PEG | **Payne Engineering Geology**

1230 Maple Road, North Saanich, Canada, V8L 5P7
E-mail: PayneEngineering@shaw.ca

Phone: (250) 655-3604
Fax: (250) 655-3608

20 October 2007

File: TOC-1

Town of Comox
1809 Beaufort Avenue
Comox, BC, V9M 1R9

Attention: Mr. G. Westendorp, Works Superintendent

Report Submission
Cape Lazo Sewage Study: Review of Onsite Sewage Systems

Dear Sir:

Please find enclosed four copies of our Cape Lazo Sewage Study. The report's main conclusions are as follows:

(1) The Cape Lazo study area includes 62 properties, mostly along Lazo Road, Hutton Road, and the south end of Kye Bay Road. Within this area, property and soil conditions are generally suitable for septic systems and, as a result, the 16 wells that we tested showed no harmful pollution from septic systems.

(2) Many of the existing sewage systems are outdated, undersized, or poorly maintained. However, this study found no major problems resulting from this.

(3) There is no need to install a municipal sewage system simply for the benefit of solving problems with existing systems.

(4) If it is desirable to create smaller lots, smaller than a half hectare, in part of the study area, it may be appropriate or necessary to first install a communal or municipal sewer system.

(5) For a property in this study area that is to be subdivided, with onsite sewage systems, VIHA (Vancouver Island Health Authority) has provided recommended minimum lot sizes. The recommended lot size may range from 0.2 to 2.0 hectares (0.45 to 5.0 acres), depending on the depth and permeability of the soil, slope of the property, and presence of potable water wells.

(6) Under the new Sewerage System Regulation, any homeowner that repairs, upgrades, or replaces an existing sewage system must hire a qualified Wastewater Practitioner or professional engineer to design the new sewage system and register with VIHA.

Please phone me at 655-3604 if you have further questions.

Sincerely,
Payne Engineering Geology Limited

Michael Payne, PEng, PGeo

2007-10-20, Cover Letter.wpd

Copy: C. Holmes, Koers and Associates Engineering, Courtenay

Cape Lazo Sewage Study:

Review of Onsite Sewage Systems

20 October 2007

Prepared for

Town of Comox
Comox, BC

Prepared by

Payne Engineering Geology
1230 Maple Road, North Saanich, BC, V8L 5P7
250-655-3604 PayneEngineering@shaw.ca

PEG File: TOC-1

Table of Contents

1. Introduction 1

1.1 Project Background 1
1.2 Objectives of this Study 1
1.3 Limitations of this Study 1

2. Site Evaluation and Test Results 2

2.1 Scope of this Review 2
2.2 Overview of the Cape Lazo Study Area 3
2.3 Applicable Laws and Regulations 5
2.4 Soil Analysis 6
2.5 Homeowner Interviews 6
2.6 Testing of Well Water Quality 6

3. Summary and Conclusions 7

3.1 Typical Soil Profile 7
3.2 Ground Water and Water Wells 7
3.3 Evaluation of Existing Sewage Systems 9
3.4 Problems With Existing Sewage Systems 11
3.5 Benefits of a Municipal Sewage System in this Area 11
3.6 Effect of a Municipal Water Supply on Indoor Water Use 12
3.7 Recommendations for Residential Lot Sizes 12
3.8 Requirements of the Sewage Regulation 14

Appendices

1 - Water Well Depths and Yields 16

2 - Interviews With Homeowners 17

3 - Well Water Quality 22

4 - Summary of 2007 Auger Holes 30

5 - Summary of 2002 Test Pits and Boreholes 34

6 - Permeameter Tests 35

7 - Soil Texture Analysis 36

8 - Subdivision Standards 37

9 - Figures 55
Figure 1 - Study Area
Figure 2 - Soil and Ground Water Conditions
Figure 3 - Well Water Quality

10 - Statement of General Conditions 59

1. Introduction

This 59-page report reviews onsite sewage systems in the Cape Lazo area. *This report is subject to the attached Statement of General Conditions (Appendix 10).*

1.1 Project Background

The Cape Lazo area is a suburban to sub-rural neighbourhood of approximately 60 properties on the Comox Peninsula, mostly along Lazo Road. Currently, each developed property has an onsite sewage system and a domestic water well. However, the Town of Comox has recently annexed this area, and plans to install municipal water mains. The Town is assessing the need to install a municipal sewer system.

The main purpose of this study is to evaluate how well existing septic systems are functioning and advise on the benefits of installing a municipal sewer to parts or all of the newly annexed area.

A secondary purpose is to advise the Town on appropriate policies for subdividing land while continuing to use onsite sewage systems within the study area.

1.2 Objectives of this Study

The objectives of this study are as follows.

1) Describe the typical soil profile in the study area, particularly as it affects septic systems.
2) Review typical ground water and water well conditions.
3) Evaluate how well septic systems are working in the Cape Lazo area.
4) In areas where existing septic systems are working poorly, describe the problems.
5) Identify the main benefits to installing a municipal sewer to parts of the study area.
6) Review the effects of installing a municipal water supply, in particular, increased indoor water use and resulting stresses on septic systems.
7) For new residential subdivisions in this area, recommend a suitable minimum lot size.

1.3 Limitations of this Study

This is an overview study. We did not evaluate site and soil conditions, or conditions of sewage systems, on any specific property. We evaluated well water quality as an indirect way to evaluate how well existing septic systems are treating wastewater. For this reason, we tested well water for the most common wastewater pollutants, fecal coliform bacteria (an indicator for pathogenic microorganisms), and nitrate. The test results provide a reasonable overview of ground water quality, but may not accurately reflect water quality at other times of the year.

2. Site Evaluation and Test Results

2.1 Scope of this Review

During April through June of 2007, PEG (Payne Engineering Geology) reviewed the overall performance and potential longevity of onsite sewage systems in the Cape Lazo Study Area. This review included the following main activities:

- Meeting with Mr. Glenn Westendorp of the Town of Comox.
- Discussion with Dave Cherry, Environmental Health Officer, Vancouver Island Health Authority.
- Review of maps and reports relating to terrain, soils, geology, hydrology, aquifers, and wells of the area.
- Review of background reports (listed below).
- Initial reconnaissance of the Study Area on April 17.
- Augering 10 test holes with a hand auger, and logging the soil profile, on April 18 - 19.
- Measuring the depth of the water table in PVC standpipes, on April 19.
- Conducting 8 borehole permeameter tests, on April 19.
- Interviewing 15 property owners, and collecting 15 well water samples, on April 19 - 20.
- Coordinating with North Island Labs of Comox, for the analysis of the 15 samples.
- Arranging for Cantest Labs of Victoria to analyse the soil texture of 7 soil samples.
- Collecting two additional well water samples on May 8.
- Analysis of water quality in reference to drinking water criteria.
- Analysis of site and soil suitability with reference to the BC *Sewerage System Standard Practice Manual.*
- Discussions with a 16th property owner on May 29.

Michael Payne and Bob Chapman conducted the interviews and field studies. Sandra Felgenhauer, of North Island Labs, assisted with re-sampling of two water wells, and directed the laboratory analysis of water samples. The Town of Comox provided the following background reports:

Engisch, C., January 2003. *Archeological Impact Assessment, Interim Report, Contract #1: Lazo Road Water System, Lazo, British Columbia.* Baseline Archaeological Services report to Regional District of Comox - Strathcona. Baseline file 02027.

Marsh, William M., April 2002. *Toward a Management Plan for the Lazo Watershed and Queen's Ditch.* Report by University of British Columbia to Regional District of Comox - Strathcona.

Miller, C., July 2002. *Geotechnical Assessment, Kye Bay Sanitary Sewer and Water System.* Levelton Engineering report to Koers and Associates Engineering Ltd. Levelton file 602 - 0048.

The following table is a summary of the project.

Table 1
Summary of the Project

Contacts:	Client: Town of Comox Civil engineer: Chris Holmes, P.Eng., Koers and Associates Engineering Ltd., Courtenay Onsite sewage system specialist: Michael Payne, P.Eng., P.Geo., North Saanich	
Site Features	Existing	Proposed
Land use:	Primarily single-family residential. One tourist commercial operation (Cape Lazo Resort).	No change planned. There are a few larger properties within the study area that may have some potential for a residential subdivision.
Lot sizes:	Typically 0.4 to 2.0 hectares (1 to 5 acres), except typically 1,000 to 2,000 square metres (0.25 to 0.5 acre) along Hutton Road.	No change planned.
Buildings:	Typically one house, three-bedrooms, per lot.	No change.
Water supply:	Domestic water wells, mostly dug, some drilled.	The Town of Comox plans to construct a water supply pipeline. Some residents may continue to use wells as a primary or secondary water supply.
Sewage system:	Onsite sewage systems, typically a septic tank with gravity distribution to a septic field.	The purpose of this study is to help evaluate the benefits of a new, municipal sewer in this area.

2.2 Overview of the Cape Lazo Study Area

The Cape Lazo Study Area is the area of approximately 62 lots, mostly along Lazo Road, recently incorporated into the Town of Comox (See Figure 1, Appendix 9). For interviews and well sampling, we subdivided the Study Area into 16 sub-areas, with three or four properties in each sub-area (See Table 2 below and Figure 1). For each sub-area, we interviewed one homeowner and sampled that owner's well.

Six of the properties, plus one park, have no civic address and are assumed to be unoccupied. We could not contact anybody in Area D, despite repeated phone calls and knocking on doors. We added Area Q, for a well located outside the Study Area, on Hillbank Road, that supplies water to a house inside the Study Area, in Area J.

Table 2
Sub-Areas for Interviews and Well Sampling

Area	Lots	Roads
A	1 - 4	721, 685, and 647 Lazo Rd, plus 655 and 675 Hutton Rd
B	5 - 8	616 to 638 Hutton Rd
C	9 - 12	640 to 656 Hutton Rd
D	13 - 16	Hutton Road, vacant lot plus 664 to 672 Hutton Rd
E	17 - 20	680 to 684 Hutton Road, plus vacant lot. *On the Town of Comox map, Figure 1, these are incorrectly labelled as 603 to 611 Lazo Road.*
F	21 - 24	570 to 593 Lazo Rd, including park
G	25 - 28	566 to 544 Lazo Rd
H	29 - 32	532 to 484 Lazo Rd
I	33 - 36	464 to 424 Lazo Rd
J	37 - 40	406 to 372 Lazo Rd
K	41 - 44	343 to 350 Lazo Rd, plus 953 Kye Bay Rd
L	45 - 48	360 Lazo Rd, vacant lot, and 975 to 993 Kye Bay Rd
M	49 - 52	Vacant lot plus 1031 to 1045 Kye Bay Rd
N	53 - 56	1065 to 1093 Kye Bay Rd
O	57 - 59	1125 to 1139 Kye Bay Rd, including vacant lot
P	60 - 62	1151 Kye Bay Rd, plus 250 and 298 Simon Crescent
Q	63 - 65	Hillbank Road (outside of the Cape Lazo Study Area)

The following table is an overview of the physical setting of the Cape Lazo Study Area, based on our review of regional maps and background reports, and our site reconnaissance.

Table 3
Physical Features of the Cape Lazo Study Area

Feature	Typical Conditions in the Study Area
Elevation:	0 to 32 m a.s.l. *From topographic maps.*
Land slope:	1% to 10% (except Cape Lazo bluffs)
Soils mapping:	Lowland: Kuhushan soil association, sandy loam and loamy sand, rapidly drained. Aolian (sand dunes) over marine deposits. Upland: Bowser soil association, loamy sand and gravelly sandy loam, imperfectly drained. Marine deposits over till, at typical depth of 50 to 100 cm. *From Soils of Southern Vancouver Island (Jungen, 1985).*
Rock outcrops:	None seen. *From site reconnaissance, April 2007*

Aquifers:	Aquifer number	407	408
	Name:	Point Holmes Aquifer	Comox - Merville Aquifer
	Location:	Lowland Area	Upland Area
	Materials:	Sand and gravel	Sand and gravel
	Stratigraphic unit:	Salish sediments	Quadra Sediments
	Productivity:	Moderate	Moderate
	Vulnerability:	High	Low
	Demand:	Low	High
	Quality concerns:	Isolated	Local
	Quantity concerns:	None	None
	See Figure 1, Appendix 6, for Lowland and Upland Areas *Information from BC Ministry of Environment, Aquifer Classification Database, July 2007.*		
Water wells:	Approximately 60 wells in the Study Area. See Appendices 1 and 2 for more details.		
Water bodies:	The main water body in the Study Area is Queen's Ditch. This ditch has several tributary ditches. It drains seasonally flooded farmland west of the study area, runs along the north side of Southwind Road, then flows into the Strait of Georgia near Point Holmes (See Figure 1, Appendix 9) No other major creeks or ditches have been mapped in the study area. *From BC Water Resources Atlas and Comox Valley Project Watershed Society, 2007.*		
Slope condition:	See discussion below		

Most of the slopes in the Study Area are no steeper than 15% and are typically stable. However, the Cape Lazo bluffs, on the northeast shoreline east of Kye Bay Road, are steeper than 100% (1:1) and are unstable. These bluffs are about 30 metres high and are subject to wave erosion at the base and occasional slumping. This study did not include a geotechnical assessment of the bluffs. However, the erosion problem raises a concern as to whether existing or future onsite sewage systems near the bluffs have an influence on the stability of the bluffs.

