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March 10, 2023

WSP E&I Canada Limited
3450 Harvester Road, Suite100
Burlington, ON L7N 3W5

Attn: Matt Senior

Re: Vibration Assessment
1450 King Road
Quantum Realty Management
SWM Facility Works
Burlington, ON
Our File No. 22266

INTRODUCTION

In accordance with your request and the requirements imposed by the City of Burlington for site plan approval, OZA Inspections Ltd. conducted a preliminary vibration assessment with respect to the proposed development and the potential impact of construction vibrations relative to existing buildings/property adjacent to the site. The purpose of this assessment is to determine a baseline for vibration levels and recommend associated controls necessary towards the preservation of the neighbouring buildings.

Prediction models were developed based on conventional types of machinery generally used in the works proposed for this project. Standard equipment was modeled separately to assess the impact. Predicted vibration levels were compared with thresholds for building damage to determine the required safe set-back distances.

Vibration impact shall be controlled through the implementation of recommended mitigation measures and vibration monitoring of key operations.

CONSIDERATIONS

This phase of the site development is specific to re-design of the stormwater management facility (SWMF). Currently stormwater management is located in the southeast part of the site. The proposed work involves relocation of the SWMF to the north site area, to allow development of the south site area. This work shall involve excavation of the dry pond, associated grading, construction of a concrete headwall, oil grit separator, spillway, access road and stormwater drainage pipe to King Road. The proposed structures shall involve granular, compacted bedding. Rock excavation is not anticipated.

The geotechnical report (Geotechnical Investigation Report, File WW21012079, Wood Environmental & Infrastructure Solutions, January 24, 2023) for this site indicates that excavations will encounter different soil types, and proceed below the groundwater level. However, work can be completed with conventional excavation equipment. Bedding, pipe back fill shall involve compaction to 98% SPMDD.

Based on our review of the Site Plans (Site Layout Plan, Drawing No. SP1, Interim SWMF Grading Plan, Sheet 8 of 14, File WW21012079, Wood, January 2022), we estimate that the proposed pond construction and associated works is offset by approximately 10± metres to the nearest building, 598 King Forest Court, immediately north of the site. The next nearest building is 578 King Forest Court, 30± metres to the proposed spillway.

We have anticipated that construction activities for this project as described above will involve the following conventional construction equipment:

- Bulldozers
- Excavators
- Compactors (vibratory drum roller and/or hoe-pac)
- Earthmovers, Dump trucks

ASSESSMENT METHODS / DETAILS

For assessment of ground borne vibration impact, measurement of the Peak Particle Velocity (PPV) is widely accepted as the best descriptor of potential for damage. However, pre-construction assessment involves prediction methods.

The United States Department of Transportation has published procedures (Reference: United States Federal Transit Administration, Transit Noise and Vibration Impact Assessment, Report No. 0123, September 2018) for construction vibration prediction. The reference values provided are considered a reasonable average based on a wide range of site conditions. This procedure involves the use of reference values at a given distance factored into a distance attenuation calculation to determine the predicted PPV value at various distances. These predicted values are then compared to appropriate criterion to determine impact.

CRITERIA

This section forms a preliminary criteria guideline and the basis for the calculation of the set-back distances.

Currently there is not a universally accepted standard in Ontario for limiting vibration relative to heavy construction such as grading, excavation and vibratory compaction. Subsequently, vibration and loss control consultants like us rely on our expertise, and interpretation of resources, such as international vibration standards and studies. For specific projects, many factors are typically considered, including but not limited to the structural sensitivity and construction methods (source characteristics).

More restrictive vibration limits are generally applied to vibration sensitive structures, such as buildings designated under the Ontario Heritage Act than for modern buildings.

