GZA
GeoEnvironmental, Inc.

Engineers and Scientists

November 20, 2008
File No. 01.0019260.30

MacLaughlin Management and Design (MMD)
12 Kady Lane
Kensington, NH 03833

Attention: Mr. Terry MacLaughlin

One Edgewater Drive
Norwood
Massachusetts
02062
781-278-3700
FAX 781-278-5701
www.gza.com

Re: GZA Response to Report by Simpson Gumpertz & Heger
Larsen Rink Settlement
45 Pauline Street
Winthrop, Massachusetts

Dear Mr. MacLaughlin:

Upon review of the above referenced report by Simpson Gumpertz & Heger (SGH) recently provided by you, GZA GeoEnvironmental, Inc. (GZA) has prepared this letter to provide clarification on several items discussed in the report.

The report by SGH provides a summary of the construction project from their point of view, and makes a number of statements that GZA does not agree with, and/or which we believe require some clarification, including the following:

1. The SGH report indicates that the test pits performed by Prism Builders did not encounter organic soils. GZA has no record of this specific observation being documented prior to the SGH report, and given the locations of the test pits as originally reported by Prism Builders in June 2007, it seems unlikely that no organic soils were encountered. We also note that on page 3 of the SGH report, the locations of the test pits performed by Prism, were changed by Prism between June 2007 and June 2008 from locations in the central and northern portion of the ice rink area to the southern portion of the ice rink area. Note that, generally, more organics, heave and settlement were encountered in the northern and central portions of the ice area than the southern portion.

2. The SGH report incorrectly states that a thawing rate of the system used by Prism of one foot per day was reported by GZA. The following is a direct quote from GZA's

Frozen Ground Summary Report dated May 25, 2007, which summarizes our understanding of the thawing system: "*We understand that the thawing system supplier has indicated that thawing penetration can reportedly reach up to 1 foot per day (presumably when the pipes are in direct contact with the frozen soil). However, considering the limitation of high groundwater table and existing concrete-encased tie rods on our site, excavation below about 3 to 4 feet below grade will likely not be feasible. Hence, it is possible that the thawing rate of the heated pipe system could be much lower than the quoted maximum rate, which could have significant schedule impacts.*"

3. SGH notes that frozen ground was not identified by GZA in our original report dated December 4, 2006. This is correct, and we point out that the subsurface explorations performed by GZA for this original geotechnical evaluation could not be performed within the ice rink area as was originally planned, because the ice rink was in service during the time that the Town desired the geotechnical study to be performed. Explorations within the ice rink prior to demolition would need to penetrate the existing, closely spaced, active refrigerant pipes which the Town stipulated must remain in service during the study.

4. The SGH report states that Prism received direction from GZA with regard to the thawing operation. On Page 10 SGH states that Prism completed the additional work due to the frozen ground in accordance with the direction provided by GZA and the Town. In addition, SGH states on page 10 that Prism were apparently taking direction from GZA and the Town. On page 11 SGH states that "*Prism was taking direction from both GZA and the Town in implementing the accelerated ground thawing process*". GZA did not provide direction to Prism at any time on the project. GZA did not have an onsite presence during the thawing operation. GZA did not provide direction to Prism in the field or to anyone on the project team. GZA acted as a consultant to MMD, and indirectly to the Town, providing our engineering opinions. Our contract with the Town did not have a supervisory element for providing direction to the contractor. GZA recommended to MMD and the Town that the subsurface soils would need to be fully thawed and allowed to settle prior to construction. We did not recommend the accelerated heating system and we understood at the time that the means and methods of the ground thawing operation were Prism's responsibility with equipment donated to the Town.

5. GZA received email correspondence from Prism indicating the ground was thawed. In a June 19 email, Prism states, "*please be advised that the second half of the rink is completely defrosted.*" In another Prism email dated June 25, Prism states, "*My superintendent and site contractor easily dug the pits with a mini-excavator. If I'm not mistaken each time, a town employee happened to be present. Also, when dug, the ground water was rushing into the pits, further indicating thawed soils.*" It

appears that Prism made a judgment that the frozen soils had thawed. GZA did not observe the test pits or provide a judgment whether the ground was thawed before the heating system was moved.

6. SGH states on page 3 that Prism followed the recommendations of GZA's May 25, 2007 report. This statement is not completely correct. GZA recommended the following construction monitoring program with the Contractor providing GZA with the monitoring data at least weekly for our review:

Structure/medium	Locations	Frequency
Top of concrete encased ties	Every 50 feet along every tie, every 25 feet along ties with greater than 6 inches of initial heave.	Daily, decreasing to weekly after rate of settlement slows sufficiently.
Settlement platforms on soil	Minimum of one per each quarter of ice area (minimum of 4 total), placed approximately midway between ties.	Monday, Wednesday and Friday each week, decreasing to weekly after rate of settlement slows sufficiently.

As shown in GZA's July 6 report, Prism monitored ties every 25 feet and 2 settlement platforms on a daily basis (4 to 5 days a week) from June 4 until June 19 (about 2½ weeks). Two settlement platforms were provided versus the recommended four. GZA received monitoring data on June 19, versus the recommended weekly frequency. We received no further monitoring data on the project from Prism. We note that the decision to move the thawing equipment and place the surcharge was made without GZA consultation and before GZA received monitoring data.

7. The SGH report states on page 4 "*GZA indicated in their 21 June 2007 Draft Report and the 6 July 2007 Final Report that based on review they see no continuing trend of settlement. The stability of the data may indicate that the settlement has already occurred. If so, and if the Owner (Town) is confident that the soils are fully thawed, it would be acceptable to remove the surcharge and move it to the next area.*" We also note that our Preliminary Monitoring Data Review document dated July 6, 2007 states the following: "*To confirm the ground is fully thawed, we recommend test pits be performed at several locations with GZA observation. We understand that the tie beams must be lowered prior to construction to avoid interference with proposed piping below the ice. The proposed method of lowering these tie beams should be discussed amongst the team members prior to implementation.*" And earlier in this document, we state: "*We are concerned that the tie beams remaining heaved (and assumed to be in contact with the soil immediately below the beams) may indicate that bridging around voids may have occurred in the previously frozen soils. That is,*

if the soil within the previous frozen zone has settled due to melting of ice lenses and the tie beams and upper soils have not settled, small voids may be present in the previously frozen soils. If this is the case, these voids could later collapse and cause settlement of the beams and rink floor." After our July 6 report, the project team did not further consult GZA on this risk of voids and subsequent settlement. The recommended test pits were not performed.

Please contact the undersigned should you have any questions regarding the above.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Martin A. Rodick, P.E.
Project Manager

William H. Hover, P.E.
Consultant/Reviewer

for Bruce W. Fairless, P.E.
Associate Principal

cc: Sean Driscoll (Town of Winthrop)
Mary Hall, Lew Litwack, Ken Johnston (GZA)

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October 20, 2008

CERTIFIED MAIL
RETURN RECEIPT REQUESTED
Richard White – Town Manager
Town of Winthrop
One Metcalf Square
Winthrop, MA 02152

Re: Construct ice rink system & dasher boards
Larsen Skating Rink, 46 Pauline Street, Winthrop, MA

Dear Mr. White:

This Firm represents Prism Builders, Inc. ("Prism") the general contractor on the above Project.

After learning about the post-construction floor settlement in the Rink, Prism retained the building forensic engineering firm of Simpson Gumpertz & Heger ("SGH") to investigate the causes of the settlement. As you may know, SGH is one of most highly respected firms of its type in New England.

SGH investigated the post-construction settlement and issued a report dated October 8, 2008, a copy of which is enclosed. SGH concluded that Prism had no responsibility for the post-construction floor settlement. Specifically, SGH concluded that the settlement was caused by the failure of the substrate soils to be sufficiently thawed prior to installation of the floor surface and that Prism was not responsible for the insufficient thawing.

It is my understanding that Winthrop is holding $126,533 of sums due to Prism because of the post-construction floor settlement. In light of the SGH report, please forward that sum to Prism forthwith. Should Winthrop fail to pay Prism forthwith, Prism has instructed me to file suit. In that case, in addition to the principal sum due and interest, Prism will seek its legal fees pursuant to MGL c. 231, §6F, since Winthrop has no defense to payment.

Very truly yours,

Maury E. Lederman

MEL/htl
Enclosure
cc: Prism Builders, Inc. (w/o enclosure)
Travelers Casualty and Surety Company (w/o enclosure)
Simpson Gumpertz & Heger (w/o enclosure)

8 October 2008

Mr. Robert Waxman
Prism Builders, Inc.
107 Audubon Road
Bldg 1/ Suite 19
Wakefield, MA 01880

Project 080485 – Evaluation of Cause(s) of Post-Construction Settlement, Larsen Skating Rink, 46 Pauline Street, Winthrop, MA

Dear Mr. Waxman:

At your request, Simpson Gumpertz & Heger, Inc. prepared this letter summarizing our evaluation, our findings, and our conclusions regarding the cause(s) of the post-construction settlement of the new ice rink system at the above-noted site.

Background

The purpose of our evaluation is to determine the most likely cause(s) of the post-construction settlement observed at the above-noted site.

We received a ring binder from Prism containing documents they received or prepared during the course of the work and several additional documents obtained at our request. We have reviewed the available documents and have relied on them for the development of our opinions. Based on these documents, we understand the following as the relationship of the parties involved in the work:

Parties Involved

- Town of Winthrop (Town) – Owner
- MacLaughlin Management and Design (MMD) – Designer of ice rink modifications for Owner
- Foley Buhl Roberts & Associates (FBR) – Structural Engineer and subconsultant to MMD
- GZA GeoEnvironmental, Inc. (GZA) – Geotechnical Engineer and subconsultant to MMD
- Prism Builders, Inc. (Prism) – General Contractor
- J. DeVincent Corp. (JDV) – Earthwork subcontractor to Prism

Review of Documents

Based on our review of the documents, we determined the following:

- Prism was awarded the project based on the contract documents that included the test pit logs for TP1 thru TP4 and two boring logs GZ1 and GZ2, from the GZA 4 December 2006 Geotechnical Report, all of which showed no frozen ground, Fig 1.

- After demolition of the old rink and excavation to a depth of between 3 and 4 ft below existing finish grade, Prism encountered frozen soil. Prism notified all of the parties of this differing site condition which was not identified by any of the test pits or borings previously completed and reported by GZA in their 4 December 2006 report.

- GZA completed an additional investigation and summarized their findings and recommendations in a report dated 25 May 2007. This investigation included three new borings within the ice rink, B101, B102, and B103, see Fig 1.

    - The borings confirmed the presence of frozen ground, and two of the borings identified a layer of peat below the rink, some of which was also frozen.
    - GZA concluded that there was about 1 to 3 ft of unfrozen sand and gravel fill over 2 to 5 ft of frozen sand and gravel over 3 to 4 ft of frozen peat, over about 2 ft of unfrozen peat in two of the borings, giving a total thickness of frozen soils that varied from 4 to 8 ft and the frozen zone extended to a depth of approximately 6.5 to 10 ft below existing grade or to El 3 ft to El 7 ft.
    - GZA also tested three samples of the peat from the frozen zone and reported natural water content of the samples between 229% and 633%. The report also notes that the Peat samples had several ice lenses in them with thickness of about 1/16 to 1/4 in. each.
    - Ground water level was determined to be at El 9.8 ft, about 1.8 ft below the existing grade at that time.
    - GZA also noted that a test pit was excavated by JDV during their site visits, see Fig 1. GZA reported that at this test pit they observed frozen ground to a depth of 7 to 8 ft below grade beginning at a depth of about 2 ft below the ground surface at that time and extending to about 9 to 10 ft.
    - GZA also reported that the concrete-encased structural steel ties below the former ice rink had heaved upward and that a survey dated 14 May 2007 confirmed that the tie beam near the center of the rink had a high point near the middle of the rink that was about 14 in. higher than at the outside wall.
    - GZA noted that accelerated thawing was underway over half the rink at the time of their report and that thawing penetration can reportedly reach up to 1 ft per day.

