Use of Thermal Infrared (TIR) Imagery to Identify Groundwater Discharge Areas Associated with Known Groundwater Contaminants of Potential Concern Part I: Mapping

Sami Morgan, Jennifer Collins, Matrix Solutions

The purpose of using thermal infrared (TIR) imagery to identify potential groundwater discharge areas associated with known groundwater contaminants of potential concern was to improve the conceptual understanding of local hydrogeological conditions of the Site, refine the exposure pathway characterization and aid in evaluating potential impacts to surface water near an operational sour gas plant in southeast Alberta.

In September 2020, Matrix Solutions Inc. in collaboration with Shell Canada Ltd. completed an airborne TIR survey to identify thermal anomalies potentially associated with groundwater discharge areas that may have groundwater contaminants present. A Forward-Looking InfraRed (FLIR) SC6000 LWIR (8 to 9.2 µm) sensor to collect the imagery was mounted in a DHC-6 Twin Otter fixed-wing aircraft and flown over section blocks of two creeks, adjacent to the operating sour gas plant. Water temperatures were recorded by five in-stream temperature sensors to radiometrically calibrate the thermal signature of the imagery. To achieve seamless coverage, imagery data were:

- Geo-rectified to correct for variations in aircraft trajectory and orientation,
- Calibrated using response curves to account for attenuation path and emissivity of natural water; and
- Symbolized to accentuate thermal contrasts.

The TIR imagery was used to identify potential groundwater discharge locations both within stream channels and as seeps or seepage faces along the land surface. Thermal anomalies identified in TIR imagery were overlain with GIS coverages and paired with other datasets and indicators to select locations for potential seeps and favorable conditions for in-stream discharge. Locations were selected based on areas that were cooler than the surface temperature of the adjacent land or water by 2°C or more, located where an aquifer outcrops at surface and not located within a shadowed area. Several instream discharge areas were found to be within 150 m from the known potentially contaminated groundwater plume.

This presentation will outline the methodology to process the data to produce GIS mapping which formed the basis to select potential groundwater discharge areas for future field verification of offsite impacts of the known contaminants of concern.

Sami Morgan

Sami Morgan, M.Sc., P.Geo. is a hydrogeologist with 5 years of experience in environmental hydrology and hydrogeology research and support. She completed her M.Sc. Earth Sciences – Hydrogeology at Simon Fraser University, specializing in buried valley aquifer systems in northeastern British Columbia. She has a diverse background in hydrogeology and geology and has managed multiple projects including groundwater monitoring programs and data management programs. Her technical experience includes 3D conceptual site model development, hydrogeologic mapping, and analyzing environmental soil and groundwater quality data.

Jennifer Collins

Jennifer Collins, B.Sc., P.Geol. has 15 years of experience in the fields of hydrogeology, groundwater resource management, environmental assessment/remediation/risk management and project management. Her project experience includes groundwater-related monitoring, assessment, licensing and exploration, as well as contaminated sites management and integrated wetland and surface water monitoring programs. She has provided technical support for a variety of clients within oilfield (upstream and midstream), industrial, mining, municipal, agricultural and private sectors throughout Alberta.