GS2023-14

Manitoba's aggregate program: past, present, future

by J.W. Rentz

Summary

The Manitoba Geological Survey is updating the assessment of aggregate resources in the province. Initial studies were primarily published between the 1970s and mid-1990s, with a few publications in the 2000s. The initial areas selected for updating are the Winnipeg Metropolitan Region and the Arden area. The aggregate resource maps in these areas are being re-evaluated to determine the accuracy of the existing maps and identify new potential deposits. Additionally, a database will be created that incorporates both historical and new data. This is being accomplished by reviewing historical information, more recently acquired field-based data, the latest high-resolution digital elevation models and available imagery (satellite and orthorectified).

In Brief:

- History of Manitoba's aggregate exploration/mapping program and comparison of historic to current methodologies
- Aggregate maps for the Winnipeg capital region and Arden area are being updated

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Introduction

Aggregates are a combination of rock fragments, and are typically derived by extracting sand and gravel from surficial deposits or crushing bedrock. The current understanding of aggregate resources in Manitoba is based on mapping efforts that were largely completed 30–50 years ago. Since these initial mapping efforts, there has been little to no record about what material has been extracted and where resources have been depleted. There have also been technological advances since these initial mapping efforts, such as high-resolution digital elevation models and satellite imagery, which allow for a more accurate mapping of surficial features. The initial paper-based maps have been digitally captured and are in the process of being updated within a Geographic Information System (GIS) environment to remove inaccuracies in the dataset. The inaccuracies in the maps are important to correct since Policy Area 8 of the Provincial Planning Regulation of Manitoba dictates that economically valuable mineral deposits shall be protected from land uses that limit mineral exploration and development (Government of Manitoba, 2011), meaning that development on such lands is restricted.

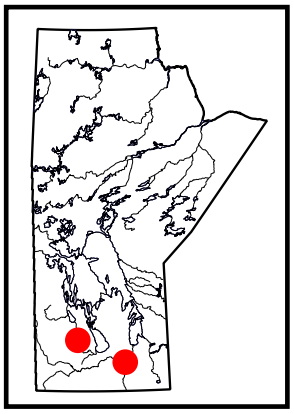
In 2023, mapping of aggregate resources in Manitoba was restarted with the current goals of this program being to

- re-evaluate and update the previous mapping efforts within a GIS environment and identify new potential deposits using new data and high-resolution imagery; and
- create a database structure that can incorporate legacy datasets and newly acquired data.

The initial focus for updating the aggregate resource mapping is the Winnipeg Metropolitan Region and the Arden area (NTS 62J6).

Previous work

Prior to the 1970s, Manitoba's public aggregate information was extracted from 1:250 000 scale Quaternary geology maps (Groom, 1999). These small-scale maps were very broad in their content, resulting in reduced accuracy in the geographic positioning of sites and data, and did not include smaller, yet significant, deposits. To address this, the Department of Energy and Mines in the early 1970s undertook a mapping and resource evaluation program to gain a better understanding of the aggregate resource within the province of Manitoba. This program was completed by a combination of provincial geologists and external consulting and engineering firms.



In the 1970s, the priority for aggregate mapping was to cover the southern portion of Manitoba at a scale of 1:50 000 (Groom, 1999). Aggregate deposits were mapped and evaluated by examining airphotos, stereoscopic imagery, backhoe test pits, hand-augured or hand-dug holes, geophysics surveys, boreholes, roadcuts and borrow or gravel pits. When possible, sand and gravel samples were collected to analyze for particle size and if possible, lithology (e.g., granite, limestone and less desirable lithologies such as chert and shale). Aggregate data collected from both remote observation and fieldwork were subsequently published in aggregate reports, open file reports or consulting company reports. In 1988, twelve compilation aggregate maps of the southern portion of the province were published at a 1:250 000 scale, which captured the state of knowledge at the time (Manitoba Energy

and Mines, 1988a–l). By the mid-1990s, aggregate mapping had been completed for most of southern Manitoba (Figure GS2023-14-1) and the program was largely disbanded.

