CHUNG & VANDER DOELEN
ENGINEERING LTD.

HYDROGEOLOGICAL & SWP
POTENTIAL CONTAMINATION STUDY
Proposed Residential Re-development
ODC Tooling & Molds Property, Waterloo, Ontario

SUBMITTED TO:
Ontario Die Company Ltd.
119 Roger Street
Waterloo ON N2J 3Z6

ATTENTION:
Mr. Ronald Levene

FILE NO / H16053 / March 20, 2017

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March 20, 2017
FILE NO.: H15053

Mr. Ronald Levene
Ontario Die Company Ltd.
119 Roger Street
Waterloo ON N2J 3Z6

Dear Mr. Levene:

RE: HYDROGEOLOGICAL & SWP POTENTIAL CONTAMINATION STUDY
Proposed Residential Re-development at
ODC Tooling & Molds Property, Roger St. & Moore Ave. S., Waterloo, Ontario

This combined ***Hydrogeological & SWP Potential Contamination Study*** of a proposed residential re-development plan for the Ontario Die Company Ltd. (ODC) property located at Roger St. and Moore Ave. S. in Waterloo, addresses Region of Waterloo requirements for both a ***Hydrogeological Study*** and for a ***Source Water Protection (SWP) Potential Contamination Study***, as described through the pre-application consultation process.

If you have any questions or concerns regarding the report, please contact the undersigned at your convenience.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

William (Sandy) Anderson, M.Sc., P.Eng.
Senior Hydrogeologist and Engineer

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1.0 INTRODUCTION

This Hydrogeological & SWP Potential Contamination Study addresses two specific Region of Waterloo requirements for a proposed residential re-development plan of the Ontario Die Company Ltd. (ODC) Tooling & Molds property in Waterloo, Ontario. Figure 1 (Appendix A) shows the location of the 2.1-hectare property along Waterloo's southern boundary with Kitchener, at the intersection of Roger Street and Moore Avenue South.

The Development Concept (GSP Plan, Appendix A) would replace the existing industrial operation and seven single-family residences on the property with a mixture of medium-density residential units, including three 6-storey apartments, one 3-storey apartment, and five stacked townhouse complexes. The current official plan designation for the property is Low Density Residential and is proposed for Mixed Use Medium Density Residential. The property is currently zoned for General Residential (GR-1) and Industrial (I-1) and is proposed for Multi Residential 6 (MR-6).

The groundwater-related study requirements outlined by the Region are as follows:

1. Hydrogeological Study – Based on the ODC property location within Region Wellhead Protection Sensitivity Areas (WPSAs) associated with the William Street Well Field, this Study is required if more than one level of underground parking is planned and/or if any part of the building and/or parking structure will be installed below the water table. If a study is not submitted, the applicant is to confirm that the proposed development will not be constructed below the water table, to the satisfaction of the Region.

2. Source Water Protection (SWP) Potential Contamination Study - In accordance with Section 4.1(a) of the Region's Implementation Guideline for the Review of Development Applications on or Adjacent to Known or Potentially Contaminated Sites, this Study must be acceptable to the Region and meet the following:
   - be prepared by a professional engineer or geoscientist qualified to assess groundwater conditions,
   - assess past and present potential sources of site contamination which may affect groundwater, involve detailed records review and, if necessary, site groundwater testing (Note: site groundwater testing should be included unless the study author can reliably conclude that there is no probability of site groundwater contamination based on the records review), and
   - provide conclusions that clearly summarize site groundwater conditions and the potential for groundwater contamination due to past or present site activities.

2.0 BACKGROUND INFORMATION

Background information utilized in completing this Study are cited in Section 7.0 and include:

- Published government geological maps and water well records.
- Hydrogeological studies commissioned by the Region of Waterloo relating to wellfield

hydrogeology and wellhead protection.
- Subsurface investigations of other properties in the general area.
- A 2008 'Phase 1 Environmental Site Assessment (ESA)' of the ODC property (Trow Associates Ltd., 2008).
- A 2013 'Limited Subsurface Soil and Groundwater Investigation' report of the ODC property (LVM, October 2013).

