Report to Community and Protective Services Committee

To: Chair and Members
Community and Protective Services Committee

From: Anna Lisa Barbon, Deputy City Manager, Finance Supports

Cheryl Smith, Deputy City Manager, Neighbourhood and Community-Wide Services

Subject: Thames Pool Condition Update and Repair Options

Date: July 18, 2023

Recommendation

That, on the recommendation of the Deputy City Manager, Finance Supports, and the Deputy City Manager, Neighbourhood and Community-Wide Services, the following actions **BE TAKEN**:

a) That the report dated July 18, 2023, titled “Thames Pool Condition Update and Repair Options” **BE RECEIVED** for information; and,

b) Civic Administration **BE PROVIDED DIRECTION** by City Council on the preferred option outlined in this report.

Executive Summary

As directed by Council at the April 4, 2023, meeting, the purpose of this report is to update the condition assessment of the Thames Pool; identify the scope of necessary repairs; and the associated costs and timelines.

A site visit and visual inspection conducted on April 6, 2023, found continued cracking, widening, and spalling of the previously identified cracks. Evidence of sand deposits and flooding were noted as well.

Two repair options are further detailed in this report, both focus on “like for like” repairs. Option 1 includes repairs to the return piping to operate the pool as it had previously with the reinstallation of hydrostatic relief ports and includes new weeping tile and site drain to monitor and mitigate groundwater levels. Option 2 repairs are similar to Option 1 except rather than install the return piping under the slab they would be installed under the pool deck and enter at the pool walls. This adjustment would move the return piping further above the groundwater table and reduce the probability of damage.

The above detailed repairs are complex due to the proximity to the river, weather sensitive construction and unknown variables such as the substructure and unpredictable weather events. In addition, sufficient time for detailed design, permits and consultation, public tendering, and weather sensitive construction it would not be feasible for the pool to be operational for the 2024 season. Contingent on direction and funding, the earliest the pool could be open for use is 2025.

The updated costing for Option 1 is estimated to be $1.92 million in current dollars and Option 2 is estimated to cost $2.23 million in current dollars.

Linkage to the Corporate Strategic Plan

This report is aligned with the following strategic areas of focus in the City of London Strategic Plan (2023-2027):

- Climate Action and Sustainable Growth: London's infrastructure and systems are built, maintained, and operated to meet the long-term needs of the community.

- Wellness and Safety: London has safe, vibrant, and healthy neighbourhoods and communities.

Analysis

1.0 Background Information

1.1 Previous Reports Related to this Matter

- Infrastructure Update - Thames Outdoor Pool (CPSC, March 21, 2023)
- Parks and Recreation Master Plan Annual Report (CPSC, January 31, 2023)
- Recreation and Sport Summer Program Updates (CPSC, May 31, 2022)
- Parks and Recreation Master Plan Annual Report (CPSC, March 29, 2022)
- Thames Pool Revitalization (CPSC, February 11, 2008)
- Thames Capital Replacement Project (RC2621) (CPSC, December 10, 2007)
- Thames Outdoor Pool Capital Replacement Project (RC2621) – Public Consultation Process (CPSC, October 29, 2007)
- Allocation of Provincial Capital Grant (CPSC, May 28, 2007)

2.0 Discussion and Considerations

2.1 Background and Purpose

At the meeting on April 4, 2023, Council resolved the following:

a) provide a report by the end of July 2023 to the Community and Protective Services Committee (CPSC) providing an updated condition assessment and identifying the scope of necessary repairs and associated costs to re-open the Thames Pool with sufficient repairs for the safe operation of same, in time for summer of 2024;

b) conduct a thorough community engagement process starting in Q2 of 2023, and provide the results to Council by the end of Q3 of 2023; it being noted that the engagement process will include soliciting feedback on pool vs. splash pad, indoor pool vs. outdoor, pool size and type etc.;

c) develop a comprehensive staff report, to come to Council in 2024, including all available options and estimated costs for the future of the Thames Pool if rebuilt or relocated, noting the importance of equitable access across the city, options to include, but not limited to:

    - rebuilding a pool in Thames Park that can withstand extreme weather conditions;
    - seeking out a new location for a pool;
    - future potential uses for the recreational opportunities for Thames Park should Thames Pool be decommissioned; and,
    - funding opportunities from other levels of government and private fundraising.

d) after the above-noted staff report has been completed, offer another opportunity for community input via a public participation meeting on the report findings; and,

e) provide a report back to a future CPSC meeting regarding the Thames Pool Report that was intended to identify the likely causes of the Thames Pool failure and propose potential solutions to remedy concerns.

The February 2023 report prepared by Aquatics Design & Engineering outlining the likely causes of the Thames Pool failure and potential solutions is attached as Appendix A. The comprehensive report prepared by Aquatics Design & Engineering outlining in detail the two options for repair and associated costs dated June 2023 is attached as Appendix B.

As due diligence and to ensure the presented options are feasible under the Conservation Authority Act, consultation with Upper Thames River Conservation Authority (UTRCA) is underway. Their Pre-Consultation comments are attached as Appendix C.

The purpose of this report is to provide updates and information on the following:

- Condition assessment of Thames Pool;
- Repair options, associated timelines, and costs;
- Risks and mitigation strategies; and,
- Proposed next steps.

2.2 Condition Assessment

A site visit and visual inspection was conducted by Aquatics Design & Engineering on April 6, 2023. Based on this assessment and a comparison of photos from fall 2022 and spring 2023, continued cracking, widening, and spalling of the existing cracks was observed. Evidence of sand deposits and flooding were noted as well.

The location of the pool is subject to significant flood risk and hydrostatic pressures. The increased length and width of the cracking can be attributed to the freezing action of water expanding within the existing cracks. Ground water penetrating the slab from below has caused spalling or blistering of the floor slab concrete. Additional sand debris found in the pool tank at core sample openings would indicate groundwater pressure under the tank, forcing that material into the pool.

In late March 2023, spring flood conditions occurred in Thames Park. A debris line in the pool tank, higher than the debris line noted in 2022, is indicative of the point at which the hydrostatic pressure of the ground and flood waters reached equilibrium. Photographs showing these conditions can be found in the second report prepared by Aquatics Design & Engineering, included as Appendix B.

Overall, the condition of the pool has deteriorated since the initial failure and the fall 2022 review.

2.3 Current Pool Design and Options for Repair

The previous staff report (March 21, 2023) identified that Thames Pool had experienced:

- Differential movement in the slab, or pool floor;
- Failures in the piping systems; and,
- A loss of base support.

The most probable cause is hydrostatic uplift pressure or frost penetration below the slab, and both are related to the groundwater conditions of the site. Because this is a naturally occurring condition, these risks cannot be eliminated, only mitigated to varying degrees.

Two repair options are detailed in this report, and both focus on “like for like” repairs, meaning Thames Pool would be the same configuration, with the same features and orientation as currently exists. In the March 2023, report, the repairs were referred to as minimum repairs (option 1) and extensive repairs (option 2). That is consistent in this report but simplified as Option 1 and Option 2.

The basic operation of a pool is a continuous circulation of water from the drain lines, into the filtration equipment, which then flows back into the pool through return lines. In Thames Pool, both the main drain lines and return supply lines are below the pool slab, with piping buried in the soil or aggregate material below and around the pool.

The location of Thames Pool piping below the slab makes it particularly vulnerable to damage from movement of the slab and unstable soil conditions. Floor returns pushed above the pool floor surface are evidence of damage to the piping systems. The only way to repair the piping is the removal of the entire pool floor slab, excavate below the piping to remove it and backfill with new material before installing new supply and drainage piping.

High ground water levels are another concern at the Thames Pool site. Installing a weeping tile to allow for the passive drainage of groundwater away from the pool is required at minimum. A site well to allow for monitoring of ground water conditions is also highly recommended.

<u>Option 1</u>

Option 1 is basic repairs to the underfloor piping to make the pool operable again and the installation of hydrostatic relief ports and a weeping tile and site drain to monitor and mitigate ground water levels.

The underfloor piping would be replaced in the same locations and connected to the existing piping along the walls. The main drain lines will remain under the floor. This is necessary for proper drainage via gravity and pump action. The placement of return lines under the floor is a consideration for competitive pools, so that swimmers in the outside lanes are not disadvantaged by the return flow of water into their lanes from wall mounted returns. Option 1 has return lines replaced under the slab as is the current design.

A weeping tile under the pool allows for ground water to be directed away from the pool tank by passive, gravity action and a site well allows for visual inspection access to ground water levels. Should hydrostatic pressure increase greater than the weeping tile capacity, relief ports in the new main drains allows ground water to be discharged into the pool tank. These are all basic mitigation measures.

<u>Option 2</u>

In Option 2, the excavation of the pool slab is needed, as well as excavation along the pool sides. The main drain lines would be replaced under the slab, but the floor returns would be relocated to the side walls. This allows for the piping to be secured to the side walls with the ability to insulate the pipes. These are additional mitigation measures to address movement due to hydrostatic pressures and freeze-thaw cycles. Additional excavation of the pool deck area is necessary to complete the repairs in Option 2.

A weeping tile, site well and hydrostatic relief ports are also included in this option.

The impact of side wall returns on competitive swimmers can be limited by installing the wall returns at staggered heights along the wall. During competition, the higher returns can be shut off and the lower returns continue operating to provide pool water circulation.

2.4 Risks and Mitigation

The proximity to the Thames River and high ground water levels are challenging site conditions creating flooding and hydrostatic pressure risks for Thames Pool. This report presents baseline repair and mitigation efforts but does not consider a full redesign that may withstand the risks and more fully avoid infrastructure damage.

Options 1 and 2 both provide repairs and basic mitigation to make the pool functional. Option 2 provides an additional preventative measure by relocating the pool return piping to a higher elevation, secured to the pool tank walls, and insulated.

Figure 1 provides a summary of the measures included in both options. The mitigation strategy of increasing the pool ballast refers to additional concrete thickness of the floor slab to provide additional weight. This can be included in either Option 1 or 2 but is not currently accounted for in the design or costing because a structural engineer would need to design this based on further investigations of the site conditions.

Two additional measures, providing a manhole with backflow prevention and reducing the overall depth and size of the pool, are presented for consideration but not included in the current scope or costing of either option.

Risk Mitigation Strategies

Risk	Mitigation	Option 1	Option 2	Notes
Unknown ground water levels	Installation of a site well	Included	Included	Site well is a necessary monitoring measure and should be installed to provide a visual of ground water levels.
Hydrostatic pressure from ground water	Relief ports in main drains	Included	Included	Allows water from hydrostatic pressure to be released into tank.
Unknown pool tank ballast	Increase pool slab thickness	Can be incorporated into this design	Can be incorporated into this design	Structural engineers calculate concrete slab thickness for added ballast in pool tank to resist upward pressure from ground water.
Groundwater damage to floor returns	Abandon floor returns and install wall returns	Not Included	Included	Remove return piping from below the pool tank and secure them to exterior of pool walls. Aids winterization operations.
Pool slab deterioration	Removal of existing pool slab and remediate soils	Included	Included	Remove slab in lane area and replace with reinforced slab, refer to ballast.
Freeze / Thaw cycle	Insulation	Not Included	Included	Provide insulation around piping.
Hydrostatic pressure from ground water	Manhole with backflow valves and drain to Thames River	Not Included For Consideration	Not Included For Consideration	Replaces site well and offers better control of ground water conditions.
Pool Depth	With removal of slab, infill deep-end of pool	Not Included For Consideration	Not Included For Consideration	Reduce the depth of pool, to reduce the intrusion into the ground water level.

Figure 1 Risk Mitigation Strategies

Aquatic Design & Engineering recommends Option 2 be undertaken, with an additional recommendation that a site well be established for monitoring ground water as soon as it is feasible.

2.5 Timelines

Should Council provide direction to proceed with either of the options presented, a Source of Financing will need to be identified. Following those approvals, a comprehensive project at Thames Pool would be expected to have a duration of between eighteen and twenty-four months, depending on the option selected. This includes the necessary planning work including site and structural analysis, engineering, detailed designs, permits and tendering prior to construction (10-12 months) and construction period (7-10 months) but excludes winter months. Option 1 could be completed in 18 months, while Option 2 would have a longer duration, up to 24 months.

Further geotechnical and engineering investigations, site surveys and analysis are required to fully understand the constraints of the site. Due to the location of the pool within the flood plain, the UTRCA would require a Section 28 permit application to review and authorize the work. Preliminary discussions with the UTRCA suggest this would be considered a "Municipal Project Review – Minor" application. Since the Thames Pool is existing infrastructure within the floodplain, UTRCA policies would allow for the proposed reconstruction and/or repairs, subject to UTRCA permit requirements, based on a finalized design. However, "the current location of the pool is subject to significant flood risk. As such, the UTRCA **strongly recommends** that the City explore options to decommission and/or relocate the pool to a location outside of the floodplain". (Emphasis in original Appendix C).

The design, engineering, and construction of an aquatics facility is a specialized industry, with limited qualified companies offering services on a commercial or public use scale. Most consultants and contractors have been completely booked for the 2023 season with many already booked for the 2024 season and beyond.

For these reasons, it is realistic to expect the Thames Pool construction could not begin before the 2024 construction season and is dependent on approval and financial resources being available. If construction begins in 2024, the earliest the pool could be open for use is 2025.

Due to the need for approvals; extent and complexity of repairs; the weather dependent nature of the work; continuing labour and material shortages; and winter shutdowns, it is conceivable, and the risk exists that the pool would not be completed for the short summer season in 2025.

3.0 Financial Impact/Considerations

The phase 1 report provided a construction value estimate only, based on previous new build projects completed in 2020 and 2021. This was intended to be a proxy indication of the relative costs of the options presented in the staff report, not a comprehensive project budget estimate. Consulting fees and contingency amounts were not included.

In the phase 2 report, the services of a cost consultant were utilized to prepare an updated costing. This provides a more detailed cost estimate based on the scope of work; quantity calculations for materials and tasks; consultants fees; and current market prices. Design contingency and construction contingency amounts were also included in the updated estimates.

The complexity of repair work compared to new construction and the need to work within the confines of the existing pool tank incurs additional costs. For example, there is more excavation by hand to avoid damage to remaining structures and cranes will be required to lift small excavation equipment in and out of Thames Pool.

The updated costing for Option 1 is estimated to be $1.92 million. An increase in construction costs represents the largest portion (44%) of the $1.54 million increase. The addition of design fees (16%) and contingency fees (40%) into this costing exercise accounts for the remainder.

Non-residential construction costs in Southern Ontario have increased 12.3% between 2022 and 2023, driven largely by concrete and equipment costs. Concrete has increased 15% in price over the past two years, and further 8% increase in the first quarter of 2023. (Statistics Canada)

The Architectural, Engineering and Related Services Price Index issued by Statistics Canada, shows the average cost of professional services, including those required for this project have increased an average of 12% over the past three years in Ontario.

Option 2 is estimated to cost $2.23 million, an increase of $1.63 million over the phase 1 report. Similar cost pressures to Option 1 are responsible for this escalation. Option 2 requires additional design and engineering work to address the additional excavation and work around the pool deck and sides of the pool. The proportion of the increased amount is 17% for design and consulting, 44% for contingency and 39% for construction.

For both options, the addition of a French drain and manhole provides further mitigation measures and has been provided as a separately priced option. This measure is estimated to cost an additional $230,000.

Should Council direct Civic Administration to proceed with either repair option, a Source of Financing must be secured to proceed. The Infrastructure Gap Reserve Fund would be the most appropriate source of financing should Council wish to proceed.

4.0 Next Steps

Pending Council direction to proceed, and financing approved, Civic Administration would pursue the necessary technical and engineering studies to inform a detailed design process based on the approved repair options. Procurement methods to engage design and construction contracts would also be explored.

Based on the direction provided by Council, Civic Administration will develop a comprehensive community engagement strategy that will seek input on the future of Thames Pool as directed by Council on April 4, 2023. The timing of this process and the development of a comprehensive staff report is contingent upon Council direction to proceed and the associated timelines of this work.

Conclusion

Based on an updated assessment, it is evident that soil instability, hydrostatic pressure and freeze-thaw cycles continue to damage Thames Pool. The risks to infrastructure located in a flood plain can be mitigated through various measures but never completely eliminated. This report presents two options to provide baseline repairs and mitigation efforts. The repairs would not alter the current configuration or layout or amenities available at Thames Pool.

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Jon-Paul McGonigle, Director, Recreation and Sport

Recommended by: **Anna Lisa Barbon, Deputy City Manager, Finance Supports**
Cheryl Smith, Deputy City Manager, Neighbourhood and Community-Wide Services

Appendix A: Aquatics Facilities Review Report I – Preliminary Review

Aquatic Facilities Review

Report I – Preliminary Review

Existing review for City of London

London
CANADA

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February 2023
DEI Project No. 22297

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TERRAPEX

IRC Building Sciences Group
CONSULTING | ENGINEERING | DESIGN

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Terms of Reference

Aquatic Design and Engineering, a Division of DEI Consulting Engineers has been retained by the City of London to review the infrastructure failure of Thames Pool located at 15 Ridout St. South, London.

The report is meant to:

- Provide a visual assessment of current conditions.
- Identify possible causes of the noted failure and,
- Provide options and potential repair solution(s) with high-level costing estimates.

Our consulting team consists of DEI Consulting Engineers, Aquatic Design and Engineering, Terrapex, and IRC. Each firm brings specialized expertise to the team, including aquatics design, structural, geotechnical, and building science engineering disciplines.

Executive Summary

Aquatic Design & Engineering, Terrapex and IRC have visited the site on several occasions to review the existing condition of the pool and the areas immediately adjacent and conducted a variety of testing.

This report provides a high-level overview of the visual inspections, core sample testing and soil analysis performed on site, to outline the general condition of the existing pool tank. Observations noted in this report are based on pre-existing conditions, provided drawings, and consultation with staff from the City of London.

Based on reviews of the facility and test results, Aquatic Design & Engineering recommends remedial actions be taken to address concerns related to damaged components and mitigate risk of failure. Other findings outlined in this report identify items that may not be of immediate concern but would improve the efficiency and operation of the pool once addressed.

Introduction

Aquatic Design & Engineering, Terrapex and IRC have reviewed the original design plans provided and compared them to what has been installed and the current condition of the pool tank in question. During several site visits, the team reviewed site conditions and gathered information relating to the cracking and movements of the pool tank and loss of water, as described by the City of London team.

At the time of facility inspections and review, the system was not operational, and the pool tank was partially empty. The tank had been winterized for the season with water to act as ballast within the pool itself. Potentially, further investigation may be required with full system operational to pinpoint specific concerns brought forth with the team during the site review(s).

The purpose of this report is to complete a condition assessment of the pool tank and identify possible causes of the noted failures. The report also proposes possible repair solutions and high-level cost estimates. Once general repair strategies are formulated, further investigation, refinement, development, and design will be required.

Timeline (approximation)

The following provides a brief history and timeline of events for Thames pool.

Thames pool originally opened in 1927, making it one of the City of London's oldest pools. In 2007 the city began to plan for a major rejuvenation project with an approximate construction cost of $4.5 million. This update provided the facility with accessibility upgrades, a beach entry into the pool with spray features, and a 50M eight lane lap pool. Construction began in 2009/2010.

In 2010, during construction of the pool a significant flood caused some re-work to be done. In 2018, another significant flood occurred, with water levels at approximately 4 feet (1200mm) above the pool deck.

The following season in 2019, water usage at the facility nearly doubled the previous season. This was likely due to a broken return line to the pool, potentially caused by the flood. A repair to a return line was completed in the fall of 2019. Prior to the return piping repairs, broken pipes could explain the water usage increase, with the pool system 'pushing' water into the ground below the pool vs sending water to the returns in the pool.

In January 2020, another flood resulted in water entering the filtration room, however not the rest of the building. The pool was closed in September of 2020 and the pool fully drained for tank repairs. Renovations to the pool house also began in September 2020. This project continued into spring 2021.

During the 2020-2021 renovation, the pool tank remained empty from September 2020 until January 2021, while hydrostatic pressure was relieved via the main drain's hydrostatic relief valves and water discharged using a submersible pump. The hydrostatic valves placed in one of the main drains were fitted with a ball valve and set to a constant flow equaling the pump discharge rate. Typically, an outdoor pool condition for winter protection would have the pool approximately half full of water to overcome any freeze / thaw conditions and upward pressure from hydrostatic lift due to ground water. Thames Pool was partially filled between January and March 2021. In March of 2021, the pool was drained again for work to continue within the pool tank.

During the 2021 season water usage continued to increase and three (3) additional returns were repaired when the pool closed for the season in September 2021. The remainder of the renovations to the pool, caulking and painting were completed in the spring of 2022.

As part of annual opening operations, the pool was completely filled following the painting and caulking to test and verify pool mechanical systems. Within a short time period, the pool lost most of the water. Further inspections found damage to the pool slab and protruding floor returns in (May) spring 2022.

The consulting team began an investigation into the failure of Thames Pool in September 2022 and a final report was prepared in February 2023.

Facility Overview and Observations

Our consulting team, including aquatic designers, building science engineers and geotechnical engineers completed three site visits during September 2022. We reviewed the original design plans for the 2010 rebuild and compared them to the actual on-site installations and the current condition of the pool tank. Additionally, a geotechnical investigation and subsurface soil testing (Terrapex) and concrete compressive strength testing (IRC) were conducted. Those independent reports are appended to this document. This report shall be read in conjunction with Terrapex and IRC's reports as a full encompassing document.

The original plans for the 2010 reconstruction, designed by Shore Tilbe Irwin & Partners (Perkins & Will), dated 2007, were provided for review. This information has been compared to progress photos taken during the construction phase and a visual review of the as-built structure. Discussions with pool operational staff, a review of maintenance and utility records and a comprehensive visual inspection of existing conditions provided background information.

The focus of this report is to investigate the potential causes of the pool tank cracking and of the protruding floor returns within the 50m - 8 lane area of the pool and provide options to repair these concerns. Some additional cracking and abnormalities were also identified in the shallow / beach entry of the pool.

A water usage report was provided, showing historical water usage from 2015 – 2021 from May through to September. In 2018, nearing the end of the season a significant spike in water usage was recorded after a flat (average) water usage season which aligned with the previous years. This spike could also correlate to the February 2018 flooding event damaging a return line or breaking a floor return fitting causing water to leak out of the pool basin. This change in water usage appears to be the beginning of the increased water consumption based on the records provided.

The following year, 2019, an increased water usage is noted over previous years. In 2019, the water usage is approximately 2.5 times the average usage from 2015 – 2017. A repair to the return line and return fittings was completed in the fall of 2019 to address the water loss.

In 2020 and 2021 the water usage compared to 2015 – 2017 is approximately 4 times the average. A portion of the increased usage could be a result of filling and emptying the pool during this time period. Mechanical room flooding clean-up, and failures in the return lines may also account for some of the increased water usage.

Further, it was communicated that a renovation of the pool coping, and gutter was performed prior to winterization of the pool in 2021. Possible water use explanation is from construction work and personnel on site.

The work / renovation on pool coping and gutter continued into late fall and early winter resulting in less than an ideal condition for the pool tank to be properly prepared for the winter cycle. To provide a safe working environment, the pool must be drained. The additional ballast or weight of a partially filled pool can counteract hydro-static lift pressure. Due to its proximity to the Thames River and the potential for high ground water levels to be present around the pool basin, hydrostatic uplift is a year-round risk.

During the initial site meeting to discuss the project, the pool was empty to allow for visual inspection. The hydrostatic relief valve in one of the main drains was open to permit the release of ground water and pressure on the tank. A submersible pump was used to discharge the incoming water as quickly as it was entering the pool tank. See Figure 1.

It was also noted during the site meeting at project kick-off that the pool, if left on its own drains down to the silt line as shown on Figure 4. This would indicate that the piping, either from the pool drains or return piping has a break at that level, approximately minus 8 feet (-2500) below pool deck.

Figure 1 – Ground water in main drain, with pump

Figure 2 – Significant fracture in lane 1 at break point to deep area

Figure 3 – Floor return protruding from pool floor

Figure 4 – Debris marking water lost line, and pump extracting ground water

Figure 5 – Cracking within shallow end @ beach entry area

Figure 6 – Original coping damage, prior to recent renovation
Indication of pool tank / deck movement
(Photos from 2016)

Conclusion and Recommendations

Based on the investigations completed, the likely causes of the Thames pool failure are:

- Differential movement in the slab, or pool floor;
- Failures in the piping systems; and,
- A loss of base support.

