Government of Saskatchewan

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GUIDANCE DOCUMENT FOR DEVELOPMENTS AND SUBDIVISIONS WHERE ONSITE WASTEWATER TREATMENT SYSTEMS ARE PROPOSED

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1.1. Guidance Overview and Relationship to other Saskatchewan Legislation

Onsite wastewater treatment and disposal regulations (*The Private Sewage Works Regulations*) and guidelines are intended to minimize the impact of sewage effluent on water supplies, communities and neighbours. Onsite Wastewater Treatment Systems (OWTS) are not just temporary installations that should be replaced eventually by centralized sewage treatment services, but permanent approaches to treating wastewater for release and reuse in the environment. Onsite systems are recognized as potentially viable, low-cost, long-term, decentralized approaches to wastewater treatment if they are planned, designed, installed, operated, and maintained properly in appropriate hydrogeologic environments.

The overall goal is to protect the environment and human health. This guidance document describes the required considerations for developers and municipalities in various types of locations. Based on both the density of the development and the physical characteristics of the area, a Level 1 or Level 2 Assessment may be required.

This guidance document only addresses the subdivision approval process. The subsequent Sewage Disposal Permit application process addresses the need for a lot-specific site assessment, system design and approval of each treatment system on individual lots. In addition, municipalities that intend on allowing for significant developments relying on onsite wastewater treatment systems are encouraged to use this document as a reference during land use planning exercises.

In areas where *The Shoreland Pollution Control Regulations, 1976* apply, or where municipal bylaws further restrict the usage of OWTSs, the following guide does not apply. This guide only applies to individual or small, shared treatment systems. Larger OWTS (i.e. greater than 18 m^3/day of flow, or municipally owned systems) must receive a permit from the Saskatchewan Ministry of Environment.

Proponents are encouraged to consider communal wastewater management options as an alternative to onsite wastewater treatment systems. For larger developments, life-cycle costs of communal systems are often less than properly managed onsite wastewater treatment systems. Where communal wastewater management options that fall within the scope of the *Environmental Management and Protection Act, 2002* are proposed, proponents do not need to complete the assessment contained within this guidance document. In these cases, the Ministry of Environment should be contacted.

1.1.1. Holding Tanks

It should be noted that holding tanks can currently be installed in all locations. However, for new developments, the following requirements should be met prior to considering the use of holding tanks. They are:

- Local sewage hauler: The proponent must identify a local sewage hauler in the area who agrees to remove sewage[1]. During the application process, the regulatory authorities may chose to confirm the information regarding the sewage hauler and their ability to perform the additional work.
- Approved disposal location: The proponent must identify a final disposal location of the holding tank waste that is in compliance with the Saskatchewan Ministry of Environment's Acts, Regulations and Codes.
- Service agreement: The proponent must provide evidence that the municipality in which the development is located will ensure that an approved disposal location is utilized.

The installation of all OWTS, including holding tanks, must be permitted and may be inspected before being approved by the regulatory authorities in accordance with the provisions of *The Private Sewage Works Regulations* and the information contained in the most recent version of the *Saskatchewan Onsite Wastewater Disposal Guide*. Assessments are not required in cases when holding tanks are proposed if both Community Planning and the regulatory authorities agree that the site conditions and/or regulatory constraints are such that only holding tanks will be possible in the future.

Although the regulatory authorities may support a proposal involving individual OWTS and permit their installation, the authorities do not assume responsibility for the failure of the system(s), for correcting the damage to adjacent properties, or for the construction of OWTS. This is the responsibility of the proponent and the owner(s) of the system(s). Owner(s) of holding tanks or OWTS's are responsible to ensure that a health hazard is not created. Where regulatory authorities determine that a health hazard is present, the owner will be required to remedy the situation in order to comply with *The Public Health Act, 1994*.

The next sections are designed to provide guidance on the level of subdivision or development site assessments required to assess whether OWTS are suitable. The type of the site assessments ranges from no subdivision assessment required, to Level 1 and Level 2 Assessments. Under certain conditions, a Cumulative Assessment may also be required. The type of site assessments required initially is determined based on the density (Section 1.3) of the proposed subdivision/development. Regulatory authorities may or may not ask for additional site assessment work depending on their review of the initial assessment materials.

[1] Information regarding sewage haulers can be obtained from the Saskatchewan Ministry of Environment.

1.2. Vadose Zone Characteristics of Proposed Subdivision/Development Site

Based on public health risk evaluation, acute health effects from pathogen exposures are of greatest concern. As a first step, the proponent must assess whether the proposed OWTS site(s) have the capability of attenuating pathogen loads in the vadose zone before OWTS effluent reaches shallow groundwater. The recommended approach to address vadose zone retention time for pathogen attenuation is to evaluate OWTS technical solutions for the specific soil conditions to achieve sufficient pathogen removal. No subdivision where OWTS are proposed will be approved it cannot be shown that OWTS will provide adequate protection of a Supply Aquifer against pathogens.

Fractured geologic environments require more detailed investigation, specifically including assessment of channeling to aquifers. See Section 3.3 regarding aquifer isolation.

1.3. Density of proposed subdivision/development

The density of the proposed and surrounding development should be determined for each subdivision application. Though the discussion below uses an area of ¼ section (i.e., 160 acres), this can be viewed as any continuous site of similar area (i.e. ½ mile by ½ mile, or 800 m by 800 m). The density of an area may be determined by final development plans for the immediate area of the subdivision based on discussions between the applicant and the Municipality regarding zoning bylaws and Official Community plans.

The average parcel size is determined by using the sizes of those lots, or parcels, subdivided from the existing piece of land. The lots included in the calculation should only be those lots where a typical single family residential unit and OWTS will be located. Lots where a building with an occupancy other than a single family dwelling may require a weighted average. The calculation does not include roads, parks, contingency or utility areas, which will initially remain undeveloped, but may be relied on for reinstallation of new septic systems if the first system(s) fail to perform to expectations.

1.3.1. Low Density Area

All subdivisions/developments are considered low density where:

- Less than 5 existing or proposed residential units are located on a ¼ section; **or**
- The average parcel size associated with each existing or potential residential unit is greater than or equal to 4 hectares (10 acres), with no parcel in the ¼ section smaller than 1 hectare (2.5 acres).

1.3.2. High Density Area

Subdivisions are considered high density where:

- Forty or more existing or proposed residential units will be located on a ¼ section; **or**,
- The average parcel size associated with each existing or potential residential units is less than 1 hectare (2.5 acres) and more than 4 (four) residential parcels.