- GZA recommended the following in their 25 May 2007 report:

    - Delay reconstruction as long as possible to allow complete thawing and placement of a temporary surcharge. Depending on observed settlement, it may be prudent to close the rink for the upcoming ice sports season.
    - If the above is not acceptable to the Town, the following is a suggested sequence of construction that may mitigate impacts from the settlements that

will occur from thawing of frozen ground, while helping to maintain the faster project schedule desired by the Town.

- Monitor the top of concrete-encased ties for settlement daily throughout construction.
- Excavate the upper unfrozen sand and gravel fill down to near groundwater level. Do not excavate below the groundwater table.
- Perform thawing via a surface heat pipe system, and incrementally excavate sand and gravel fill to expedite the thawing operation. Use excavated material as surcharge.
- Gauge potential thaw depth by driving a smooth rod into the ground until the tip encounters the frozen ground and driving is more difficult.
- Place surcharge of 4 ft of sand and gravel fill above finished grade.
- Once settlement appears to have tapered off, or as directed by the Town due to schedule, remove the surcharge. GZA anticipated that at least 4 to 6 weeks will be required following thawing of the ground.
- Then build the ice rink per drawings and specifications.

did not do as recommended

Prism proceeded to follow the GZA recommendations and was issued two change orders by the Town covering the additional work, Change Orders No. 2 dated 13 June 2007 and No. 4 dated 20 July 2007. The change orders specifically included providing only labor to setup and relocate the ground thawing equipment and the furnishing and installation of the insulation blankets and plastic sheeting to insulate the heating pipes. It is our understanding that the equipment and fuel for the thawing process were provided by the Town and that Prism was told, by the Town, that the system could thaw up to 1 ft per day of frozen ground. The unit supplied by the Town was a Heat King HK500 Mobile Glycol Heating System. The system was capable of supplying 364,000 BTU/hr. Prism sequentially applied the system and thawed the ground in sections and then surcharged these areas as follows:

- Thaw Between Column Lines C – F from 22 May to 30 May 2007 (9 days total)
- Thaw Between Column Lines A – C from 31 May to 8 June 2007 (9 days total)
- Thaw Between Column Lines F – J from 13 June to 19 June 2007 (7 days total)
- Surcharge Between Column Lines C – F from 5 June to 6 July 2007 (4 weeks)
- Surcharge Between Column Lines A – C from 13 June to 6 July 2007 (2 to 3 weeks)
- Surcharge Between Column Lines F – J (not yet defined)

Prism monitored the work generally as recommended by GZA and in addition completed three supplemental test pits and confirmed that thawing had been completed at the test pit locations. Prism reports the location of the test pits in an email of 25 June 2007 to be between column lines B1-C1, D2-E2, and G1-H1 and the test pit depths were all 13 ft deep below El 15 ft. An undated plan provided to us on 24 June 2008 by Prism has the three test pit locations marked between column lines 5 and 6 and between C-D, E-F, and G-H and indicates the test pits were all 12 ft deep, a copy is attached in the Appendix. Prism confirmed that the test pit locations were as marked on the 24 June 2008 plan they provided and not as previously reported in the email to GZA.

- Prism supplied the survey monitoring data and test pit results to GZA. Prism indicated that no frozen soil was observed and that no organics were intercepted in the test pits they performed.

- GZA then prepared a draft letter report dated 21 June 2007 and finalized the report in a letter dated 6 July 2007 summarizing their review of the data and their recommendations. GZA reported that their review of the survey data indicated that since the first reading of 14 May 2007 (prior to the start of thawing) to the latest reading of 19 June 2007, settlement of up to 2.25 in. occurred. Three of the nine tie beam locations settled greater than 1 in, two locations settled just under 1 in, two locations heaved up to 0.5 in., and two locations did not move. Since surcharge placement, between Column Lines C to F, Settlement Platform 1A settled 1.6 in. and Settlement Platform 2A heaved 1.3 in. Tie beam monitoring points have settled up to 0.75 in. Over the week of 12 June to 19 June 2007, minor heave up to about 0.25 in. was reported at each tie beam location except at C3, which settled between 0.25 in. and 0.5 in. GZA concluded that the data provided was difficult to understand. It was anticipated that the settlement during thawing would be at least equal to the observed prior heave (of the tie beams). Up to 1 ft of heave previously occurred, but total settlement reported was on the order of 1 to 2 in. GZA also reported that they expected settlement of several inches during the surcharge phase due to consolidation of the organic soils. Instead, the data indicate that a small amount of settlement occurred during the surcharge. The heave data was unexpected. GZA stated that the lack of appreciable settlement may indicate that the ground may not have been completely thawed as indicated by Prism or may be due to survey error.

- GZA indicated in their 21 June 2007 Draft Report and the 6 July 2007 Final Report that based on their review they see no continuing trend of settlement. The stability of the data may indicate that the settlement has already occurred. If so, and if the Owner (Town) is confident that the soils are fully thawed, it would be acceptable to remove the surcharge and move it to the next area. GZA also recommended additional test pits observed by their representatives.

- On 21 June 2007 Prism emailed GZA, MMD, and the Town representative S. Driscoll to have GZA coordinate its own efforts to confirm that the ground was thawed based on the GZA 21 June 2007 Draft Report.

- On 25 June 2007, Prism e-mailed the Town representative Mr. S. Driscoll asking for a decision regarding whether the removal of the surcharge from the first area to the next area should proceed.

- On 25 June 2007 the Town representative Mr. S. Driscoll e-mailed a response to Prism the same day in response to the Prism e-mail stating "Proceed."

- Prism then proceeded with the work and completed the final section of surcharge. Prism told us that even after the surcharge was completed they had to excavate under the tie beams and lower them to get them to the proper elevation prior to proceeding with the rink construction.

Appendix

- The recommendation by GZA to perform additional test pits was not followed, and this decision was not made by Prism.

- Prism told us that the Town started the chillers on 15 October 2007 and then used the rink to the end of December 2007 without operating the heating units under the insulation below the rink. In January or early February 2008, we understand that the Town reported a crack in the slab visible through the ice; about 1 in. of settlement was reported at that time. During the next three months, this condition became worse and by April 2007, the ice was removed and settlement of up to 8 in. was apparent near the center of the rink.

SGH Field Observations

William Konicki of SGH visited the site with you on 4 August 2008. During the site visit we met with representatives of GZA, MMD, and the Town. The following summarizes our observations:

- There is a distinct depression in the concrete slab located approximately between column lines D and F and 3 and 5, Fig 2.

- The representative from the Town indicated that they had measured as much as a 9 in. settlement at the time of the visit.

- At the south side of the rink the concrete floor appeared relatively level from the boards out about 15 ft. The first visible crack was about 14 ft from the boards.

- At the east side of the rink the concrete floor appeared relatively level from the boards out about 30 ft. The first visible crack was about 28 ft from the boards.

- At the north side of the rink the concrete floor appeared relatively level from the boards out about 15 ft. The first visible crack was about 15 ft from the boards.

- At the west side of the rink the concrete floor appeared relatively level from the boards out about 20 ft. The first visible crack was about 6 ft from the boards.

We requested that Prism survey the concrete slab prior to the Town placing ice on the rink. This was completed by Prism on 6 August 2008. The survey data provided by Prism is attached in the appendix. The survey results were plotted and a contour plan of the rink concrete slab surface was prepared by SGH, Fig 2. We also plotted the approximate limit of the first visible cracking away from the boards on Fig. 5.

SGH Analysis of the Extent of Tie Beam Heaving Prior to Thawing Operations

We used the Prism 14 May 2007 survey of the top of the Tie Beam Elevations, taken prior to the start of ground thawing, that was attached to the GZA 6 July 2007 report, to prepare a contour plan of the tie beam elevations. We prepared Fig 3 showing the elevation of the top of the tie beams and contours of the elevation of the top of the tie beams referenced to the project survey datum of El 15 ft, finish floor in the lobby.

We also prepared a contour plan of estimated tie beam heave using an average elevation of El 13.75 ft for the ends of the tie beams at the exterior wall and assuming that this was the as built elevation of the tie beams and no heave of the tie beams occurred at the exterior wall, Fig 4.

Both plans show a distinct zone of heave of the tie beams of more than 2 in. (0.16 ft) located between Colum Lines B and G and between Column Lines 2 and 6. This zone has a skewed axis along a line between C6 and G3. The maximum heave from the survey is about 14 in. (1.2 ft) at a point just north of Column Reference F4. There is a smaller zone of significant heave, greater than 9 in. between Column Lines D and a point midway between F and G and between Column Lines 3.5 and 5. This zone also has a skewed axis that is oriented similar to that described above. There is less than 2 in. of heave recorded in the area from Column Line G to the east limit of the rink between the north and south limit of the rink. There is also an area of less than 2 in. of heave located between the boards at the west end of the rink and a line about midway between Column Lines B and C and extending from the north to the south limit of the rink.

SGH Analysis of Surcharge Settlement Monitoring Data

Settlement during surcharge, after the accelerated thawing was complete, was monitored by Prism and presented in GZA's 6 July 2007 report. The data span from 4 June 2007 to 19 June 2007. The data include two settlement platforms (1A and 2A) and nine monitoring points established on top of the tie beams along the C, D, and E lines. The tie beam monitoring points are identified as C, D, and E – 1, 2, 3, however the numerals do not coincide with the column reference line numbers. The numeral 1 indicates the point is on Column Line 3, numeral 2 indicates the point is midway between Column Lines 4 and 5, and numeral 3 indicates the point is on Column Line 6, Fig 5. We have attached the table of data from the GZA report in the Appendix. We summarized the following data from the GZA report and compare it to our estimate of the heave at each point from Fig 4:

Point	Column Ref No.	Elevation		Delta(D)[1] in.	Heave(H)[2] in.	D/H %
		Initial (H)	Final (ft)			
1A	NA	11.98	11.85	1.56	4.8[3]	32
D1	D3	14.25	14.06	2.28	6.0	3
D2	D4/5	14.58	14.59	(0.12)	9.9	0
D3	D6	14.07	13.94	1.56	3.8	41
E1	E3	14.26	14.31	(0.60)	6.1	0
E2	E4/5	14.65	14.65	0.00	10.8	0
E3	E6	13.86	13.78	0.96	1.3	74
C1	C3	13.88	13.8	0.96	1.5	64
C2	C4/5	14.25	14.25	0.00	6.0	0
C3	C6	14.15	14.03	1.44	4.8	30

1. *Measured settlement during surcharge period (5/14/07 – 6/19/07).*
2. *Estimated heave of the tie beams. Based on 14 May 2007 survey by Prism (Fig. 4).*
3. *Estimated heave at plate location based on contour plot of the beam heave (Fig. 4).*

All of the monitoring point initial readings were taken before the accelerated thawing began in the area of each monitoring point except for plate No.1A which was initialized after accelerated thawing was performed. Therefore, the displacement recorded is representative of the movement that occurred only during surcharge and after thawing was stopped.

We did not include Settlement Platform 2A in the above summary since this platform was in an area east of the surcharge in place at the time of the monitoring and would not be expected to settle measurably due to the surcharge. In addition during a portion of the period of monitoring, 13 June 2007 to 19 June 2007, the area around this settlement platform was being thawed. The recorded displacement of point 2A was a heave of 1.32 in. between the initial reading on 4 June 2007 and 19 June 2007. During the period of thawing from 13 June 2007 to 19 June 2007 there was no net movement recorded.

The measured settlement of eight of the ten monitoring points are significantly lower than the estimated heave at these points, with measured settlement between 0% and 41% of the estimated heave. The remaining two points (E3 and C1) have measured settlement between 64% and 74% of the estimated heave. Four of the points surveyed with the largest estimated heave showed a small heave or no movement during the surcharge monitoring period. The heave at point D2 is likely only a survey error and we have assumed that the heave recorded at E1 is also a survey error although it is much larger than the typical range of survey error expected.