Together, the 2008 and 2013 site-specific investigations have included the following:

1. assessment of past and present potential sources of contamination on and immediately adjacent to the property,
2. borehole drilling at three locations surrounding the ODC plant, BH1 to BH3 (Figure 1 and LVM map Appendix C),
3. shallow (4.5 to 7.5 m) and deep (20 to 21.5 m) monitoring well installation and water level monitoring at each of the three drilling locations, and
4. limited soil and groundwater testing for common contaminants of concern.

3.0 SITE SETTING

3.1 TOPOGRAPHY & DRAINAGE

Figure 2 (Appendix A) presents a 2016 air photo map around the ODC property, overlain with topographic contours that indicate an approximate 10-m elevation drop across the map area from about 339 mASL on the east edge to about 329 mASL in the northwest corner. On-site, elevations fall in a westerly direction by about 4.5 m, from about 337 mASL along the east property boundary to about 332.5 mASL (+/-) along the west boundary.

Impervious surfaces make up about 52% of the 2.1-hectare property (i.e., about 1.1 hectares), including the 0.5-hectare ODC plant, the six houses along Roger Street and the various asphalt and compacted-gravel parking areas and driveways. The remaining approximately 1.0 hectare of the property is grass-covered, including the low area adjacent to the western boundary.

Surface water runoff from most the property drains in a westerly direction following topography toward the western property boundary, where an on-site catch basin (332.1 mASL approximate elevation) is located. Ultimately, this drainage is directed to an off-site municipal storm sewer that drains further west. About 10-20% of the site drainage is directed toward the municipal storm sewers along Roger St. and Moore Ave. (i.e., that along the northern and eastern edges of the property).

3.2 HYDROGEOLOGIC SETTING

3.2.1 General Setting & Source Water Protection

The ODC property is located on the eastern flank of the Waterloo Moraine, an upland landform

containing up to 130 m of texturally and spatially-variable unconsolidated geologic deposits, created by the numerous glacial advances and retreats that occurred during the Quaternary Period (P.F. Karrow, "The Quaternary Geology of the Stratford Area", 1987).

The hydrogeology of the Moraine has been characterized in considerable detail through numerous studies commissioned by the Region, mostly over the past 25 years, and documented in scientific literature (e.g., Blackport et al., 2014). This work has established that there is a strong correlation between the stratigraphy, the water resources and groundwater movement within and in the areas flanking the Moraine. Four overburden aquifers, a bedrock aquifer and four overburden aquitards have been identified and generically named (e.g. AFB1 – Aquifer 1, ATB2 – Aquitard 2, …) in a conceptual hydrogeologic model of the Moraine developed through these studies (see east-west schematic cross-section through the Moraine, Figure 6 Appendix E, Aqua Resource et al., 2009). Notably, one or more of these aquifers and aquitards may be absent at any given location.

Groundwater supply in the Region is obtained from the various aquifers found throughout the Moraine stratigraphic sequence. Shallow coarse-grained unsaturated deposits and hummocky terrain of the central core area of the Waterloo Moraine allow large volumes of recharge to infiltrate, and this water is subsequently transmitted to deeper aquifer units through erosional "windows" in the aquitards.

The Region's William Street Wellfield has the closest supply wells to the ODC property; located about 800 m to the west (Figure 1). Several studies of the Wellfield since the 1990s (e.g., most recently by XCG / ARL Groundwater Resources Ltd., Sept. 2016) have confirmed that the supply wells obtain groundwater primarily from intermediate-depth Aquifer 2 (AFB2), possibly connected to deeper AFB3, and that the wellfield capture zone extends primarily to the west-northwest toward the core of the Moraine and major recharge areas. Figure 7 Appendix E (from XCG/ARL, 2016) illustrates the Aquifer 2 potentiometric surface in the westerly capture area (after a pumping test), with elevations sloping from about 325 mASL about 1 km to the west to about 315 mASL near the well field (at OW10). Figures 17, 18 and 20 Appendix E (from XCG/ARL, 2016) show cross-sections to the west and southwest, illustrating an extensive Aquifer 2 to the west (Figure 18) and the existence of Aquitard 2 separating Aquifers 1 and 2, particularly thicker to the southwest of the wellfield (Figure 20). Figures 13 and 18 Appendix E (from Aqua Resource, 2009) show a cross-section to the east-northeast, illustrating an apparent 'pinching-out' of both Aquitard 2 and Aquifer 2 and an offsetting increase in the thickness of surficial Aquifer 1.