2.3 Applicable Laws and Regulations

In BC, the *Health Act - Sewerage System Regulation (2004)* regulates the planning, design, construction, operation, inspection, and maintenance of onsite sewage systems for single-family homes. This regulation differs from earlier regulations in BC, in that it requires a homeowner to retain the services of an *Authorized Person* (or persons) to plan, install, and maintain the sewage system according to the regulation. The Authorized Person files drawings and other relevant documents with the Health Authority. The Health Authority no longer issues sewage permits. The Authorized Person is commonly a *Registered Onsite Wastewater Practitioner* (ROWP) but may, in some circumstances, be a professional engineer or applied science technologist.

Between 1985 and 2004, the *Health Act - Sewage Disposal Regulation* regulated the permitting, construction, and operation of onsite sewage systems. Under that regulation, an Environmental Health

Officer from the Health Authority would confirm that the planned sewage system met the prescriptive requirements of the regulation, and then would issue a permit to construct the system. We would expect that most of the sewage systems in the Study Area were, at one time, permitted under the Sewage Disposal Regulation.

Before 1985, BC had no regulation specifically regulating septic systems, but the Health Act did govern some aspects of sewage systems. As a result, some of the older homes in the Study Area may have never been permitted.

2.4 Soil Analysis

In 2002, Levelton Engineering assessed foundation conditions along the proposed route of the Kye Bay sanitary sewer and water pipelines. This included 21 test pits and 19 boreholes. Of these, 5 test pits and 4 boreholes were within the Cape Lazo Study Area. Appendix 5 is a summary of the most relevant information from the 2002 Levelton report.

Appendix 4 is a summary of the soil profile in the 10 holes augered in April 2007. Appendix 6 reviews results of the borehole permeameter tests. Appendix 7 reports particle size distributions and texture classification for 7 soil samples. This information was used to confirm descriptions in the soil profile logs.

2.5 Homeowner Interviews

As discussed, our procedure involved interviewing approximately one in four residents. Within each group, we started at the top of our list of residents names, and moved down until we were able to schedule and interview. We were unable to reach any of the three residents in Area D. Appendix 2 is a summary of information provided by residents.

2.6 Testing of Well Water Quality

We tested the quality of well water as a way to evaluate the effectiveness of onsite sewage systems. Most of the wells are shallow, less than 30 feet (9 metres) deep, and are located down-slope from one or more sewage systems.

North Island Labs provided water sample bottles and a cooler. We collected water samples from a tap in each house, after running the water for one minute. We measured the electrical conductance at the time of sampling, using a hand-held meter. We stored samples in a cooler and delivered samples to North Island Labs at the end of each day of interviews. Appendix 3 shows the laboratory results.

3. Summary and Conclusions

3.1 Typical Soil Profile

Lowland Area

The Lowland Area, along Lazo Road and Hutton Road, is characterized by sand dunes. Auger holes and test pits showed deep deposits of well-drained sand (see soil analyses in Appendix 7). The inferred winter water table is 2.3 to 5.0 metres deep.

Appendices 4 and 5 summarize the typical soil profile and ground water conditions in the 2007 auger holes and 2002 test pits and boreholes. Figure 2 (Appendix 9) shows locations of the exploratory holes and pits. Figure 1 (Appendix 9) is a map of the study area.

Upland Area

In the Upland Area, the shallow soil is typically loamy sand or sandy loam, gravelly to very gravelly (see Appendix 7). Test pits revealed a flow-restrictive horizon at depth 70 to 120 cm. Typically, this layer or horizon was described as very firm silty clay loam (AH-1), or as dense very gravelly sandy loam (AH-4, BH-10). In winter, a perched water table develops on top of this flow-restrictive horizon, at a typical depth of 70 to 100 cm. At auger hole AH-1, the water table was measured at 20 cm below ground surface; this is not typical of the area.

3.2 Ground Water and Water Wells

Within the study area, existing houses draw water from wells, including shallow dug wells and deeper drilled wells (see Appendix 1). The Town of Comox plans to run a municipal water supply line through the area. This review considered the condition of the existing wells for two reasons. First, the quality of water in the wells indicates how effectively septic systems have been treating sewage. Second, some homeowners may continue to use their water wells, rather than tapping into the new water pipeline.

Lowland Area

In the Lowland Area, the main aquifer is a shallow, unconfined sand deposit, known as the Point Holmes Aquifer. BC Ministry of Environment reports few if any problems with well capacity. The aquifer is moderately productive, and the water demand is low, as a result of the low housing density.

Most houses in the lowland area have shallow wells, typically dug to a depth of 4 to 9 metres (14 to 30 ft). Reported well yields are typically 50,000 to 100,000 litres per day (10 to 20 US gallons per minute), reflecting moderate to high permeability sands (see Appendix 1).

These well yields far exceed typical domestic demand. Individual household water use does vary widely. However, average residential water use in BC is 426 litres per day per capita (113 US gpd), or 852 to 1704 litres per day (225 to 450 US gpd) for households with 2 to 4 people (from Environment Canada, Municipal Water Use, 2004 Statistics). This includes indoor and outdoor water uses.

In our interviews, most residents of the lowland area reported good water quality (see Appendix 2). A few, isolated water quality concerns have been reported. One resident (Area B) reported hard or salty water, and two residents (Areas E and J) reported high iron. Our analysis of the well in Area B showed natural dissolved mineral salts (total dissolved solids) at about 100 to 200 mg/L, when tested in April. This water would be considered non-salty, so perhaps the salty water problems are seasonal. Most of the shallow wells in the lowland area contained very low dissolved mineral salts in April, less than 100 mg/L.

Our study did not include testing wells for iron content. If iron is present in wells at higher concentrations, this is not a health concern, and may be a health benefit. Iron may be an aesthetic concern, as it tends to stain laundry and porcelain.

Over time, the septic systems in this area have caused increases in the concentration of nitrate in the shallow ground water, but the concentration in the wells that we tested remains within allowable drinking water tolerances (see Appendix 3 and Figure 3 in Appendix 9). Nitrate concentrations in well water were, typically, in the range of 0.5 to 4.0 mg/L, versus the maximum acceptable concentration of 10.0 mg/L (Health Canada, March 2007). The lab did not find fecal coliform bacteria in any of the wells tested.

For the Lowland Area, the information indicates minor, localized water quality concerns of an aesthetic nature. Our review of water quality was limited, as we only tested for fecal coliform bacteria, nitrate nitrogen, and electrical conductance. However, we did not find evidence of health concerns.

Upland Area

In the Upland, near Kye Bay Road, the main aquifer is a deep, confined sand deposit. The geological formation is called the Quadra Sands, and the aquifer is known as the Comox - Merville Aquifer. Overall, this aquifer has moderate productivity and relatively high water use. This is a large aquifer that has been tapped by more than 500 wells.

Within the upland part of our study area, most houses use water wells drilled to a depth of 50 to 70 metres (165 to 230 ft). The BC Ministry of Environment reports ample water supply in the Comox - Merville Aquifer. Some houses draw water from shallow dug wells, intercepting spring water along the steep Cape Lazo slopes (see Figure 3). Within the Upland Area, reported well yields are in the range of 33,000 to 110,000 litres per day (6 to 20 US gallons per minute), including both drilled and dug wells.

The Comox - Merville Aquifer is confined beneath low-permeability soils, so it is well protected from pollution. Although BC Environment reports some local concerns with water quality, most of the homeowners that we interviewed reported good water quality. One resident (Area L) reported yellow water, possible natural tannins and lignins, in a shallow well. In the drilled wells, our water quality testing revealed essentially pristine water; nitrate concentrations were below the lab detection limit. Our analysis of the dug wells showed nitrate concentrations in the range of 1.0 to 2.0 mg/L, indicating a harmless effect of septic systems, or another source of nitrogen. No fecal coliform bacteria were detected in any of the wells tested.

In summary, the main aquifer that provides water to drilled wells in the upland area has more than adequate water supplies, pristine water quality, and is naturally protected from pollution. We found evidence that septic systems have affected some shallow dug wells, by raising nitrate concentrations to about 1.5 mg/L. However, the measured water quality does not present health concerns. Septic systems have not affected the deep drilled wells.

3.3 Evaluation of Existing Sewage Systems

Under BC's *Sewerage System Regulation*, there are three types of treatment systems:

- Type 1 is a septic tank.
- Type 2 is a treatment plant with effluent quality that meet the criteria of total suspended solids (TSS) less than 45 mg/L and biochemical oxygen demand (BOD) less than 45 mg/L. The most commonly used Type 2 system is the extended aeration plant, often called a package treatment plant.
- Type 3 is a treatment plant with effluent quality of TSS less than 10 mg/L, BOD less than 10 mg/L, and fecal coliform bacteria less than 400 CFU per 100 mL. A common Type 3 system is the sand filter.

Within the study area, terrain and soil conditions do vary somewhat, but are generally suitable for a Type 1 system or, on some properties, a Type 2 system. Soil conditions are generally suitable for building new onsite systems that conform with the BC *Sewerage System Regulation*, and the accompanying design manual, the *Sewerage System Standard Practice Manual*. Our testing of 16 wells revealed no harmful ground water contamination arising from the use of onsite sewage systems. This is despite the fact that many of the systems are decades old, undersized, or poorly maintained.

Lowland Area

In the lowland area, the sandy soil is highly permeable but not extremely permeable (see Appendix 6). To a large extent, the deep water table compensates for the high soil permeability. The seasonal high water table is, typically, 2.3 to 5.0 m deep in this area.

These soil conditions are generally well suited for onsite sewage systems, except that the highly permeable sand is a constraint on the design. Pressure distribution systems, using pump tanks, are most appropriate for these permeable soils, although gravity distribution systems seem to have worked adequately.

Existing septic systems have affected ground water quality by increasing nitrate concentrations. Measured concentrations of nitrate-nitrogen were, typically, 0.5 to 4.0 mg/L in this area (see Appendix 3). These concentrations exceed natural background levels, but fall within drinking water guidelines. No fecal coliform bacteria were detected.

In general, an appropriate onsite sewage system for the Lowland Area would include the following:

- a septic tank (Type 1 Treatment)
- pump tank, with float switches or timer
- pressure distribution piping
- a shallow drainfield or infiltration bed

Upland Area

In the upland area, near Kye Bay Road and Simon Crescent, some lots have relatively thin soils and a shallow water table. In the vicinity of our auger holes, the typical seasonal high water table is 70 to 100 cm deep (See Appendix 4). The gravelly sandy loam soil has a moderate permeability (Appendix 6).

These soil conditions create slight to moderate constraints for designing and installing onsite sewage systems. The main design constraint is the relatively shallow water table.

Our area reconnaissance and water quality analyses in the upland area revealed no adverse effects from existing sewage systems (see lab analyses in Appendix 3). Properties in this area are typically 0.4 to 1.6 ha (1 to 4 acres). This is usually enough area to construct a sand mound to raise the distribution system above the water table. In general, an appropriate sewage system for the Upland Area would include:

- septic tank (Type 1 treatment)
- pump tank, with float switches or timer
- pressure distribution piping
- a sand mound
- up-slope curtain drain (depending on site drainage)

On some properties, it may be preferable to use a Type 2 Treatment System with a pump tank and very shallow drainfield.

Cape Lazo Bluffs

For those properties along Kye Bay Road, within the Upland Area, there is an existing problem with ongoing natural erosion and instability of the Cape Lazo bluffs. There is a concern that water from septic fields could contribute to seepage near the top of the bluffs. The scope of this study did not include evaluating the causes of instability of the bluffs. From a cursory review, our opinion is that the slope instability is caused mostly by wave erosion at the base, not by seepage near the top of the bluffs. Our analysis shows that several of the septic fields along Kye Bay Road drain away from the bluffs and toward the airport. As a result, septic systems may not have a significant influence on stability of the bluffs.

However, it would be prudent that the proponent for any large new development near the bluffs should consider the net effect of the development on the stability of the bluffs, including expected changes to ground water seepage toward the bluffs.

Hillbank Road

The only problem that we did find with ground water quality was, ironically, for a well located outside of the study area (Area Q on Figure 3). We uncovered this problem because one of the residents along Lazo Road had a connection to a neighbour's water well that is located outside the town boundary, near Hillbank Road. The well near Hillbank Road had a nitrate concentration of 10.6 to 10.7 mg/L, confirmed by re-sampling. This slightly exceeds the drinking water guideline of 10.0 mg/L. We advised the users of this well to drink bottled water until the water quality improves. This well is located inland and up-slope from the study area, so it is not likely that septic systems in the study area contaminated the well. It has been suggested that poultry wastes, from a nearby commercial farm, may have contaminated this well; however, our study did not investigate causes.

