

Summary Report Evaluating Site and Soil Conditions for a Planned New Sewage System at Hornby Island Resort

Draft report # 2 For discussion only

Location: 4305 Shingle Spit Road, Hornby Island, BC

Report to: Hornby Island Resort Ltd., attn: Mr. John Ross

Dates of site visit: 2-3 December 2008

Objectives of this initial site evaluation

1. Explore and test soil and ground water conditions in prospective drainfield or dispersal areas.
2. Recommend a type of treatment system and type of drainfield.
3. Check site and soil conditions for compliance with applicable regulations.
4. Identify one or more potential drainfield areas.
5. Recommend a design for the drainfield including loading rates, orientation, dimensions, and distribution method.
6. Provide other recommendations for site evaluation, layout, design, and construction.

This report is subject to the attached Statement of General Conditions.

Identification of Property and Proposed Construction

Location and Features

Project and location:	Project name: Redevelopment of Hornby Island Resort, a.k.a. The Thatch Civic address: 4305 Shingle Spit Road, Hornby Island, V0R 1Z0 Legal: Remainder of Lot B, Section 4-A, Nanaimo District, Plan 24915, except part in Plan 2638 RW. PID: 000-538-060 UTM coordinates of the discharge area, at test pit TP-3: UTM 10, East 376,595, North 5,485,960, +/- 10 m, datum NAD83. Lot area: 5,300 square metres (1.31 acres)			
Contacts:	Name	Company	Address	Phone
Owner	John Ross	Hornby Island Resort Ltd.	Courtenay	250-338-1454
Designer	Ron McMurtrie	R. McMurtrie and Assoc.	Hornby Island	250-335-2685
Site evaluation	Michael Payne	Payne Engineering Geology	North Saanich	250-655-3604
Previous reports	No known previous site evaluation reports.			
	Existing		Proposed	
Land use:	Resort, including restaurant and pub (100 seats), small office building, Laundromat, liquor store, three vacation cottages, and campground with 7 RV campsites.		Resort redevelopment, including new restaurant, 15 new vacation suites, liquor store, and possibly some office or retail space. Development plans to be confirmed before final design and registration of sewage system.	
Bldg size, bedrooms	Not applicable.		Vacation suites: 2 bedrooms, ~ 100 sqm (1000 sqft). Restaurant: Approx. 150 sqm (1500 sqft), 60 seats. Office and retail space: Approx. 160 sqm (1600 sqft)	
Water supply:	One drinking water well located at the upper north end of the property. One non-drinking water well at the lower south end. See Figure 1.		No changes are proposed for the water supply. The water storage, treatment, and distribution system will be upgraded, as part of the redevelopment.	

Sewage	Existing Sewage System	Proposed Sewage System
Overview:	Two or three separate sewage systems, each at least 10 years old.	A single new sewage system for the entire development.
Regulation:	Health Act, Sewage Disposal Regulation	Health Act, Sewerage System Regulation
Design flows: *	Unknown	22,300 to 22,700 Litres per day (Lpd).
Garbarator:	No.	None planned.
Water softener:	No.	None planned.
Treatment:	Septic tanks.	New sewage treatment plant.
Distribution:	Gravity.	Pressure dosing.
Dispersal:	Subsurface drain rock trenches.	To be determined.

Site Description

Ground Slopes	Overall: 3% to 10% At the drainfield areas: 6% to 7%
Geology and Terrain	Surficial geology and soils maps: Sandy marine veneer or blanket. Bowser soil association: loamy sand and gravelly sandy loam overlying moraine (till). Rock Outcrops: None
Surface water features on-site	No surface water observed on the property in December 2008. Flood Risk: No flood risk identified.
Surface water features off site	1) Roadside drainage ditch, east side of Shingle Spit Road, some water in ditch. 2) No other surface water noted within 30 metres of the property.
Seepage, springs	No seepage or springs observed, December 2008.
Drains	No known subsurface drains located upslope or downslope from the proposed drainfield areas.
Vegetation	The property has been landscaped; few native species remain.
Structures	Roads: Gravel driveway. Buildings: Several existing buildings, as noted above, and as shown on attached figures.
Slope Condition	No slope erosion or instability noted during the site reconnaissance. The property has a gentle slope.

Wells on Property and Neighbouring Properties

Property	Well distance from drainfield area, depth, reported yield
Subject property (Rem Lot B), north well	31 m from the drainfield. Well depth 53.6 m (176 ft). Well yield 95 Lpm (25 US gpm), as reported on the well log.
Subject property, south well	<i>No information available about this well.</i>
Lot A of Plan 4913, well to the west	<i>Abandoned, not a drinking water supply.</i> 26 m from the drainfield.
Lot A of Plan 4913, well to the northwest	About 60 m from the drainfield. Well details unknown.
Lot A, Plan VIP50806, to the northeast	No known wells within 30 m of the subject property.
Lot 3, Plan 32878, to the east.	No known wells on this property.

Refer to attached figures for locations of wells.

Summary of Field Program

Date	# of holes	Excavation method	Date logged	Logged by	Location, comments
2 Dec 2008	8	Backhoe	2-3 Dec 2008	M.I. Payne	See Figure 2, attached. Test pits for logging the soil profile.
8 Dec 2008	8	Hand auger		R. McMurtrie	See Appendix 2.
9 Dec 2008	5	Hand auger		R. McMurtrie	Auger holes for constant rate borehole permeameter tests.

Conclusions and Recommendations

1) Overall constraints and suitability of the property

Our evaluation shows that this property has suitable soil conditions for a sewage system for the proposed resort redevelopment. The soil profile is favourable, and the water table is deep. The property is considered capable of infiltrating a peak day sewage flow of 22,700 Lpd.

This property has a few constraints that influence the design of the sewage system. These include the following:

- The property is narrow, when measured along the contours of the land. As a result, the design will need at least two infiltration beds (seepage beds) of length at least 36 metres each. This site will need site-specific analysis of water table mounding to establish a suitable design linear loading rate. Extra measures may be needed to increase oxygenation of the treatment soils.
- The space available for drainfields is limited to narrow corridors between rows of vacation suites (see attached figures). As a result, the design will need to use infiltration beds rather than trenches, measures will be needed to increase the design soil hydraulic loading rate, and some horizontal setback distances will need to be reduced.
- The shallow soil, at depth 30 cm, is loamy and has relatively low permeability. For this reason, we recommend using deeper, sand-lined infiltration beds, with the soil infiltration surface at depth 60 to 70 cm.
- The deeper native soils, at depth 60 to 70 cm, have moderate hydraulic conductivity, lower than typical for a loamy sand to sandy loam. For this reason, and for reasons noted above, the design will need to use a sand lining consisting of ASTM C33 sand, or similar pre-approved fill sand.

Our site reconnaissance identified two preferred drainfield areas, with generally favourable soil conditions, coinciding with test pits TP-2 through TP-7, as shown on the attached figures.

2) PEG recommended type of treatment system

For this project, we recommend using the following treatment train:

- grease trap, for kitchen wastewater only
- septic tank or tanks
- effluent screen (filter), one per septic tank
- pump tank, or tanks, for dosing the treatment plant
- Orenco Advantex treatment plant (recirculating geotextile biofilter)
- pump tank, for pressure dosing to the infiltration beds
- pump with control panel for timed dosing
- pressure distribution to infiltration chambers, or shallow subsurface drip dispersal system
- sand-lined seepage bed
- soil - based treatment in unsaturated, native soil

The number of septic tanks will depend on the most efficient configuration for collecting sewage from the various buildings, assuming gravity flow from buildings into septic tanks. Septic tanks sizes should conform with standards from the BC Standard Practice Manual.

