Teedon Pit – CLC Meeting #4

September 13, 2018

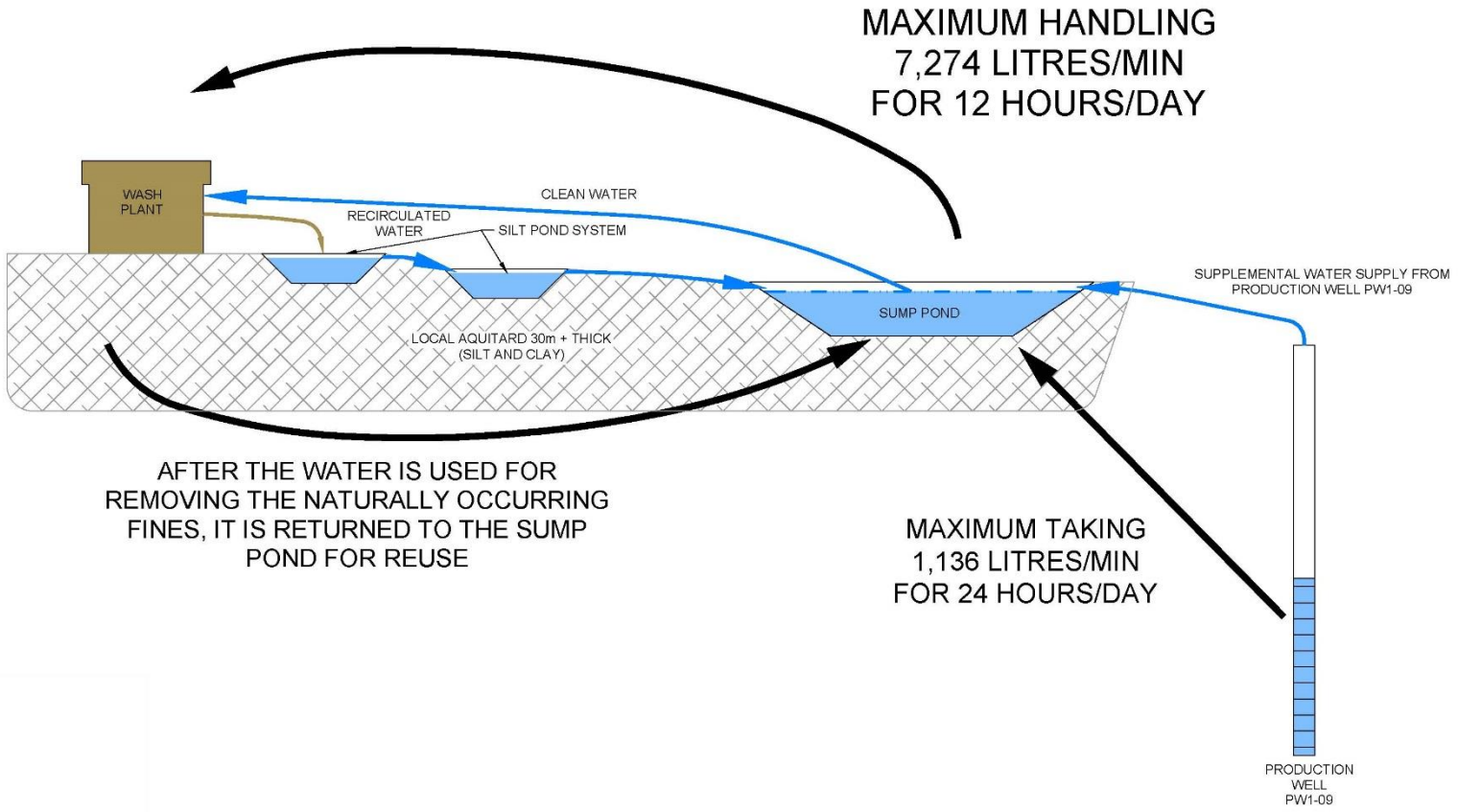
Agenda

- Teedon Hydrogeology 101 and Responses to the CLC hydrogeology questions
- Next Meeting – November 15.

GHD Hydrogeological Investigations at Teedon Pit

- Introduction of Gary Lagos, M.Sc., P. Geo, Associate at GHD
- Gary's work experience and involvement at the Teedon Pit