1.3.3. Medium Density Area

If a subdivision development is neither low or high density, it is considered a medium density area. In general, a medium density subdivision is characterized by between 5 and 39 existing or potential residential units on an equivalent ¼ section and/or equivalent residential densities on smaller parcel sizes.

1.4. Definitions

Approving Authorities include those agencies with approval roles for new subdivisions/developments. Community Planning of the Ministry of Municipal Affairs is the approving authority for new subdivisions. The municipality is the permitting authority for any new development within an approved subdivision or on an existing parcel of land.

Conceptual Hydrogeological Model is a semi-quantitative framework of available data that describes how water enters, and eventually leaves a hydrogeologic system. It is typically an idealized graphical representation in plan and cross-section (or block) diagrams that incorporates assumed physical boundaries of the flow system (e.g. appropriate site boundaries and/or watershed divides), the subsurface hydrostratigraphy, material properties like hydraulic conductivity, groundwater levels and flow directions, and groundwater sources (e.g. recharge, surface waters) and sinks (e.g. surface waters, well pumping). Conceptual model development typically requires a review of literature and data in the project area and a good hydrogeological foundation. Information on how to develop, and examples of, conceptual groundwater models can be found at:

http://www.connectedwater.gov.au/framework/conceptual_models.html ;

http://va.water.usgs.gov/online_pubs/FCT_SHT/Fs099-99/fs099_99.pdf ; and

http://www.ccme.ca/assets/pdf/pn_1144_e.pdf.

Contingency areas are areas that will remain undeveloped in the development/subdivision as planned. These areas may be relied on for reinstallation of new septic systems if the first system(s) fail to perform to expectations.

Cumulative impacts are the combined environmental impact that can occur over time from a series of similar or related actions, type of contamination, or projects. Although each action may seem to have a small or negligible impact, cumulative impacts can accumulate over time, and the combined effect can be detrimental.

Cumulative impact assessment is the process of predicting the consequences of cumulative impacts as defined above.

Hydrogeological sensitive areas are those areas known to be susceptible to contamination based on existing geology and groundwater conditions. This is difficult to determine prior to study initiation; however, the determination of whether the area is hydrogeologically sensitive should be an outcome of a Level 1 or 2 Assessment. In general, this will include areas with permeable soils, shallow groundwater tables, and/or near surface permeable fractured rock or sediments.

Regulatory authorities include agencies with authority and/or interest in this issue. They can include the Ministry of Environment, Ministry of Health, Regional Health Authorities, Saskatchewan Watershed Authority, and Ministry of Municipal Affairs.

Residential Unit is based on one typical dwelling occupied by a single family. Residential units are calculated based on the volume and quality of the wastewater discharge into an OWTS that is generated by facilities (e.g. residential, industrial, commercial, and institutional, etc.) in comparison to the volume and quality of wastewater from a typical single family dwelling.

Supply Aquifer is any groundwater aquifer that is potable, and therefore is being, or could be, used to supply drinking water.

2. Description of the Subdivision/Development Site Assessments Process

Based on the details of the proposed subdivision development, either a Level 1 or a Level 2 Assessment may be required in order to evaluate the potential for successful long-term utilization of OWTS in the subdivision development. The proponent can determine which type(s) of Assessments need to be conducted initially, based on the proposed subdivision/development details (Figure 2). In essence, the greater the density and potential impacts, the more advanced the assessment required.

This Subdivision Site Assessments Process will benefit developers, homeowners, and the general public, as the assessment(s) will result in appropriately designed and located OWTS. Adherence to recommendations made in the Site Assessment(s) should reduce the occurrence of unexpected requirements and limited choices in future OWTS construction. Completion of the Site Assessment(s) and following the associated recommendations will also help to protect public health and the environment by safeguarding the site and the region in which the development is proposed.

The intent of this process is for the proponent to demonstrate a sufficient degree of understanding and evaluation of site conditions such that the potential impact of the proposed development can be shown and methods of mitigating adverse effects determined. All calculations and assumptions to do this must be documented in the assessment(s).

The assessment(s) will be used by regulatory authorities (i.e. Ministry of Municipal Affairs, Ministry of Environment, Regional Health Authorities and the Saskatchewan Watershed Authority) as a basis for commenting on a subdivision application proposing to use OWTS. In some cases, the regulatory authorities may determine that they have sufficient existing evidence, and not require additional assessment(s). However, in these cases, the project proponent must still suggest an onsite treatment methodology and support that selection based on available information. In other cases, the authorities may require additional work in order to ascertain an appropriate level of risk.

Project proponents are encouraged to submit a subdivision assessment with to the approving authority their completed subdivision application. If the proponent does not submit an assessment with the subdivision application, it must be submitted, where required, prior to issuance of the subdivision approval. Early submission of the assessment will allow for a more timely review by regulatory authorities. However, failure to submit the assessment with the initial subdivision application will not result in the application being denied. It should be noted that the assessment may result in changes to parcel sizes, services, roads or other details of the development proposal. Therefore, proponents choosing to complete the assessment after subdivision application may incur additional costs.

In cases where holding tanks are proposed, this Site Assessment Process will be required unless the regulatory authorities explicitly agree that site specific technical details make an assessment not necessary. For instance, the Site Assessment Process may not be considered necessary if the land makes an onsite system virtually impossible, or other legislation or regulation restricts the type of system used.

Each proposed lot will usually require an individual site investigation as part of the Sewage Disposal Permit application process to be completed at the time of OWTS construction. The submission of the Assessments contained in this guidance does not meet the requirements for a Sewage Disposal Permit for all OWTS installations. The local Regional Health Authority must be contacted for approval to construct any OWTS.

The objectives of the Assessments outlined in subsequent sections of this guideline are as follows:

- To provide technical guidance to professionals involved in land development to assessing the potential for unacceptable groundwater impacts resulting from the use of individual OWTS, through an assessment process; and
- To ensure that proposals are submitted with the required technical support to allow the regulatory authorities to either support the proposed subdivision/development, to ask for more detailed site evaluation to reach a decision, or to recommend against approval.

The regulatory authorities recognize that many aspects of the Site Assessment Process, including the development of conceptual hydrogeological models, the assumptions required for predicting the fate of effluent constituents like nitrate-nitrogen, the use of nitrate-nitrogen as the critical contaminant etc., may not be technically supported in every case. Regulatory authorities recognize that as research continues, new information, approaches, and technologies may become available which warrant minor or substantial revisions to this guideline.

Project proponents or other organizations are encouraged to retain, on their behalf, professionals with demonstrated expertise in hydrogeology, specifically, those with expertise in developments that reply on onsite wastewater treatment systems. Their role is to assist in reviewing studies or reports prepared in accordance with this Guideline.

