Cumulative Effects Assessment (Water Quality and Quantity)
Best Practices Paper for Below-Water Sand and Gravel Extraction Operations in Priority Subwatersheds in the Grand River Watershed

September 2010

Context

Legislation and Policy

In Ontario, aggregate extraction is governed by numerous pieces of legislation, regulations, and policies, including the *Aggregate Resources Act* (ARA) administered by the Ministry of Natural Resources and the *Planning Act* administered by the Ministry of Municipal Affairs and Housing.

Pursuant to the ARA and the Provincial Policy Statement, 2005 (PPS), aggregate resources must be made available as close to markets as possible and managed to minimize social and environmental impacts. The responsibility for granting licences to extract aggregate resources in Ontario rests with the Minister of Natural Resources.

The 'principal of development' is established through *Planning Act* approval processes. The *Planning Act* enables municipalities to control land use planning within their jurisdiction through Official Plans, zoning by-laws, and other planning tools. In this regard, municipalities must be consistent with the PPS and conform to other provincial plans such as the Greenbelt Plan and Growth Plan for the Greater Golden Horseshoe. Before aggregate extraction can proceed, planning approvals must be obtained from the municipality. In addition, municipalities review and provide comments to the Ministry of Natural Resources (MNR) regarding aggregate licence applications and amendments.

Because watersheds are naturally-defined systems, their boundaries do not align with political boundaries (e.g., regional municipalities, counties, cities, or townships). Conservation Authorities (CAs), including the Grand River Conservation Authority (GRCA), were established to manage natural resources at a watershed scale. Under the terms of the Conservation Authorities Act (s.20) "the objects of an authority are to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals."

As part of its responsibilities under the Conservation Authorities Act, the GRCA administers Ontario Regulation 150/06. Permission from the GRCA is typically required to develop in river or stream valleys, wetlands, shorelines or hazardous lands; alter a river, creek, stream or watercourse; or, interfere with a wetland.

The GRCA is also a 'public commenting body' under the *Planning Act*. As such, it reviews and comments on municipal planning and development applications from a watershed perspective. In addition, the GRCA has delegated responsibility from the MNR for municipal plan input and review for natural hazards to ensure that municipal policies are consistent with the PPS (Section 3.0 – Natural Hazards).

The GRCA also reviews and comments directly to the MNR with respect to aggregate licence applications and amendments. Aggregate operations are exempt from Ontario Regulation 150/06 and permits for aggregate extraction are not required from the GRCA.

Grand River Watershed Characterization

The Grand River watershed is the largest in southern Ontario. Stretching about 300 kilometres from Dundalk in the north to Port Maitland on Lake Erie, the Grand River and its tributaries, including the Conestogo, Nith, Speed and Eramosa rivers, drain an area of almost 7,000 square kilometres.

Approximately 925,000 people currently reside within the Grand River watershed, the majority living in the cities of Kitchener, Waterloo, Cambridge, Guelph, and Brantford (GRCA Website). About 7 per cent of the land is urban, 67 per cent is agriculture, and 19 per cent is forest cover.[1]

According to the 2006 census, the Regional Municipality of Waterloo was the fourth–fastest growing urban area in the province, with a growth rate of approximately 9 per cent between the years 2001-2006. The *Growth Plan for the Greater Golden Horseshoe* forecasts continued high rates of growth for the watershed to 2031.

The majority of people residing in the watershed (approximately 82 per cent) rely on groundwater for their water supply, while the remainder depend on surface water sources. The City of Brantford and the Six Nations of the Grand River Territory extract 100 per cent of their domestic water supply from the Grand River.

Issue

A number of factors make the Grand River watershed an important source of close to market aggregate resources in the province, including:

- Favourable geologic conditions;
- Robust population and employment growth;
- Proximity to the Greater Toronto Area (the 'market'); and,
- Depletion of aggregate reserves in other close to market jurisdictions.

The wise management of all of the natural resources in the watershed, including water and aggregate, is essential to ensure a sustainable and healthy watershed which continues to meet the present and future needs of its growing population for clean drinking water and aggregate resources.

Background

In 2005, the Townships of North Dumfries and Puslinch asked the GRCA to "*… request support from the Grand River Watershed Municipalities for a moratorium on the extraction of aggregate below the water table until such time as appropriate studies have been completed on the cumulative effect on the water table on critical ground water and surface water resources*."

Given the importance of water quality and quantity to the health and well-being of watershed residents and the natural ecosystem, the GRCA Board supported the request. The GRCA Board directed staff to

[1] Source: Lake Erie Source Protection Region Technical Team. 2008. Grand River Watershed Characterization Report - Draft. Cambridge, ON: Grand River Conservation Authority. Pages 25, 110. http://www.sourcewater.ca/swp_watersheds_grand/Characterization_Grand.pdf

work with the MNR and the aggregate industry to develop a plan that avoided issuing new or amending existing licences for aggregate extraction below the water table in the Grand River watershed until: 1) a watershed-wide cumulative effects study was conducted, and 2) an aggregate extraction strategy that minimizes the impact on the watershed's water resources was developed.

Furthermore, the GRCA Board requested that:

- MNR and the Ministry of the Environment (MOE) secure the appropriate resources and funding to conduct the study and lead the multi-stakeholder initiative;
- MNR involve the GRCA, watershed municipalities, the aggregate industry, and the public in this study; and,
- The Source Water Protection Committee consider the impacts of aggregate extraction below the water table in developing the Source Protection Plan for the Grand River watershed (GRCA Resolution No. 126-05).

Subsequently, the GRCA, MNR, and the Ontario Stone Sand & Gravel Association (OSSGA) established a working group to collaboratively address the concerns raised by the GRCA Board. After discussion and preliminary analysis, the working group re-evaluated the feasibility of undertaking a cumulative effects assessment for the entire watershed. The working group concluded that such a comprehensive study was not possible for a number of reasons including the lack of resources, data, and science. Instead, the working group drafted a set of principles to guide future discussions and commitments to action (Appendix A).

These principles highlight:

- The importance of water and aggregate resources to the Grand River watershed;
- The need for more comprehensive and consistent data collection and monitoring protocols in order to assess cumulative effects; and,
- Commitments to jointly develop a best practices paper for assessing and addressing cumulative effects.

The principles were accepted by the GRCA in 2007 (GRCA Resolution No. 149-07). At that time, GRCA Board requested that MNR provide an opportunity for watershed municipalities and the public to review and provide comments on the best practices paper and to complete this work as quickly as possible.

This best practices paper has been developed collaboratively by the working group in accordance with the agreed-to principles.

Applicability

This best practices paper provides guidance for assessing cumulative effects potentially resulting from a new or amended licence application[2] for below-water[3] sand and gravel extraction in the Grand River watershed.[4] It is not inherently transferable to other watersheds.

[2] A major amendment to the ARA is required to change an existing above- water sand and gravel extraction operation to a below-water sand and gravel extraction operation.

[3] Below-water sand and gravel extraction means the excavation of sand and gravel from below the water table. The water table is established using the ARA provincial standards and is defined as 'the surface of an unconfined water bearing zone at which the fluid pressure in the unconsolidated medium is atmospheric'. Generally the ground water table is the top of the saturated zone.

Consultation

Comments from watershed municipalities, other agencies, aggregate producers, non-government organizations, and the public regarding this general approach were used to refine the best practices paper and will be used to develop an implementation plan.

Review

Since the assessment of cumulative effects is an evolving science informed by new methodologies and information, the MNR, MOE, OSSGA, and GRCA have agreed to review this approach on a regular basis, as needed, but not less than every two years.

1.0 Introduction

The Grand River watershed is subject to a number of pressures that impact water quality and water quantity. These pressures include population growth, changing land uses, and climate change.

The central part of the watershed has high-quality aggregate resource deposits and landform features that function as important groundwater resources and recharge/discharge zones (e.g., moraines and outwash deposits). These aggregate deposits also supply important construction material used within the watershed and beyond.

Given this background, it is important to assess the potential cumulative effects of aggregate extraction below the water table on water quality, quantity, and ecosystem health from the site scale to the subwatershed scale using sound scientific methodologies. In addition, the full life cycle of the operation needs to be considered so that appropriate site plans, including mitigation measures, buffers, and areas to avoid, are identified and implemented.

The purpose of this best practices paper is to outline a reasonable, consistent, and scientifically-defensible approach to assessing potential cumulative effects of below-water sand and gravel extraction (both new and amended operations) as part of MNR's review/approval process under the ARA.

The best practices paper specifically applies to the priority subwatersheds within the Grand River watershed identified in Figure 1.[5]

Cumulative effects mean "*the combined environmental impacts or potential environmental impact of one or more development activities, including natural resource utilization or extraction, in a defined area over a particular time period*". Cumulative effects may occur simultaneously, sequentially, or in an interactive manner.

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[4] While this paper was developed for sand and gravel extraction operations, these concepts may be cautiously applied to below-water quarry operations. However, quarry operations typically undergo a much more comprehensive assessment due to the complexity of bedrock geology and the common activity of dewatering during operations.

[5] See Appendix A, Principle 7.