The previously referenced FTA assessment report suggests limits based on the structure type; see Table 1 following:

Table 1: Construction Vibration Damage Criteria

Building Type	PPV (mm/s)
Reinforced concrete, steel or timber (no plaster)	12.7
Engineered concrete and masonry (no plaster)	7.6
Non-engineered timber and masonry	5.1
Buildings extremely susceptible to vibration damage	3.0

Other references specify PPV limits with consideration of the corresponding

frequency of the construction generated vibration, with the lower thresholds applicable at frequency levels of 10 Hz or less (ie. City of Toronto Municipal Code Chapter 363-5).

Based on our extensive experience monitoring construction we anticipate vibration frequency levels from conventional machinery measuring in the 20-50 Hz range for this project, well above the typical natural frequency of buildings (3-11 Hz). Older 'Heritage Designated' structures are often assigned lower criteria regardless of favourable frequency. We note that the age of a structure or the heritage designation does not necessarily mean that it's more susceptible to vibration than other structure types. Structure condition must be considered.

Considering the buildings adjacent to this site at King Forest Court are modern, industrial buildings, for the purposes of this assessment we have modeled based on a ***5.1 mm/s*** PPV value. Although the adjacent buildings appear modern, the structure condition is unknown and therefore we consider this a conservative approach, in line with the aforementioned City of Toronto By-law standard for pre-construction assessment.

ASSESSMENT

Table 2 presents the reference values used in prediction of the vibration levels with respect to the proposed activities and anticipated machinery.

TABLE 2 **Activity**	**Equipment Type**	**Reference Distance (m)**	**Reference PPV (mm/s)**
Grading	Dozer	7.6	2.261
Grading	Small Dozer	7.6	0.076
Compaction	Vibratory Roller / Hoe-pac	7.6	5.334
Excavation	Excavator	7.6	2.261
Hauling	Loaded Truck	7.6	1.930

Using these FTA reference values, we calculated the minimum separation distance at which a level of 3.0 mm/s is predictable for each activity (source), without consideration of site specific mitigation. The following formula was used:

$$PPV_{Source} = PPV_{Ref} (D_R/D)^n \ (mm/sec)$$

PPV_{Ref} = reference value at 7.6m
D_R = reference distance (7.6m)
D = Distance of machinery/activity to the receiver in metres
n = value for attenuation rate based on soil conditions

Factoring the Table 2 typical reference values for the various activities and factoring soil conditions for this site (n = 1.3), set-back distances for the various machinery types are presented in Table 3 following:

TABLE 3	Required Minimum Separation Distance (m)				
PPV (mm/s)	Dozer	Small Dozer	Compactor	Excavator	Dump Truck
5.1	4.5	<1	8	4.5	4

Considering reference values are general and not site specific, it is our policy to impose a safety factor of 1.5 to the Table 3 set-back distances.

MITIGATION PROCEDURES

Set-back distances outlined in Table 3 should be maintained for each of the identified activities in order to control vibration to below PPV limits generally enforced for vibration sensitive structures. Based on the reviewed site plans, construction will not encroach within ±8 metres of the nearest building to the 1450 King Road SWMF works.

Predicted vibration levels indicate work can be carried out in a safe manner, without implementation of a fulltime vibration monitoring program, as the proposed work is outside the required minimum set-back distances for the various construction vibration sources. However, we suggest vibration testing at the onset of key activities within the following Table 4 listed distances, factoring in the aforementioned 1.5 safety factor. Figure 1 enclosed illustrates the zone of influence relative to the adjacent building taking into account this safety factor. Note that only the north SWMF works are illustrated in Figure 1 due to proximity.

TABLE 4	Zone of Influence for Vibration Monitoring Requirement Distance (m)				
PPV (mm/s)	Dozer	Small Dozer	Compactor	Excavator	Dump Truck
5.1	7	1	12	7	6

Vibration testing at the onset of key activities, specifically compaction and

excavation within 12 metres of 598 King Forest Court shall verify the accuracy of the reference values used in determining the safe set-back distances and confirm vibration levels are below structure damage thresholds.

Monitoring shall serve to assess site specific machinery, and allow for additional mitigation of vibrations, as necessary. Digital, tri-axial seismographs shall be used, with sensors spiked at ground level, positioned in line between 598 King Forest Court and the vibration source, programmed to measure and record PPV in real time (see Figure 1).