Proponents or other organizations should have Level 2 Assessments conducted by scientists or engineers with professional accreditation that is appropriate to hydrogeology. Further, approved Level 2 Assessment reports should be made publicly available so that a body of knowledge begins to develop with the consequent continual improvement of the conceptual hydrogeological model.

This guideline **does not apply** to the following:

- Developments where municipal or communal sewage disposal systems are proposed;
- The assessment or approval of individual OWTS for residences that are not in a subdivision; or,
- The assessment of impacts from existing OWTS.;

2.1. Assessment Inclusion Criteria

Subject to 2.1.1, an assessment of the onsite sewage treatment and disposal practices in a subdivision development will be required in either of the following two scenarios:

1. Scenario A
   - The proposal includes an average lot size per residential unit (not including residual land) of less than 4 hectares;
   - After development is complete, more than 9 residential units are present:
     - on the quarter-section where the proposed development is located; or,
     - within 0.4 km (1/4 mile) of the proposed subdivision (including previously approved, proposed in a previous concept plan, and existing developments).; and,
   - Exclusion criteria (see section 2.1.1.) do not apply.

2. Scenario B
   - The proposal includes an average lot size per residential unit (not including residual land) of greater than or equal to 4 hectares; not including residual land;
   - After development is complete, more than 15 residential units are present:
     - on the quarter-section where the proposed development is located; or,
     - within 0.4 km (1/4 mile) of the proposed subdivision (including previously approved, proposed in a previous concept plan, and existing developments).; and,
   - Exclusion criteria (see section 2.1.1.) do not apply.

2.1.1. Exemption Criteria

In the following three scenarios, a study is encouraged but not required.

1. Where the proposal:
   - will result in less than 16 residential units on a quarter section;
   - does not contain any parcels smaller than 1 Ha; and
   - results at least 1.6 km (1 mile) between the quarter-section upon which the development is proposed and any quarter section upon which an existing medium or high density area is situated. (See the Area of Consideration in Figure 1.); or

2. Where the proposal:
   - will result in less than 16 residential units on a quarter section;
   - does not contain any parcels smaller than 1 Ha;
   - is in an area that is not sensitive; and

- Where the proponent can demonstrate to the satisfaction of the regulatory authorities that there is no significant risk to the environment (e.g. sewage effluent is hydrogeologically isolated from existing or potential supply aquifer(s)) and human health (e.g. sewage effluent will not degrade groundwater quality in more shallow aquifers to an unacceptable level). Significant information, such as previous studies or other technical evidence, to support this assertion must be submitted by the project proponent; or,

3. Where the proposal is the separation of one or two existing residential units from an area of land that is intended to remain farm land.

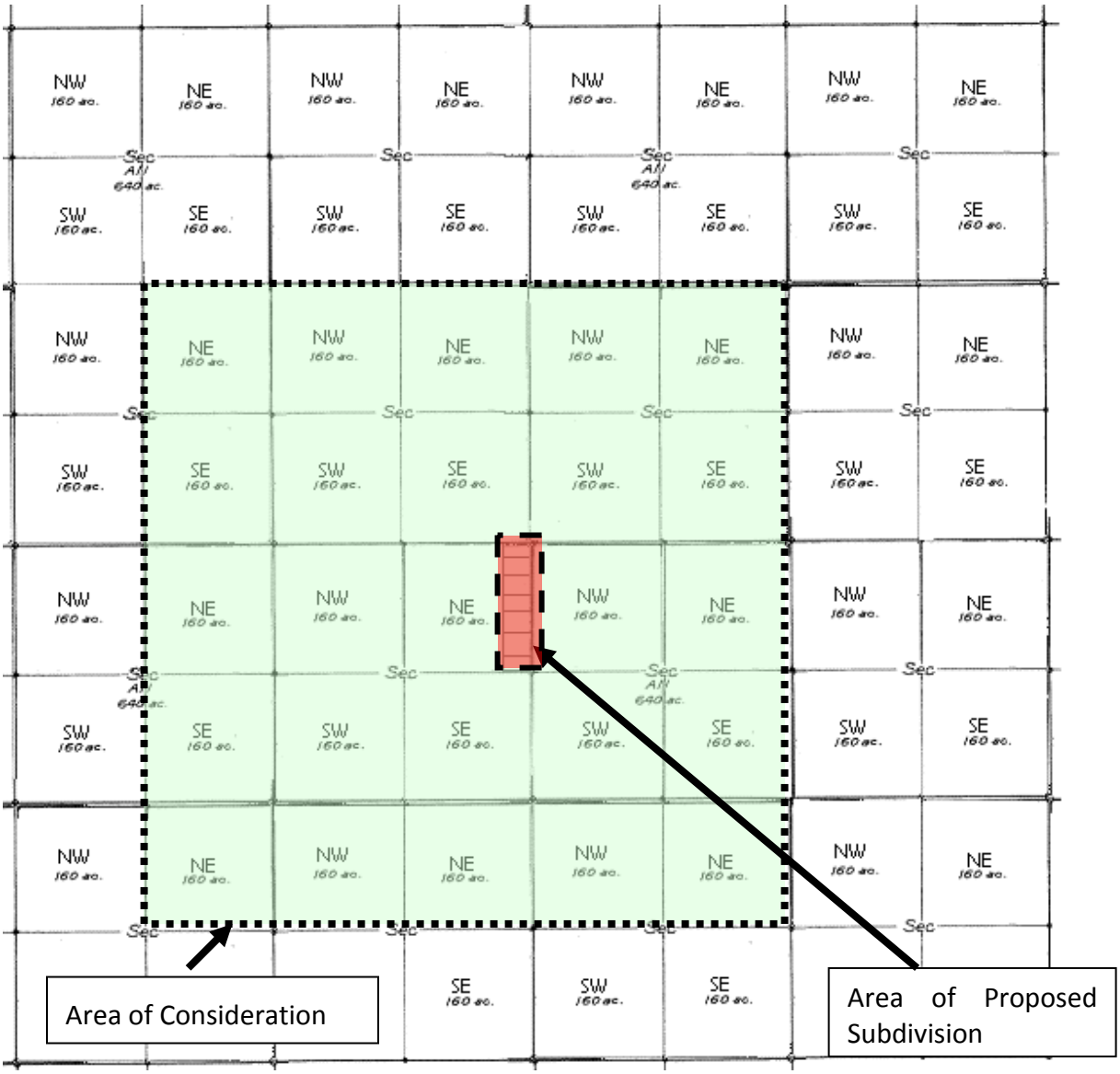


Figure 1 - Isolation Exemption - Area of Consideration

Where a study is not conducted, there is no assurance that any type of onsite wastewater treatment system can be installed on the parcels. There are some types of soils that are not suitable for any onsite wastewater treatment systems if the lot is smaller than 4 Ha. In these cases, holding tanks are the only onsite wastewater system that will be approved and the municipality will be expected to ensure that there is an approved disposal location for the wastes generated. In these scenarios, it is strongly recommended that a communal wastewater treatment system is installed for the development.

