Technical Memorandum No. 7

Regional District of Kitimat-Stikine

Lakelse Lake/Jackpine Flats
Stage 2 Liquid Waste Management Plan
Review of the Current Septic Tank Disposal Trench Designs

August 2006
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Regional District of Kitimat-Stikine
Lakelse Lake/Jackpine Flats
Stage 2 Liquid Waste Management Plant (LWMP)

Review of the Current Septic Tank Disposal Trench Designs

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1 Introduction

Jackpine Flats is a rural residential subdivision located northeast of Lakelse Lake, between Sockeye Creek and Williams Creek. Groundwater from the area ultimately flows into Lakelse Lake. The existing subdivision is constructed on very coarse gravel/cobblestone soils with a fairly high water table. Residential water supply is by individual wells and sewage disposal is by individual household septic tank and flow distribution fields.

There is potential concern that some of these septic systems may not be performing as intended, and, as a result, may be causing environmental problems. Additionally, there is a general concern that agricultural activity including the keeping of animals; and the importing of large quantities of "hog fuel" for lawn development may also be contributing to possible groundwater contamination. These sources may contribute to the discharge of nutrients (nitrogen and phosphorus) and/or fecal contaminants, including fecal coliforms, to the ground and surface waters, resulting in potential problems with drinking water source contamination and/or algal and aquatic weed growth, fish toxicity in Lakelse Lake.

The Jackpine Flats area is currently zoned for 2-acre, 5-acre, and 10-acre parcel sizes. However, there is some pressure to allow further subdivision. The Regional District of Kitimat-Stikine (RDKS) is concerned with the impact of further subdivision on the environment and specifically, on the groundwater supply for the area and potential contamination of the Lakelse Lake watershed. The soils in Jackpine Flats are very permeable and the depth to groundwater is generally only in the 6 to 7 m range (Downie, 2003). As a result, in order to provide some residence time in the soil beneath the septic tank disposal field perforated piping, the Ministry of Health has, in recent years, been requiring the inclusion of a layer of low permeable soil in the bottom of the disposal trenches to produce "slow drain" trenches.

This technical memorandum reviews the current septic tank disposal field trench designs outlined in the new Sewerage System Regulation to confirm their effectiveness in slowing natural percolation rates and providing adequate treatment. The results have been summarized and recommendations, regarding the use of a trench design for all future Jackpine Flats disposal field designs, have been provided.
This technical memorandum also develops viable strategies to address the older "grandfathered" septic systems that do not have the required "slow drain" disposal fields. Potential strategies include excavation and replacement of the disposal fields using less pervious soils, i.e., soils with more fine-grained materials, or a requirement to implement raised bed disposal fields. While these strategies would work, they would be very disruptive and potentially expensive for the homeowner. As a result, this technical memorandum has investigated and detailed other less disruptive, less expensive alternatives that could achieve the same results, i.e., slower percolation away from and beneath the disposal field pipes. The implementation of such improvements to the older systems could potentially be required under a new RDKS bylaw when the LWMP is completed.

2 Background - Typical On-Site Wastewater Treatment

2.1 Typical On-site Wastewater Treatment System

A typical on-site wastewater treatment system consists of wastewater plumbing from the house, a septic tank, and an effluent treatment system. A diagram showing a typical on-site treatment and distribution system is provided on Drawing No. 032471-SK01. A drainfield, also called a soil absorption field, is the most common type of effluent treatment system.

After preliminary treatment in a septic tank, effluent flows through a tank outlet to a distribution box to a perforated pipe drainfield, and down through filter material, usually gravel, into the soil, where final treatment occurs. A properly designed, installed, and maintained effluent treatment system kills pathogens and filters out solids. Nutrients such as phosphorous attach to soil particles, but nitrate may be carried through the soil by water.

2.2 Drainfield Location

The drainfield or soil absorption field is generally a system of perforated pipes set underground in a bed of crushed rock that allows the effluent to seep slowly into the ground, so that it may undergo further treatment. The site conditions, including slope, distance to surface water, depth to groundwater, type of soil, and location of property lines, wells, and buildings all contribute in the determination of the appropriate location to build a drainfield.