3.4 Problems With Existing Sewage Systems

This study found no evidence that sewage systems in the study area have degraded ground water. Most of the shallow wells have nitrate concentrations elevated above natural background concentrations, likely resulting from either septic systems or farm fertilizers. However, in the study area, measured nitrate concentrations meet drinking water guidelines. No fecal coliform bacteria were detected in any of the wells tested.

We found no serious problems with the design or operation of existing onsite sewage systems, but did find a few minor problems. Some systems were installed prior to 1985, before the era of sewage permits, and as such we know nothing of their method of design and construction. We found some systems that do not meet current regulatory requirements for setback distances from the septic tank or septic field to the nearest well or ocean shoreline. Our interviews revealed that some homeowners have not maintained their sewage systems. Regular maintenance should include, at least, periodic inspection of the tank and drainfield, and occasional pump out of the septic tank. These are general comments, however, as our study did not include inspecting or evaluating any individual septic systems.

In summary, the existing septic tanks, with drainfields in sandy soils, have effectively removed harmful constituents from the sewage.

3.5 Benefits of a Municipal Sewage System in this Area

In general, the study area does not require a municipal sewer system. Some of the septic systems are old, undersized, and poorly-maintained. However, our testing of 16 wells showed that, overall, these systems have adequately protected ground water quality.

If there is a need for smaller lots in part of the study area (smaller than a half hectare), then it may be necessary or appropriate to have a municipal sewer system.

We spoke with 16 residents in the study area, including four along Hutton Road. Only one resident expressed a desire to have a municipal sewer system; the other 15 said they wanted to continue with their onsite systems (see Appendix 2). In general, residents of the study area can expect moderate costs when building new onsite sewage systems. This review indicates most properties could use a Type 1 Treatment System (septic tank), although a few may require a Type 2 or Type 3 Treatment System.

3.6 Effect of a Municipal Water Supply on Indoor Water Use

For this study, one concern raised was that a new municipal water supply might encourage residents to use more water. If this were to happen, increased indoor water use would increase sewage flows to existing septic systems, stressing the capacity of existing septic fields.

In our professional opinion, residents are not expected to increase indoor water use, for several reasons:

- Most residents have ample, low-cost water supplies from their own wells, as discussed above.
- Increases in water use, if any, are more likely to be outdoor uses, particularly summertime irrigation, thus having no influence on septic systems.
- As discussed below, the Town's proposed water pricing structure will encourage water conservation, likely decreasing overall water use.

Furthermore, although existing septic fields are mostly undersized relative to current standards, water quality testing shows they have adequately treated sewage.

The price of water affects how it is used. The Town of Comox is considering installing individual water meters and charging residents based on water used. Many municipalities have found that water metering causes residents to change their habits, thus decreasing water use in the community.

In Canada, communities with municipal water meters use 34% less water per capita (Environment Canada, 2000). However, the effect seems to be smaller in urban areas, as compared with suburban areas. This suggests smaller changes, perhaps 20%, can be attributed to indoor water use, versus perhaps a 50% reduction in outdoor water use. As a result, this study area may find a small reduction, perhaps 20%, in total sewage flows to septic systems, in response to the installation of new water meters. However, despite this, the volume of organic wastes discharged to septic systems will likely remain about the same, but with less dilution.

In conclusion, considering the net effect of a new municipal water supply, and the potential effects of using water meters, we would predict a small decrease in sewage flows into septic systems, perhaps up to 20%.

3.7 Recommendations for Residential Lot Sizes

We recommend that the Town of Comox use the Vancouver Island Health Authority's *Subdivision Standards* (VIHA, 2003) to establish appropriate minimum lot sizes based on each property's suitability for onsite sewage systems (see Appendix 8).

The Subdivision Standards (Table A, Appendix 8) shows that the recommended minimum lot size ranges from 0.2 ha (0.45 ac) to 2.0 ha (5.0 ac) depending on the site conditions, particularly slope of the lot and depth of native mineral soil. In general, the depth of native mineral soil is equal to the depth of the seasonal high water table. The minimum recommended drainfield area, for each proposed new lot, ranges from 535 to 890 square metres, depending on soil conditions. Additional subdivision approval requirements for each drainfield area, taken from the Standards, are listed below:

- The percolation rate must not be slower than 30 minutes per inch.
- Each drainfield area must be at least 15 metres from a probable breakout point.
- The drainfield area must be at least 30 metres from the natural boundary of a water body.
- The drainfield area must measure at least 25 metres across, measured along the contour of the land.

Proposed new lots with existing dwellings must also meet the same standards.

We have not evaluated site and soil conditions on any private property, so we cannot recommend a minimum subdivision lot size for any particular existing property. However, we can provide a hypothetical example of how the Subdivision Standards work. Consider, for example only, the large lot at 1151 Kye Bay Road, located in the Upland Area. We have information on soil conditions near that lot, in particular, auger holes AH-1 and AH-2. Those auger holes indicate the following (see Appendix 4):

- loamy sand and sandy loam, gravelly to very gravelly
- seasonal high water table (native soil depth) at 20 cm to 70 cm
- land slope 1% to 4%
- field-saturated soil hydraulic conductivity (Kfs) of 36 to 48 cm/day

Now, if these conditions were representative of 1151 Kye Bay Road, then the most favourable parts of the property could have, hypothetically, a native soil depth of 60 to 80 cm. For a soil depth greater than 61 cm, Table A (Appendix 8) then gives:

- Soil is classified as a loam, based on Kfs = 36 - 48 cm/day.
- The minimum required drainfield area, per new lot, is 715 square metres.
- The soil depth within each drainfield area is to meet the minimum soil depth of 61 cm.

In this example, the depth of native soil in the selected drainfield area is to be at least 61 cm. However, depending on natural variations in the depth of soil, the combined areas with the deeper soils may not provide for a full 715 square metre drainfield area on each proposed lot.

Under favourable circumstances, where at least 61 cm depth of soil is found on each proposed new lot, over a large enough area, the minimum lot size would be 1.0 hectares (2.5 acres). However, under less favourable circumstances, where the depth of soil in each drainfield area is 46 to 61 cm, for example, the minimum lot size is 2.0 ha (5.0 ac). For this example only, the resulting subdivision lot size would be either one hectare or two hectares, depending on the areal distribution of soil conditions.

In general, three options exist for sewage services for a new subdivision:

(1) Individual onsite sewage systems on each lot.
(2) Municipal sewer.
(3) A cluster sewage system with a communal drainfield.

Option (3) above is typically organized under a bare land strata plan (under the Strata Property Act) and managed by a strata corporation. However, some municipalities and regional districts have chosen to own and operate cluster sewage systems.

Under suitable circumstances, the VIHA Subdivision Standards allow for cluster sewage systems (Option 3). In those situations, the Standards specify that the drainfield area must be large enough for the number of lots involved, and the depth of native soil must be greater than 90 cm (for a land slope less than 10%). With a cluster system, the Subdivision Standards do not specify a minimum lot size, just a minimum size of drainfield area and soil depth.

In summary, we recommend using the VIHA Subdivision Standards to establish minimum lot sizes for future subdivision of land within the Cape Lazo Study Area. Each proposed subdivision should be evaluated based on site conditions, as evaluated by a qualified professional or wastewater practitioner.

For proposed new lots with individual onsite sewage systems, recommended lot sizes may range from 0.2 to 2.0 hectares (0.5 to 5.0 acres). As discussed above, for a hypothetical new subdivision near Simon Crescent, in the upland part of our study area, the recommended minimum lot size would be in the range of 1.0 to 2.0 hectares (2.5 to 5.0 acres).

3.8 Requirements of the Sewage Regulation

BC's *Sewerage System Regulation* requires that homeowners hire an *Authorized Person* (typically a registered practitioner or professional engineer) to plan and register all new, upgraded, and repaired sewage systems. Many municipalities require homeowners to upgrade their sewage system to current standards when obtaining a building permit.

Under the Regulation, the designer of the sewage system (the authorized person) is required to write a brief Operation and Maintenance Manual for the sewage system, including regular inspections. Each homeowner is required by law to hire a qualified repairman (ROWP) to maintain the system according to the manual.

Report prepared by:

Payne Engineering Geology Ltd.

Michael Payne, PEng, PGeo

C:\Documents and Settings\Michael\PEG Files\Projects\TOC\1\7 - Rpt\2007-10-20, R1, F.wpd

Report distribution

4 copies - G. Westendorp, Town of Comox
2 copies - C. Holmes, Koers and Associates Engineering Ltd.

Appendix 1
Water Well Depths and Yields
From BC Ministry of Environment's on-line WELL database

Area (1)	Location: Address or legal description	Owner at time of construction	Well Depth		Well yield		SWL		Well tag # (2)
			m	*ft*	*Lpd*	*USgpm*	*m*	*ft*	
A	DL 191	* A. Jane	NR	NR	NR	NR	NR	NR	12017
A	Lot 3 of Plan 14276	G. Evans	11.9	39	55,000	10	9.4	31	23496
A	685 Lazo Road	Cape Lazo Resort	32.6	107	136,000	25	8.2	27	85269
A	DL 191	* Shearer	NR	NR	NR	NR	NR	NR	12147
A	DL 191	* Butchers Point	6.1	20	NR	NR	NR	NR	12087
A	685 Lazo Road	Rob Buchan	7.3	24	82,000	15	NR	NR	63231
A	DL 191	* Maitland	5.5	18	NR	NR	NR	NR	12159
A	DL 191	* R.E. Kenny	3.7	12	NR	NR	NR	NR	12089
A	DL 191	* Weston	5.5	18	NR	NR	NR	NR	12048
A	DL 190	* G. Rasmussen	5.5	18	NR	NR	5.5	18	12449
E	684 Hutton Road	Art McKenzie	9.1	30	82,000	15	5.5	18	63233
G	DL 89	* J.J. Trisner	NR	NR	NR	NR	NR	NR	12560
G	DL 89 G	* J.J. Frisner	NR	NR	NR	NR	NR	NR	12404
H	522 Lazo Road	Bruce Inrig	12.5	41	109,000	20	4.6	15	53912
H	DL 89 G	* E. Ellik	6.1	20	NR	NR	6.1	20	12129
H	484 Lazo Road	* Michael Hendren	6.1	20	NR	NR	5.5	18	12130
I	Lot 2 of Plan 2545	Don Knight	34.1	112	27,000	5	12.8	42	23414
J	382 Lazo Road	* W.C. Cottingham	3.7	12	NR	NR	2.4	8	12122
J	382 Lazo Road	W. Cottingham	14.0	46	NR	NR	0.6	2	34573
J	*Not indicated*	* R.T. Smith	4.3	14	NR	NR	2.7	9	12406
K	Lot 1 of Plan 44452	Ken Bell	65.2	214	33,000	6	22.9	75	33815
L	Lot 1 of Plan 2175	Ireland	64.6	212	109,000	20	18.3	60	27176
L	Lot B of Plan 37066	Al Albrecht	69.8	229	82,000	15	34.4	113	53009
M	*Not indicated*	* B. Slienca	6.1	20	NR	NR	NR	NR	12407
N	1081 Kye Bay Road	Sommerville	63.1	207	82,000	15	44.2	145	49098
P	DL 93	* S. Silke	9.8	32	NR	NR	NR	NR	12082
P	*Not indicated*	* Cape Lazo Wireless	21.3	70	NR	NR	NR	NR	1897
P	DL 93	R. Stovall	49.7	163	136,000	25	19.8	65	26483

Notes
* Well was constructed before 1950 and may have since been abandoned.
(1) These areas (Area A through Area Q) refer to the areas shown on Figure 1 in Appendix 9.
(2) The Well Tag Number is the reference number used in BC Environment's WELL Database.
(3) Most or all of the well logs listed above indicate the Aquifer Type as *Sand.*

Abbreviations
SWL - Static Water Level
DL - District Lot
NR - Not Recorded in the WELL Database
USgpm - US gallons per minute, as reported on well log.

Appendix 2
Interviews with Homeowners

From interviews April 19 - 20, 2007.
References to resident's names and addresses have been removed to preserve resident's privacy.