There is a small isolated area near the southeast corner of the rink with a heave of up to 3.9 in.

SGH Analysis of Extent of Post Construction Settlement and Total Settlement

We used the Prism 6 August 2008 survey of the floor of the rink to prepare a contour plan of the rink slab settlement, Fig 2. The Prism survey is based on a local datum El 0.0 ft at the top of the slab, at the inside face of the boards at the south side of the rink, at Column Line F. Because some of the survey points were above the datum selected by Prism we recomputed the settlements relative to the highest point and established this high point as the reference datum, see Fig. 2.

We determined that the maximum measured settlement was about 10.71 in. (0.89 ft) at the intersection of Column Line E and Column Line 4. There is a distinct zone of settlement between Column Line B and a point midway between Column Lines F and G and between column Lines 2 and 6. This zone has a skewed axis along a line between C6 and F3. There is a smaller zone of significant settlement, greater than 6 in., between Column Lines C and a point midway between Column Lines E and F and between Column Lines 3 and 6. This zone also has a skewed axis that is oriented similar to that described above. There is a significant area with less than 1 in. of settlement from Column line G to the east limit of the rink and between the north and south limit of the rink. There is a smaller area with less than 3 in. of settlement from Column Line B to the west limit of the rink.

We also prepared the following table comparing the post construction settlement and also the total settlement due to surcharge (Delta) plus the post construction settlement (S), to the measured heave of the tie beams (H):

Point	Column Ref No.	Delta (D) in.[1]	Heave(H) in.[3]	Settlement(S) in.[4]	S/H %	(S+D)/H %
1A	NA	1.56	4.8	5.5	114	147
D1	D3	2.28	6.0	4.5	75	113
D2	D4/5	(0.12)[2]	9.9	6.5	66	66
D3	D6	1.56	3.8	5.5	145	186
E1	E3	(0.60)[2]	6.1	6.5	106	106
E2	E4/5	0.00	10.8	9.0	83	83
E3	E6	0.96	1.3	4.0	307	381
C1	C3	0.96	1.5	4.5	300	364
C2	C4/5	0.00	6.0	6.5	108	108
C3	C6	1.44	4.8	7.5	156	186

Note:

1. *Measured settlement during surcharge period 5/14/07-6/19/07*
2. *Measured values of Delta (D) are negative indicating heave; a value of zero (0) is used in the computed ratio (S+D)/H.*
3. *Estimated heave of the tie beams, based on 14 May 2007 survey by Prism.*
4. *Measured settlement based on 6 August 2008 survey by Prism.*

We determined that nine of the ten points tabulated have a total settlement (S+D) that is greater than 80 % of the measured heave, only one point (D2) has a total settlement that is less (66% of the measured heave). Eight of the ten points have total settlement (S+D) larger than the measured heave and two points have a total settlement of more than three times the measured heave.

We also determined that eight of the ten points tabulated have a post construction settlement (S) that is greater than 80% of the measured heave: Only two points (D1 and D2) have a post construction settlement that is less (75 and 66 % respectively). Seven of the ten points have a post construction settlement equal to or larger than the measured heave and four of these points have a post construction settlement that is significantly larger than the measured heaved. The average post construction settlement of the eight monitoring points, excluding E3 and C1, is 106% of the heave at these same points.

SGH Analyses of Ground Thawing

We completed an analysis of the time and energy, as heat, needed to thaw up to 1 ft of ground per day, to thaw 5 ft of frozen sand and gravel fill, and the additional 3 ft to 4 ft of frozen peat reported by GZA, Prism, and JDV.

The information available for the Heat King HK500 unit used at the site is limited to only the heater capacity of the unit (364,000 BTU/hr) and the maximum thawing area of 11,200 sq ft, a copy is attached in the Appendix. We located a comparable unit produced by another manufacturer for comparison, the Thawzall S3000, a copy of the data sheets are attached in the Appendix. The Thawzall Ground Heater S3000 has a gross heat capacity of 385,000 BTU/hr, a net heat capacity of 321,000 BTU/hr, and a maximum thawing area of 6,000 sq ft, depending on the soil type and accessories installed on the unit. The normal operating temperature of the Thawzall unit is advertized as 100 to 180 degrees F. The Thawzall unit is advertised to thaw up to 1 ft per day, depending on soil conditions.

We assumed the equipment was installed over the largest single area thawed by Prism, between either Column Lines C to F and F to J. The largest area thawed is about 80 ft x 90 ft, or about 7,200 sq ft. Assuming the entire maximum net heat capacity is applied to the area without heat loss upward to the air, the average heating rate is about 1,070 BTU/day/sf. We also computed the average heating rate for the system when applied to the smallest area thawed, between Column Lines A to C. The smallest area thawed is about 90 ft by 32 ft, or 2,880 sq ft. Assuming the unit is operated at the maximum net heat capacity the average heating rate is about 2,675 BTU/day/sf.

We than assumed that the soil and the ice in the soil pores is at or close to 32°F and only the phase change of the ice from solid to liquid must be completed to thaw the soil and pore water. In this case, the required heat input for a cubic foot of soil is equal to the weight of water (as ice) in the soil times the latent heat of melting of ice (fresh water ice) of 144 BTU/lb.

For a typical moist sand and gravel fill that is well compacted, the approximate weight of water in the soil would be in the range of 5 to 7 lbs/cf. To thaw a one foot thickness of this material per day requires between 720 and 1008 BTU/day/sf, or about 1,000 BTU/day/sf on average. This matches the advertised 1 ft per day rate of thawing for the Thawzall S3000 and should be similar for the Heat King HK500 unit used on the site. This also matches the average heating rate applied to the largest area thawed on the site of about 1070 BTU/day/sf. Based on this analysis we determined that 5 ft of frozen compact sand and gravel could be thawed in about 5 days in the two largest areas thawed between Column Lines C to F and F to J and in about 2 days for the smallest area thawed between Column Lines A to C.

We then evaluated the heating needed to thaw the frozen peat layer. We assumed the water content is no less than 200% and as high as 600% as reported by GZA. We assumed a specific gravity of solids of 1.5 based on data for silty and sandy peat from Reference [1] and assuming a saturated soil condition. We computed a void ratio of 3.0 and 6.0 respectively, a dry unit weight of about 23 pcf to 9.4 pcf respectively, and the weight of water in a cubic ft of saturated peat to be about 47 lbs to 56 lbs, respectively. The required heat input to thaw 1 cubic ft of frozen peat is 6,700 BTU's for a water content of 200% and 8,000 BTU's for a water content of 600%. Trying to thaw 1 ft per day of frozen peat requires a heat input of between 7,000 and 8,000 BTU/day/sf. This is about seven to eight times the heating rate of the unit when used on the two largest areas thawed. At the heating rate available for the unit used and when applied to the largest area thawed, only 0.125 ft of frozen peat would thaw in a day, producing an estimate of 28 additional days to thaw a 3.5 ft thickness of frozen peat. When applied to the smallest area thawed, only 0.33 ft of the frozen peat would thaw in a day producing an estimate of about 11 additional days to thaw a 3.5 ft thickness of frozen peat.

We also performed a one-dimensional thawing computation following USACOE TM 5-852-6, Arctic and Subarctic Construction, Calculation Methods for Determination of Depths of Freeze and Thaw in Soils, January 1988. The methodology allows an estimate of the time to thaw a given soil layer once the soil properties are known and the thawing index of the air above the soil is computed from the heat input versus time. We selected soil properties consistent with the soil descriptions reported by GZA and summarized above. We computed that with a constant uniform heat input under the temporary insulation blankets at a constant temperature at the soil surface of 200°F (close to the advertised normal operating temperature range of the Thawzall S3000 unit) that a 5.5 ft thick layer of frozen sand and gravel fill could be thawed in about 7 to 8 days; to thaw the additional 3.5 ft thick layer of frozen peat with a water content of 200% would require at a minimum an additional 34 days and could be longer if peat with the larger water content (600%) were present. We determined that to thaw the Fill and the 3.5 ft of organics would take at least 41 days.

Discussion

It is clear that the frozen ground was not anticipated in the contract documents and that the Town and Prism dealt with this discovery as required by the contract by issuing two change orders that amended the contract. Prism then completed the additional work under the change orders and in accordance with the direction provided by GZA and the Town.

Prism was not the designer of the thawing operation and was apparently taking direction from both GZA and the Town. The Town provided the equipment and the fuel and Prism provided the insulation and the labor needed to install and relocate the components as needed. It is still not completely clear who determined when the system was to be moved from location to location. The timing of the thawing operations does indicate that if the thawing rate of 1 ft per day was accurate, presumably as assumed by Prism based on input from the Town, about 9 ft of ideal soil could be thawed in the 9 days it was applied to the largest area between Column Lines C to F, about 10 ft or more between Column Lines A to C where it was used at about 2.5 times the average heating rate and for the remaining area thawed between Column Lines F to J about 7 ft of ideal soil could be thawed where it was used for only 7 days.

Our analyses support the reported rate of thawing of 1 ft per day of ideal soil and that the ideal soil to obtain a thawing rate of 1 ft per day is a sand and gravel fill with about 7 lbs of water per cu ft of soil. At locations where the frozen peat is present under the sand and gravel fill, it is not likely that much if any of the frozen peat was thawed by this process. This is particularly true in the two largest areas thawed (between Column Lines C to F and F to J) where the heating rate was lowest. In the smallest area thawed (between Column Lines A to C) where the heating rate was highest perhaps about 1.5 ft of peat may have been thawed.

Along the edges of the rink, there may have been some edge effects that reduced the initial thickness of frozen ground and/or the amount of frozen ground present at the start of thawing. This may have allowed the edges to thaw more completely than the center of the rink. Based on the test pit results reported by Prism and by the GZA borings on the south side of the building, it is also possible that organic soils are not continuously present at shallow depths on the south side of the rink, which would explain why the soils in this area were observed to be completely thawed and no organics were observed in the test pits excavated by Prism to confirm that the ground was thawed.

The monitoring results tend to support the premise that the frozen organic soils were not thawed prior to surcharging and therefore very little settlement occurred during this stage of the work. The measured settlement of between 1 in. and 2.2 in. is likely due to recompression of the previously preloaded and preconsolidated unfrozen peat below the frozen zone during the surcharge. The locations near the center of the rink that have little to no measured settlement may be located over areas of peat that were almost completely frozen, with little to no thickness of unfrozen peat to be recompressed under the weight of the surcharge,

The extent of heave of the original rink, based on the tie beam heave measurements, is superimposed over the extent of the post construction settlement of the rink slab on Fig 5. It is clear that the extent of heave and settlement correspond well. The locations of largest heave and largest settlement do not match, but this may be due to the lack of a settlement measurement by Prism at Column F4. We suspect that this value, if obtained, would increase the correlation of the location of maximum heave and maximum settlement. Our evaluation also indicates that the settlement during surcharging did not account for more than about 30% of the measured heave and that the average post construction settlement can account for all of the measured heave at eight of the ten monitoring points (average S/H = 106%). This is consistent with the premise that most of the prior heave of the rink was likely related to the ice lenses in the frozen peat and the thawing and surcharging of the sand and gravel fill produced very little settlement. We expect that as the peat subsequently thawed the weight of the soil above was sufficient to prevent the formation of voids where the ice lenses previously existed, closing these gaps as the ice thawed. At the remaining two monitoring points (E3 and C1) where the post construction settlement is much larger than the measured heave (S/H = 300%) it is not clear what produced this difference. In addition, the monitoring points in the area of largest heave (D2 and E2) recorded little to no settlement during surcharging but the post construction settlement indicates that not all the original heave was recovered as post construction settlement. The cause of this difference is also unclear.

The post construction settlements also likely include some secondary consolidation of the previously preloaded and preconsolidated peat due to the effective pressures from the final rink construction over the one year period since construction was completed. This would tend to make the average post construction settlement somewhat larger than the measured heave and is consistent with the average ratio of settlement to heave (S/H = 106%) we computed for eight of the ten monitoring points.