It is our understanding that the 2010 redevelopment did not include a site well. Based on visual review, the amount of consistent ground water present below the tank would have a detrimental effect on the pool and its systems, if left unchecked, especially during a freeze thaw cycle. Ground water pressure has been known to force a pool such as Thames out of the ground causing extensive damage. The floor returns presently being pushed upwards, along with the significant cracking of the pool slab in lane one (1), would be evidence of ground water pressure and differential movement of the slab. See Figure #2 and Figure #3.

At no point should the pool tank be empty without monitoring the ground water level. Currently there is no way to achieve this at Thames Pool. At present there are insufficient relief valves and based on construction photos, there is no evidence of a weeping tile system. A site well should be installed to detect ground water levels prior to the water being removed from the pool. The pool tank water level should never be below the ground water level and additional hydrostatic relief valves need to be installed within the pool tank.

There is significant damage to the under pool return piping system. Pressure testing of the return system would conclude a significant failure of the piping. Water within the pool tank has been lost to approximately the level of the break point at the deep end. This is indicated in Figure #4 above, with blue paint and an arrow along with the debris line. Based on discussions with operational staff and photos from the original construction, it can be concluded that the return line depths are in-line with the debris markings on the wall. This level is the recorded level of where the pool would drain to on its own after being filled. This return piping elevation relates to an approximate minus 8 feet (-2500) invert below the present pool deck level, or a -4 to -5-foot invert below the shallow end pool floor. This aligns with construction photos provided.

The geotechnical investigation concluded the slab-on-grade pool floor has experienced cracking and a loss of base support. This loss of base support may be the result of slab movement, failures in the piping system below the slab releasing the pool water directly into the soil, or a combination of both. Examination of the core samples and the core holes indicated that voids appeared to be present below the pool floor. At several of the inflow pipes located on the pool floor, there are deposits of predominantly sand material. This was also evident during a site meeting where a threaded rod was inserted into one of the open floor returns and sand and dirt was removed.

Based on the timeline events and the on-site discussion, an educated assumption would be that the broken pool piping system was causing an increase in ground water levels around the pool shell. When the pool tank emptied the pool water that has pressurized the sub-soils was released by the hydrostatic valves.

The following table provides some options, all which would require a site well to be established in the adjacent shrub area near the base of the waterslide. This location would avoid a visual distraction and minimize re-construction of the pool deck at this time. The addition of a site well could be used to monitor ground water levels as well as a location to remove ground water from around the pool prior to the pool being emptied. Presently, the pool needs to be drained and the hydrostatic plugs removed for ground water pressure to be relieved into the pool tank. It should be noted that the site well is a not a complete solution. Because the site well is separated from the pool tank with no weeping tile system, we are dependent on gravity moving the water in and around the pool to the lowest point within the site well. Additional hydrostatic relief ports are also recommended.

Possible Repair Options

Option 1 ($) – Minimum Repairs	
Site well within shrub area	$25,000
Remove the existing pool slab, excavate below return piping (approx. 4')	$120,000
Replace all below slab piping at pool shell, connect to existing main	$40,000
Replace pool slab, with finishes (paint to match existing)	$175,000
Additional relief ports	$15,000
Sub-total	**$375,000.00**

Option 2 ($$)– Extensive Repairs	
Site well within shrub area	$25,000
Remove pool slab and piping and reinstall piping with wall returns at a higher elevation, connect to existing main, replace slab	$350,000
Remove pool deck to access new piping	$2100,000
Additional relief ports	$15,000
Sub-total	**$600,000.00**

Option 3 ($$$) – Rehabilitation of Pool	
Site well within shrub area	$25,000
Remove pool gutter and partial wall	$120,000
Replace with modular Stainless Steel gutter profile incorporating return system, abandon existing returns	$2,520,000
Install thickened slab and reduce pool depth	$200,000
Install membrane on repaired existing slab, abandon floor return system	$1,120,000
Additional relief ports	$15,000
Sub-total	**$4,000,000.00**

Option 4 ($$$$) – New Pool	
Site well within shrub area	$25,000
Remove pool complete and pool deck immediately adjacent to pool	$1,410,000
Construct new pool complete, incorporating significant provisions to reduce ground water pressures	$9,825,000
Install weeping tile system and backflow valves	$725,000
Additional relief ports	$15,000
Sub-total	**$12,000,000.00**

**Values above are estimates based on historic projects from 2021-2022*
Soft costs, engineering fees, markups/overhead and profits, etc. have been estimated.

Each of the above options have pros and cons associated with them. The options are only meant for high level consideration to aid in determining the next steps and course of action. Each option increases the complexity of the remodeling and the associated price tag. Within each option there could potentially be sub-options of varying complexities. This would be determined through a detailed design process.

At no point should the pool tank be empty without ground water levels being checked. In order to accomplish this a site well is mandatory. The existing automatic pool hydrostatic relief are designed to relief the pressure build-up due to hydrostatic lift based on the ground water level, as the pool water begins to lower below the ground water level. Controlling the flow by means of valves attached to the relief valves does not relieve the full up-lift pressure, only permits a means for the water to escape in a controlled manner. Hydrostatic lift pressure is still being applied to the tank.

Option 1 – General repair (estimate $375,000)

Scope

- Establish a site well to monitor and manage groundwater conditions
- Provide additional relief ports in the pool slab to help relieve hydrostatic pressure
- Remove pool slab, replace below slab piping, reconnect to existing main lines
- Replace pool slab to existing depth

Provides a quick fix to return the pool back to usable condition, however, may not provide a long-term solution as the site well is independent from the pool and we would be relying on gravity and ground water flow to the local site well. Construction phase would be approximately 6 months.

Pros	Cons
Quick fix	Band-aid solution
Least expensive	Damage may re-occur with high ground water or flood

Option 2 – General repair and mitigation (estimate $600,000)

Scope

- Provide site well and additional relief ports
- Remove pool slab, pool deck and piping – Install new piping
- Install new wall returns at higher elevations, connect to existing main lines
- Replace pool slab with thicker concrete to provide more mass

Similarly provides a quick fix, however with an increase in the mass of concrete for the floor of the pool. This would aid to offset the buoyancy and stress the pool shell sees now compared to ground water levels. Again, as noted in Option 1, the local site well would be relying on gravity and ground water flow. Construction phase would be approximately 8 months.

Pros	Cons
Quick fix	Band-aid solution
Second least expensive	Damage may re-occur with high ground water or flood
Additional pool slab thickness to help to offset buoyancy	Reduced pool depth, may affect diving
Less water, improves filtration	

Option 3 – General repair, mitigation, and alterations (estimate $4M)

Scope
- Provide site well and additional relief ports
- Install modular gutter with return system, abandon wall returns
- Install membrane on existing slab, abandon floor returns
- Install new, thicker slab on top of existing slab

A more comprehensive option that begins to address a long-term repair and prevention. A redesigned piping system would reduce the risk of damage to the pipes. The local site well would still be relying on gravity and ground water flow to move water away from the tank, as in Options 1 and 2. Construction phase would be approximately 12 months.

Pros	Cons
Begins to address longer-term solutions	With membrane, ground water may cause it to float
Additional pool slab thickness to help to offset buoyancy	Reduced pool depth, may affect diving
Eliminated piping around the pool	Damage may re-occur with high ground water or flood
Less water, improves filtration	

Option 4 – New Pool (estimate +/- $12M depending on design)

Scope
- Remove entire pool and deck
- Construct new pool / aquatic amenities
- Incorporate design and engineering provisions to mitigate groundwater pressures

This option addresses a long-term solution with proper installation of weeping pipe connected to a site well to remove water from around and under the pool tank. Weeping tile pipe around the foundation of the pool directed to a site well or French drain area with backwater valves would ensure any ground water can be discharged away from the pool. The new pool would be designed and engineered for the site conditions of high groundwater levels. Construction would take about 16 months, depending on the design.

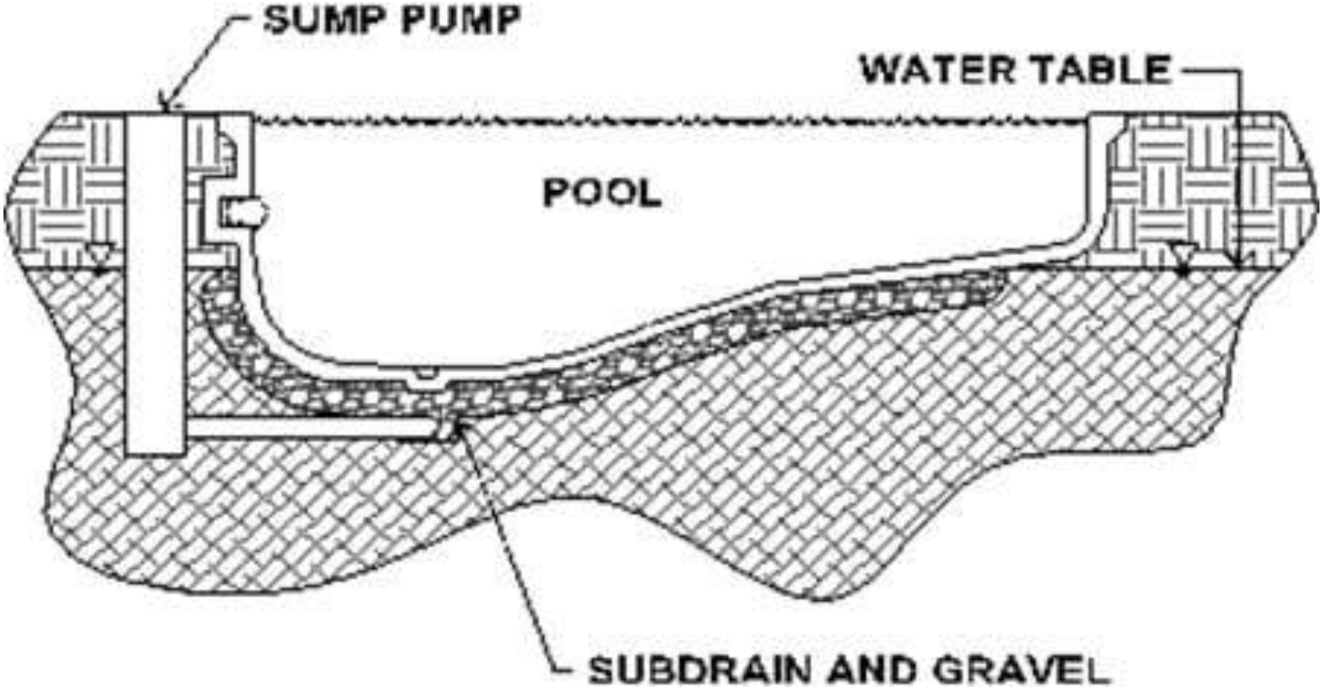
It should be noted that no system can withstand the damages caused by flood conditions. Damage caused by flood water levels above the finished deck level, as seen in 2018, is unpredictable. Option 4 would be the best resolution for this potential condition, however, would not prevent a flood.

Pros	Cons
Provides proper installation in a flood plain	Most expensive
	Risk of damage can not be completely eliminated in a flood plain

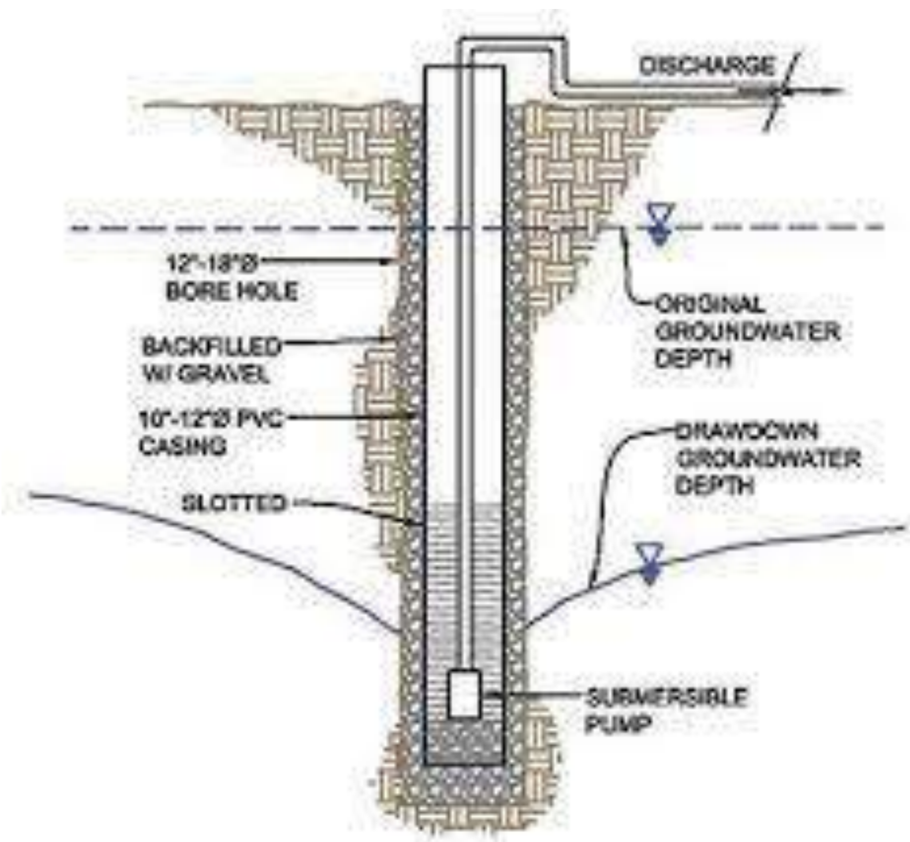
The following support documents from IRC and Terrapex form part of this summary and provide a more in-depth detail of current concrete status along with sub-soil conditions.

Please do not hesitate to contact us if additional information or if clarification is required.

General illustrations



Typical pool with a site well and below pool weeping tile system.



Sample Site well with submersible pump.

.

Hydrostatic relief valve with collection tube.

Appendices

The following independent reports summarize findings similar to the above and provide specific detail on the soil conditions below the tank (Terrapex Environmental) and concrete analysis (IRC Building Science). This report shall be read in conjunction with the Terrapex and IRC reports as a full encompassing document.

A Rimkus Company

IRC Building Sciences Group
2121 Argentia Road, 4th Floor
Mississauga, Ontario, L5N 2X4
Tel: 905.607.7244, Fax: 905.607.7288

Toll Free: 1.888.607.5245

Aquatic Design & Engineering
55 Northland Road
Waterloo, Ontario
N2V 1Y8

February 3, 2023

Tel: 519-504-0119

Attention: **Mr. Jamie Lopes**

E-Mail: Jlopes@aquaticdesigns.ca

RE: Condition Report – Crack Assessment
Thames Park Pool
15 Rid out Street South
London, Ontario
N6C 3W6

Project Ref: IRC#: **10617-HB22-206CR**

Dear Mr. Lopes:

In accordance with your instructions, personnel with IRC Building Sciences Group performed the visual assessment of the concrete forming the walls and the floor slab of the outdoor pool at the above referenced project site. The purpose of the assessment was to establish the current condition of the concrete forming the swimming pool shell.

Executive Summary

The Thames Park Pool is 50 m long class A pool, incorporating eight(8) swimming lanes and was constructed circa 2009. Visual assessment revealed shrinkage cracks in the concrete forming the lap pool floor slab at random locations. Subgrade material is oozing out of the crack lines in the concrete forming the floor slab in localized areas. Some areas of the slab are exhibiting out of plane displacement of the section of concrete slab along crack lines, most likely caused by frost heave or hydrostatic pressure. In some localized areas, the concrete forming the pool walls is exhibiting medium size cracks and need to be explored further.

During our survey, cracks were marked on the concrete slab forming the lap pool tank. A crack delineation survey is attached in the appendix B of this report, identifying the location of these cracks in the pool floor slab.

Four (4) concrete core samples were retrieved from the floor slab of the pool tank. Three (3) core samples were used to ascertain the compressive strength of the concrete and the one (1) core sample was used to determine the air-void ratio of the existing floor slab. Concrete test results indicate the compressive strength and air/ void ratio are satisfactory for the exterior pool environment.

Pool shell is in unsound condition and needs massive remediation work in the form of structural rehabilitation of concrete and addressing the hydrostatic pressure and unsound substrate conditions.

1.0 SCOPE OF WORK

The primary objective of the assessment was described as under:

.1 Review all relevant documentation provided to IRC Group.

.2 Perform visual assessment of the pool tank concrete slab and the associated pool deck to identify typical anomalies.

.3 Retrieve cores from the concrete slab to establish the compressive strength of the concrete as well as the air-void ratio of the concrete forming the pool floor to establish the quality of concrete to withstand Freeze-Thaw stresses.

.4 Prepare the condition assessment report to document all the potential anomalies revealed during the visual assessment, concrete testing and provide necessary recommendations.

2.0 DOCUMENTATION REVIEW

- Architectural drawings prepared by Shore Tilbe and Irwin Architects.

3.0 BACKGROUND INFORMATION

Concrete forming the pool walls and the slab was treated with crystalline waterproofing material.

4.0 METHODOLOGY

The following methodology was adopted to carry out the visual assessment of the concrete forming the pool walls and floor slab forming the outdoor swimming pool tank.

IRC personnel visited the site on September 15th and 29th of 2022, to carry out visual assessment of concrete slab within pool tanks and the associated deck.

Photographs were taken during the course of the investigation and are presented in Appendix A and are referenced throughout the report.

Concrete core samples were sent to the certified concrete testing library to establish the compressive strength and air content of the concrete forming the pool slab.

4.1 Project Team

The following personnel were involved in performing this assessment and in the preparation of this report:

.1 Chander Thusu, B. Eng., BSS, Manager, Building Sciences.

.2 Kathiravel Karunananthan, CET., BSS., RRO Project Manager, Building Sciences.

.3 Anwar Farah, Junior Project Coordinator, Building Sciences

5.0 OBSERVATIONS AND CRACK SURVEY

The following was observed during the course of this preliminary visual assessment (Photographgraphs1 to 10):

1. Lap pool is 50 meter long, eight(8) lane pool, located along the south side of the Thames Park pool complex and coated with epoxy paint(Photographs 1 and 2).
2. Depth of pool ranges from approximately 1.20 meter to 3.70 meter from the shallow to the deep end of the lap pool respectively.
3. Leisure pool is located along the North side of the outdoor pool complex and accessed by beach entry ramp.(Photograph 3).
4. The pool deck is delineated from the pool tank by coping tiles(Photograph 4).
5. Depth markings and warning signs are located on the pool deck at visible locations.
6. Base of metal railings cored into the concrete were observed to be in in good condition and did not show any evidence of surface corrosion(Photographs 5 and 6)

7. Concrete forming the lap pool slab and walls is exhibiting random cracking and are depicted in crack survey drawing, attached with this report in appendix B.
8. Cracks are mostly shrinkage in nature. However in some locations, the cracks are exhibiting out of plane displacement of the slab in localized areas. At the displaced location, the concrete forming the pool slab is exhibiting spalling of the concrete(Photographs 7, 8, 9 and 10).
9. Concrete forming the pool walls is exhibiting longitudinal crack(Photograph 11).
10. Subgrade material was oozing out of crack indicating upward displacement of the saturated soil due to hydrostatic pressure (Photograph 12)
11. Four (4) concrete samples were taken on the lap pool tank slab for compressive testing. One (1) sample is to be tested for air-void ratio. Location of sampling have been shown on the drawing in Appendix B of this report.

5.1 Concrete Compressive and Air Void ratio tests.

1. Based on the laboratory test, the concrete is deemed satisfactory for the exterior exposure in summer or winter submerged conditions.
2. Average compressive strength of concrete based on three core samples was equal to 57 MPa.
3. Air content based on one core sample was established to be 7.5 %.
4. The test results are attached in the Appendix C of this report.

6.0 CONCLUSIONS

Based on the observations, compressive test and the air-void ratio testing , the following anomalies are present in the pool tanks:

1. Random cracking evident in the concrete forming the pool slab. Some of the cracks are due to upward displacement of the part of the slab along the crack lines.
2. Localized cracking evident in the concrete forming pool walls
3. Spalling of concrete of pool slab concrete along some crack lines indicating upward displacement by hydrostatic pressure.
4. Water egress from the pool tank along crack lines is likely and which will undermine the subgrade material.

7.0 RECOMMENDATIONS

Based on the aforementioned observations and conclusions, the following is recommended:

Option A

- Address the subgrade conditions and design means to dissipate the hydrostatic pressure to avoid the further deterioration of the pool concrete slab.
- Remediate all the cracks in concrete forming pool shell.
- Install new pool coating suitable for the pool environment and freeze -thaw exposure

Option B

- Address the subgrade conditions and design means to dissipate the hydrostatic pressure.
- Rebuild the pool tank in its entirety taking into consideration the alleviation of hydrostatic pressure.

We trust that the enclosed is satisfactory for your purposes. If you have any questions regarding the enclosed, please do not hesitate to contact me at your earliest convenience.