Should testing/monitoring determine that vibration levels are below 5.1 mm/s at the minimum separation distance, and consistent with the reference values used in this assessment, further monitoring and mitigation will not be required. In the event that any of the tested activities produce levels over 5.1 mm/s, vibration mitigation measures may be required, including but not limited to:

- Application of a minimum set back distance based on actual site vibration levels, where feasible
- Use of equipment known to produce lower generating vibration where set-back distances are not feasible, verified through site specific vibration monitoring
- Use of smaller vibratory equipment, such as a 48-inch drum versus a 60-inch drum roller, in low mode
- Smaller excavators/bulldozers for grading and granular placement work
- Ongoing remote vibration monitoring with automated alert notification capability for vibration levels approaching damage thresholds

We note that construction vibration may result in frivolous complaints at levels well below damage thresholds. For this reason, we suggest that a pre-construction baseline condition survey be conducted of the two properties north of the work, 578 and 598 King Forest Court, as a precaution, and at the discretion of the developer. Properly conducted condition surveys are useful for damage claim mitigation, should an issue arise.

CONCLUSION

OZA Inspections Ltd. conducted a pre-construction vibration impact assessment for the proposed SWMF works at 1450 King Road in Burlington. Based on modelling, work will not encroach within the minimum set-back distances for structures, as specified for implementation of a full-time vibration monitoring program.

Initial testing of vibration levels from key construction operations in the north site areas is recommended, along with baseline, pre-construction documentation of the adjacent buildings.

INDEMNITY

The information and recommendations contained in this report represent our judgement in light of the limitations and industry standards for the preparation of similar reports. Judgement was exercised in gathering and analyzing the information obtained and the compilation of our report. This report carries no guaranties or warranties as to the structural competence of adjacent building. This report must be a read as a whole.

Notwithstanding full compliance with the specifications of the project, approval of the construction plan and the successful completion of the work, the Contractor shall be solely responsible for any damage, direct or indirect, arising from the work and shall hold OZA harmless from any costs, liens, charges, claims or suits, including the costs of defence arising from such damage, real or alleged. OZA accepts no responsibility for damages that may be suffered by any third party as the result of decisions made or actions taken based on this report.

Respectfully submitted,

OZA Inspections Ltd.



David Williams
Senior Vice President

Erik Quist
P.Eng.