GZA borings 101 and 102 confirmed at least 3 ft of frozen peat below the fill and are located in the area of largest heave and largest post construction settlement, see Fig 5. GZA boring 103 confirmed up to 4 ft of frozen soil but showed no organics to the bottom of the boring at 9 ft below the rink level and is located in an area of minimal heave and minimal post construction settlement. The test pit excavated on 11 May 2007 between Column Lines G and H and 5 and 6 confirmed 7 to 8 ft of frozen soil with no organics reported and is also located in an area of minimal heave and minimal post construction settlement. All of the above are located in areas that had the lowest heating rate during thawing. This also supports our determination that areas without frozen organics were completely thawed and areas with frozen organics were not thawed. Similarly the test pits by Prism also confirm this determination.

The reported timing of the development of the settlement of the new rink about 3 to 4 months after it was put in service and the accelerated rate of settlement increase after the new heating elements under the insulation were reportedly turned on in January or February 2008 is also consistent with a rapid thawing of the remaining frozen peat, which then allowed settlement to rapidly occur.

Conclusions

We conclude the following:

1. Prism was taking direction from both GZA and the Town in implementing the accelerated ground thawing process and the means and methods used were selected,

specified, and/or provided by others, for who Prism was not responsible, and merely installed and relocated as needed by Prism.

2. Prism, either by direction from or based on the thawing rate of the soil provided by others, for whom Prism was not responsible, relocated the equipment to allow for 7 to 9 ft or more of thawing to occur.

3. The thawing rate of 1 ft per day reported by Prism and GZA is accurate only for an ideal soil consisting of a sand and gravel fill with up to 7 lbs of water per cubic ft.

4. The heat capacity of the portable Heat King HK 500 heating system provided by the Town was not capable of thawing 1 ft per day of frozen peat and more likely only capable of thawing 0.1 ft to 0.3 ft per day of frozen peat depending on the water content of the frozen peat and the heating rate applied.

5. It is highly likely that most of the frozen peat, particularly near the center of the rink, was not thawed during the period of accelerated thawing and subsequently thawed and compressed after the construction work was completed and the new below slab heaters were turned on.

6. Accelerated thawing of the areas with frozen peat would have required an additional 11 to 28 days depending on the heating rate used and the water content of the frozen peat.

Sincerely yours,

William P. Konicki

COMMONWEALTH OF MASSACHUSETTS
WILLIAM P. KONICKI
32170
REGISTERED PROFESSIONAL ENGINEER

William P. Konicki, P.E.
Senior Principal
O:\DATEFILE\2008\Konicki, W\WPK74-l.ras.doc

Cc: Maury E. Lederman – Murtha Cullina, LLC

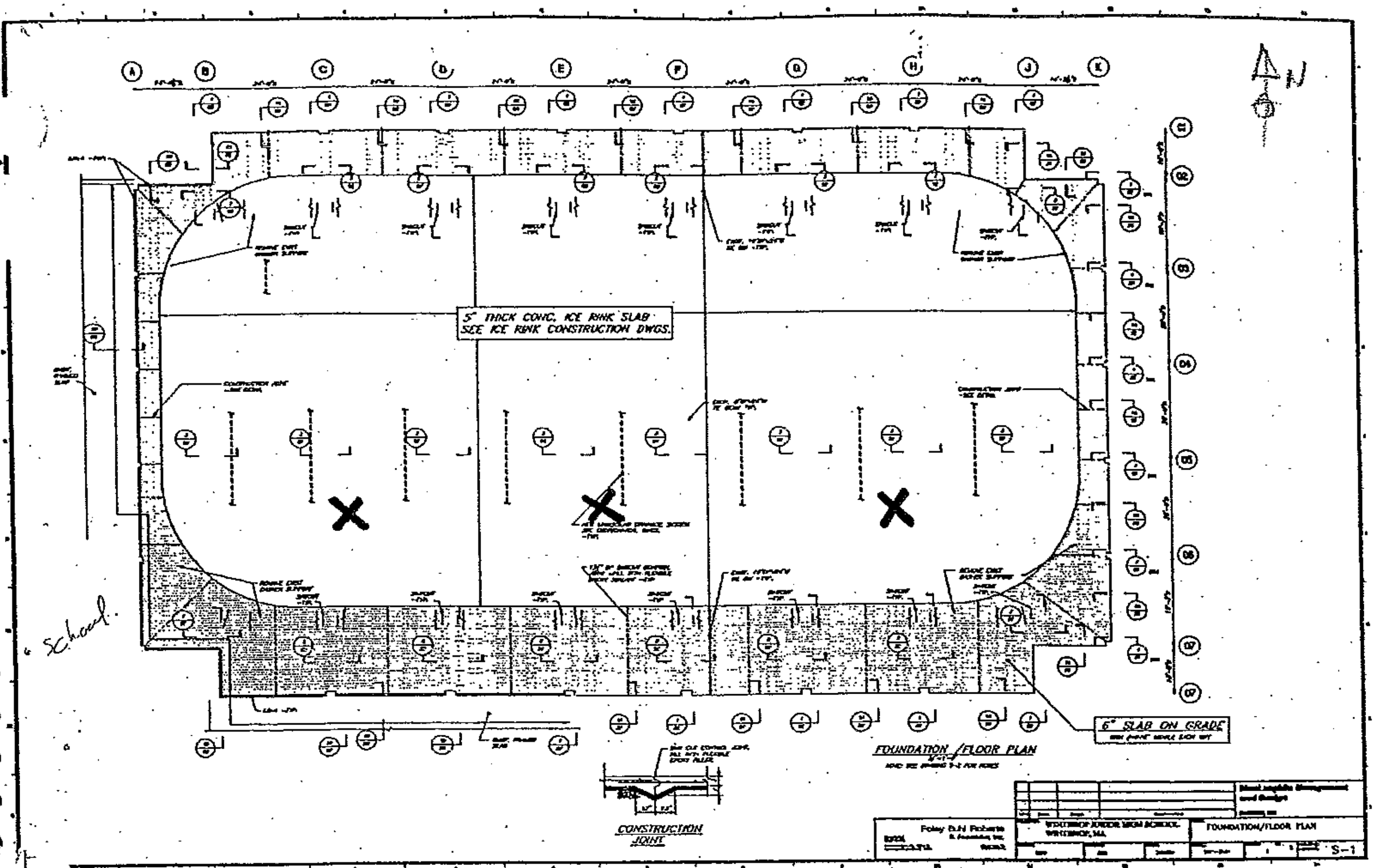
Attachments

Figure 1 – Subsurface Exploration Summary and Location Plan
Figure 2 – Plan of Slab Settlement Contours
Figure 3 – Plan of Heaved Tie Beam Elevation Contours
Figure 4 - Plan of Tie Beam Heave Contours
Figure 5 – Composite Plan of Rink Heave, Settlement, and Cracking

Appendix
Prism 24 June 2008 Test Pit Location Plan
Prism 6 August 2008 Settlement Survey Data
Prism 14 May 2007 Heave Survey of Tie Beams
GZA Summary of Post Thaw Settlement Data
Heat King HK500 Mobile Glycol Heating System Data Sheets
Thawzall S3000 Ground Heater Data Sheets

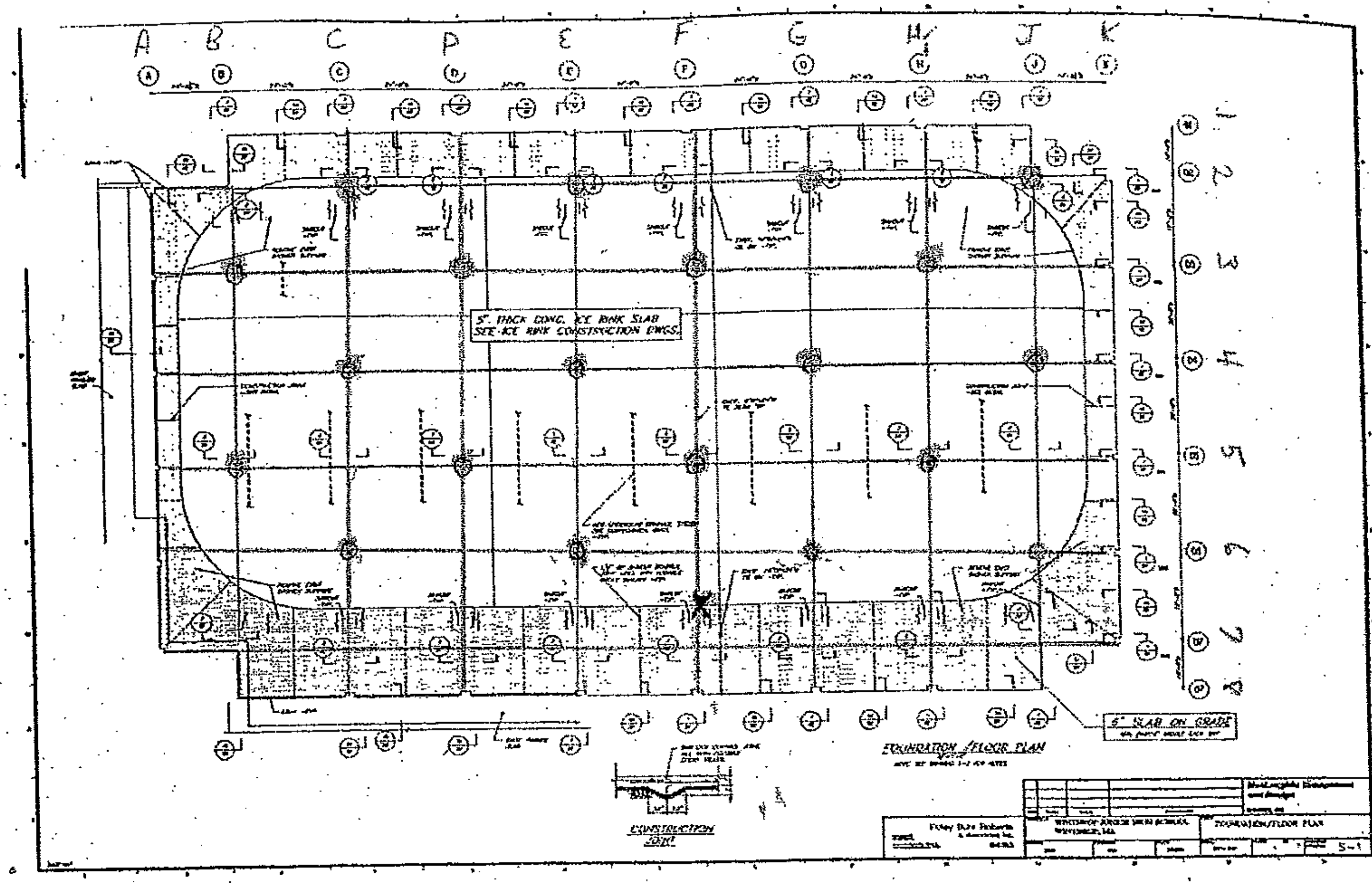
References

1. Gunaratne, W. Stinnette, P., Mullins, A.G., Kuo. C.L. and Echelberger, W.F., "Compressibility Relations for Peat and Organic Soil," ASTM Journal of Testing and Evaluation, Vol. 26, No. 1 January 1998, pp. 1-9.