Yours Truly,
IRC Building Sciences Group

Chander Thusu B.Eng. BSS
Building Sciences Manager

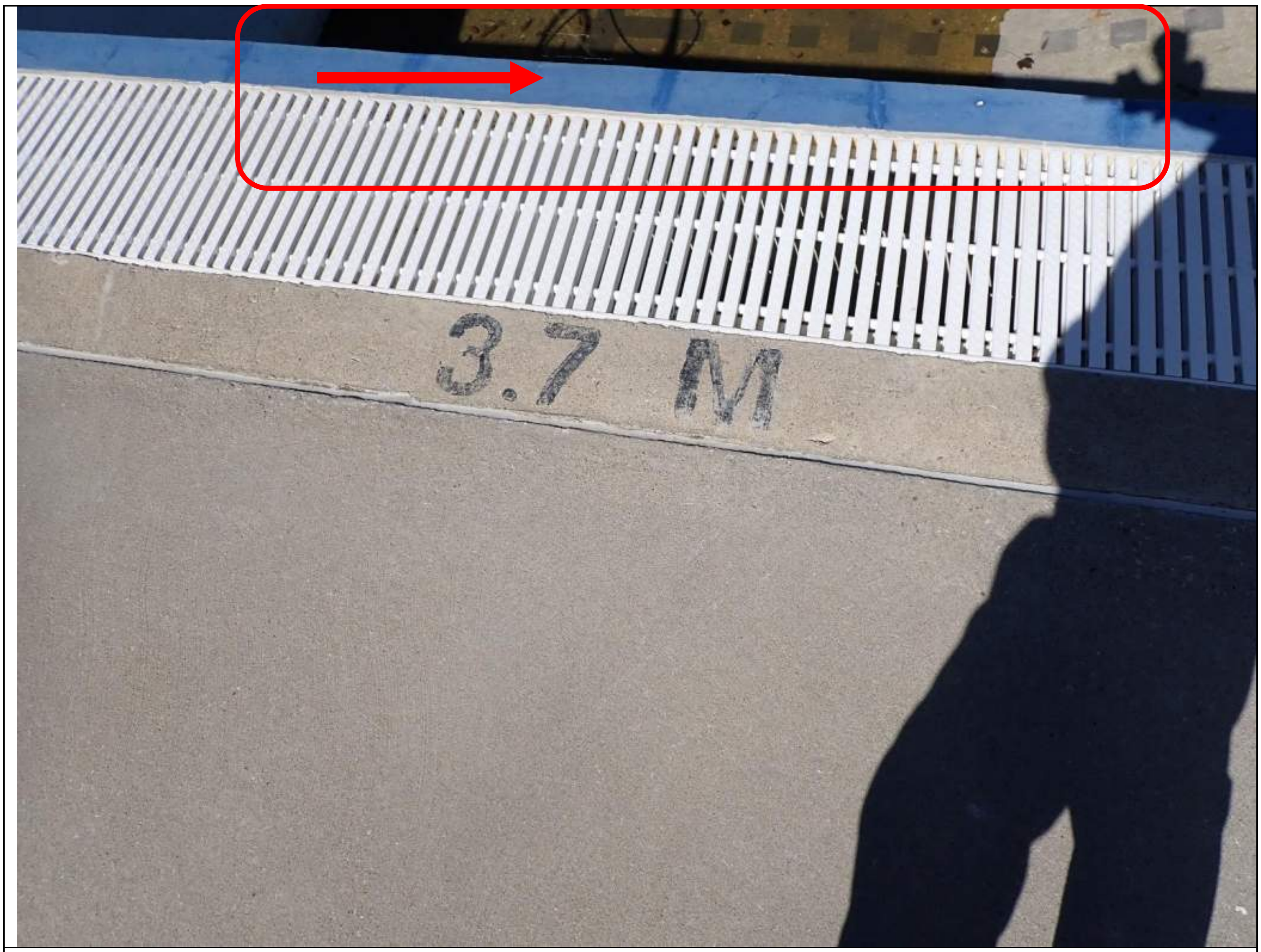
Appendix A

(Photograph Log)

PHOTOGRAPH 1: Overview of Eight(8) Lane Lap Pool

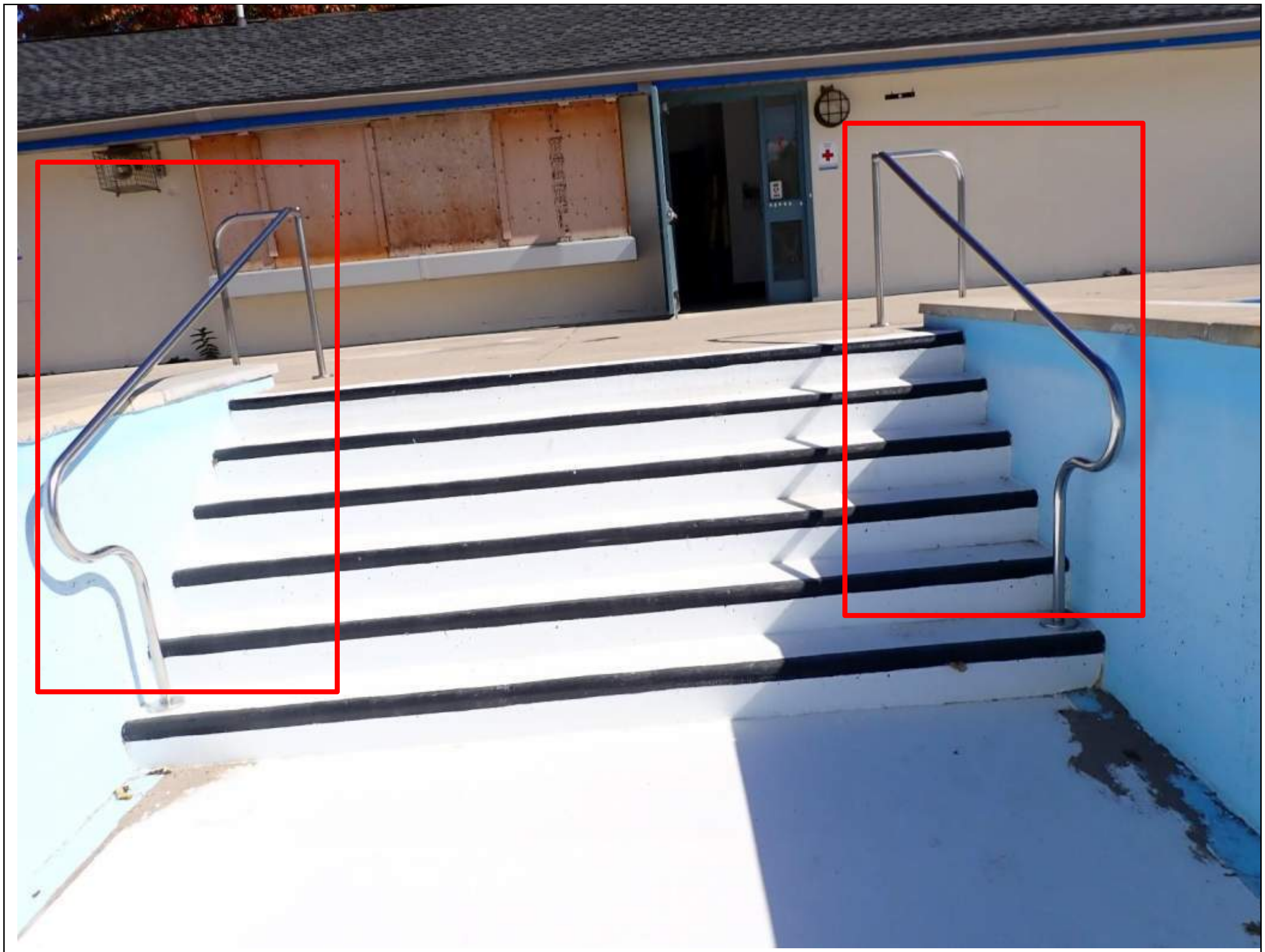
PHOTOGRAPH 2: Closeup of deep end of Lap Pool

PHOTOGRAPH 3:Overview of Leisure Pool

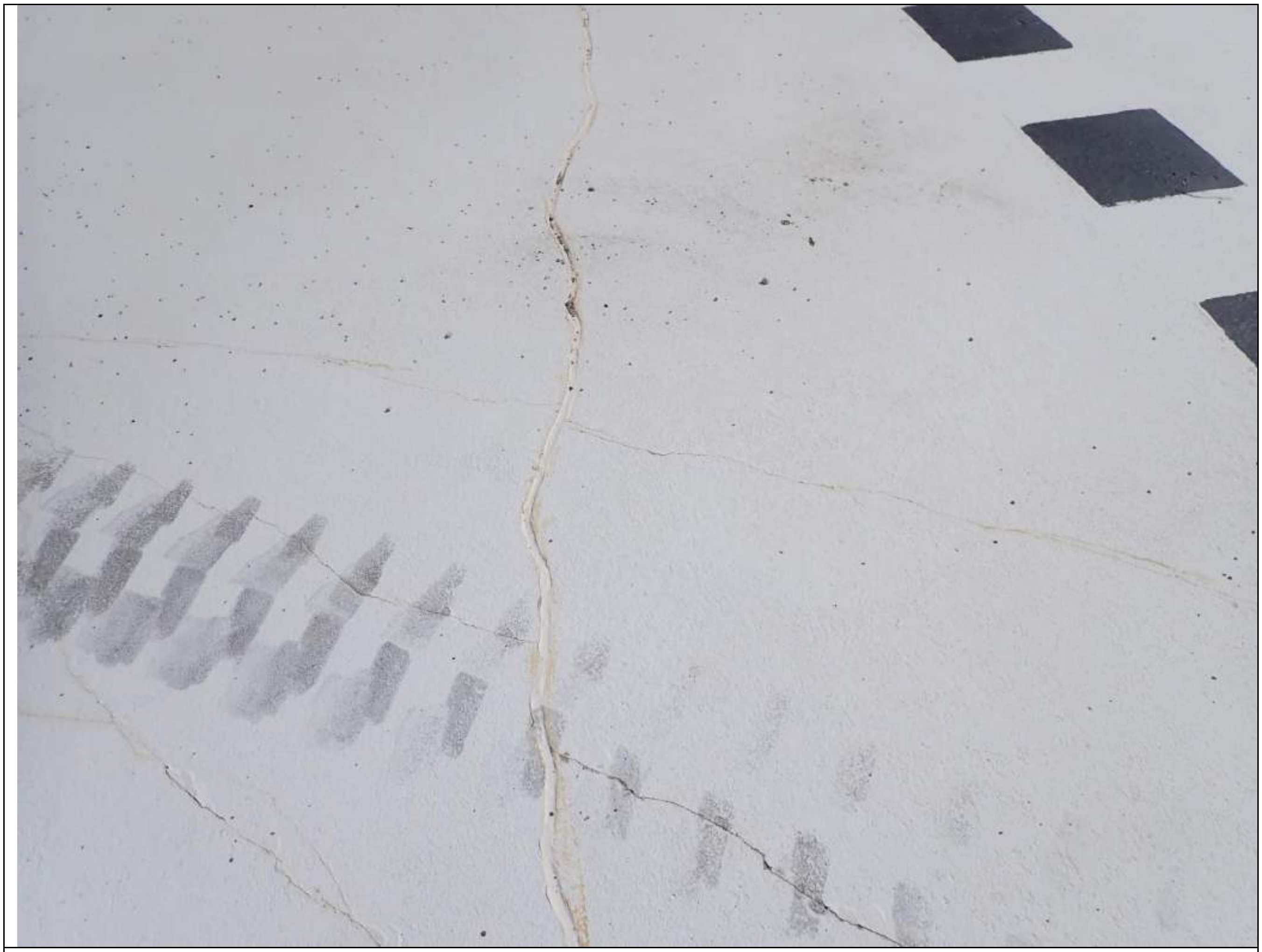


PHOTOGRAPH 4: Coping tile on top of pool wall delineating pool from the deck

PHOTOGRAPH 5: Stainless Steel railing appears sound



PHOTOGRAPH 6: Handrails at the entrance stairs to Lap pool appear sound.



PHOTOGRAPH 7 : Large Size Cracks present in the concrete forming pool floor slab.

PHOTOGRAPH 8: Large Size Cracks present in the concrete forming pool floor slab.

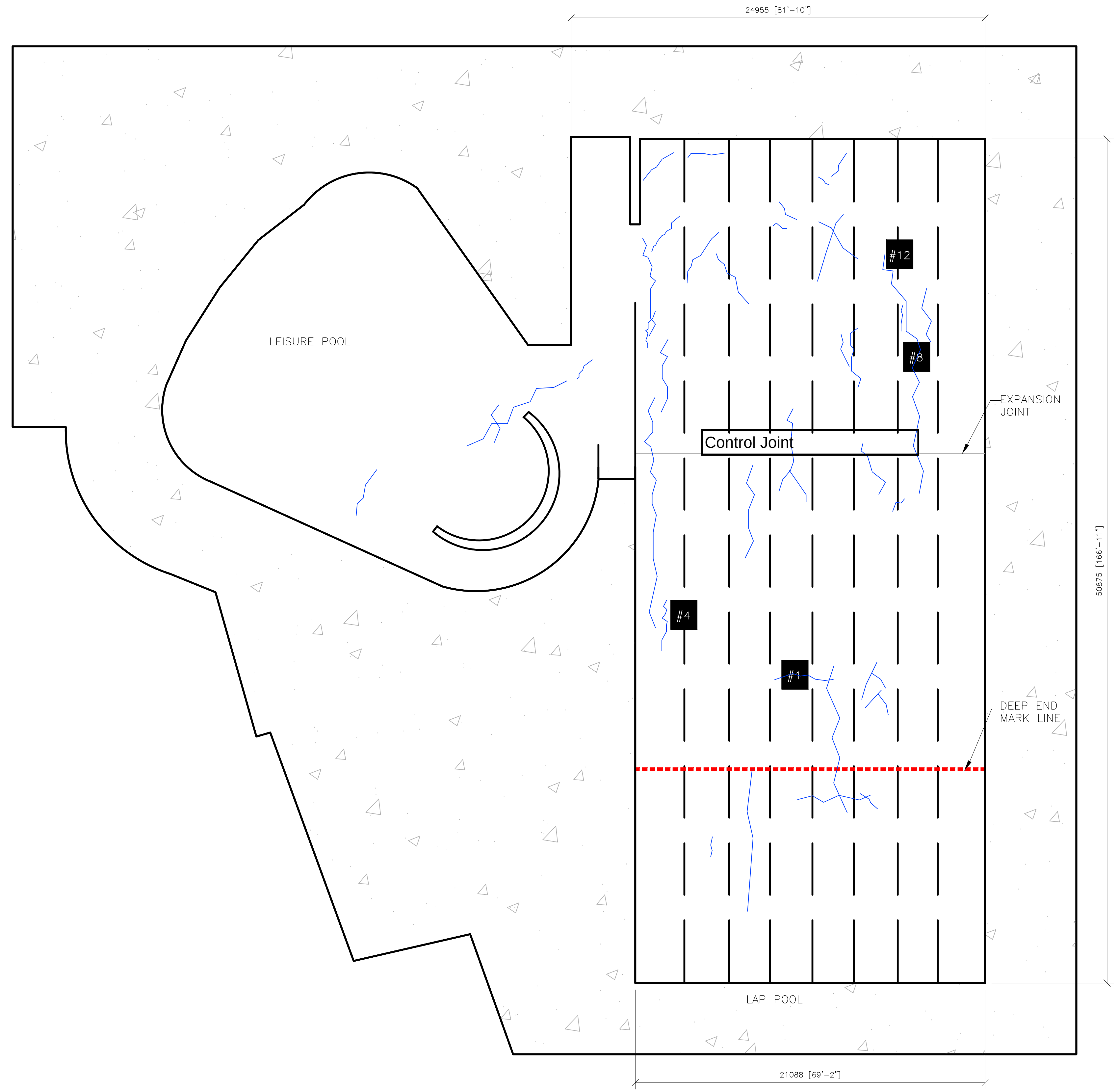
PHOTOGRAPH 9: Narrow Cracks present in the concrete forming pool floor slab.

PHOTOGRAPH 10: Spalling of concrete along the crack line evident in the pool slab.

PHOTOGRAPH 11: Longitudinal cracking of the concrete forming pool wall

PHOTOGRAPH 12: Hydrostatic pressure evident in the form of subgrade material forced out along the crack line.

APPENDIX B
Pool Plan



1 D1 CRACK DELINEATION
SCALE 1:300

LEGEND:
- ■ SAMPLE LOCATION
- ~ CRACK LOCATION

IRC Building Sciences Group
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2121 ARGENTIA ROAD, 4TH FLOOR
MISSISSAUGA, ONTARIO, L5N 2X4
TEL:905.607.7244, FAX:905.607.7288
1.888.607.5245 WWW.IRCGROUP.COM

TITLE:	CRACK SURVEY DELINEATION	IRC #:	10617
CLIENT:	AQUATIC DESIGN & ENGINEERING	W.O.#:	HB22-206CR
PROJECT:	THAMES POOL PARK 15 RIDOUT ST S LONDON, ONTARIO	SCALE:	AS NOTED
		DATE:	NOVEMBER 2022

NORTH:

DRN.:	A.F		
CHK.:	C.T		
DWG.#:	D1	REV.#:	REV 0X

PEN COLOR CODE:C1-0.10 C2-0.20 C3-0.30 C4-0.40 C5-0.50 C6-0.10 C7-0.15

APPENDIX C
TESTS

1801 Wentworth Street, Unit 10
Whitby, ON, L1N 8M2
Canada
www.ghd.com

GHD Project No.: 11221062-08

November 15, 2022

IRC Building Sciences Group
2121 Argentia Road
Mississauga, ON, L5N 2X4

Attention: Mr. Chander Thusu

Re.: Concrete Core Investigation
Thames Pool Slab
London, ON

Summary of Concrete Core Test Results				
Core Data	Client Core No.	4	8	12
	GHD Core No.	543	544	545
	Core Location	n/a	n/a	n/a
Laboratory Test Results	Compressive Strength of Concrete Core			
	MPa	60.0	59.8	51.6
	L/D Ratio	1.90	1.83	1.97
	Density (kg/m^3)	2302	2310	2294
Remarks	Compressive Strength Testing of Concrete Cores as per LS-410 / CSA A23.2-14C Strength (MPa) correction factor applied to samples with a L/D ratio of <2.00 as per CSA A23.2-14C Cores tested in a saturated state			

Regards,

Matt Rawlings
Laboratory Manager

1801 Wentworth Street, Unit 10
Whitby, Ontario L1N 8R6
Canada
www.ghd.com

Transmittal

10 November 2021

Attention	Chander Thusu	**GHD Ref No.**	11221062-08
To	IRC Building Sciences Group	**GHD Project Manager**	Vincent Zappia

Project name	Thames Pool, London
Subject	Lab Report
Number of Pages (Includes Cover Page)	2

Date of Sampling	Laboratory No.:	Material Type	Test(s) Performed
-	CST-22-150	Concrete Core	Air Void

Remarks:
Should you require any additional information, or have any questions, please contact the GHD project manager.

Issued by: Krishna Jadeja Signed: Krishna

Distribution List:

Name	Company	Email
Chander Thusu	IRC Building Sciences Group	cthusu@ircgroup.com
Kathiravel Karunananthan	IRC Building Sciences Group	karuna@ircgroup.com
Vincent Zappia	GHD	vincent.zappia@ghd.com
Krishna Jadeja	GHD	krishna.jadeja@ghd.com

Filing: Correspondence File

Microscopical Determination of Parameters of The Air-Void System in Hardened Concrete (LS 432)

Client:	**IRC Building Sciences Group**	**Test Code:**	**CST-22-150**
Project/Site:	**Thames Pool Slab, London, ON**	**Project no.:**	**11221062-08**

Operator:	Joe Sullivan	Date Placed:	n/a
Stone Size:	19.0mm	Date Sampled:	n/a
Station No.:	Sample 1	Date Received:	4-Nov-22
Location:	n/a	Lot No.:	n/a
MTO No.:	n/a	Sec. Seal No.:	n/a

Air Void System Parameters

Dimensions of Tested Sample	92x125	**mm**
Total Area Tested	**11500**	**mm^2**
Total Number of Stops	1394	
Total Traverse Length (T_t)	3206	**mm**
Air Content (A)	7.5	**%**
Void Frequency (n)	0.295	**mm-1**
Paste Content (p)	21.6	**%**
Paste / Air Ratio (p/A)	2.89	
Average Chord Length (L)	0.253	**mm-1**
Specific Surface (a)	15.8	**mm-1**
Spacing Factor (L')	0.183	**mm**

Additional laboratory reporting information available upon request.

Remarks:

Performed by:	**Joe Sullivan**	**Date:**	**November 8, 2022**
Verified by:	**Matt Rawlings**	**Date:**	**November 8, 2022**

Laboratory Location: **GHD Limited - 347 Pido Road, Unit 29, Peterborough, ON**

GEOTECHNICAL INVESTIGATION REPORT

Thames Pool
Thames Park
25 Ridout Street
London, Ontario

February 6, 2023

Terrapex Environmental Ltd.
90 Scarsdale Road
Toronto, Ontario, M3B 2R7
Telephone: (416) 245-0011
Email: toronto@terrapex.com
Website: www.terrapex.com

DISTRIBUTION: **DEI & Associates Inc.** **PDF** **PROJECT CT3663.00**

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Terrapex Environmental Ltd. (Terrapex) has been retained by DEI & Associates Inc. on behalf of the The Corporation of the City of London to undertake a geotechnical investigation with respect to possible ground/structure movements at the existing outdoor pool at the Thames Park property at 15 Ridout Street, London, Ontario.

The purpose of the investigation was to conduct a visual assessment of the pool structure, carry out a drilling program to include concrete and subsurface soil sampling and testing, and report on the potential causes of the ground/structure movements and make recommendations of remedial measures.

This report presents the results of the investigation performed in accordance with the general terms of reference outlined above and is intended for the guidance of the owner and the design architects or engineers only.

2.0 FIELDWORK

Previous to this investigation, the City of London had a contractor perform ground penetrating radar imaging of the pool tank slab-on-grade floor to investigate immediately below the floor and identify 13 potential corehole locations; the contractor then cored 8 of those locations. The fieldwork for this investigation was carried out on September 28, 2022, and consisted of coring at an additional 5 locations as well as advancing one sampled borehole and three dynamic cone penetration tests (DCPTs) to depths ranging from 1.5 m to 2.4 m below grade, in order to assess the concrete, granular base materials and subgrade soils related to the pool tank floor. The locations of the coreholes, borehole and DCPTs were distributed across the pool tank floor to be representative of the conditions present and are shown on the Borehole Location Plan attached in Appendix B.

Public locates were arranged through Ontario One Call for the site.

The fieldwork for this project was carried out under the supervision of a senior geotechnical engineer from Terrapex using a Dando Terrier drill rig owned by Terrapex. The borehole was logged in the field and the extracted soil samples were transported to our laboratory for detailed examination and testing.

Standard penetration tests (SPT) were carried out in the course of advancing the borehole to take representative soil samples and to measure penetration index values (N-values) to characterize the condition of the various soil materials. The number of blows of the striking hammer required to drive the split spoon sampler through 300 mm depth increments was recorded and these are presented on the borehole log in Appendix C as penetration index values.

The DCPTs were advanced by our Dando Terrier drill rig in accordance with the DIN EN ISO 22476-2 DPH2 standard. The number of blows of the striking hammer required to drive the cone through 300 mm depth increments was recorded and these are presented on the DCPT borehole logs in Appendix C as penetration index values.

Groundwater level observations were made in the borehole during advancement of the borehole and following the completion of its advancement.

3.0 LABORATORY TESTS

The soil samples recovered from the split spoon sampler were properly sealed, labelled and brought to our laboratory. They were visually classified and the results of the classification are presented on the borehole log sheet in Appendix C. Moisture content tests were carried out on all samples and the results are plotted on the borehole log sheet in Appendix C.

The concrete cores from five of the corehole locations were trimmed, capped and loaded to failure to determine the compressive strength of the individual concrete specimens. The test results are presented in Table 1 below.

Table 1

Corehole #	Diameter (mm)	Length (mm)	Density (kg/m3)	Compressive Strength (MPa)
3	146	182	2303	51.0
6	94	186	2310	56.7
9	146	200	2296	50.9
11	146	183	2289	46.7
13	146	200	2321	49.4

4.0 SITE AND SUBSURFACE CONDITONS

Full details of the subsurface and groundwater conditions at the site are given on the Borehole Log Sheets attached in Appendix C of this report.

The following paragraphs present a description of the site and a commentary on the engineering properties of the various soil materials contacted in the boreholes.

4.1. Site Description

The site is the outdoor pool complex with the municipal address of 25 Ridout Street, London, Ontario that is located in Thames Park (15 Ridout Street, London). The pool complex consists of an 8 lane 50 metre pool with an attached beach area with spray features and water slide. The water structures have been constructed with Portland cement concrete and the surrounding decks and interconnecting areas are predominately Portland cement concrete. The pool is 50 m long east to west and 20.5 m wide north to south with a surface area of about 1025 m^2. There is an approximately 56 m long north to south by 9 m wide east to west building adjacent to the east side of the pool and beach area containing change rooms, mechanical rooms, etc.

Approximately 70 m north of the pool complex is the South Thames River. The pool complex is constructed within the river's floodplain. To the east of the pool complex is a parking lot, tennis courts and a playground area. To the north there is grassed and forested areas with a paved trail that parallels the river. To the west and the south are grassed areas with some playing fields.

4.2. Subsurface Conditions

Eight coreholes were previously advanced through the slab-on-grade pool floor by others and Terrapex advanced an additional five coreholes. The thickness of the concrete at the locations of the coreholes is tabulated in Table 2.

Table 2

Corehole #	Thickness of concrete (mm)	Remarks
1	196	25 mm void below slab
2	135	Cored by others
3	190	Cored by others
4	190	10 mm void below slab
5	185	Cored by others
6	205	8 mm void below slab
7	190	Cored by others
8	190	16 mm void below slab
9	210	Cored by others
10	196	Cored by others
11	190	Cored by others
12	195	5 mm void below slab
13	205	Cored by others

The thicknesses of the concrete measured at the coreholes ranged from 135 mm to 210 mm, though generally the concrete thicknesses were between 190 mm and 205 mm. The 135 mm thickness at Corehole 2 was significantly less then the slab thickness at all the other corehole locations. The average thickness, excluding Corehole 2, was 195 mm.

One sampled borehole and three DCPTs where advanced through coreholes in the pool slab-on-grade floor. At the sampled borehole the base material below the slab-on-grade pool floor was a 1.2 m thick fill layer of gravelly sand with trace silt and clay. Underlying the gravelly sand, the borehole encountered a silty sand with trace to some gravel fill material that extended to the depth of borehole termination at 1.8m. The SPT N values and DCPT N values recorded in the below slab fill materials ranged from 14 to 69 blows per 300 mm of penetration, indicating compact to very dense conditions.

Moisture content tests on collected samples had results that ranged from 3 to 5%.

4.3. Groundwater

Groundwater level and cave-in of the unlined side walls of the borehole/DCPTs were measured during the course of the drilling and upon completion of advancement of the borehole/DCPTs. All borehole/DCPTs remained dry and open following completion of drilling.

5 DISCUSSION AND RECOMMENDATIONS

The existing pool tank, beach area and slide were constructed c.2010. Until 2009 a north-south oriented eight lane 50 m pool occupied the area immediately west of the building containing the changes rooms, mechanical rooms, etc. In 2007 a geotechnical investigation (Trow Associates Inc., 2007-06-01, Project LNGE00009135A) was carried out with respect to the proposed construction of the now existing pool structures.

The following discussions and recommendations are based on the factual data obtained from the coreholes, borehole and DCPTs advanced at the site by **Terrapex** and are intended for use by the client and design architects and engineers only.

Contractors bidding on or conducting work associated with the pool complex should make their own interpretation of the factual data and/or carry out their own investigations.

