11301 Olive Lane
 Anchorage, AK 99515
 Telephone: 907-344-5934
 Fax: 907-344-5993

EXPLORATION B-

R-10 LOT 10

NGE-TFT PROJECT NAME: Lewis & Clark Subdivision NGE-TFT PROJECT NUMBER: 4865-17

PROJECT LOCATION: Anchorage, AK EXPLORATION CONTRACTOR: Discovery Drilling, Inc.

EXPLORATION EQUIPMENT: Track-mounted CME 75 EXPLORATION METHOD: Hollow Stem Auger w/ NWJ Rods

SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer LOGGED BY: A. Smith

DATE/TIME STARTED: 11/1/2017 @ 4:50:00 PM DATE/TIME COMPLETED: 11/1/2017 @ 6:00:00 PM

EXPLORATION LOCATION: N/A GROUND ELEVATION: Approx. 1130 ft above msl

▽ GROUNDWATER (ATD): None observed ▼ GROUNDWATER (11/3/2017): 14.1 ft bgs (May not be representative)

EXPLORATION COMPLETION: See comments below WEATHER CONDITIONS: Clear, calm, 34°F

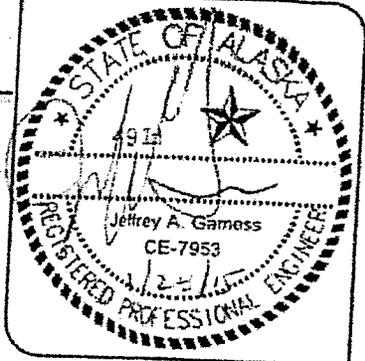
DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (in)	FIELD BLOWS	(N) ₆₀	LAB RESULTS	REMARKS/NOTES	WELL DIAMETER
0											
			<p><i>SURFICIAL ORGANIC DEPOSITS</i>, consist of a mixture of grasses, leaf litter, root masses, peat, and organic silt</p> <p><i>COLLUVIAL DEPOSITS, SILTY SAND WITH GRAVEL (SM)</i>, loose to medium dense, olive brown, damp, gravel up to 2" in diameter</p>	S1	11	0 1 1	3		N/A		
				S2	16	6 5 7	20		S2 MC = 8.3%		
5			<p><i>GLACIAL TILL DEPOSITS, SANDY SILT WITH GRAVEL (ML)</i>, stiff to very stiff, tannish gray, damp, varying gravel content</p>	S3	18	5 8 9	24		S3 MC = 9.4% 24.8% gravel, 38.1% sand, 37.1% silt P0.02 = 30.9% FC = F3		
				S4	18	6 8 11	16		S4 MC = 10.0%		
10				S5	18	3 7 5	10		S5 MC = 20.5%		
15				S6	13	5 7 16	22		S6 MC = 19.4%	3"+ gravel at end of sampler.	

Bottom of borehole at 16.5 ft bgs.
 Set 1" PVC casing to BOH. Hand slotted casing from 11.5-16.5 ft bgs. Backfilled annulus with pea gravel from 11.5-16.5 ft bgs, cuttings to 3.5 ft bgs, then bentonite chips to ground surface. Hydrated chips to form seal.

GARNISS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

2701 E TUROSS ROAD SUITE 101 ANCHORAGE, AK 99507 - PHONE (907) 552-1100 FAX (907) 552-1101 WEBSITE WWW.GARNISSENGINEERING.COM



SOIL LOG - PERCOLATION TEST

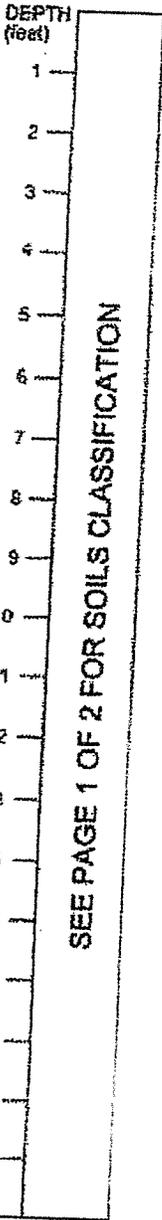
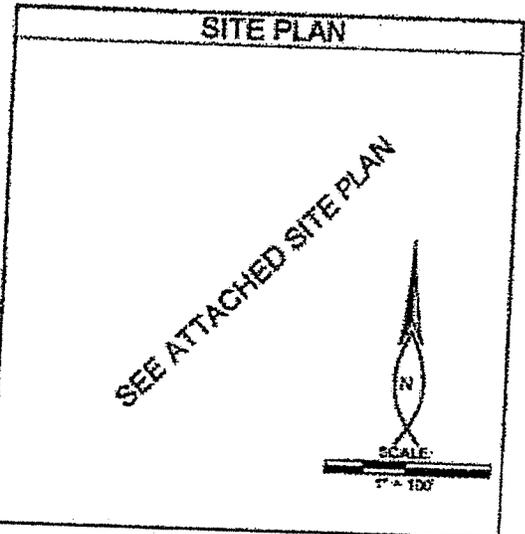
LEGAL DESCRIPTION: LEWIS AND CLARK SD (PROPOSED - LOT 15) R-10 LOT 11
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / SA GROUP DATE: SEE PAGE 1 OF 3

TEST HOLE #16

PAGE 2 OF 2

SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		



DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	

	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/14/2015	1	3:34	-	6"	-
		2	4:04	30	0"	6"
		3	4:04	-	6"	-
		4	4:34	30	0"	6"
		5	4:34	-	6"	-
		6	5:04	30	0"	6"

PERCOLATION RATE 5 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 2 FT. AND 3 FT.