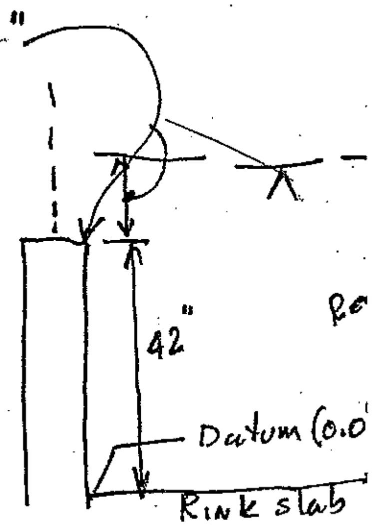


X = TEST PIT LOCATION, DEPTH OF 12'±

Prism Test Pit
Locations to Confirm
Frozen ground Thawed



x TOP OF BOARD ELEVATION 15.75"



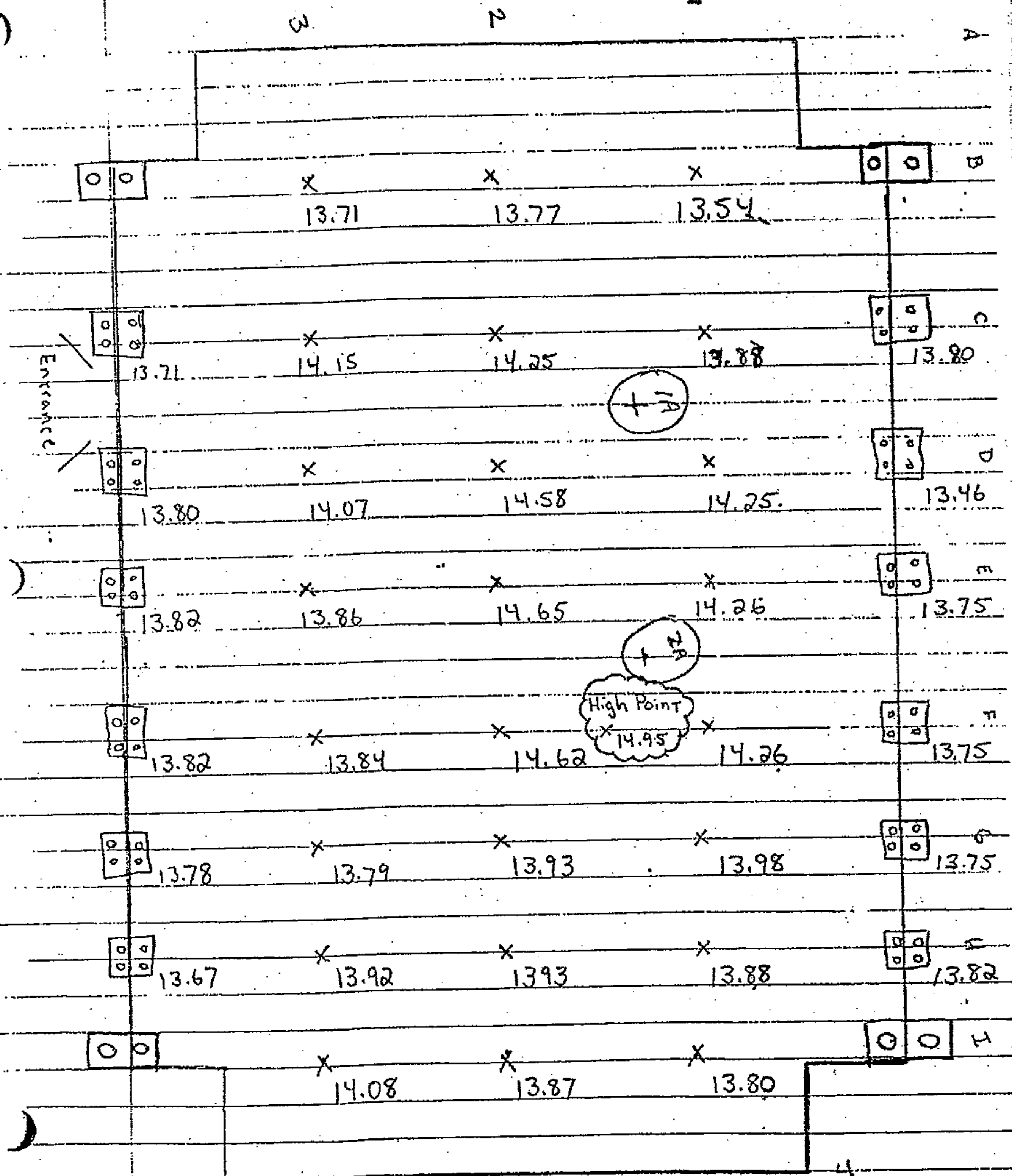
B3 - 59.75
B5 - 60.00
C2 - 59.25
C4 - 63.75
C6 - 64.50
D3 - 61.50
D5 - 64.13
E2 - 59.75
E4 - 67.75
E6 - 60.75

F3 - 62.00
F5 - 58.50
G2 - 57.75
G4 - 58.00
G6 - 58.00
H3 - 57.25
H5 - 58.00
J2 - 57.00
J4 - 57.00
J6 - 58.50

Prism 6 Aug 08 Survey

14 May 2007

From July 6, 2007 GZA Report



Finish Floor at Lobby
15.00

Prism survey of
Tie Beams.

GZA File No. 19260.2

LARSEN RINK
POST-THAW SETTLEMENT DATA

	6/4/07	6/5/07	6/6/07	6/7/07	6/8/07	6/12/07	6/13/07	6/14/07	6/15/07	6/18/07	6/19/07
1A	10.48	10.36	10.39	10.38	10.36	10.34	10.36	10.34	10.34	10.34	10.35
2A	10.40	10.47	10.52	10.50	10.53	10.52	10.51	10.52	10.50	10.50	10.51
D1	10.08	10.01	10.01	10.04	10.07	10.01	10.03	10.05	10.05	10.05	10.06
D2	10.64	10.58	10.58	10.60	10.60	10.60	10.57	10.59	10.58	10.58	10.59
D3	10.00	9.92	9.92	9.98	9.96	9.90	9.94	9.94	9.94	9.94	9.94
E1	10.35	10.29	10.29	10.30	10.31	10.28	10.28	10.30	10.29	10.30	10.31
E2	10.68	10.64	10.64	10.67	10.67	10.65	10.63	10.64	10.64	10.65	10.65
E3	9.80	9.73	9.73	9.77	9.78	9.75	9.72	9.74	9.76	9.78	9.78
C1	--	--	--	--	--	--	9.80	9.79	9.80	9.80	9.80
C2	--	--	--	--	--	--	10.25	10.24	10.24	10.24	10.25
C3	--	--	--	--	--	--	10.06	10.04	10.03	10.03	10.03

**Benchmark used = 8.00 (Measurements are to a mark on measurement platform poles)

	5/14/07	6/4/07	6/5/07	6/6/07	6/7/07	6/8/07	6/12/07	6/13/07	6/14/07	6/15/07	6/18/07	6/19/07	Delta (in)
1A		11.98	11.86	11.89	11.88	11.86	11.84	11.86	11.84	11.84	11.84	11.85	1.56
2A		11.90	11.97	12.02	12.00	12.03	12.02	12.01	12.02	12.00	12.00	12.01	(1.32)
D1	14.25	14.08	14.01	14.01	14.04	14.07	14.01	14.03	14.05	14.05	14.05	14.06	2.28
D2	14.58	14.64	14.58	14.58	14.60	14.60	14.60	14.57	14.59	14.58	14.58	14.59	(0.12)
D3	14.07	14.00	13.92	13.92	13.98	13.96	13.90	13.94	13.94	13.94	13.94	13.94	1.56
E1	14.26	14.35	14.29	14.29	14.30	14.31	14.28	14.28	14.30	14.29	14.30	14.31	(0.60)
E2	14.65	14.68	14.64	14.64	14.67	14.67	14.65	14.63	14.64	14.64	14.65	14.65	0.00
E3	13.86	13.80	13.73	13.73	13.77	13.78	13.75	13.72	13.74	13.76	13.78	13.78	0.96
C1	13.88	--	--	--	--	--	--	13.80	13.79	13.80	13.80	13.80	0.96
C2	14.25	--	--	--	--	--	--	14.25	14.24	14.24	14.24	14.25	0.00
C3	14.15	--	--	--	--	--	--	14.06	14.04	14.03	14.03	14.03	1.44

**Benchmark Used = 15.00 (Measurements are to base of measurement platforms

Notes: 1. Data provided by Prism Builders on 6/19/07 and 6/21/07.
2. Points 1A and 2A are settlement platforms, other points are on the top of concrete-encased tie beams.

HEAT KING

CROWN CONSTRUCTION EQUIPMENT

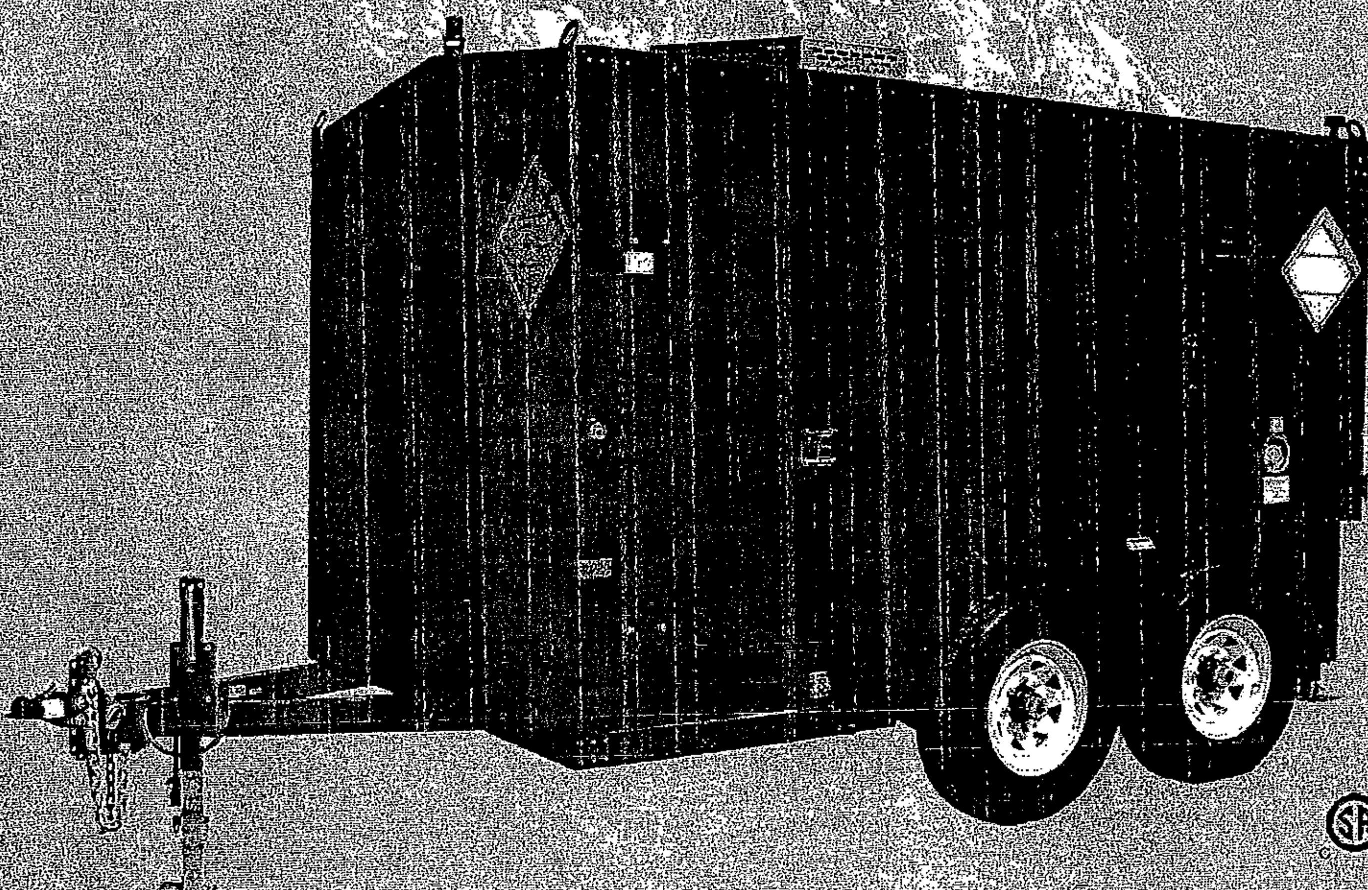
HK500

The HK500 Mobile Glycol Heating System

The HK500 is the most powerful of the Heat King family. This unit was designed for big jobs in mind. Quiet and efficient yet powerful enough to thaw 11,200 ft^2 of ground, cure 22,400 ft^2 of concrete or provide temporary heat for up 15,000 ft^2.