Permit to Take Water Renewal



Hydrogeology Program Since DFA Acquired Teedon Pit

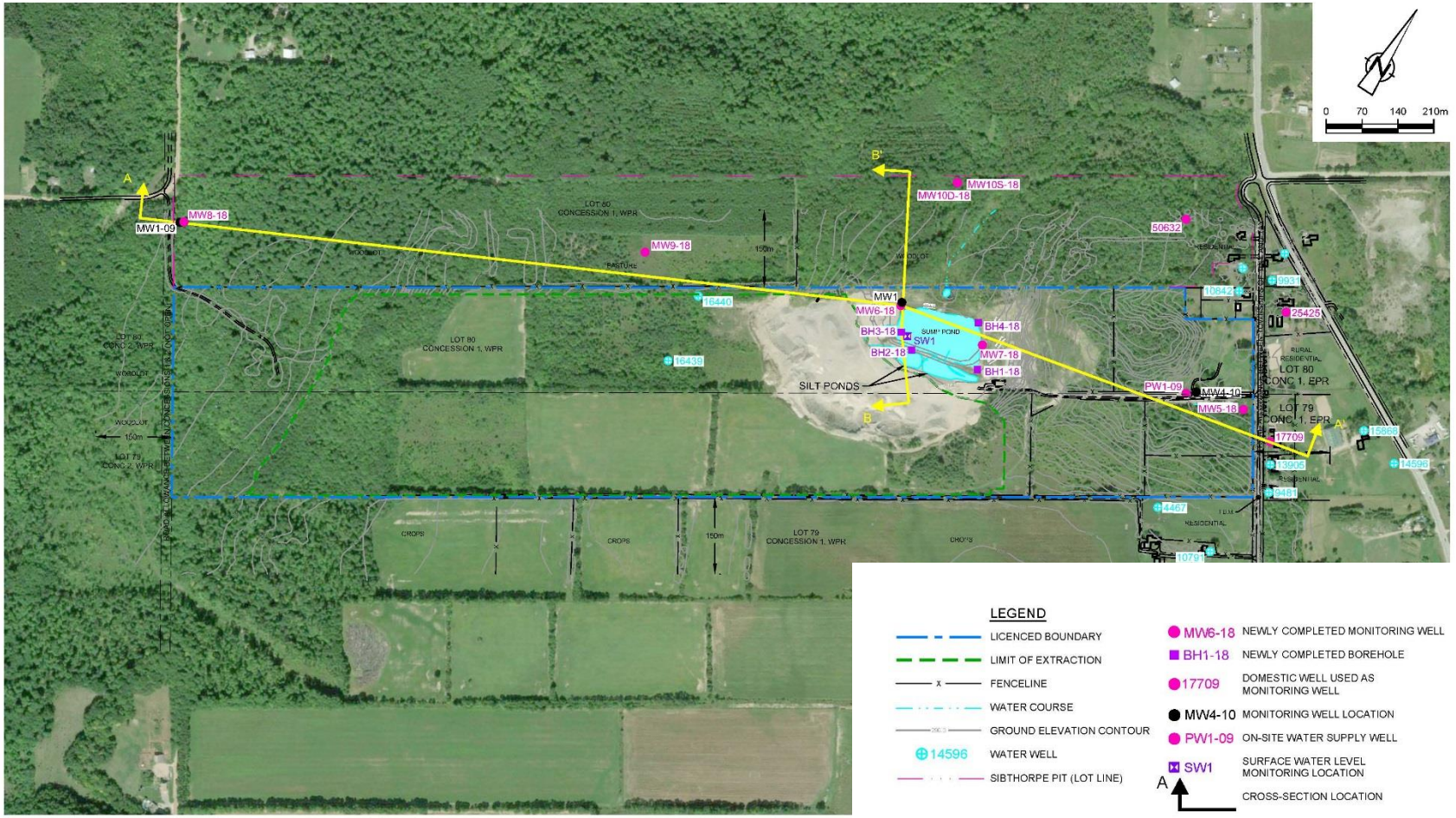
- Installed 7 additional groundwater monitoring wells for hydraulic monitoring purposes
  - Currently 1 production well, 10 monitoring wells, and 3 domestic wells monitored for the Site
- Installed pressure transducers/data loggers in all new monitoring wells (existing monitoring wells had pressure transducers/data loggers)
- Completed 4 boreholes to evaluate the geology in the area of the sump pond and settling ponds.
- For every new monitoring well and borehole, soil cores 1.5 m (5 feet) in length were collected and examined in detail to describe the geologic conditions (lithology, structure, moisture content)
- Every soil core was photographed and placed in core boxes and the core boxes are stored at the Teedon Pit
- 21 soil samples were selected and determined the grain size distribution in the Local Aquitard and Upper Aquifer units
- Conducted single well response tests (slug tests) at 2 monitoring well locations

Hydrogeology Program Since DFA Acquired Teedon Pit – cont'd

- Have collected water level measurements using pressure transducers/data loggers in every monitoring well after the well installation
- Installed a pressure transducer/data logger in the Sump Pond
- Invited Ministry of Environment, Conservation and Parks (MECP) to observe installation of new monitoring wells.
- Shared geology from new wells and boreholes with Ontario Geologic Survey (OGS). Invited OGS to observe the installation of monitoring wells.
- Set up pump system to restrict taking from production well.
- Completed neighbour well survey.
- Sent licensed well contractor to neighbours that expressed concerns of sediment in their wells.
- Presented monitoring data to CLC.

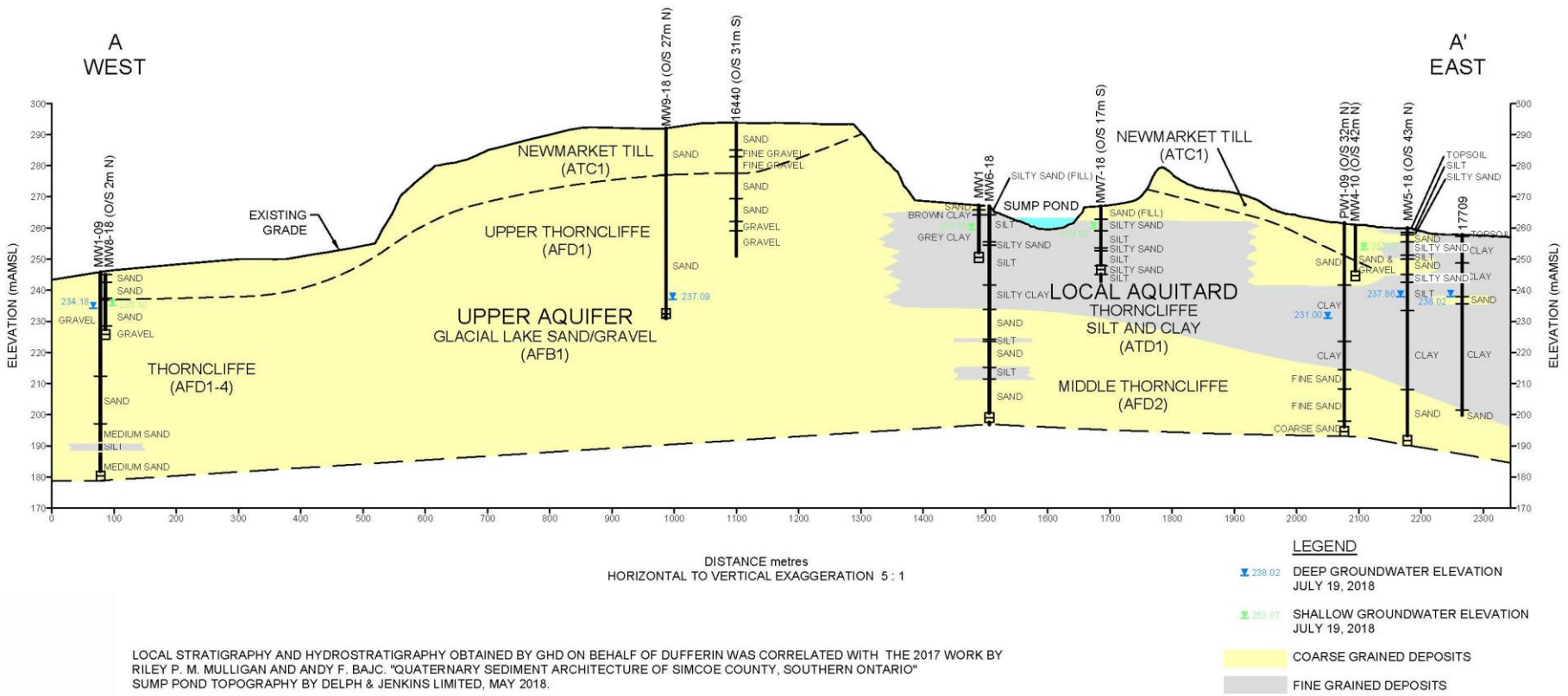
GHD Hydrogeological Investigations at Teedon Pit