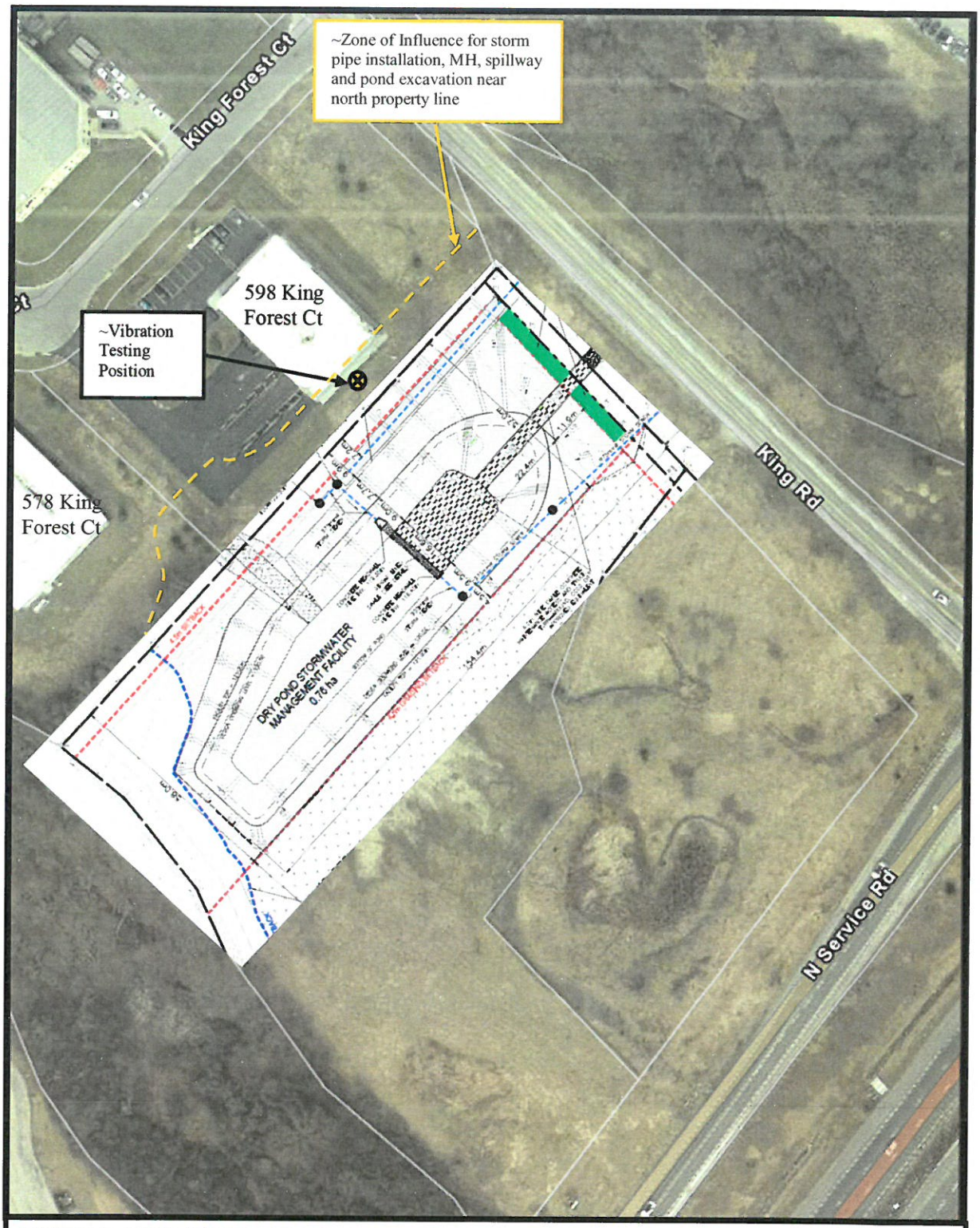