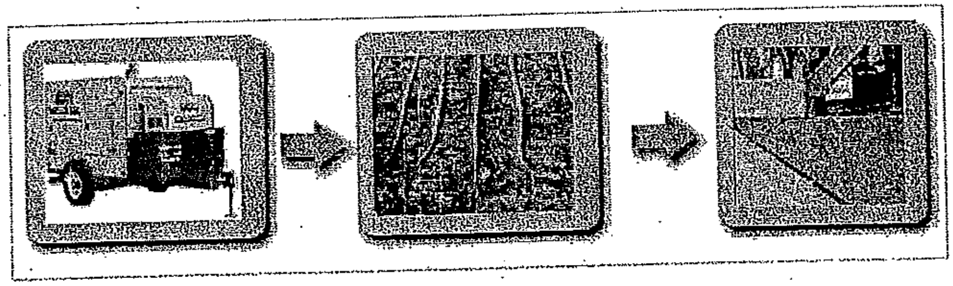
Features:

- Thaw up to 11,200 ft^2
- Cure up to 22,400 ft^2
- Temporary Heat up to 15,000 ft^2
- Computer controlled System
- Digital Temperature Monitoring
- Large Glycol Reservoir
- Large Access Doors
- Double Loop Technology
- Enclosed Electric Hose Reel
- CSA / UL Certified



BUILT TO STAY ON TOP

Ground Heater - Thawzall Ground Heating Systems



All Thawzall ground heater models are fully contained ground heating systems which use a boiler system to heat a biodegradable, environmentally safe propylene glycol mixture. The propylene glycol mixture is then circulated through industrial hydronic hose via the Thawzall ground heater unit to efficiently heat the soil and soften the frozen ground for digging, concrete pouring, and other cold weather constructing needs.

Thawzall ground heater can thaw up to 12,000 square feet of soil per set-up with hydronic hose at 24" on center hose spacing. Optimum ground heating is achieved with hydronic hose at 16" on center spacing. Depending upon soil conditions, a Thawzall ground heater can thaw up to 12" of frost soil every 24 hours. This ground heating process is environmentally-friendly since the heat transfer fluids never leave the ground heater system. That means only heat penetrates the ground to thaw the soil. The flexibility of the hydronic hose used with the ground heater allows you to custom fit your layout to any cold weather application. Thawing trenches is also possible with the Thawzall ground heater by laying your hydronic hose in long parallel lines. If the hose is laid along side footings, the Thawzall ground heater will keep them frost free and will keep footings from heaving due to frost penetration.

For effective use of the Thawzall ground heater system, lay hose in loops, 24" on center, over area to be thawed (6,000 square feet per set). Cover the hose with construction blankets to improve efficiency. With this set-up, expect the Thawzall ground heater to thaw up to 12" of frost soil depth per 24 hour period in most soil conditions.

Granite City Rental is your ground heater rental solution. The hydronic heat produced by the Thawzall ground heater system can heat soil quickly and efficiently to keep your cold weather construction project on schedule. Call Granite City Rental today for your ground heater rental. Granite City Rental has all the construction heat rental equipment you need for your winter construction project. Call (800) 328-7094 to schedule you ground heater rental today.

800-328-7094

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Thawzall
MagTec
Ground Heater
Ground Heater E1100
Ground Heater E2200
Ground Heater E3000
Ground Heater S3000
Artic Bear Cub
Artic Bear HD
Artic Bear XHD
Pump Pack
Hose Handling System
Remote Manifold
Booster Pump
Red Wave Insulation Blankets
HX-Series Heat Xchangers
Pure Hydronic Air Heater
Dryvex MC5200
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LB White
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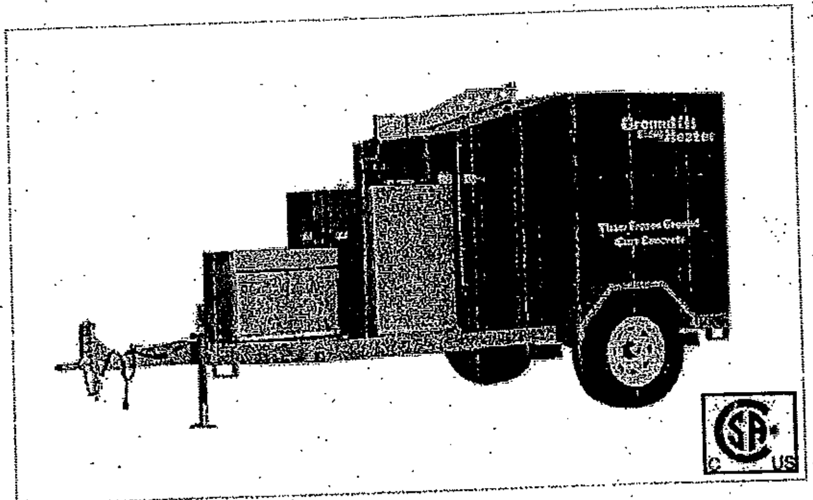
S3000



Thaw ground - quickly, easily, and economically

- 3,000 - 4,500 sq. ft. standard
Varies based on soil conditions. Complete a Ground Heaters' Thaw Cost Plan.

Cure concrete - in cold weather with confidence

- up to 6,000 sq. ft. standard
Varies based on application. Complete a Ground Heaters' Cure Cost Plan.

Up to 100 hours run-time

Engineered for reliable, trouble-free start

Easy to operate

Economical

Dependable

Built Tundra Tough™

84% heater efficiency - highest in the industry

Thaw and cure large areas:

Thaw up to 1 foot deep/day(dependent on conditions)

Set, finish and cure concrete like it's summer

Protect newly poured concrete from frost

Dimensions and capacities

Length	181"
Width	91"
Height	93"
Ground clearance	12"

Frost Prevention (std equipment)	up to 9,000 sq ft
Frost Prevention (w/ accessories)	up to 27,000 sq ft
Air heat capacity (w/ accessories)	535,000 sq ft
Performance monitoring system	yes

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  - Ground Heater E2200
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  - Ground Heater S3000
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  - Artic Bear XHD
  - Pump Pack
  - Hose Handling System
  - Remote Manifold
  - Booster Pump
  - Red Wave Insulation
  - Blankets
  - HX-Series Heat Xchangers
  - Pure Hydronic Air Heater
  - Dryvex MC5200
  - Dryvex R110
  - Dryvex R55
  - Dryvex AM3000
  - How It Works, Curing
  - How It Works, Thawing
- Curing Blankets
- Power Blanket
- Frost Fighters
- LB White

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How It Works-THAWING

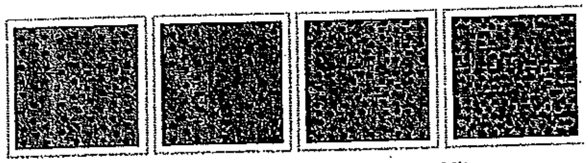
The versatile Ground Heater® - solves cold weather construction problems! Ground Heaters®' dry, radiant, hydronic heat is economical and easy to use!

- Thaw frozen ground for excavation and concrete placements
- Thaw up to 1 foot deep per day!
- Accurately quote winter construction jobs
- Deliver projects on time
- Keep crews and equipment working all winter
- Protect exposed footings from frost heaving
- No need to build temporary roads.. adjacent ground stays frozen

Problem:

Ice in the soil!

Know Your Dirt! Ice Content of Frozen Soils



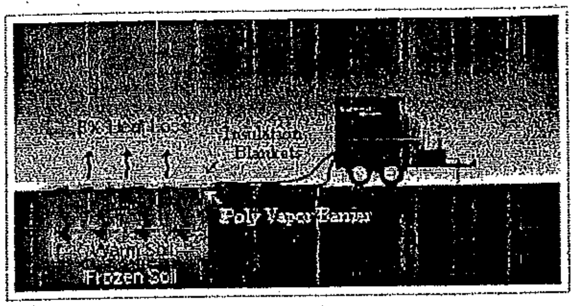
Gravel	Sand	Clay	Silt
5 to 7 lbs. in 1 cu. ft.	14 to 18 lbs. in 1 cu. ft.	16 to 22 lbs. in 1 cu. ft.	15 to 52 lbs. in 1 cu. ft.
Up to 1,001 Btu's required to melt ice	Up to 2,574 Btu's required to melt ice	Up to 3,146 Btu's required to melt ice	Up to 7,436 Btu's required to melt ice

Melting ice requires 143 Btu's per pound!

Frost Facts

- Soil does not freeze
- Water in soil freezes
- Ice binds soil
- Melting ice requires 143 Btu's per pound!

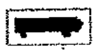
Ground Heater® System



94% of the **heat** is conducted into frozen ground!

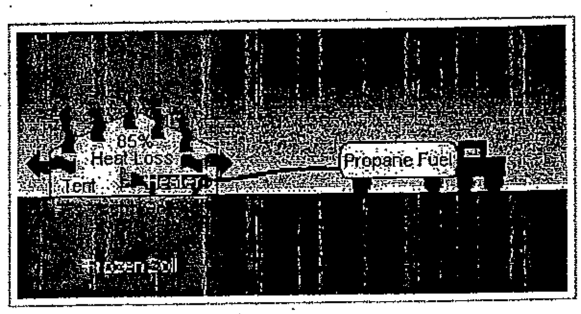
- Thaws at a fast rate - typically 1 ft. deep per day
- Achieves up to 10' thaw depth per application
- No temporary enclosure to build
- Uses fuel efficiently; fuel costs per cu. ft. thawed:

 = less than 1¢

 = 37¢

- Requires minimal supervision
- Utilizes BTU's efficiently with minimal heat loss

Hot Air System



Only 15% of the **heat** is conducted into the frozen ground!

- Limited thaw depth
- Requires building costly temporary enclosures
- Requires noisy propane heaters
- Creates outrageous propane bills
- Emits noxious fumes into enclosure
- Requires constant supervision

Thawing 6,000 sq. ft., 3 ft. deep

System	Hot Air 	Ground Heater	
Time	25 days	OWN 3 Days	RENT 3 Days
Equipment/labor/ materials cost	\$2,877	\$530	\$1,436

Fuel Cost	$6,600	$132	$132
Total Job cost	$9,477	$662	$1,568
Cost/cu. ft.	**52.7¢**	**3.7¢**	**8.7¢**

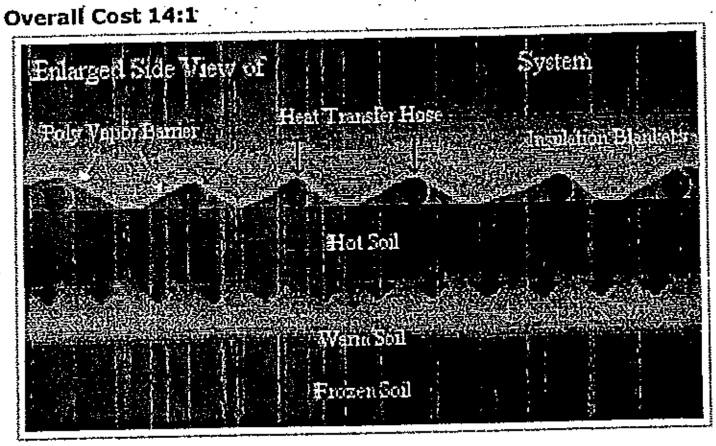
NOTE: Figures above are based on average rates/costs. Actual rates/cost incurred may vary depending upon geographical location.

Ground Heater®  **out-performs hot air!**
Thawing 6,000 sq. ft., 3 ft. deep

Time 8:1

Fuel Cost 50:1

Overall Cost 14:1



1. Prepare Site Scrape snow and ice from thaw site.
2. Position Heat Transfer Hose Space hose 2 feet on center over thaw site area. A closed system, only heat goes into ground.
3. Lay Poly Vapor Barrier Place minimum 3 mil poly vapor barrier to contain water vapor.
4. Prevents loss of heat
5. Keeps soil moist for better heat conduction
6. Keeps hoses and blankets clean
7. Place Insulation Blankets
8. Prevent heat loss and direct heat into ground. Requires 2 to 3 layers of high R value blankets.