Pump tanks should be sized and designed for flow equalization. A different type of treatment plant may be used, provided that the selected plant can meet the project-specific effluent quality criterion: 90th percentile effluent BOD and TSS less than 15 mg/L. For the purpose of this report, this is referred to as a Type 2 (15/15) treatment system. If the design of the soil-based treatment system follows the recommendations of this report, we see no need to use a Type 3 treatment system.

3) Recommended dispersal location

Use two long and narrow infiltration beds, located between rows of buildings, approximately as shown on attached Figures 3 and 4.

If septic tanks, treatment plants, building foundations, or any other permanent structures are to be located below the seasonal high water table, then these structures must be located more than 7.5 metres downslope or down-gradient from the infiltration beds. This is to provide adequate seepage, drainage, and soil-based treatment near the infiltration beds.

Structures that are placed above the seasonal high water table may be closer than 7.5 metres from the infiltration beds, but must be at least 3.0 metres away. We would not expect these structures to interfere with seepage and drainage, but the installation or repair could cause physical damage to the infiltration beds if the setback distance was less than 3.0 metres.

4) Protection of soils in the dispersal area

The drainfield soils must be protected from machine damage during all phases of construction and operation of the resort. This is especially important for this project, because the native soil is relatively sensitive to structural damage when wet, and because of the cost of importing sandy soil to replace the native soil that is damaged.

The drainfield area must be fenced off during all stages of construction. No machinery, equipment, or materials are to be stored on or moved over the drainfield area at any time, except as necessary to construct the drainfield. For drainfield construction, the only acceptable equipment is a lightweight track excavator and hand tools (shovel, wheelbarrow). Apart from constructing the drainfield, there are to be no excavations of soil from the drainfield area, and no placing of soil or fill over the drainfield area. Any such activity will nullify most of the conclusions of this report.

During operation of the resort, it will be necessary to prevent vehicles from driving over the drainfield areas. This will require a wall or barrier of some kind, such as a hedge, low decorative fence, low retaining wall, or curb. This feature can be integrated into the overall landscaping of the property.

5) Compliance with the Sewerage System Regulation

The drainfield site conditions, and the recommended type of sewage system, comply with requirements of the Sewerage System Regulation, provided that the design, installation, and operation follow the recommendations of this report. If monitoring reveals problems during operation, the owner and the maintenance technician must contact the designer immediately.

6) Design recommendations

The recommended infiltration beds have the following dimensions:

- North Bed: 36 to 37 m long; 6.5 m wide
- South Bed: 39.5 to 40.5 m long; 6.1 to 6.2 m wide
- combined infiltration surface area: 470 to 490 sqm
- bed depth: 0.65 m
- thickness of sand lining: 0.25 to 0.35 m
- chamber depth: 0.35 m
- chambers: 0.86 m (34 in) wide by 0.30 m high
- chamber cover: 0.10 to 0.20 m

Our project specific analysis has confirmed that a sand lining of thickness 25 cm can reasonably be expected to produce equivalent to Type 3 disinfected effluent at the base of the sand lining.

Some design guides recommend limiting infiltration beds to a width of less than 4.0 m, at least for infiltration of septic tank effluent. For this project, considering the low effluent BOD of 5 to 15 mg/L, and the deep well-aerated sandy loamy soils, a bed width of 6.0 to 7.0 metres is considered suitable.

Chambers offer some advantages over other effluent distribution options. If using chambers, one design option is to place a thin layer of pea gravel (about 50 mm) over the sand, and place chambers on the gravel; this may improve effluent distribution to the sand.

As discussed, subsurface drip dispersal is an alternative to infiltration chambers. Another viable option is to use a pea gravel infiltration bed with pressure distribution laterals and orifice covers in the pea gravel.

For the design of this sewage system:

- Use water-saving fixtures in all new buildings, including low-flush toilets.
- Use pressure dosing with a dosing frequency of 12 to 36 doses per day.
- Roof drainage should be either: (1) captured and reused on the property, for outdoor uses, such as irrigation or wash water; (2) discharged to the ocean via underground drainage pipes; or (3) discharged to ground using silt traps and professionally-designed infiltration trenches or beds.
- If roof drainage is discharged to ground, it should be at least 10 metres downslope from the wastewater infiltration beds.
- Parking areas and driveways may be built as close as 0.5 metres from the edge of the infiltration bed so long as there is a curb along the edge of the parking area or driveway. The curb must be substantial enough to divert surface runoff away from the infiltration bed, and also to keep traffic off the infiltration bed. The subgrade of the parking area or driveway will need to be built before building the infiltration bed.
- The Resort should retain Ron McMurtrie, P.Eng., to review the design and construction of all structures located within 3.0 metres (10 ft) of the infiltration beds, since these structures could influence or damage the beds.

7) Additional site evaluation recommended

The following additional site evaluation will need to be completed before the final design of the sewage system:

- Measure the depth of the water table in standpipes, to be measured on average once every 2 - 3 weeks, during the months of January through March of 2009.
- Re-evaluate the depth of the water table.
- Reconsider the system design, if appropriate.

Before commissioning of the new sewage system, we recommend:

- Develop a plan to monitor changes in ground water quality.
- Install two to four monitoring wells, to a depth of about 3 metres.
- Start the ground water sampling before commissioning the system.

8) Drinking water protection

The new sewage system, as proposed, is not expected to affect drinking water quality. The nearest drinking water well is located more than 30 metres upslope from the proposed infiltration beds.

However, regardless of activities on the Resort property, it is important to protect the drinking water supply well from pollution by complying with the Ground Water Protection Regulation, including ensuring that the well has an adequate surface annular seal. This protects the well by preventing leakage of shallow ground water into the well.

Annular well seals consist of bentonite or cement, placed around the surface casing (steel pipe) to a specified minimum depth. A new BC law, the Ground Water Protection Regulation, requires that new drinking water wells be constructed by a registered well driller, with a surface annular seal. The law requires that this seal extend to a depth of at least 4.5 metres (15 ft), although in some circumstances, such as a retrofit of an old well, a shallower seal may be allowed if authorized by a qualified hydrogeologist.

There may be one or more abandoned wells located on adjacent properties. Recognizing that Hornby Island Resort has no particular influence on its neighbours' actions, all abandoned wells should be properly sealed, in conformance with the Ground Water Protection Regulation. In fact, this is required by law. Alternatively, an abandoned well may be converted to a secure monitoring well, under direction from a qualified hydrogeologist.

We understand that Ron McMurtrie, P.Eng., will design the new water system for the Resort. The water system will probably need to conform with requirements of the Drinking Water Protection Act and Regulation, and will therefore need source water approval, a construction permit, and an operating permit from VIHA (Vancouver Island Health Authority). The Hornby Island Resort should contact VIHA to confirm regulatory requirements for the new water system.