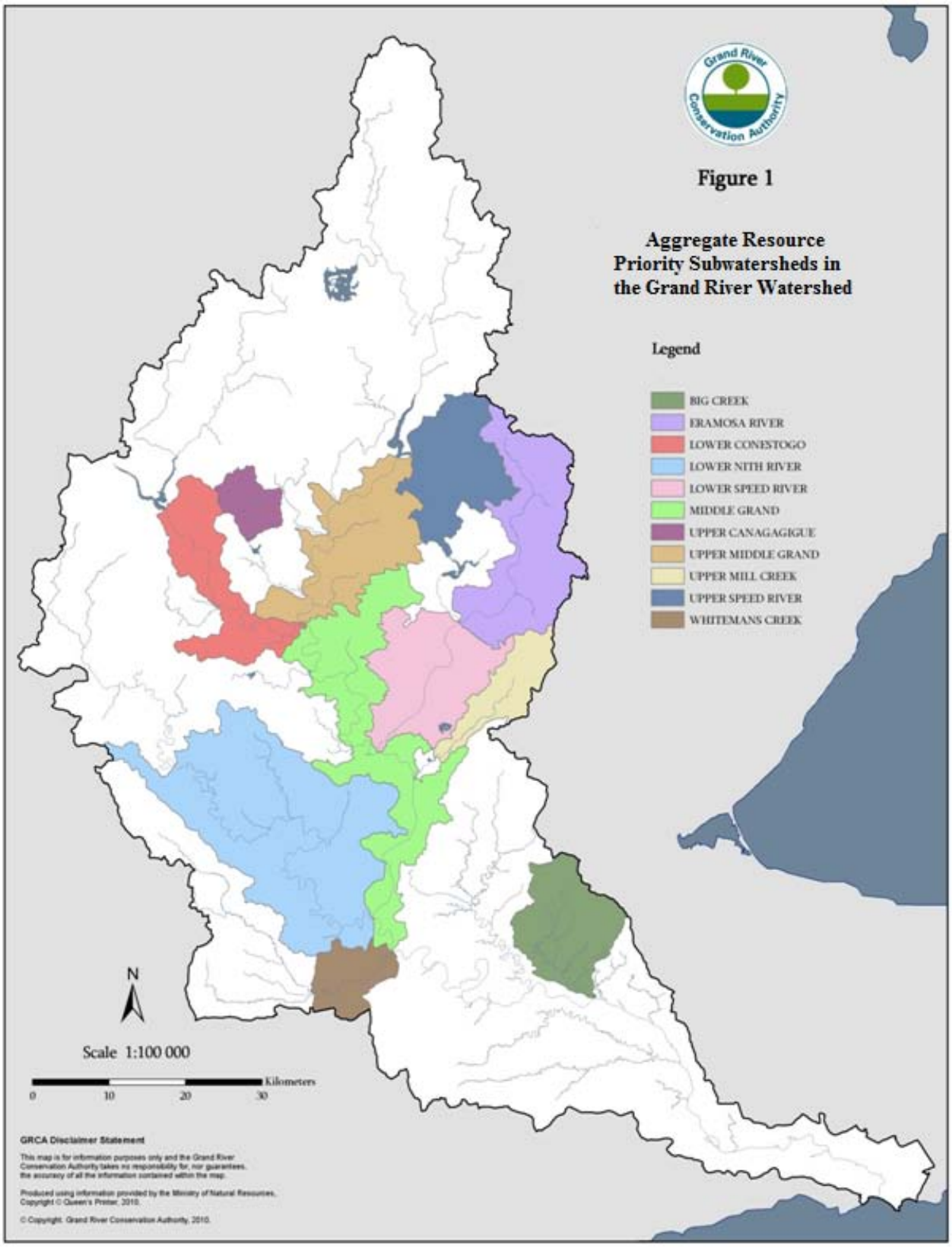
Figure 1
Aggregate Resource Priority Subwatersheds in the Grand River Watershed
Legend
BIG CREEK
ERAMOSA RIVER
LOWER CONESTOGO
LOWER NITH RIVER
LOWER SPEED RIVER
MIDDLE GRAND
UPPER CANAGAGIGUE
UPPER MIDDLE GRAND
UPPER MILL CREEK
UPPER SPEED RIVER
WHITEMANS CREEK
N
Scale 1:100 000
0 10 20 30 Kilometers
GRCA Disclaimer Statement
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Where multiple activities occur in proximity to each other, the potential exists for the impacts resulting from site-specific activities to overlap and combine with the impacts of other activities.[6] The cumulative impact of all of the activities may potentially contribute to environmental degradation. An assessment of cumulative effects should address multiple scales (e.g., from the local to subwatershed scale) and timeframes, in part dictated by the scale and scope of the potential impacts.

Within the Grand River watershed, priority subwatersheds are located where:

- The potential for significant sand and gravel extraction below the water table is high but extraction has not yet occurred or has occurred on a limited basis; or,
- The subwatershed has significant sand and gravel extraction occurring below the water table.

This best practices paper outlines the process an applicant will be encouraged to follow for the assessment of cumulative effects associated with licence applications or amendments to below-water extraction of sand and gravel in priority subwatersheds (Appendix B).

Assessing cumulative effects is good practice. Where there is a licence application or amendment for a below-water sand and gravel extraction operation, the applicant should assess their proposal according to the requirements set out in Sections 2.2 and 2.3.

This best practices paper outlines a general approach to assessing potential cumulative effects that may be associated with below-water sand and gravel extraction operations. It includes guidance for initial screening, data collection and sharing, monitoring protocols, groundwater modeling, and mitigation.

The appropriate scale to collect and analyze data and assess potential cumulative effects includes both the local area and subwatershed levels. The review and/or collection of data at appropriate locations and over an appropriate time period are essential in order to establish a baseline from which to measure impacts. Where available, recent subwatershed plans/studies, other regional studies, and source water protection water budget analyses may provide useful baseline information.[7]

With respect to below-water sand and gravel extraction, potential impacts on water quantity can arise from a combination of:

- Dredging, where groundwater and precipitation replace the sand and gravel that is extracted from the pit pond;
- Evaporation from the pit pond and other processing operations (e.g., wash plants); and,
- The levelling of the groundwater table across the pit pond.

Potential impacts to water quality could result in changes to:

[6] Proximity means the areas identified as being impacted or potentially impacted, identified by the hydrogeological studies required in support of a licence application or amendment under the ARA.

[7] In subwatersheds, there are a variety of land uses that combine and contribute to the overall water balance (e.g., agricultural and golf course irrigation, urban development, municipal water takings, industrial water use, and aggregate extraction). Changes to land use patterns can result in changes to the overall water balance to varying degrees, both positive and negative. To assess the potential impacts of a combination of proposed land use changes and to identify actions to minimize these anticipated impacts, a subwatershed plan/study is usually undertaken, led by the GRCA and/or the municipality. Information contained in existing subwatershed plans/studies can help inform the cumulative impact assessment encouraged in this best practices paper.

- Temperature;
- Biological (nutrients) parameters; and,
- General chemistry.

Hydrogeological studies required in support of a licence application or an amendment under the ARA, currently characterize potential water quantity and quality impacts for each site. Where two or more pits are operating in proximity to each other, or where it has been determined that there may be broader cumulative effects at the subwatershed scale, hydrogeological studies which incorporate cumulative impact assessment will be encouraged. The MNR and OSSGA will work with applicants and licensees to encourage their participation in the approaches outlined in this paper.[8]

2.0 Assessment of Cumulative Effects Related to Sand and Gravel Operations Below the Water Table in the Grand River Watershed

Cumulative impact assessments have several components. The assessment must place the site in context within the surrounding landscape. The subwatershed is the basic geographical unit for assessment. The level of subwatershed considered (i.e., secondary, tertiary, quaternary) in relation to the application needs to be established. To make this determination, the application should undertake an initial assessment which includes spatial, temporal, and incremental impacts.

Data collection needs must also be addressed. Subsequent to data acquisition, other assessment components need to be identified including:
- Monitoring programs;
- Survey data;
- Data reporting format (i.e., common database); and,
- Use of groundwater modelling applications (if warranted).

If cumulative effects are to be properly assessed, data sharing among aggregate producers and regulatory authorities, the GRCA, and municipalities is advantageous in order to obtain a comprehensive view of groundwater/surface water impacts in the subwatershed. In addition, a consistent protocol for monitoring impacts and undertaking potential mitigative actions is encouraged.

2.1 Initial Assessment

An initial assessment should be carried out in consultation with the MNR and MOE, affected municipalities, and the GRCA. Additional information may also be available from nearby aggregate operators and other relevant studies. The assessment should identify and describe the:
- Existing site(s) proposed for extraction;

[8] Incorporating a cumulative impact assessment into a hydrogeological study at a subwatershed scale is different than developing a subwatershed plan/study (see Section 2.3). A subwatershed plan/study is a technical report which describes hydrological and ecological functions and interconnections within a defined drainage area and recommends strategies and targets to protect, restore and enhance water resources and natural systems in advance of land use change. It is usually initiated as a requirement specified in a municipal official plan under the Planning Act. Usually all stakeholders in the subwatershed are invited to participate and sometimes share costs depending on the scale and scope of the work. The requirements for subwatershed plans/studies are beyond the scope of this paper.