2.2. Note regarding Sensitive Areas and Conditions

It is important to note that even though a proponent may meet the requirements for a particular the type of Assessment in this guideline, the regulatory authorities reserve the right to require a more detailed level assessment on any site deemed to be particularly sensitive, or with unusual conditions. In addition, even though a proponent may meet the requirements for an exemption, the regulatory authorities reserve the right to require an assessment on any site deemed to be particularly sensitive, or with unusual conditions. The likelihood of this occurring is greater where:

- The development proposed has a higher density than previous developments in the area;
- The scale of the proposal is such that an increased degree of assurance is appropriate, or;
- It is known that pre-existing high levels of groundwater contamination by nitrate-nitrogen and/or pathogens exist in the region.

Although the regulatory authorities may support a subdivision application involving OWTS on a sensitive area or under sensitive conditions, the regulatory authorities do not assume responsibility for failure of the system(s), for correcting damage to adjacent properties, or for the construction of new OWTS. This is the responsibility of the proponent and/or owner of the system.

3. Data Collection and preliminary site evaluation

The first required step for any assessment is data collection – desktop and field data. The basic requirements for desktop data and a field program are listed below. Additional data and more detail are required for a Level 2 Assessment. Analysis and reporting requirements are described in Sections 4 (Level 1 Assessment) and 5 (Level 2 Assessment). The key requirement is *representative* data, which may differ on a site-specific basis, and which must be defensible as such by the developer/consultant.

3.1. Desktop review

A desktop review of available geological and hydrogeological information must be conducted prior to conducting the preliminary field program. The review should include but not necessarily be limited to:

- Topographic maps (ideally at a scale of 1:20,000 or better).
- Soil and aggregate reports.
- Geology maps (Note that regional scale maps are available on the Saskatchewan Watershed Authority website).
- Hydrogeology reports or publications for the region.
- Hydrogeologic or septic suitability reports for adjacent subdivision developments.
- Available water well records (Saskatchewan Watershed Authority).
- Available reports for nearby developments.
- Air photo and/or orthophotos of area.

3.2. Field Program

Based on the results of the review of available information, a field program must be designed. The purpose of the field program is to conduct a preliminary assessment of the feasibility of onsite wastewater treatment systems in the development. The program should include:

- A field survey of existing monitoring and/or water wells to establish the depth to the water table, water table gradient, etc.
- A field inventory of water supply wells within 1.0 km of the proposed development should be conducted to verify and update the provincial water well database. This survey should also include all springs and dugouts that access shallow ground water. The results should also determine the number of down-gradient wells within 1.0 km that could be potentially impacted by the proposed development.
- Test-pits to identify any restrictive layers, stratigraphy, texture, structure, water table information, and to determine near surface conditions. The number of test pits (to a minimum depth of 3 meters) must be sufficient to delineate the local geological and hydrogeological conditions. A justification for the depth and number of test pits selected must be included in the final report. Proponents and contractors should ensure that all Occupational Health and Safety requirements for excavations are met.
- Borehole drilling, logging, and the installation of groundwater monitoring wells where there is not sufficient subsurface data (e.g. water well records) below the depth of test pitting for use in the desktop review.
- Representative soil grab samples from both test pits and drilling should be analyzed in the laboratory to determine the grain size distribution for soil classification and estimate hydraulic conductivity where appropriate. The report should justify the number of samples as sufficient to determine representative conditions.

- Where tractable, groundwater monitoring wells should be fully developed, sampled for water quality, and monitored for fluctuations in water table elevation. A number of representative groundwater samples (from either water wells or monitoring wells) should be collected for analysis of samples for major ions (specifically including chloride since it can be a conservative tracer of OWTS effluent), and water quality and redox analyses for constituents like nitrate, total coliforms, *E.Coli*, dissolved oxygen, and reduced iron. The consultant/proponent should be prepared to support the number of samples taken and location of standpipes as representative.

Note: In the case of fractured geologic environments, a more detailed investigation, specifically including assessment of channeling to aquifers, is required. See Section 3.3 regarding aquifer isolation.

3.3. Evaluate supply aquifer isolation

Developments will normally be considered as low risk where it can be demonstrated that sewage effluent is hydrogeologically isolated from existing or potential Supply Aquifer(s) and will not degrade groundwater quality in more shallow aquifers to an unacceptable level. In making this assessment, the proponent and/or the consultant must evaluate the most probable groundwater receiver for sewage effluent: its definition must be defended by hydrogeological data and information obtained through a test pit and/or test drilling program. The potential for OWTS isolation from groundwater aquifers must be assessed on a site-specific basis. In some cases, it may also be necessary to demonstrate isolation from sensitive surface water environments.

When it is demonstrated that the sewage effluent will not enter water supply aquifers, the lot density of the proposed development may be dictated by factors such as wastewater treatment and disposal system replacement (or contingency) areas (if proposed), and by the minimum setback distances, such as between the OWTS and wells (as defined by *Saskatchewan Onsite Wastewater Disposal Guide*).

3.3.1. Report requirements for aquifer isolation

If aquifer isolation is ascertained, an abbreviated assessment report may be submitted for subdivision approval. This report should include Part 1 (i.e. details about the proposed subdivision/development) of the Level 1 Report (Section 4.1) along with sufficient interpretation of the hydrogeological data reviewed and collected at the site to defend the conclusion of isolation.

3.4. Evaluate vadose zone conditions

Soil conditions and vadose zone depth should be assessed to determine whether sufficient retention time would be attained for pathogen removal, and whether there is sufficient ‘safety’ to that retention time to allow for virus attenuation.

Pathogens are the most critical acute hazard from OWTS. Sufficient steps MUST be taken to sufficiently reduce the risk of pathogens entering potable water supplies.

Depending on the OWTS technology employed, differing levels of pathogens are removed within the treatment system, with the remaining being discharged into the soil. Proper operation of the OWTS depends on unsaturated soils (i.e., the vadose zone) removing the remaining pathogens from the effluent prior to it entering the groundwater.

Pathogen removal within the vadose zone is dependent on the pathogens being retained long enough to be sufficiently subjected to environmental conditions that result in their inactivation or die-off. Retention time is dependent on how quickly the effluent will flow through the soil, which is governed by the soil's hydraulic conductivity. Since hydraulic conductivity can vary by several orders of magnitude between different soils, the required vadose zone depth to yield a sufficient retention time will be dependent on the hydraulic conductivity of the soil present at any given site.