9) Installation procedure

The owner must hire a Registered Onsite Wastewater Practitioner (Installer) to supply and install the sewage system in compliance with the design engineer's drawings and specifications, and subject to the following:

- The Engineer (Ron McMurtrie) must confirm the layout and setback distances at the start of installation.
- The leak tests on the tanks, and pressure testing of the drainfield, must be witnessed by the Engineer, unless otherwise authorized in writing.
- The infiltration chambers and backfill may be placed after the Engineer has witnessed the pressure test.

10) Monitoring and maintenance

After installation of the sewage system, the designer will write the Operation and Maintenance Manual (owner's manual). This manual should include at least the following measures:

- Regular inspection and maintenance by a registered practitioner.
 - Effluent sampling and lab testing.
 - Water well sampling and lab testing.
 - Installation of monitoring wells and sampling and testing of ground water, downslope from the infiltration beds.
 - The design engineer should review the operation and performance of the sewage system after the first two years of operation, then once every five years.
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Draft report for discussion purposes only.

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Appendices

1. Statement of general conditions
2. Observed soil conditions
3. Evaluation of the selected drainfield site
4. Summary of calculations
5. Figures

Appendix 1

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 Payne Engineering Geology (PEG) 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. Construction activities on the site or adjacent sites may change or alter these geological materials.

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.

Risks and Liability

We recommend that our client engage PEG to review all design drawings and constructed works that are based on our conclusions and recommendations. This is a requirement of the *Association of Professional Engineers and Geoscientists of BC*.

Standard of Care

We exercise a standard of care consistent with that level of skill and care ordinarily exercised by members of the profession currently practising under similar conditions.

Appendix 2 Observed Soil Conditions

Test Pit Summary

Depths in: centimetres

TP	Soil description at depth of 65 to 75 cm (1)					Depth to restrictive layer	Mottled or gleyed soils	Root depth	Measured water table or seepage (3)	SHWT (4)	Land slope (2)
	Texture	Fine gravel	Coarse gravel	Structure	Rupture resistance						
1	Loamy sand	5%	5%	abk 3	Very friable	> 220	None	200	113 to > 215	190	5%
2	Loam	1%	1%	abk 2 - m 0	Very friable	> 200	None	170	104 to > 190	160	7%
3	Loamy sand - sand	20%	20%	sg 0 - abk 2	Loose - very friable	> 200	None	120	153 to > 197	200	7%
4	Sandy loam - loam	5%	1%	abk 2	Friable	> 180	None	170	123 to > 176	170	7%
5	Sand - loamy sand	30%	5%	sg 0 - abk 3	Very friable	> 215	None	135	> 208	> 215	7%
6	Sandy loam	10%	1%	abk 3	Firm	> 200	None	120	> 203	> 200	6%
7	Loamy sand	15%	5%	gr - abk 3	Friable	> 150	None	150	> 143	> 150	7%
8	Silt loam - sandy loam	5%	5%	sg 0 - abk 3	Friable	> 230	None	220	> 230	> 230	6%

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 7 Dec 2008, 6 Jan 2009, and 13 Jan 2009.
- (4) Seasonal High Water Table (SHWT) is defined as the highest water table that is sustained for more than two - three consecutive weeks (based on USDA and SPM definitions). It is estimated from the measured depths shown.
- (5) Coarse gravel is gravel in size range of 19 to 75 mm (0.75 to 3.0 inches).

Abbreviations

<u>Pit Location</u>	<u>Structure</u>	<u>USDA Consistence</u> (Rupture resistance)	<u>Moisture</u>
• D/S - Downslope	• sg - single grain	• L - loose	• S - saturated
	• m - massive	• VFR - very friable	• W - wet
<u>Interpretation</u>	• gr - granular	• FR - friable	• M - moist
(ts) - topsoil	• abk - angular blocky	• FI - firm	• D - dry
(till) - glacial till	• sbk - subangular blocky	• VFI - very firm	
(w.till) - weathered till	• pl - platy	• EF - extremely firm	
	• pr - prismatic	• SR - slightly rigid	
	• cpr - columnar	• R - rigid	
		• VR - very rigid	

Test Pit Logs

Date: 2-3 December 2008

Locations: See Figure 2 attached.

Logged by: M.I. Payne

Standpipe construction: 75 mm diam. PVC pipe.

TP-1

Depth (cm)	Colour	Texture	Structure	Rupture resistance	Coarse gravel (%)	Roots quantity, depth	Mottles	Moisture seepage
0 - 25	Olive	silt loam (fill), gravelly	gr 3	friable	5%	many fine	none	moist
25 - 75	Dark brown	loamy sand	abk 3	very friable	5%	few fine	none	moist
75 - 190	Black to olive	loamy sand and sandy loam, very gravelly, shells common	sg 0	friable	25%	few medium	none	moist
190 - 220	Olive	sand, very gravelly	sg 0	friable	30%	few medium to depth 200 cm	none	moist-wet
220	BOTTOM of pit							

TP-2

Depth (cm)	Colour	Texture	Structure	Rup.res. Consistence	Coarse gravel	Roots	Mottles	Moisture
0 - 25	Dark brown	loamy sand and loam (fill)	gr 3	very friable	5%	common fine	none	moist
25 - 65	Dk brown to black	loamy sand and loam, gravelly, shells common	abk 3	friable	10%	few coarse	none	moist
65 - 125	Yellow brown	loam (organic, spongy)	abk2 - m0	very friable	1%	common coarse	none	moist-wet
125 - 170	Dk brown	sand, extremely gravelly	sg 0	loose	30%	few medium	none	moist
170 - 200	Olive	sand, very gravelly	sg 0	loose	10%	few medium to depth 170 cm	none	wet
200	BOTTOM of pit							

TP-3

Depth (cm)	Colour	Texture	Structure	Rup.res.	Coarse gravel	Roots	Mottles	Moisture
0 - 20	Black	loamy sand and sandy loam, gravelly (lopsoil)	gr 3	friable	5%	many fine	none	moist
20 - 110	Black	loamy sand and sand, very gravelly, shells common	sg0-abk2	loose to very friable	20%	few coarse	none	moist
110 - 200	Black	loam, gravelly, a few shells	abk 3	friable	2%	few coarse to depth 120 cm	none	moist
200	BOTTOM of pit							

TP-4

Depth (cm)	Colour	Texture	Structure	Rupture resistance	Coarse gravel (%)	Roots quantity, depth	Mottles	Moisture seepage
0 - 50	Black	sand, gravelly, shells common	sg0-abk3	friable	5%	common fine	none	moist
50 - 85	Black	sandy loam and loam, few shells	abk 2	friable	1%	few coarse	none	moist-wet
85 - 115	Black	sand, very gravelly, many shells	sg0-abk3	very friable	20%	common medium	none	moist
115 - 180	Olive brown	sand, extremely gravelly	sg0	loose	30%	few medium to depth 170 cm	none	moist
180	BOTTOM of pit							

TP-5

Depth (cm)	Colour	Texture	Structure	Rup.res. Consistence	Coarse gravel	Roots	Mottles	Moisture
0 - 15	Dark brown	loamy sand, gravelly	sg0-gr3	very friable	1%	many fine	none	moist
15 - 45	Brown	loam, gravelly, few shells	abk2	very friable	5%	few fine	none	moist
45 - 95	Black	sand and loamy sand, very gravelly, shells common	sg0-abk3	very friable	5%	few fine	none	moist
95 - 135	Dark olive	loam and sandy loam, few shells	abk3	very friable	2%	few fine to depth 135 cm	none	moist-wet
135 - 200	Black	loamy sand, very gravelly, few shells	sg0-abk2	very friable	10%	none	none	moist
200 - 215	Dark brown	sand, extremely gravelly, shells common	sg0	loose	20%	none	none	moist
215	BOTTOM of pit							

TP-6

Depth (cm)	Colour	Texture	Structure	Rup.res.	Coarse gravel	Roots	Mottles	Moisture
0 - 50	Dark brown	loamy sand, gravelly, few shells	gr 3	friable	5%	common fine	none	moist
50 - 85	Yellow brown	sandy loam	abk 3	firm	1%	few fine	none	moist
85 - 105	Olive	loam and silt loam	abk 2	friable	1%	few fine	none	wet
105 - 170	Black	loamy sand, gravelly	abk 2	friable	2%	few medium to depth 120 cm	none	wel
170 - 200	Olive	loamy sand, very gravelly	sg0-m0	friable	10%		none	wel **
200	BOTTOM of pit ** Some seepage of septic tank effluent into bottom of pit, from a broken distribution pipe.							