The existing slab-on-grade pool floor has experienced cracking and a loss of base support. The cracking has developed from external forces applied to the slab resulting in differential movements of the slab. Some components of the pool piping system have been displaced upward and are currently up to 100 mm above the floor of the pool indicating that differential movement of the slab has likely occurred. The loss of base support may be the result of the slab movement, failures in the piping system below the slab, or a combination of both.

5.1. Slab-on-grade Pool Floor Movement

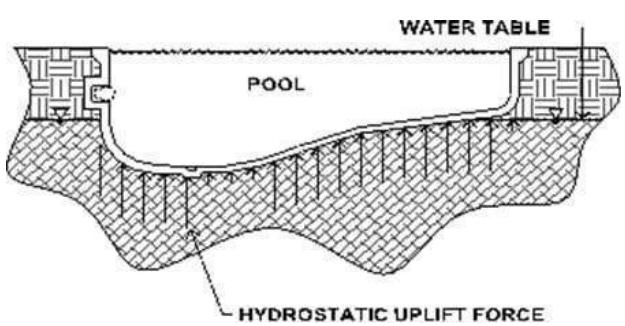
The two most probable mechanisms that could result in the differential movement of the slab-on-grade pool floor are frost penetration below the slab and hydrostatic uplift.

Both of these mechanisms are related to the groundwater conditions at the site. The Trow 2007 geotechnical report indicated that at the time of investigation (May 28, 2007) their observations indicated a groundwater level about 2 m below the existing ground surface. The report also cautions that higher groundwater levels would occur in wet seasons and when the South Thames River level was high.

Frost penetration into soils results in the freezing of groundwater contained in the soil pores. When water freezes it expands in volume by approximately 9%. The expansion of frozen groundwater in a base material or soil supporting a structure can cause upward forces on the structure that result in movement. If the movement is uniform across the structure, then the entire structure is displaced equally. If there is differential movement, the structure experiences stresses that may result in cracking, shearing or other failure of the structure.

Frost penetration is prevented by providing sufficient insulating material between the exterior ground surface and the base material or supporting soil. Typically, 1.2 m of soil cover or equivalent insulation is specified for the London area. The slab-on-grade would rely on the water in the pool to insulate against frost penetration. In the event that the pool is partially or fully drained during the winter, then frost would be expected to penetrate into the base material and supporting soil. The generally dense condition of the base material and supporting soil implies that void space available in these materials would be at a minimum and therefore the amount of water available for freezing would be minimal. While some movement from frost penetration is possible, it would not account for the magnitude of displacement indicated by the raised piping system components.

Hydrostatic uplift occurs when the groundwater level rises above the base of a structure and applies an upward pressure to the structure. If the uplift pressure exceeds the downward pressure (typically the weight) of the structure, or a section of the structure, then upward movement can occur. Again, if the movement is uniform, the entire structure will be displaced upward equally. If there is differential movement, cracking, shearing or other failure of the structure may occur. Any movement of the pool floor will also result in the movement and probable damage of the piping system that penetrates through the pool floor.



The downward pressures on the slab-on-grade pool floor can be simplified to two conditions. At the edges of the slab, the pool tank walls and surrounding soil exert a downward pressure on the slab. Most of the slab however only experiences a downwards pressure from the water contained in the pool. These exerted downward pressures, combined with the weight of the slab are what resist any upward pressures applied to the slab. If the groundwater level rises significantly above the level of water in the pool, the pool slab will lift. As the downward pressure on the slab is greater at the edges of the pool, this deferential would result in differential movements of the slab. The degree of upward movement observed in the raised piping system components in the pool slab would support hydrostatic uplift as the likely cause of the recent slab movement.

Sub-slab drainage is often used to prevent hydrostatic uplift and could be used to generally prevent the groundwater level from exceeding the water level in the pool. It must be noted that sub-slab drainage would not prove effective when the South Thames River overtops its banks and inundates the floodplain to levels above the sub-slab drainage system. During such a flood event the water in the pool would have to be maintained at a level equal to or greater than the level of the floodwater.

Hydrostatic relief valves installed in the pool floor slab can assist in preventing hydrostatic uplift, but the capacity of the valves has to be such that the rise of the water level in the pool can match the rise of the groundwater level outside the pool.

5.2. Slab-on-grade Pool Floor Base Material

At the coreholes advanced by others, examination of the cores and coreholes indicated that voids appeared to be present below the slab-on-grade pool floor. As the coreholes had been advanced some time before Terrapex's investigation and we had not witnessed the coring procedure, we could not assign quantitative values to the depth of the void spaces. At the five coreholes advanced by Terrapex the void space ranged from 5 mm to 25 mm.

At several of the inflow pipes located in the pool floor, there are deposits of predominantly sand material lying on the pool floor. The sand would have been sucked into the piping system at points where the piping has become disconnected or broken. It is hypothesized that the lifted vertical sections of pipe may have become disconnected from the horizontal feeder pipe system. While the water leakage through the broken piping system is undoubtedly creating some localized voids below the pool structure, this does not readily explain the widespread existence of the areal void just below the slab. A more probable explanation for the areal void would be that surface disturbance (e.g. soil boiling) of the supporting base material occurred during an episode of hydrostatic uplifting. The disturbance may have created some localized high points that the slab is now resting on resulting in the void space below the remainder of the slab.

While the floor base material appears to have been well compacted at the time of its placement, it is no longer providing full support to the underside of the pool floor slab. The floor slab is having to bridge across the void(s) and this will create stresses in the slab that should not be present.

The stresses could result in cracking of the slab.

The voids could be filled by injection grouting to re-establish full support, but in the event the existing slab is removed to repair the pool piping system, the new slab-on-grade pool floor would be poured on remediated base material compacted to 100% of its Standard Proctor maximum dry density (SPMDD).

6 LIMITATIONS OF REPORT

The Limitations of Report, as quoted in Appendix ‘A’, are an integral part of this report.

Yours respectfully,
Terrapex Environmental Ltd.

LICENSED PROFESSIONAL ENGINEER 2023-02-17 W. J. KORYNKIEWICZ 2450350 PROVINCE OF ONTARIO

Jayne Zaatar, P.Eng.
Project Engineer

Walter Korynkiewicz, P.Eng.
Manager, Materials Testing & Inspection

APPENDICES

APPENDIX A

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

This report has been completed in accordance with the terms of reference for this project as agreed upon by DEI & Associates Inc. (the Client) and Terrapex Environmental Ltd. (Terrapex) and generally accepted engineering consulting practices in this area.

The conclusion and recommendations in this report are based on information determined at the inspection locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation. If new or different information is identified, Terrapex should be requested to re-evaluate its conclusions and recommendations and amend the report as appropriate.

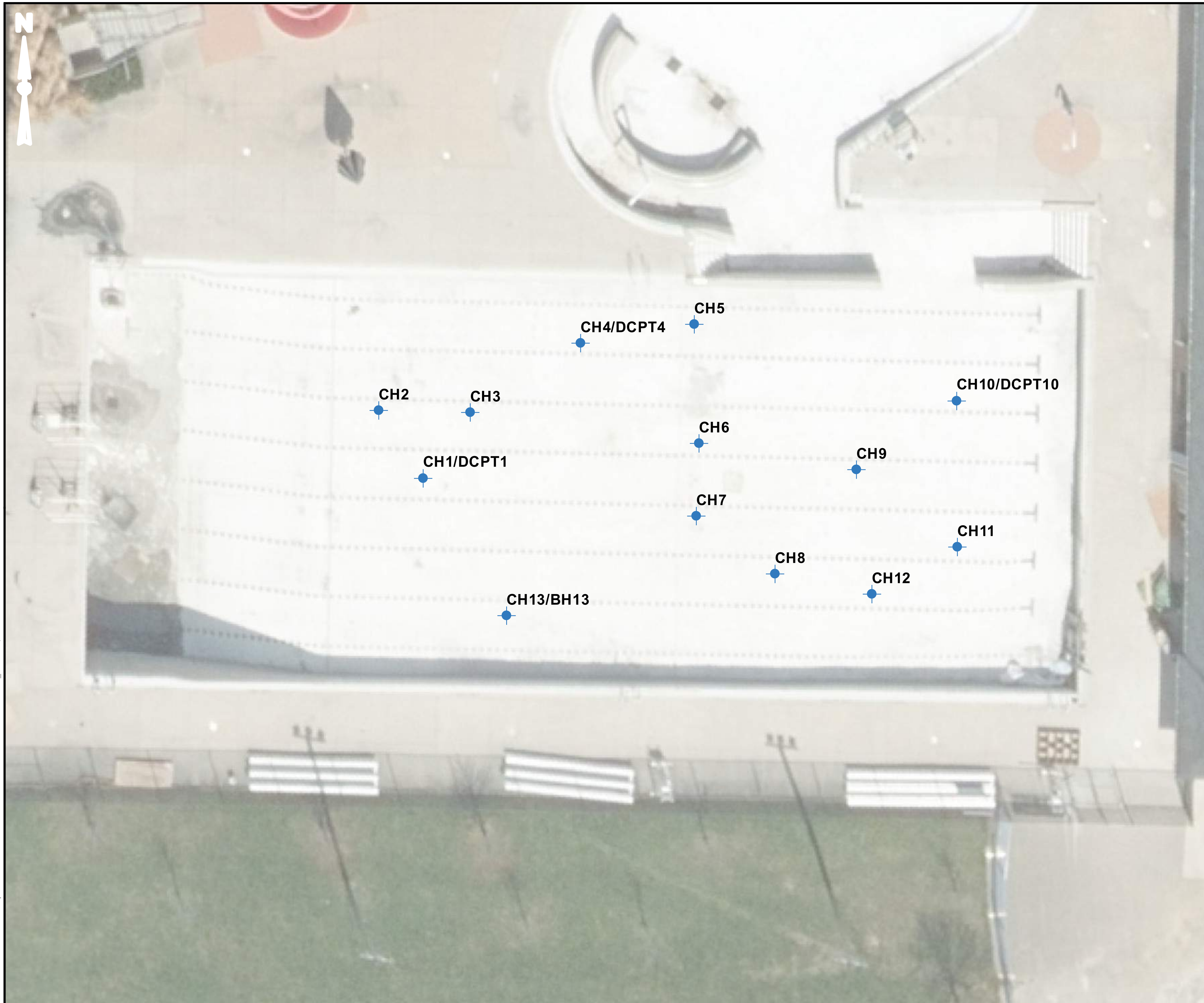
The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made as set out in this report. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

This report was prepared for the sole use of DEI & Associates Inc. and the Corporation of the City of London. Terrapex accepts no liability for claims arising from the use of this report, or from actions taken or decisions made as a result of this report, by parties other than DEI & Associates Inc. and the Corporation of the City of London.The material herein reflects Terrapex's judgement in light of the information available to it at the time of preparation. We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We also recommend that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases where these recommendations are not followed, Terrapex's responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

The comments given in this report on potential construction problems and possible methods are intended for the guidance of the design engineer, only. The number of inspection locations may not be sufficient to determine all the factors that may affect construction methods and costs. Contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

APPENDIX B

BOREHOLE LOCATION PLAN



LEGEND

SAMPLE LOCATIONS (TERRAPEX, 2022)

0 2 4 6 8
Metres

DATA SOURCE: FIRST BASE SOLUTIONS
MAP PROJECTION: NAD 1983 UTM ZONE 17N

CLIENT:	DEI & ASSOCIATES INC
SITE LOCATION:	15/25 RIDOUT STREET LONDON, ONTARIO

TERRAPEX

TITLE:
COREHOLE, BOREHOLE AND DCPT LOCATION PLAN

DRAWN BY:	PROJECT NO.:	CHECKED BY:
JS	CT3663.00	WK
REVISION:	DATE:	FIGURE:
00	DECEMBER 2022	1

C:\Users\USeroul\OneDrive - Terrapex Environmental Ltd\PROJECTS\Toronto\CT3600\CT3663.00 15_25 Ridout, London\MXD\CT3663.00 FIG 1 LOCATION PLAN.mxd

APPENDIX C

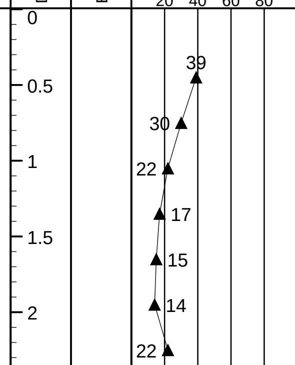
BOREHOLE LOG SHEETS

CLIENT: DEI & Associates Inc.	PROJECT NO.: CT3663.00	RECORD OF: BH1
ADDRESS: 15 Rideout Street South, London		

CITY/PROVINCE: London Ontario	NORTHING (m): -	EASTING (m): -	ELEV. (m) -
CONTRACTOR: Testing	METHOD: Dynamic Cone Penetration Testing		
BOREHOLE DIAMETER (cm): 5	WELL DIAMETER (cm): -	SCREEN SLOT #: -	SAND TYPE: -
SEALANT TYPE: -			

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) 40 80 120 160 / N-VALUE (Blows/300mm) 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		196mm Concrete	0 – 2.2		39, 30, 22, 17, 15, 14, 22			Dynamic cone					
		END OF BOREHOLE											



TERRAPEX	LOGGED BY: JZ	DRILLING DATE: 28-SEP-22
	INPUT BY: JZ	MONITORING DATE:
	REVIEWED BY: -	PAGE 1 OF 1

CLIENT: DEI & Associates Inc.	PROJECT NO.: CT3663.00	RECORD OF: BH4
ADDRESS: 15 Rideout Street South, London		

CITY/PROVINCE: London Ontario	NORTHING (m): -	EASTING (m): -	ELEV. (m) -
CONTRACTOR: Testing	METHOD: Dynamic Cone Penetration Testing		
BOREHOLE DIAMETER (cm): 5	WELL DIAMETER (cm): -	SCREEN SLOT #: -	SAND TYPE: - / SEALANT TYPE: -

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

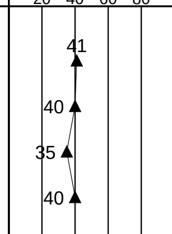
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		190mm Concrete	0 – 1.5		56, 59, 69, 68								
		END OF BOREHOLE											

TERRAPEX	LOGGED BY: JZ	DRILLING DATE: 28-SEP-22
	INPUT BY: JZ	MONITORING DATE:
	REVIEWED BY: -	PAGE 1 OF 1

CLIENT: DEI & Associates Inc.		PROJECT NO.: CT3663.00	**RECORD OF:**
ADDRESS: 15 Rideout Street South, London			**BH10**
CITY/PROVINCE: London Ontario	NORTHING (m): -	EASTING (m): -	ELEV. (m) -
CONTRACTOR: Testing	METHOD: Dynamic Cone Penetration Testing		
BOREHOLE DIAMETER (cm): 5	WELL DIAMETER (cm): -	SCREEN SLOT #: -	SAND TYPE: - / SEALANT TYPE: -

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	(new title) SV/TOV (ppm or %LEL)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		196mm Concrete	0 – 1.5		41, 40, 35, 40			Dynamic cone					
		END OF BOREHOLE											



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REVIEWED BY: -	PAGE 1 OF 1

CLIENT: DEI & Associates Inc.	PROJECT NO.: CT3663.00	RECORD OF: **BH11**
ADDRESS: 15 Rideout Street South, London		

CITY/PROVINCE: London Ontario	NORTHING (m): -	EASTING (m): -	ELEV. (m) -
CONTRACTOR: Testing	METHOD: Dynamic Cone Penetration Testing		
BOREHOLE DIAMETER (cm): 5	WELL DIAMETER (cm): -	SCREEN SLOT #: - / SAND TYPE: -	SEALANT TYPE: -

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SHEAR STRENGTH (kPa) ● 40 80 120 160 / N-VALUE (Blows/300mm) ▲ 20 40 60 80	WATER CONTENT (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	RECOVERY (%)	SV/TOV (ppm or %LEL) (new title)	LABORATORY TESTING	WELL INSTALLATION	REMARKS
		19mm Concrete	0										
		gravelly sand trace silt and clay (FILL)	0.5		41, 56	3	1		27				
			1		42	5	2A		55				
		moist, brown, silty sand, trace to some gravel (FILL)	1.5		30	5	2B		55				
		END OF BOREHOLE											

TERRAPEX	LOGGED BY: JZ	DRILLING DATE: 28-SEP-22
	INPUT BY: JZ	MONITORING DATE:
	REVIEWED BY: -	PAGE 1 OF 1

Appendix B: Aquatics Facilities Review Report II – Comprehensive Review

Aquatic Facilities Review

Report II – Comprehensive Review

Existing review for City of London

London
CANADA

Thames Pool
15 Ridout Street S.
London, ON
N6C 3W6

June 2023
DEI Project No. 22297

Prepared by:

AQUATIC DESIGN & ENGINEERING
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TABLE OF CONTENTS

Terms of Reference

In April 2023, Aquatic Design and Engineering, a Division of DEI Consulting Engineers was retained by the City of London to review ongoing concerns with Thames Pool located at 15 Ridout St. South. A prior review of the same facility was conducted by Aquatic Design and Engineering in September 2022. This report is considered Report II – Comprehensive Review of the project and should be read in conjunction with Report I – Preliminary Review.

This Report II - Comprehensive Review shall provide a high-level overview to supplement the original findings and to be used as a comparison from 2022, to 2023, based on a visual inspection of the general condition of the existing pool tank. Observations noted in this report are based on the visual inspection, pre-existing conditions, existing plans, and conversation with staff from the City of London.

The purpose of this report is to:

- Provide a high-level review of the current conditions, as noted above.
- Outline two (2) repair and mitigation options for the City of London's consideration.
- Detail construction requirements and costing estimates, and,
- Recommend a repair option.

At the time of the site meeting and facility inspection, the system was not operational, and the pool tank was partly empty. The tank had been winterized for the season with water to act as ballast within the pool itself. However due to previous tank structure and piping damage, minimum water remains within the tank.

Facility Overview and Observations

Our consulting team, including aquatic designers, building science engineers and geotechnical engineers completed three site visits during September 2022 (Phase 1). We reviewed the original design plans for the 2010 rebuild and compared them to the actual on-site installations and the current condition of the pool tank. Additionally, a geotechnical investigation and subsurface soil testing (Terrapex) and concrete compressive strength testing (IRC) were conducted. Those independent reports are appended to Report I – Preliminary Review. Aquatics Design and Engineering's report shall be read in conjunction with Terrapex and IRC's reports as a full encompassing Report I – Preliminary Review.

The original plans for the 2010 reconstruction, designed by Shore Tilbe Irwin & Partners (Perkins & Will), dated 2007, were provided for review. This information has been compared to progress photos taken during the construction phase and a visual review of the as-built structure. Discussions with pool operational staff, a review of maintenance and utility records and a comprehensive visual inspection of existing conditions provided background information.

The focus of the Report I – Preliminary Review was to investigate the potential causes of the pool tank cracking and of the protruding floor returns within the 50m - 8 lane area of the pool and provide high-level options to repair these concerns. Some additional cracking and abnormalities were also identified in the shallow / beach entry of the pool.

A water usage report was provided, showing historical water usage from 2015 – 2021 from May through to September. In 2018, nearing the end of the season a significant spike in water usage was recorded after a flat (average) water usage season which aligned with the previous years. This spike could also correlate to the February 2018 flooding event damaging a return line or breaking a floor return fitting causing water to leak out of the pool basin. This change in water usage appears to be the beginning of the increased water consumption based on the records provided.

The following year, 2019, an increased water usage is noted over previous years. In 2019, the water usage is approximately 2.5 times the average usage from 2015 – 2017. A repair to the return line and return fittings was completed in the fall of 2019 to address the water loss.

In 2020 and 2021 the water usage compared to 2015 – 2017 is approximately 4 times the average. A portion of the increased usage could be a result of filling and emptying the pool during this period. Mechanical room flooding clean-up, and failures in the return lines may also account for some of the increased water usage.

Further, it was communicated that a renovation of the pool coping, and gutter was performed prior to winterization of the pool in 2021. Possible water use explanation is from construction work and personnel on site.

The work / renovation on pool coping and gutter continued into late fall and early winter resulting in less than an ideal condition for the pool tank to be properly prepared for the winter cycle. To provide a safe working environment, the pool must be drained. The additional ballast or weight of a partially filled pool can counteract hydro-static lift pressure. Due to its proximity to the Thames River and the potential for high ground water levels to be present around the pool basin, hydrostatic uplift is a year-round risk.

During the initial site meeting in September 2022 to discuss the project, the pool was empty to allow for visual inspection. The hydrostatic relief valve in one of the main drains was open to permit the release of ground water and pressure on the tank. A submersible pump was used to discharge the incoming water as quickly as it was entering the pool tank. See Figure 1.

It was also noted during the site meeting at project kick-off that the pool, if left on its own drains down to the silt line as shown on Figure 3a. This would indicate that the piping, either from the pool drains or return piping has a break at that level, approximately minus 8 feet (-2500) below pool deck.

Report I - Ground water in main drain, with pump, June 2022

For further information and details please refer to Report I – Preliminary Review report dated February 2023.

Requirements of Report II - Comprehensive Review report

In April 2023, Aquatics Design and Engineering was engaged to complete a Report II - Comprehensive Review report on the condition of Thames Pool; to further detail repair options and costing; and recommend an approach. A site visit was conducted on April 6, 2023.

The intention would be to make the pool operable again and incorporate additional design and operational items that may mitigate potential damage due to high ground water levels and hydrostatic pressure.

The damage resulted from the pool being moved in the soil. This is demonstrated by the following:

1. Concrete cracks in the pool floor
2. Broken / shifted pipes below the bottom of the pool (can not get photos of these buried piped until pool floor is removed, and piping excavated)
3. Floor returns being pushed above the slab level.

The report will present baseline repair and mitigation efforts but does not consider a full re-design that may avoid the current situation from re-occurring. Challenging site conditions at Thames Pool include the proximity to the Thames River and high groundwater levels, which present flooding and hydrostatic pressure risks.

Current Conditions

Aquatic Design & Engineering have reviewed the existing conditions and compared photos from 2022 to 2023 conditions noting the cracking and movement of the pool tank and loss of water as described by the City of London team. The following photo comparisons of equal viewpoints from Fall 2022 to Spring 2023 indicate increasing fracture of the pool tank and widening of the existing cracks; additional sand debris deposits and evidence of flooding.

The increased cracking can be attributed to water freezing and expanding within the crack itself. Ground water penetrating the slab from below can cause 'blistering' or 'spalling' of the concrete, as evident in Fig 2a and 2b. Although the 2022-2023 winter was fairly mild in comparison to recent winters, the continued cracking and spalling is evident. (Figures 4a & 4b and 5a & 5b)

Additional sand debris has accumulated within the pool tank at core sample openings, indicating ground water pressure under the pool tank. (Figures 1a & 1b)

Spring flood conditions occurred in Thames Park in late March 2023. A photo taken April 6, 2023, shows the debris line in Thames Pool consistent with the flood level. (Figure 3b) The water in the tank equalizes with the external hydrostatic pressure of the flood waters.

Figure 1a – Overview of lap pool (September 2022)

Figure 1b – Overview of lap pool (April 2023)

Additional sand has accumulated within the pool tank around the core sample openings indicating ground water under the pool forcing granular materials (backfill) from under the pool into the pool tank.

Figure 2a – Significant fracture in lane 1 at break point to deep area (June 2022)

Figure 2b – Significant fracture in lane 1 at break point to deep area (April 2023)

The cracking along lane 1 near the break point has increased and the crack now extends from the break point to the shallow end wall, indicating further stress placed on the tank due to ground water and freeze / thaw conditions.

Figure 3a – Debris marking water lost line, and pump extracting ground water (June 2022)

Figure 3b – Debris marking water flood line and lost water line (April 2023)

Ground water the week prior to site meeting was noted within the flood plain and lower field, approximatly at the same level as the debris line on the pool wall.

Figure 4a – Fracture in lane 1 at break point to deep area (June 2022)

Figure 4b – Fracture in lane 1 at break point to deep area (April 2023)

Cracking along the lane 1 towards the deep end is increasing in length as well as the crack is opening. (becoming wider)

Figure 5a – Cracking at deep-end slope point (September 2022)

Figure 5b – Cracking at deep-end slope point (April 2023)

Cracking along the break point across the pool with the deep end on the right side of the photo is increasing in length as well as the crack is opening (becoming wider) in places.