A FOUR HOUR FRESDAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ROD CAMPBELL

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

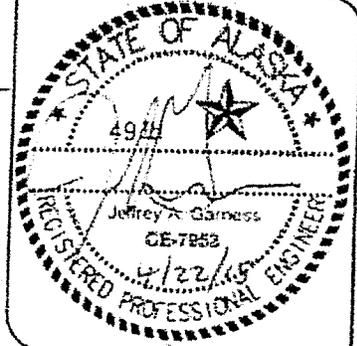
PERFORMED BY GEO. LIA. I, JEFFREY A. GARNISS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE. 1/25/15

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK S.D. (PROPOSED - LOT 2B) R-10 LOT 12
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC - SA GROUP DATE: 1/6/2015

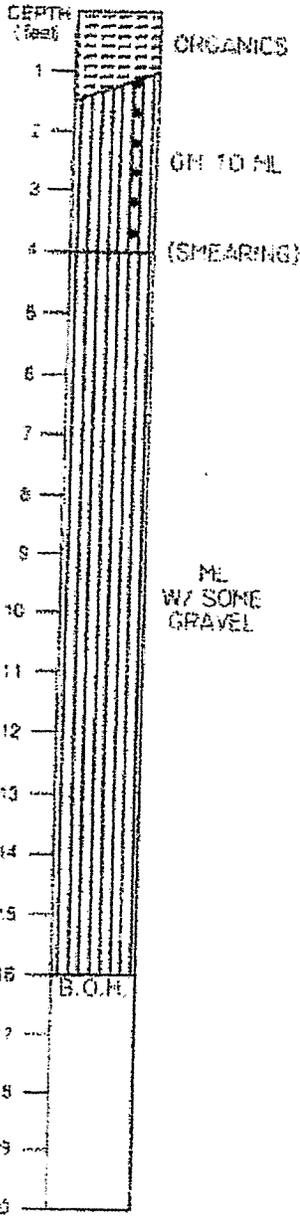
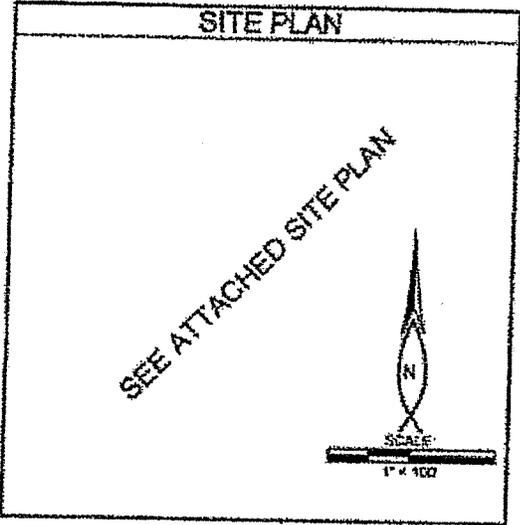


TEST HOLE #29

PAGE 1 OF 2

SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		



DEPTH TO GROUNDWATER	DATE
DRY	1/8/2015
DRY	1/15/2015
DRY	4/17/2015

LOWER BENCH	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
	1/7/2015	1	3:05	-	6"	-
	2	3:25	30	5-1/2"	1/2"	
	3	3:35	-	5"	-	
	4	4:05	30	4-5/8"	3/8"	
	5	4:05	-	6"	-	
	6	4:35	20	5-5/8"	3/8"	

PERCOLATION RATE 80 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)

TEST RUN BETWEEN 4 FT. AND 5 FT.

A FOUR HOUR FRESHWATER WAS PERFORMED: YES NO

SOIL LOGGED BY: ROB CAMPBELL/JOSY MAUS PERCOLATION TEST PERFORMED BY: ROB CAMPBELL

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE 4/22/15

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

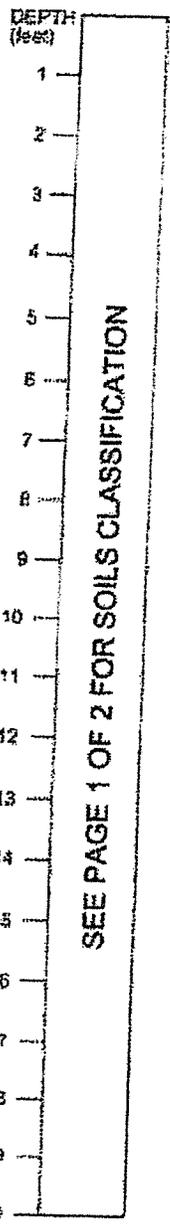
2101 F. LODGE ROAD SUITE 101 ANCHORAGE, ALASKA 99503-2718 TEL: 907.562.0200 WEBSITE: www.garnesseng.com



SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK S/D (PROPOSED - LOT 29) R-10 LOT 12
 PERFORMED FOR: B&G COUNTRY ENTERPRISES, LLC / B&G GROUP DATE: SEE PAGE 1 OF 2

TEST HOLE #29 PAGE 2 OF 2



SOIL CLASSIFICATIONS

GW	ORG
GP	ML
GM	CL
GC	OL
SW	MH
SP	CH
SM	OH
SC	

DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	

SITE PLAN

SEE ATTACHED SITE PLAN

	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/15/2015	1	3:25	-	6"	-
		2	3:55	30	4-1/2"	1-1/2"
		3	3:55	-	6"	-
		4	4:25	30	4-1/2"	1-1/2"
		5	4:25	-	6"	-
		6	4:55	30	4-1/2"	1-1/2"

PERCOLATION RATE 20 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 2 FT. AND 3 FT.
 A FOUR HOUR PRESSDAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ROS CAMPBELL

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF BENCH.

PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/26/15



Northern Geotechnical Engineering Inc.
 d.b.a. Terra Firma Testing
 11301 Olive Lane
 Anchorage, AK 99515
 Telephone: 907-344-5934
 Fax: 907-344-5993

EXPLORATION B-8

R-10 LOT 12

NGE-TFT PROJECT NAME: Lewis & Clark Subdivision NGE-TFT PROJECT NUMBER: 4865-17

PROJECT LOCATION: Anchorage, AK EXPLORATION CONTRACTOR: Discovery Drilling, Inc.