Aggregate mapping and inventory assessment continued in the summer of 1999 with updating of the Winnipeg capital region and the Ochre River area (Groom, 1999). These mapping efforts were completed by one geologist (H. Groom) and further efforts continued until 2008 (Groom, 2008). The details of this work were primarily published in the Manitoba Geological Survey's (MGS) Report of Activities series with limited publication of maps.

In 2018, with the goal to modernize access to the aggregate maps and associated data, as well as to prepare for their update, the MGS undertook a project to digitally capture all the previous mapping efforts and create a single database that could be used for aggregate resource mapping purposes in the future (Hodder et al., 2019).

Current work

There have been many technological advancements since the initial aggregate program commenced, which allow the identification of potential surface aggregate deposits in a more

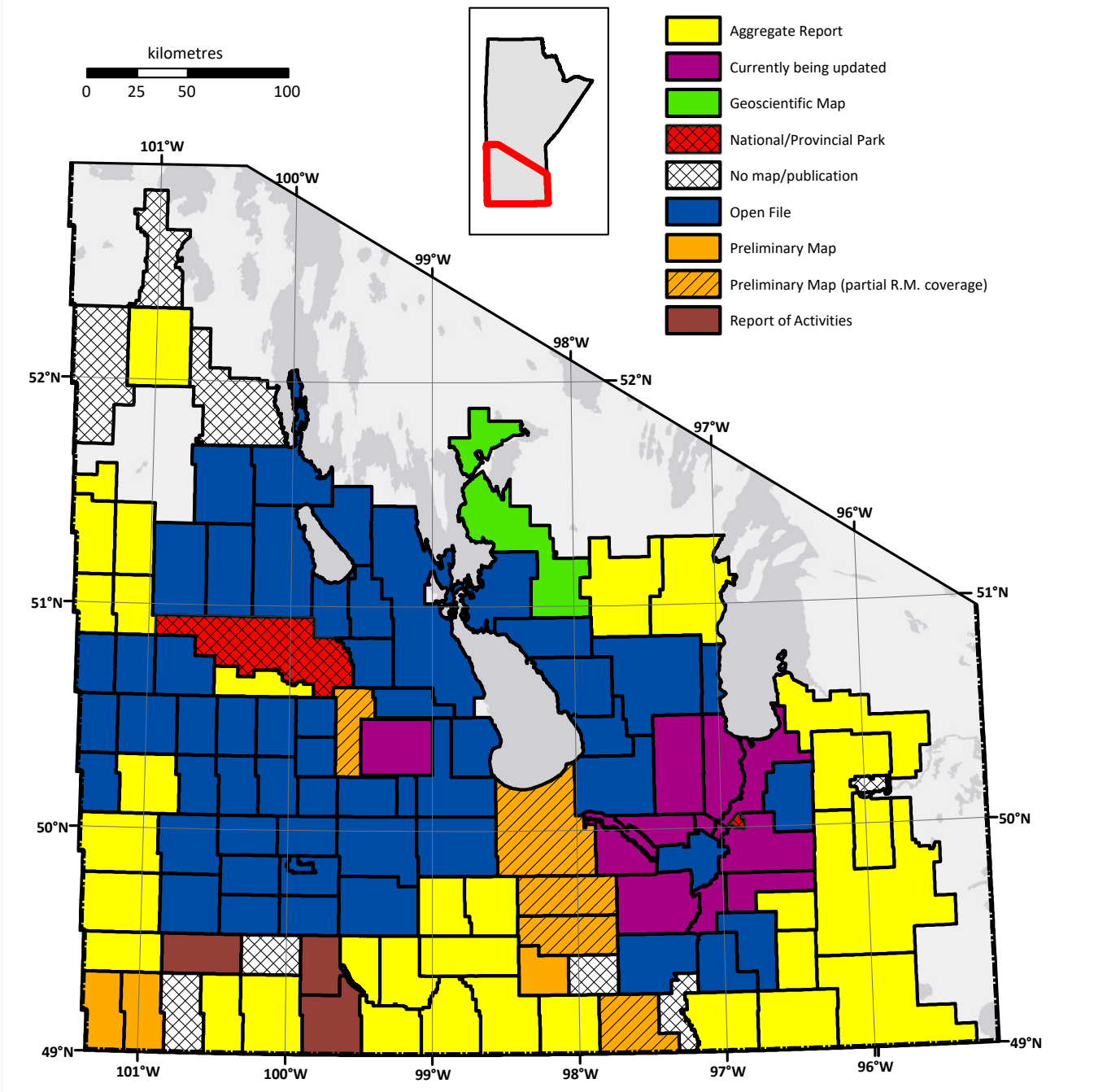


Figure GS2023-14-1*: Updated map showing the state of aggregate mapping in southern Manitoba. The original map is available online (https://manitoba.ca/iem/geo/surficial/aggregate.html) as an interactive bibliography for each rural municipality (R.M.).*