The ***Source Water Protection*** initiatives in the Region of Waterloo (Grand River Source Protection Committee, 2012 and 2015) have established four Well Head Protection Areas (A, B, C & D); WHPA-A for the immediate 100-m zone around each municipal well and WHPA-B to D based on modelled groundwater 'times of travel' to each well (or wellfield) of 2, 5 and 25-years, respectively. In addition, relative groundwater '*vulnerability*' to contamination scores (on an increasing scale from 1 to 10) have been established for all lands within the WHPAs. The ODC Site is located just outside (or east of) the William Street Wellfield WHPA-D (Figure 1 and Appendix E Figure 10.29). This means that groundwater beneath the property (at an unspecified depth) is not predicted to travel to the William Street wells within 25-years and, as a result, no specified vulnerability to contamination of the groundwater beneath this property has been identified, based on hydrogeological considerations in relation to the Wellfield. Although the ODC property is outside the 25-year protection area, it is noteworthy that the Region has identified the WHPA-D to be an '*Issue Contributing Area*', to recognize that three contaminants

(chloride, sodium and TCE/trichloroethylene) already contribute to existing concern at the William Street wells.

3.2.2 Area Around ODC Property

The Quaternary geological mapping by Karrow (1987) indicates an extensive area around the ODC property and the William Street Wellfield is underlain by a surficial geologic deposit of "poorly to well sorted ice-contact sand and/or gravel deposit", which Karrow indicates is often interlayered with clayey to sandy silt deposits.

The 2013 LVM data (Appendix C) confirm that the ODC site is underlain by 'near-surface' layers of silt and silty sand to about the 2 to 4-m depth, which are in turn are underlain by an up to 22-m thick 'coarsening-downward' sand deposit that extends to at least the 314 mASL elevation (at BH1). These data indicate an absence of a shallow water table in the surficial silty layers and confirm a deeper water table in the sand deposit at about the 17.5 to 20-m depth. The September 18, 2013 water table elevations from the three wells only vary by 0.04 m (316.98 to 316.94 mASL), suggesting an essentially very flat water table (0.0005 m/m – 0.04 m drop across 80 m).

Figures 3 and 4 present two hydrogeologic cross-sections (A-A' and B-B') to illustrate the variable hydro-stratigraphic relationship between the site and the regional aquifer/aquitard system in different directions from the Wellfield. Figure 1 shows the orientation of the two sections and the locations of the representative 'intermediate-depth' borehole/well data used to prepare the sections. Figure 1 also provides water level elevation data for each of these representative borehole/wells and site-specific interpretations of the groundwater flow direction, where available. Appendix D provides the borehole/well logs and maps showing well locations and interpreted flow directions for individual site, where available.

Southeastward along Section A-A', the hydrogeological setting is generally like that shown in XCG/ARL Figure 20 cross-section to the southwest; specifically, a thick Aquitard 2 underlying the water table Aquifer 1. Previous dewatering assessments at the 187 King Street property (Bauer Lofts, Anderson Geologic 2006) indicate that Aquifer 1 in this area is very substantial, but there is limited if any apparent significant hydraulic connection to the William Street wells. Aquifer 1 was encountered at five additional properties in this southeast direction (see Figure 1) and in each instance the Aquifer 1 and/or Aquitard 2 groundwater elevations were in the 323 to 325-mASL range.