EXPLORATION EQUIPMENT: Track-mounted CME 75 EXPLORATION METHOD: Hollow Stem Auger w/ NWJ Rods

SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer LOGGED BY: A. Smith

DATE/TIME STARTED: 11/2/2017 @ 10:00:00 AM DATE/TIME COMPLETED: 11/2/2017 @ 12:40:00 PM

EXPLORATION LOCATION: N/A GROUND ELEVATION: Approx. 1066 ft above msl

▽ GROUNDWATER (ATD): None observed ▼ GROUNDWATER (I): N/A

EXPLORATION COMPLETION: Backfilled with cuttings WEATHER CONDITIONS: Foggy, calm, 30°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (in)	FIELD BLOWS	(N) ₆₀	LAB RESULTS	REMARKS/NOTES
0			SURFICIAL ORGANIC DEPOSITS, consist of a mixture of grasses, leaf litter, root masses, peat, and organic silt							
5			COLLUVIAL DEPOSITS, SILTY GRAVEL WITH SAND (GM), medium dense to very dense, tannish gray, damp, gravel up to 1" in diameter							
				X	S1	17	6 7 7	20	S1 MC = 8.0%	
				X	S2	21	10 19 18	40	S2 MC = 7.3%	Varying silt content throughout with thin silt layers approx. 1" in thickness.
				X	S3	18	10 18 15	31	S3 MC = 7.0% 49.0% gravel, 18.4% sand, 32.6% silt	
				X	S4	20	9 19 23	40	S4 MC = 6.5%	Significantly increased drilling resistance in dense till at approx. 22 ft bgs.
			(ML), increased silt content	X	S5	16	19 49 47	N/A	S5 MC = 4.0%	Some fractured rock in sampler from approx. 25.5-26 ft bgs.
30			Bottom of borehole at 30.75 ft bgs.	X	S6	11	27 50 3"	N/A	S6 MC = 16.3%	

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)

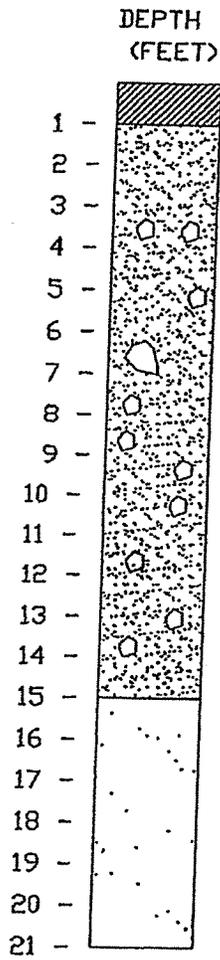


SOILS LOG - PERCOLATION TEST

Date Performed: 10/14/16

Performed For: Todd Brownson

Legal Description: Lewis & Clark S/D, Lot 8- South Side R-10 L0



T.H. Location: See Location Map

Groundwater? No

Depth ---

Water Depth

After Monitoring, Dry Date: 10/24/16

#	Date	Gross Time	Net Time	Depth	Net Drop
1	10/19	0	--	2'	--
2	10/19	30	30 min.	4'	2'
3	10/19	32	--	2'	--
4	10/19	62	30 min.	4'	2'
5	10/19	65	--	2'	--
6	10/19	95	30 min.	4'	2'

Percolation Rate 15 min./Inch Perc Hole Diameter 6"
 Test Run Between 3' and 4'

Comments: Presoaked.

Performed By NorthRim Eng. I SEE CERTIFY THAT THIS TEST WAS
 Performed in Accordance with All State/Municipal Guidelines in Effect
 ON THIS DATE. DATE: 10/22/16

**NORTHRIM
 ENGINEERING**
 PO Box 770724
 Eagle River, Alaska 99577
 907.694.7028



TESTHOLE LOG
 GEOTECHNICAL

TH21

LEWIS & CLARK S/D
 LOT 8 - SOUTH

Date: 10/22/16 SHEET: 21 of 26



Northern Geotechnical Engineering Inc.
 d.b.a. Terra Firma Testing
 11301 Olive Lane
 Anchorage, AK 99515
 Telephone: 907-344-5934
 Fax: 907-344-5993

EXPLORATION B-7

R-10 LOT 13

NGE-TFT PROJECT NAME: Lewis & Clark Subdivision
 PROJECT LOCATION: Anchorage, AK
 EXPLORATION EQUIPMENT: Track-mounted CME 75
 SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer
 DATE/TIME STARTED: 11/3/2017 @ 9:45:00 AM
 EXPLORATION LOCATION: N/A
 ▽ GROUNDWATER (ATD): Approx. 25.0 ft bgs
 EXPLOATION COMPLETION: See comments below

NGE-TFT PROJECT NUMBER: 4865-17
 EXPLORATION CONTRACTOR: Discovery Drilling, Inc.
 EXPLORATION METHOD: Hollow Stem Auger w/ NWJ Rods
 LOGGED BY: A. Smith
 DATE/TIME COMPLETED: 11/3/2017 @ 11:45:00 AM
 GROUND ELEVATION: Approx. 1022 ft above msl
 ▼ GROUNDWATER (I): 24.1 ft bgs
 WEATHER CONDITIONS: Foggy, calm, 30°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (in)	FIELD BLOWS	(N ₁) ₆₀	LAB RESULTS	REMARKS/NOTES	WELL DIAGRAM
0			SURFICIAL ORGANIC DEPOSITS, consist of a mixture of grasses, leaf litter, root masses, peat, and organic silt COLLUVIAL DEPOSITS, SANDY SILT (ML), trace gravel, stiff, tannish gray, damp								
5			GLACIAL OUTWASH DEPOSITS, GRAVEL WITH SILT AND SAND (GP-GM), dense, olive brown, damp, gravel up to 2" in diameter		S1	15	4 5 10	12	S1 MC = 22.1%		
15			GLACIAL TILL DEPOSITS, SILTY SAND WITH GRAVEL (SM), dense, olive brown, damp, gravel up to 3" in diameter		S2	19	8 38 50 3"	N/A	S2 MC = 6.7%		
25			GLACIAL OUTWASH DEPOSITS, GRAVEL WITH SAND (GP), dense, olive brown to dark gray, saturated, gravel up to 2" in diameter		S3	12	29 50 3"	N/A	S3 MC = 7.1% 21.8% gravel, 55.7% sand, 22.5% silt	Increased drilling resistance at approx. 16 ft bgs.	
30					S4	12	7 17 50 3"	N/A	S4 MC = 10.8%		