efficient manner. Global positioning system (GPS) capability has increased the accuracy of sample and site locations, and GIS software allows mapping within a digital environment. Perhaps most importantly, publicly available light detection and ranging (LiDAR) digital elevation models (Government of Manitoba, 2023) can delineate elevation changes at 1–5 m horizontal resolution and 0.09–0.15 m vertical resolution (with resolutions being area dependent), which allows the identification of changes in topography that may be related to aggregate deposits (i.e., Figure GS2023-14-2). The availability of digital high-resolution orthophotography (e.g., Google Earth, Esri® Maps and Bing Maps) allows land cover to be easily viewed in greater detail, particularly in areas where LiDAR data may not exist, and provides a tool to track the size and locations of existing pits/quarries.

Using the more detailed digital elevation models (Government of Manitoba, 2023) allows the MGS to update the historical deposit outlines and polygons (e.g., Figure GS2023-14-3) and to identify new surface deposits.

As a part of this new project, a centralized field site database is being updated and brought to modern digital standards for public access. The database will house all pertinent data for the deposits including location, site and sample descriptions, stratigraphic information and general deposit information. Currently, the available information is found within the original reports and maps; an index of these maps is located on the MGS website at https://manitoba.ca/iem/geo/surficial/aggregate.html. Data from the initial digital data capture of previous mapping are also available for download in Hodder et al. (2019).

Future work

Preliminary work will include digitization of historical data, incorporation of data from various governmental departments and reinterpretation of remote sensing imagery. A cross-jurisdictional review is currently underway to inform how information is best presented and what type of information should be captured. As part of this review, all stakeholders are encouraged to contact the author with questions or comments.

The initial mapping will be focused on both the Winnipeg Metropolitan Region, as well as the Arden area, which was previously mapped for surficial geology by Hodder and Trommelen (2015) and Hodder and Gauthier (2020). An example of the updated Arden map area is shown in Figure GS2023-14-4.

Economic considerations

Aggregate is an essential resource within the engineering and construction industries and is commonly used for road construction, foundation construction, railroad base and concrete/asphalt formation. The increasing demand for aggregate, especially from the metropolitan region, requires that the inventory of this important resource be updated. Furthermore, additional resources need to be identified, and areas that have a high resource potential need to be protected from future development. Past estimations predicted that high quality aggregate deposits within the metropolitan region may be depleted as early as the year 2026 (The UMA Group, 1976) and there is currently no up-to-date aggregate inventory for this region. Therefore, it is imperative that all aggregate resources be identified in order to inform land-use planning and be available for future growth in the metropolitan region.