Pool Piping

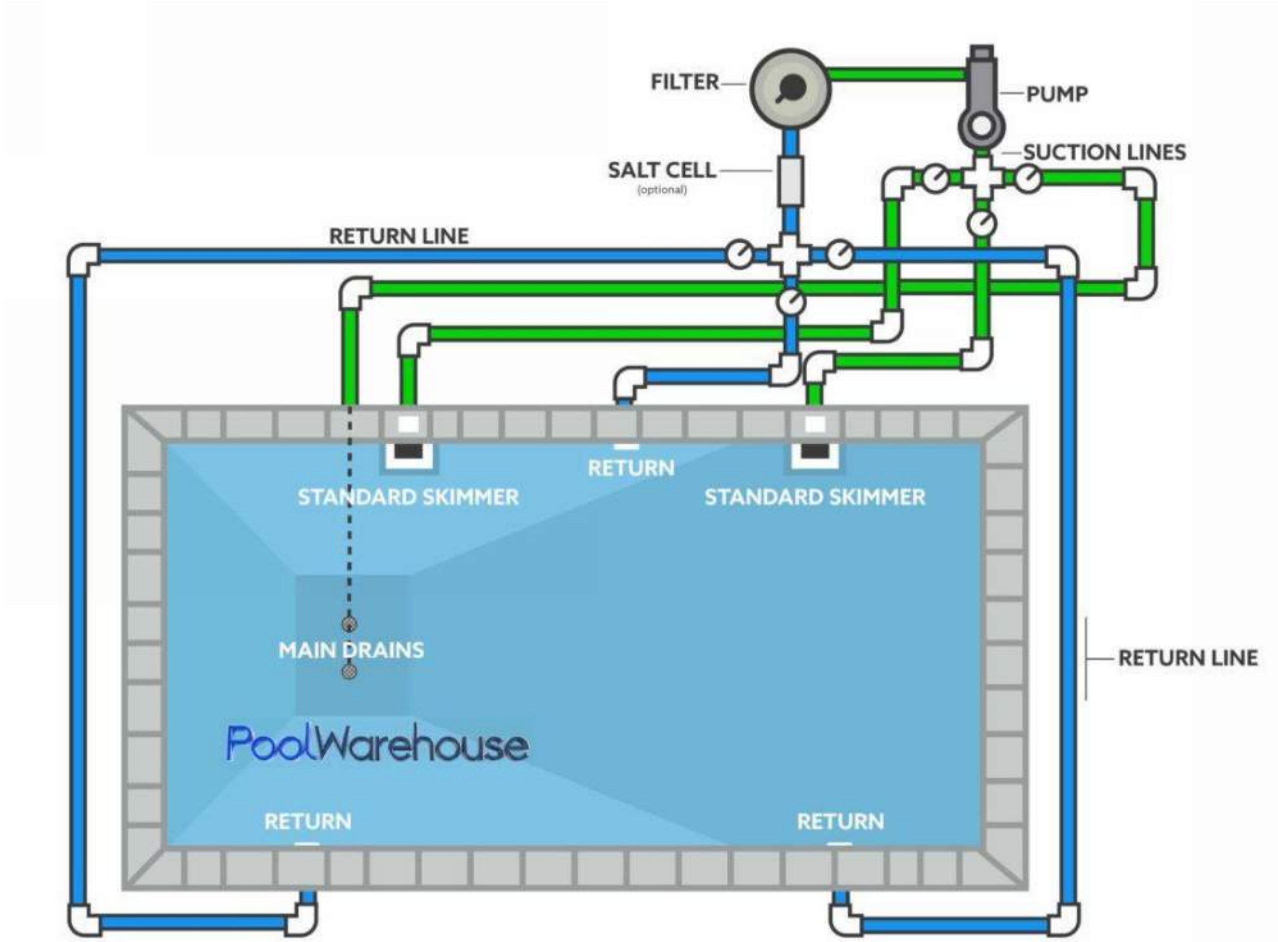

Figure 6 Basic pool piping diagram – example for illustration only

Pool water is kept clean by recirculating water and filtering the recirculating water. Pumps draw water from the pool, either from the drains or gutters / skimmers via suction pipelines (green). Once the water has been filtered and cleaned, it flows back into the pool via return pipelines (blue). In this example, return lines are wall mounted.

In Thames Pool specifically, both the suction (main drain lines) and the return (supply lines) piping system is below the pool floor. This means the piping is buried in the soil below and around the pool. The Report I – Preliminary Review discusses the breaks and movement in the pipes and how it has shifted. The below photo shows the return water fitting pushing through the concrete floor of the pool.

Figure 7, Report I – Preliminary Review – Floor return protruding from pool floor, June 2022

From this observation the concrete pool floor must be removed to correct the piping.

The suction (drains) are the large square units in the bottom of the deep end, these drains must remain in this location. The return pipes can be in the floor or in the side wall of the pool.

The current design using floor returns is both correct and incorrect depending on priority.

Floor Returns
The floor returns are preferred for a 50-meter competition pool. The reason is lane 1 and 8 would not be at a disadvantage due to the force of returning water jets on the side of the swimmer.

Sidewall Returns
Sidewalk returns can be designed to be located higher on the pool wall to reduce damage from high groundwater levels. The sidewall returns are also 'preferred' for winterization of the piping for an outdoor pool. These pipes can then be arranged to a proper gravity drainage location and avoid the winter freezing conditions.

A compromise between these priorities would be to install wall returns at staggered heights that are controlled independently. During competitions, the higher height wall returns would be turned off to minimize the effect of the return flow on the swimmer, while still maintaining proper water flow for sanitization to and from the pool. Wilfrid Laurier University pool is an example of this staggered return piping design and is used for competitive events.

Constructing Pools in Flood Plains

For a typical pool construction outside of a flood plain, the ground conditions are known and generally constant. The pool's concrete structural design considers the site conditions. The weight of the concrete and pool water provide downward force and the pool is stable in the ground. This total weight of pool tank and water within the tank overcomes the upward forces of any potential ground water.

A pool constructed in the flood plain, which has varying ground water level conditions, requires special consideration. These best practice items are:

1. Increasing thickness of the pool tank itself to overcome the potential hydrostatic lift (upward-pressure) the ground water will exert on the pool tank.
2. Hydrostatic pressure mitigation would include relief valves to allow rising ground water to flow into the pool tank.
3. Gravity drains in winter to storm sewer or river after pool is dechlorinated.
    a. Pool drains are left open to permit any water entering the tank from the relief valves to drain naturally as ground water subsides.
4. Some method of under pool dewater system with or without pumps.
5. Not very deep, example 4' (1200) to reduce the uplift pressure.

This pool does not meet any of these requirements. To date we have only included for items #2 and #4 above in the pricing, with a passive under pool dewatering system which excludes pumps.

When a pump is added to the dewatering system, it requires electrical power. If there is a power fluctuation or outage during a flood or high-water level event, damage may result. The damage may not occur when the river rises, as the pool is also being filled with river water and equalizing hydrostatic pressure. But the receding river water can recreate the uplift condition. This event requires operations to close a drain valve and keep the pool full of water, until ground water saturation also recedes. Consequently, with pumps being installed, then a dewatering permit must be applied for and granted as it is predicted to exceed the 50,000L per day (9 gallons per minute) acceptable water discharge permitted during peak water events.

A similar condition with passive drainage of ground water to a river has been implemented in the City of Kitchener at the Kiwanis Outdoor pool. The pool resided on the banks of the Grand River and through Big-O drainage pipe along with the pool drains connected to a manhole with backwater valves permit free drainage of ground water that may occur around the pool. Although the pool basin is only 4'-6" (1400mm) deep at its deepest point the proximity to the river and within a flood plain is comparable to City of London, Thames Pool.

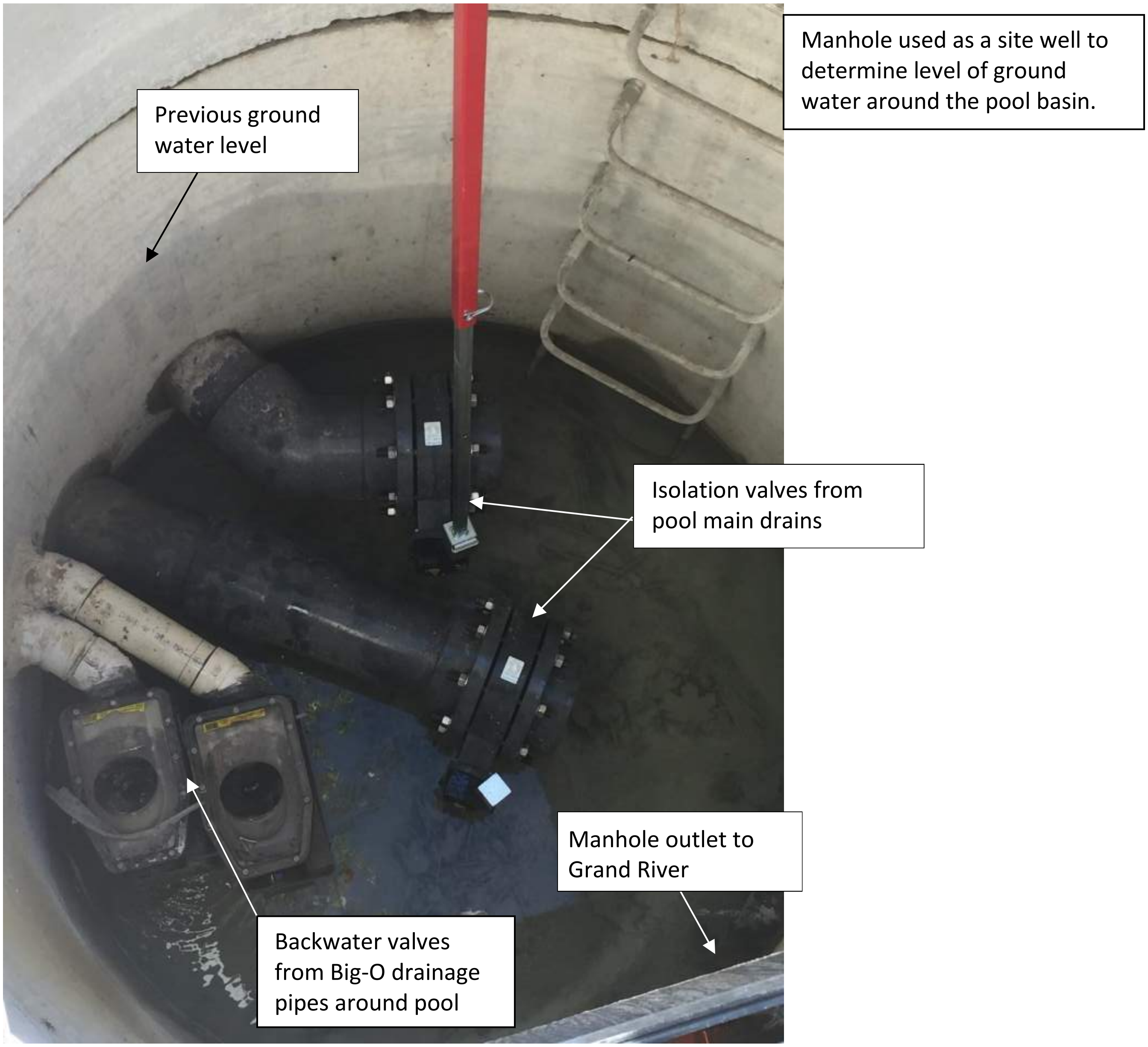

Figure 8 Kiwanis Park, Kitchener manhole drainage system.

Some of the above items are beyond the simple repair and we recommend they be given consideration. Further mitigation items could also be explored, such as reduction of the pool depth. The reduction of the depth of the pool would provide less instruction into the water table and in turn reduce the upward pressure exerted on the pool tank.

Repair Options

Option 1 outlines the basic repairs needed to return the pool back to its pre-damaged condition. Some mitigation is also provided by the means of 'Big-O' passive drainage pipe to a site well. This would provide visual reference to ground water trapped around the pool tank and at what level below the pool deck the ground water resides.

Option 2 also provides the basic repairs need to return to the pool back to its pre-damaged condition. This option also provides 'Big-O' drainage pipe to a site well, however, also moves the floor return jets to the walls of the pool. This would provide easier winterization and reduce some risk of pipe movement due to ground water levels.

Within the appendix of this report, drawings ASK-1 and ASK-2 illustrate the two repair options and ASK-3 and ASK-4 provide details.

Timelines

Realistically, the repairs to Thames Pool could not be undertaken before the 2024 construction season and would be expected to take six to eight months.

Due to the location of the Thames Pool within the flood plain, further site investigations, surveys and analysis would be necessary. Consultation with the Upper Thames River Conservation Authority (UTRCA) and a permit to work in a flood plain must be issued.

The design, engineering and construction of aquatics facilities is a specialized industry. Most consultants and contractors have been completely booked for the 2023 season, with many already booking into 2024 and beyond as well.

Planning for 2024 permits sufficient time for further site investigations, engineered plans and detailed designs. It also allows for community engagement to be completed.

Depending on procurement measures some time saving methods can be applied, such as design build or collaborative partnerships between owner, consultants, and installer.

Detailed Scope

<u>Option 1</u> – Status quo repairs, refer to ASK-1

1. Cut and remove existing pool slab, approximately 8-12” thick.
    a. Offset cut approximately 18-24” inward from existing pool walls in 50m lap area and dispose.
2. Excavate approximately 5’ below pool slab area and dispose of materials if unsuitable for reuse.
3. Remove all PVC pipe back to main / header, main is located in shallow end.
    a. May require some pool deck removal near top of steps / outdoor shower area.
4. Place crushed stone as a base for new piping throughout entire area, ensuring a uniform and level base. (Approx 14” minimum)
5. Excavate / drill a site well, minimum 18” diameter and 18’ deep.
    a. Site well shall be placed in vegetation are near slide.
6. Weeping tile / Big ‘O’, Install minimum four (4) headers along 50m length. Connect to main header at deep end of pool. Big ‘O’ to be wrapped in landscape cloth to prevent soil and finds entering system.
    a. Connect header to site well. Horizontal boring will be required.
7. Backfill pool area uniformly with crushed stone in preparations for new PVC return piping.
8. Place all new PVC piping and connect to main / header, provide risers to new floor return system.
9. Place four (4) new main drains with hydrostatic relief valves and connect to main drain header.
    a. Include 8” drain sumps as additional hydrostatic relief ports.
10. Backfill pool area uniformly with crushed stone in preparations for new concrete pool slab.
11. Install minimum 10m bar, 8” on center each way, drill and dowel into existing slab to connect new rebar to existing.
12. Provide grounding rod and bond new bar to ground.
13. Place water stop at all joints, (swellseal/Emseal)
14. Provide block outs for all piping / floor return locations and place concrete, minimum C1 mix, 35 mpa, up to 7% air entrainment, 5-8” slump, no plasticizer. Slab thickness shall be min 12” with thickened edge, 18”. Provide a construction joint with 6” PVC center build water stop at 25m length (@breakpoint/ slope)
15. Install all floor returns (72) flush with finished concrete.
16. New concrete shall slope to drains and match perimeter elevations throughout.
17. Hydroblast pool tank complete, including beach entry and walls to meet ICRC-CSP #3, any damage to pool lips/handhold shall be assessed and replaced at contractor’s expense.
18. Route out all cracks and patch
    a. Fill pool and preform a water tightness test if failure contractor shall drain and repair all necessary areas and repeat leak test until successful.
19. Parge enter pool and apply minimum two (2) coats Rumac pool paint with all associated contrasting lines.
    a. Alternate finish WR Meadows – Cemkote-Flex ST

Option 2 – Minimal Repairs, refer to ASK-2

1. Cut and remove existing pool slab, approximately 8-12” thick.
    a. Offset cut approximately 18-24” inward from existing pool walls in 50m lap area and dispose.
2. Excavate approximately 5’ below area removed and dispose of materials if unsuitable for reuse.
3. Remove all PVC pipe back to main / header, main is located in shallow end.
    a. May require some pool deck removal near top of steps / outdoor shower area.
4. Place crushed stone as a based for pool throughout entire area, ensuring a uniform and level based.
5. Place four (4) new main drains with hydrostatic relief valves and connect to main drain header.
    a. Include 8” drain sumps as additional hydrostatic relief ports
6. Excavate / drill a site well, minimum 18” diameter and 18’ deep.
    a. Site well shall be placed in vegetation are near slide.
7. Weeping tile / Big ‘O’, Install minimum four (4) headers along 50m length. Connect to main header at deep end of pool. Big ‘O’ to be wrapped in landscape cloth to prevent soil and finds entering system.
    a. Connect header to site well. Horizontal boring will be required.
8. Backfill pool area uniformly with crushed stone in preparations for new pool slab.
9. Removed guard chairs, handrails, diving boards etc, secure / store and reinstall c/w all necessary anchors/bases/ grounding etc.
10. Remove pool deck and excavate to approximately 4’ depth, (excavation width shall comply with Ministry of Labour requirements) backfill with crushed stone to form a uniform base. Install Big ‘O’ pipe and connect to site well.
11. Core drill through pool walls for 72 new wall returns, Place new PVC piping header around pool. Pipe to be installed on a 0.5-1% slope to permit free drainage for winterization.
    a. All piping shall be fastened to pool walls (pipe brackets) to prevent pipe movement/ sagging.
12. Backfill with crushed stone to top of pipe system and install minimum 2” of rigid SM insulation above /on top of pipe and extend out beyond pool wall minimum 3’ and turn down. (Insulation should form an L on its side or install insulation as an upside-down U is better to protect the pipe).
13. Continue backfill with crushed stone to underside of existing pool deck.
14. Hydroblast pool tank complete, including beach entry and walls to meet ICRC-CSP #3, any damage to pool lips/handhold shall be assessed and replaced at contractor’s expense.
15. Route out all cracks and patch
    a. Fill pool and preform a water tightness test if failure contractor shall drain and repair all necessary areas and repeat leak test until successful.
16. Parge enter pool and apply minimum two (2) coats Rumac pool paint with all associated contrasting lines.
    a. Alternate finish WR Meadows – Cemkote-Flex ST
17. Reconnect all deck drains and replace all deck drains (Zurn or Watts deck drains) to match existing.
18. Provide minimum 6x6 WWM for new concrete and tie into existing deck c/w grounding.
19. Slope pool deck to lower ground and / or deck drains. Provide a boom finish to match adjacent deck. Include all necessary anchor for guard chairs, handrails, diving boards, etc that are affect by deck removal.
20. Additional option for the site well to be connected to a French drain outside the fence area c/w backwater valves for passive ground water mitigation.

An option for either of the above is replacement of the site well with a manhole and backwater valves to allow for passive water removal from around the pool tank during low ground water events and to discharge to the river and / or lower ground.

As noted above with the City of Kitchener, Kiwanis Park a manhole can be used as a site monitoring as well as to permit passive draining or ground water from around the pool tank.

Costing

Aquatics Design & Engineering engaged the services of a cost consultant for the Report II - Comprehensive Review report. This provides a more detailed cost estimate based on the scope of work; quantity calculations for materials and tasks; consultant fees; and current market pricing.

Report I – Preliminary Review provided a construction value estimate only based on previous projects completed in 2020 and 2021. This did not include design and engineering fees or a contingency allowance.

Construction costs have increased significantly over the past three to four years. This can be attributed to several factors including material and skilled labour shortages and lingering supply chain disruptions. Concrete has increased 15% in price from 2021 to 2022 and a further 8% in the first quarter of 2023. In recent weeks, concrete plants in the GTA have had rotating closures due to a lack of raw materials. The proposed Thames Pool repairs would require significant amounts of concrete.

Option 1 ($) – Status quo repair 2024	
Removal of existing pool slab, excavate below return piping, new engineered fill	$275,328
Replum floor return system, new weeping drain system	$235,606
New pool slab and finishes	$456,234
	$967,163.000
Design fee, General conditions (25%)	$241,791
Design Contingency (30%)	$290,149
Escalation (Q3 2024) (10%)	$96,716
Sub-total	**$1,595,825.00**
Project Contingency (20%)	$319,164
Project Estimate	**$1,914,983.00**

Option 2 ($$) – General repair and mitigation 2024	
Removal of existing pool slab, excavate below return piping, new engineered fill	$494,874
New wall return system, new weeping drain system	$172,509
New pool slab and finishes	$457,734
	$1,125,120.00
Design fee, General conditions (25%)	$281,280
Design Contingency (30%)	$337,536
Escalation (Q3 2024) (10%)	$112,512
Sub-total	**$1,856,445.00**
Project Contingency (20%)	$371,290
Project Estimate	**$2,227,738.00**

Option for further mitigation	
Add French drain and manhole	$114,721
Design fee, General conditions (25%)	$28,680
Design Contingency (30%)	$34,416
Escalation (Q3 2024) (10%)	$11,472
Sub-total	**$189,289.00**
Project Contingency (20%)	$37,858
Project Estimate	**$227,147.00**

**Values above are rounded, appendix provides detailed costing breakdown*
Soft costs Permits, etc have not been included.

Risks & Constraints / Mitigation

The present pool location in proximity to the Thames River, within a flood plan will continue to be a risk, regardless of mitigations and repairs implemented. Some items may reduce the day-to-day risks; however, no preventative measure can be made to eliminate the potential flood risk and damage based on the pool and facility current location.

Option 1 noted above restores the pool back to its pre-damaged condition while providing an additional means for ground water to be removed from below the pool slab via the weeping tile (Big 'O' drain line). As water levels rise and fall, the weeping tile pipe will allow water trapped below the slab to be removed. The addition of the site well also permits operations to monitor ground water levels in order to direct when the pool tank can be drained safely.

Option 2, above takes additional measures beyond option 1 and replaces the pool return piping from below the slab, relocated to the pool walls in the lane area. This measure permits natural drainage of the lines to aid operations in winterization of the pool. Attaching the relocated pipes to the pool wall further reduces the risk of high ground water levels damaging the pipes, as they become 'part' of the pool tank.

Risk	Mitigation	Option 1	Option 2	Notes
Unknown ground water levels	Installation of a site well	INCLUDED ☑	INCLUDED ☑	Site well is a necessary monitoring measure and should be installed to provide a visual of ground water levels
Hydrostatic pressure from ground water	Relief ports in main drains	INCLUDED ☑	INCLUDED ☑	Allows water from hydrostatic pressure to be released into tank
Unknown pool tank ballast	Increase pool slab thickness	CAN BE INCORPORATED INTO THIS DESIGN ⊖	CAN BE INCORPORATED INTO THIS DESIGN ⊖	Structural engineer calculates concrete slab thickness for added ballast in pool tank to resist upward pressure from ground water
Groundwater damage to floor returns	Abandon floor returns and install wall returns	NOT INCLUDED ☒	INCLUDED ☑	Remove return piping from below the pool tank and secure them to exterior of pool walls
Pool slab deterioration	Removal of existing pool slab and remediate soils	INCLUDED ☑	INCLUDED ☑	Remove slab in lane area and replace with reinforced slab, refer to ballast
Freeze / Thaw cycle	Insulation	NOT INCLUDED ☒	INCLUDED ☑	Provide insulation around piping

Risk	Mitigation	Option 1	Option 2	Notes
Hydrostatic pressure from ground water	Utility access hole with backflow valves and drain to Thames River	NOT INCLUDED For Consideration	NOT INCLUDED For Consideration	Replaces site well and offers better control of ground water conditions
Pool Depth	With removal of slab, infill deep-end of pool	NOT INCLUDED For Consideration	NOT INCLUDED For Consideration	Reduce the depth of pool, to reduce the intrusion into the ground water level

Conclusions

There is significant damage to the under-pool floor return piping system. This was evident during the initial site meeting where a threaded rod was inserted into one of the open floor returns and sand and dirt was removed. Pressure testing of the return system would conclude a significant failure of the piping. Without excavation, there is no way to isolate and identify piping branch lines or pinpoint damaged areas.

Damage to the pool tank continues to be a concern with fractures growing as indicated in the photos above with time lapse showing the damage continuing to progress. Recent localized flooding within the greenspace adjacent to the pool further complicates repair and mitigation, as this will be a constant hazard.

Option 1 and 2 would both provide repairs and mitigation to make the pool operable again.

Option 2 provides a potentially longer-term preventative measure, by locating the return piping at a higher level secured to the exterior of the pool tank walls. This is intended to minimize damage due to freeze thaw cycles and hydrostatic pressure.