TP-7

Depth (cm)	Colour	Texture	Structure	Rupture resistance	Coarse gravel (%)	Roots quantity, depth	Mottles	Moisture seepage
0 - 30	Dark brown	sandy loam, gravelly	gr 3	friable	2%	common medium	none	moist
30 - 75	Dark brown	loamy sand, gravelly, shells common	gr3-abk3	friable	5%	common medium	none	dry-moist
75 - 150	Dark brown	loamy sand, gravelly, few shells	sg0-abk3	moderately hard	2%	common coarse, to depth 150 cm	none	dry
150	BOTTOM of pit							

TP-8

Depth (cm)	Colour	Texture	Structure	Rup.res.	Coarse gravel	Roots	Mottles	Moisture
0 - 50	Dark brown	sandy loam (topsoil)	gr 3	friable	1%	few fine	none	moist
50 - 60	Yellow brown to olive	sand, very gravelly	sg0-abk3	friable	5%	few fine	none	moist
60 - 200	Black to olive	silt loam and sandy loam	sg0-abk3	friable	5%	few coarse	none	moist-wet
200 - 230	Black	sand, very gravelly	sg 0	loose	20%	few medium to depth 220 cm	none	moist
230	BOTTOM of pit							

Percolation Tests

No percolations tests conducted for this site evaluation.

Constant Head Borehole Permeameter Tests

Method and calculations from *Measurement of Hydraulic Conductivity of Soils In-situ* (Moors and Waller, 1993).

Shallow Tests at Depth 30 to 40 cm

Site: <i>Hornby Island Resort, Shingle Spit Road, Hornby Island</i>	Test date: <i>December 8, 2008</i>
Height of air hole (H): <i>20 cm</i>	Permeameter: <i>ID = 10.23 cm</i>
	Tested by: <i>Ron McMurtrie</i>

Auger Hole #		AH-1	AH-2	AH-3	AH-4	AH-5	AH-6
Location		North west	North central	North central	North east	South west	South central
Nearest test pit		TP-7	TP-6	TP-5	TP-5	TP-2	TP-3
AH depth	<i>cm</i>	33	33	35	36	34	37
AH diameter	<i>cm</i>	8	8	8	9	8	8
AH radius (a)	<i>cm</i>	4.0	4.0	4.0	4.5	4.0	3.8
Soil texture		SL	LS	L	L	LS - L	LS - L
Soil structure		gr 3	gr 3	abk 2	abk 2	abk 3	abk 2
Rate of fall	<i>mm/min</i>	0.5	3.5	1.3	3.5	10.5	0.5
Conversion	<i>2.17 or 8.22</i>	8.22	8.22	8.22	8.22	8.22	8.22
Flow rate (Q)	<i>mL / min</i>	4	29	10	29	86	4
Soil factor (F)	<i>0.2 to 0.9</i>	0.65	0.65	0.65	0.65	0.65	0.65
K(fs) = Q x F	<i>cm/day</i>	3	19	7	19	56	3
K(fs)	<i>mm/day</i>	30	190	70	190	560	30
K(sat)	<i>mm/day</i>	60	380	140	380	1,120	60
K(sat)	<i>m/day</i>	0.1	0.4	0.1	0.4	1.1	0.1

Footnotes

Permeameter construction, test method, and calculations based on Moors and Waller (1993)

K(fs) is the field-saturated hydraulic conductivity of the soil at the depth tested.

Interpretation: Preliminary design values for K(fs) at depth 15 to 35 cm

Based on 6 tests above.

Design value for K(fs): 7 cm/day or 70 mm/day (based on low median value).

Design value for peak day soil HLR, Type 2 effluent: 29 mm/day (based on Taylor formula, SPM, Appendix G).

Recommendation

Conduct 6 to 8 tests at depth of ~ 70 cm. Consider deeper infiltration bed or sand lined infiltration bed.

Deep Tests at Depth 60 to 70 cm

Site: <i>Hornby Island Resort, Shingle Spit Road, Hornby Island</i>	Test dates: <i>December 8-9, 2008</i>
Height of air hole (H): <i>20 cm</i>	Permeameter: <i>ID = 10.23 cm</i>
Tested by: <i>Ron McMurtrie</i>	

Auger Hole #		AH-7	AH-8	AH-1R	AH-4R	AH-5R	AH-9	AH-10
Location		South central	South central	North west	North east	South west	North central	North central
Nearest TP		TP-3	TP-3	TP-7	TP-5	TP-2	TP-6	TP-5
AH depth	cm	60	65	70	67	70	68	70
AH diameter	cm	7.5	7.5	8.0	8.0	8.0	8.0	8.0
AH radius (a)	cm	3.8	3.8	4.0	4.0	4.0	4.0	4.0
Soil texture		LS - S	LS - S	LS	S - LS	LS - L	SL	S - LS
Soil structure		sg 0	sg 0	gr 3	sg 0	abk 3	abk 3	sg 0
Rate of fall	mm/min	1.6	8	3	35	7	1.0	4
Conversion		8.22	8.22	8.22	8.22	2.17	2.17	2.17
Flow rate (Q)	mL / min	13	66	25	288	15	2	9
Soil factor (F)	0.2 to 0.9	0.76	0.76	0.65	0.74	0.65	0.65	0.74
K(fs) = Q x F	cm/day	10	50	16	213	10	1	6
K(fs)	mm/day	100	500	160	2,130	100	10	60
K(sat)	mm/day	200	1,000	320	4,260	200	20	120
K(sat)	m/day	0.2	1.0	0.3	4.3	0.2	0.0	0.1

Interpretation: Preliminary design values for K(fs) at depth 50 to 70 cm

Based on 7 tests above.

Design value for K(fs): 10 cm/d = 100 mm/d

K(sat): 20 cm/d = 200 mm/d

Design value for peak day soil HLR:

- Type 2 effluent: 38 mm/d.
 - Type 3 effluent: 60 mm/d
- (based on Taylor formula, SPM, Appendix G).

Note: For Type 2 effluent to LS-SL, the SPM recommends peak day HLR = 49 mm/d (Table 2-8).

Recommendation

Use a sand lined subsurface infiltration bed, with discharge of Type 2 (15/15) to fill sand at depth ~ 35 cm, and infiltration of Type 3 (sand filtered) effluent into native soil at depth ~ 65 cm.