In addition to properly locating the drainfield, sizing the drainfield is also important. The drainfield size is based on a number of factors, some of which are the type of soil, the depth of the water table, and the number of bedrooms in the house (which is an indicator of future water usage based on number of residents). Some soils are better suited for septic systems than others. Well-aerated soil with good permeability is desired. Clay soil will generally have lower permeability and will require a larger drainfield than a system located in sandy soil. Boring or digging holes at several locations on the lot and examining the soil in these holes can assist in determining the type of soil. The location of surface water, such as a lake, and underground water supplies, such as wells, must be identified. Drinking water wells should be located away from a septic tank system and vice versa.
TYPICAL ON-SITE WASTEWATER TREATMENT AND DISTRIBUTION SYSTEM
2.3 Distance to Groundwater or Barrier Layer

An important factor in effluent treatment is the distance wastewater travels through soil before reaching seasonal high water tables, perched water tables, bedrock, or any restrictive layer that prevents water from passing through the soil. Substantial treatment should occur in the first meter of soil below the bottom of the drainfield if the soils are appropriately permeable. To ensure adequate effluent treatment, the bottom of the drainfield should be at least one meter above the seasonal high water table, bedrock or other restrictive layer. When there is less than one meter of vertical distance; bacteria, viruses, and other contaminants may be carried with wastewater directly to groundwater. In this type of situation, an alternative to the traditional drainfield must be used.

2.4 Soil

Soil type is an important consideration for the selection and design of the effluent treatment component of an on-site wastewater treatment system. The rate at which water moves through soil is one characteristic that must be considered.

The soil percolation (“perc”) test measures how quickly water moves through saturated soil. The percolation rate is measured by conducting a soil perc test that determines the number of minutes it takes ponded water in a test hole to drop about 25 mm (1") in elevation. The perc rate is a good indicator of whether a typical drainfield is feasible and, if so, the proper size required for a given wastewater loading rate. The perc test must be conducted in unfrozen and unsaturated ground, in the area where the drainfield will be located.

A good rule of thumb to follow is to ensure the soil percolation rate at the site of a drainfield must be no faster than 5 minutes per 25 mm (1 in.) and no slower than 60 minutes per 25 mm (1 in.) (Hygynstrom et al., 2003). If the soil has a percolation rate faster than 5 minutes per 25 mm (1 in.), installing 30 cm (12 in.) of loamy sand liner with a percolation rate of 15 to 20 minutes per 25 mm (1 in.) in the trench and sizing the system as if that were the natural soil percolation rate would correct the situation. If perc rates are slower than 60 minutes per 25 mm (1 in.), the soils are too tight and an alternative effluent treatment method should be considered.

2.5 Setback Distances

To protect the environment and human health, minimum setback distances are required for the location of the drainfield. Do not use areas subject to flooding, ponding or surface drainage from surrounding areas. Structures such as sidewalks, patios, driveways, garages, and storage buildings constructed over a drainfield will eliminate effective effluent treatment.

The Standard Practice Manual provides minimum required horizontal setback distances. A “Professional” as defined in the Regulation can make deviations from the table presented below. All horizontal setbacks must be measured from the infiltrative surface, (i.e., trench wall) to the nearest edge of the restriction (i.e., well, building).
Table 1
Recommended Horizontal Setback Distances

<table>
<thead>
<tr>
<th>Distance To</th>
<th>From Edge of Distribution System (m)</th>
<th>From Watertight Subsurface Treatment Tank (m)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Lagoon</td>
<td>Type 1</td>
</tr>
<tr>
<td>Property lines</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Source of drinking water, well or water suction lines</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Water lines (pressure)</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Drainage or building perimeter drain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up-gradient</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Down-gradient</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Building non-dwelling</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>Building dwelling</td>
<td>60</td>
<td>3</td>
</tr>
<tr>
<td>With basement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up-gradient</td>
<td>60</td>
<td>3</td>
</tr>
<tr>
<td>Down-gradient</td>
<td>60</td>
<td>9</td>
</tr>
<tr>
<td>Break-out point</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Utility Services</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Fresh water/Marine water³</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