- Geologic/Hydrogeologic Cross-Section Locations



GHD Hydrogeological Investigations at Teedon Pit

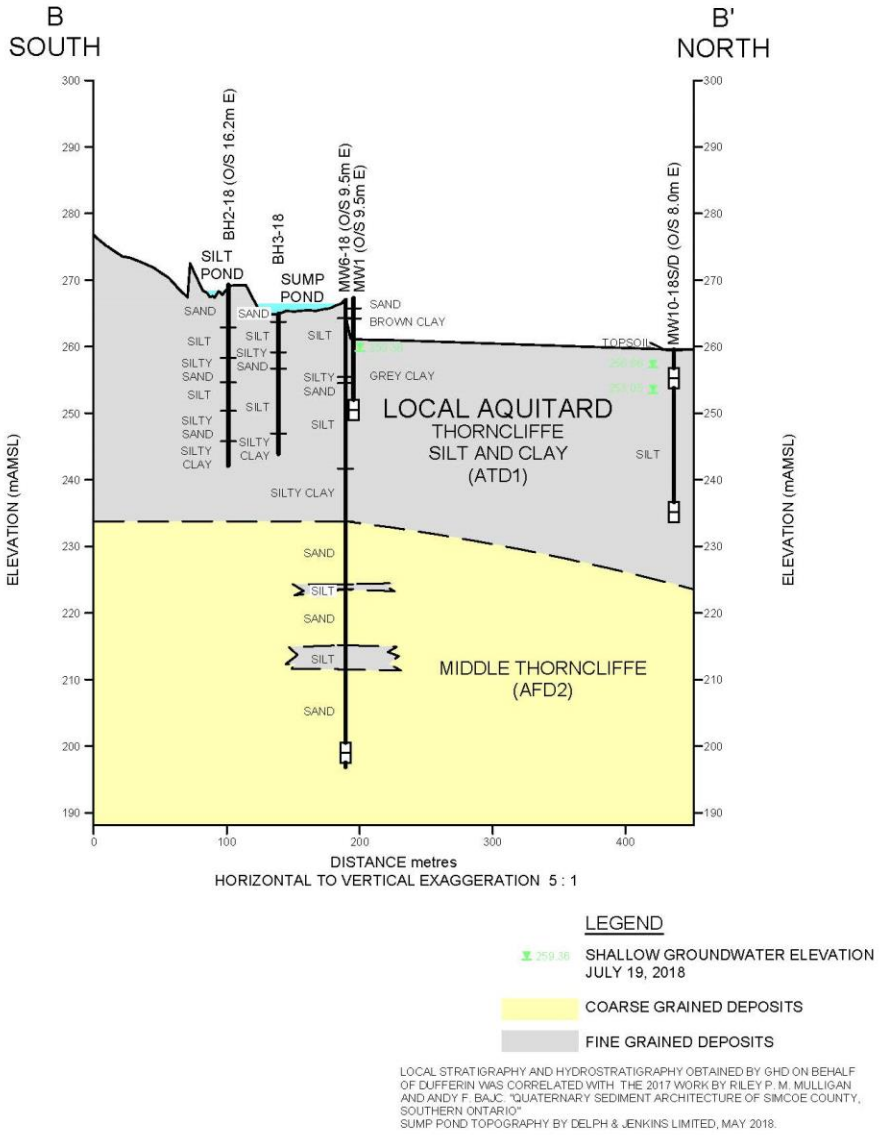
- Geologic/Hydrogeologic Cross-Section A-A’



LOCAL STRATIGRAPHY AND HYDROSTRATIGRAPHY OBTAINED BY GHD ON BEHALF OF DUFFERIN WAS CORRELATED WITH THE 2017 WORK BY RILEY P. M. MULLIGAN AND ANDY F. BAJC. "QUATERNARY SEDIMENT ARCHITECTURE OF SIMCOE COUNTY, SOUTHERN ONTARIO"
SUMP POND TOPOGRAPHY BY DELPH & JENKINS LIMITED, MAY 2018.

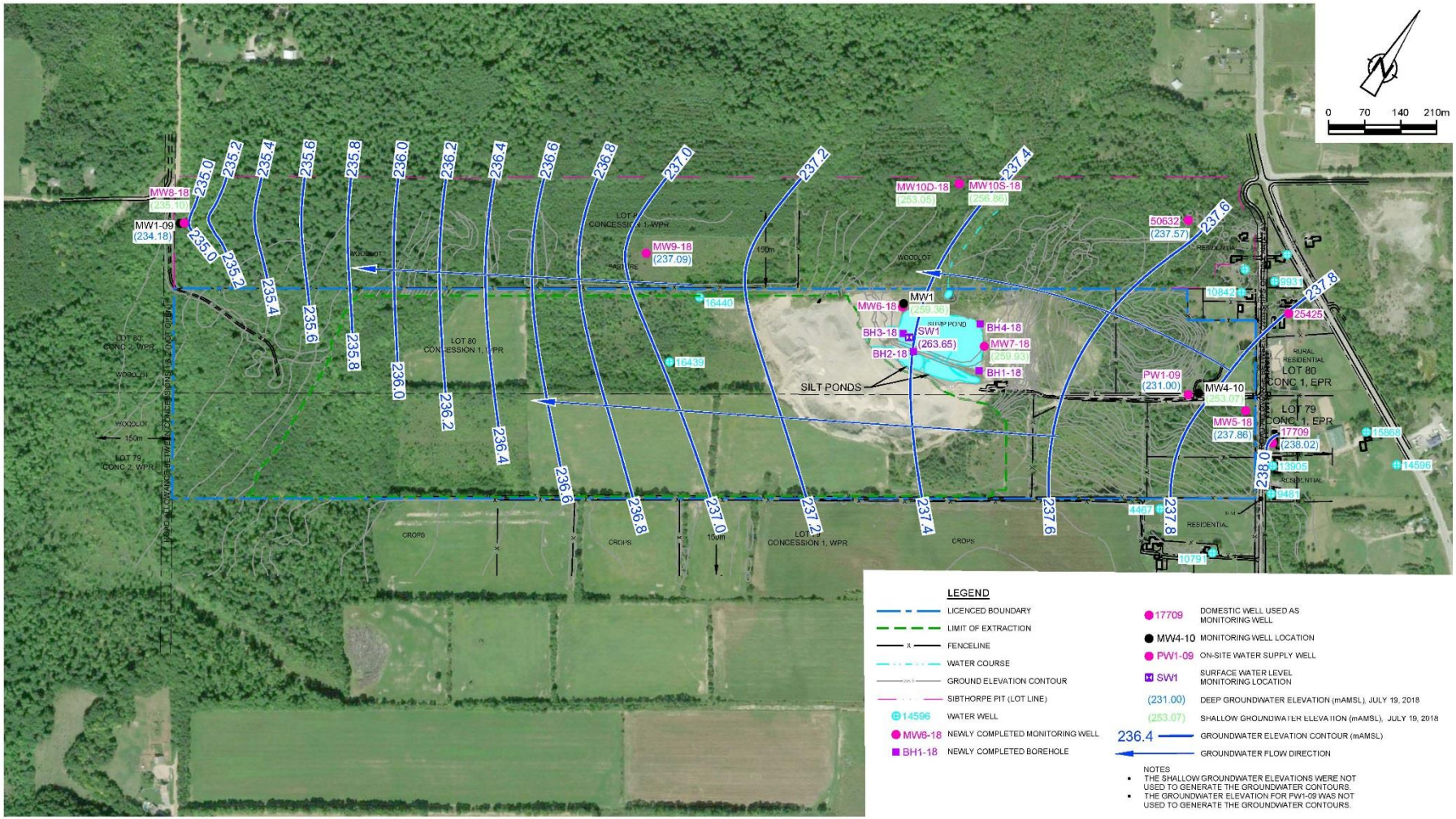
GHD Hydrogeological Investigations at Teedon Pit