Given the large volume of the pool water to be processed and returned to the pool, there is limited wall space to provide sufficient and equal circulation along the wall. Reduction of pool volume would reduce the number of return jets and potential sizes of pipe and number of drains required. This could be achieved by reducing the size or depth of the pool. This has not been included in either option but is presented as a possible consideration in future.

Recommendations

That a site well be established at Thames Pool as soon as possible to monitor ground water levels and provide data related to site conditions and trends.

That the scope of repairs and mitigation measures identified as option 2 be undertaken.

That the optional mitigation measure of a manhole and French drain system be considered.

That an operational review of winterization procedures be undertaken with staff.

Please do not hesitate to contact us if additional information or clarification is required.

Sincerely,

Jamie Lopes, Senior Project Manager
Recreation Division, Associate
22297 Report for Thames Pool - Phase 2 - May 2023.doc

Thames Pool Repairs - Options 1 & 2				*May 18th, 2023 R3*			
Section	***Description***	***Quantity***		***Unit $***		***Total***	***Sub-Totals***
	OPTION 1:						
	1) Removal of Tank Slab:						
	drain pool water (by City)	0.00	sum	$0.00	sum	$0.00	
	sawcut existing 12" tank slab into 2m x 2m pieces	1,894.00	m	$15.75	m	$29,828.00	
	rmv conc slabs (74 pcs) - crane & men	40.00	hrs	$500.00	hrs	$20,000.00	
	disposal of concrete (294m3)	19.00	bins	$750.00	bins	$14,250.00	$64,078.00
	1a) Removal of Piping Incl Re/Re Pool Deck:						
	sawcut / remove pool deck	144.00	m2	$50.00	m2	$7,200.00	
	excavation (by hand) to expose piping	40.00	hrs	$300.00	hrs	$12,000.00	
	rmv drainage piping	16.00	hrs	$150.00	hrs	$2,400.00	
	backfill by hand (reuse extg)	24.00	hrs	$330.00	hrs	$7,920.00	
	backfill import granular b	15.00	mton	$21.00	mton	$315.00	
	form pool deck - n/a	0.00	m2	$0.00	m2	$0.00	
	drill & dowel	574.00	ea	$25.00	ea	$14,350.00	
	placing slab on grade - labour	4.00	hrs	$300.00	hrs	$1,200.00	
	placing slab on grade - pump (1)	4.00	hr	$750.00	hr	$3,000.00	
	finishing slab on grade	144.00	m2	$15.00	m2	$2,160.00	
	concrete supply - 35 Mpa C1	14.00	m3	$175.00	m3	$2,450.00	$52,995.00
	2) Excavate 1.5m Down to Piping / Rmv Piping:						
	crane lift excavation equipment in & out of pool	8.00	hrs	$500.00	hrs	$4,000.00	
	excavation - small machines & men	8.00	days	$7,500.00	days	$60,000.00	
	trucking excavated material off site	103.00	lds	$200.00	lds	$20,600.00	
	disposal costs at local dump	103.00	lds	$100.00	lds	$10,300.00	
	temporary shoring (if required) - allowance	1.00	sum	$50,000.00	sum	$50,000.00	
	rmv u/g pvc pool piping, once exposed	96.00	hrs	$100.00	hrs	$9,600.00	
	disposal bins	5.00	ea	$750.00	ea	$3,750.00	
							$158,250.00
	3) Backfill to u/s of New Tank Slab:						
	backfill pool - material granular b delivered	3,172.00	mton	$21.00	mton	$66,612.00	
	backfill pool - e/o for slinger truck	40.00	hrs	$200.00	hrs	$8,000.00	
	backfill pool - small machines & labour	40.00	hrs	$530.00	hrs	$21,200.00	
	skim slab to protect pool base (50mm) - material	49.00	m3	$125.00	m3	$6,125.00	
	skim slab to protect pool base (50mm) - labour	8.00	hrs	$300.00	hrs	$2,400.00	$104,337.00
	4) New Water Supply / Drainage Pool Piping:						
	100mm pvc piping (no excavation)	443.00	m	$100.00	m	$44,300.00	
	150mm pvc piping (no excavation)	15.00	m	$150.00	m	$2,250.00	
	200mm piping (no excavation)	28.00	m	$200.00	m	$5,600.00	
	300mm pvc piping (no excavation)	50.00	m	$300.00	m	$15,000.00	
	floor drains	4.00	ea	$2,000.00	ea	$8,000.00	
	hydrostaic relief pump	2.00	ea	$4,500.00	ea	$9,000.00	$84,150.00
	5) New Weeping Tile System / Well:						
	100mm weeping tile	219.00	m	$50.00	m	$10,950.00	
	boring under tank walls for weeping tile	1.00	sum	$2,500.00	sum	$2,500.00	
	excavate new well - small machines & men	1.00	day	$4,000.00	day	$4,000.00	
	trucking excavated material off site	18.00	lds	$200.00	lds	$3,600.00	
	disposal costs at local dump	18.00	lds	$100.00	lds	$1,800.00	
	450 hdpe pipe for well	6.00	m	$600.00	m	$3,600.00	
	backfill material granular b	649.00	tons	$21.00	tons	$13,629.00	
	backfill well - small machines & labour	16.00	hrs	$440.00	hrs	$7,040.00	
	sump pump (mobile) - not included	0.00	ea	$0.00	ea	$0.00	$47,119.00

Thames Pool Repairs - Options 1 & 2				*May 18th, 2023 R3*			
Section	**Description**	**Quantity**		**Unit $**		**Total**	**Sub-Totals**
	OPTION 1:						
	6) New Tank Slab:						
	drill & dowel into extg slab - 300mm o/c	454.00	ea	$25.00	ea	$11,350.00	
	reinforcing steel - 10M @ 200 tbew	15.00	mton	$2,900.00	mton	$43,500.00	
	form slab on grade - n/a	0.00	m2	$0.00	m2	$0.00	
	placing slab on grade - labour	304.00	m3	$55.00	m3	$16,720.00	
	placing slab on grade - pumps (2)	8.00	hr	$750.00	hr	$6,000.00	
	finishing slab on grade	947.00	m2	$12.00	m2	$11,364.00	
	concrete supply - 35 Mpa C1	304.00	m3	$175.00	m3	$53,200.00	$142,134.00
	7) Tank Repairs / Finishes:						
	hydro blast tank wall and beach area	1,875.00	m2	$90.00	m2	$168,750.00	
	repair damaged cracks - allowance	1.00	sum	$40,000.00	sum	$40,000.00	
	parge & paint tank	1,875.00	m2	$50.00	m2	$93,750.00	
	floor drains - supply	4.00	ea	$1,000.00	ea	$4,000.00	
	floor jets - supply	72.00	ea	$50.00	ea	$3,600.00	
	install drains & jets	16.00	hrs	$250.00	hrs	$4,000.00	
	cost of water to fill pool - not included (by City)	0.00	m3	$0.00	m3	$0.00	$314,100.00
						$967,163.00	$967,163.00
	Contractor General Conditions & fee	25.00%				$241,791.00	
	Design Contingency	30.00%				$290,149.00	
	Escalation (Q3 2024)	10.00%				$96,716.00	
						$1,595,819.00	
	Contingency	20.00%				$319,164.00	
						$1,914,983.00	
	Pool Size 50m x 21m + Beach 21m x 25m					15,930.00	sft
	Cost per square foot					$120.21	

Thames Pool Repairs - Options 1 & 2				May 18th, 2023 R3			
Section	**Description**	**Quantity**		**Unit $**		**Total**	**Sub-Totals**
	OPTION 2:						
	1) Removal of Tank Slab:						
	drain pool water (by City)	0.00	sum	$0.00	sum	$0.00	
	sawcut existing 12" tank slab into 2m x 2m pieces	1,894.00	m	$15.75	m	$29,828.00	
	rmv conc slabs (74 pcs) - crane & men	40.00	hrs	$500.00	hrs	$20,000.00	
	disposal of concrete (294m3)	19.00	bins	$750.00	bins	$14,250.00	$64,078.00
	1a) Removal of Piping Incl Re/Re Pool Deck:						
	sawcut / remove pool deck	144.00	m2	$50.00	m2	$7,200.00	
	excavation (by hand & small machine) to expose piping	40.00	hrs	$450.00	hrs	$18,000.00	
	trucking excavated material off site	79.00	lds	$200.00	lds	$15,800.00	
	disposal costs at local dump	79.00	lds	$100.00	lds	$7,900.00	
	rmv drainage piping	16.00	hrs	$150.00	hrs	$2,400.00	
	backfill by hand & small equipment	40.00	hrs	$510.00	hrs	$20,400.00	
	backfill import granular b	1,732.00	mton	$21.00	mton	$36,372.00	
	form pool deck	84.00	m2	$100.00	m2	$8,400.00	
	drill & dowel	930.00	ea	$25.00	ea	$23,250.00	
	placing slab on grade - labour	16.00	hrs	$300.00	hrs	$4,800.00	
	placing slab on grade - pump (1)	6.00	hr	$750.00	hr	$4,500.00	
	finishing slab on grade	651.00	m2	$15.00	m2	$9,765.00	
	concrete supply - 35 Mpa C1	65.00	m3	$175.00	m3	$11,375.00	
	deck floor drains - supply	10.00	ea	$250.00	ea	$2,500.00	
	deck floor drains - connect	10.00	ea	$100.00	ea	$1,000.00	$173,662.00
	2) Excavate 1.5m Down to Piping / Rmv Piping:						
	crane lift excavation equipment in & out of pool	8.00	hrs	$500.00	hrs	$4,000.00	
	excavation - small machines & men	8.00	days	$7,500.00	days	$60,000.00	
	trucking excavated material off site	103.00	lds	$200.00	lds	$20,600.00	
	disposal costs at local dump	103.00	lds	$100.00	lds	$10,300.00	
	temporary shoring (if required) - allowance	1.00	sum	$50,000.00	sum	$50,000.00	
	rmv u/g pvc pool piping, once exposed	64.00	hrs	$100.00	hrs	$6,400.00	
	disposal bins	2.00	ea	$750.00	ea	$1,500.00	$152,800.00
	3) Backfill to u/s of New Tank Slab:						
	backfill pool - material granular b delivered	3,172.00	mton	$21.00	mton	$66,612.00	
	backfill pool - e/o for slinger truck	40.00	hrs	$200.00	hrs	$8,000.00	
	backfill pool - small machines & labour	40.00	hrs	$530.00	hrs	$21,200.00	
	skim slab to protect pool base (50mm) - material	49.00	m3	$125.00	m3	$6,125.00	
	skim slab to protect pool base (50mm) - labour	8.00	hrs	$300.00	hrs	$2,400.00	$104,337.00
	4) New Water Supply / Drainage Pool Piping:						
	100mm pvc piping (no excavation)	87.00	m	$100.00	m	$8,700.00	
	150mm pvc piping (no excavation)	0.00	m	$150.00	m	$0.00	
	200mm piping (no excavation)	210.00	m	$200.00	m	$42,000.00	
	300mm pvc piping (no excavation)	66.00	m	$300.00	m	$19,800.00	
	floor drains	4.00	ea	$2,000.00	ea	$8,000.00	
	hydrostaic relief pump	2.00	ea	$4,500.00	ea	$9,000.00	
	core drill holes in tank walls for new jets	72.00	ea	$350.00	ea	$25,200.00	$112,700.00

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Thames Pool Repairs - Options 1 & 2 — ***May 18th, 2023 R3***

Section	Description	Quantity		Unit $		Total	Sub-Totals
	OPTION 2:						
	5) New Weeping Tile System / Well:						
	100mm weeping tile	332.00	m	$50.00	m	$16,600.00	
	boring under tank walls for weeping tile	1.00	sum	$2,500.00	sum	$2,500.00	
	excavate new well - small machines & men	1.00	day	$4,000.00	day	$4,000.00	
	trucking excavated material off site	18.00	lds	$200.00	lds	$3,600.00	
	disposal costs at local dump	18.00	lds	$100.00	lds	$1,800.00	
	450 hdpe pipe for well	6.00	m	$600.00	m	$3,600.00	
	backfill material granular b	649.00	tons	$21.00	tons	$13,629.00	
	backfill well - small machines & labour	32.00	hrs	$440.00	hrs	$14,080.00	
	sump pump (mobile) - not included	0.00	ea	$0.00	ea	$0.00	$59,809.00
	6) New Tank Slab:						
	drill & dowel into extg slab - 300mm o/c	454.00	ea	$25.00	ea	$11,350.00	
	reinforcing steel - 10M @ 200 tbew	15.00	mton	$2,900.00	mton	$43,500.00	
	form slab on grade - n/a	0.00	m2	$0.00	m2	$0.00	
	placing slab on grade - labour	304.00	m3	$55.00	m3	$16,720.00	
	placing slab on grade - pumps (2)	10.00	hr	$750.00	hr	$7,500.00	
	finishing slab on grade	947.00	m2	$12.00	m2	$11,364.00	
	concrete supply - 35 Mpa C1	304.00	m3	$175.00	m3	$53,200.00	$143,634.00
	7) Tank Repairs / Finishes:						
	hydro blast tank wall and beach area	1,875.00	m2	$90.00	m2	$168,750.00	
	repair damaged cracks - allowance	1.00	sum	$40,000.00	sum	$40,000.00	
	parge & paint tank	1,875.00	m2	$50.00	m2	$93,750.00	
	floor drains - supply	4.00	ea	$1,000.00	ea	$4,000.00	
	wall jets - supply	72.00	ea	$50.00	ea	$3,600.00	
	install drains & jets	16.00	hrs	$250.00	hrs	$4,000.00	
	cost of water to fill pool - not included (by City)	0.00	m3	$0.00	m3	$0.00	$314,100.00
						$1,125,120.00	***$1,125,120.00***
	Contractor General Conditions & fee	25.00%				$281,280.00	
	Design Contingency	30.00%				$337,536.00	
	Escalation (Q3 2024)	10.00%				$112,512.00	
						$1,856,448.00	
	Contingency	20.00%				$371,290.00	
						$2,227,738.00	
	Pool Size 50m x 21m + Beach 21m x 25m					15,930.00	sft
	Cost per square foot					$139.85	

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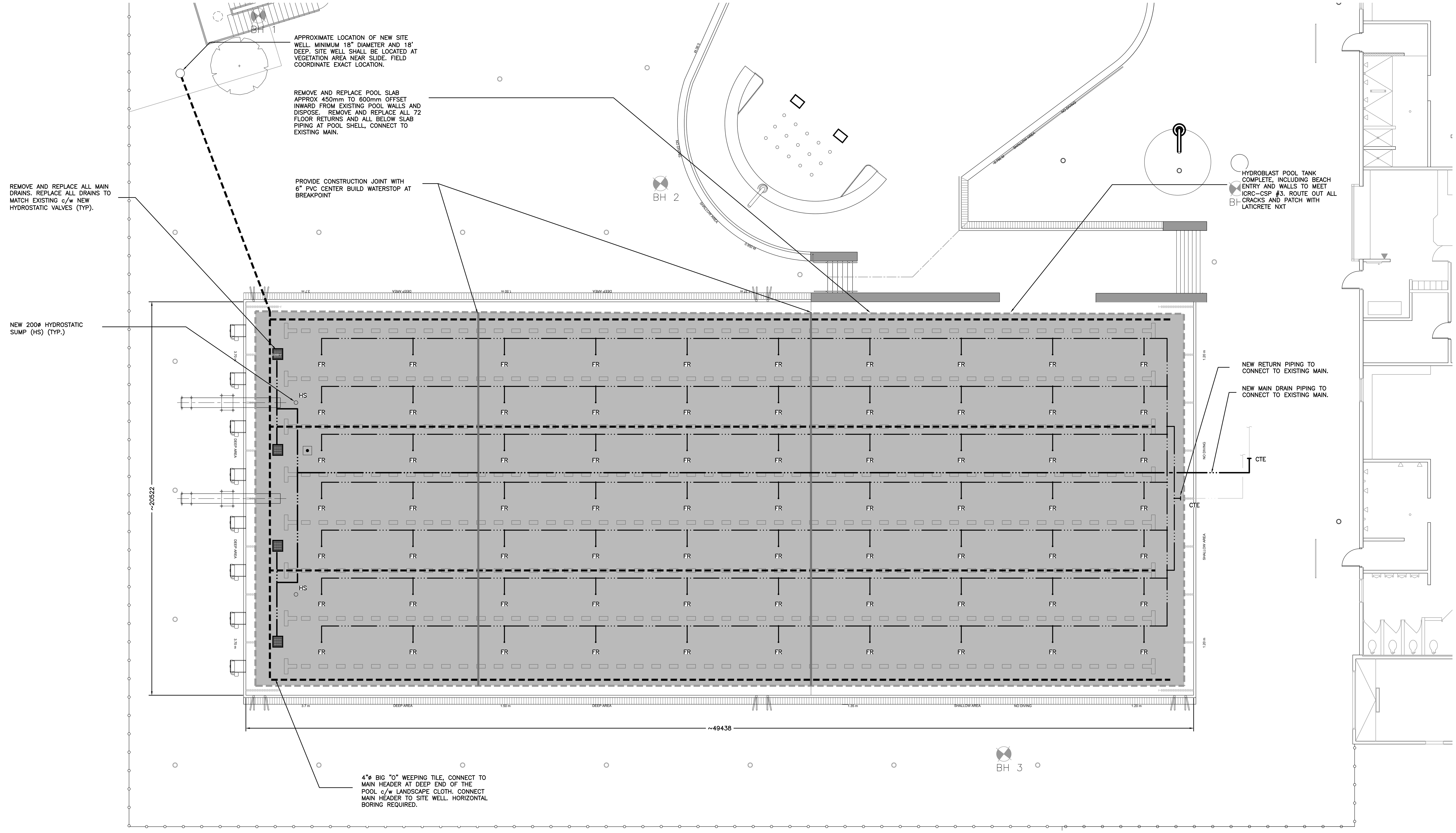
Thames Pool Repairs - Options 1 & 2				May 18th, 2023 R3			
Section	**Description**	**Quantity**		**Unit $**		**Total**	**Sub-Totals**
	SEPARATE PRICE (Not Included in Options 1 or 2):						
	1) MH in lieu of Well w/ 65m French Drain to River:						
	precast manhole, 2.4m dia.x 6m deep	1.00	ea	$35,000.00	ea	$35,000.00	
	delete 450 HDPE pipe well	-1.00	sum	$40,709.00	sum	-$40,709.00	
	tree / shrub removal	1.00	sum	$10,000.00	sum	$10,000.00	
	excavate 2m x 2m french drain	390.00	m3	$45.00	m3	$17,550.00	
	disposal of excavated material off site	390.00	m3	$15.00	m3	$5,850.00	
	piping from MH to river	65.00	m	$150.00	m	$9,750.00	
	filter cloth	598.00	m2	$25.00	m2	$14,950.00	
	backfill clear stone	858.00	tons	$60.00	tons	$51,480.00	
	gabion stone at rivers edge	1.00	sum	$5,000.00	sum	$5,000.00	
	restoration - sod / topsoil	195.00	m2	$30.00	m2	$5,850.00	
	sump pump (mobile) - not included	0.00	ea	$0.00	ea	$0.00	$114,721.00
						$114,721.00	
	Contractor General Conditions & fee	25.00%				$28,680.00	
	Design Contingency	30.00%				$34,416.00	
	Escalation (Q3 2024)	10.00%				$11,472.00	
						$189,289.00	
	Contingency	20.00%				$37,858.00	
						$227,147.00	

Ingersoll & associates inc.



POOL LAYOUT – OPTION 1
SCALE: 1:100

PRELIMINARY
15 MAY 2023

ISSUANCES

No	DATE YY.MM.DD	DESCRIPTION	BY
1	YY.MM.DD	ISSUED FOR REVIEW	XX

Seal

North Project North True North

RENOVATION ......

THAMES PARK POOL ASSESSMENT

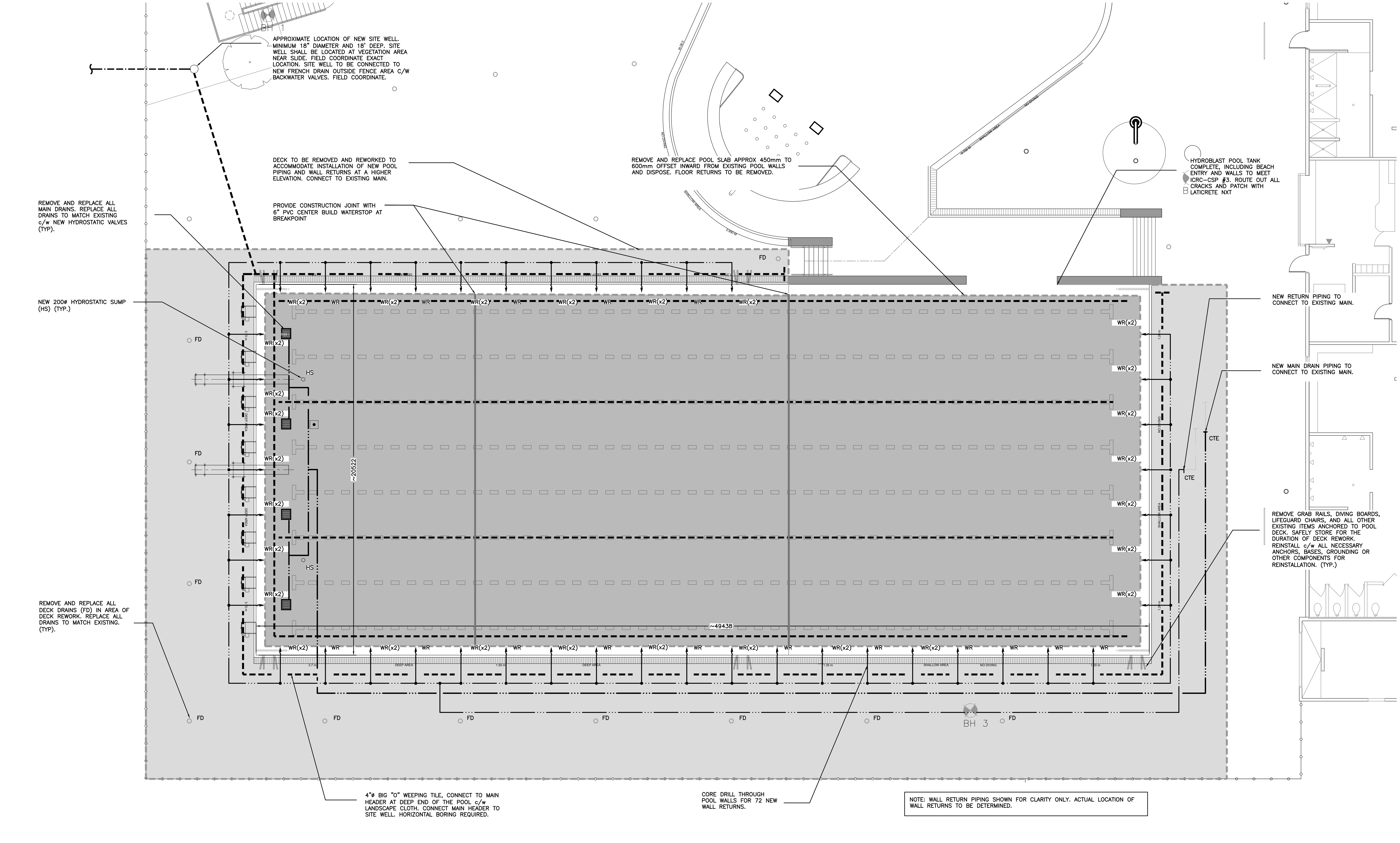
1891 Wharncliffe Road South, London, ON

Sheet Title

THAMES POOL REPAIR OPTION 1

AQUATIC DESIGN & ENGINEERING
Pool, Waterpark & Natatorium Systems Design
A division of DEI & Associates Inc.
55 Northland Road, Waterloo, ON N2V 1Y8
Phone: 519-725-3555
Email: dei@deiassociates.ca Website: deiassociates.ca

Drawn by	Checked by	Approved by
ZT	JL	JL
Scale	Project Date	Print Date
AS NOTED	AUG 2022	
Project No.	Drawing No.	
22297	ASK-1	



POOL LAYOUT – OPTION 2

SCALE: 1:100

PRELIMINARY
15 MAY 2023

The contractor shall verify all dimensions and report all errors and discrepancies to the Consultant before commencement of the work.
The drawings show general arrangement of services. Follow as closely as actual building construction will permit. Obtain approval for relocation of service from Consultant before commencement of the work.
The drawings do not indicate all offsets fitting and accessories which may be required. Provide the same to meet the required conditions.
Drawings and specifications, etc., prepared and issued by the consultant are the property of the consultant and must be returned at the completion of the project. These documents are not to be duplicated or copied without the consent of the Consultant.
Do not scale this drawing.