Thus, specifying a single vadose zone depth that needs to be met at all sites would result in being significantly overly cautious for some sites (with slow hydraulic conductivities) and significantly under-protective for other sites (with fast hydraulic conductivities). Instead, a performance-based approach is employed to reduce the likelihood of being unnecessarily cautious or restrictive, but also to be sufficiently protective.

Based on currently available scientific knowledge and conventional OWTS configurations, a minimum effluent retention time of 60 days through the vadose zone is likely necessary to achieve at least a 3-log (i.e., 99.9%) removal of the pathogens. Given this retention time, the required vadose zone depth can be determined, based on site-specific hydraulic conductivity field measurements. Table 1 gives some examples of the vadose zone depth, as measured from the infiltrative surface (e.g. bottom of dispersal trench, etc) to the water table, necessary to provide sufficient retention time under various hydraulic conductivities. Actual depths should be based on site-specific soil measurements.

Table 1 - Examples of vadose zone depths to provide a 60 day hydraulic retention time

Soil Type	**Unsaturated Hydraulic Conductivity** [(1)] **(m/day)** (indicative examples)	**Depth needed (m)** (for 60-day retention time)
Sands - *wet* [(2)]	0.1 m/day	6.0 m
Sands - *damp* [(2)]	0.017 m/day	1.0 m
Silts - *wet*	0.017 m/day	1.0 m
Silts - *damp*	0.004 m/day	0.25 m [(3)]

Clays - *wet*	0.002 m/day	0.13 m [3]
Clays - *damp*	0.0001 m/day	0.006 m [3]

1. Assumes absence of macropores, such as fractured soils.
2. In this example, "wet" refers to 90% saturation, and "damp" refers to 60% saturation. Conductivities extrapolated from Figure 4 of Schaap and Leij 2000. Actual conductivities to be determined on a site-specific basis.
3. Recommended minimum vadose zone depth is 1.5 m (see Saskatchewan Onsite Wastewater Disposal Guide).

Consideration should also be given to whether this retention time (and hence, vadose zone depth) provides sufficient pathogen removal. The critical factor is the level of uncertainty in the characterization of soil conditions within the vadose zone. Areas with greater variety in soil conditions should either be assessed more thoroughly (to reduce the uncertainty) or have more protective assumptions placed on them (i.e., require deeper vadose zones). Other factors that may need to be considered include whether fractured soils/bedrock (or other macropores and similar features) are present which will dramatically reduce effluent retention time within the vadose zone.

A subdivision development using OWTS will not be approved unless it can be shown that the proposed OWTSs will provide adequate protection of a Supply Aquifer against pathogens. In some cases this may require incorporating more stringent pathogen treatment components within the OWTS (e.g. package treatment plants).

4. Level 1 Assessment Report

The goal of the Level 1 Assessment is to develop a sufficiently robust conceptual model (i.e. schematic diagram) of the site hydrogeology to evaluate the fate of OWTS effluent in the subsurface and groundwater system.

The Level 1 Assessment report should include a description and interpretation of a preliminary conceptual hydrogeological model, in addition to information about proposed and existing parcels and OWTSs. Conclusions on the fate of OWTS effluent in the context of the conceptual hydrogeological model, and recommendations on whether OWTS use is protective of human health and the environment must be included in the assessment.

The conclusions and recommendations of the Level 1 Assessment should consider the suitability of each proposed lot and the overall subdivision for onsite wastewater treatment and disposal. Specifically, conclusions and recommendations should describe any site restrictions, alternative design criteria, treatment potential, impact of treated effluent, mounding concerns, and other technical issues/topics related to onsite wastewater treatment and disposal. It is expected that these conclusions be based on current scientific knowledge and properly referenced in the report.

Note: Reports that evaluate communal OWTS impacts based solely upon requirements for individual OWTS that are found in the *Saskatchewan Onsite Wastewater Disposal Guide* will be rejected by the regulatory authorities.

4.1. Level 1 Report constituents

The Level 1 Assessment report should include the following five parts:

(1) Details about the proposed subdivision/development.

Site drawing(s) and associated report sections should include the following for the proposed and *surrounding areas*, including:

- the development/subdivision area, including identification of all parcels and lot boundaries;
- the number of existing (or proposed) parcels on surrounding quarter sections (or other adjacent areas);
- description of the proposed land use and type of development expected;
- proposed and existing sewage systems in the area and their set-backs;
- existing and proposed water supply points (including private water wells), including their depths and the expected formations that they will be screened in;
- any reserve or contingency areas proposed for development/subdivision;
- surface drainage characteristics present or planned that may affect the system(s);
- identification of any cuts, banks, slopes, or other features that might cause stability concerns created by a proposed on-site system;
- identification of any vegetation indicative of soil moisture conditions;
- description of the type of on-site systems and typical installation and design information;
- estimation of the anticipated or typical sewage volumes used in the assessment; and
- other appropriate and relevant information.

(2) A preliminary conceptual hydrogeological model (e.g. On-Site Wastewater Treatment Systems in Subdivisions (2009), Section 4.1.4) and associated water budget. At a minimum, drawings in this part of the report should include the following information for the proposed subdivision *and surrounding* area:

- regional and local hydrogeology and geology information;
- springs, dugouts or water wells accessing shallow groundwater for domestic purposes;
- any surface water bodies, whether perennial or ephemeral, that may be affected by OWTS;
- existing or planned drainage courses;
- topographic contour lines;
- water table and/or piezometric surface contours for individual hydrogeologic units;
- any relevant separation distances;

- at least one vertical cross-section that illustrates the preliminary hydrogeological conceptual model of regional and local groundwater system(s), the identification of all aquifers being used for well water supplies, and schematic diagrams indicating where the groundwater plumes of OWTS effluent will travel in the subsurface; and
- Climate conditions (including, for instance, estimates of precipitation, evapotranspiration, and groundwater recharge).

(3) Soils information. At a minimum, this part of the report should include the following information for the proposed subdivision and *surrounding* area:

- The predominant soil series or mapping unit of the subdivision area, and any significant minor soil series shown on soil maps in the area; and,
- Summary of soil information (soil logs should be appended to the document) including:
  - Describe the soil profile (texture, structure, and parent material) of expected soil series on the site;
  - Describe soil moisture conditions and indicators of soil moisture conditions;
  - Describe permeability or drainage classifications/characterizations;
  - Identify any soil water or soil structure and/or characteristics that might affect soil suitability, system design, and location of the system;
  - Identify any soil moisture conditions that will adversely affect suitability for onsite systems; and
  - Include any evidence of a seasonally high water table.