- Geologic/Hydrogeologic Cross-Section B-B’



GHD Hydrogeological Investigations at Teedon Pit

- Groundwater Monitoring - Site Deep Groundwater Contours (July 19, 2018)



Teedon Pit Hydrogeologic Model/Pit Operation

Upper Aquifer

Hydraulic Conductivity of Upper Aquifer

$1x10^{-2}$ cm/sec

Horizontal groundwater flow velocity through Upper Aquifer

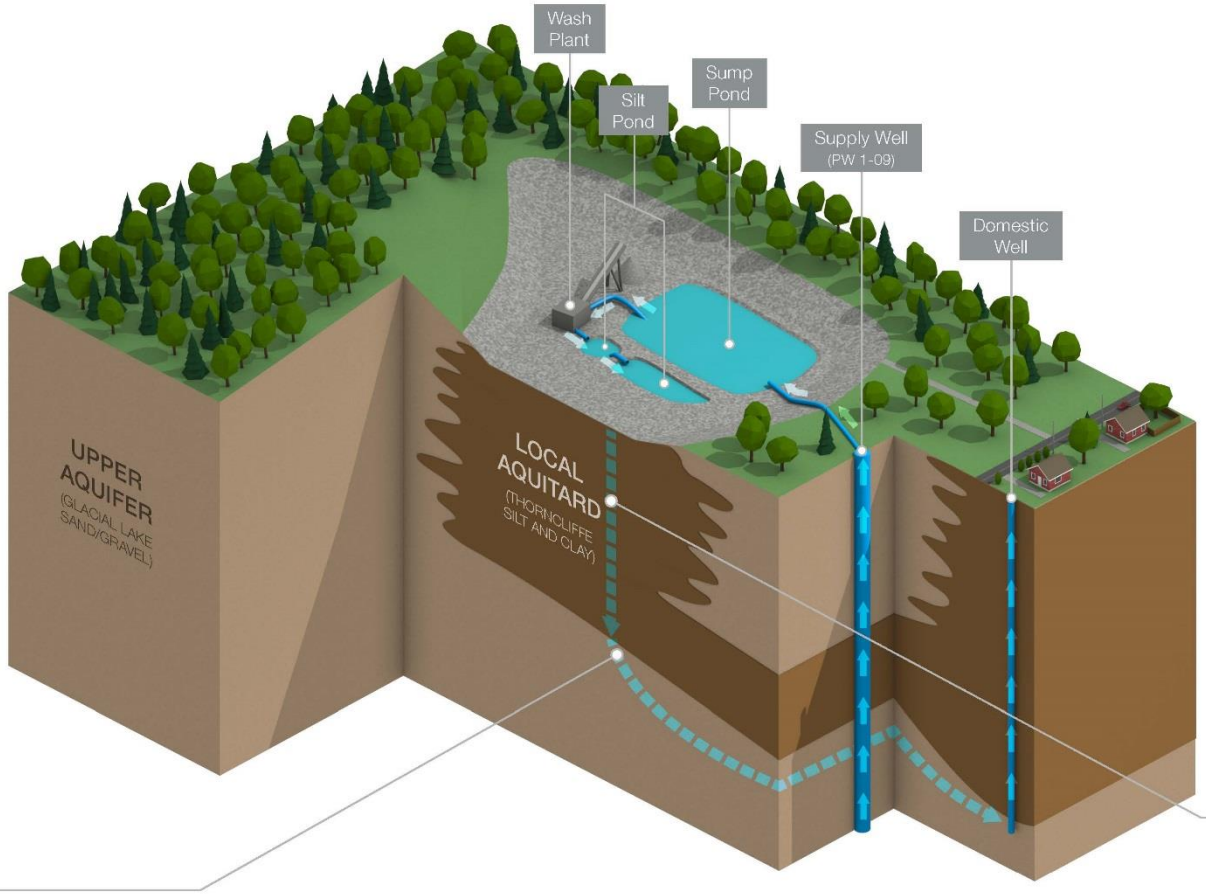
53 to 21m/year

Distance from Sump Pond to nearest Domestic Well

500m

Travel time of groundwater through the Upper Aquifer from the Sump Pond following travel through Local Aquitard to nearest Domestic Well

9.5 to 24 years



Local Aquitard

Hydraulic Conductivity of Local Aquitard

$1x10^{-5}$ cm/sec

Vertical groundwater flow velocity through Local Aquitard beneath Sump Pond

3m/year

Thickness of Local Aquitard beneath Pond

30m

Vertical travel time of groundwater through Local Aquitard from bottom of Sump Pond to Upper Aquifer