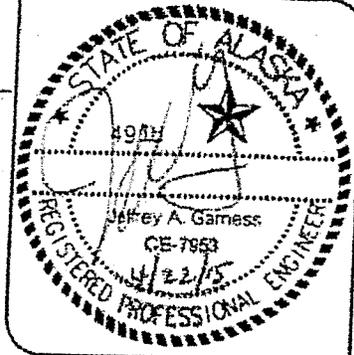
Bottom of borehole at 31.25 ft bgs.
 Set 1" PVC casing to BOH. Hand slotted casing from 21.25-31.25 ft bgs. Backfilled annulus with cuttings to 3.5 ft bgs, then bentonite chips to ground surface. Hydrated chips to form seal.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

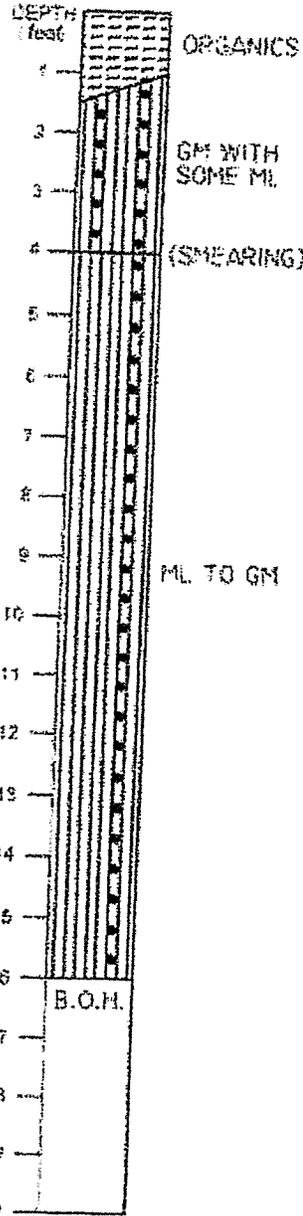
1100 E. TUMATA ROAD SUITE 207 ANCHORAGE, ALASKA 99501 PHONE: (907) 227-8171 FAX: (907) 227-8170 E-MAIL: JGARNESS@GEGENGINEERS.COM



SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK SQ (PROPOSED - LOT 5) R-10 LOT 14
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / SA GROUP DATE: 1/7/2015

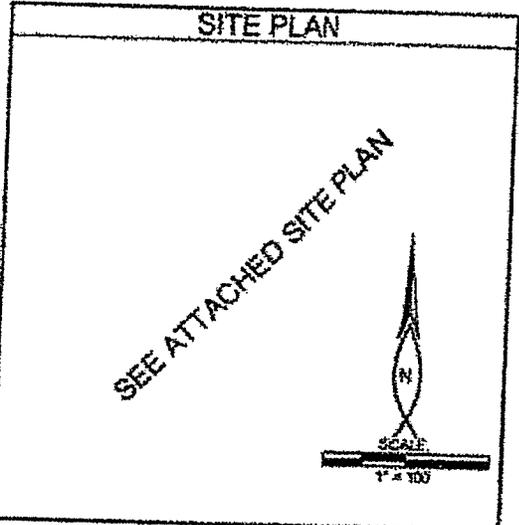
TEST HOLE #5
PAGE 1 OF 2



SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		

DEPTH TO GROUNDWATER	DATE
DRY	1/7/2015
DRY	1/15/2015
DRY	4/17/2015



	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
LOWER BENCH	1/8/2015	LIQUID LEVEL DID NOT DROP DURING FIVE-SOAK				

PERCOLATION RATE >120 (ML/INCH) PERC. HOLE DIA. 8 (INCHES)
 TEST RUN BETWEEN 4.5 FT. AND 5.5 FT.
 A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

LOGGED BY: JODY MAUS PERCOLATION TEST PERFORMED BY: DAVID GARNESS

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.
 PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 4/22/15

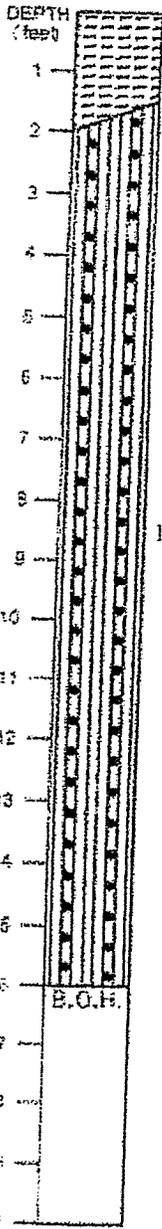
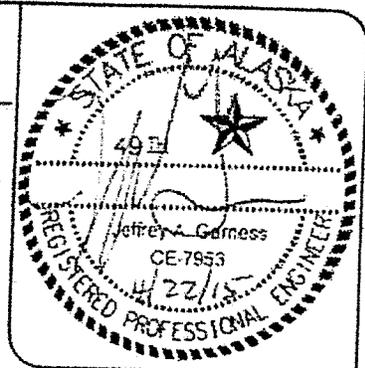
GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK S/D (PROPOSED - LOT 9) R-10 LOT 16

PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / 64 GROUP DATE: 1/19/2015



TEST HOLE #9

SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		

DEPTH TO GROUNDWATER	DATE
DRY	1/7/2015
DRY	1/16/2015
DRY	4/17/2015

SITE PLAN

SEE ATTACHED SITE PLAN

DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
1/8/2015	1	1:47	-	6"	-
	2	2:17	30	4-1/4"	1-3/4"
	3	2:17	-	6"	-
	4	2:47	30	4-1/2"	1-1/2"
	5	2:47	-	6"	-
	6	3:17	30	4-1/2"	1-1/2"

PERCOLATION RATE 20 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 4.5 FT. AND 5.5 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

LOGGED BY: JODY MAUS PERCOLATION TEST PERFORMED BY: DAVID GARNESS

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.
 PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 4/22/15



Northern Geotechnical Engineering Inc.
 d.b.a. Terra Firma Testing
 11301 Olive Lane
 Anchorage, AK 99515
 Telephone: 907-344-5934
 Fax: 907-344-5993

EXPLORATION B- R-10 LOT 16

NGE-TFT PROJECT NAME: Lewis & Clark Subdivision NGE-TFT PROJECT NUMBER: 4865-17

PROJECT LOCATION: Anchorage, AK EXPLORATION CONTRACTOR: Discovery Drilling, Inc.