Property Information								
Address	Area Group	Property number	Width of lot (m)	Length of lot (m)	Area (acres)	Area (sq.m.)	# of separate dwellings	Comments
Hutton Road	A	4			0.5	2,023	1	
Hutton Road	B	5	28	58	0.4	1,600	1	
Hutton Road	C	10	15	58	0.22	880	1	
Hutton Road	E	20	15	64	0.24	971	1	
Sand Pines Dr	F	23			0.7	2,711	1	
Lazo Road	G	26			5.0	20,000	1	
Lazo Road	H	32			5.0	20,000	1	
Lazo Road	I	34			2.3	9,105	2	
Lazo Road	J	37	55	170	2.5	10,000	1	
Lazo Road	J	38	45	200	2.5	10,000	1	
Knight	K	43	125		3.6	14,407	1	
Kye Bay Road	L	48			5.0	20,234	1	Eroding slope at back
Kye Bay Road	M	51			1.1	4,452	1	Newly renovated home
Kye Bay Road	N	55	37	128	1.3	5,059	1	
Kye Bay Road	O	57	60	150	2.3	9,105	1	
Simon Crescent	P	61			1.1	4,613	1	
Hillbank Road	Q	63	90	110	2.5	10,000	1	

Existing Sewage Systems (Details of system are for system 1)

Area	# of sewage systems	# of BR for system 1	# of BR for system 2	Treat-ment type	Septic pump	Length of drainfield (m)	L, W of drainfield area (m)	Company maintaining the sewage system	Is the system working	Foot notes
A	1	3		st	No	uk		Not sure	Yes	1
B	1	2		st	No	uk	18, 10	Not sure	Yes	2
C	1	3		st	No	uk	---	Able and Ready (2006), Roto Rooter (2000)	Yes	3
E	1	2		st	No	46	15, 4	None	Yes	4
F	1	2		st	No	uk	---	Not sure	Yes	
G	1	3		st	No	uk		None	Yes	5
H	3	3	2	st	No	uk		Self	Yes	6
I	2	5	1	st	Yes	30		Not sure	Yes	7
J	1	2		st	No	uk		Not sure	Yes	8
J	1	2		st	No	uk		Not sure	Yes	9
K	1	3		st	No	120	20, 12	Able + Ready	Yes	10
L	1	4		st	No	uk		Self	Yes	
M	1	3		stp	Yes	30		System installed by Mid Island Bobcat 6 mon ago	Yes	11
N	1	3		st	No	61	30, 3	Able + Ready	Mostly	12
O	1	4		st	No	98	25, 20	Able + Ready	Yes	13
P	1	4		st	No	76	30, 15	Not sure	Yes	14
Q	1	N/A				uk				15

General Notes on Sewage Systems

All residents said their drainfield used subsurface trenches, rather than a sand mound.

Abbreviations

BR - Bedrooms
L,W - Length, Width
st - septic tank
stp - sewage treatment plant
uk - unknown

Footnotes on Sewage Systems

1. Pumped last year
2. 18-years at this home. Septic tank pumped 5 years ago.
3. Small Pump Access. Tank pumped Aug 2006. Owner asked if a chlorinated water supply would damage the septic system. We explained that chlorinated water is common with septic systems and works fine; also explained there is no need to add yeast, or any other product, to the system.
4. New system in approx 1982. Septic field in front yard, near road. Well is in back yard near shore line (down slope of septic). Septic system on adjacent lot is approx 10 years old. Last pump out was about 10 years ago.
5. Summer home until mid 90's
6. The first two systems service the main house. Pumped out every 3 years. System # 1 has 2 septic tanks. System # 2 is a tank and drainfield.
7. System 1 is new, about 3 years old. System 2 is old and serves a cottage.
8. Last pumped 8 years ago.
9. Last pumped 8 years ago.
10. Pumped 2005. Large area available for drainfield installation (~ 1000 sq.m.).
11. Brand new system with aeration tanks
12. Two drainfield lines of 100 ft each. Well is 10 metres down slope of septic field. Pump out every year. Have had problems with root intrusion into septic field. System is 35 years old and may need to be replaced.
13. Pumped 2003. Well approx. 30 metres from septic field.
14. 750-gallon tank, pumped once every 3 years.
15. Drainfield is about 40 m (120 ft) from the well. No information requested on the sewage system as it is outside of the town boundary.

Water Wells

Area	# of wells	Well #1 depth (ft)	Well #1 yield (gpm)	Well #1 OK?	Well #2 depth (ft)	Well #2 OK?	Name of driller	Last water quality test	Company that maintains the well	Foot note
A	1	30		Yes			Dug well	Never	Self	
B	1	30		Yes			Dug	2003		1
C	1	25		Yes			Dug	uk		2
E	1	42	15	Yes			Anderson	1983	none	3
F	1	16		Yes			Unknown	Years		4
G	1	14		Yes			Dug well	2006	Self	
H	3	20		Yes	20		Dug	2005		5
I	2	12		Yes	20		Unknown	2007	Self	6
J	0									7
J	1	20		No			Unknown	Never		8
K	1	25		Yes			Unknown	2005	Pump House	9
L	1			Yes			Unknown	Years	None	10
M	2	25	1.5	Yes		No	Dug well	uk	Self	11
N	2	207	15	Yes	16		Anderson	2004	Ian McGill	12
O	1	202	20	Yes			Anderson	2001	Self	13
P	1	192	7	Yes			Anderson	Years	Self	
Q	1	65		Yes			Unknown	uk		14

Footnotes on Water Wells

1. Runs out of water, or water turns "salty" in drier months.
2. Root growth in well at one time. Coliform levels were high in 2003.
3. Good supply. Have an iron filter.
4. Excellent Water - Drinks 8 glasses a day and in good health.
5. Water levels vary with precipitation but has never gone dry. The second well is inactive. There is also a third well but it too is inactive.
6. Well 1 is connected to house. The well is located in a spring. Well 2 is for the garden.
7. Well is not on the subject property; it is near Hillbank Road (property Q-63), outside of the Study Area.
8. Water well is near Hillbank Road, property Q-63. Well 1 is used for irrigation only, due to high iron content.
9. Near shoreline. Good water quality. Good quantity. Tested 2 years ago. Only ran dry when over-watering.
10. Well is working; however, water is yellow and is not used for drinking. Well location is not known.
11. Had a second well drilled on property but water quality is not good. Dug well is down near beach.
12. Well 2 is partway down the slope to the ocean. No problems with well 1. Well 2 is abandoned.
13. Well TAG # 27176. Have water treatment: Carbon filter, reverse osmosis, drinking only. Water softener installed but not currently used.
14. Well supplies water to properties J-37 and J-38. M. Payne spoke with users about the water quality and advised drinking bottled water.

Appendix 3
Well Water Quality

Tests by North Island Laboratories, Courtenay

Summary of Well Water Quality

Area	Date sample collected	Time sample collected	Location	Electrical conductance (μS/cm)	Foot note	Fecal Coliform Bacteria	Nitrate Nitrogen (mg/L)
A	20/04/2007	10:33	Kitchen Sink	50		ND	0.77
B	19/04/2007	12:10	Kitchen Sink	230	1	ND	2.16
C	19/04/2007	13:30	Kitchen Sink	160		ND	2.72
E	20/04/2007	14:15	Outside Tap	40		ND	<0.01
F	19/04/2007	11:02	Kitchen Sink	10	2	ND	2.22
G	19/04/2007	10:20	Kitchen Sink	150		ND	0.03
H	19/04/2007	14:35	Kitchen Sink	400		ND	4.07
I	19/04/2007	15:34	Kitchen Sink	220		ND	0.82
J					3		
J	08/05/2007	12:15	Outside Tap	270	4	ND	1.00
K	20/04/2007	11:45	Kitchen Sink	330		ND	1.34
L	19/04/2007	17:20	Kitchen Sink	550	5	ND	0.01
M	20/04/2007	9:03	Kitchen Sink	370		ND	1.33
N	20/04/2007	10:40	At Well Head	300		ND	<0.01
O	20/04/2007	9:50	Kitchen Sink	370	6	ND	<0.01
P	20/04/2007	12:17	Outside Tap	350		ND	<0.01
Q	08/05/2007	12:15	Outside Tap	480	7	ND	10.7

Abbreviations
ND -- Not Detected

Footnotes on Well Water Quality

1. Water softener installed
2. Been here for 40 years. Would rather stay on her own well water.
3. See results for property Q-63. M. Payne spoke with the users of the well and advised that they drink bottled water.
4. M. Payne advised the owner to drink bottled water.
5. Water is yellow.
6. Sampled the non - treated water.
7. First sample: EC = 300 µS, FCB = ND, Nitrate = 10.6 mg/L.

The following six pages are full copies of the lab reports.

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

Certificate of Analysis

Report To:	Payne Engineering Gelology Ltd Michael Payne 1230 Maple Road North Saanich, B.C. V8L 5P7	Lab Number: Date Reported: Date Completed: Date Received:	58414 2 May 07 2 May 07 19 Apr 07 16:34

58414-01 26 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	0.03	mg/L	10 MAC

58414-02 23 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	2.22	mg/L	10 MAC

58414-03 5 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	2.16	mg/L	10 MAC

58414-04 10 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	2.72	mg/L	10 MAC

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted
Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to change.

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

58414-04 10 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines

58414-05 32 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	4.07	mg/L	10 MAC

58414-06 34 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 19 Apr 07 0:00

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	0.82	mg/L	10 MAC

58414-01

Test	Method	Analyst	Date
Fecal Coliforms (MF)	MF	NIL	20/04/2007
Fecal Coliforms (MF)	MF	NIL	19/04/2007
Nitrate (N)	TM6.1 APHA based method	NIL	01/05/2007
Nitrate (N)	TM6.1 APHA based method	NIL	24/04/2007

Approved By: ______________________

Sandra Felgenhauer, M.Sc. or
Catherine Black B.Sc. (co-owners)

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted
Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to change.

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

Certificate of Analysis

Report To:	Payne Engineering Gelology Ltd Michael Payne 1230 Maple Road North Saanich, B.C. V8L 5P7	Lab Number:	58437
		Date Reported:	2 May 07
		Date Completed:	2 May 07
		Date Received:	20 Apr 07 15:27

58437-01 51 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	1.33	mg/L	10 MAC

58437-02 4 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	0.77	mg/L	10 MAC

58437-03 61 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	<0.01	mg/L	10 MAC

58437-04 57 **Well Water**

Sampled By: Bob Chapman
Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	<0.01	mg/L	10 MAC

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted
Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to change.

02/05/2007 16:30

North Island Laboratories

• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

58437-04 57 **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines

58437-05 55 **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	<0.01	mg/L	10 MAC

58437-06 43 **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	1.34	mg/L	10 MAC

58437-07 20 **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	<0.01	mg/L	10 MAC

58437-08 38 **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	10.7	mg/L	10 MAC

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted
Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to change.

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

58437-09 **48** **Well Water**

Sampled By: Bob Chapman

Sampling Date: 20 Apr 07 9:15

Test	Result	Units	Drinking Water Guidelines
Fecal Coliforms (MF)	<1	CFU/100ml	
Nitrate (N)	0.01	mg/L	10 MAC

58437-01

Test	Method	Analyst	Date
Fecal Coliforms (MF)	MF	NIL	20/04/2007
Nitrate (N)	TM6.1 APHA based method	NIL	01/05/2007
Nitrate (N)	TM6.1 APHA based method	NIL	24/04/2007

Approved By: ________________

Sandra Felgenhauer, M.Sc. or
Catherine Black B.Sc. (co-owners)

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted
Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to change.

02/05/2007 16:30

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

Certificate of Analysis

Report To:	Payne Engineering Geology Ltd Michael Payne 1230 Maple Road North Saanich, B.C. V8L 5P7	Lab Number:	58770
		Date Reported:	25 May 07
		Date Completed:	25 May 07
		Date Received:	8 May 07 13:00

Sampled By: S. Felgenhauer
Sampling Date: 8 May 07 12:15

Test		Result	Units	Detection Limit
58770-01	**J-38 Well #1**	**65' Well**		
Conductivity		475	uS	1 uS
Fecal Coliforms (MF)		<1	CFU/100ml	1 CFU/100ml
Nitrate (N)		10.60	mg/L	0.01 mg/L
58770-02	**J-38 Well #2**	**20' Well**		
Conductivity		266	uS	1 uS
Fecal Coliforms (MF)		<1	CFU/100ml	1 CFU/100ml
Nitrate (N)		1.00	mg/L	0.01 mg/L

58770-01

Test	Method	Analyst	Date
Conductivity	Conductance meter	NIL	11/05/2007
Conductivity	Conductance meter	NIL	09/05/2007
Fecal Coliforms (MF)	MF- APHA 9222 based	NIL	08/05/2007
Nitrate (N)	TM6.1 APHA based method	NIL	23/05/2007

Approved By: ____________________

Sandra Felgenhauer, M.Sc. or
Catherine Black, B.Sc. (co-owners)

Appendix 4
Summary of 2007 Auger Holes

General Information

Location:	Cape Lazo area, Town of Comox
Date:	18 - 19 April 2007.
Method:	Hand auger, 7 cm diameter.
Weather:	Sunny with cloudy periods, showers on 19 April.
Logged by:	M.I. Payne
Locations:	See Figure 2 in Appendix 9.
Standpipes:	Open-bottom, slotted, 25-mm diameter PVC pipe, installed in AH-2, AH-3, and AH-4.