Additional Information Available on Request

- | | |
|--|---|
| <ul style="list-style-type: none"> • Land till • Driller's water well records • Photographs • Permeameter test results | <ul style="list-style-type: none"> • Estimates of pathogen reduction in unsaturated soil, using the Minnesota Pollution Control Agency model. • Water table measurements • Estimate of future water table mounding |
|--|---|

Appendix 3 Evaluation of the Selected Drainfield Site

This section compares observed and measured site conditions with the recommendations of British Columbia's *Standard Practice Manual (SPM)*, Part 2, and includes our recommendations for design and construction.

Relevant Standard from SPM Part 2 (September 2007)	Evaluation	Comments																																				
2.2 Design Flow The selected design flow should equal or exceed the rate recommended in the SPM.	PEG: The property is considered capable for a peak day flow up to 22,700 Lpd. As designed: See comment.	Ron McMurtrie, P.Eng., has calculated a preliminary design flow of 22,300 Lpd.																																				
2.3.3.2 Vertical separation, native soil The vertical separation in native soil should equal or exceed the recommended separation in Tables 2-4 and 2-5.	SPM recommended: > 25 cm PEG recommends: > 60 cm As designed: 100 cm																																					
2.3.3.2 Vertical separation, total The total, as-constructed, vertical separation should exceed the amount recommended in Tables 2-4 and 2-5.	SPM recommended: > 60 cm PEG recommends: > 90 cm As designed: 120 to 180 cm	Total vertical separation will vary between winter and summer operating conditions.																																				
2.3.3.3 Horizontal Setback, Critical The horizontal separation distances from "critical" features should exceed the amounts shown in Table 2-6, unless otherwise justified in writing by a Professional.	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">SPM recommended distance to:</th> <th style="text-align: center;">Type 3 **</th> <th style="text-align: center;">As designed</th> <th style="text-align: center;">Comment</th> </tr> </thead> <tbody> <tr> <td>Source of drinking water</td> <td style="text-align: center;">> 30 m</td> <td style="text-align: center;">31 m</td> <td>The nearest well is the Resort's drinking water well, 31 metres upslope from the drainfield.</td> </tr> <tr> <td>High rate well</td> <td style="text-align: center;">> 60 m</td> <td style="text-align: center;">> 90 m</td> <td></td> </tr> <tr> <td>High rate well in unconfined aquifer</td> <td style="text-align: center;">> 90 m</td> <td style="text-align: center;">> 90 m</td> <td>The Resort's well is not a High Rate Well, as defined in the SPM.</td> </tr> <tr> <td>Breakout</td> <td style="text-align: center;">> 7.5 m</td> <td style="text-align: center;">~ 22 m</td> <td>Potential breakout near high tide mark.</td> </tr> <tr> <td>Upslope drain</td> <td style="text-align: center;">> 3 m</td> <td style="text-align: center;">> 4 m</td> <td></td> </tr> <tr> <td>Fresh water</td> <td style="text-align: center;">> 15 m</td> <td style="text-align: center;">> 30 m</td> <td></td> </tr> <tr> <td>Fresh water (seasonal)</td> <td style="text-align: center;">> 15 m</td> <td style="text-align: center;">20 m</td> <td>to roadside ditch</td> </tr> <tr> <td>Marine water</td> <td style="text-align: center;">> 15 m</td> <td style="text-align: center;">~ 24 m</td> <td></td> </tr> </tbody> </table>	SPM recommended distance to:	Type 3 **	As designed	Comment	Source of drinking water	> 30 m	31 m	The nearest well is the Resort's drinking water well, 31 metres upslope from the drainfield.	High rate well	> 60 m	> 90 m		High rate well in unconfined aquifer	> 90 m	> 90 m	The Resort's well is not a High Rate Well, as defined in the SPM.	Breakout	> 7.5 m	~ 22 m	Potential breakout near high tide mark.	Upslope drain	> 3 m	> 4 m		Fresh water	> 15 m	> 30 m		Fresh water (seasonal)	> 15 m	20 m	to roadside ditch	Marine water	> 15 m	~ 24 m		
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** We have used the Type 3 setback distances because the wastewater is expected to meet Type 3 criteria at the base of the sand lining.																																						

Relevant Standard from SPM	Evaluation			Comments
2.3.3.3 Horizontal Setback, Other The SPM recommends that horizontal setback distances to "other" features should exceed amounts in Table 2-7. ** We have used the Type 3 setback distances because the wastewater is expected to meet Type 3 criteria at the base of the sand lining.	SPM recommended distance to:	Type 3 **	As designed	Comment
	Property line	> 1.5 m	> 1.5 m	** See note in left column.
	Water line	> 1.0 m	> 1.0 m	
	Building (no perimeter drain)	> 1.0 m	~ 1.2 - 2.0 m	Shallow pad footings, for decks, may be built 1.2 m from the edge of the infiltration bed, if less than 0.70 m deep.
	Dwelling (with no perimeter drain)	> 2.0 m	> 2.0 m	
	Subsurface drain above the water table (incl foundation drains)	> 2.0 m***	> 2.0 m	*** We recommend a setback of 2.0 m. The SPM does not consider this situation.
Utility services	> 1.0 m	> 1.0 m		

Relevant Standard from SPM	Evaluation		Comments
2.3.4.1 Seepage Bed HLRs For seepage beds, the SPM recommends reducing the soil HLR (hydraulic loading rate) by a factor of 1.35.	For this project, the suggested factor of 1.35 is not needed because: (1) the soil is well aerated (SL, SHWT > 160 cm); (2) the effluent is well aerated (BOD < 15 mg/L); and (3) the soil HLR has been conservatively selected to be lower than shown in SPM Table 2-8.		This design process is consistent with other design manuals (standards of practice) including US EPA (Otis et al, 2002) and Crites et al (2000)
2.3.4.2 Soil HLRs The native soil HLR should be less than indicated in Table 2-8.	SPM recommends: Peak day HLR < 55 mm/d (see comments) PEG recommends: HLR = 35 to 50 mm/d Preliminary Design Rates: (from design sketches, A _{is} = 480 sq.m.) Peak day soil HLR: 46-47 mm/d Ave day soil HLR: 12 to 23 mm/d (for peaking factor of 2.0 to 4.0)		For Type 3 effluent discharged to a well-structured sandy loam, using a seepage bed, the SPM recommends a peak-day soil HLR of 74 / 1.35 = 55 mm/d. However, as noted above, the factor of 1.35 is not needed for this project. Based only on the measured soil permeability, without the factor of 1.35, the SPM (Appendix G) recommends soil HLR = 60 mm/d.
2.3.4.3 HLRs for Sand Lining The sand HLR should be less than indicated in Table 2-9.	SPM recommends: Peak day sand HLR < 64 mm/d (for Type 2, C33 sand) PEG recommends: Sand HLR = 40 to 56 mm/d (see comments) Preliminary Design Rates: (based on A _{is} = 480 sq.m.) Peak day sand HLR: 46-47 mm/d Average day sand HLR: 12 to 23 mm/d		The preliminary design sand HLR is considered conservative, because the design calls for BOD/TSS < 15/15, rather than the usual Type 2 criterion of < 45/45. As discussed above, the seepage bed factor of 1.35 is not required for this project. If using chambers, it is not necessary for the chambers to cover 100% of the sand bed surface. Chambers with louvers allow for considerable side wall infiltration, especially with splashed pressure distribution.