Conversely, eastward along Section B-B' to the ODC property, the hydrogeological setting has similarities to that shown in Aqua Resource Figure 18 cross-section to the east-northeast; specifically, a thicker upper sand deposit and a possible absence of Aquitard 2. The lower groundwater elevations at the ODC site and at other sites along this cross-section (about 316 to 317 mASL) are more consistent with Aquifer 2 groundwater elevations (i.e., about 309 to 314 mASL at William Street Aquifer 2 Wells W1B and W2), compared to the higher Aquifer 1 groundwater elevations at the Wellfield (about 320 mASL at OW5B) and to the southeast (323 to 325 mASL, Figures 1 and 3). The lower groundwater elevations to the east may be due to an absence of Aquitard 2 (thus allowing unimpeded groundwater movement to greater depths). An alternative explanation is that the long-term pumping of the William Street Aquifer 2 wells

has resulted in a lower and 'flattened' groundwater levels in the known 'downgradient' direction from the Wellfield.

Notwithstanding the possible stratigraphic reasons for the groundwater level differences around the Wellfield, the very flat water table at the ODC property (0.0005 m/m) and the generally similar potentiometric elevations at other properties along this eastern cross-section (i.e., 316-316.5 mASL), suggests that the SWP placement of the ODC property outside the 25-year WHPA-D appears reasonable.

4.0 SUMMARY OF ESA & SUBSURFACE SOIL/GROUNDWATER TESTING

Appendix B provides the executive summary from Trow's 2008 Phase 1 ESA and Appendix C provides the executive summary and selected data from LVM's 2013 subsurface investigation.

4.1 ADJACENT LAND USES & POTENTIAL CONTAMINANT SOURCES

In the Phase 1 ESA, Trow documents historical land use activities on and around the ODC property and identifies potential sources of contamination. Appendix B provides Trow's list of Areas of Potential Environmental Concern (APEC) and Potential Contaminants of Concern (PCOC) in relation to both site building materials and site soil/groundwater, as well as a map showing the ODC plant layout.

LVM (2013) reviewed the 2008 Phase 1 ESA and provided a more conventional list of the Areas of Potential Environmental Concern (APEC) along with the associated Potential Contaminating Activities (PCA) that relate to soil and groundwater (see Appendix C). The PCAs / APECs identified include:

1. Activities in the ODC building relating to ***liquid chemical use and storage***, specifically: a) the significant black staining observed around machinery, waste oil / coolant holding tanks and a quenching oil holding tank, and b) the large quantities of chemical drum storage, spillage and absence of secondary containment.
2. Activities outside the ODC building relating to a ***metal dust collector and scrap metal bins***, specifically the significant orange staining of asphalt and concrete.
3. The existence of ***soil fill*** on the ODC property, used historically for grading purposes during building construction, without specific reference to location or nature of the fill.
4. The previous existence of ***heating oil tanks*** at the six existing / former residences along Roger St., with specific documentation of tank removal at one of these buildings.

While each of the above PCAs / APECs have the potential to result in on-site groundwater contamination, those relating to heavy metals, oils and coolants do not normally result in widespread groundwater contamination beyond on-site source areas, particularly to deeper regional groundwater sources. Although no lists of specific liquid chemicals were provided in the 2008/2013 assessments, the possibility that chlorinated solvents were used at the ODC facility has not been ruled out. Several chlorinated solvents (or DNAPLs, dense non-aqueous phase liquids) were commonly used in the machine tooling and stamping industry (as well as in other industries such as dry cleaning) and these chemicals have a much greater potential to result in widespread and significant groundwater

contamination, due to their density and limited subsurface attenuation.