EXPLORATION EQUIPMENT: Track-mounted CME 75 EXPLORATION METHOD: Hollow Stem Auger w/ NWJ Rods

SAMPLING METHOD: Modified Split-spoon w/ 340lb autohammer LOGGED BY: A. Smith

DATE/TIME STARTED: 11/2/2017 @ 3:15:00 PM DATE/TIME COMPLETED: 11/2/2017 @ 4:40:00 PM

EXPLORATION LOCATION: N/A GROUND ELEVATION: Approx. 1088 ft above msl

▽ GROUNDWATER (ATD): None observed ▼ GROUNDWATER (I): 15.0 ft bgs

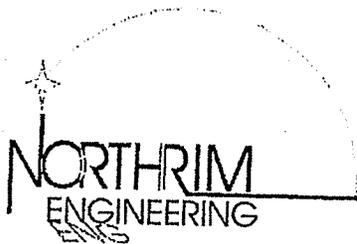
EXPLORATION COMPLETION: See comments below WEATHER CONDITIONS: Clear, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (in)	FIELD BLOWS	(N ₁) ₆₀	LAB RESULTS	WELL DIAGRAM
0			<i>SURFICIAL ORGANIC DEPOSITS</i> , consist of a mixture of grasses, leaf litter, root masses, peat, and organic silt							
			<i>COLLUVIAL DEPOSITS, SILTY SAND (SM)</i> , very loose, reddish brown to tannish gray, damp, gravel up to 2" in diameter		S1	16	0 1 1	3	S1 MC = 22.9% 51.2% gravel, 33.7% sand, 15.1% silt	
			<i>GLACIAL TILL DEPOSITS, SANDY SILT WITH GRAVEL (SM)</i> , stiff to hard, tannish gray, damp, gravel up to 3" in diameter		S2	11	3 11 14	41	S2 MC = 14.2% 22.0% gravel, 31.3% sand, 46.7% silt P0.02 = 41.6% FC = F3	
5					S3	17	7 8 8	13	S3 MC = 9.5%	
			<i>GLACIAL OUTWASH DEPOSITS, POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)</i> , dense, olive brown, damp, gravel up to 2" in diameter		S4	18	10 14 11	29	S4 MC = 3.8%	
10					S5	16	12 12 17	29	S5 MC = 6.2% 33.5% gravel, 55.3% sand, 11.2% silt	
			<i>GLACIAL TILL DEPOSITS, SILTY SAND WITH GRAVEL (SM)</i> , dense, olive gray, damp to wet, gravel up to 2" in diameter							
15					S6	14	23 50	N/A	S6 MC = 7.0%	

Bottom of borehole at 16.0 ft bgs.
 Set 1" PVC casing to BOH. Hand slotted casing from 11-16 ft bgs. Backfilled annulus with pea gravel from 11-16 ft bgs, cuttings to 3.5 ft bgs, then bentonite chips to ground surface. Hydrated chips to form seal.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)



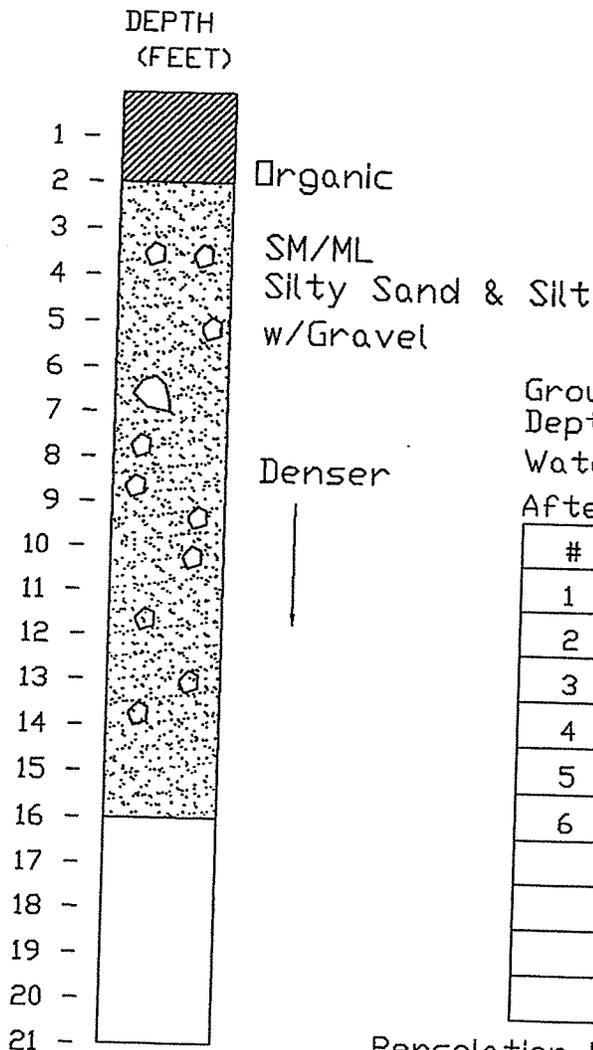
SOILS LOG - PERCOLATION TEST

Date Performed: 9/16/16

Performed For: Todd Brownson

Legal Description: Lewis & Clark S/D, Revised To Lot 17 R-10 LOT

T.H. Location: See Location Map



Groundwater? No
Depth ---

Water Depth

After Monitoring: None Date: 10/14/16

#	Date	Gross Time	Net Time	Depth	Net Drop
1	9/16	0	--	3'	--
2	9/16	30	30 min.	6.5'	3.5'
3	9/16	32	--	3'	--
4	9/16	62	30 min.	6.5'	3.5'
5	9/16	65	--	3'	--
6	9/16	95	30 min.	6.5'	3.5'

Percolation Rate 8.6 min./Inch Perc Hole Diameter 6"
Test Run Between 3' and 4'

Comments: Presoaked, Deepened To 16'

Performed By NorthRim Eng. I [Signature] CERTIFY THAT THIS TEST WAS
Performed in Accordance with All State/Municipal Guidelines in Effect
ON THIS DATE. DATE: 10/22/16

NORTHRIM ENGINEERING PO Box 770724 Eagle River, Alaska 99577 907.694.7028		TESTHOLE LOG	TH9
		GEO TECHNICAL	
		LEWIS & CLARK S/D LOT 17	
		Date: <u>10/22/10</u>	SHEET: <u>9 of 26</u>