Relevant Standard from SPM	Evaluation	Comments
<p>2.3.5.2 Soil Linear Loading Rate The soil linear loading rate (LLR) should be less than indicated in Table 2-11, after adjusting for timed dosing and steep slopes.</p>	<p>SPM: Peak day LLR < 124 Lpd/m PEG recommends: Peak day LLR < 300 Lpd/m; ave day LLR < 150 Lpd/m. Preliminary Design Rates: (based on total bed length of 76 to 77 m) Peak day LLR: ~ 295 Lpd/m Average day LLR: 72 to 148 Lpd/m</p>	<p>Our project-specific analysis shows that the infiltration bed, as designed, is not expected to cause significant water table mounding or oxygen depletion in the soil. Average day LLR, measured at the base of the sand lining, is expected to fall within the range recommended in the SPM.</p>
<p>2.3.6.1 Site Capability For site constraints listed in SPM Table 2-12, the Manual recommends design alternatives.</p>	<p>No soil constraints identified. At depth 50 to 70 cm, the typical soil Kfs = 10 cm/d = 100 mm/d.</p>	
<p>2.3.6.2 Limiting Conditions For certain type of sewage systems, Table 2-13 recommends site limitations.</p>	<p>No limiting conditions have been identified. The soil and slope are suitable for an infiltration bed.</p>	<p>Use a sand-lined infiltration bed, as recommended.</p>
<p>2.3.6.3 Flood Plains The the sewage system should be elevated a minimum height about the I in 20 year flood elevation.</p>	<p>During our site reconnaissance (Dec-2008), we saw no evidence of flooding. Overall, the property is well-drained, with a typical slope of 5% to 7%.</p>	

This table lists standards regarding site conditions, drainfield sizing and layout. It does not list standards relating to the design and construction of the sewage system. Table is based on the BC *Sewerage System Standard Practice Manual*.

References

- Crites, R.W., S.C. Reed, and R.K. Bastian, 2000. *Land Treatment Systems for Municipal and Industrial Wastes*. McGraw - Hill, New York, USA.
- Otis, R., J. Kreissl, R. Frederick, R. Goo, P. Casey, and B. Tanning, February 2002. *Onsite Wastewater Treatment Systems Manual*. EPA / 625 / R-00 / 008. Published by United States Environmental Protection Agency, Office of Water, Office of Research and Development.

Appendix 4 Summary of Calculations

Depth of Soil, Allowable System Types, and Recommended Vertical Separation

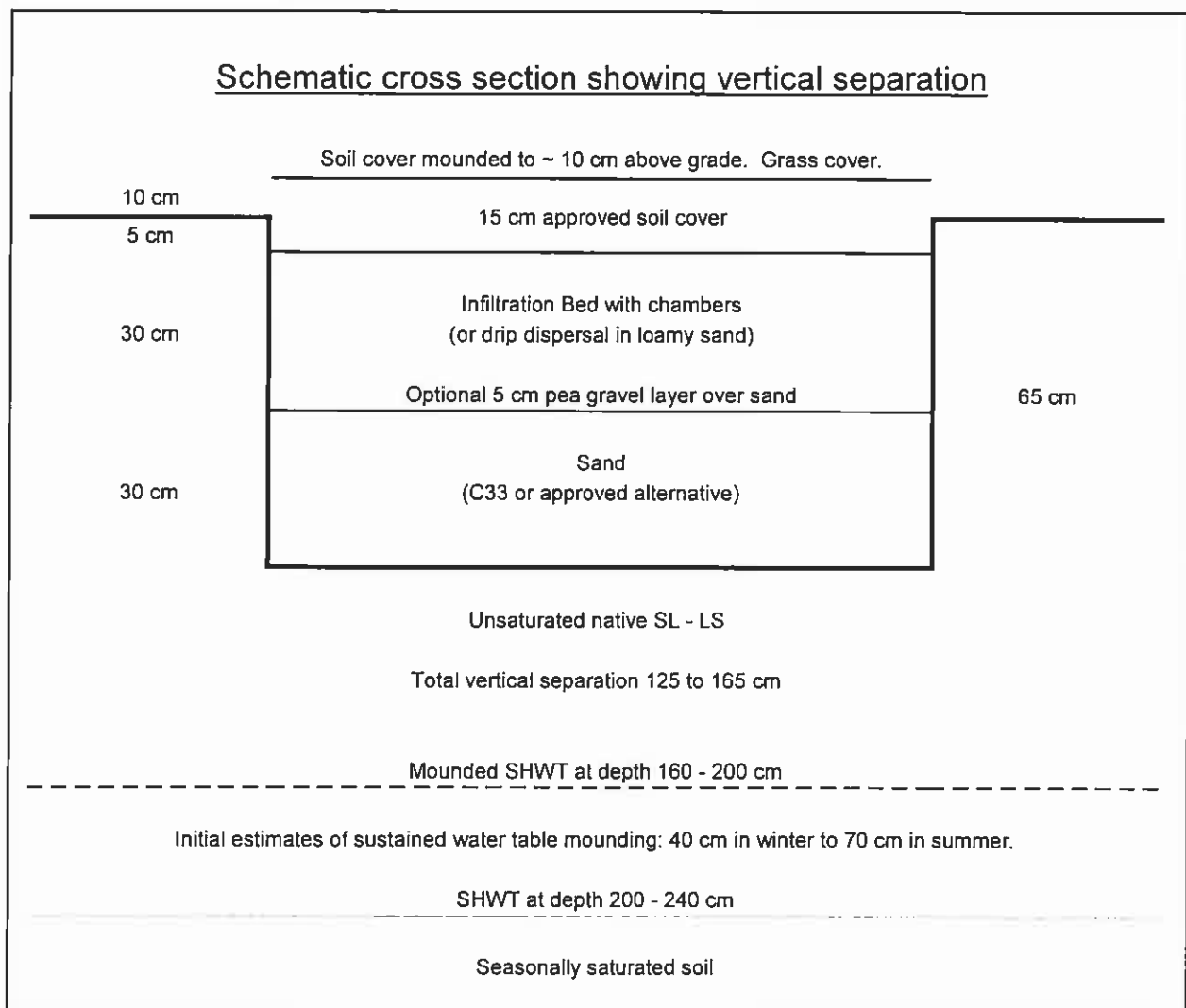
Depth of Seasonal High Water Table = 160 to 240 cm

Type of system recommended in SPM: Type 1, 2, or 3 allowed

Type recommended by PEG: Type 2 (15/15)

Vertical separation recommended in SPM: > 60 cm

PEG recommended depth or height of sand infiltration surface: 65 cm (see figure below)



Soil Hydraulic Loading Rate (HLR) for Infiltration Bed
based on design flow = peak day flow