Thaw fast - typically 1 foot deep/ day!

Thaw cheap - as low as 3.7¢/cu. ft.

Thaw deep - up to 10 feet/application

Thaw easy - no enclosures to build; set up is simple

Thaw large areas - up to 12,000 sq. ft./application

Thaw safe - certified in the US and Canada

800-328-7094

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

May 25, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

133 Federal Street
10th Floor
Boston, MA 02110
617-482-1000
Fax: 617-482-6868
www.gza.com

Re: Frozen Ground Summary Report
Larsen Rink - Proposed Slab Reconstruction
Winthrop, Massachusetts

Dear Mr. MacLaughlin:

In accordance with our agreement dated May 17, 2007, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this report to MacLaughlin Management and Design (MMD, Client) summarizing the results of our frozen ground evaluation for the proposed slab reconstruction at the existing Larsen Rink building at 45 Pauline Street in Winthrop, Massachusetts. Previous explorations inside the rink building were shallow test pits outside of the rink area. The test pits did not identify frozen ground.

The objectives of this current study were to: 1) evaluate subsurface conditions in the frozen ground area beneath the rink; 2) evaluate the potential impacts of the frozen ground on the proposed reconstructed ice rink; 3) outline below-grade construction options to mitigate these impacts; and 4) provide monitoring recommendations.

BACKGROUND

The reconstruction project includes new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink, consistent with one of the alternatives presented in our geotechnical report dated December 4, 2006, and shown on Contract Drawing No. G-1 prepared by GZA.

As stated in our previous report, this option of slab support should mitigate, but will not eliminate the differential settlement of the proposed slab due to ongoing secondary compression of compressible organic soils present below the building and observed

- Performed a program of geotechnical laboratory testing including water content and organics content tests performed on 3 samples of organic soils from boring GZ-102.

- Performed geotechnical engineering analyses to evaluate the effects of the frozen ground on the project and methods to mitigate settlement.

- Prepared this geotechnical engineering report summarizing our findings and recommendations.

SUBSURFACE EXPLORATIONS

Borings

Three borings (GZ-101 through GZ-103) were performed within the former ice rink area by New Hampshire Boring, Inc. of Brockton, Massachusetts, on May 21, 2007. Borings GZ-101 and GZ-102 were performed in areas where the greatest heave was observed, and GZ-103 was performed in a less-heaved area, approximately 6 feet from the edge of the former rink. The borings were advanced via cased drilling methods with continuous split spoon sampling through unfrozen ground in GZ-101 and through frozen and unfrozen ground in GZ-102 and GZ-103. Rock coring techniques were used to advance through the frozen ground in GZ-101. Borings GZ-101 and GZ-102 were advanced to depths of about 13 to 16 feet, and each was terminated within likely natural granular soils below an organic soil layer. Boring GZ-103 was advanced to a depth of 9 feet, and did not encounter organic soils.

Boring locations are shown on Figure 1. Boring logs are attached as Appendix B.

SUBSURFACE CONDITIONS

Soil and Frozen Ground

Based on the recent explorations, subsurface conditions consisted of about 1 to 3 feet of unfrozen sand and gravel fill over 2 to 5 feet of frozen sand and gravel fill, over 3 to 4 feet of frozen organic soils in borings GZ-101 and GZ-102. The total thickness of organic soils in borings GZ-101 and GZ-102 was approximately 5 to 6 feet. In boring GZ-103, no organic soils were encountered and the frozen zone did not extend beneath the fill into the natural soils, which consisted of clay and silt at this location.

The total thickness of the frozen soils encountered in the borings ranged from 4 to 8 feet, and the frozen zone extended to a depth of approximately 6.5 to 10 feet below existing grade, which corresponds to approximate elevations +3 to +7 feet. Refer to the boring logs in Appendix B for additional details.

Our previous report anticipated organic soil beneath the rink based on adjacent borings outside the rink building, but did not anticipate frozen soils. Previous explorations inside the rink building consisted of shallow test pits outside of the rink area and did not encounter frozen ground. During our previous evaluation, we discussed the possibility of frozen ground beneath the rink with industry experts (Ice Builders) who indicated that because the rink operation was seasonal (versus operational all year), frozen ground below the rink was unlikely to be a major concern during construction.

There are three potential sources of soil settlement beneath the ice rink. These are:

1. Thawing of the frozen soil;
2. Consolidation of the thawed soil under self-weight and new surcharge loads; and
3. Time-related secondary compression of the organic soil.

The amount of the settlement due to thawing of frozen ground and soil consolidation is difficult to estimate, but is expected to be greater than the amount of heave experienced by the concrete-encased tie beams, which was measured to be up to approximately 14 inches.

If this high amount of settlement occurred after ice rink reconstruction, the settlement effects would be intolerable as the concrete would crack and settle, and associated refrigerant and heat piping systems would likely fail.

Thawing of the frozen soil and soil consolidation will require time. We understand there is a need to have the rink back in operation for the coming ice sports season. Thus, the settlement will need to be accelerated so that the majority of the settlement due to thawing, consolidation, and a portion of the secondary compression is complete prior to constructing the permanent slabs and systems.

Alternatives to accelerating the settlement are not considered economically feasible. These include excavating and replacing the compressible and/or frozen soil with off site fill or supporting rink loads on piles bearing below the compressible and/or frozen soil.

Accelerated thawing is currently underway over half of the rink area. Although thawing penetration can reportedly reach up to 1 foot per day, we are concerned that thawing of the frozen soil will not be complete in the available time to allow construction to proceed in time for the rink to be open for the next ice sports season. Ideally, all frozen ground should be thawed before construction continues.

Consolidation of the thawed ground can be accelerated and post-construction settlement mitigated by placing a temporary surcharge load for a period of time, forcing the primary consolidation settlement and some of the secondary compression to occur. Typically surcharge loads are at least 3 to 5 feet of soil placed above the finished grade. This

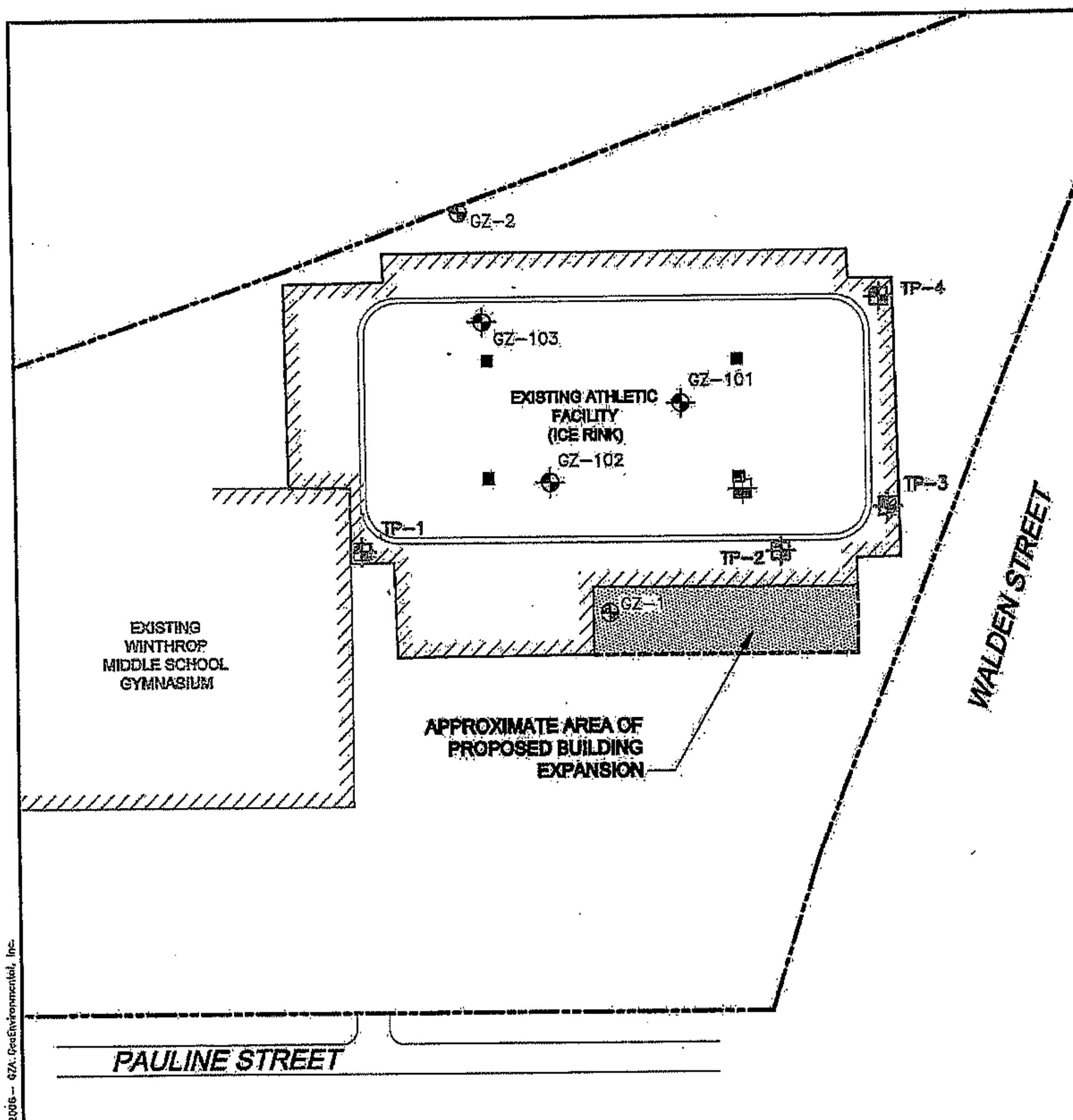
4. As soon as possible install a minimum of four settlement platforms to monitor ground settlement over time. Install at the lowest excavated grade. Suggested locations of settlement platforms are shown on the attached Figure 1. Settlement platforms should be placed approximately midway between tie beams.
5. Potentially thaw depth may be gauged by driving a smooth rod into the ground until the tip encounters the frozen ground and further driving is more difficult.
6. At the Contractor's option, following full thawing in an area and prior to placing surcharge, the proposed geogrid layers and sub-slab drainage pipes may be constructed in that area, provided perforated PVC collection pipes are replaced by suitable flexible perforated pipe, such as corrugated black ADS pipe (with subgrade sloped to drain towards manifold pipes).
7. Place surcharge consisting of 4 feet of sand-gravel fill or equivalent above finished grade. Monitor ties and settlement platforms and provide data to GZA for review.
8. Once settlement appears to have tapered off or as directed by the Town due to schedule, remove the surcharge. We anticipate that at least 4 to 6 weeks of surcharge will be required following thawing of the ground. This surcharge duration may be reduced by providing a greater surcharge.
9. Build ice rink slab and piping systems per existing contract drawings and specifications.

Monitoring Program

We recommend the following construction monitoring be performed via optical or laser survey methods:

Structure/medium	Locations	Frequency
Top of concrete encased ties	Every 50 feet along every tie, every 25 feet along ties with greater than 6 inches of initial heave.	Daily, decreasing to weekly after rate of settlement slows sufficiently.
Settlement platforms on soil	Minimum of one per each quarter of ice area (minimum of 4 total), placed approximately midway between ties.	Monday, Wednesday and Friday each week, decreasing to weekly after rate of settlement slows sufficiently.