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

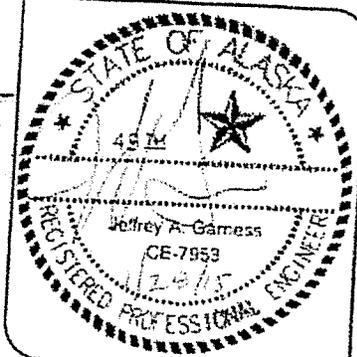
200 E. FAIRBANKS ROAD, SUITE 100 • ANCHORAGE, AK 99501 • PHONE (907) 551-4114 • FAX (907) 551-0144 • WWW.GARNESSENGINEERING.COM

SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK SID (PROPOSED - LOT 12)

PERFORMED FOR: BIG COUNTRY LLC / S4 GROUP

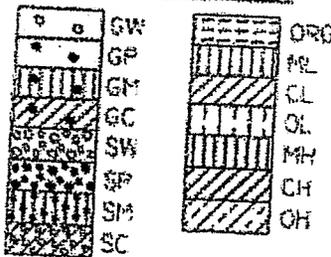
DATE: SEE PAGE 1 OF 2



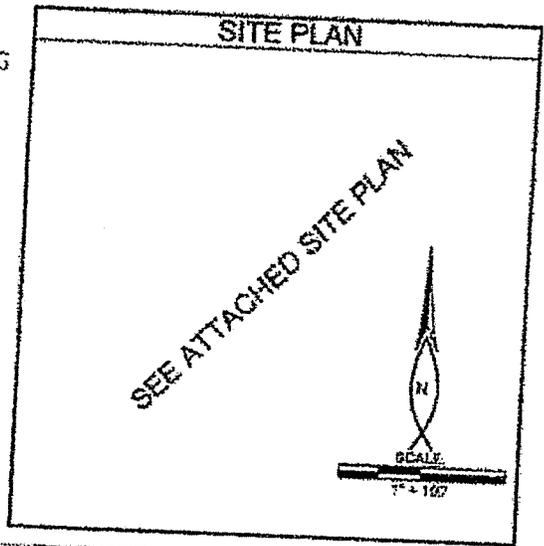
TEST HOLE #12

PAGE 2 OF 2

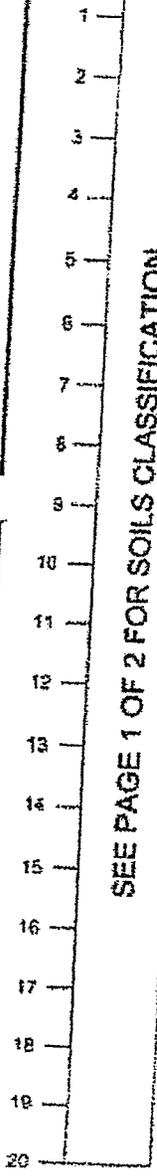
SOIL CLASSIFICATIONS



DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	



DEPTH (feet)



SEE PAGE 1 OF 2 FOR SOILS CLASSIFICATION

	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/14/2015	1	3:00	-	6"	-
		2	3:06	6	0"	6"
		3	3:08	-	6"	-
		4	3:17	9	0"	6"
		5	3:17	-	6"	-
		6	3:38	18	0"	6"
		7	3:36	-	6"	-
		8	3:58	20	0"	6"
		9	3:55	-	6"	-
		10	4:16	20	0"	6"

PERCOLATION RATE 3.3 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)

TEST RUN BETWEEN 2 FT. AND 3 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ANDREW GRAY

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

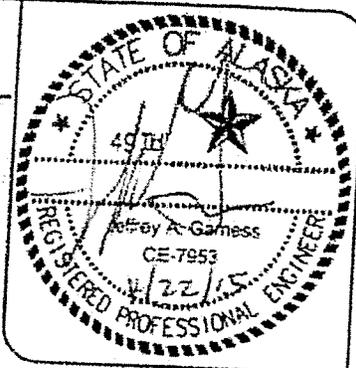
PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/20/15

GARNESS ENGINEERING GROUP, Ltd

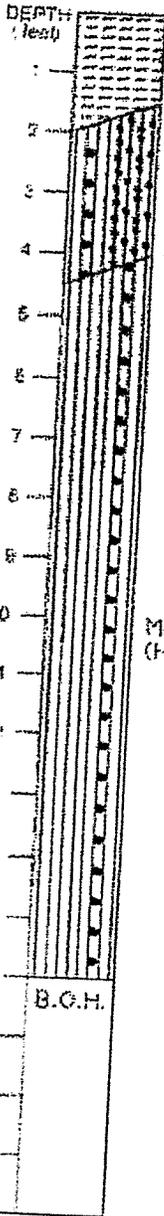
CIVIL & ENVIRONMENTAL ENGINEERS

SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK SD (PROPOSED - LOT 13) **R-10 LOT 19**
 PERFORMED FOR: BIG COUNTRY ENTERPRISES, LLC / B4 GROUP DATE: 1/22/2015



TEST HOLE #13
PAGE 1 OF 2



SOIL CLASSIFICATIONS

	GW		ORG
	GP		ML
	GM		CL
	GC		OL
	SW		MH
	SP		CH
	SM		OH
	SC		

SITE PLAN

SEE ATTACHED SITE PLAN

DEPTH TO GROUNDWATER	DATE
DRY	1/2/2015
DRY	3/15/2015
DRY	4/17/2015

DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
1/2/2015	1/4" DROP IN 3 HOURS - DID NOT PERK (RG)				
1/5/2015	DEEPEMED BENCH - RESET PERK - NO DROP DURING PRE-SOAK (DG)				

PERCOLATION RATE >120 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)
 TEST RUN BETWEEN 4.56.5 FT. AND 5.57.5 FT.