Effluent quality Type: Type 3, at base of sand lining

Method 1: Soil Hydraulic Loading Rate Based on Percolation Rate
Method not used

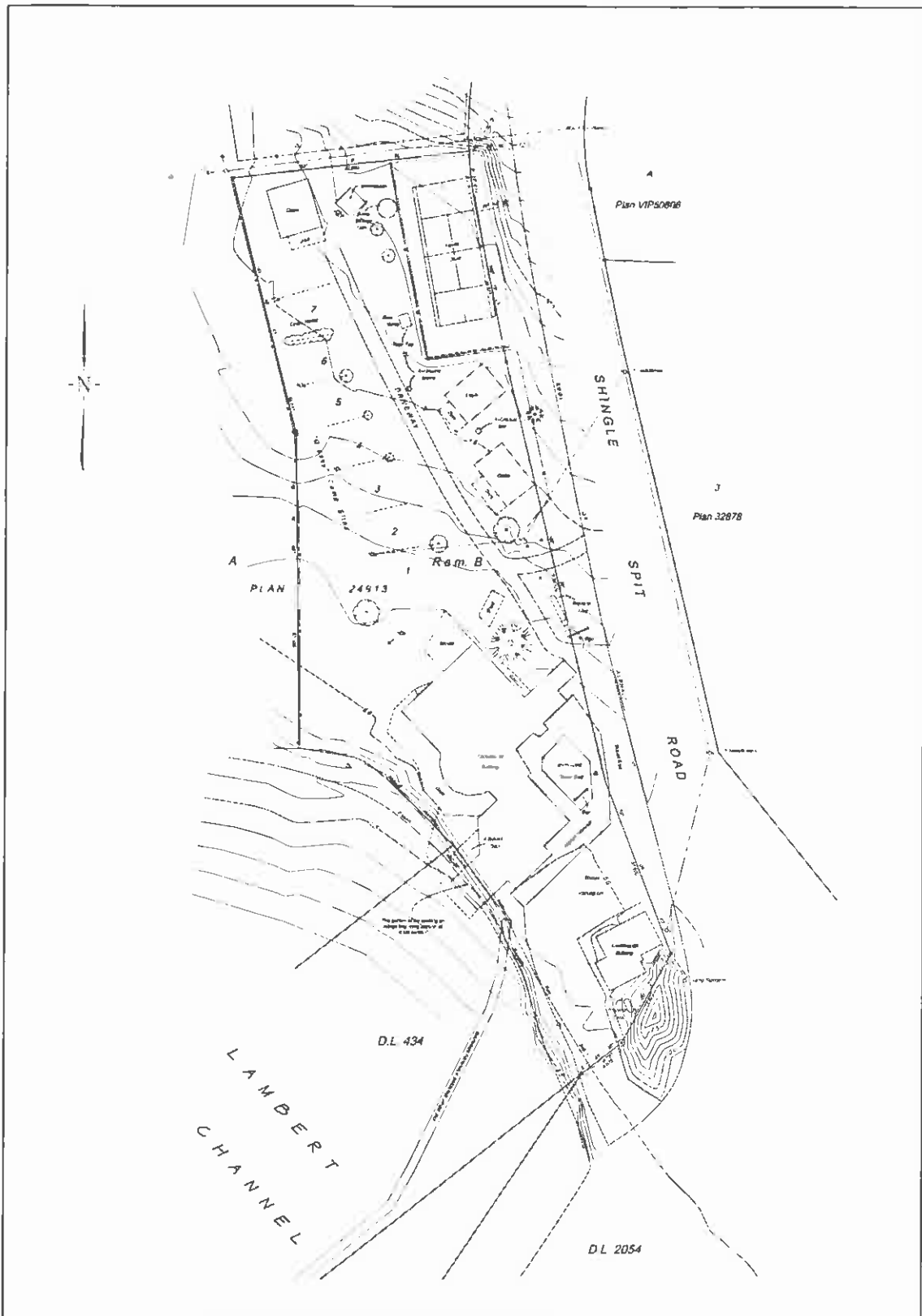
Method 2: Using Soil Texture and Structure (representative of drainfield area)
Soil HLR recommended in SPM: 74 Lpd per sqm

Method 3: Using Tests of Hydraulic Conductivity
Representative K(fs): 10 cm/day = 100 mm/day
K(sat) = 2.0 K(fs) = 20 cm/day = 200 mm/day
Soil HLR recommended in SPM: < 60 Lpd per sq.m. (Using permeameter test results and Taylor equation.)

PEG Recommended Design Soil HLR
Type 3: < 60 Lpd per sqm (based on peak day flow)

Appendix 5 Figures

- Figure 1 - Location of the Property and Wells
- Figure 2 - Test Pit Locations
- Figure 3 - Proposed Redevelopment of the Resort
- Figure 4 - Proposed Layout of Infiltration Beds



HORNBY ISLAND RESORTS LTD.

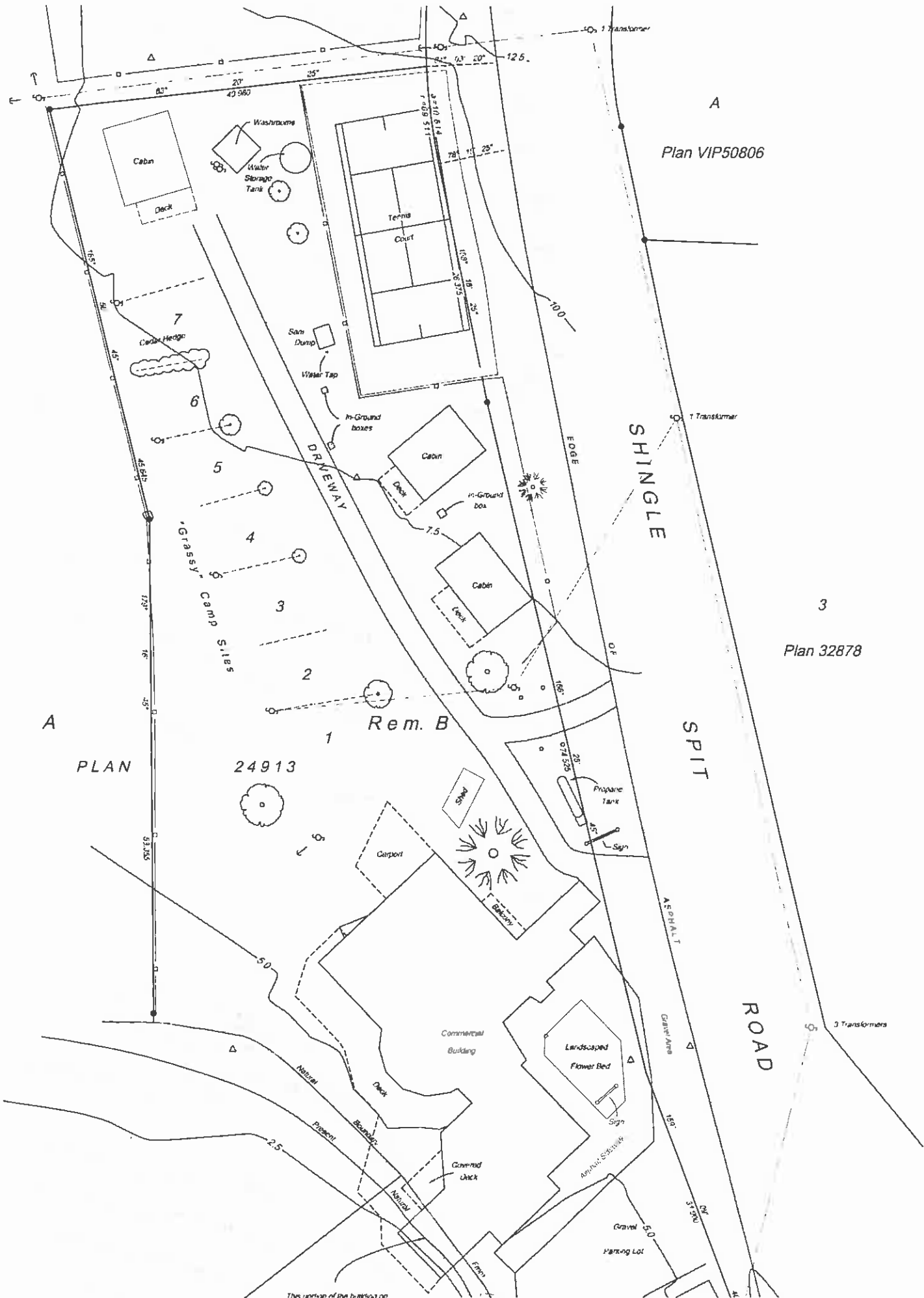
TOPOGRAPHIC SITE PLAN ON REM. B, SECTION 4A, HORNBY ISLAND, NANAIMO DISTRICT, PLAN 24915, EXCEPT PART IN PLAN 2638RW.