ISSUANCES

No	DATE YY.MM.DD	DESCRIPTION	BY
1	YY.MM.DD	ISSUED FOR REVIEW	XX

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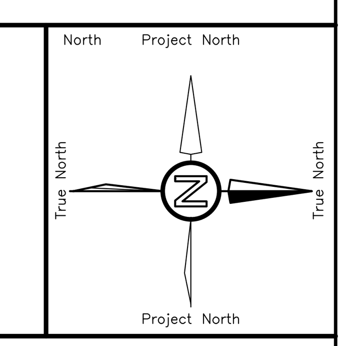

RENOVATION ......

THAMES PARK POOL ASSESSMENT

1891 Wharncliffe Road South, London, ON

Sheet Title

THAMES POOL REPAIR OPTION 2

AQUATIC DESIGN & ENGINEERING
Pool, Waterpark & Natatorium Systems Design
A division of DEI & Associates Inc.
55 Northland Road, Waterloo, ON N2V 1Y8
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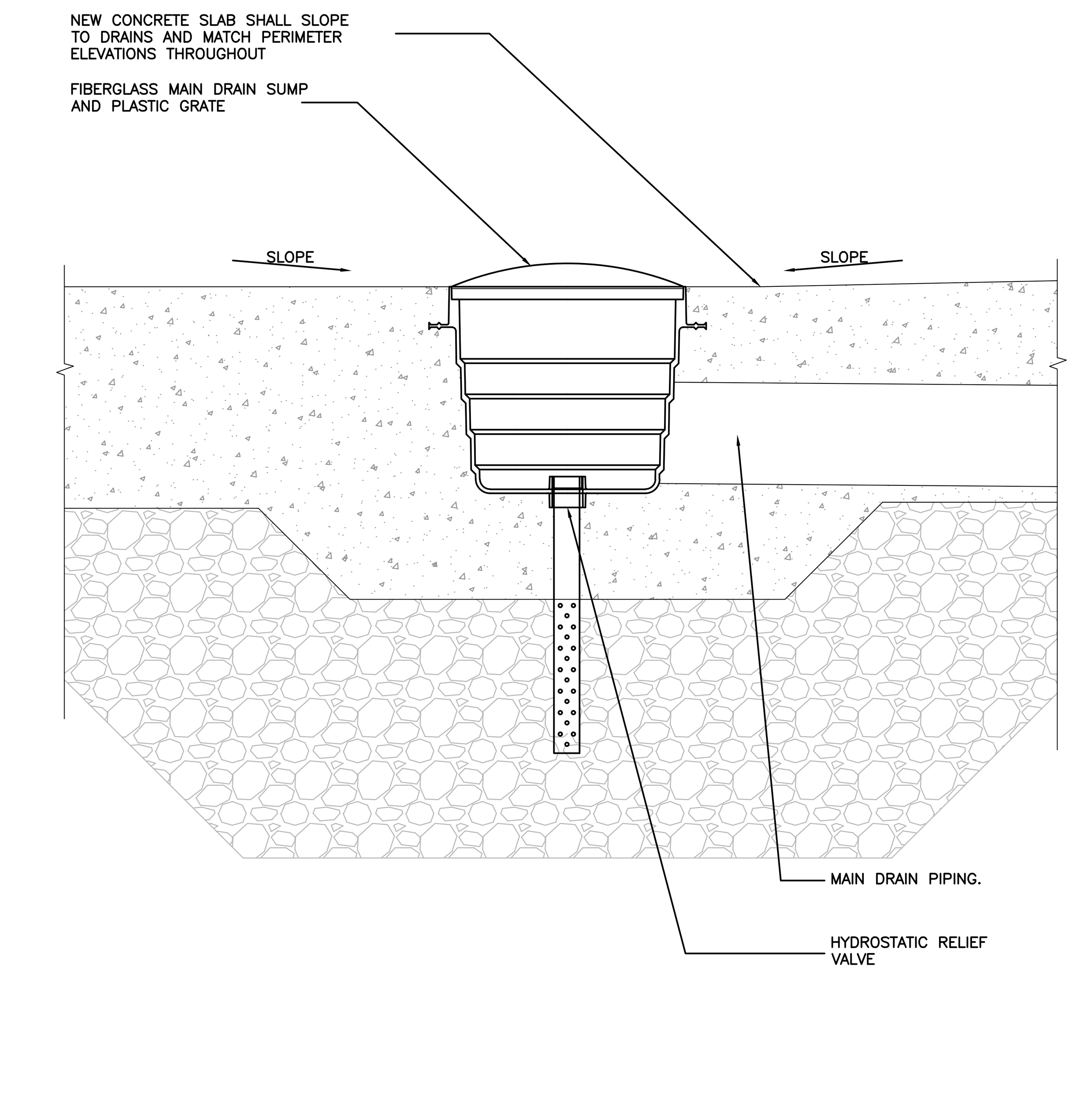
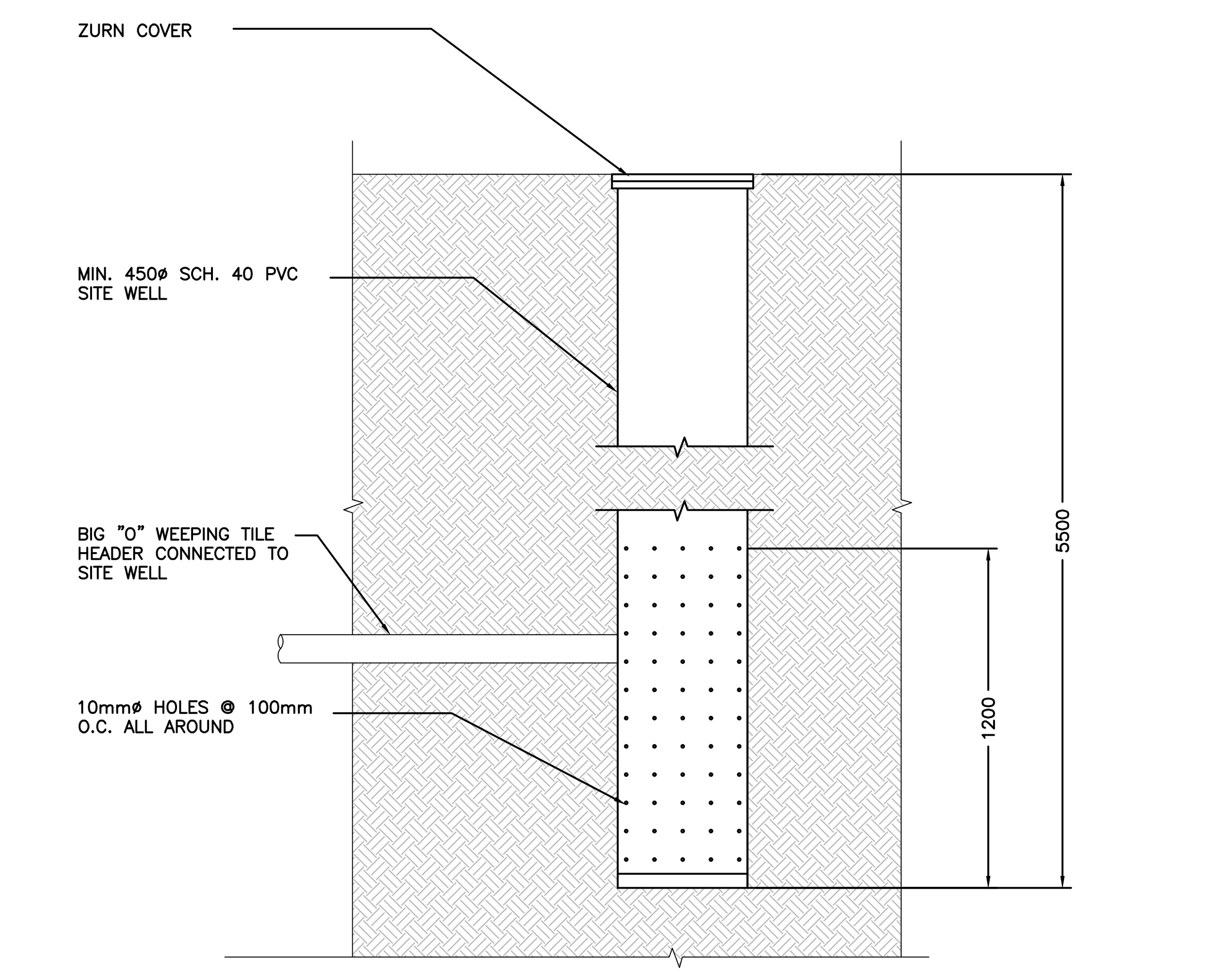
Email: dei@deiassociates.ca Website: deiassociates.ca

Drawn by	Checked by	Approved by
ZT	JL	JL
Scale	Project Date	Print Date
AS NOTED	AUG 2022	

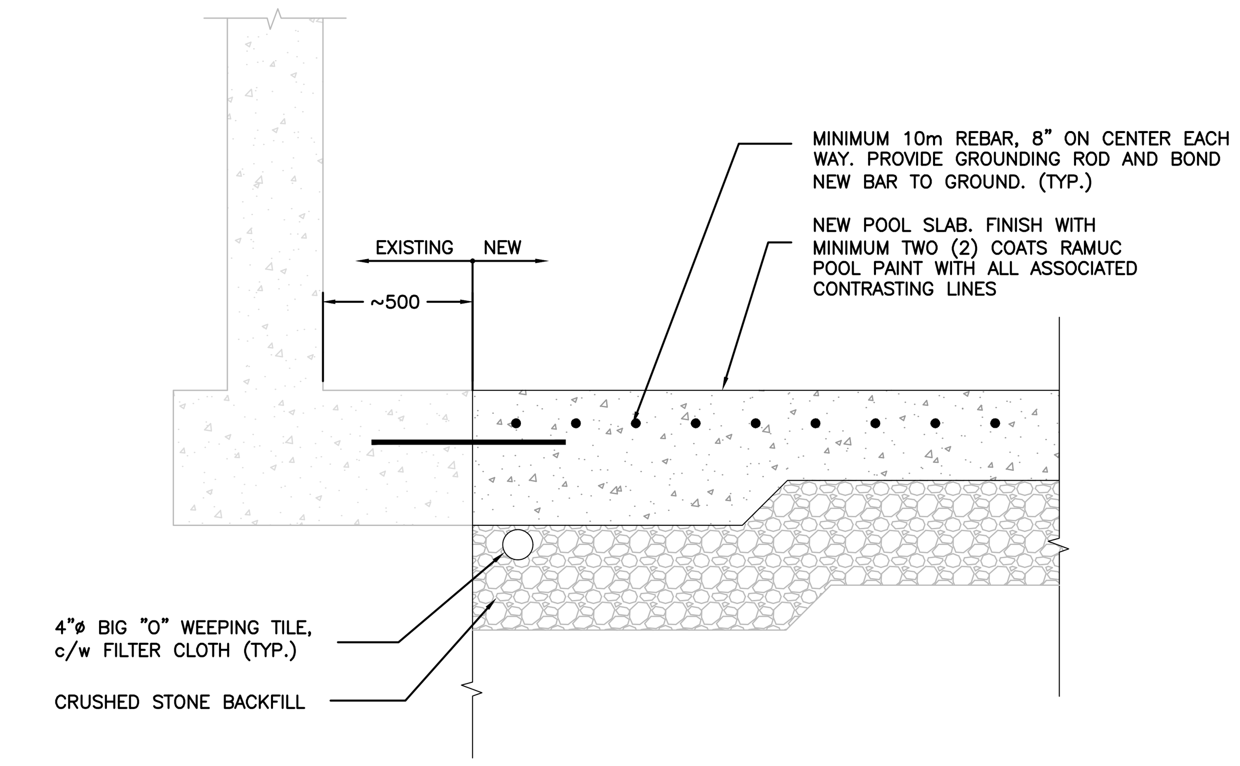
Project No.	Drawing No.
22297	ASK-2



TYPICAL 457x457 (18x18) MAIN DRAIN DETAIL



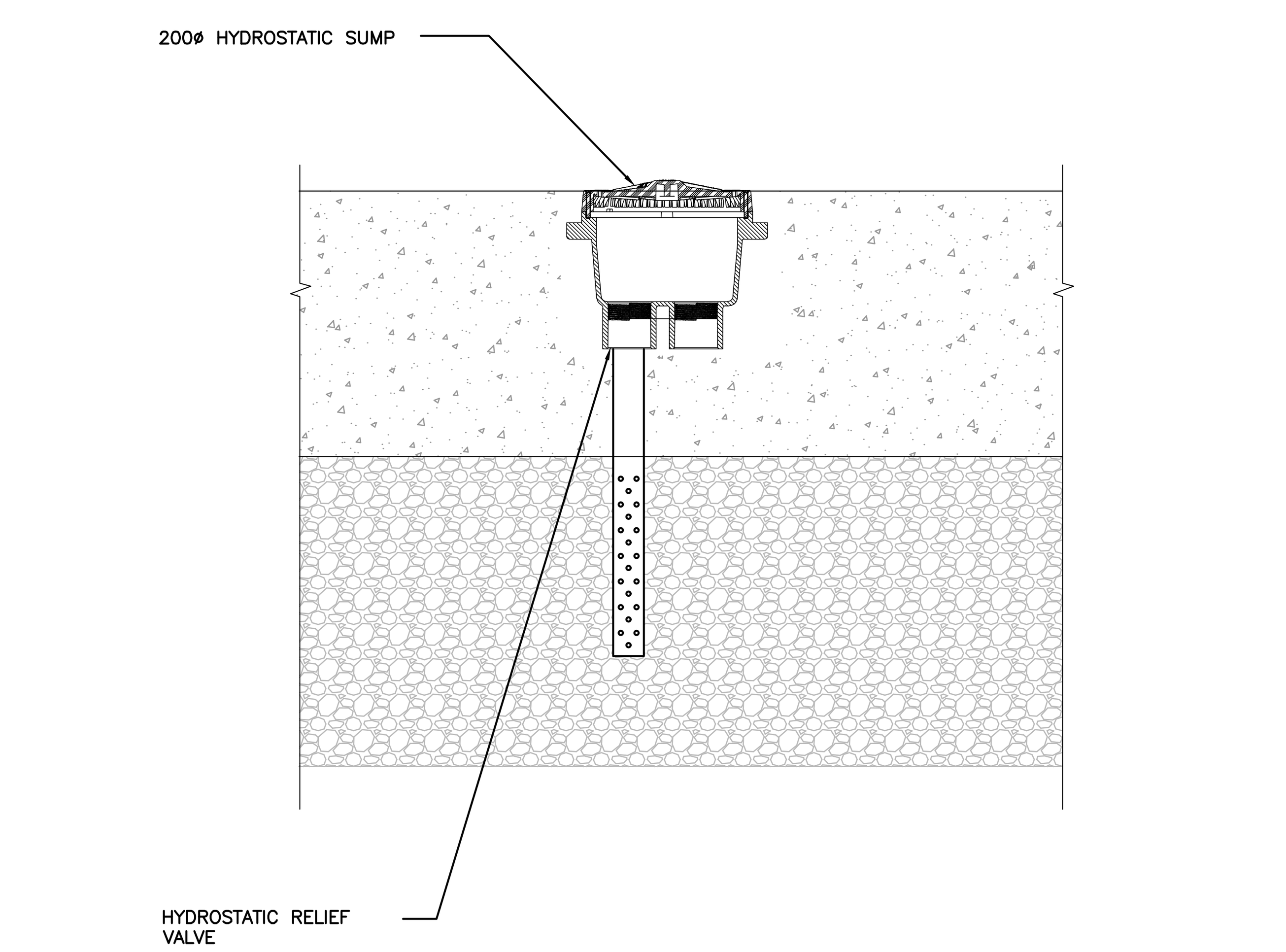
SITE WELL DETAIL



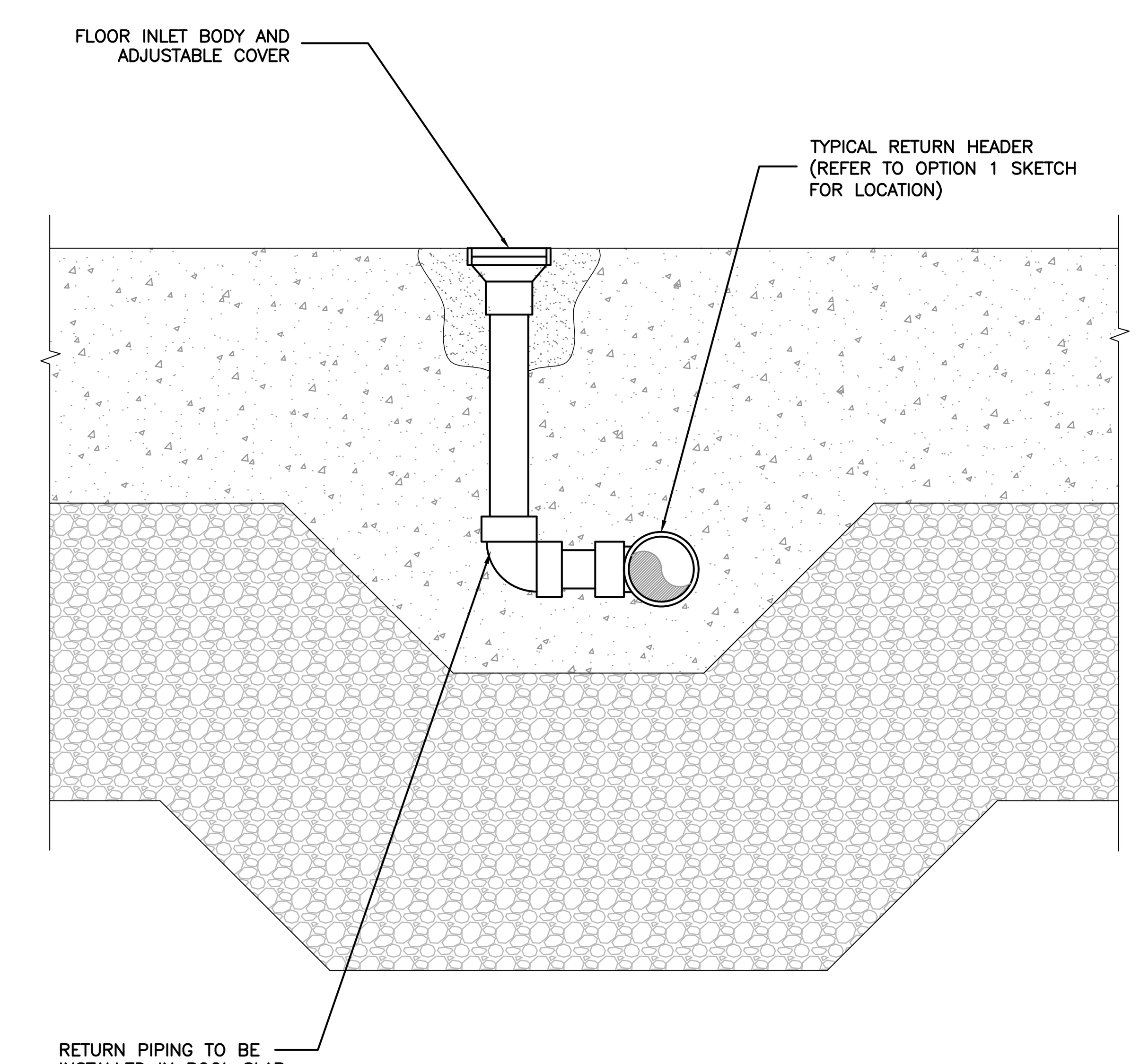
TYPICAL POOL CROSS-SECTION

AQUATIC EQUIPMENT SCHEDULE

Item	Description	Manufacturer	Product / Model	Qty
1	18x18 (457x457) PVC SUPER SUMP c/w DOMED FRAME AND GRATES, 183.06 SQ.IN. OF OPEN AREA PER DRAIN, 8"ø SIDE PORT AND 2"ø BOTTOM PORT CONNECTIONS, VGBA COMPLIANT, COLOUR: WHITE	LAWSON AQUATICS	MLD-SG-1818-WT	4
2	ADJUSTABLE FLOOR RETURN FITTINGS, 2" SLIP WITH 1-1/2" SLIP BUSHING, WHITE	STA-RITE	08417-0000	72
3	HYDROSTATIC SUMP, STARGUARD 8" MAIN DRAIN, DUAL BOT PORTS ABS SUMP w/ RING AND COVER WHT 2PK	PENTAIR	500120	2
4	HYDROSTATIC RELIEF VALVE, 1-1/2" MIP, SPRING LOADED	HAYWARD	SP-1056	6
5	HYDROSTATIC COLLECTION TUBE, 1-1/2" / 2" FIP, 300mm LONG, SLOTTED	HAYWARD	SP-1055	6



TYPICAL 200ø HYDROSTATIC SUMP DETAIL



TYPICAL FLOOR RETURN (FR) DETAIL

PRELIMINARY
15 MAY 2023

ISSUANCES

No	DATE YY.MM.DD	DESCRIPTION	BY
1	YY.MM.DD	ISSUED FOR REVIEW	XX

Seal

North Project North
True North
True North
Project North

RENOVATION ......