A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

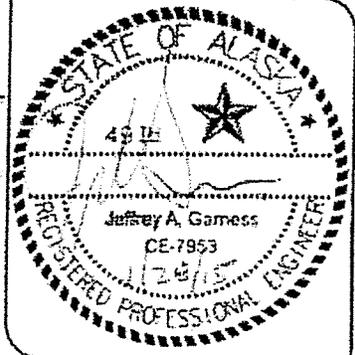
LOGGED BY: JODY MAUS PERCOLATION TEST PERFORMED BY: ROB CAMPBELL/DAVID GARNESS

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.
 PERFORMED BY GEG, Ltd. I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 4/22/15

GARNESS ENGINEERING GROUP, Ltd

CIVIL & ENVIRONMENTAL ENGINEERS

1000 W. TAZEWELL BLVD. SUITE 100 • ANCHORAGE, ALASKA 99501 • PHONE (907) 562-1100 • FAX (907) 562-1101 • WEBSITE: www.garnesseng.com



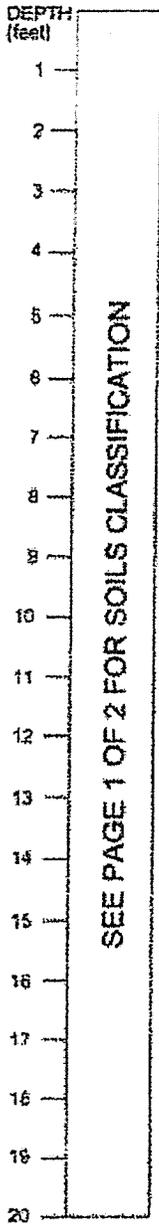
SOIL LOG - PERCOLATION TEST

LEGAL DESCRIPTION: LEWIS AND CLARK S-D (PROPOSED - LOT 13)

R-10 LOT 19

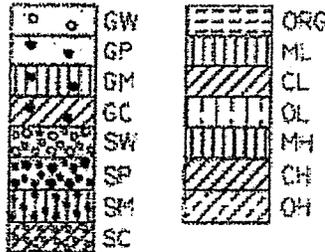
PERFORMED FOR: BIG COUNTRY LLC / S4 GROUP

DATE: SEE PAGE 1 OF 2

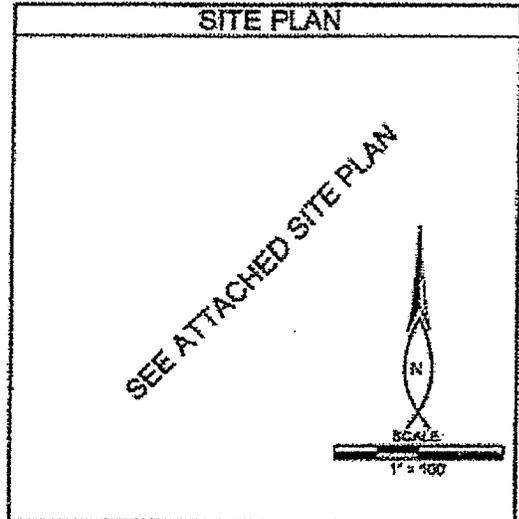


TEST HOLE #13 PAGE 2 OF 2

SOIL CLASSIFICATIONS



DEPTH TO GROUNDWATER	DATE
SEE PAGE 1 OF 2	



	DATE	READING	CLOCK TIME	NET TIME (MINUTES)	WATER LEVEL READING	NET DROP (INCHES)
UPPER BENCH	1/14/2015	1	3:05	-	6"	-
		2	3:35	30	1-3/4"	4-1/4"
		3	3:35	-	6"	-
		4	4:05	30	1-7/8"	4-1/8"
		5	4:05	-	6"	-
		6	4:35	30	1-7/8"	4-1/8"

PERCOLATION RATE 7.3 (MIN./INCH) PERC. HOLE DIA. 6 (INCHES)

TEST RUN BETWEEN 2 FT. AND 3 FT.

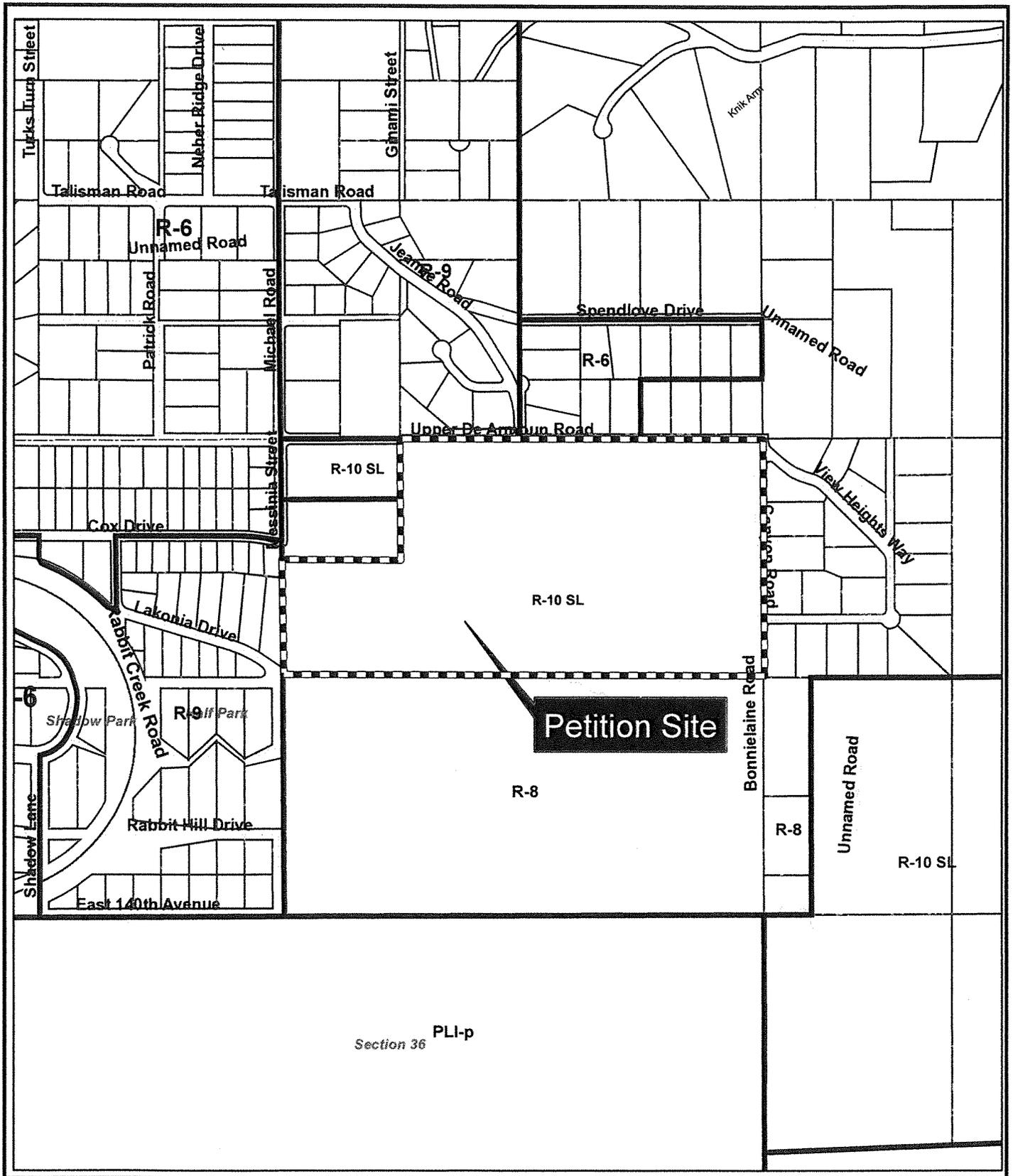
A FOUR HOUR PRESOAK WAS PERFORMED: YES NO