- Proximity to licenced above- and below-water sand and gravel aggregate extraction operations and the potential for overlapping cumulative effects including changes to surface water drainage patterns and water balance;
- Proximity to licence applications for proposed above- and below- water sand and gravel extraction operations;
- Degree of environmental degradation existing within the subwatershed, if available (e.g., ground water/surface water quantity and quality, impacts on natural features and functions, ecosystem health);
- Potential impacts on the level of stress that the proposed below- water sand and gravel extraction operation may have, using the most current stress assessment provided by the GRCA;[9]
- Proximity to municipal water wells and intakes, if the information is available;
- Vulnerability of the groundwater resources in the subwatershed and the potential impact that the proposed below-water sand and gravel extraction operation may have on vulnerability (if any); and,
- Other activities or features in the study area that could significantly affect or rely on groundwater resources.

Once screening and scoping is complete, the cumulative impact assessment for a proposed below-water sand and gravel extraction operation should be addressed at the local and subwatershed scales, as set out in Sections 2.2 and 2.3.

2.2 Local Scale Cumulative Effects

Responsibility for assessing local-scale cumulative effects associated with applications for new or amended licences rests largely with the individual proponents, with review by MNR and other agencies (e.g., affected municipality (ies), GRCA, MOE, Fisheries and Oceans Canada (DFO)). The concept of what is 'local' will be addressed on a site-by-site basis, although it is generally implied that it would be the area impacted or potentially impacted by the proposed operation. Local-scale cumulative effects may exceed the property boundaries of the site.

A local-scale cumulative impact assessment should:

1. Characterize the existing conditions at the site and in the vicinity of the site, and during the extractive and rehabilitation stages;
2. Assess the potential impacts to groundwater and surface water resources from the proposed below-water sand and gravel extraction operation relative to the impacts of existing above- and below-water sand and gravel extraction operations for all development stages;
3. Establish monitoring requirements to identify and distinguish between individual and cumulative effects, as appropriate; and,
4. Establish a mitigation and implementation plan, as appropriate.

The ARA provincial standards establish the minimum requirements for Level 1 and Level 2 hydrogeological studies for proposed below-water sand and gravel extraction operations. An understanding of the major elements of potential local-scale cumulative effects can be assessed based on the technical evaluation of:

[9] The most current water budgets and stress assessments carried out under the Source Protection Program are available from the GRCA for all priority subwatersheds. Level of stress is defined by the Ministry of Environment under the Clean Water Act.

- Water wells;
- Springs;
- Groundwater aquifers;
- Surface water courses and bodies; and,
- Discharge to surface water.

As detailed in the ARA provincial standards, potential impacts to the above items should be addressed through:

- Monitoring and management plans;
- Mitigation measures, including trigger mechanisms, if necessary; and,
- Contingency plans.

The responsibility for local-scale cumulative impact assessments will be based on the order in which applications and approvals are received. In other words, each successive applicant should address any overlapping impacts between their proposal and licenced operations in proximity. There is a possibility of multiple applications being received within the same time frame. These application scenarios should be addressed on a case-by-case basis.

The cumulative impact assessment should consider impacts from both a spatial and a temporal perspective. Spatial impacts may occur where impacts from a proposed below-water sand and gravel extraction operation overlap with those from other sand and gravel extraction operations. In addition to elements considered under the ARA provincial standards, overlying zones of influence could potentially impact:

- Wetland hydroperiods;
- Groundwater levels; and,
- Thermal and chemical properties of surface and groundwater.

Temporal impacts may occur where potential operations overlap in time and duration. The applicant should assess cumulative effects resulting from existing conditions and potential impacts that could reasonably be expected to occur in the future (according to site plans or other available information) during different stages of each site's operation and rehabilitation phases. It is recognized that it may not be possible for applicants to obtain all of the desired information regarding other operations and reasonable assumptions may need to be used.

2.3 Watershed/Subwatershed Scale Cumulative Effects

The appropriate scale for this assessment is typically the quaternary-level watersheds (e.g., Mill Creek watershed). A broader scale approach may be encouraged if the proposed aggregate operation drains directly to a higher-level watershed or if reasonably-anticipated potential cumulative effects are likely to occur at a broader scale.

Through a hydrogeological assessment, each successive applicant for a below-water sand and gravel extraction licence or licence amendment, will be encouraged to provide information and analyses that will place the impacts of their proposal into the subwatershed context. The assessment should:

- Compare pre-extraction, operational, and post-rehabilitation for the site;
- Include estimates for precipitation, evapotranspiration/evaporation, run-off, and infiltration/recharge; and,
- Identify the nature and extent of anticipated changes to water quality.

Each successive applicant will be encouraged to prepare an inventory of other below-water aggregate extraction operations in the same subwatershed (either licenced or with an active licence application) and prepare an estimate of the cumulative effects. This estimate should be based on each site at its full operational size (i.e., maximum open water exposure, usually at the end of operations). This analysis will ideally be based on the assessment prepared and submitted for each site as part of the application for licence. The MNR will facilitate access to this information on cumulative effects.

The GRCA and MNR will review the cumulative impact assessment provided by the applicant. The GRCA will advise MNR about the significance of the cumulative effects at the subwatershed scale. In the event that the cumulative effects within the subwatershed are deemed significant, the applicant will be encouraged to develop and implement a mitigation plan, in collaboration with the MNR, MOE, GRCA, affected watershed municipalities, and other willing water takers in the subwatershed.

3.0 Other Assessment Considerations

3.1 Data Collection

Data collection is one of the most important components of a cumulative impact assessment. Data collection efforts are needed to support the assessment of:

1) Water quantity (i.e., water balance). Applicants should assess the following, as appropriate:
- Interference to municipal or private wells;
- Lowering of the water table (temporary, seasonally, yearly);
- Quantity of groundwater discharging to or recharging from surface water features including, but not limited to, ponds, streams, wetlands, and/or springs/seeps;
- Effect of water taking and changes in hydraulics from activities (e.g., aggregate washing, inflow due to aggregate removal);
- Changes in the quantity or pattern of groundwater recharge and discharge;
- Change in hydraulics from the creation of surface ponds; and,
- Effect of permanent surface ponds on surface water or groundwater quantity.

2) Water quality. Applicants should address the following, as appropriate:
- Potential changes in groundwater/surface water temperature, chemistry, and biology (i.e., nutrients);
- Potential changes to the vulnerability of groundwater resources; and,
- Potential impact of the creation of ponds on existing surface water or groundwater quality or temperature.

3.2 Establishing a Monitoring Program

The assessment of potential cumulative effects requires a coordinated collection and storage of data. Complications arise if data are referenced to different benchmarks, established using different coordinate systems, collected at different times or at different frequencies, or collected using different methodologies.

In priority subwatersheds, the following steps will enable the creation and maintenance of a common monitoring database, supplemented by existing data available from other agencies and aggregate producers.

- **Select Monitoring Area**

The monitoring area will be defined taking into account the area potentially impacted by licenced sand and gravel extraction operations and licence applications for below-water sand and gravel extraction operations. The monitoring program will be designed to detect impacts to the groundwater and surface water systems. Collection of data at appropriate locations throughout the monitoring area should commence prior to extraction taking place in order to establish a baseline from which to measure the nature and extent of change.

- **Establish a Common Survey Datum**

A common survey datum, NAD83 (or any updates) will be used so that new data collected can be easily compared. Where possible, data collected as part of existing operations should be converted to the common datum.

- **Create a Common Data Collection Database**

A standardized digital relational database will be developed that sorts and merges data from all licenced operations. The design will accommodate all monitoring points, all categories of data and different data collection scheduling (frequency), and integrate historical data. Use of a common database will facilitate comparisons among sites.

- **Synchronization of Monitoring Events and Streamlining Data Collection Points**

A data collection schedule will be coordinated amongst the various aggregate operations so that data are collected on a synchronous basis. Monitoring requirements will also be streamlined where duplication of data collection occurs, where possible (i.e., a monitoring point on one site may be very close to a similar point on an adjacent site).

- **Data Collection**

Once the database and coordinated data collection schedule is established, synchronized data from each operation will be collected, compiled, reduced as needed and merged with the historical data in the newly created Standardized Digital Data Collection Database. These data will be made available to government agencies, local operators and the local municipality to assist in any assessment of the groundwater and surface water regimes.

- **Data Sharing/Access**

Access to the common database will be streamlined to ensure ready and reliable access to all relevant data.

3.3 Use of Groundwater Models

The use of numerical groundwater, surface water, or integrated models is one method to quantitatively predict potential cumulative effects. Numerical modelling may be particularly useful in areas with below-water sand and gravel extraction operations in proximity and/or sensitive areas with a lower tolerance for environmental impacts.

Modelling activities can be conducted at either or both of the study scales if/where it is required. At the local scale, it is likely that the applicant would develop a new (or adapt an existing) detailed site-specific model to address the proposed site and cumulative effect assessment analyses. At the broader scale, the GRCA or the municipality may have an existing model that is applicable.

3.4 Monitoring Impacts and Taking Mitigative Action

Interpretation of the monitoring data will have to be conducted to determine if changes to the groundwater and surface water systems represent an impact that warrants mitigative action. If mitigative action is deemed necessary, it will be determined on a site-by-site basis and should be consistent with the conditions specified in the operator's existing Permit To Take Water (PTTW), should one exist. Such action could include (but is not be limited to) additional monitoring, a change in extraction methods, a change to extraction phasing (as defined by the site plan, which would require a major site plan amendment to implement), or cessation of activities. This process (impact and mitigation) will be guided by a mitigation plan (see Section 2.3).