4.2 SOIL & GROUNDWATER CONTAMINANT CHARACTERIZATION

The 2013 subsurface investigation consisted of soil and groundwater characterization for PCOCs (including chlorinated DNAPL solvents) at three locations surrounding the ODC plant, BH1 to BH3 (Figure 1 and LVM map Appendix C). This results of this work are described in the LVM executive summary (Appendix C). The following points summarize the results:

- 'Near-surface' (0.05-0.6 m) and 'deep' (16 to 20 m +/-) soil samples from each location were analysed for metals and petroleum hydrocarbons. All reported concentrations were either below method detection limits or below MOECC Table 2 standards for residential/ parkland/institutional land use for coarse-textured soils.
- All three 'deep' soil samples and the 'near-surface' soil sample from BH1 were analysed for volatile organic compounds (VOC) and one 'near-surface' sample from BH3 was analysed for poly-aromatic hydrocarbons (PAHs), with all results reported below method detection limits.
- and the sporadic presence of elevated concentrations of some heavy metals (arsenic, barium, cobalt, and lead), PAHs and/or F2/F3 hydrocarbons in the surface fill, typically in the upper 0.6 m, but no deeper than 1.4 m.
- Groundwater samples from all three deep monitoring wells (noting all three shallow wells were dry) were analysed for metals, petroleum hydrocarbons and VOC, and one sample (from BH1) was analysed for PAHs. All reported concentrations were either below method detection limits or below MOECC Table 2 standards for residential/ parkland/institutional land use for coarse-textured soils.

Very low concentrations of TCE (0.44 ug/L) and 1,1,1-TCA (0.67 ug/L), both chlorinated solvents, were detected at well BH3 on the apparent-upgradient eastern side of the ODC plant. As well, very low concentrations of chloroform (0.49 to 0.74 ug/L) and toluene (0.24 to 0.77 ug/L) were detected at two of the three wells. While these very modest VOC detections are not considered problematic, these initial detections warrant that confirmatory work be conducted during the planned Phase 2 ESA to confirm their absence at significant concentrations and at all relevant aquifer locations and depths.

The elevated sodium concentrations (45 to 350 mg/L), although below the Table 2 standards, are not unusual given the urban setting where extensive salting of roads, sidewalks and parking lots has been practiced for well over five decades. As discussed in Section 3.2.1, the Region has identified sodium as an issue of concern at the William Street Wellfield and is receptive to all efforts to reduce salt loading in the urban area.

5.0 HYDROGEOLOGICAL ASSESSMENT of DEWATERING, RECHARGE & AQUIFER VULNERABILITY

1. Dewatering. The re-development plan proposes finished floor elevations of the buildings that are similar to the existing grades on and around the property (i.e., in the 334 to 337 mASL range +/-). The 6-storey apartments are planned to have two floors of underground parking and this would

place the second underground level in the 327 to 330 mASL range (+/-). Even with an additional 1 m allowance for seasonal water table fluctuation, it is apparent that the deepest garage levels would be on the order of 10 to 13 m above the water table (317 mASL +/-). On this basis, the proposed underfloor parking garages will not require any construction or permanent dewatering.

2. Recharge. The development plan includes several green areas where groundwater recharge can be expected to occur under similar water budget conditions to pre-development conditions. In addition, there is considerable opportunity to enhance groundwater recharge compared to pre-development conditions by infiltrating 'clean' roof-top runoff from the nine proposed buildings via recharge galleries placed beneath or adjacent to the buildings. The very deep water table and the permeable 'dry' sands make this property particularly amenable for incorporating an 'enhanced-recharge' approach.

3. Aquifer Vulnerability. The existing property is not underlain by surficial low-permeability soils layers that provide significant protection to underlying aquifers, so the excavation of near-surface silt and silty sand soils for garage construction is not expected to increase aquifer vulnerability to contamination.

6.0 ASSESSMENT of SOURCE WATER PROTECTION POTENTIAL CONTAMINATION

The following points address various aspects of potential site contamination as it relates to Source Water Protection of the William Street Wellfield.

1. The available data collected at the property during the 2013 limited subsurface investigation found no evidence of any significant soil or groundwater contamination.

2. The hydro-stratigraphic assessment presented in Section 3.0 of the current report indicates there is little, if any, significant groundwater movement from the ODC property toward the William Street Wellfield and suggests that the SWP Plan placement of the site outside the Wellfield 25-year Well Head Protection Area (WHPA-D) and Issue Contributing Area (ICA), is appropriate.