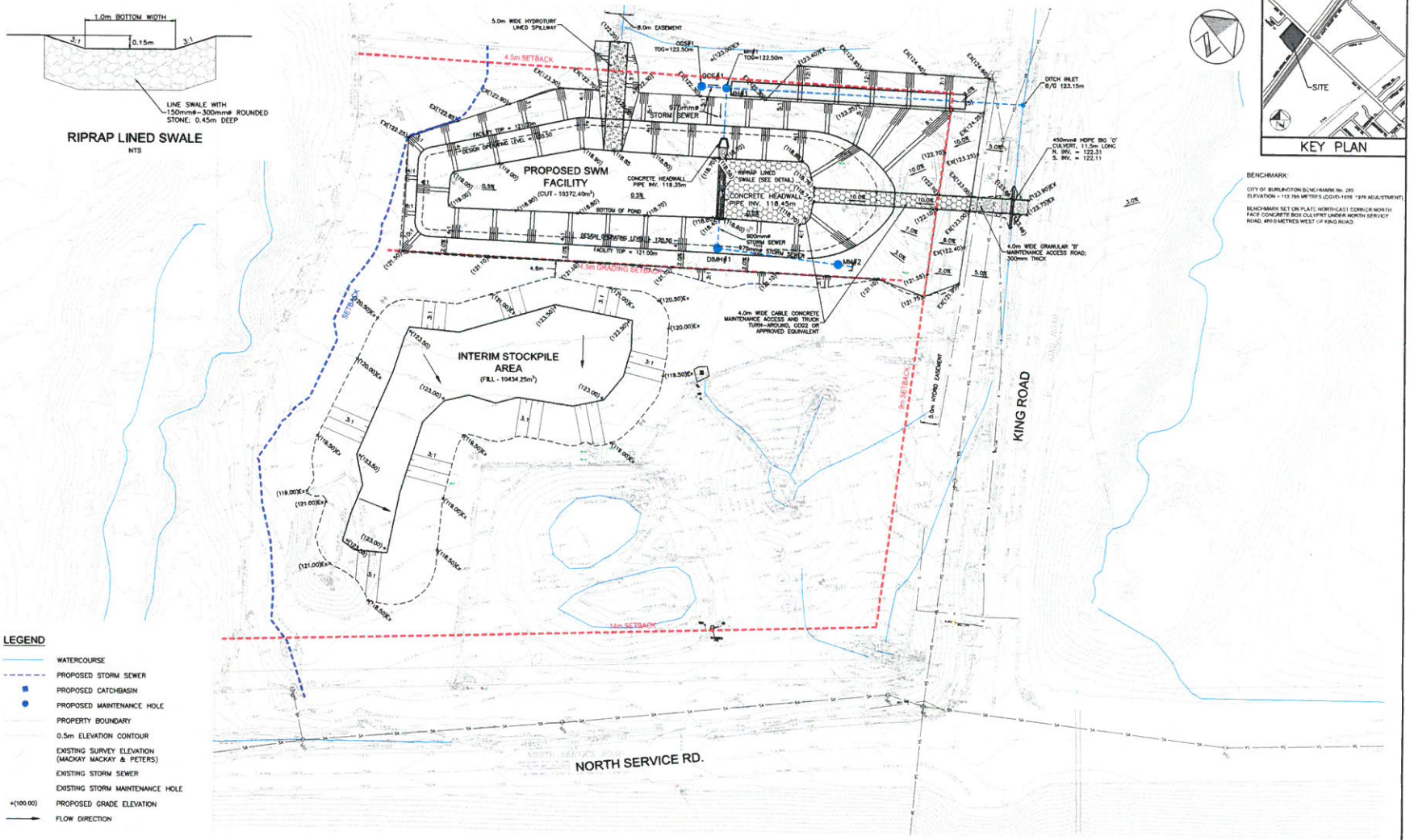