3.5 Data Sharing

Each applicant that undertakes a cumulative impact assessment should provide sufficient documentation in the hydrogeological assessment to permit subsequent applicants to extend the cumulative impact assessment, as necessary. Furthermore, any ongoing monitoring data necessary to characterize and confirm the extent of cumulative effects should be shared (preferably in a consistent and common database) so that both agencies and other operators/applicants can address issues associated with cumulative effects.

Similarly, all potentially-relevant agency data should be shared in a consistent and timely manner to ensure the best and most current information is available to all parties.

3.6 Roles and Responsibilities

GRCA to:

- Provide applicants with access to the most current flow gauging data;
- Provide applicants with access to the water budget and watershed stress level information for priority subwatersheds;
- Participate with MNR and MOE to develop a coordinated data collection schedule for the various below-water sand and gravel extraction operations, streamline monitoring requirements where duplication of data collection occurs, and create a standardized digital relational database;
- Where minimum flow thresholds have not been established, make a recommendation to MNR based on the likely significance of the cumulative effects to minimum baseflow in the subwatershed;
- Provide comments on how the cumulative effects and the proposed monitoring program for the proposed site should be incorporated into any ongoing watershed monitoring programs;

- Review cumulative impact assessments provided by the applicant and advise MNR about the significance of the cumulative effects at the subwatershed scale; and,
- Participate in a regular review of the best practices paper with MNR, MOE, and OSSGA.

MNR to:

- Advise applicants of the benefits of completing a cumulative impact assessment when applying for new licences and amendments to extract sand and gravel below the water table in the Grand River watershed and encourage them to follow the best practices paper;
- Prepare and maintain an inventory of all sand and gravel extraction operations within the Grand River watershed (either licenced or with a licence application);
- Participate with MOE and GRCA to develop a coordinated data collection schedule for the various below-water sand and gravel extraction operations, streamline monitoring requirements where duplication of data collection occurs, and create a standardized digital relational database;
- Maintain a common monitoring database for priority subwatersheds;
- Facilitate access to the updated annual water budget information for below-water sand and gravel extraction operation sites within the priority subwatersheds;
- Evaluate the cumulative impact assessment provided by the applicants and make recommendations;
- Where cumulative effects within the subwatershed are deemed significant, the applicant will be encouraged to develop and implement a mitigation plan in collaboration with the GRCA, MOE, watershed municipalities, and other willing water takers in the subwatershed; and,
- Participate in a regular review of the best practices paper with MOE, GRCA, and OSSGA.

MOE to:

- Participate with MNR and the GRCA to develop a coordinated data collection schedule for the various below-water sand and gravel extraction operations, streamline monitoring requirements where duplication of data collection occurs, and create a standardized digital relational database; and,
- Participate in a regular review of the best practices paper with MNR, OSSGA, and GRCA.

OSSGA to:

- Communicate the content and merits of the best practices paper to applicants;
- Encourage applicants to undertake cumulative impact assessments as part of their licence application or amendment for sites within the priority subwatersheds;
- Participate in the regular review of the best practices paper with MNR, MOE, and GRCA; and,
- Encourage members to coordinate common data collection and monitoring requirements.

APPENDIX A

PRINCIPLES

Ontario Ministry of Natural Resources/Grand River Conservation Authority/OSSGA

June 22, 2007

1. Water is an essential resource. The Grand River watershed faces many pressures which impact water quality and water quantity, including population growth, shifting land uses and climate change. Most of the water supply for watershed residents is from surface and ground water. Therefore, it is important that water be protected and managed effectively in order to meet human needs and maintain ecosystem health.

2. Aggregate resources are an essential economic resource to the Province of Ontario and should be protected and made available from close-to-market deposits. Use of close-to-market resources has environmental and health benefits as compared to hauling aggregate from more distance sources.

3. In the Grand River watershed, there is an overlap of significant high quality aggregate resource deposits and landform features that are important for ground water recharge (e.g. some moraines and outwash deposits). It is important to determine the impacts of aggregate extraction below the water table on water quality and quantity and ecosystem health from the site to the subwatershed[10] scale over the full life cycle of the operation so that appropriate avoidance or mitigation measures can be identified and implemented.

4. Ontario has comprehensive legislation and policy in place that governs the review of proposals for aggregate extraction. In order to be approved, proposals for aggregate extraction below the water table must demonstrate that water resources will be protected and that potential impacts will be avoided or mitigated at geographic scales from the site to the subwatershed scale.

5. Review of potential impacts associated with aggregate extraction below the water table should be based on sound scientific principles and experience. Appropriate data collection and ongoing monitoring is a critical component of a science-based approach.

6. An appropriate scale to collect data and determine impact is the subwatershed. The collection of data at appropriate locations throughout a subwatershed is important in order to establish a baseline from which to measure the nature and extent of change as a result of various land use activities. There should be enough data collection points in order to establish change as a result of aggregate extraction or other land use activities.

[10] A subwatershed means a subunit of a watershed, often defined as the drainage area of a tributary of a watercourse. www.waterfronttrail.org/library-glossary.html

7. It is appropriate to focus data collection and cumulative[11] impact assessment in subwatersheds within the Grand River system where:
   - The potential for significant aggregate extraction below the water table is high but extraction has not yet occurred or has occurred on a limited basis, or
   - The subwatershed has significant aggregate extraction occurring below the water table and data are available or could be made available (by enhancing existing monitoring) for analysis.

8. MNR will work cooperatively with the GRCA and the aggregate industry to develop a paper to cumulative impact assessment and best practices from the site to the subwatershed scale. This paper will provide a vital analytical tool for evaluating the potential cumulative effects of new aggregate extraction below the water table and amendments of existing operations below the water table, for identifying the best avoidance and mitigation measures from the site to the subwatershed scale, and for monitoring results. MNR will encourage and advise applicants of the benefits of completing a cumulative impact assessment when applying for new aggregate extraction and amendments to existing operations below the water table in the Grand River watershed.

9. MNR, GRCA and other experts will examine existing data and monitoring programs and suggest alterations to ensure consistent and reliable collection procedures, methods, and reporting protocols in support of cumulative impact assessment. MNR will work with the aggregate industry to develop a standard protocol for providing electronic information.

10. Monitoring is important for identifying whether or not avoidance or mitigation measures are effective and for identifying corrective actions if problems are encountered. MNR and the aggregate industry will continue to work cooperatively to ensure that monitoring data are available and accessible to inform future decision-making from the site to the subwatershed scale.

[11] Cumulative effects mean the combined environmental impacts or potential environmental impact of one or more development activities, including natural resource utilization or extraction, in a defined area over a particular time period. Cumulative effects may occur simultaneously, sequentially, or in an interactive manner.

APPENDIX B

GRAND RIVER WATERSHED PRIORITY SUBWATERSHEDS

Figure B-1
Aggregate Resources of the Big Creek Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:100 000

0 1 2 Kilometers

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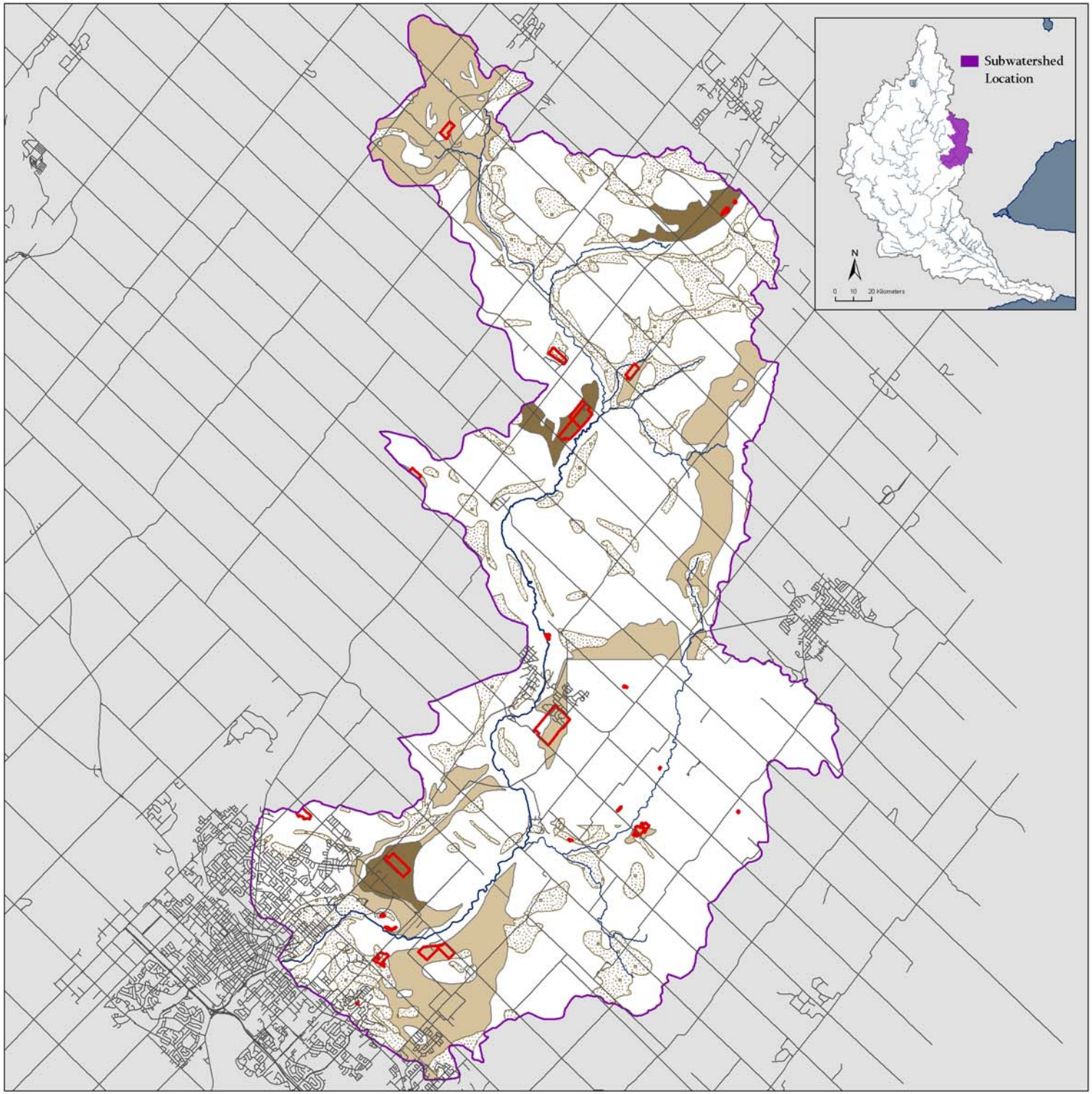