Summary of Auger Holes

	Soil type at depth 60 cm (1)		Land	Flow restrictive layer		Depth of soil	Root	Measured water table	Seasonal high water	AH
AH	Soil description: texture	Coarse gravel	slope (2)	*depth in cm*	*type*	mottling *cm*	depth *cm*	depth (3) *cm*	table (4) *cm*	depth *cm*
1	Sandy loam, very gravelly	2%	1%	70	SiCL *	70	25	24	20	90
2	Sand to loamy sand, very gravelly	1%	4%	> 90		> 90	90	82	70	90
3	Sand, very gravelly	2%	3%	> 100		> 100	75	87	75	100
4	Sandy loam, gravelly	5%	2%	> 70		> 70	> 70	> 70	100	70
5	Sand	< 1%	1%	> 110		> 110	75	> 110	230	110
6	Sand	< 1%	1%	> 115		> 115	75	> 115	400	115
7	Sand	< 1%	1%	> 115		> 115	90	> 115	500	115
8	Sand	< 1%	1%	> 110		70	70	> 110	500	110
9	Sand	< 1%	1%	> 110		> 110	> 110	> 110	500	110
10	Sand (fill)	< 1%	1%	> 110		> 110	> 110	> 110	500	110

* SiCL - Silty Clay Loam

Footnotes

(1) Soil classification is based on the US Department of Agriculture ***Field Book for Describing and Sampling Soils, Version 2.0*** (Schoeneberger, 2002).
(2) Slope measured with Suunto PM-5/360 PC hand-held inclinometer, +/- 2%.
(3) Water table measured on 19 April 2007.
(4) Seasonal High Water Table (SHWT) is defined as the highest water table that is sustained for more than two consecutive weeks (based on USDA definition). The SHWT is estimated from the soil profile, from the measured depth of water table in standpipes (PEG, 2007; Levelton, 2002), and from the reported depth of water table in dug wells.

Auger Hole Logs

AH-1

Location: Near # 298 Simon Crescent. UTM, Zone 10, East 365,660 m, North 5,507,270 m,+/- 10 m.

Depth *cm*	Colour *(2)*	USDA texture *(1)*	coarse gravel *(3)*	Structure type, grade	Consist-ence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 45	Dark brown (10YR3/3)	Sandy loam, very gravelly (ts)	2%	sg - gr 0-3	VFR	25	common fine			moist - saturated
45 - 70	Dark yellow brown (10YR4/4)	Loamy sand, gravelly	2%	sg - sbk 0-2	FR		No roots			saturated
70 - 90	Light yellow brown (2.5Y6/4)	Silty clay loam		NA	VFI		No roots	70 -	many prominent	moist - wet
90	BOTTOM							90	seepage below 25 cm	

AH-2

Location: Near 1151 Kye Bay Road. UTM, Zone 10, East 365,600 m, North 5,506,965 m,+/- 10 m.

Depth *cm*	Colour	USDA texture	coarse gravel	Structure type, grade	Consist-ence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 30	Dark yellow brown (10YR3/4)	Loamy sand, gravelly (ts)	1%	sg - gr 0-3	VFR		common fine			moist
30 - 75	Dark yellow brown (10YR3/6)	Loamy sand to sand, gravelly to very gravelly	1%	sg 0	L		few fine			moist
75 - 90	Dark yellow brown (10YR4/4)	sand, very gravelly	5%	sg 0	L	90	few fine		No mottles	wet - saturated
90	BOTTOM								seepage below 80 cm	

AH-3

Location: NW corner of 1093 Kye Bay Road. UTM, Zone 10, East 365,615 m, North 5,506,805 m,+/- 15 m.

Depth *cm*	Colour	USDA texture	coarse gravel	Structure type, grade	Consist-ence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 55	Dark olive brown (2.5Y3/3)	Loamy sand, gravelly (ts)	1%	sg - sbk 0-2	VFR		many fine			dry - moist
55 - 110	Brownish yellow (10YR4/6)	Sand, very gravelly, medium - coarse grained	2%	sg 0	L	75	few fine		No mottles	wet - saturated
100	BOTTOM								seepage below 85 cm	

AH-4

Location: Near border of 993 and 975 Kye Bay Rd. UTM, Zone 10, East 365,500 m, North 5,506,470 m,+/- 20 m.

Depth *cm*	Colour	USDA texture	coarse gravel	Structure type, grade	Consist-ence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 40	Black (10YR2/1)	Sandy loam, gravelly (ts)	1%	sg - abk 0-3	FR		common medium			moist
40 - 65	Black (10YR2/1)	Loamy sand, gravelly, organic	5%	sg - abk 0-3	FR		few fine			moist
65 - 70	Dark brown (10YR3/3)	Loamy sand, very gravelly	5%	sg 0	FR	70 +	few fine		No mottles	moist-wet
70	BOTTOM	Auger refusal in stony soil								

AH-5

Location: Southwind Drive, 25 m from mail boxes. UTM, Zone 10, East 365,160 m, North 5,506,130 m,+/- 10 m.

Depth cm	Colour	USDA texture	coarse gravel	Structure type	Structure grade	Consistence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 25	Dark yellow brown (10 YR3/4)	Sand, fine - med (ts)	< 1%	sg	0	L		many fine			dry-moist
25 - 75	Yellow brown (10YR5/6)	Sand, med	< 1%	sg	0	L	75	few fine			dry- moist
75 - 110	Light yellow brown (2.5Y6/3)	Sand, med	< 1%	sg	0	L		No roots		No mottles	moist
110	BOTTOM										

AH-6

Location: SW corner of 622 Sand Pines Drive. UTM, Zone 10, East 364,545 m, North 5,505,750 m,+/- 30 m.

Depth cm	Colour	USDA texture	coarse gravel	Structure type	Structure grade	Consistence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 15	Dark yellow brown (10YR4/4)	Loamy sand (ts)	2%	sg	0	L		many fine			dry-moist
15 - 115	Pale yellow (2.5Y7/3)	Sand	< 1%	sg	0	L	75	few fine		No mottles	dry-moist
115	BOTTOM										

AH-7

Location: Brown Road right-of-way. UTM, Zone 10, East 364,600 m, North 5,505,560 m,+/- 10 m.

Depth cm	Colour	USDA texture	coarse gravel	Structure type	Structure grade	Consistence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 30	Very dark grey (10YR3/1)	Loamy sand (ts)	< 1%	sg - sbk	0-2	S		many fine			dry
30 - 90	Dark yellow brown (10YR4/6)	Sand, fine - med	< 1%	sg	0	L	90	few fine			dry
90 - 115	Light olive brown (2.5Y5/4)	Sand, fine - med	< 1%	sg	0	L		no roots		No mottles	dry
115	BOTTOM										

AH-8

Location: Hutton Road, near 655 and 675 Hutton. UTM, Zone 10, East 364,530 m, North 5,505,525 m,+/- 10 m.

Depth cm	Colour	USDA texture	coarse gravel	Structure type	Structure grade	Consistence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 15	Light yellow brown (2.5 Y 6/4)	Loamy sand (ts)	< 1%	sg	0	L		many fine			dry
15 - 40	V. dark grey brown (2.5Y3/2)	Loamy sand, organic	< 1%	sg - sbk	0-3	S		common fine			dry
40 - 70	Olive brown (2.5Y4/4)	Sand, medium	< 1%	sg	0	L	70	few fine			dry
70 - 110	Light olive brown (2.5Y5/6)	Sand, medium	< 1%	sg	0	L		no roots	70 -	few faint	moist
110	BOTTOM								110		no seepage

AH-9

Location: Near 685 Lazo Rd and 650 Hutton Rd. UTM, Zone 10, East 364,500 m, North 5,505,465 m,+/- 10 m.

Depth cm	Colour	USDA texture	coarse gravel	Structure type	Structure grade	Consistence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 15	Dark grey brown (2.5Y4/2)	Sand (ts)	< 1%	sg	0	L - S		many fine			dry
15 - 50	Olive brown (2.5Y4/3)	Sand, med - coarse	< 1%	sg	0	L - S		few fine			dry
50 - 110	Light olive brown (2.5Y5/3)	Sand, med - coarse	< 1%	sg	0	L - S	110 +	few coarse		No mottles	dry
110	BOTTOM										

AH-10

Location: Near 616 - 622 Hutton Road. UTM, Zone 10, East 364,460 m, North 5,505,390 m,+/- 10 m.

Depth *cm*	Colour	USDA texture	coarse gravel	Structure type, grade		Consist-ence	Roots depth	Roots quant, size	Mottles depth	Mottles quant, contrast	Moisture
0 - 5	Olive brown (2.5Y4/3)	Sand, gravelly (topsoil)	2%	sg	0	L		many fine			dry
5 - 50	Olive brown (2.5Y4/4)	Sand, gravelly (fill)	2%	sg	0	L		few medium			dry
50 - 75	Light olive brown (2.5Y5/3)	Sand (fill*), med - coarse	< 1%	sg	0	L - S		few fine			dry
75 - 110	Very dark grey brown (2.5Y3/2)	Sandy loam to loamy sand (buried topsoil)	2%	sg - abk	0-3	VFR	110 +	few fine		No mottles	moist
110	BOTTOM	* tennis ball excavated from depth 70 cm.									

Footnotes

1. Soil classification is based on the US Department of Agriculture ***Field Book for Describing and Sampling Soils*** (Schoeneberger, 1998).
2. Codes shown in brackets refer to ***Munsell Soil Colour Charts*** (2000).
3. Coarse gravel (%) is defined as portion of soil consisting of particles larger than 19 mm (3/4 inch).

Abbreviations used on test pit logs

Structure

- sg - single grain
- m - massive
- gr - granular
- abk - angular blocky
- sbk - subangular blocky
- pl - platy
- pr - prismatic
- cpr - columnar

Grade

- 0 - structure-less
- 1 - weak
- 2 - moderate
- 3 - strong

USDA Consistence

- L - loose
- VFR - very friable
- FR - friable
- FI - firm
- VFI - very firm
- EF - extremely firm
- SR - slightly rigid
- R - rigid
- VR - very rigid

- S - soft
- SH - slightly hard
- MH - moderately hard
- HA - hard
- VH - very hard
- EH - extremely hard
- R - rigid
- VR - very rigid

Texture notes

- (ts) - topsoil

Appendix 5
Summary of 2002 Test Pits and Boreholes

from Levelton Engineering report (Miller, July 2002)
includes only test pits and boreholes within the Cape Lazo Study Area

Summary of Test Pits and Boreholes

				Flow restrictive layer		Measured water table depth (3)	Seasonal high water table (4)	Total depth
#	Area (2)	Elev *metres*	Soil type at depth 60 cm (1)	*depth in cm*	*type*	*cm*	*cm*	*cm*
TP-2	A	7.5	Sand	> 250		> 250	500	270
TP-3	A	7.1	Sand	> 250		> 250	500	250
BH-15	F	5.9	Sand	> 300		> 300	450	300
TP-4	H	5.9	Loamy sand	> 250		> 250	400	250
BH-14	I	5.9	Sand	> 300		> 300	270	300
TP-5	I - J	3.8	Sandy loam	> 300		230	230	300
BH-12	J - K	6.2	Loamy sand	> 300		> 300	400	300
TP-11	M	28.7	Sand, very gravelly (fill)	~ 150	Dense sand	150	120	240
BH-10	P	31.5	Loamy sand, gravelly	60	Dense loamy sand	104	60	300

Footnotes
(1) Soil classification is based on the US Department of Agriculture ***Field Book for Describing and Sampling Soils, Version 2.0*** (Schoeneberger, 2002).
(2) Refer to Figure 2, Appendix 9, for locations of test pits and boreholes.
(3) Water table measured slotted PVC standpipes on 16 April 2002.
(4) Seasonal High Water Table (SHWT) is defined as the highest water table that is sustained for more than two consecutive weeks. The SHWT is estimated from the soil profile, and from measured depth of the water table in standpipes and dug wells.

Appendix 6
Permeameter Tests

Client: *Town of Comox*		File: *TOC-1*
Location: *Cape Lazo Study Area*		Date: *19 April 2007*
Height of air hole (H): *20 cm*	Permeameter: *ID = 5.18 cm and ID = 10.23 (for AH-15, 17, 18)*	Tester: *M.I. Payne*

Auger Hole #		11	12	13	14	15	16	17	18
Area		O - P	N - O	L	I - J	G	E	A, D	A, C
Approx location		1151 Kye Bay Rd	1093 Kye Bay Rd	975 Kye Bay Rd	406 Lazo Rd	622 Sand Pines Dr	680 Hutton Rd	655 Hutton Rd	650 Hutton Rd
Near auger hole		AH-2	AH-3	AH-4	AH-5	AH-6	AH-7	AH-8	AH-9
AH depth	*cm*	37	38	40	60	62	61	58	61
AH diameter	*cm*	7	7	7	7	7	7	7	7
AH radius (a)	*cm*	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Soil texture		LS - S, G	LS, G	SL - LS	S	S	S	S	S
Soil structure		sg 0	sg0 - sbk2	sg0 - abk3	sg 0	sg 0	sg 0	sg 0	sg 0
Rate of fall	*mm/min*	25	21	15	16	76	250	42	135
K(fs)	*cm/day*	49	31	22	31	559	485	309	992
K(fs)	*mm/day*	490	310	220	310	5,590	4,850	3,090	9,920
K(sat)	*mm/day*	980	620	440	620	11,180	9,700	6,180	19,840
K(sat)	*m/day*	1.0	0.6	0.4	0.6	11.2	9.7	6.2	19.8

Permeameter construction, test method, and calculations based on Mooers and Waller (1993)
K(fs) is the field-saturated hydraulic conductivity of the soil at the depth tested.