Acknowledgments

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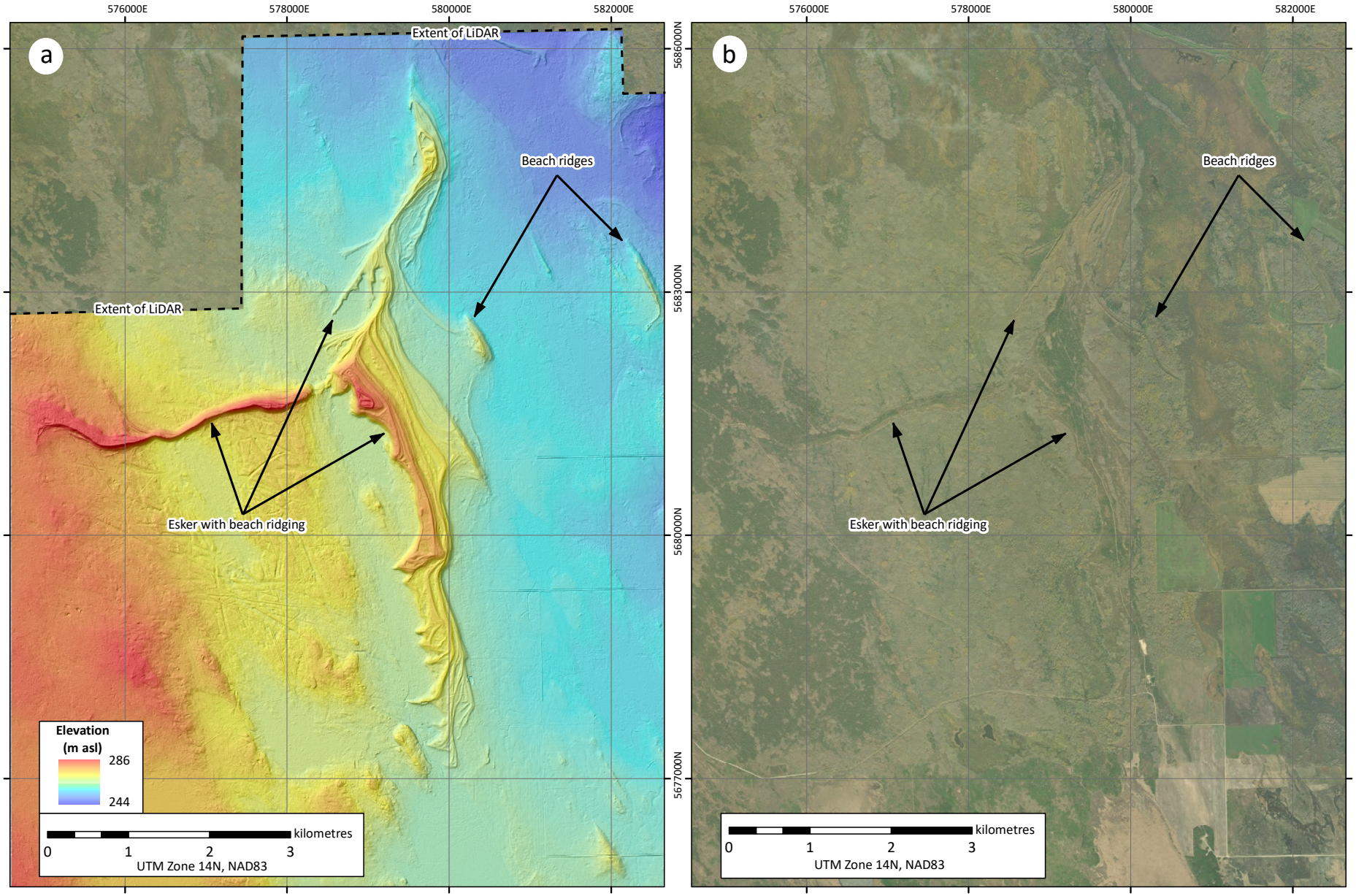

Figure GS2023-14-2: *Example of high-resolution digital elevation models and imagery available to map aggregate resources, Rural Municipality of Fisher, Manitoba:* ***a)*** *light detection and ranging (LiDAR) hillshade image (GeoManitoba, 2006) shows elevation changes at 5 m horizontal resolution and 0.09–0.15 m vertical resolution, in approximate 3-D, which allows geologists to better identify landforms that may contain sand and gravel (eskers and beach ridges);* ***b)*** *orthoimagery of the same location shows the effects of vegetation and land use that may have contributed to poor mapping accuracy. Basemaps were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri software, please visit <https://esri.ca/>.*