10 years

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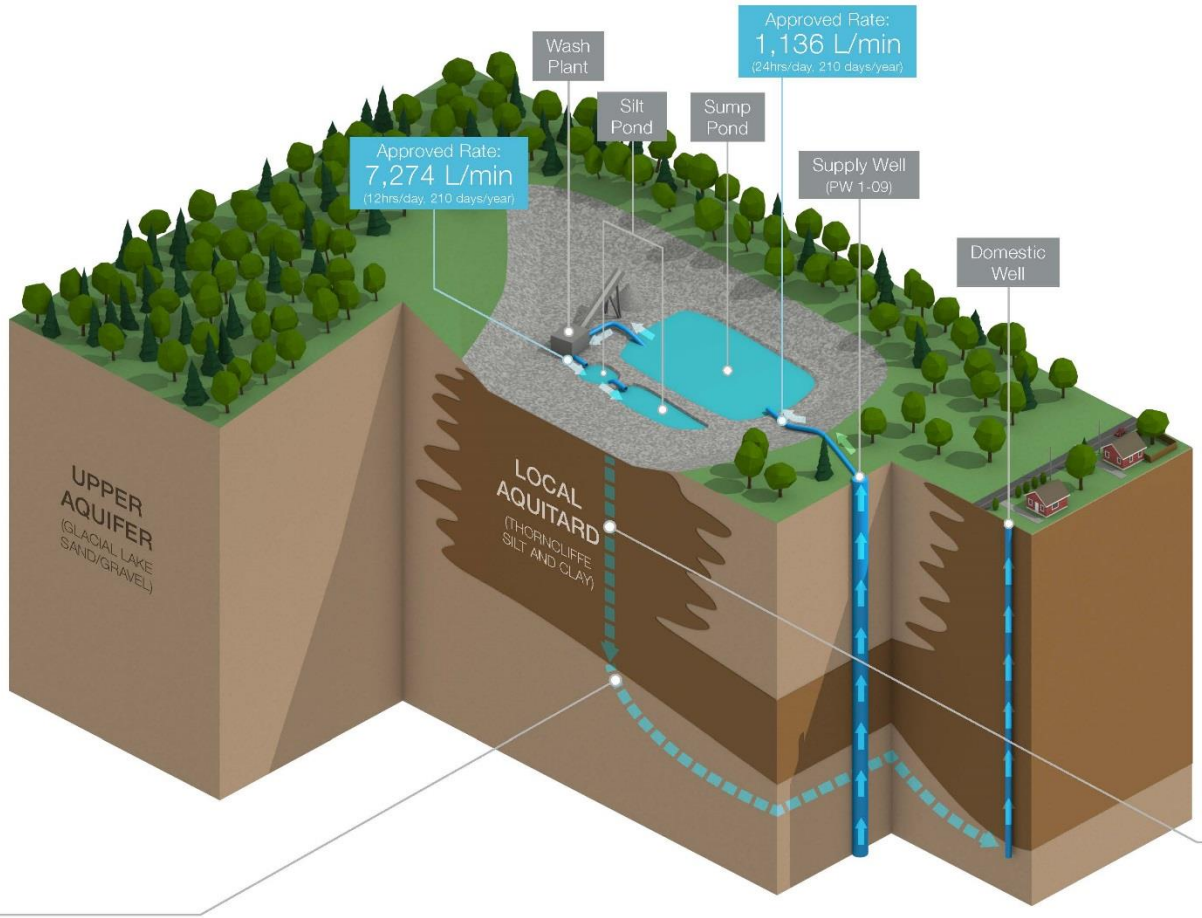

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Vertical travel time of groundwater through Local Aquitard from bottom of Sump Pond to Upper Aquifer