(4) Complete a preliminary assessment of the fate of OWTS effluent, using nitrate-nitrogen as an indicator, **and** a comparison of the fate of OWTS effluent with proposed and existing water supply aquifer(s).

Available information should be used to estimate the potential recharge to the site via infiltration of precipitation and the subsequent fate of the OWTS effluent in the subsurface according to the conceptual hydrogeologic model. Recharge rates should be scientifically determined. They are likely to be based on available literature, meteorological data, and the nature of the soils beneath the soil treatment system and down gradient areas as determined during the test pit program. The results can be used in conjunction with the average daily sewage flow to estimate the potential for dilution of nitrate-nitrogen in groundwater. Emphasis should be given to predicting where nitrate and other contaminants could travel in the long term and their ultimate cumulative impact on aquifers (particularly those being used for water supply), wetlands, stream and lakes.

If there is significant natural groundwater recharge at the site (i.e. central and northern Saskatchewan), dilution of OWTS effluent by natural recharge before reaching by the down gradient property boundary can be considered for this preliminary assessment.

Arguments for other attenuating mechanisms can also be incorporated if adequately supported by scientific research or field monitoring data. All assumptions used in the preliminary OWTS effluent and nitrate impact assessment should be stated and substantiated.

Detailed predictions of the shape of individual contaminant plumes and a description of specific contaminant concentrations over space and time are not required for a Level 1 Assessment, although they should be approximated in the conceptual model so the predicted fate of the OWTS effluent in the subsurface is clear. The hydrogeologic unit that the OWTS effluent ultimately resides in should be shown in the context of the water supply aquifer(s) and well sites.

(5) Classify the Subdivision/Development's suitability for OWTS, and recommend locations.

Considering the information collected in the Level 1 Assessment, the report should classify subdivision/development's suitability for the proposed type of OWTS as:

- Unsuitable except for holding tank
- Severe limitations
- Moderate limitations
- Well suited

The report should also illustrate the optimum location and orientation of the proposed OWTS, considering wastewater treatment and disposal design and water supply issues.

Parts 1 through 5 can be used to determine the proposed number of lots. However, where it has been demonstrated that the sewage effluent will not enter supply aquifers, the lot density of the proposed development may be dictated by factors such as OWTS replacement areas (if proposed) and by the minimum set-back distances for individual on-site systems (and their contingency areas).

5. Level 2 Assessment

5.1. Additional Field program requirements

In general, a more detailed analysis and resulting conclusions must be completed in a Level 2 Assessment. This will typically involve all of the activities included in the Level 1 Assessment and additional drilling, core logging, and installation of groundwater monitoring wells in order to obtain an improved understanding of the subsurface, and to support a more robust site hydrogeology conceptual model. It also involves additional hydrogeological interpretation.

In addition to the information contained within the Level 1 assessment, proponents required to submit a Level 2 Assessment must perform a more detailed analysis that includes (but is not limited to) the following:

The field program should include a door-to-door inventory of:

- water supply, irrigation, or industrial water wells within 1.0 km of the proposed development (and any high pumping rate wells in a larger area). The condition and details of local wells, including the method of construction, water level, pump intake and well depths, water use, general water quality and suitability of the well for future monitoring, if required, should be determined. All springs and dugouts that access shallow ground water should also be included. The proponent should estimate the number of down-gradient wells within 1.0 km that could be potentially impacted by the proposed development and the uses of these;
- municipal/communal wells within 1.5 kms down-gradient should be located; and
- any onsite wastewater systems (except holding tanks) within 1.0 km of the proposed development.

Where warranted, the hydrogeological conceptual model should include

- field estimates of hydraulic conductivity (i.e. from single well tests, single well pump tests, and/or pump tests with monitoring wells); and
- field-measured vertical and/or horizontal hydraulic gradients.

In addition to the Level 1 Assessment requirements, storm water management features and a minimum of two geological cross-sections should be included on the site drawings.

When determining the type of OWTS to be used, the proponent should also consider proposed water supply characteristics that may affect OWTS long-term performance.

When considering impacts, the proponent should identify the existence of any surface water body that may be impacted by the OWTS in the subdivision. A preliminary Nitrate Impact Assessment is NOT required *per se* in the Level 2 Assessment, but may come out of the Cumulative Assessment.

6. Cumulative Nitrate Assessment

A cumulative nitrate assessment may be required to assess whether the development's OWTS, in conjunction with other local and regional nitrate sources, can cause concentrations of nitrate-nitrogen in groundwater to be such that the environment and/or human health are adversely affected.

6.1. Cumulative Nitrate Concentration from Regional Sources

A cumulative nitrate assessment is the evaluation of all known and planned sources of nitrate in a region that could influence surface or groundwater quality. It includes estimating or modeling the influence of these sources on the nitrate concentration in groundwater at the down-gradient boundary of the proposed subdivision. It should be required only if the probability of intercepting an OWTS effluent plume by a well at the down-gradient subdivision boundary is greater than 90%.

The cumulative nitrate assessment includes the following key steps:

- Construct a conceptual model of all significant regional point and non-point nitrate sources (e.g. within a 1 km radius of the proposed development) such as:
  - point sources: OWTS; golf courses; feedlots; lagoons; landfills; industrial facilities; etc.
  - non-point sources: agricultural sources, including manure and sludge spreading and fertilizer application; industrial activities; etc; and,
- Estimate (model) nitrate contributions (mass loading) from each of the sources, and their potential influence on the nitrate concentration profiles in the aquifer beneath the proposed development and down-gradient of that development. Predictive assessment such as described in Section 6.2.3 may be used as applicable and justifiable.
  - Field verify nitrate loading estimates and nitrate concentration profiles (emphasize the proposed development footprint and 1 km down-gradient of the proposed development). Monitoring-based assessments such as described in Sections 6.2.1 and 6.2.2 may be used as applicable and justifiable.;
  - For point sources, identify existing or install new sampling wells down-gradient, in the plume (confirm that plume is sampled by using chloride tracer or other appropriate plume markers); and,
  - For non-point sources, make use of existing wells down-gradient of the non-point areas; and,
- Use estimated and field verified aquifer nitrate concentrations, along with well capture zone calculations, to predict nitrate concentration in well water in those cases where an OWTS effluent plume is likely to be intercepted by a well. Apply this concentration to the risk characterization phase of the subdivision assessment.