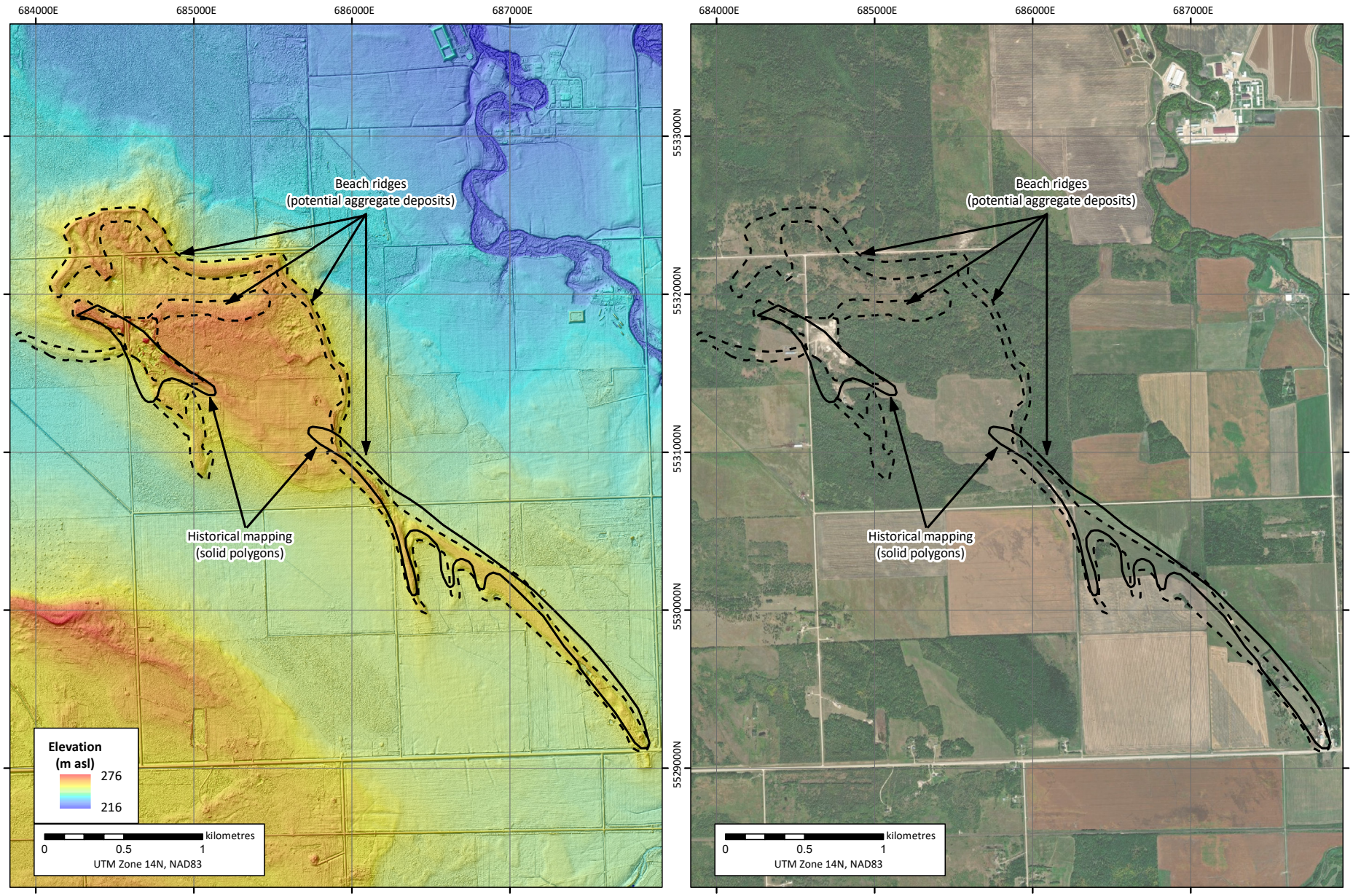

Figure GS2023-14-3: *Example of high-resolution digital elevation models and imagery available to map aggregate resources, near Vivian, Manitoba:* ***a)*** *light detection and ranging (LiDAR) hillshade image (ATLIS Geomatics Inc., 2016) with 1 m horizontal resolution and 0.03–0.05 m vertical resolution; both historical mapped deposits and corrected and newly mapped potential deposits are shown;* ***b)*** *orthoimagery of the same location shows the effects of vegetation and farming that may have contributed to poor mapping accuracy. Historical mapping polygons from Hodder et al. (2019). Basemaps were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri software, please visit <https://esri.ca/>.*