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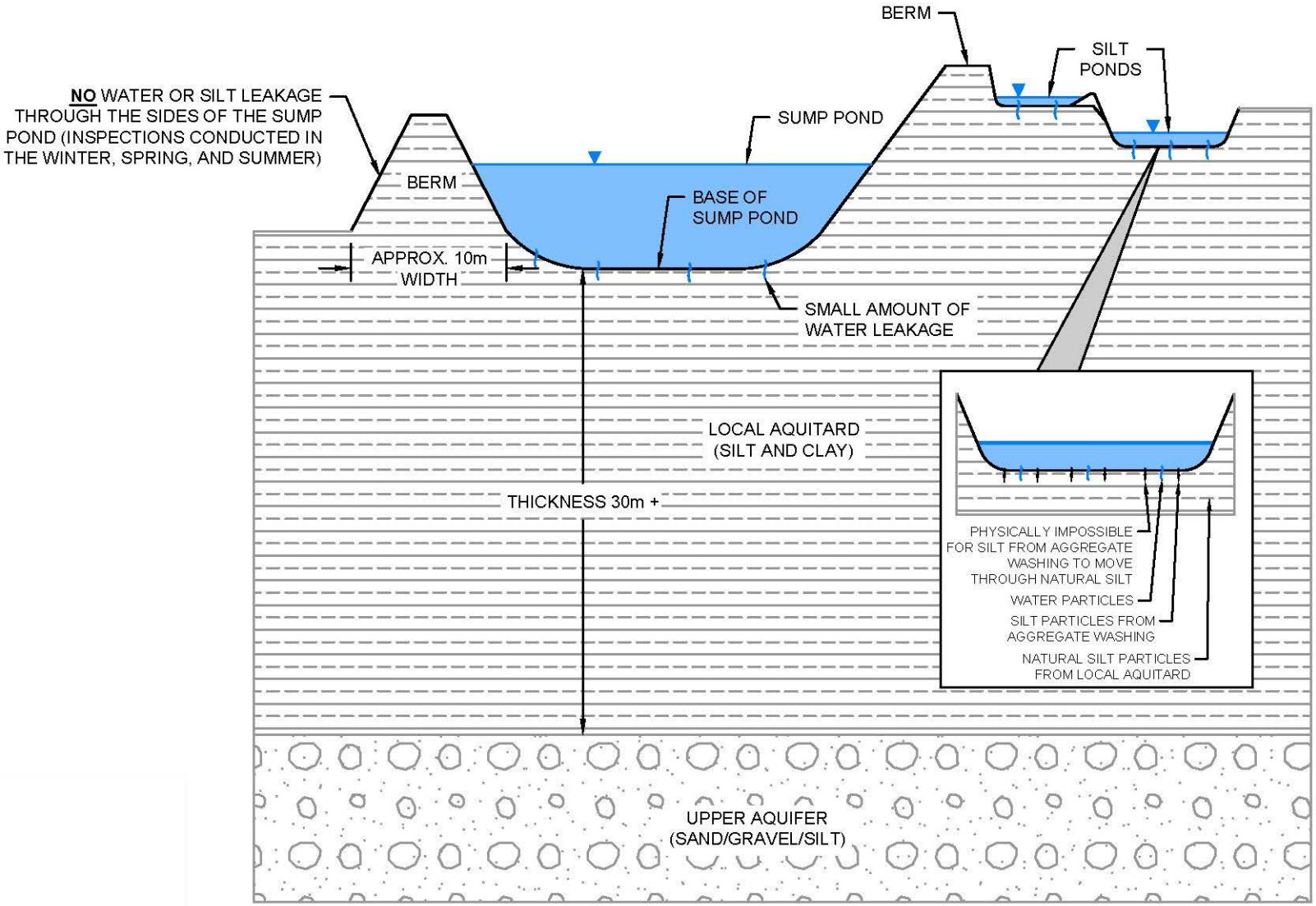
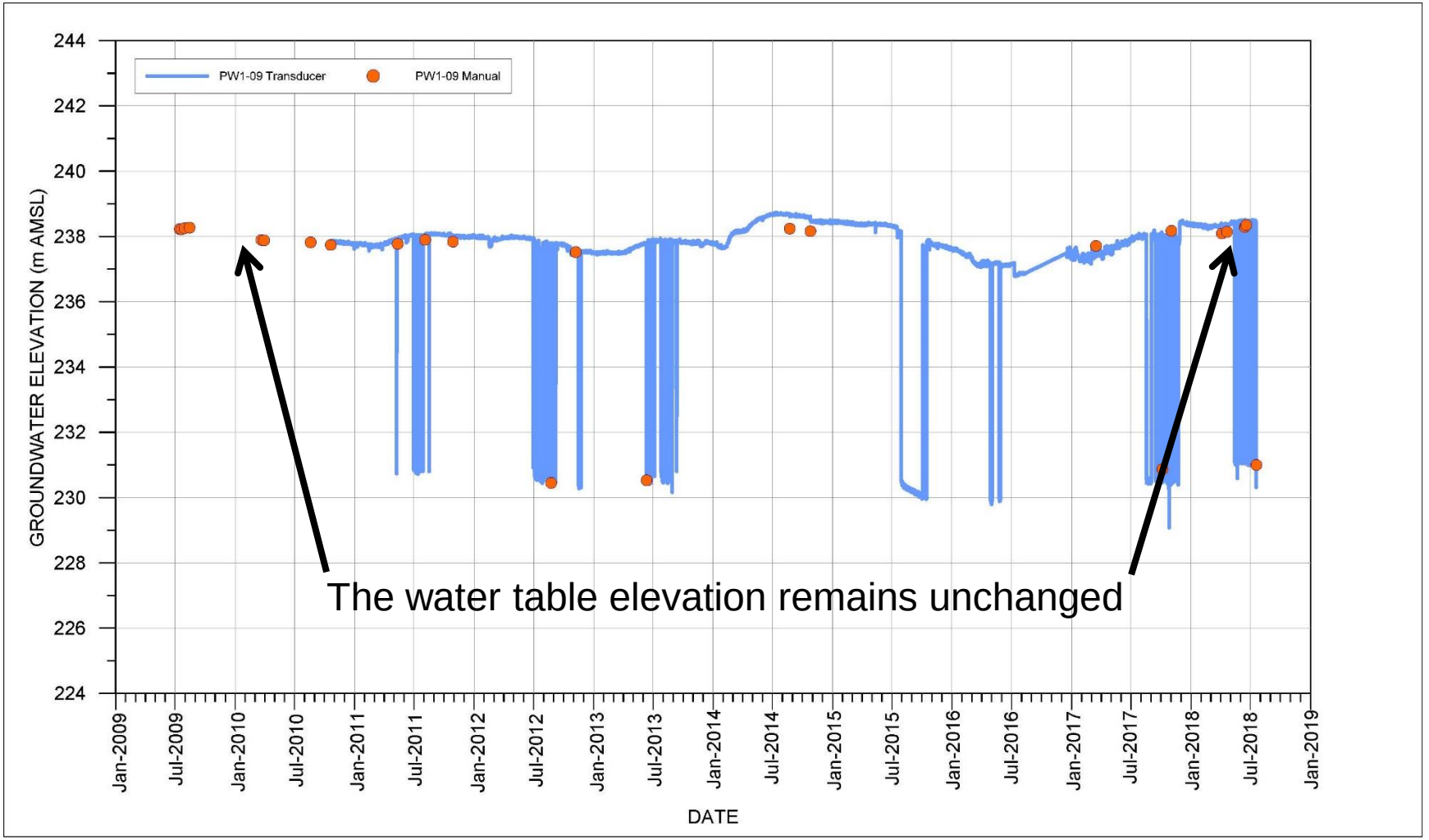
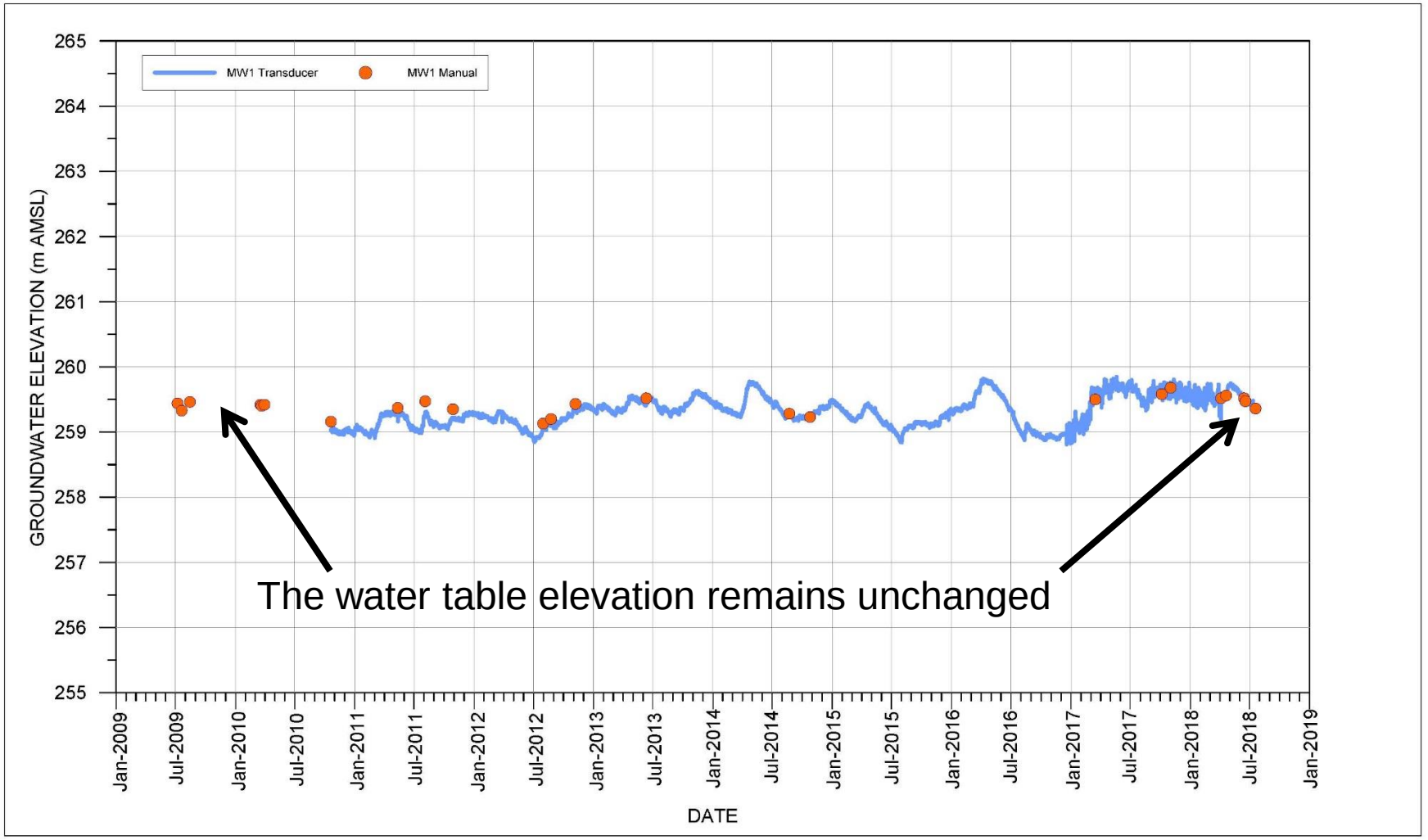
Schematic of Sump and Silt Ponds