6.2. Monitoring and Predictive Based Assessments

The regulatory authorities recognize that groundwater, infiltrating precipitation, and sewage effluent will not be completely mixed at the property boundary. It is also recognized that processes such as absorption, denitrification, filtration and biodegradation may attenuate contaminants as the effluent passes moves through the unsaturated zone into the saturated zone.

Since these processes are extremely difficult to quantify, they are usually only considered as a safety factor. However, if the consultant/proponent can provide satisfactory documentation to the regulatory authorities regarding the presence and extent of these processes onsite, their impact on nitrate concentrations can be considered. As discussed below, there are a number of ways in which this can be done.

6.2.1. Monitoring Existing Development

In some situations, there may be nearby developments replying on OWTS in a similar hydrogeological environment. If this development has been in place for a lengthy period of time, information on existing groundwater quality could be used to demonstrate the combined effect of all available attenuation processes to assess the impact of the proposed development. The onus is on the proponent and/or the consultant to demonstrate adequately that:

- the existing and proposed developments are located in similar hydrogeological environments;
- sewage effluent (quantity and quality) from the existing and proposed developments are comparable; and
- monitoring produces results which accurately represent water quality conditions beneath the existing development and ideally identify that treated OWTS effluent is present in the subsurface (by using tracers like chloride, etc).

The consultant and/or proponent must provide a clear rationale for the number of times the site is sampled, the period of time over which the sampling has been undertaken (capturing seasonal variations), and the rationale for the use of this information in the assessment.

6.2.2. Monitoring Phased Development

In situations where there is no existing development, it may be possible to develop lands considered in the planning document in phases, beginning with the up-gradient portion. Information obtained from monitoring effluent discharged from OWTS in the up-gradient phase, and its impact on groundwater, can then be used to determine the extent to which the down-gradient portion of the site can be developed. Before recommending the approval of such a phased development, the regulatory authorities must be satisfied that adequate planning controls, based on discussions with the Municipality regarding zoning bylaws and municipal development plans, are in place to regulate development of the down-gradient portion of the site.

6.2.3. Predictive Assessment

The following considerations and assumptions should be used in assessing the combined nitrate load of individual OWTS and other point and non-point nitrate sources at the boundary of residential developments in a predictive sense:

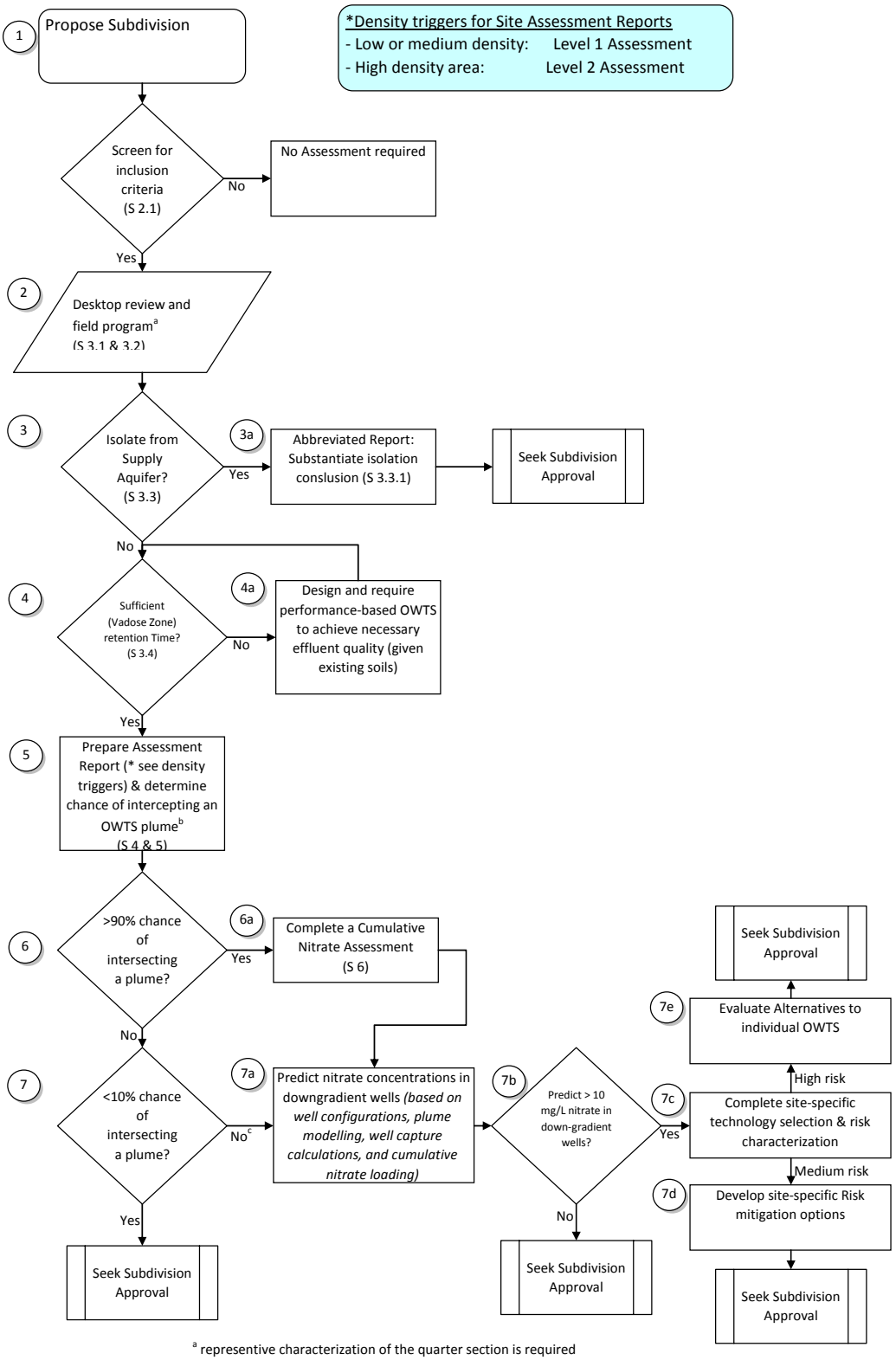
- Contaminant Source: In most cases, total nitrogen (all species) converted to nitrate-nitrogen is considered as the critical contaminant. For the purposes of predicting the potential for groundwater impacts, total nitrate loading and an average day flow should be selected and supported by the proponent.;
- Contaminant Attenuation: Only dilution will typically be accepted by the regulatory authorities as a quantifiable attenuation mechanism for nitrate unless there is clear evidence for groundwater denitrification in the hydrogeological unit being evaluated. The fate of bacteria must also be considered.
- Dilution with infiltrating precipitation. Mixing with groundwater flowing through the site will normally not be allowed because it is usually not possible to control upgradient land uses. 'Flow through' will not be considered where sensitive hydrogeological conditions exist. However, where upgradient lands have been fully developed for a considerable period of time, the quantity and quality of groundwater flow available to dilute the effluent entering the receiving groundwater may be considered.
- Published groundwater recharge estimates should be used if available for the region. If not, the amount of precipitation and evaporation should be obtained from Environment Canada. Where available, reliable, long-term, site-specific information, obtained for detailed water balance and/or groundwater studies, can be used. Estimates of the amount of water that infiltrates into the ground must be based on site specific factors such as soils, topography, surface geology, and impermeable areas (including roof tops and paved areas).
- The volume of sewage effluent, if used as dilution water in mass balance calculations, should be based on the average day flow.
- Mathematical (computer) models may be used to assess the impact potential. Although the selection of model software will be left to the proponent, the regulatory authorities must be provided with information on the model's validation and how its limitations and assumptions affect the results. All model simulations must include appropriate sensitivity analyses.