¹Any reduction of horizontal setback distances must be reported to the Health Authority, verified by the site/soil evaluation report and approved by a Professional.
²Any reduction of horizontal setback distances will require installation of environmental monitoring sampling wells to verify compliance with effluent quality parameters. Any setback from freshwater or source of drinking water less than 15 m requires an active local government by-law outlining monitoring and maintenance conditions.
³Measured from edge of water or high tide line.
⁴For mound systems, setback will be from the nearest edge of the required infiltrative area (i.e., trench wall).
3 New Sewerage System Regulation Trench Design

The British Columbia Health Act Sewage Disposal Regulation was repealed and replaced with the Sewerage System Regulation, effective May 31, 2005. The new Sewerage System Regulation replaces the preceding prescriptive Sewage Disposal Regulation with an outcome-based, industry-driven approach. The Stage 2 LWMP Technical Memorandum No. 5 – “Review of the New Sewerage System Regulation” summarized the changes in the new regulation to show how they may impact the implementation of the RDKS Lakelse Lake-Jackpine Flats LWMP.

The British Columbia Ministry of Health Services has developed and issued a Sewerage System Standard Practice Manual to accompany the new Sewerage System Regulation. This Standard Practice Manual provides design standards for sewerage systems handling less than 22,700 L/day of domestic sewage, and which include the following methods of treatment and disposal:

- Septic tanks,
- Sewage treatment plants,
- Disposal fields,
- Treatment mounds, and
- Sewage lagoons (without effluent outlet).

Design criteria and standards for designing trenches for effluent distribution are described in the Standard Practice Manual. The trench construction criteria, as outlined in Section 11.2.2 of the Standard Practice Manual, are provided below:

- Trench bottom to be level across the width and length.
- Trench length must be level or with a positive slope in the direction of flow not exceeding 5 cm in 30 m (2 in. in 100 ft).
- Trench length to be oriented parallel with contour (perpendicular to slope).
- Trenches should have a long aspect ratio, i.e. be long and narrow, to provide equal distribution.
- To have not less than 15 cm (6 in.) drain rock [aggregate] depth between point of discharge and trench bottom.
- To have 5 cm (2 in.) drain rock [aggregate] cover above effluent disposal pipe.
- Cover drain rock with a non-biodegradable, breathable geotextile material or equivalent (i.e., building paper or landscaping cloth).
- Cover trenches with not less than 15 cm (6 in.) of soil or sod.
- Trench soil backfill to be slightly crowned to allow for settling.
- To be graded to provide groundwater drainage away from dispersal area.

The Standard Practice Manual includes the following aggregate (drain rock) specifications:

- Aggregate must be non-biodegradable (concrete rubble is not an acceptable aggregate because it can degrade).
• Effective size range from 2 cm (1/3 in.) to 5 cm (2 in.).
• All aggregate must be washed and screened and contain less than 5% fines, silt or clay coating.

A diagram showing the trench design based on the Standard Practice Manual is provided on Drawing No. 032471-SK02.

In addition to the above mentioned trench design criteria, the Standard Practice Manual also describes how to size and construct the trench, as well as outlines recommendations for an effluent infiltration monitoring well and distribution box. Under the new Sewerage System Regulation, "registered practitioners" and/or "professionals" are responsible for planning, installing, and maintaining the wastewater systems. As such, the Sewerage System Regulation allows the "registered practitioner" and/or the "professional" to design, construct or operate a system based on the site conditions, but outlines the expected outcome of the design, construction, and operation of the treatment system.

4 Trench Design Based On Jackpine Flats Area Conditions

The Jackpine Flats subdivision area is characterized by coarse to bouldery gravel, which has high to very high percolation rates. Even though effective treatment requires percolation rates in the range of 5 to 30 minutes per 25 mm (5 to 30 minutes per inch), the Stage 1 LWMP Technical Memorandum No. 1 – “Summary of Background Studies” stated that the Ministry of Health’s records show some pre-installation percolation rates of well under one minute. These measured percolation rates are likely too fast and may not provide the necessary residence time in the soil for adequate treatment to occur.

Due to the highly permeable soil conditions and shallow depth to groundwater, it is recommended that the criteria for any new trench construction (described in the Standard Practice Manual and outlined in Section 2) in the Jackpine Flats area be modified to include a minimum of 30 cm of loamy sand between the perforated pipe and trench bottom, instead of drain rock. A diagram showing the modified trench design for Jackpine Flats is provided on Drawing No. 032471-SK03.