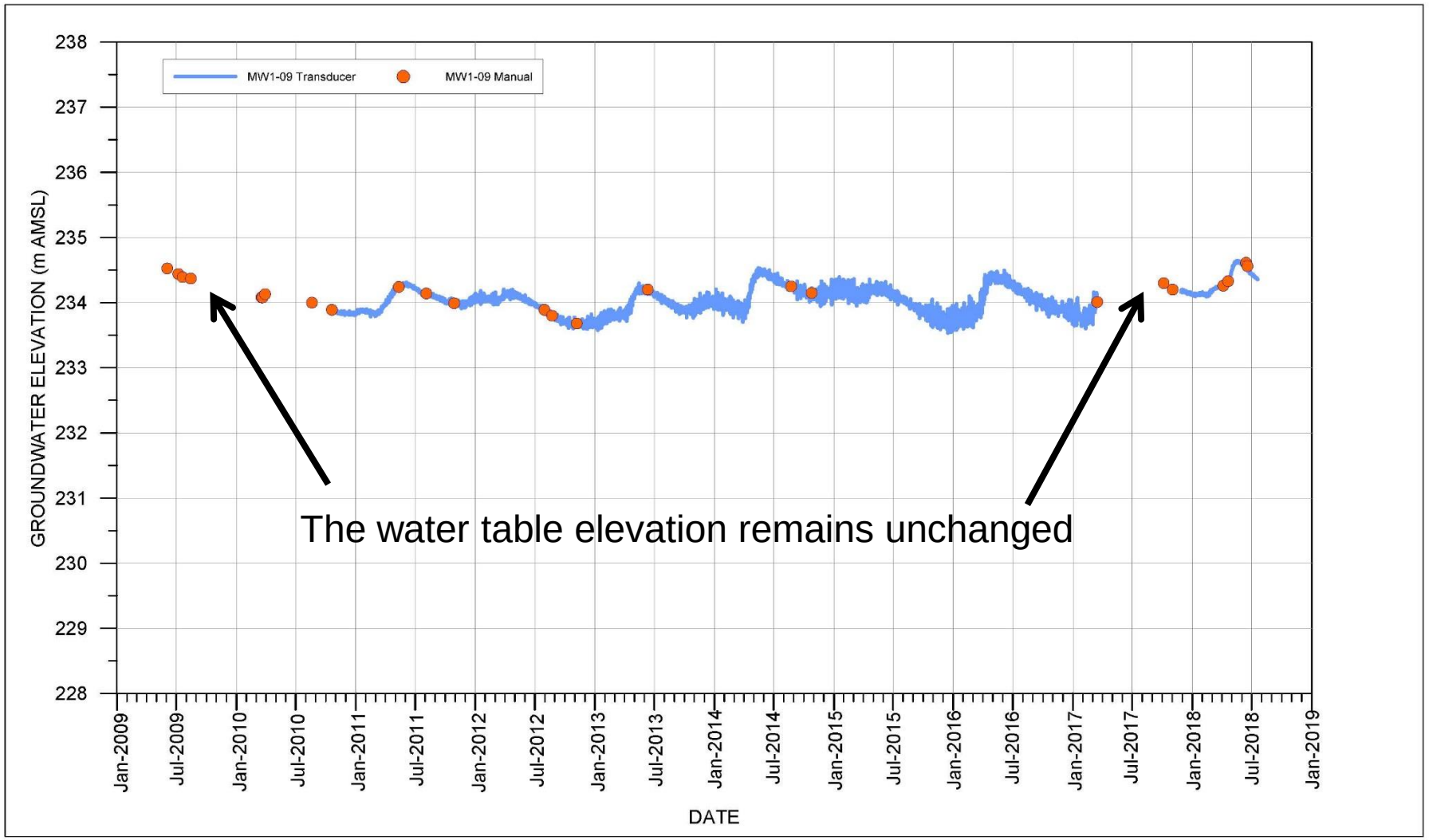
Source Well Hydrograph (PW1-09)



MW1 Hydrograph



MW1-09 Hydrograph



Hydrogeology Questions from CLC

1. Does the Teedon Pit have an impact on water table levels or groundwater quality?
2. Does the washing of aggregates:
   - Impact water levels?
   - Impact water quality?
   - Contaminate groundwater with silt or cause turbidity?
3. The existing Teedon Pit is approved to extract to 1.5 m above the high water table. Is this sufficient to protect the water table?
4. Does removing aggregate take away the natural filter?
5. Can the settling ponds be lined?
6. Is more monitoring needed? Is there an impact on the Alliston aquifer?
7. Why is silt in neighbour's wells? Cause of orange water?
8. Why does the site not measure turbidity?
9. Can research be done on water travelling underground?
10. It has been said "it is the worlds cleanest water", should the precautionary principle be used?

Hydrogeology Questions from CLC

1) Does the Teedon Pit have an impact on water table levels or groundwater quality?
   - The Teedon Pit does not have an impact on water levels as shown by the hydrographs (water level data collected continuously with pressure transducers/data loggers).
   - The Teedon Pit does not have an impact on groundwater quality.
   - There are no sources of contamination within the pit and the filtration and other physical, chemical, and biological processes are active.