Interpretation: Conceptual Design Values for K(fs)

Lowland Area: 480 cm/day

Upland Area: 30 cm/day

Based on median measured K(fs) of 485 cm/day and 31 cm/day, respectively.

Appendix 7
Soil Texture Analysis

Tests by Cantest, Winnipeg

AH	Depth *cm*	Gravel % *> 2.0 mm*	For % passing 2.0 mm sieve			Texture classification
			Sand	*Silt*	*Clay*	*USDA*
AH-1	20	43.0%	70%	21%	9%	Sandy loam, very gravelly
AH-2	50	40.4%	87%	10%	3%	Sand to sandy loam, very gravelly
AH-4	30	15.9%	75%	16%	9%	Sandy loam, gravelly
AH-5	50	0.0%	98%	1.4%	0.9%	Sand, medium grained
AH-7	50	0.1%	99%	0.8%	0.7%	Sand, fine to medium
AH-8	50	0.4%	97%	1.4%	1.2%	Sand, medium to coarse
AH-10	60	0.6%	99%	0.5%	0.6%	Sand, medium to coarse

Appendix 8
Subdivision Standards

from Vancouver Island Health Authority, 2003.

This is not the complete document; this excerpt includes pages 1 to 17 of 24.

Subdivision Standards

VANCOUVER ISLAND
health
authority

Revised June 26, 2003

Table of Contents

A Introduction 3

B Explanation of Terms 4-6

C Assessment Requirements 7-8
a) C.1 Sample Application Plot Plan 9

D Site and Design Requirements 10

D.1 Table A Minimum Lot Size and Covenant Area
for Properties on Approved Waterworks Systems 11
D.2 Table B Minimum Lot Size and Covenant Area
For Properties Serviced By Private (Individual Well) Water Supplies 12

E Hydogeological Requirements 13

F Waterworks System Approval 14

G Private Water Supplies - Wells 15

H Community Sewage Systems – Health Act 15-16

H.1 Table "C" Septic Tank Effluent 16

H.2 Table "D" Package Treatment Plant Effluent 17

Appendix A. Application For Subdivision Form 18

Appendix B. Site Assessment Form 19

Appendix C. Sample Restrictive Covenant 20-24

A. Introduction

In July 2002, the Vancouver Island Health Authority (VIHA) and the Vancouver Coastal Health Authority (VCHA) (The Authorities) reviewed the previous standards for subdivision of lots serviced by onsite sewage systems.

These standards are applicable to proposed subdivisions referred to the health authority from the Ministry of Transportation Approving Officer. Approving Officers of individual municipalities in consultation with the health authority may adopt a different standard or establish exemptions to this standard based on existing factors within the municipality which provide assurances for future sewer services or ongoing maintenance of systems through operation and maintenance bylaws.

It is the purpose of these standards to ensure that new lots created within the boundaries of the Authorities (not on an existing sewer system) will support a primary and reserve sewage system. The intent is to provide a viable long-term solution for onsite wastewater, thereby eliminating the need for costly extension of sewer systems.

These standards were designed to address concerns of detrimental cumulative impact associated with increased density using onsite systems. The intent is to prolong the expected life of sewage systems and safeguard the environment and public health.

These policies are considered to be a minimum standard for Vancouver Coastal Health Authority and the Vancouver Island Health Authority. However, local government, Islands Trust, or other agencies may have additional requirements.

These standards are a public reference for guidance and information in the subdivision process and will undergo periodic review and update. Please contact the local Health Officer in your area if you have comments or questions.

B. Explanation of Terms

1. Absorption Field Area (AFA)

The area required on each proposed lot to accommodate an absorption field (drainfield) for an estimated daily sewage flow of at least 1365 litres (300 gallons) per day (3 bedroom home). The AFA must include a Primary AFA and a 100% Reserve AFA. If necessary, a 15 metre (50 foot) buffer area to a breakout point must be included.

2. Breakout Point

A location that is downslope of an AFA, where effluent may surface onto the land or into a roadside ditch, embankment, curtain drain, interceptor drain, or relief drain.

3. Cumulative Effect

The combined environmental impact that can occur over time from a series of similar or related actions, contaminates, or projects. Although each action may seem to have a negligible impact, the combined effect can be detrimental.

Increasing density increases the risk for sewage effluent to surface, migrate to neighbouring properties, or contaminate ground water. Hydrogeological assessment requirements are included in this standard to address cumulative risks associated with sloping properties, lands with rapidly draining soils or ground water.

4. Dimension of Covenant Area (Absorption Field Area)

Absorption field trenches are installed across the slope to provide maximum area of absorption. Increasing the trench length (dimension across slope) reduces the number of overall trenches required and reduces the potential of downslope breakout.

5. Ground Water Table Assessment

All subdivision proposals must address the seasonal or permanent ground water table. A hydrogeological assessment may be required when the drainage of surface water, permeability of the soil, density of the development or any other condition indicates further study is necessary. Assessments must also provide data concerning the impact of the proposed development on the quality of the ground water.

6. High Water Mark

A point on the shoreline, which corresponds

a). For a controlled lake, to the highest water level within the normal operating range.

b). For any other body of tidal or non-tidal water, to the average highest water level calculated from measurements taken over a sufficient number of years to enable a reasonable estimate.

7. Minimum Natural Mineral Soil Depth

That portion of the native soil profile which ***DOES NOT*** include: forest litter, humus, prolonged saturated zones, highest seasonal water table, pans, crusts, alternating material stratification, cemented layers, bedrock, large cobbles, boulders, shale, fill material, reworked soil, and disturbed native soil. Soil depth requirements are shown in **Table A and B**.

8. Overall Lot Slope

The natural slope of a proposed lot measured from the highest to lowest elevation and recorded in percentage. Areas of excessive slope may be excluded from this calculation provided that these areas are not included when determining the minimum lot size requirements.

A B.C. Land Surveyor or Professional Engineer may have to verify this slope or provide topographical maps.

10. Restrictive Covenant Area

The area set aside on the lot to accommodate a primary absorption field, reserve absorption field, and downslope setback area (if necessary). The size of the area is determined by slope, native mineral soil depth, percolation rate, and downslope breakout potential. The restrictive covenant is registered against the land title to protect the site from uses other than the onsite system. Please refer to **Appendix C**.

11. Waterworks System

A system of water supply, approved pursuant to the requirements of the Drinking Water Protection Act and Subdivision Regulation (Local Services Act) and applicable local government servicing by-laws. A water system includes its source, treatment, storage, transmission and distribution facilities, but does not include a water supply servicing only one single family residence. The system must be owned, operated and maintained by a regional district, a strata corporation or an improvement district under the Water Act or the Municipal Act.

12. Wet Season Assessment

Some Subdivision proposals may be held in abeyance pending wet season assessment. This will enable a thorough evaluation of drainage, water table and porosity of soils. The coastal wet season is generally from November 1st to March 31st.

Some geographical areas may require special consideration, (i.e. varying annual rainfall may require assessments in different months).

C. Assessment Requirements

1. **Soil Testing**

a) To demonstrate consistency of soil conditions and depth within each primary and reserve absorption field area, provide:
   - A **minimum** of two – four-foot observation holes per area
   - A **minimum** of one percolation test hole in the centre of each area.

b) To demonstrate conditions and depth of soil on sloping lots, which have a potential breakout area, provide:
   - A **minimum** of two - four foot observation holes at least 15 metres (50 feet) apart, in addition to the test holes noted in 1 a).

c) If zoning permits more than one dwelling per lot, additional observation holes may be required.

d) Observation holes must be at least .6 metres (2 feet) in width and should be protected to prevent injury.

2. **Flagging**

Flag the location of all observation holes, percolation holes, the corners of each absorption field area, and the corners of each proposed lot. All flags must be numbered and accurately correspond to the subdivision plan.

3. **Subdivision Plan** **(A Sample Plot Plan is Shown on Page 9**

The proposed subdivision plan must include:

a) The location of all observation holes and percolation test holes with numbering or coding corresponding accurately to the onsite flagging.
b) All proposed lot boundaries and lot areas drawn to scale.
c) The slope within the absorption field areas (measured in %).
d) Scale plan showing dimension of absorption field areas.
e) Location and area of all surface water, wet areas, marshland, existing and proposed ditches and drainage work.
f) Location of all existing and proposed well sites, including wells on neighbouring properties.
g) Location of all existing buildings and roadways.
h) Location of easements or covenants and note their purpose.
i) Location of all exposed bedrock within 15 metres (50 feet) of a proposed AFA.
j) North arrow.

4. Topographical Maps and Slope Confirmation

Topographical mapping and/or confirmation from a B.C. Land Surveyor or Professional Engineer of overall lot slope and/or slope within absorption field areas may be required if:

- Overall slope exceeds 15%.
- The property is covered with dense vegetation.
- Requested by an Environmental Health Officer or Approving Officer.

5. Application Submission and Fee Payment

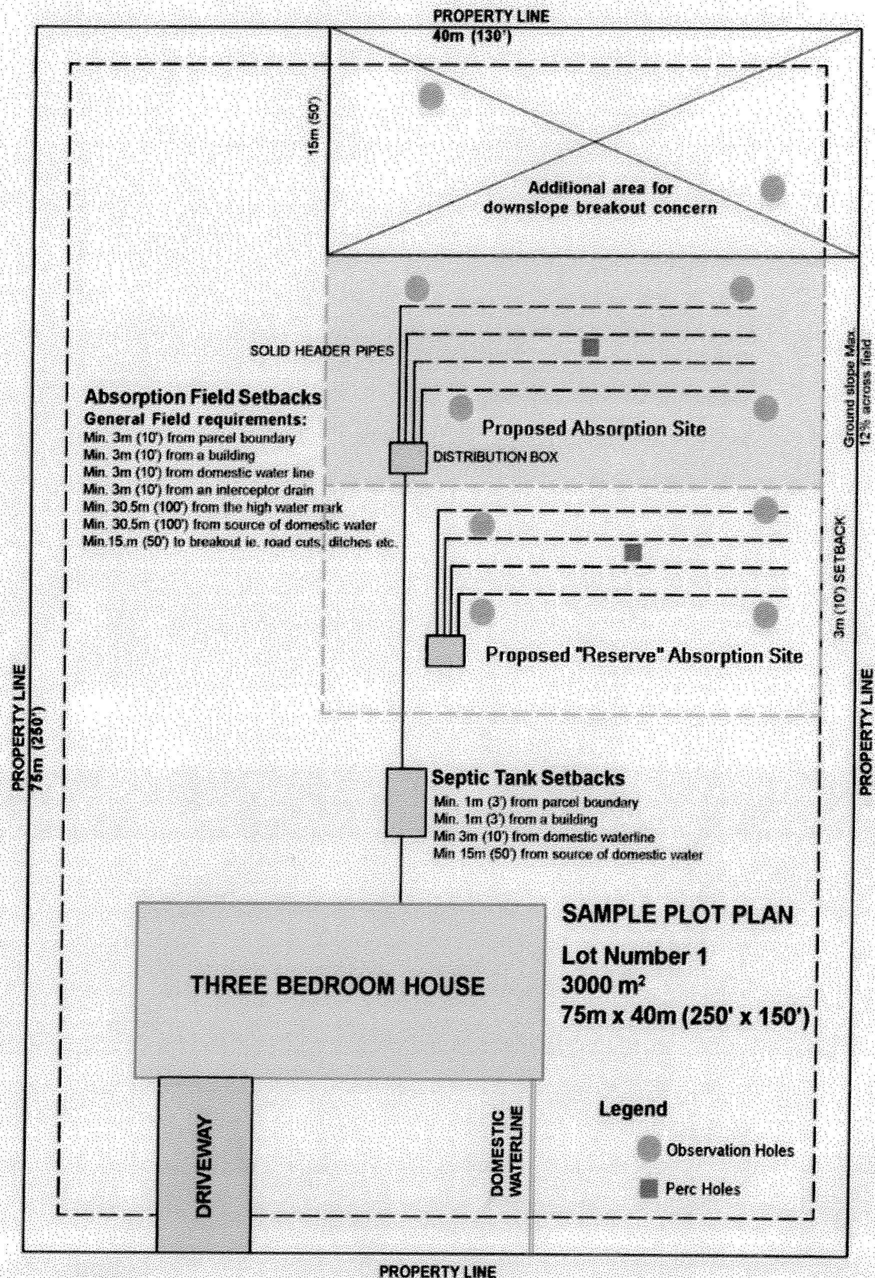
Forward the completed application to the Approving Officer; include the plan, application for subdivision, site assessment form, application assessment form, topographical maps and slope confirmation, and all other relevant data.