Figure B-2
Aggregate Resources of the Eramosa River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:165 000

Kilometers
0 1 2

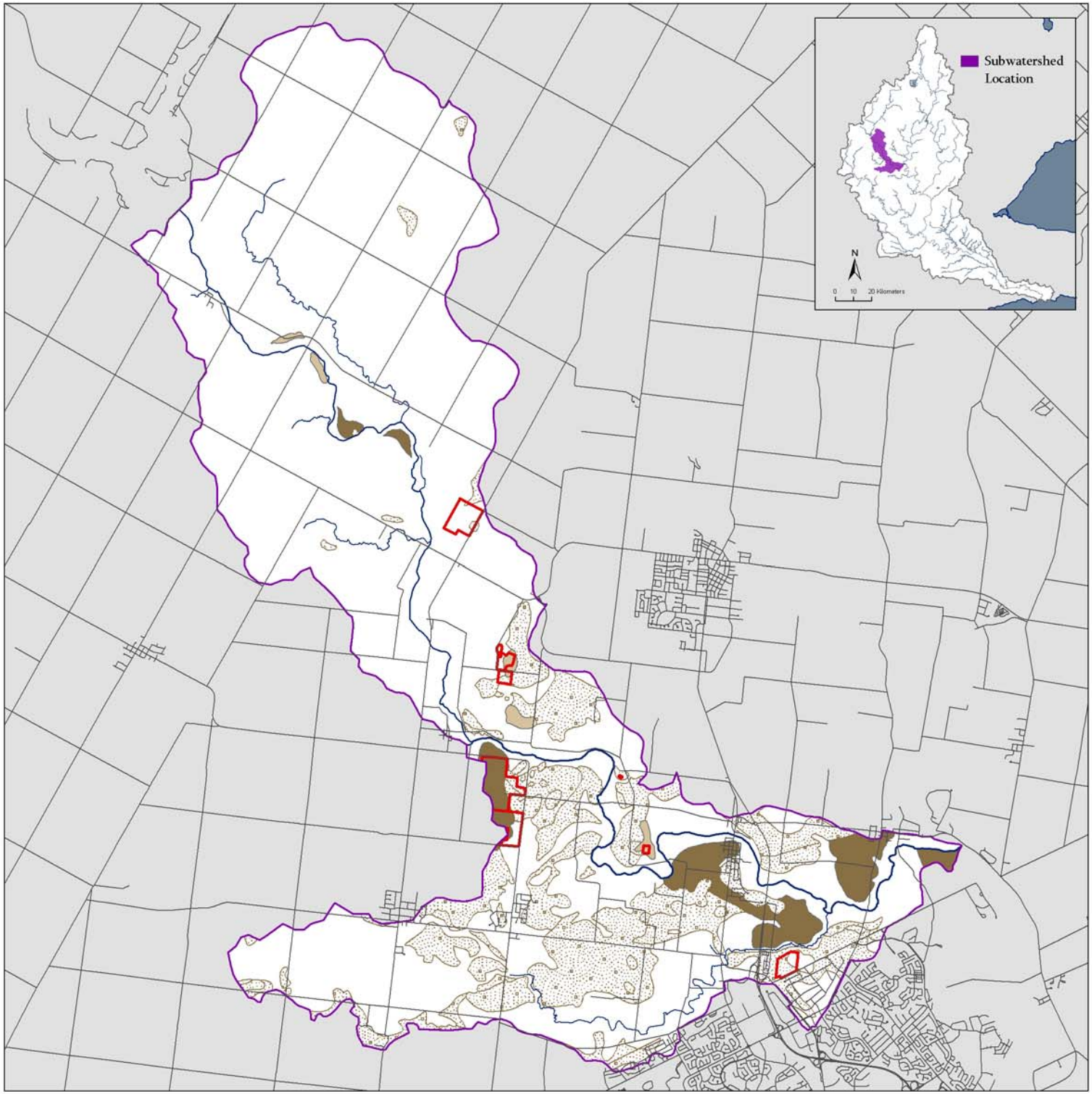

Figure B-3
Aggregate Resources of the Lower Conestogo River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:130 000

0 1 2 Kilometers

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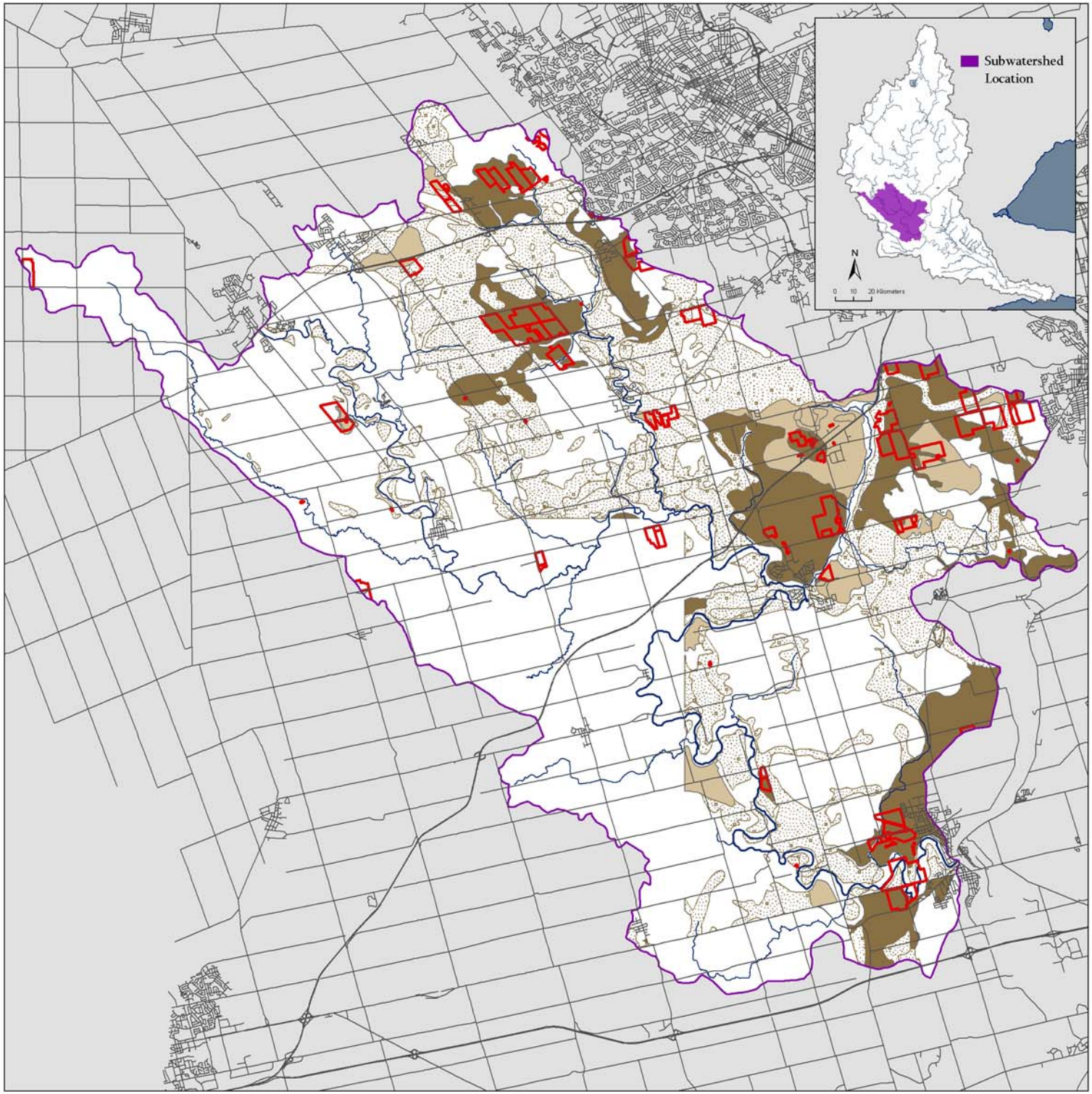

Figure B-4
Aggregate Resources of the Lower Nith River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:205 000