The 30 cm of loamy sand will increase the residence time of wastewater effluent in the soil, thereby increasing the level of effluent treatment before the effluent reaches the groundwater table. The required length of the new disposal field would be based on the percolation rate of the loamy sand, not the native gravelly soils.

5 Strategies to Deal With Older Disposal Fields

If it is determined that an on-site septic tank system is failing and as a result is no longer treating wastewater effluent, the system must be modified or replaced entirely. Common reasons for failure include:
TRENCH DESIGN
BASED ON STANDARD PRACTICE MANUAL

NOTES
* DRAIN ROCK SIZE RANGES FROM 2cm TO 5cm, CONTAINS LESS THAN 5% FINES, SILTS OR CLAY.
MODIFIED TRENCH DESIGN FOR JACKPINE FLATS
- Improperly sited system in terms of topographic and soil conditions. System is installed in an area with a high groundwater table.
- Improperly sized system. System does not accommodate the experienced flows.
- Improperly installed system.
- Improperly operated and maintained system.

Even if the on-site treatment system is properly designed, installed, and maintained, on-site treatment systems have a limited life. The average age at which septic system failure occurs at is approximately 18 years (Sherman et al., 1998). However, some systems in some areas have experienced failure as early as less than five years. Early failures are typically due to hydraulic overloading. Hydraulic overloading means that the household is generating more wastewater than the septic disposal field can absorb.

Viable strategies to deal with older (existing) “grandfathered” septic systems that do not have the recommended "slow drain" disposal fields include either installing an entirely new system or retrofitting an existing system. The following sections outline strategies to potentially address the older "grandfathered" septic systems.

5.1 Entirely New System

The first option for mitigating an older on-site septic system is to install a brand new disposal field system. If a new system was installed, a few different alternatives could be used depending on the specific site conditions and the recommendations provided by either the "registered practitioner" and/or the "professional" responsible for planning, installing, and maintaining the on-site wastewater system.

A new on-site wastewater treatment system can be comprised of a septic tank with a new pressurized distribution system, a new large distribution bed, a new-layered trench distribution system, or even a new mound distribution system. A packaged-type treatment system could also be installed to treat the wastewater prior to disposal. However, a packaged-type treatment system may be too expensive for each individual household to install and maintain.

Assuming current soil conditions in Jackpine Flats are greater than 61 cm of gravelly sand, according to Table 11-1 in the Standard Practice Manual (which specifies recommended linear loading rates for residential strength wastewater), the recommended wastewater linear loading rate is 60 L/m/day. However, if 20 to 30.5 cm of fine sand and/or loamy sand were added to the trench bottom to increase the residence time in the soil, according to Table 11-1 the linear loading rate would decrease to 34 L/m/day. As a result of the decrease in linear loading rate, and in order to treat the same volume of wastewater generated, the lateral lengths of the perforated distribution pipes would have to be increased to compensate for the increase in residence time and decrease in linear loading rate. Regardless of the type of new system installed, implementing a minimum 30 cm layer of loamy sand below the distribution pipe is highly recommended for the Jackpine Flats area.
area. As a result, the system would be sized according to the soil perc rate of this additional 30 cm soil layer.

5.2 Retrofit - Pressurized Distribution System

To improve overall performance of an existing treatment system, a pump can be added to an existing septic tank and disposal field system. This type of system is typically termed a pressurized distribution system. Due to the highly permeable soil conditions of Jackpine Flats, the gravity flow system currently used may not be successfully distributing the effluent throughout the full length of the lateral effluent distribution pipes. As such, it is possible that only a small section of the distribution bed is being utilized for effluent treatment. This can result in inadequate treatment including a bleed through of nutrients, especially phosphorus (because the soil has a finite phosphorus adsorption capacity).

A pump can be added in the third chamber of a three-chamber septic tank, in an integrated chamber, or in a separate pump tank. Adding a pump to retrofit an existing septic system ensures that the effluent is evenly distributed the full length of the lateral distribution pipes. By doing so, the entire distribution bed can be effectively used to treat the effluent. The pump system works by pressurizing the perforated pipes, and as a result, it evenly distributes the effluent all across and along the distribution network and therefore, also the soil. According to the Standard Practice Manual, 4.7 mm diameter holes for effluent from a septic tank with effluent filter are recommended. For higher levels of treatment, 3.1 mm diameter holes could be used.