Hydrogeology Questions from CLC

To be discussed further at the next CLC

2) Does the washing of aggregates:

- Impact water levels?
  - No, the hydrographs at the Site show no changes in water levels due to aggregate washing
  - The only changes in water levels are due to natural seasonal fluctuations
- Impact water quality?
  - There are no sources of contamination created by aggregate washing
  - Aggregate washing involves only the mechanical removal of fines from aggregates without the use of chemicals
- Contaminate groundwater with silt or cause turbidity?
  - There is little water leaking from settling (silt) or Sump Ponds to the underlying geologic deposits
  - There are at least 30m of Local Aquitard comprised of fine grained material protecting the aquifer
  - It is physically impossible to mobilize silt through the local aquitard. Silt cannot move through silt.

Hydrogeology Questions from CLC

To be discussed further at the next CLC

3) The existing Teedon Pit is approved to extract to 1.5 m above the high water table. Is this sufficient to protect the water table?
   - It might seem that a gravel pit excavation 1.5 m above the highest water table is something unique. This is not the case.
   - There are vast areas of the province where the water table is naturally close to the ground surface or even exposed in ponds or wetlands.
   - There are many construction projects where excavation occurs at or below the water table and management practices protect groundwater.

Hydrogeology Questions from CLC

To be discussed further at the next CLC

4) Does removing aggregate take away the natural filter?

- Scientists rely on the Source + Pathway + Receptor model to evaluate the risk of groundwater pollution.
- There has to be a source of pollution.
- A pit may reduce the amount of sand and gravel above the water table, but it doesn't stop the filtration process.
- Most filter beds made of sand in water treatment plants are only a few centimetres or a couple of metres thick.
- Mandatory setbacks from the edge of a pit to property boundary alone are at least 15 metres. This allows plenty of opportunity for filtration and other physical, chemical, and biological processes to occur.
- A world-wide literature review for the Ontario Ministry of Natural Resources confirmed that not a single instance of contamination could be found to be caused by a pit or quarry.

Hydrogeology Questions from CLC

To be discussed further at the next CLC

5) Can the settling ponds be lined?

- The settling (silt) ponds are lined naturally by the fine-grained (silt and clay) material removed by aggregate washing
- This is common practice in the aggregate industry
- In addition the settling (silt) ponds are on at least 30 metres of fine-grained (silt and clay) deposits of the Local Aquitard
- The Local Aquitard forms a very thick liner protecting the underlying Upper Aquifer

Hydrogeology Questions from CLC

To be discussed further at the next CLC

6) Is more monitoring needed? Is there an impact on the Alliston aquifer?

- Dufferin currently conducts significant monitoring at the site (both up and down gradient of the Pit and washing operations). Monitoring results demonstrate that there is no change in water levels since washing began at the site. As such, there is no impact to the Alliston aquifer based on this data.
- Monitoring at the Teedon pit is in line with monitoring at other pits in Ontario.
- Currently there are 10 monitoring wells, 3 domestic wells, production well, and sump pond equipped with pressure transducers/data loggers being monitored this network provides sufficient coverage.

Hydrogeology Questions from CLC

7) Why is there silt in neighbour's wells? Cause of orange water?

- There are numerous reasons that silt could be in the neighbours wells:
  - Silt vs. scale from hard water (two separate issues)
  - Improper well design or construction (slot size might be too large and a sandpack might not be part of well construction)
  - Insufficient well development after construction
  - Corrosion of well casing, liner or screen causing holes
  - Failure of the annular or casing seal
  - Scaling of the well screen (iron bacteria)
  - Improper or lack of well maintenance
  - Many of the well complaints do not have well logs and consequently no construction details are known.
- Cause of orange water is very common well problem
  - From naturally occurring iron bacteria in the well or iron accumulations around well screen
  - Generally fixed with water softener, filters or combination

Hydrogeology Questions from CLC

8) Why does the site not measure turbidity?

- Turbidity is a measure of the relative clarity or cloudiness of water.
- Turbidity data are collected for the following purposes:
  - Effectiveness of well design
  - Stabilization parameter/indicator of steady state conditions prior to the collection of groundwater samples.
  - Determine optimum groundwater withdrawal rates.
  - Maintenance of a well.
- The Dufferin monitoring wells have different construction details and are not used for producing water consequently measuring turbidity is not an “apples to apples” comparison to neighbour wells.
- Given the above, turbidity measurements would not be beneficial.

Hydrogeology Questions from CLC

9) Can research be done on water travelling underground?

- Common practice in hydrogeologic studies is to establish groundwater flow velocities through indirect means for porous media (sand and gravel deposits).
- Groundwater flow velocities are determined using known/calculated variables:
  - The hydraulic conductivity (K) of the media are determined through single-well response tests (slug tests), pumping tests, or grain size distribution.
  - The horizontal and vertical hydraulic gradients (i) are determined using groundwater contours (change in groundwater elevation as function of distance).
  - The porosity (n) of the media is factored in the equation (assumed to be 30 percent).
  - $v = \frac{K \quad i}{n}$ This has been determined at Teedon Pit (see Conceptual Model).
  - It will take between 9.5 and 24 years for a drop of water at the settling pond to reach the nearest domestic well.

Hydrogeology Questions from CLC

To be discussed further at the next CLC

10) It has been said “it is the worlds cleanest water”, should the precautionary principle be used?

- The statement is based on the study conducted by William Shotyk and others “Trace Elements in Recent Groundwater of an Artesian Flow System and Comparison with Snow: Enrichments, Depletions, and Chemical Evolution of the Water” published in the Journal of Environmental Monitoring in 2010.
- The study was conducted in two farms near Elmvale within the Simcoe Lowlands (discharge area)
- Study compared trace element concentrations in snow and groundwater springs and noted generally depletion/removal of some trace elements (notably antimony and lead) by groundwater “filtration processes”
- However, it is the clay fraction minerals of the glacial lake sediments within the Simcoe Lowlands within the discharge areas and not the deposits within the Simcoe Uplands areas which are removing the trace elements in snow
- Cation exchange capacity of the clay minerals removes trace elements but it occurs under ideal pH conditions within discharge zones containing fine-grained glacial lake sediments
- Therefore, the study by Shotyk and others cannot be used to form the basis of the “world’s cleanest water” for this area (Simcoe Uplands)
- Design and monitoring programs ensure that washing operations at pits do not impact the water table.

Next Meeting

- Next Meeting – November 15

Dufferin
Aggregates

A division of CRH Canada Group Inc.