Kilometers
0 1 2

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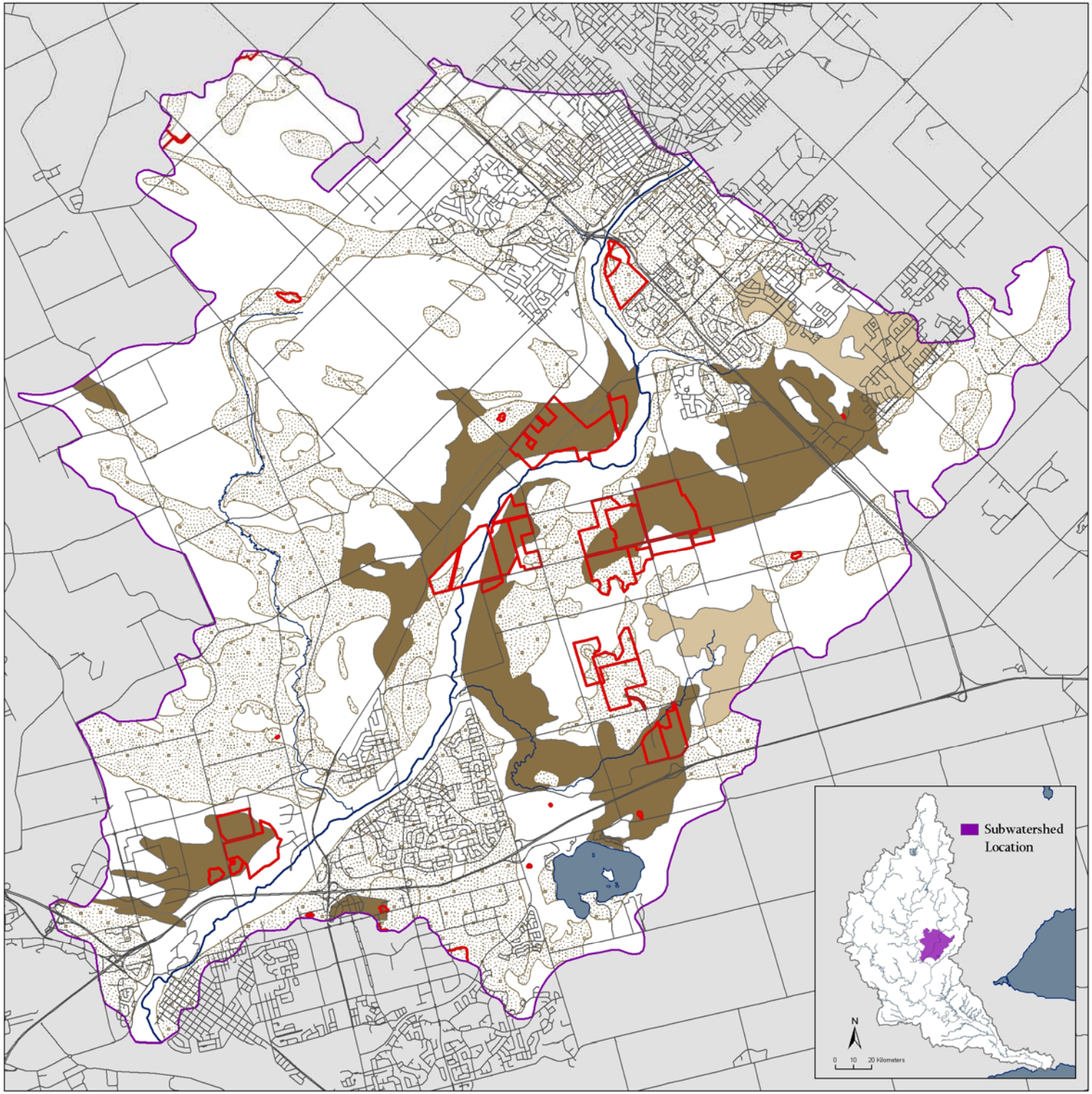

Figure B-5
Aggregate Resources of the Lower Speed River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:105 000

Kilometers
0 1 2

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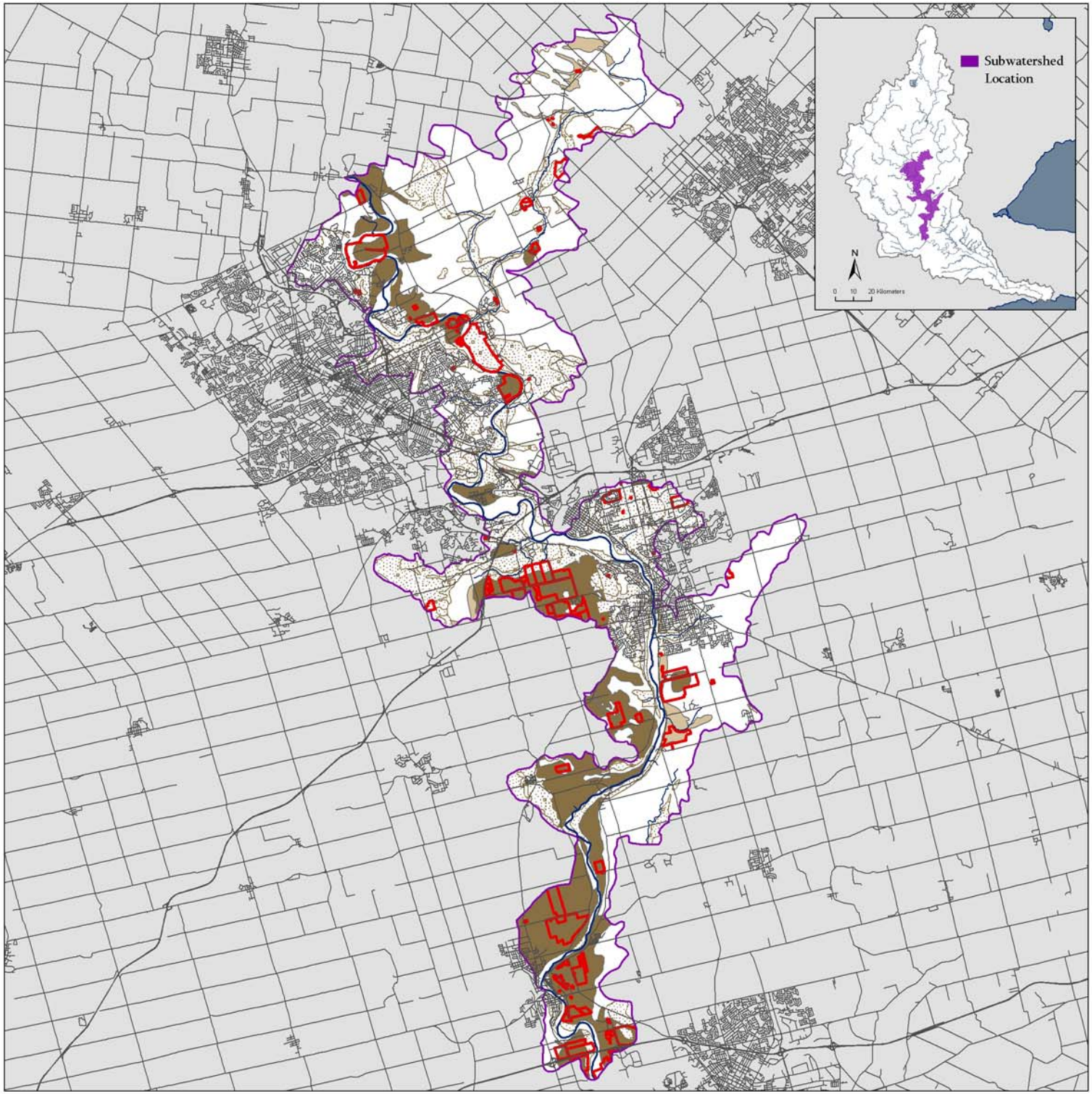

Figure B-6
Aggregate Resources of the Middle Grand River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:260 000