The referral will then be sent to the Vancouver Island Health Authority for review.

A fee of $250 plus $100 per lot must be submitted at the time of application. The application will not be considered without confirmation of payment.

The application and assessment forms are provided in **Appendix A** and **Appendix B**. Contact your local Environmental Health office for additional copies.

SAMPLE APPLICATION PLOT PLAN



SUBDIVISION ASSESSMENT STANDARDS

D. Site and Design Requirements

The following minimum site and design requirements apply to each proposed lot in a subdivision application:

1. Each proposed lot must meet the requirements in **Table A**, for properties serviced by an approved waterworks system or **Table B,** for properties serviced by individual wells

2. The percolation rate of the soil in the proposed restrictive covenant area must not exceed 30 minutes per 2.5 cm. (inch).

3. The restrictive covenant area must be set back at least 15 metres (50 feet) from an existing or potential breakout point.

4. Proposed restrictive covenant areas shall be at least 30.5 metres (100 feet) from the natural boundary of tidal and non-tidal water. The elevation of the AFA shall be 1 metre (3 feet) above the 20-year flood level.

5. The minimum dimension of a restrictive covenant area across the slope is 25 metres (80 feet).

6. The natural slope of the proposed restrictive covenant area shall not exceed 30%.

7. For existing houses in a proposed subdivision:

   - Proposed lots with existing dwellings shall have an approved sewage disposal system and/or one that meets acceptable standards, and a reserve area in accordance with this standard. If, during the assessment the existing system is determined to be unacceptable, upgrading may be necessary. Covenants for both primary and reserve field areas shall be provided.
   - If the existing sewage disposal drainfield is less than 30.5 metres (100 feet) from a body of non-tidal water or source of drinking water, the well or field will have to be relocated.

8. A wet season assessment may be required during the winter months, typically from November to March.

9. Some latitude may be given to the minimum soil depth in the table to the corresponding minimum lot size, if a proposed parcel has uniform and continuous soil coverage throughout the entire parcel, overall lot slope of 15% or less, and no apparent breakout points, seepage areas, or other risks, or limiting factors. The absolute minimum parcel size shall be .2 hectares (½ acre). The soil depths indicated in Table A, Column 3 may be considered for this section.

10. Proposals with minimum native mineral soil depths and overall lot slopes exceeding 15% may require a restrictive covenant recommendation to the Approving Officer limiting development on the property to one dwelling.

Table "A"

D.1 Minimum Lot Size and Covenant Area for Properties On Approved Waterworks System

Slope Within Covenant Area (%)	Minimum Native Mineral Soil Depth m.(in.)	Min. Native Mineral Soil Depth m. (in.) Overall lot slope 15% or less *See #9 above	Minimum Lot Size	Minimum Covenant Area Based On Percolation Rate and Absorption Field Length 1365 litres (300 gal.) Estimated daily flow		
				Sands-Gravels 5 Min/2.5 cm 5 Min/inch	Loams 6-15 Min/2.5 cm Min/inch	Silts 16-30 Min/2.5 cm Min/inch
Up to 15%	1.2 m. 48"	.9 m. 36"	.2 ha ½ acre	535 m^2 5760 ft^2	715 m^2 7700 ft^2	890 m^2 9580 ft^2
	.9 m. 36"	.76 m. 30"	.3 ha ¾ acre			
	.76 m. 30"	.61 m. 24"	.5 ha 1 acre			
	.61 m. 24"	.46 m. 18"	1 ha 2.5 acres			
	.46 m. 18"	.46 m. 18"	2 ha 5 acres			
15 to 30%	1.2 m. 48"	1.2 m. 48"	.5ha 1 acre[2]			
	.9 m. 36"	.9 m. 36"	.5 ha 1.25 acres			

Table "B"

D. 2 Minimum Lot Size and Covenant Area for Properties Serviced by Private (Individual well) Water Supplies

<table>
<tr><th rowspan="2">Slope Within Covenant Area (%)</th><th rowspan="2">Minimum Native Mineral Soil Depth m. (in.)</th><th rowspan="2">Minimum Lot Size</th><th colspan="3">Minimum Covenant Area Based On Percolation Rate and Absorption field length 1365 litres (300 gal.) Estimated daily flow</th></tr>
<tr><th>Sands-Gravels 5 Min/2.5 cm 1 – 5 Min/Inch</th><th>Loams Min/2.5 cm. 6 – 15 Min/Inch</th><th>Silts Min/2.5 cm. 16 – 30 Min/Inch</th></tr>
<tr><td rowspan="3">Up to 15%</td><td>.9 m.
36″</td><td>1 ha
2.5 acres</td><td rowspan="5">535 m^2
5760 ft^2</td><td rowspan="5">715 m^2
7700 ft^2</td><td rowspan="5">890 m^2
9580 ft^2</td></tr>
<tr><td>.61 m.
24″</td><td>1.5 ha
3.75 acres</td></tr>
<tr><td>.46 m.
18″</td><td>2 ha
5 acres</td></tr>
<tr><td rowspan="2">15 to 30%</td><td>1.2 m.
48″</td><td>1 ha
2.5 acre</td></tr>
<tr><td>.9 m.
36″</td><td>2.0 ha
5 acres</td></tr>
</table>

E. Hydrogeological Requirements

Hydrogeological assessments may be required under the following conditions or circumstances:

1. Potential for ground water contamination.
   - Rapidly draining soils and location/status of aquifer.
   - Area not serviced by an approved waterworks system.

2. Concern for cumulative effects on sloping and/or neighbouring properties and the related potential for ground water or surface water contamination.

3. Historical or existing concerns in the area of the proposed subdivision, i.e. malfunctioning sewage disposal systems, drainage problems, contaminated ground water table or aquifers.

4. Increased density, i.e. developments greater than 10 parcels, phased developments exceeding a total of 10 parcels, or average parcel density of less than 1.0 ha. (2.5 acres).

5. Assessment of community sewage disposal systems – Section H.

A hydrogeological assessment must be completed by a qualified hydrogeologist or hydrogeological engineer, registered as a Geoscientist or Professional Engineer in British Columbia.

F. Waterworks System Approval (Including Main Extensions)

All community water systems must comply with the Drinking Water Protection Act and Regulations.

Alterations or extensions to an existing water system servicing a proposed subdivision will require a construction permit prior to commencing work. Refer to the Guidelines for Approval of Waterworks for further details.

A waterworks system must be owned, operated, and maintained by:

- An Improvement District regulated under the Water Act or the Local Government Act, or
- A Local Government, or
- A Strata Corporation regulated under the Water Utility Act.

Subdivision proposals that do not meet this requirement will require individual private water supplies for each parcel.

Before the installation of any waterworks the Regional Public Health Engineer must issue a construction permit. Plans for consideration of construction permits must be forwarded to:

Regional Public Health Engineer	Phone:	250-755-6299
Vancouver Island Health Authority	Fax:	250-755-3372
1665 Grant Avenue		
Nanaimo BC V9S 5K7		

The Medical Health Officer, Drinking Water Officer, or designate must approve the water quality of waterworks systems. Parameters and requirements for water testing are available at your local Environmental Health office.

A valid operating permit must be obtained prior to putting a waterworks system into use.

G. Private Water Supplies – Wells

The Drinking Water Protection Act does not apply to a domestic water system that serves only one single family residence.

Local governments may have subdivision or servicing bylaws that address water quality and/or quantity for individual dwellings at the time of subdivision.

Health Authority staff may comment on high levels of chemical parameters with potentially adverse health effects.

Surface water sources do not provide water of reliable quality. Water from surface sources, including springs and shallow wells, may require additional treatment including disinfection.

H. Community Sewage Systems – Health Act

1. A community sewage system is defined as a sewage system servicing more than one lot, or more than one dwelling in a strata plan. The maximum daily sewage flow under the jurisdiction of VIHA is less than $22.7m^3$/day or 5000 imperial gallons/day. Proposed community systems with flows exceeding this rate will be referred to Ministry of Water, Land and Air Protection.
2. These community systems must comply with the Provincial Sewage Regulation (Health Act) and the following conditions:

    a) A primary and reserve absorption field area must be demonstrated with a minimum native mineral soil depths as specified in **Tables C and D**.

    b) A hydrogeological assessment may be required for all community sewage systems. A professional geoscientist, licensed to practice in British Columbia, must complete this assessment. The following are minimum concerns the hydrogeologist must address:

    - Ability of site to treat and dispose of effluent.
    - Protection of groundwater aquifers i.e. Ministry of Water, Land and Air Protection standards for well separation as specified in the Municipal Sewage Regulation.
    - The groundwater mounding effect.
    - The cumulative impact the sewage system will have on neighbouring properties and the receiving environment.

c) A restrictive covenant may be required for the primary and reserve absorption field areas. This covenant area must extend at least 3 metres (10 feet) from all portions of the designed absorption area including from the toe of the slope of designed raised absorption systems. Additional covenant area is also required if the hydrogeological report specifies further setbacks due to the groundwater mound effect, breakout, or impact to the receiving environment.

d) A Professional Engineer must design the system and provide working drawings. The design engineer shall supervise the installation of the approved system and provide a sealed certificate of the installed works.

e) All community systems must be owned and operated by a Regional District, Municipality, or a Strata Corporation (Local government may have additional requirements).

Community Sewage System Standards

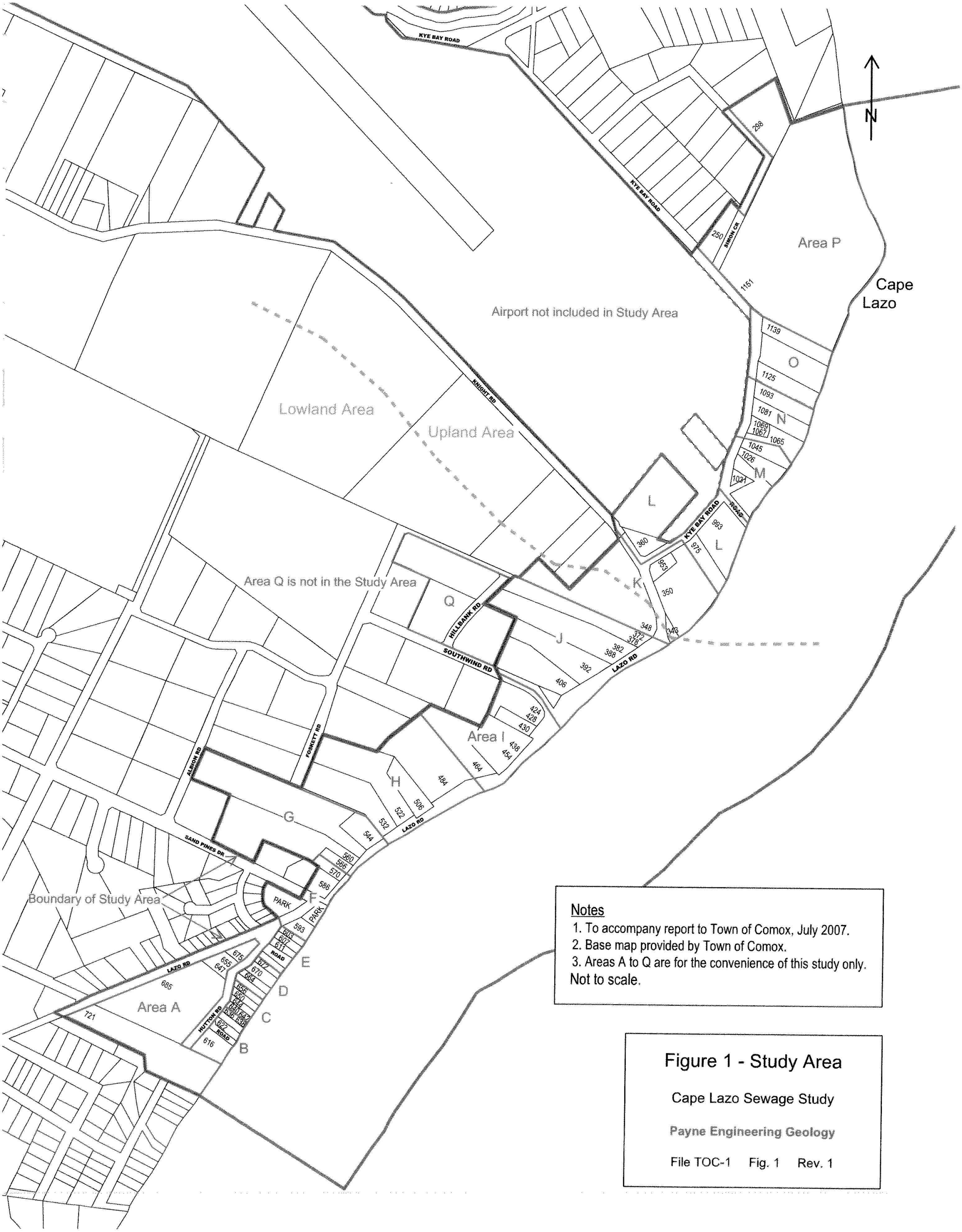
H.1 Table "C" – Septic Tank Effluent

<table>
<tr><th colspan="5">Septic Tank Treatment
Servicing Community Sewage System</th></tr>
<tr><th colspan="5">Minimum natural porous soil depths and absorption field length requirements for every 4500 litres (1000 Gal.) of estimated daily sewage flow</th></tr>
<tr><th>Slope within Absorption Field Area</th><th>Minimum Depth of Native Mineral Soil m. (in.)</th><th>Sands & Gravels Min/2.5 cm. 1-5 Min/Inch</th><th>Loams Min/2.5 cm. 6-15 Min/Inch</th><th>Silts Min. 2.5 cm. 16-30 Min/Inch</th></tr>
<tr><td>0% - 10%</td><td>.9 m. (36 ")</td><td rowspan="2">390 m. (1300')</td><td rowspan="2">600 m. (2000 ')</td><td rowspan="2">900 m. (3000')</td></tr>
<tr><td>11 – 30 %</td><td>1.2 m. (48")</td></tr>
<tr><td colspan="5">All absorption field areas are to be at least 15 m. (50 feet) from a possible breakout point.
The length requirements include 100% reserve</td></tr>
</table>