SCALE 1:300

LEGEND

◊ Utility Pole	▲ Contour line - spot height
• Fire Alarm	⊞ Standard access road door
○ Disposal Tank	⊞ Survey marker
⊙ Contactor's box	⊞ Drain
⊙ Fire Alarm	⊞ Alarm
⊙ Valve	⊞ Utility cover

Utility pole - 3 ft x 4 ft
 4000 lbs capacity in upright and second tier
 2000 lbs in second tier
 2000 lbs in second tier
 2000 lbs in second tier



Plan VIP50806

Plan 32878

PLAN

24913

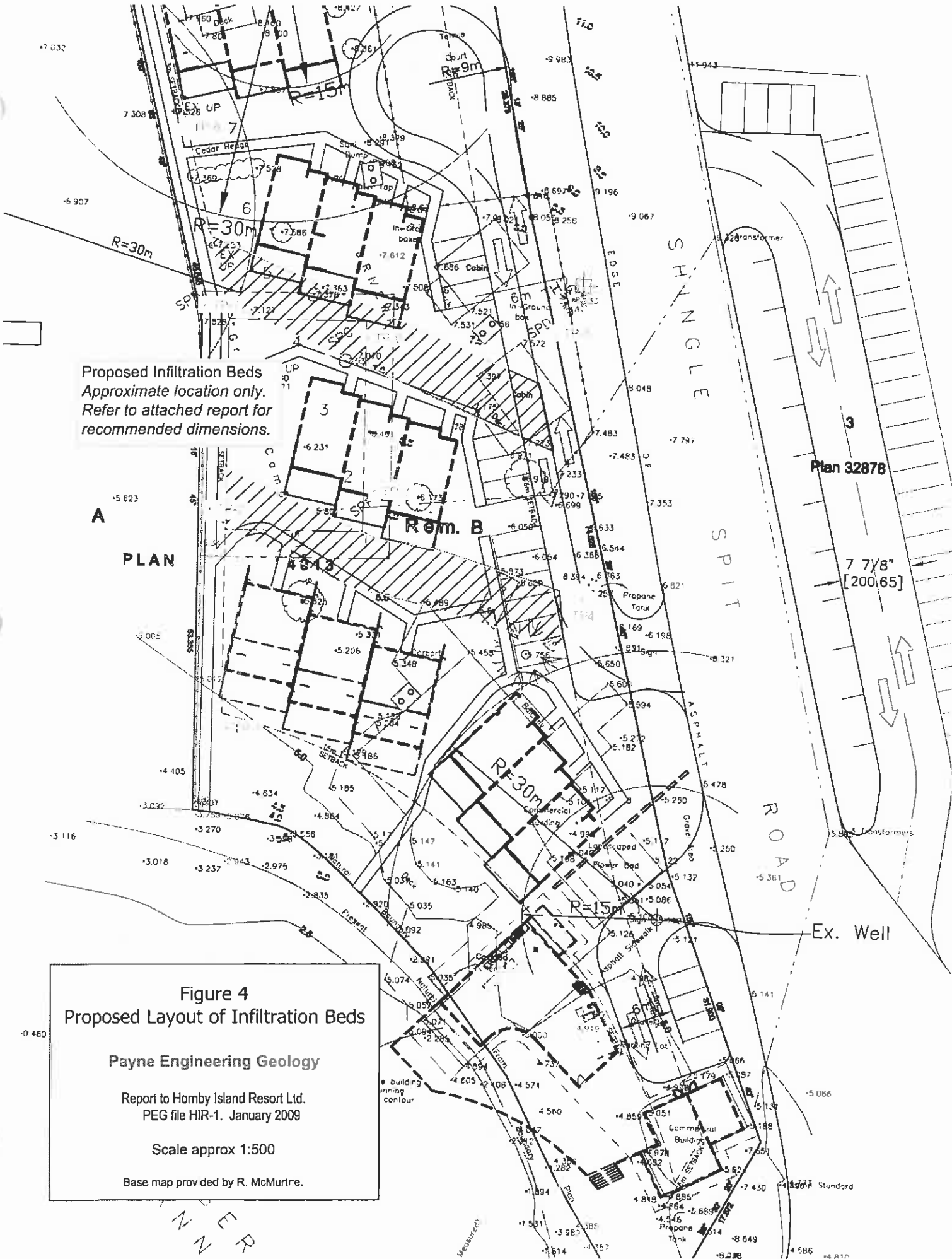
Rem. B

ROAD

The portion of the building on



Figure 3
Proposed Redevelopment of the Resort
Payne Engineering Geology
 Report to Hornby Island Resort Ltd., PEG file HIR-1, Jan 2009
 Scale approx 1 : 600
 Base map provided by Blue Sky Architecture Inc.



Proposed Infiltration Beds
 Approximate location only.
 Refer to attached report for
 recommended dimensions.

A
PLAN

Plan 32878
 7 7/8" [200.65]

Figure 4
Proposed Layout of Infiltration Beds

Payne Engineering Geology

Report to Hornby Island Resort Ltd.
 PEG file HIR-1. January 2009

Scale approx 1:500

Base map provided by R. McMurrie.

N
 E
 R

Ron McMurtrie and Associates, Consulting Engineers

5225 Jerow Road, Hornby Island, BC V0R 1Z0
(250) 335-2685 email: jasmurtrie@island.net

November 28 2009

Hornby Island Resort
4325 Stungie Spit Road,
Hornby Island BC
V0R 1Z0

ATTENTION: MR. JOHN ROSS
RE: HORNBY ISLAND RESORT – SEWAGE SYSTEM DESIGN
Project No: 0608

Dear Sir:

Further to our preliminary design work completed in March, 2009 this letter is to confirm that the design of the proposed sewage system for the above noted project is in accordance with the latest version of the BC Sewerage System Regulation, Standard Practice Manual (SPM). Setbacks for the proposed dispersal area (drainfield) are as follows:

"Critical Setbacks"

All drinking water wells (Thatch and neighbouring properties) >30m
Municipal water >15m

"Other Setbacks"

Property Lines: 3m
Water Lines: 3m
Building Dwellings: 3m
Utility Services: 1m

I trust the foregoing meets your needs at this time. If you have any questions or require further information please do not hesitate to contact my office.

Yours truly


Ron McMurtrie, P. Eng