3. Notwithstanding points 1) and 2) above, the Region and City planning approval process for re-development of the ODC facility has appropriately required that a Record of Site Condition (RSC) be obtained to confirm the absence of any site contamination within allowable standards for the proposed residential land use or completion of a satisfactory Risk Assessment (RA) to address any contaminants not addressed by the MOECC standards. It is understood that the work necessary to obtain the RSC (with or without an RA) will require the satisfactory completion of an updated Phase 1 ESA and a thorough Phase 2 ESA that assesses all PCAs / APECs, is completed in conjunction with plant demolition / clean-up, all in accordance with MOECC requirements.

4. It is expected that the proposed residential re-development of the ODC property, complete with a satisfactory RSC and an effective salt management plan, will *reduce* the potential for contamination of source water at the property.

Respectfully submitted,
CHUNG & VANDER DOELEN ENGINEERING LTD.

William (Sandy) Anderson, M.Sc., P.Eng.
Senior Hydrogeologist and Engineer

7.0 REFERENCES

The following documents, maps, or other publications have been used in the preparation of this report.

- Aecom Canada Limited (2017). "**Functional Servicing Report, 93-119 Roger Street, Waterloo**".
- Alston Associates Inc. (January 2014). "**Geotechnical Investigation, King and John Street, Waterloo**".
- Anderson Geologic Limited (2006). **"Hydrogeological Study for Construction Dewatering, Bauer Lofts Property, Waterloo"**.
- Aqua Resource et al. (2009). **"Region of Waterloo Tier 3 Assessment"**.
- Blackport, R. et al. (2014). **"Developing science-based policy for protecting the Waterloo Moraine groundwater resource"**, Journal Canadian Water Resources Journal, Volume 39.
- CVD Engineering Ltd. (2016). **"Geotechnical Investigation, Proposed Twenty-Storey Mixed-Use Building, 181 King Street South, Waterloo"**.
- CVD Engineering Ltd. (March 2012). **"Phase II Environmental Site Assessment, 144 Lucan St., Waterloo"**.
- CVD Engineering Ltd. (April 2012). **"Phase 2 Environmental Site Assessment, 220-226 King St. South, Waterloo"**.
- Grand River Source Protection Committee (2015). **"Grand River Source Protection Plan"**.
- Grand River Source Protection Committee (2012). **"Grand River Source Protection – Approved Assessment Report"**.
- Karrow, P. F. (1987). **"Quaternary Geology of the Stratford Area"**, Ontario Geological Survey, Map 2559.
- LVM Inc. (2012). "**Limited Subsurface Soil and Groundwater Investigation, ODC Tooling & Molds, division of Ontario Die Company Ltd.**".
- MTE Consultants Inc. (2012). "**Phase Two Environmental Site Assessment, St. Louis School, 75 Allen Street, Waterloo**".
- Premier Environmental Services Inc. (2013). **"RSC #211949 for 141-145 Caroline St. South and 156 Park St., Waterloo"**.

- R. J. Burnside & Associates Limited (2016). **"William Street Well Field, 2015 Biennial Groundwater Monitoring Report"**.

- Terraqua Investigations Ltd. (1995). **"Hydrogeologic Study of the Waterloo Moraine"**.

- Terraqua Investigations Limited" (1997). **"Background Hydrogeological Assessment, William St. and Seagram Water Supply System"**.

- Trow Associates Inc. (2008). "**Phase I Environmental Site Assessment, 93, 97, 99, 103, 107, 109, 111 and 119 Roger Street, Waterloo**".

- XCG Consultants Ltd. - with ARL Groundwater Resources Ltd. (Sept. 2016). "**William Street and Strange Street Water Supply Systems, Class Environmental Assessment, Environmental Study Report**".

APPENDIX A
Figures

APPENDIX B
Executive Summary from 2008 Phase 1 ESA (Trow Associates)

APPENDIX C
Executive Summary & Data from 2013 Limited Subsurface Soil and Groundwater Investigation (LVM)

APPENDIX D
Miscellaneous Borehole Logs, Well Records & Maps

APPENDIX E
Miscellaneous Figures from Region of Waterloo Studies