H.2 Table "D" – Package Treatment Plant Effluent

Package Treatment Plant or Extended Treatment (Type 2 and 3) Servicing Community Sewage System				
Minimum natural porous soil depths and absorption field length requirements for every 4550 litres (1000 gal.) of estimated daily sewage flow package treatment plant effluent – Maximum 45/60 (B O D/T S S)				
Slope within Absorption Field areas	**Minimum Depth of Native Mineral Soil m. (in.)**	**Sands and Gravels**	**Loams**	**Silts**
0 - 10%	**.9 m. (36")**	**150 m. (500 ')**	**215 m. (700')**	**305 m. (1000')**
11- 30%	**1.2 m. (48")**			
All absorption field areas are to be at least 15 m. (50 ft.) from a possible breakout point. The length requirements include 100% reserve. Type 3 Level Treatment may be required.				

Appendix 9
Figures



Notes

1. To accompany report to Town of Comox, July 2007.
2. Base map provided by Town of Comox.
3. Areas A to Q are for the convenience of this study only.

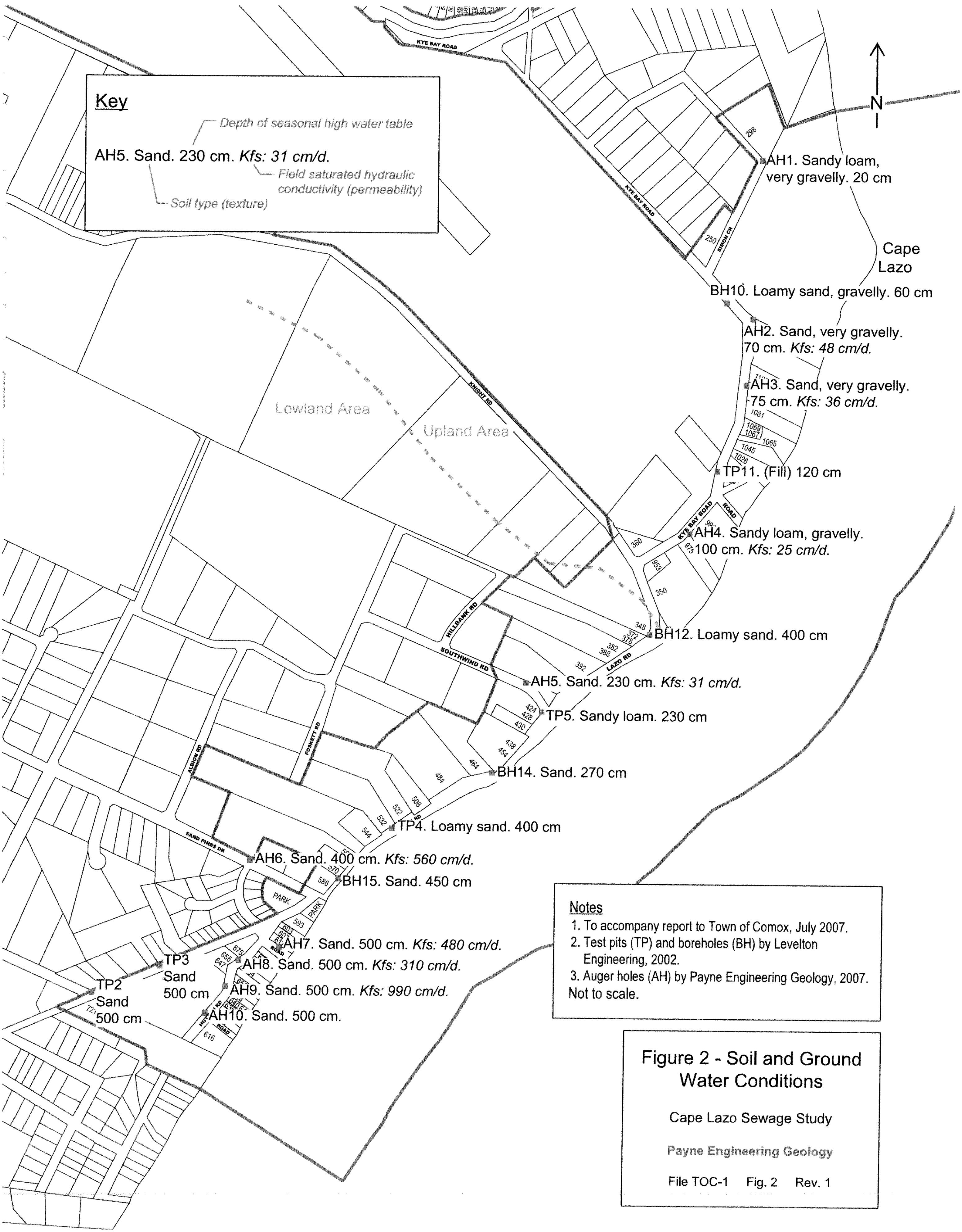
Not to scale.

Figure 1 - Study Area

Cape Lazo Sewage Study

Payne Engineering Geology

File TOC-1 Fig. 1 Rev. 1



Notes

1. To accompany report to Town of Comox, July 2007.
2. Test pits (TP) and boreholes (BH) by Levelton Engineering, 2002.
3. Auger holes (AH) by Payne Engineering Geology, 2007.

Not to scale.

Figure 2 - Soil and Ground Water Conditions

Cape Lazo Sewage Study

Payne Engineering Geology

File TOC-1 Fig. 2 Rev. 1

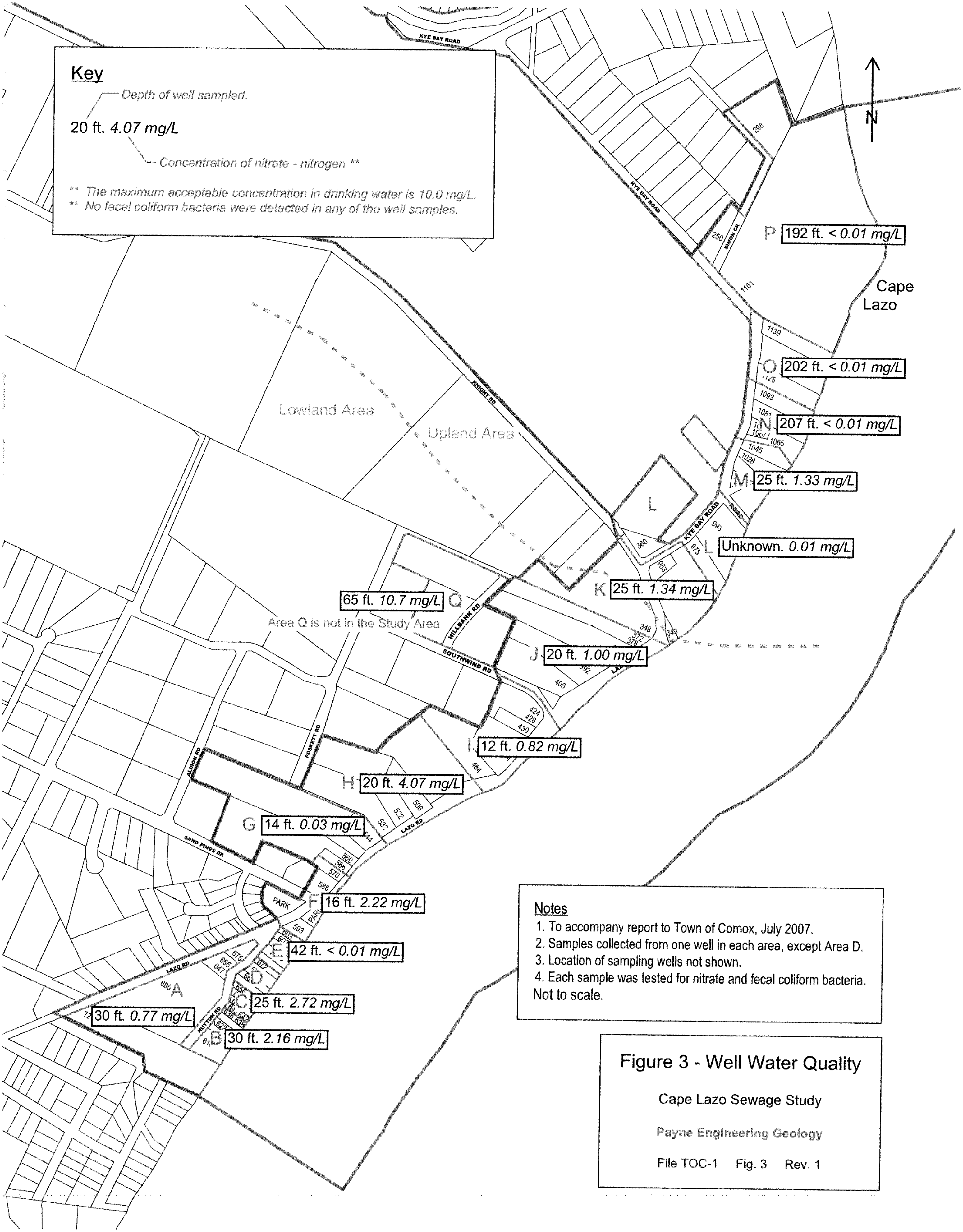


Figure 3 - Well Water Quality

Cape Lazo Sewage Study

Payne Engineering Geology

File TOC-1 Fig. 3 Rev. 1

Appendix 10
Statement of General Conditions

Scope of this Report
This review report satisfies only those objectives stated in the introduction. Payne Engineering Geology (PEG) has not conducted a *Site Investigation, Hydrogeology Study* or *Environmental Impact Assessment.*

Use of this Report
This report pertains only to a specific project. If the project is modified, then our client will allow us to confirm that the report is still valid. We prepared this report only for the benefit of our Client and those agencies authorized by law to regulate our Client's activities. No others may use any part of this report without our written consent. To understand the content of this report, the reader must refer to the entire, signed report. We cannot be responsible for the consequences of anyone using only a part of the report, or referring only to a draft report. This report reflects our best judgement based on information available at the time. Any use of this report, or reliance on this report, by a third party is the responsibility of that third party. We accept no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based on this report.

Reliance on Provided Information
PEG has relied on the accuracy and completeness of information provided by its client and by other professionals. We are not responsible for any deficiency in this document that results from a deficiency in this information.

Logs of Test Holes or Wells and Subsurface Interpretations
Ground and ground water conditions always vary across a site and vary with time. Test hole and well logs show subsurface conditions only at the locations of the test hole or well. The precision with which geological and geotechnical reports show subsurface conditions depends on the method of excavation or drilling, the frequency and methods of sampling and testing, and the uniformity of subsurface conditions.

Descriptions of Geological Materials and Water Wells
This report includes descriptions of natural geological materials, including soil, rock, and ground water. PEG based these descriptions on observations at the time of the study. Unless otherwise noted, we based the report's conclusions and recommendations on these observed conditions.

Changed Conditions
Conditions encountered by others at this site may differ significantly from what we encountered, either due to natural variability of subsurface conditions or construction activities. Our client will inform us about any such changes, and will give us an opportunity to review our recommendations. Recognizing changed soil and rock conditions, or changed well conditions, requires experience. Therefore, during construction or remediation, a qualified professional should be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Standard of Care
PEG exercises a standard of care consistent with that level of skill and care ordinarily exercised by members of the profession currently practising under similar conditions.