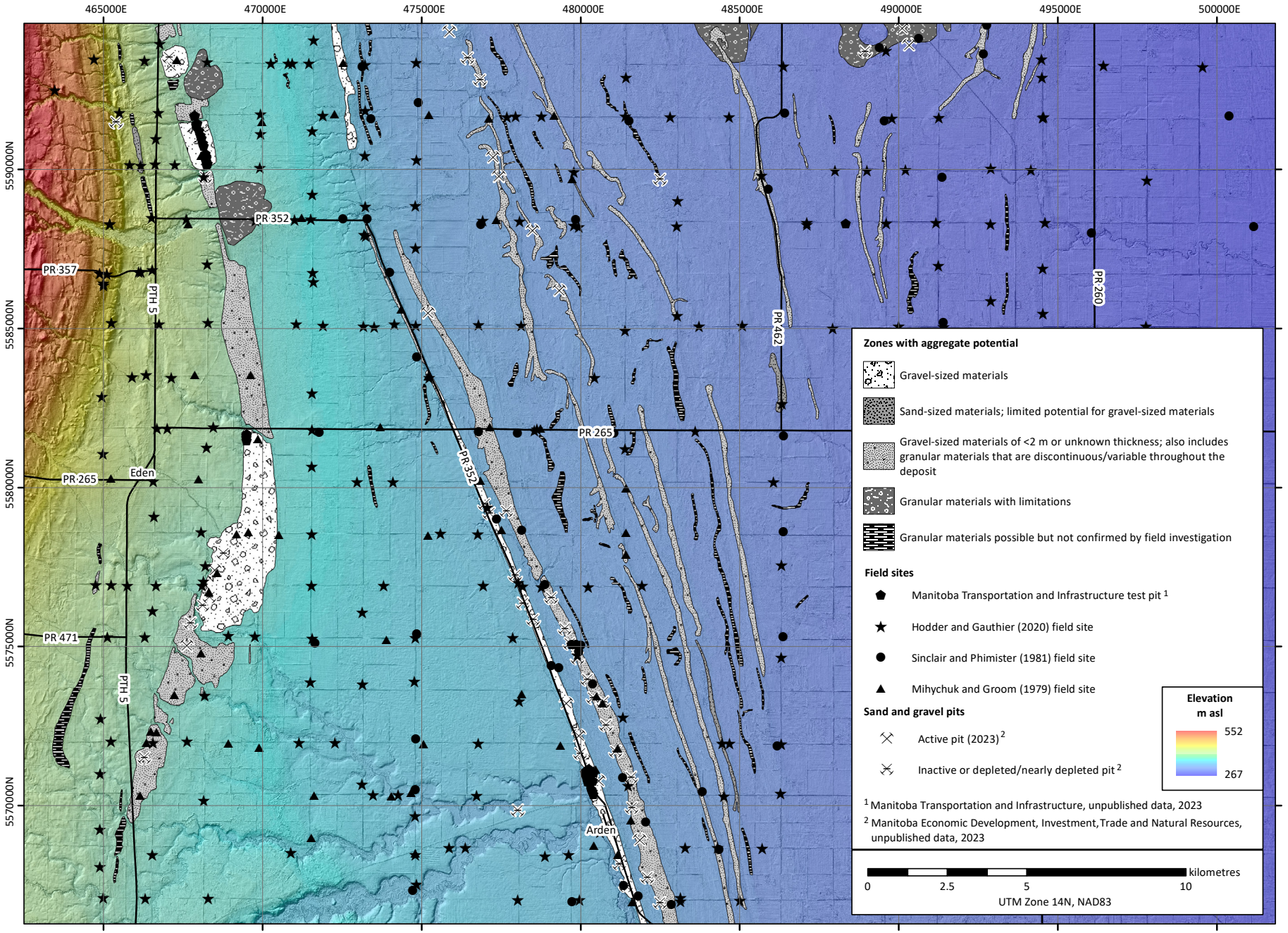

Figure GS2023-14-4: *Preliminary interpretation of the aggregate potential within the Arden area, Manitoba, using a light detection and ranging (LiDAR) hillshade image (Groupe Info Consult, 2018), field station and pit data. The legend is preliminary and adapted from Ricketts (2014); it is an example of the type of legend that may be used on the final maps.*

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