The proponent must use a dilution model that is reasonable and the selection of the model can be defended to the satisfaction of the regulatory authorities.

7. Risk decision framework

The framework presented in Figure 1 is a risk-based process optimization and decision tree for subdivision OWTS assessments.

The framework encompasses all phases of the necessary and required desktop and field-based assessment, defines when Level 1 or Level 2 assessment reports are required, and points to where and how the data collected and interpreted in the assessments should be used. A cumulative nitrate assessment will be required only when there is a high probability of OWTS effluent interception by a well. The framework includes risk management opportunities for performance-based treatment alternatives and risk mitigation options[2].



[a] representive characterization of the quarter section is required

[b] based on subdivision layout and OWTS orientation with respect to groundwater flow direction

[c] i.e., predicted chance of intersecting a plume between 10% and 90%

Figure 2 - Risk-based framework for subdivision OWTS assessment

7.1. Step-by-step narrative of the framework

When a developer proposes a subdivision where a public wastewater treatment network is economically unfeasible or otherwise unavailable, they will be required to adhere to this Guidance Document for on-site wastewater treatment systems. In some cases a subdivision-level assessment is not required. However, it should be noted that all individual OWTS in Saskatchewan require field-based assessments, including test pits or bore holes for soil characterization, during the Sewage Disposal Permit application process. For all significant developments (Step 1: Section 2.1), a desktop data review and a field program that includes test pits, bore holes and hydrogeological characterization will be required (Step 2: Section 3.1 – 3.2). The most important aspect at this stage of the subdivision assessment is planning and collecting data and samples that are representative of that particular ¼ section (and the immediately surrounding land). The requirements to defensibly achieve representativeness will be site-specific – if the soil, geography and hydrogeology are very homogeneous across the ¼ section, relatively few randomly sited samples can satisfy the representativeness requirement. However, if there is significant variability in any of these parameters, an increasingly larger number of samples will be required. Note at this stage in the framework that an assessment report is not yet required.

Step 3 in the framework is an inquiry of whether supply aquifers are isolated from the OWTS effluent (Section 3.3), either by non-fractured bedrock, impermeable clay seams, significant coal seams, or other means. If it aquifer isolation is determined, developers will need support this (Step 3a: Section 3.3.1) with data collected in Step 2 and an effluent isolation report. This report must include field and desktop data from the development site and adjacent area with sufficient interpretation of that data to support the conclusion that OWTS effluents from the subdivision will be isolated from supply aquifers.

If there is insufficient evidence of isolation, or clear evidence of shallow potable groundwater beneath the proposed development, Step 4 is the inquiry of whether sufficient vadose zone retention time will be achieved (Section 3.4). If this cannot be substantiated, a risk management action takes the process through an OWTS design loop (Step 4a) that allows the developer to evaluate and propose advanced treatment that can achieve the necessary effluent parameters (e.g. pathogen attenuation).

Once Step 4 has been satisfied, either a Level 1 or Level 2 assessment report is required (Step 5: Section 4 or 5), with a subdivision in a high density area requiring a Level 2 report. A required aspect of data interpretation for either assessment report is a calculation of the probability of intercepting an OWTS effluent plume, based on subdivision layout and OWTS orientation with respect to groundwater flow direction and velocity. If this calculation shows greater than 90% probability of plume interception at the down-gradient boundary of the subdivision (Step 6), a cumulative nitrate assessment (see Section 6) is required (Step 6a: Section 6), following which nitrate

concentrations should be predicted for down-gradient wells (Step 7a). If the probability of plume interception is between 10% and 90% (Step 7), the cumulative assessment is not required – proceed directly to Step 7a to predict nitrate concentrations (see On-Site Wastewater Treatment Systems in Subdivisions (2009), Section 2.4.7).

The inquiry in Step 7b is whether concentration of nitrate in well water (if a plume is intercepted by the well) exceeds the drinking water nitrate guideline of 10 mg/L of nitrate-nitrogen[2]. If the 10 mg/L value is exceeded, a site-specific technology selection process and risk characterization is required (Step 7c). This characterization should carry the probability of plume interception from either Step 6 or Step 7 and characteristics of the receptors (people) residing in and down-gradient of the subdivision. Unless there is compelling evidence to support a statement that infants or pregnant mothers would not reside in or visit residences that use shallow groundwater supplies, we must assume that this susceptible population will be present.

Therefore, the final evaluation of risk compresses down to the probability of a well intercepting an OWTS plume. If this probability is between 10 and 90%, a number of risk mitigation approaches (Step 7d) are available to reduce the chance of exposure or the concentration of nitrate to which one is exposed. If the probability is high (> 90%), risk management requires the developer to assess alternatives to individual onsite wastewater treatment systems for wastewater treatment (Step 7e).

At three stages – following Steps 3a, 7 and 7b – the developer can move on to seek subdivision approval from the Ministry of Municipal Affairs. Additionally, developers can seek approval following risk management actions in Steps 7d or 7e, and subsequent amendments to the subdivision development plan.

[2] To retain conservatism in the risk framework, the 90th percentile from the predicted nitrate nitrogen concentration should be used to address the inquiry in Step 7b.

8. References

The list below is provided to assist potential contractors. It is not a complete list of literature that may need to be reviewed or obtained as part of this project.

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Appendix A - Saskatchewan Subdivision Assessment Working Committee

This document was developed under the guidance of a task group that included participation from:

- The Saskatchewan Watershed Authority, Hydrology and Groundwater Services;
- The Saskatchewan Watershed Authority, Policy and Risk Management
- The Ministry of Environment, Municipal Branch;
- The Ministry of Health, Population Health Branch; and,
- The Ministry of Municipal Affairs, Community Planning Branch

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