The pump operates using either an on-demand pump dosing system which uses a wide angle, single load-rated, float switch or some other type of level control device to turn the pump on/off, or a narrow angle float switch connected to a timer relay housed within a watertight control panel. According to the Standard Practice Manual, a timed dosing is preferred. A timed dosing requires surge capacity in the septic tank/pump chamber.

The Ministry of Health recommends the inclusion of a layer of low permeable soil at the bottom of the disposal trenches to develop a “slow drain” design. If a layer of low permeable soil were to be added, the entire distribution system would have to be excavated and removed prior to adding the soil layer. Therefore, adding a 30 cm layer of loamy sand between the points of discharge (perforated pipe) and the trench bottom of an existing distribution system is not feasible for a retrofit project.

5.2.1 Pressurized Distribution System Using Existing Distribution Piping

The pressurized distribution system described in Section 5.2 may be installed such that the system continues to operate using the existing distribution piping. However, the existing pipe diameter may be too large for a pressurized system and as a result may cause the soil to be overloaded. Effective treatment would not be achieved.
5.2.2 Pressurized Distribution System Using Smaller Diameter Distribution Piping

If the retrofit option described in Section 5.2.1 is not feasible, it is possible to use smaller diameter pipes by inserting a smaller diameter pipe inside the existing larger diameter pipe. A diagram showing this retrofit for existing systems is provided on Drawing No. 032471-SK04.

The smaller pipe would have single perforations, preferably pointed up. When the dosing pressure pump is activated, these small pipes would be completely filled along the length of the distribution system. The jets of effluent from the smaller pipe would enter the large perforated pipe and drain away. The advantage of this system would be to ensure that the entire length of the existing distribution field is fully utilized, thereby providing better use of the capacity of the soils to further treat the effluent.

The details of this type of distribution system, including the pump chamber, the distribution box, clean-outs, etc. are left for the “registered practitioner” or “professional” to consider.

6 Summary and Conclusions

This technical memorandum briefly reviewed onsite wastewater treatment systems currently used by Jackpine Flats residents and the existing soil and groundwater conditions. This technical memorandum also described the septic tank disposal field trench design outlined in the new Sewerage System Regulation to confirm its effectiveness in slowing natural percolation rates and providing adequate treatment.

In order to provide sufficient residence time in the soil beneath the perforated disposal field piping, the Ministry of Health recommends the inclusion of a layer of low permeable soil, i.e. drain rock at the bottom of the disposal trenches. Due to the highly permeable soil conditions and shallow depth to groundwater (6 to 7 m range) in the Jackpine Flats area, this technical memorandum recommends the following:

- Modifying the trench construction criteria described in the Standard Practice Manual to include a minimum of 30 cm of loamy sand between the perforated pipe and trench bottom, instead of drain rock. The addition of the loamy sand layer will increase the residence time of wastewater effluent in the soil, thereby increasing the level of effluent treatment before the effluent reaches the groundwater table.

This technical memorandum also investigated feasible strategies to deal with older “grandfathered” septic systems that do not have the recommended “slow drain” disposal fields. Strategies include installing an entirely new on-site wastewater treatment system or retrofitting the existing system with a pressurized distribution system using either existing distribution piping or smaller diameter
NEW SMALLER DIAMETER PERFORATED PIPE
EXISTING PERFORATED PIPE
SOIL MEDIA (GRAVEL/COBBLESTONE)
WASTEWATER

RETROFIT FOR EXISTING SYSTEMS
USING SMALLER DIAMETER DISTRIBUTION PIPING
distribution piping inserted into the existing distribution piping. Replacing an existing system with an entirely new system would be the most expensive of the available options. A more economical strategy would be to retrofit an existing system with a pressurized distribution system and smaller diameter distribution piping inserted into the existing distribution piping. However, prior to replacing or retrofitting any existing system, a "registered practitioner” or "professional” must assess the site conditions to ensure the correct approach is taken to certify adequate levels of treatment are achieved.

7 References


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