Kilometers
0 1 2

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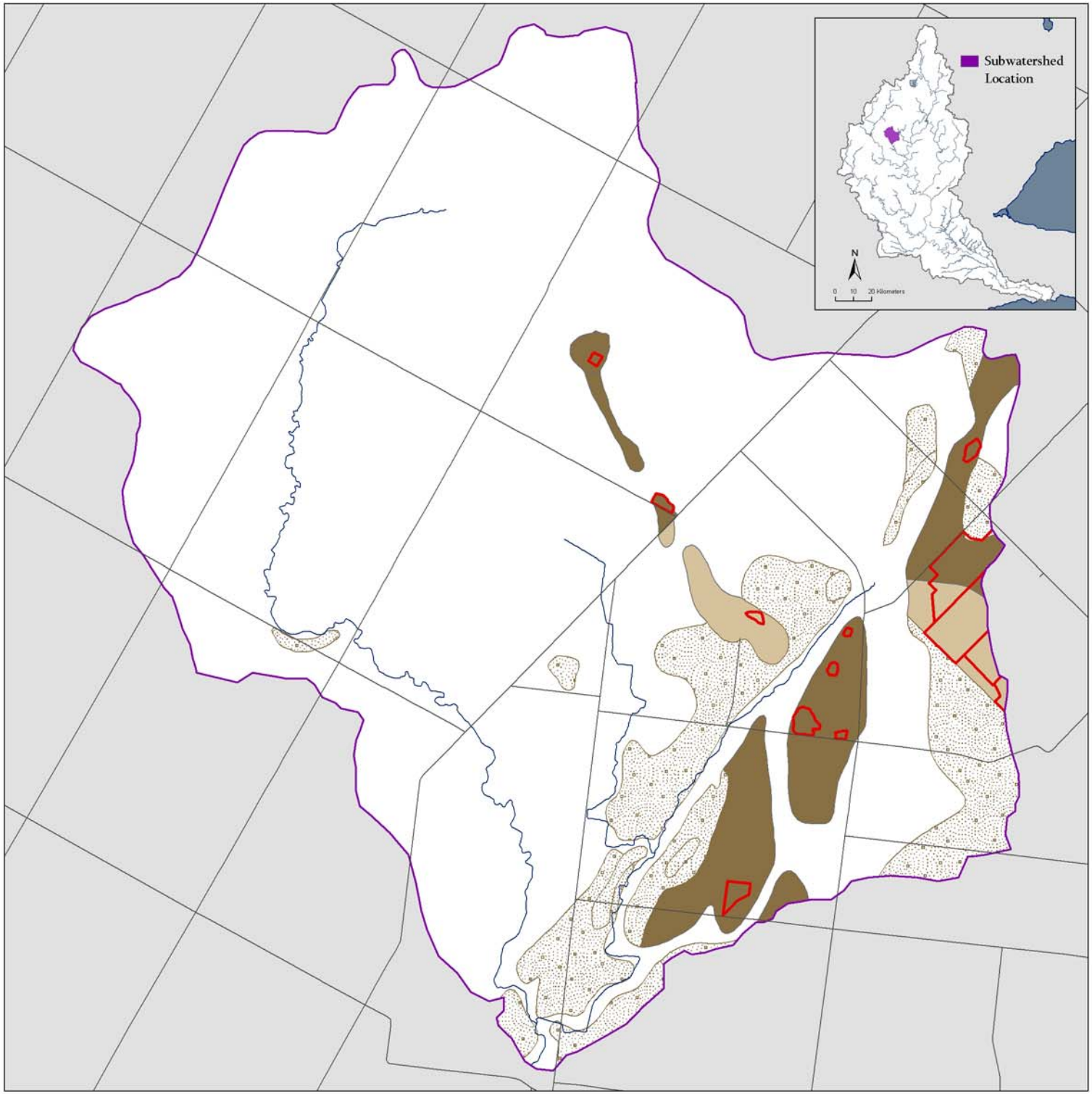

Figure B-7
Aggregate Resources of the Upper Canagagigue Creek Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:52 000

0 1 2 Kilometers

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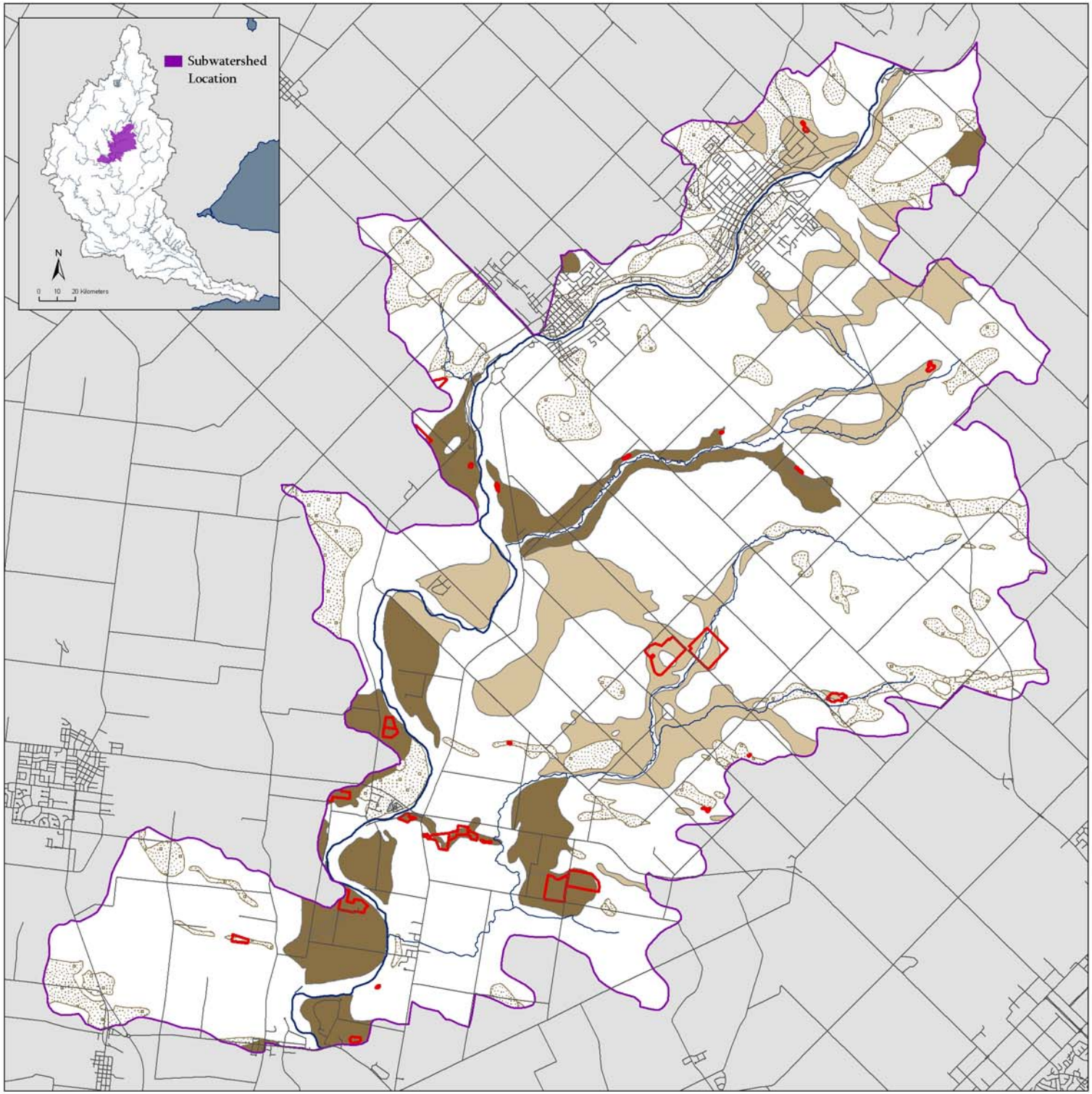

Figure B-8
Aggregate Resources of the Upper Middle Grand River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:120 000

Kilometers
0 1 2

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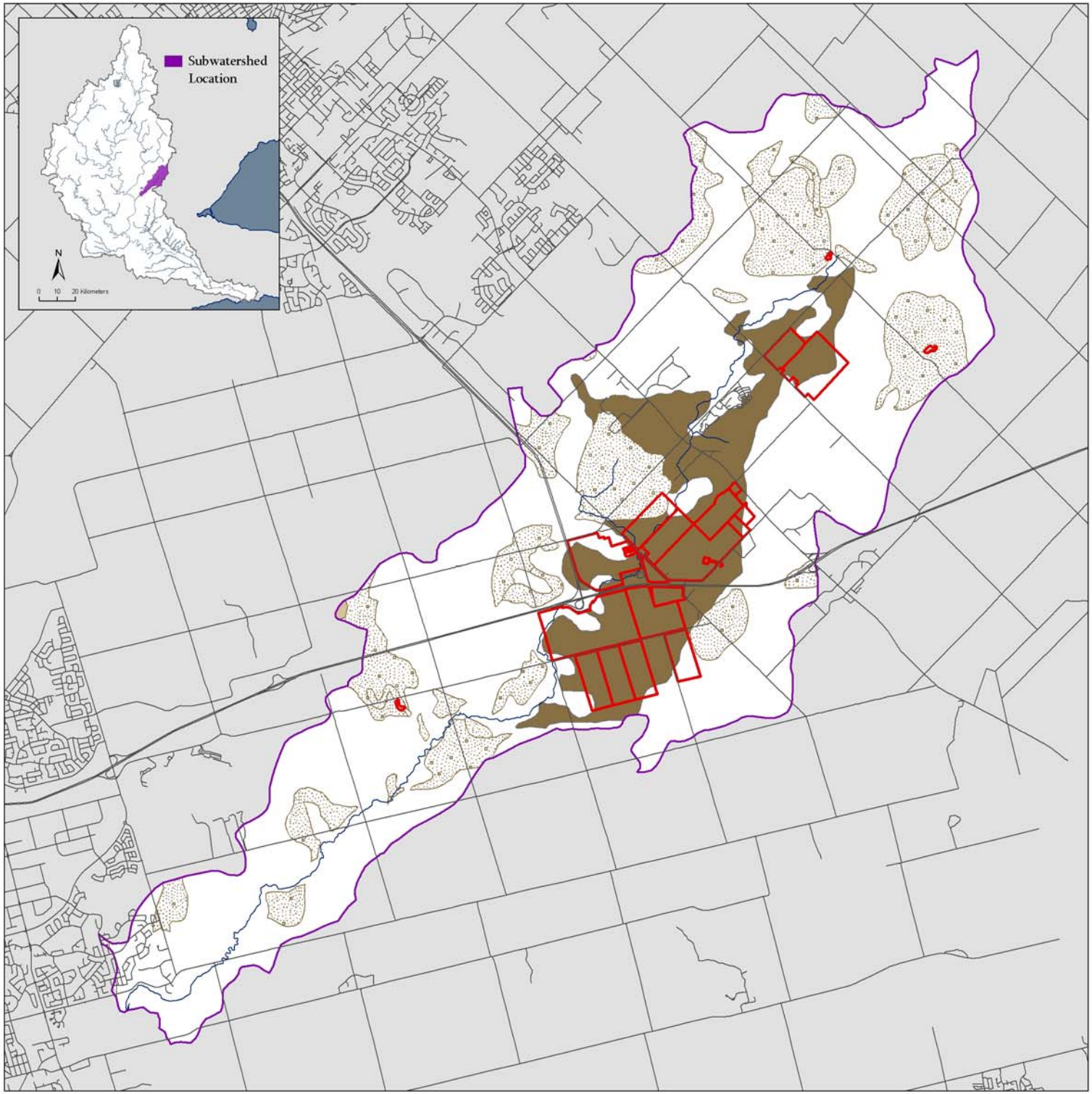