SOILS LOGGED BY: SEE PAGE 1 OF 2 PERCOLATION TEST PERFORMED BY: ANDREW GRAY

COMMENTS: PERCOLATION READINGS ARE WITHIN 1/16 OF INCH.

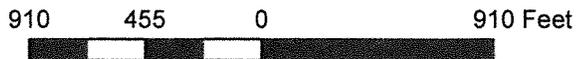
PERFORMED BY GEG. Ltd I, JEFFREY A. GARNESS, CERTIFY THAT THIS WAS PERFORMED IN ACCORDANCE WITH ALL STATE AND MUNICIPAL GUIDELINES IN EFFECT ON THIS DATE: 1/28/15

S12519

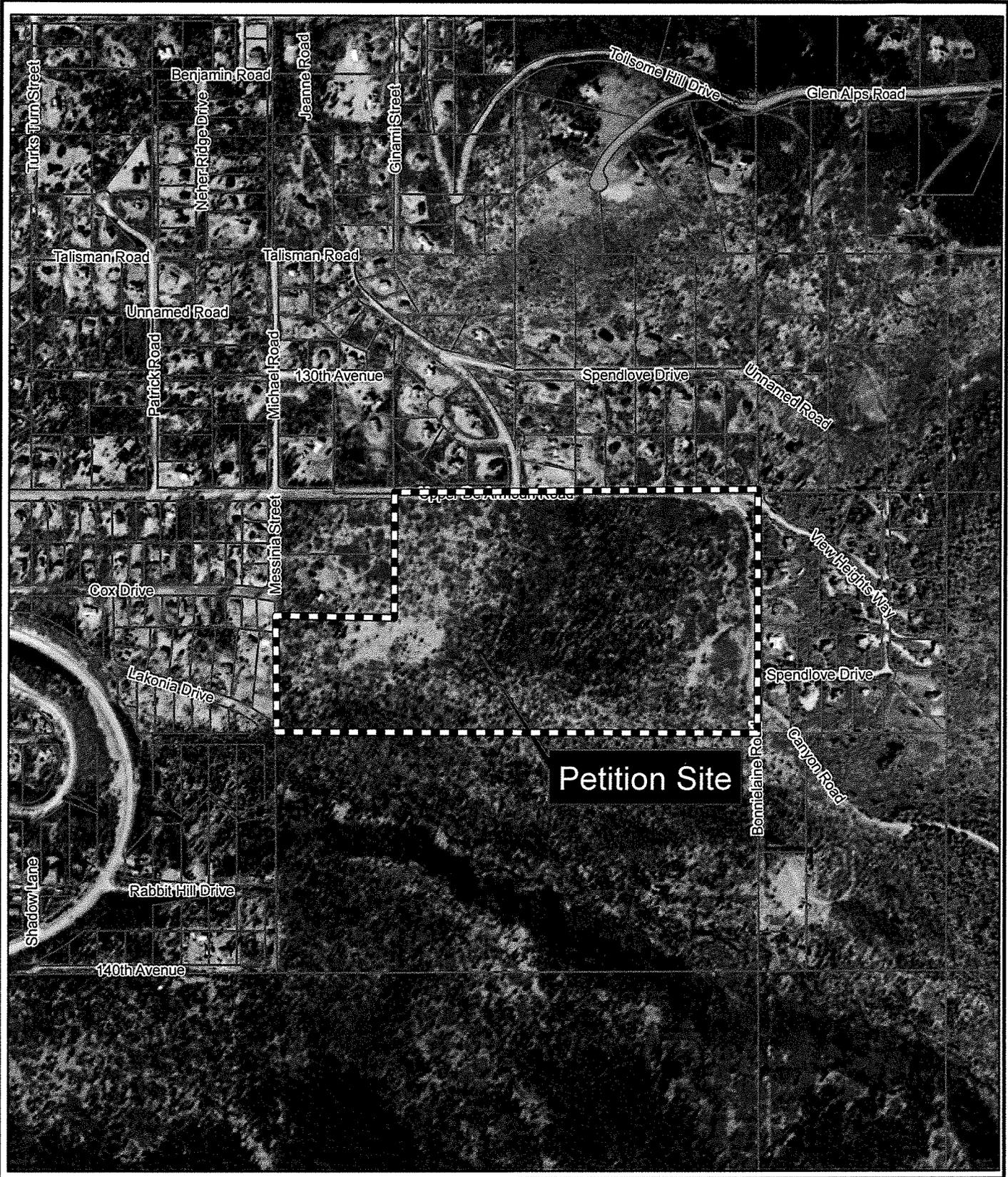


Municipality of Anchorage
Planning Department

Date: September 10, 2019

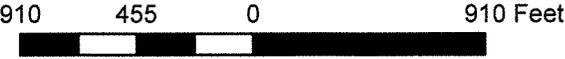


S12519



Municipality of Anchorage
Planning Department

Date: September 10, 2019



S12519 PHN

Buffer = 500ft

Parcels = 77