FIGURE 1: VIBRATION ZONE OF INFLUENCE

OZA INSPECTIONS LTD 1450 KING ROAD MARCH 2023 NTS

SITE PLANS



Plotted: 2022-06-30
Last Saved: 2022-06-30
Plotted By: richard.bortolo
Last Saved By: richard.bortolo
Path: I:\WW21012079 - Quantum\Work\Mary\Dwg 8 - SWMF Grading.dwg

No	Date	Drawn	Appr'd	Revisions
1	22-01-14	MBK	MJS	INITIAL SPA SUBMISSION

APPROVALS

PRELIMINARY

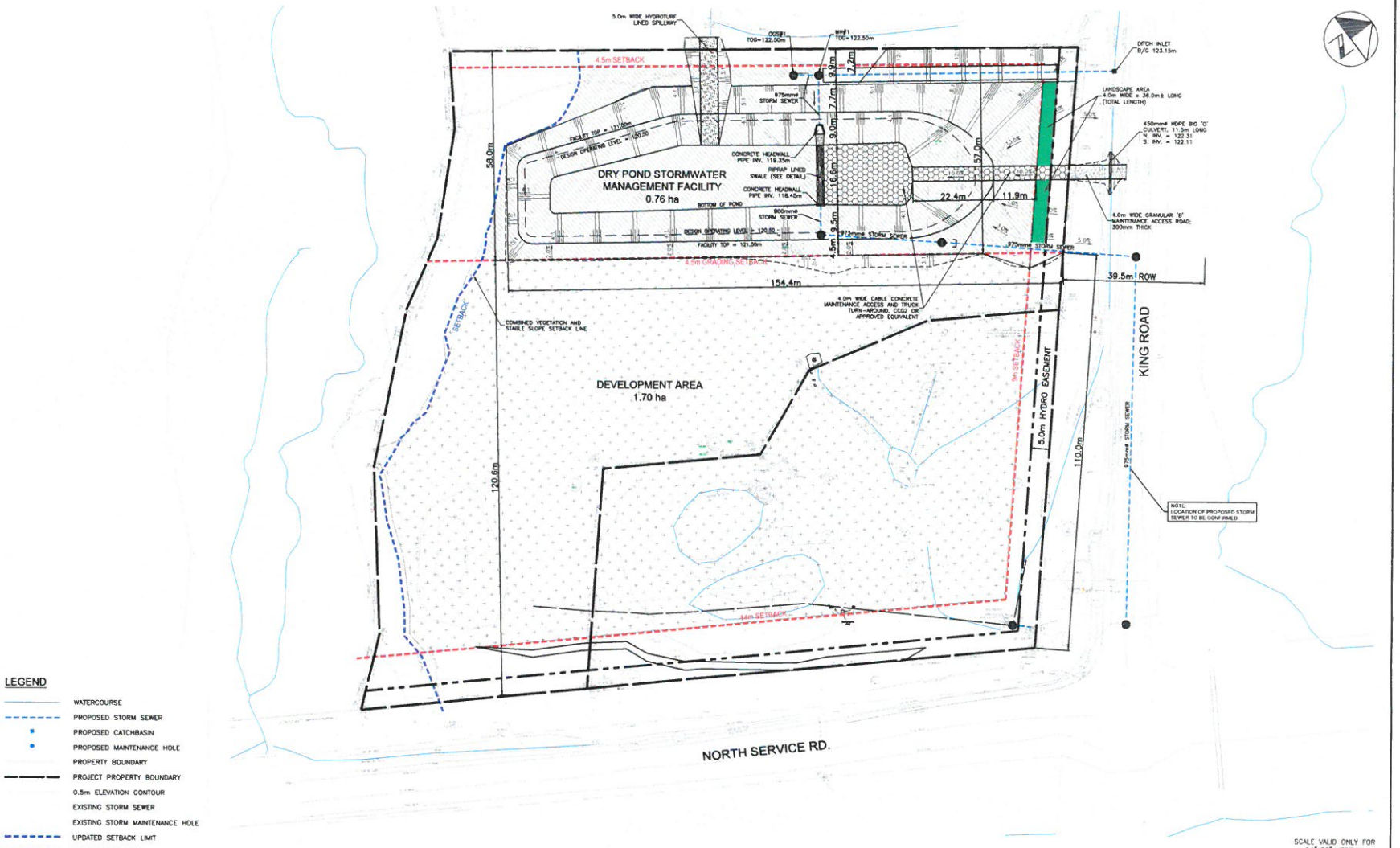
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Date	JANUARY 2022		

1450 KING ROAD
QUANTUM REALTY MANAGEMENT

INTERIM SWMF GRADING PLAN

wood.

Contract No.
Consultant File No. WW21012079
Drawing No. SHEET 8 OF 14



LEGEND

- WATERCOURSE
- PROPOSED STORM SEWER
- PROPOSED CATCHBASIN
- PROPOSED MAINTENANCE HOLE
- PROPERTY BOUNDARY
- PROJECT PROPERTY BOUNDARY
- 0.5m ELEVATION CONTOUR
- EXISTING STORM SEWER
- EXISTING STORM MAINTENANCE HOLE
- UPDATED SETBACK LIMIT
- ROW SETBACK LIMIT

Plotted: 2022-08-30
Last Saved: 2022-08-30
Plotted By: richard.bortolo
Last Saved By: richard.bortolo
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SCALE VALID ONLY FOR 24"x36" VERSION

1450 KING ROAD QUANTUM REALTY MANAGEMENT	SITE LAYOUT PLAN	wood.	Scale 1:500 (0, 10, 20) Consultant File No. WW21012079 Drawing No. SP1