THAMES PARK POOL ASSESSMENT

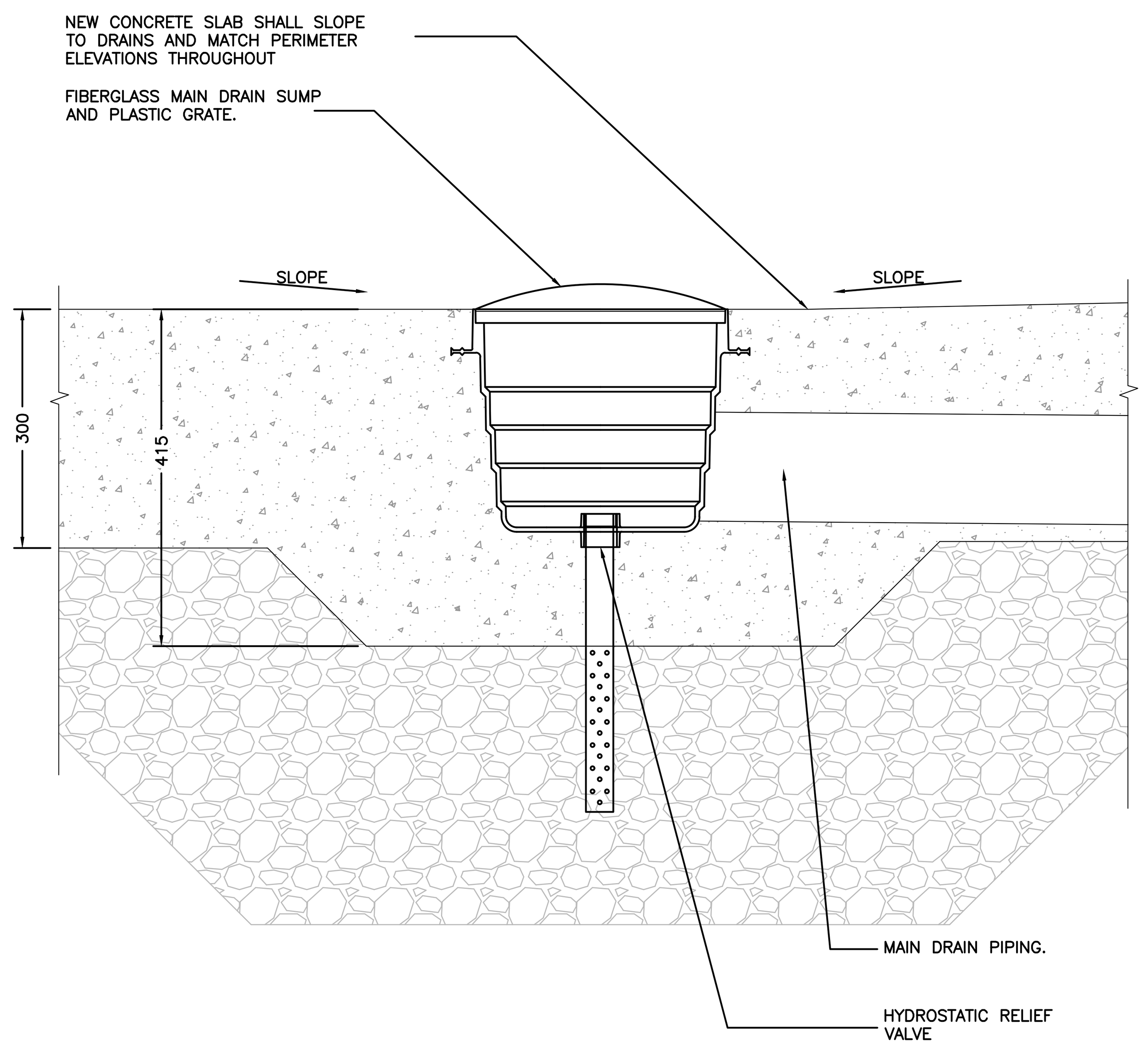
1891 Wharncliffe Road South, London, ON

Sheet Title

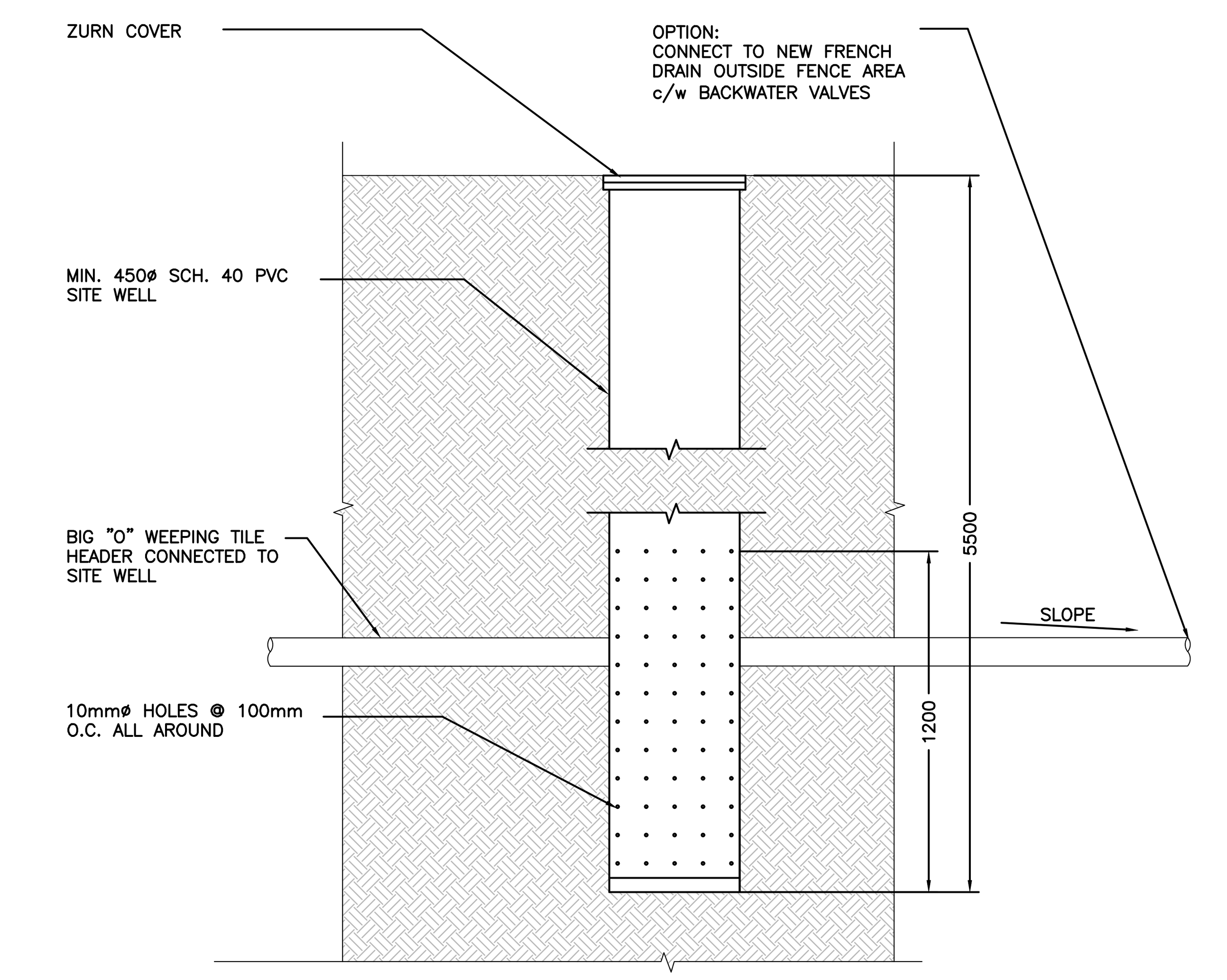
OPTION 1 DETAILS AND SCHEDULE

AQUATIC DESIGN & ENGINEERING
Pool, Waterpark & Natatorium Systems Design
A division of DEI & Associates Inc.
55 Northland Road, Waterloo, ON N2V 1Y8
Phone: 519-725-3555
Email: dei@deiassociates.ca Website: deiassociates.ca

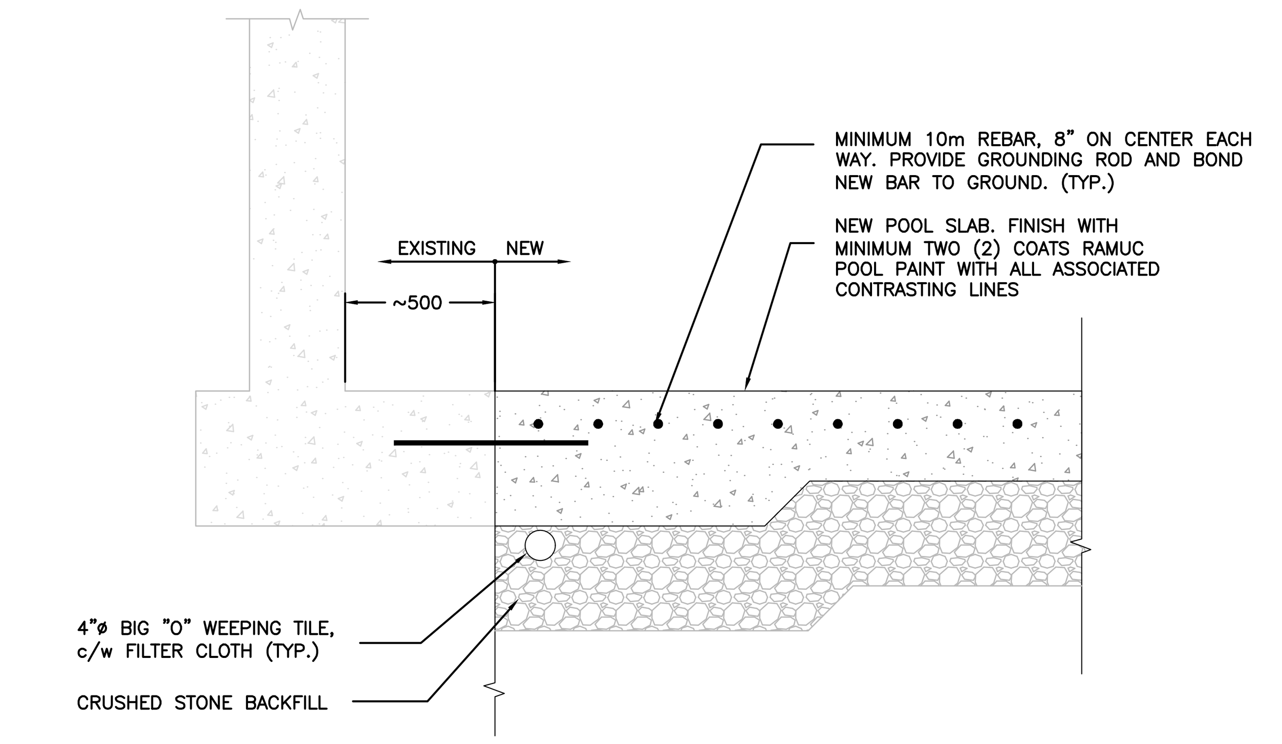
Drawn by	Checked by	Approved by
ZT	JL	JL
Scale	Project Date	Print Date
AS NOTED	AUG 2022	
Project No.	Drawing No.	
22297	ASK-3	



TYPICAL 457x457 (18x18) MAIN DRAIN DETAIL



SITE WELL DETAIL

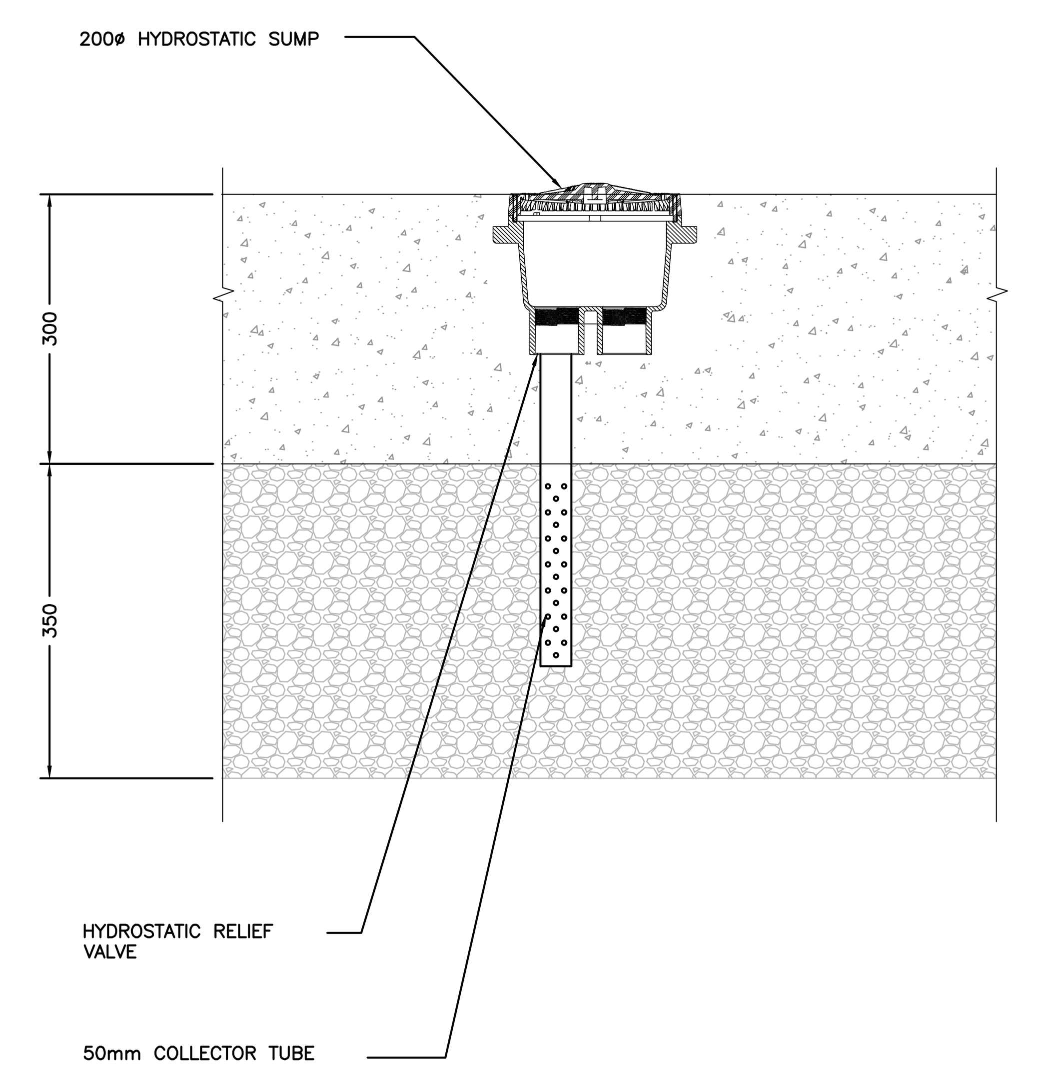


TYPICAL POOL CROSS-SECTION

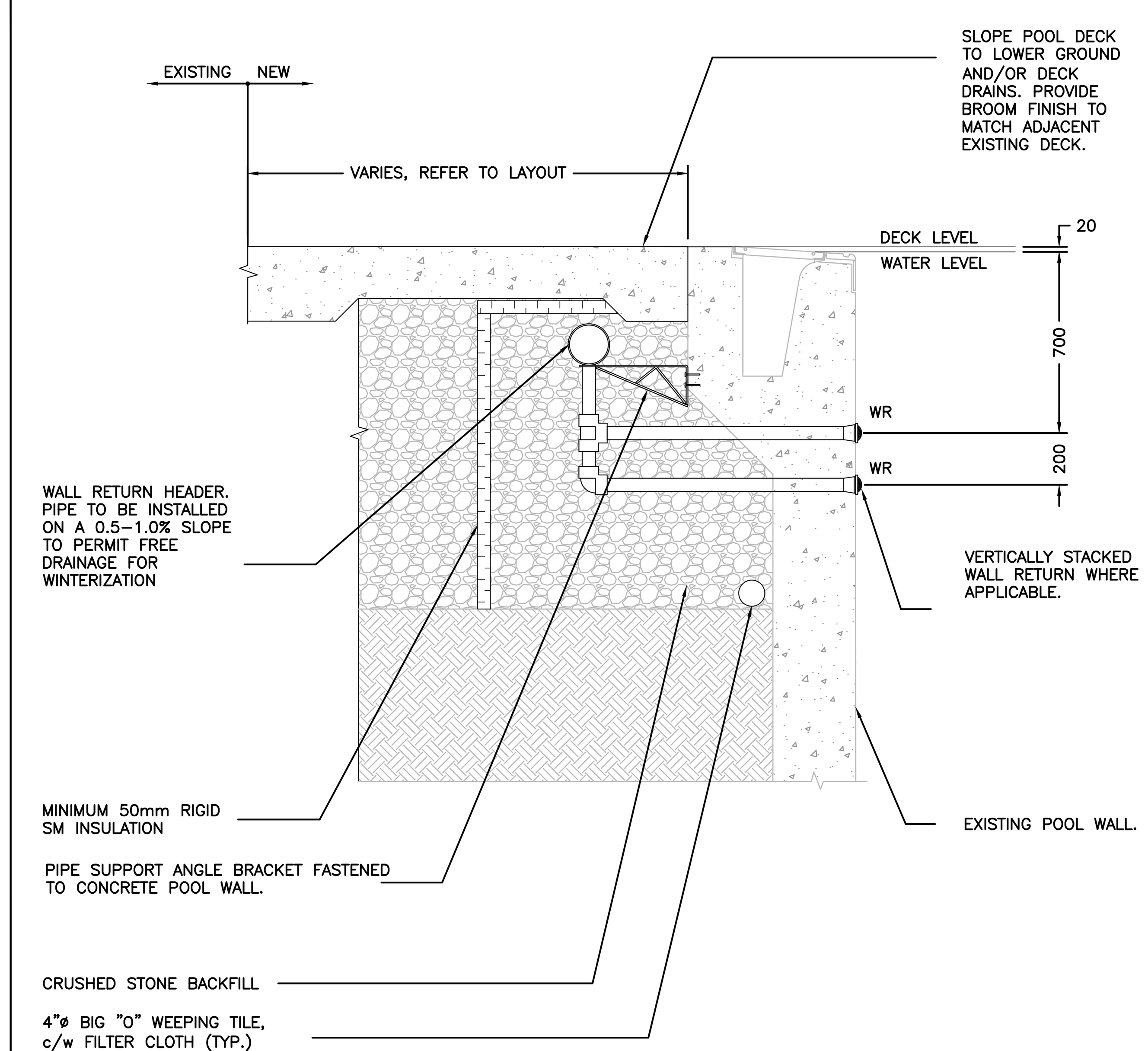
AQUATIC EQUIPMENT SCHEDULE

Item	Description	Manufacturer	Product / Model	Qty
1	18x18 (457x457) PVC SUPER SUMP c/w DOMED FRAME AND GRATES, 183.06 SQ.IN. OF OPEN AREA PER DRAIN, 8"ø SIDE PORT AND 2"ø BOTTOM PORT CONNECTIONS, VGBA COMPLIANT, COLOUR: WHITE	LAWSON AQUATICS	MLD-SG-1818-WT	4
2	ADJUSTABLE WALL RETURN FITTINGS, 1-1/2" SLIP, 3/16", 3/4" IN 90 DEGREE NOZZLE - WHITE	STA-RITE	08429-0000	72
3	HYDROSTATIC SUMP, STARGUARD 8" MAIN DRAIN, DUAL BOT PORTS ABS SUMP w/ RING AND COVER WHT 2PK	PENTAIR	500120	2
4	HYDROSTATIC RELIEF VALVE, 1-1/2" MIP, SPRING LOADED	HAYWARD	SP-1056	6
5	HYDROSTATIC COLLECTION TUBE, 1-1/2" / 2" FIP, 300mm LONG, SLOTTED	HAYWARD	SP-1055	6

PRELIMINARY
15 MAY 2023



TYPICAL 200ø HYDROSTATIC SUMP DETAIL



TYPICAL POOL WALL AND DECK DETAIL

ISSUANCES

No	DATE YY.MM.DD	DESCRIPTION	BY
1	YY.MM.DD	ISSUED FOR REVIEW	XX

Seal

North Project North True North True North Project North

RENOVATION ......

THAMES PARK POOL ASSESSMENT

1891 Wharncliffe Road South, London, ON

Sheet Title

OPTION 2 DETAILS AND SCHEDULE

AQUATIC DESIGN & ENGINEERING
Pool, Waterpark & Natatorium Systems Design
A division of DEI & Associates Inc.
55 Northland Road, Waterloo, ON N2V 1Y8
Phone: 519-725-3555
Email: dei@deiassociates.ca Website: deiassociates.ca

Drawn by	Checked by	Approved by
ZT	JL	JL
Scale	Project Date	Print Date
AS NOTED	AUG 2022	
Project No.	Drawing No.	
22297	ASK-4	

Appendix C: UTRCA Pre-Consultation Comments

Appendix C

UPPER THAMES RIVER
CONSERVATION AUTHORITY

Thames
Canadian Heritage River

"Inspiring a Healthy Environment"

June 5, 2023

The Corporation of the City of London
663 Bathurst Street
London, Ontario
N5Z 1P8

Attention: Ashley Howard, City of London (via email – ahoward@london.ca)

Re: UTRCA Pre-Consultation Comments
Thames Park Community Pool – Proposed Repairs
15 Ridout Street South
City of London

BACKGROUND:

The Upper Thames River Conservation Authority (UTRCA) has been in discussion with staff from the City of London regarding potential repairs to the Thames Park Community Pool, located at 15 Ridout Street South in the City of London.

It is our understanding that since reconstruction in 2010, the Thames Park Community Pool has experienced significant damages due to surface water flooding, compounded by hydrostatic pressures from high groundwater levels. As a result, the pool is in need of significant repairs in order to re-open for public use. City staff are compiling a report to bring to City Council, which will explore the feasibility of various options for the facility, including permit requirements from the UTRCA.

Based on conversations with City of London staff, it is our understanding that the following repairs may be needed:

- Removal and replacement of pool base;
- Replacement and relocation of pool plumbing;
- Below-grade drainage improvements;
- Installation of hydrostatic valves;
- Installation of groundwater monitoring wells;

The City has pre-consulted with the UTRCA to determine application requirements and considerations through the Section 28 permit process. Although we can provide information based on the current proposal, the full details and extent of the repairs is to be confirmed at a later date after review by a qualified professional.

CONSERVATION AUTHORITIES ACT:
Section 28 Regulations – Ontario Regulation 157/06

As shown on the enclosed mapping, the subject lands are regulated by the UTRCA in accordance with Ontario Regulation 157/06, made pursuant to Section 28 of the *Conservation Authorities Act*.

The regulation limit is comprised of riverine flooding and erosion hazards associated with the South Thames River.

The UTRCA has jurisdiction over lands within the regulated area and requires that landowners obtain written approval from the Authority prior to undertaking any site alteration or development within this area including filling, grading, construction, alteration to a watercourse and/or interference with a wetland.

The current location of the pool is subject to significant flood risk. Wherever possible, the UTRCA directs development away from hazard lands in order to protect life and property from flooding and erosion. With this in mind, the UTRCA recommends that the City thoroughly explore oppourtunities to decommission and/or relocate the pool to a location outside of hazard lands in order to protect the public and prevent costly maintenance and repairs in the future.

However, since the Thames Pool is existing infrastructure within the floodplain, UTRCA policies would allow for the proposed reconstruction and/or repairs, subject to UTRCA permit requirements.

Depending on the final scope of work being proposed, the UTRCA may require the following as part of a complete permit application submission:

- A completed Conservation Authorities Section 28 permit application, available on our website at: http://thamesriver.on.ca/wp-content/uploads/PlanningRegulations/application_for_consent.pdf
- The associated permit review fee (to be confirmed based on final proposal). The 2023 UTRCA fee schedule is available on our website at: https://thamesriver.on.ca/wp-content/uploads/UTRCA2023-section-28-permit-fees.pdf
- Site plan and construction drawings, including cross-sections;
- Grading plans;
- Floodproofing details, to the extent possible, prepared by a qualified professional;
- Sediment and erosion control plans;
- Contingency plans; and,
- Details on any fill to be imported or exported from the site.

Should the City decide to pursue the proposed works, please contact a regulations officer at the UTRCA to confirm the above-noted permit requirements prior to preparing an application submission.

SUMMARY:

In closing, UTRCA policies would accommodate the currently proposed repairs to the Thames Pool through our permit process, as described by City of London staff through pre-consultation discussions. However, we would like to reiterate that the current location of the pool is subject to significant flood risk. As such, the UTRCA **strongly recommends** that the City explore options to decommission and/or relocate the pool to a location outside of the floodplain.

As indicated, the subject lands are regulated by the UTRCA due to the presence of riverine flooding and erosion hazards associated with the South Thames River. Prior to establishing any form of new development or site alteration on these lands within the regulated area (including filling, grading, construction and/or alteration to a watercourse), we remind the City to contact UTRCA staff as a Section 28 permit will be required.

We look forward to supporting the City on the preferred alternative for the facility. If you have any questions regarding this information or would like to proceed with submitting a complete application package, please contact the undersigned.

Yours truly,
UPPER THAMES RIVER CONSERVATION AUTHORITY

Michael Funk
Land Use Regulations Officer

Enclosure: Regulation Limit mapping (please print on legal size paper to ensure accurate scales)

c.c. - Lynda Stewart, City of London (via email – lstewart@london.ca)
- Jessica Schnaithmann, UTRCA (via email – schnaithmannj@thamesriver.on.ca)
- Jenna Allain, UTRCA (via email – allainj@thamesriver.on.ca)

Regulated Areas

Regulation under s.28 of the *Conservation Authorities Act*

Development, interference with wetlands, and alterations to shorelines and watercourses. O.Reg 157/06, 97/04.

Legend

- UTRCA Watershed (2017 LiDAR)
- Assessment Parcel (MPAC)
- Watercourse (UTRCA)
  - Open
  - Tiled
- Regulated Wetland
- Flooding Hazard Limit
- Erosion Hazard Limit
- Regulation Limit 2021

The mapping is for information screening purposes only, and shows the approximate regulation limits. The text of Ontario Regulation 157/06 supersedes the mapping as represented by this data layer. This mapping is subject to change. A site specific determination may be made by the UTRCA.

This layer is the approximate limit for areas regulated under Ontario Regulation 157/06 - Upper Thames River Conservation Authority: Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, which came into effect May 4, 2006.

The UTRCA disclaims explicitly any warranty, representation or guarantee as to the content, sequence, accuracy, timeliness, fitness for a particular purpose, merchantability or completeness of any of the data depicted and provided herein.

The UTRCA assumes no liability for any errors, omissions or inaccuracies in the information provided herein and further assumes no liability for any decisions made or actions taken or not taken by any person in reliance upon the information and data furnished hereunder.

This map is not a substitute for professional advice. Please contact UTRCA staff for any changes, updates and amendments to the information provided.

This document is not a Plan of Survey.

Sources: Base data, Aerial Photography used under licence with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry Copyright © Queen's Printer for Ontario; City of London.

Notes:
15 Ridout Street South, London - Thames Park

Created By: MF May 29, 2023

* Please note: Any reference to scale on this map is only appropriate when it is printed landscape on legal-sized (8.5" x 14") paper.

0 60 120 240
metres
1:3,000

N

UPPER THAMES RIVER
CONSERVATION AUTHORITY