Figure B-9
Aggregate Resources of the Upper Mill Creek Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:100 000

Kilometers
0 1 2

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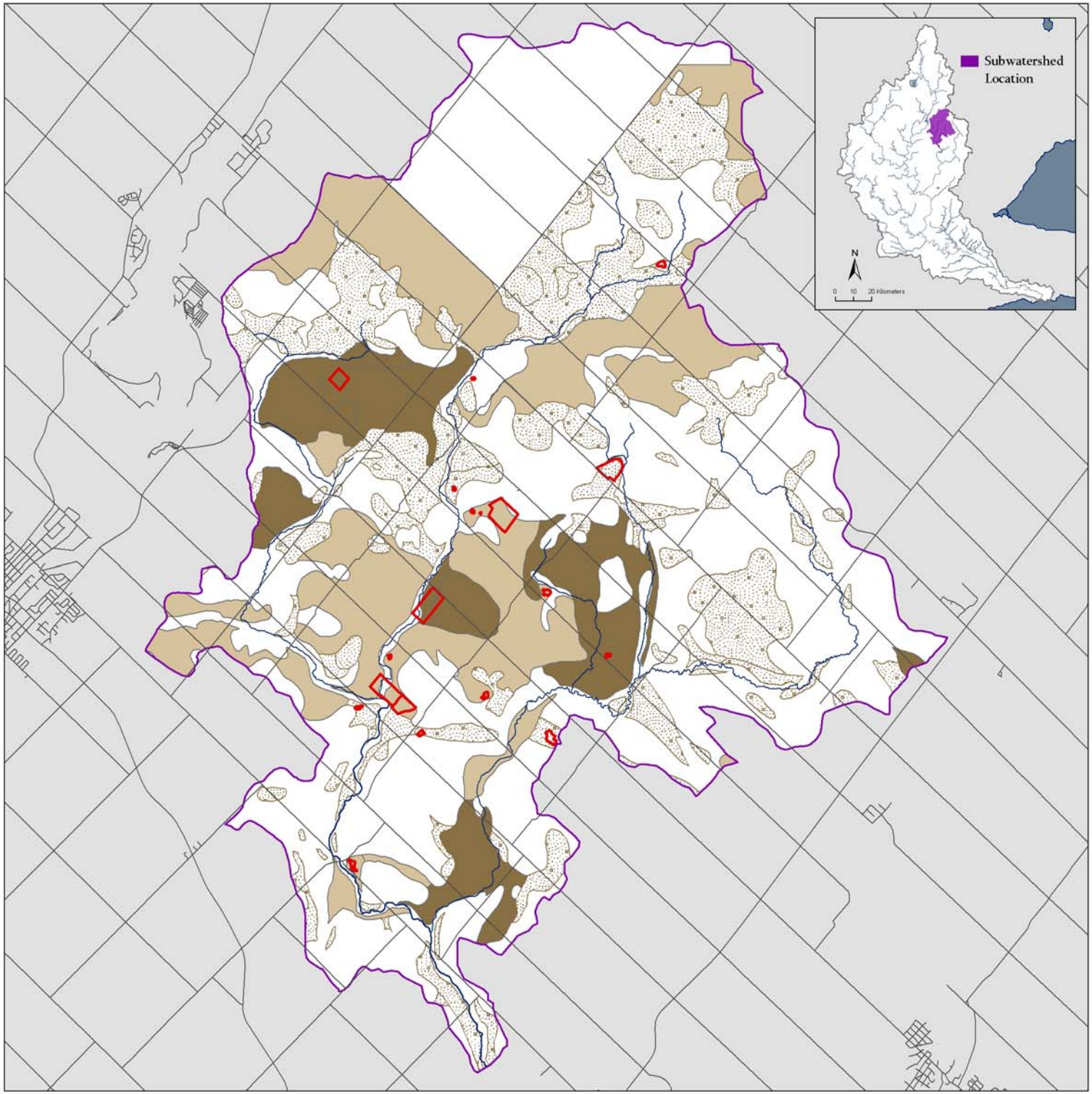

Figure B-10
Aggregate Resources of the Upper Speed River Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:112 000

0 1 2 Kilometers

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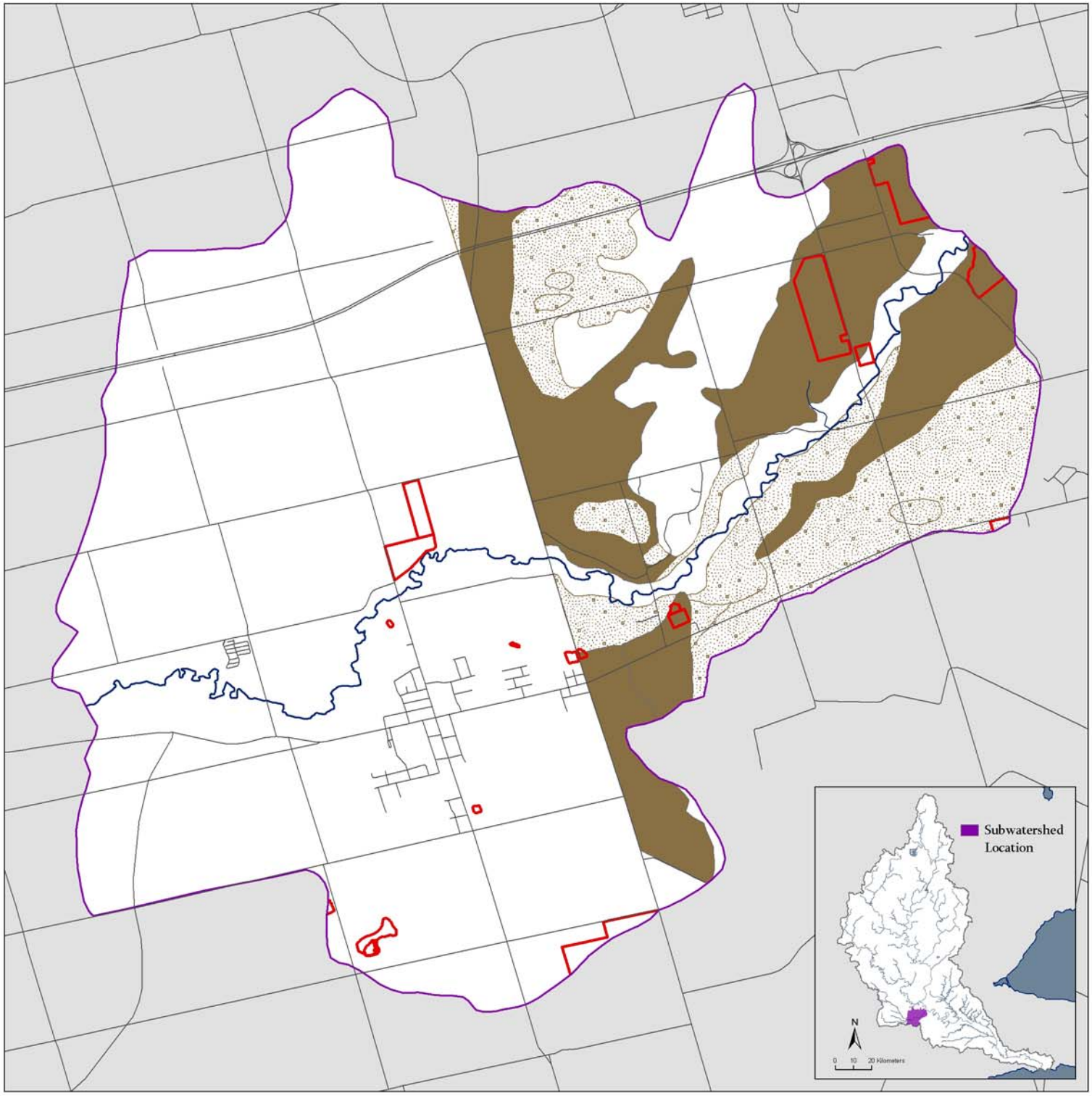

Figure B-11
Aggregate Resources of the Whitemans Creek Subwatershed

Legend

- Licensed Pits and Quarries
- Subwatershed Boundary

Sand and Gravel Resource Areas
Significance *

- Primary
- Secondary
- Tertiary

* Complete coverage for this map layer is currently unavailable.

N

Scale 1:64 000

0 1 2 Kilometers

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