Settlement platforms consist of a 3 foot by 3 foot piece of ¾-inch pressure-treated plywood with a 1-inch cast iron pipe flange bolted to the center of the plywood. Insert and attach 1-inch cast iron pipe into the flange and extend above grade as necessary. Once placed, the settlement platform should not be disturbed or knocked during construction. It may be cut off 6 inches below finished grade and left in place after construction. Survey to



LEGEND

GZ-101	BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON MAY 21, 2007.
GZ-1	BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON NOVEMBER 8, 2006.
TP-1	TEST PIT PERFORMED BY RONALD MARINI CORP. OF NEWTON, MA AND OBSERVED BY GZA ON NOVEMBER 8, 2006.
	APPROXIMATE LOCATION OF TEST PIT EXCAVATION PERFORMED BY CONTRACTOR ON MAY 11, 2007.
	PROPOSED SETTLEMENT PLATFORM
	PROPERTY LINE

NOTE

1. THE BASE MAP WAS DEVELOPED FROM A PLAN PROVIDED BY THE TOWN OF WINTHROP ENTITLED "ATHLETIC FACILITY - SITE PLAN", DRAWING NO. AF-1, BY JOSEPH E. STANUNAS ASSOCIATES ARCHITECTS OF HUDSON, MA, DATED 1/4/71, SCALE: 1/8"=1'-0".

2. THE LOCATIONS OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS MADE IN THE FIELD FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USE.

SCALE 1" = 40' FEET
0 20' 40' 80'

PROJ. MGR: MAR
DESIGNED BY: MAR
REVIEWED BY: MBH
OPERATOR: OCO
DATE: 12-01-2006

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
PH: (781) 278-3700
Fax: (781) 278-5701

LARSEN RINK RENOVATIONS
45 PAULINE STREET
WINTHROP, MASSACHUSETTS

EXPLORATION LOCATION AND PROPOSED INSTRUMENTATION PLAN

PROJECT NO. 19260.20

FIGURE NO. 1

GZA-J:\19,000-20,999\19260\19260-20.MR\Figures\CAD\19260-20_Exploration Location and Proposed Instrumentation Plan.DWG [11x17] May 29, 2007 - 12:15pm. oliver.oliveira

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, MA 02064

Larson Rink - Proposed Slab Reconstruction

Winthrop, MA.

Boring No. GZ-101
Page No. 1 of 1
File No. 19260.2
Checked By: MAR

Drilling Co. New Hampshire Boring, Co.
Foreman Todd Penticost
GZA Rep. Ron Kubiak
Date Start 5/21/2007 End 5/21/2007
Location See Exploration Location Plan
GS. Elev. 11.25 Datum Note 5

	Casing	Sampler
Type	NW	Split Spoon
I.D./O.D.	3"/3.5"	1-3/8"/2"
Hammer Wt.	300#	140 lbs.
Hammer Fall	24"	30"
Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
5/21/07	10:45	1.8'	13.5'	2 min.

DEPTH	CASING	BLOWS	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	NOTES
			S-1	17/12	0-1.4	6-57		Very dense, brown, fine to coarse SAND some Gravel, trace SILT. Bottom 1": dark brown fine to medium SAND, little (+) SILT (FILL) (bottom 6" is frozen.)	FILL	1
			S-2	6/6	1.4 - 1.9	100/5" - 100		S-2: Frozen, dark gray-brown clayey SILT, fine(+) to medium SAND, some (-) SILT (FILL)		2
			C-1	60/15	3.2 - 8.2	1.3*		C-1: Top 15": unfrozen, dark gray-brown clayey SILT, some (+) fine to coarse SAND, some (-) Gravel. (FILL)	4.5' ±	
5				/38		6.5*		Bottom 38": Frozen, dark brown, fine-grained PEAT, little woody fibers.		
						for 2'				
						0.8*			PEAT	
						0.3*				
			C-2	60/23	8.2 - 13.2	2.3*		C-2: Top 21": Dark brown, fine grained PEAT little woody fibers; 1" piece was frozen. Bottom 2": Brown, fine to coarse SAND and GRAVEL, trace SILT (unfrozen)		
10						for 3'			10'±	
						0.3*			SAND and GRAVEL	
			S-3	24/6	13.5 - 15.5	12-10		Wet, medium dense, brown, fine to coarse SAND and Gravel, trace SILT (unfrozen)		3
15						13-16				4
								Bottom of Boring at 15.5'		
20										
25										

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. * denotes approximate coring rate (minutes/foot, unless noted otherwise). Coring down pressure was approximately 150 psi from 3.2' to 6.2', and 100 psi from 8.2' to 13.2'
3. Coarse piece of Gravel lodged in tip of core barrel (Core Sample No. C-2)
4. Frozen soil was encountered between depths of approximately 0.5' and 8.5'.
5. Elevations per laser level survey by Prism Builders, Inc. Referenced to El. 15.00 at top of lobby floor

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, MA 02064

Larson Rink - Proposed Slab Reconstruction

Winthrop, MA

Boring No. GZ-102
Page No. 1 of 1
File No. 19260.2
Checked By: MAR

Drilling Co.	New Hampshire Boring, Co.
Foreman	Todd Penticost
GZA Rep.	Ron Kubiak
Date Start	5/21/2007 End 5/21/2007
Location	See Exploration Location Plan
GS. Elev.	14.8 Datum Note 4

	Casing	Sampler
Type	NW	Split Spoon
I.D./O.D.	3" / 3.5"	1-3/8"/2"
Hammer Wt.	300#	140 lbs.
Hammer Fall	24"	30"
Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
NOT RECORDED				

DEPTH	CASING BLOWS	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	NOTES
		S-1	24/13	0-2	5-8		Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt. (FILL)	FILL	1, 2
					18-12				
		S-2	21/16	2-4	11-13		Very dense, brown, fine to coarse SAND, some Gravel, trace Silt. (FILL) Bottom 6" is frozen.		
					50-70/3"				
5									
		S-3	10/4				Frozen, brown, fine to medium SAND, some (+) Silt. (FILL) S-3A: Frozen, dark brown, fine grained PEAT.	6.5±	
		S-3A	15	6.2 - 7	15/3" 30			PEAT	
		S-4	24/24	7-9	35-40		Frozen, dark brown, fine-grained PEAT, little Woody Fibers. 3" Layer of Fibrous PEAT, Numerous 1/16"± and few 1/8"± ice lenses. One 1/4" ice lens in Fibrous Peat.		
					36-36				
10		S-5	24/20	9-11	18-4		S-5: Dark brown, fine-grained PEAT. Bottom 3" is PEAT and fine to medium SAND. Top 9"± is frozen and has ice lenses similar to sample S-4.		3
					7-16			11±	
		S-6	24/12	11-13	14-25		S-6: Wet, very dense, brown, fine to coarse (unfrozen) SAND and Gravel, little (-) Silt changing to fine to medium SAND trace (+) Silt.	SAND & GRAVEL	
					29-35				
							Bottom of Boring at 13 feet.		
15									
20									
25									

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. Advanced boring with casing to 3.5 feet, open-hole advancement from 3.5 to 7 feet, used casing from 7 feet to bottom of boring.
3. Frozen soil was encountered between depths of approximately 3 and 10 feet.
4. Elevations per laser level survey by Prism Builders, Inc. Referenced to El. 15.00 at top of lobby floor

LABORATORY TESTING DATA SHEET

Project Name Larsen Rink
Project No. 19260.20
Project Engineer M. Rodick

Location Winthrop, MA
Assigned By R. Kubiak
Report Date 5/25/2007

Reviewed By [signature]
Date Reviewed 5/25/07

				Identification Tests						Density	Strength Tests								
Boring No.	Sample No.	Depth ft.	Lab No.	Natural Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	Org. %	γ_d MAX (pcf) W_{opt} (%)	CBR Water Content %	CBR Dry unit wt. pcf	CBR @ 0.1" @ 0.2"	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Laboratory Log and Soil Description
GZ-102	S-3A	6.2-7	1	229					74.0									
GZ-102	S-4	7-9	2	633					86.3									
GZ-102	S-5	9-11	3	633					85.4									

GZA GeoEnvironmental, Inc.
Engineers and Scientists

GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

July 6, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

Re: Preliminary Monitoring Data Review
Larsen Rink - Slab Reconstruction
Winthrop, Massachusetts

One Edgewater Drive
Norwood
Massachusetts
02062
781-278-3700
FAX 781-278-5701
www.gza.com

Dear Mr. MacLaughlin:

In accordance with our agreement dated May 17, 2007, GZA GeoEnvironmental, Inc. (GZA) has reviewed monitoring data supplied by Prism Builders of Wakefield, Massachusetts (Prism), the project general contractor. Monitoring recommendations were contained in our Frozen Ground Summary Letter dated May 25, 2007. Since issuance of our letter, we attended a meeting at the site on June 6, 2007, where monitoring and construction progress were discussed. We received the attached monitoring data and related information from Prism between June 14 and 25, 2007. GZA prepared the attached settlement-time plots based on the data.

BACKGROUND

The reconstruction project includes new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink.

A test pit performed in May, 2007 in the rink area showed approximately 7 to 8 feet of frozen ground, beginning at a depth of approximately 2 feet below grade and extending to approximately 9 to 10 feet, when the reach of the machine was exceeded. GZA subsequently performed test borings in the rink area and observed frozen soil thickness ranged from 4 to 8 feet, and the frozen zone extended to a depth of approximately 6.5 to 10 feet below existing grade, which corresponds to approximate elevations +3 to +7 feet[1] (project datum).

Based on the borings, subsurface conditions consisted of about 1 to 3 feet of unfrozen sand and gravel fill over 2 to 5 feet of frozen sand and gravel fill, over 3 to 4 feet of frozen organic soils in

[1] Elevations presented in this report are approximate and are based on ground elevations provided by Prism Builders. We understand the elevations are based on an assumed project datum of +15.0 feet at the existing lobby floor (reference datum unknown).

MONITORING DATA

We received two pages of monitoring data from Prism. The first page was a hand-drawn sketch plan showing survey elevations of the top of the tie-beams surveyed on or about May 14, 2007, prior to starting the thawing. Also shown on the plan is the location of two settlement monitoring platforms (1A and 2A) installed on the excavated grade after thawing equipment was removed and before the surcharge was placed.

The second page was a spread sheet of survey data referenced to the plan by column location. Comparing the first reading (May 14) to the latest (June 19) indicates settlement of up to 2¼- inches. Three of the 9 tie-beam locations settled greater than 1 inch, 2 locations settled just under 1 inch, 2 location heaved up to about ½-inch and 2 locations did not move.

Since surcharge placement, Settlement Platform 1A has settled 1.6 inches and Settlement Platform 2A has heaved 1.3 inches. Tie-beam monitoring points have settled up to ¾-inch. Over about the last week (June 12 through 19) minor heave up to about ¼-inch was reported at each tie-beam locations except at C3 which settled between ¼ and ½ inch.

GZA has not visited the site since our meeting of June 6, 2007.

DISCUSSION

The settlement/heave trends of the data provided to GZA for interpretation is difficult to understand. It was anticipated that the amount of settlement during thawing would be at least equal to the observed heave. Up to about one foot of heave has previously occurred (based on survey of the top of concrete tie beams on May 14, 2007), but total settlement reported have been on the order of 1 to 2 inches. In addition, we anticipated settlement of several inches during the surcharge phase due to consolidation of the organic soils. Instead, the data indicates that a small amount of settlement has occurred during the surcharge phase. The heave trend over the last week is outside the normal range of measurement error and is unexpected. It appears the majority of the settlement occurred during the thawing phase.

The lack of appreciable settlement may indicate that the ground may not be completely thawed as indicated by Prism. It may also be due to survey error.

The data indicates that the tie-beams remain heaved from their originally-constructed position, similar to their positions prior to thawing and surcharging. We are concerned that the tie beams remaining heaved (and assumed to be in contact with the soil immediately below the beams) may indicate that bridging around voids may have occurred in the previously frozen soils. That is, if the soil within the previous frozen zone has settled due to melting of ice lenses and the tie beams and upper soils have not settled, small voids may be present in the previously frozen soils. If this is the case, these voids could later collapse and cause settlement of the beams and rink floor.

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the exploration logs.

3. Water level readings have been made in the explorations at the times and under the conditions stated on the logs. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed building are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc (GZA). It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

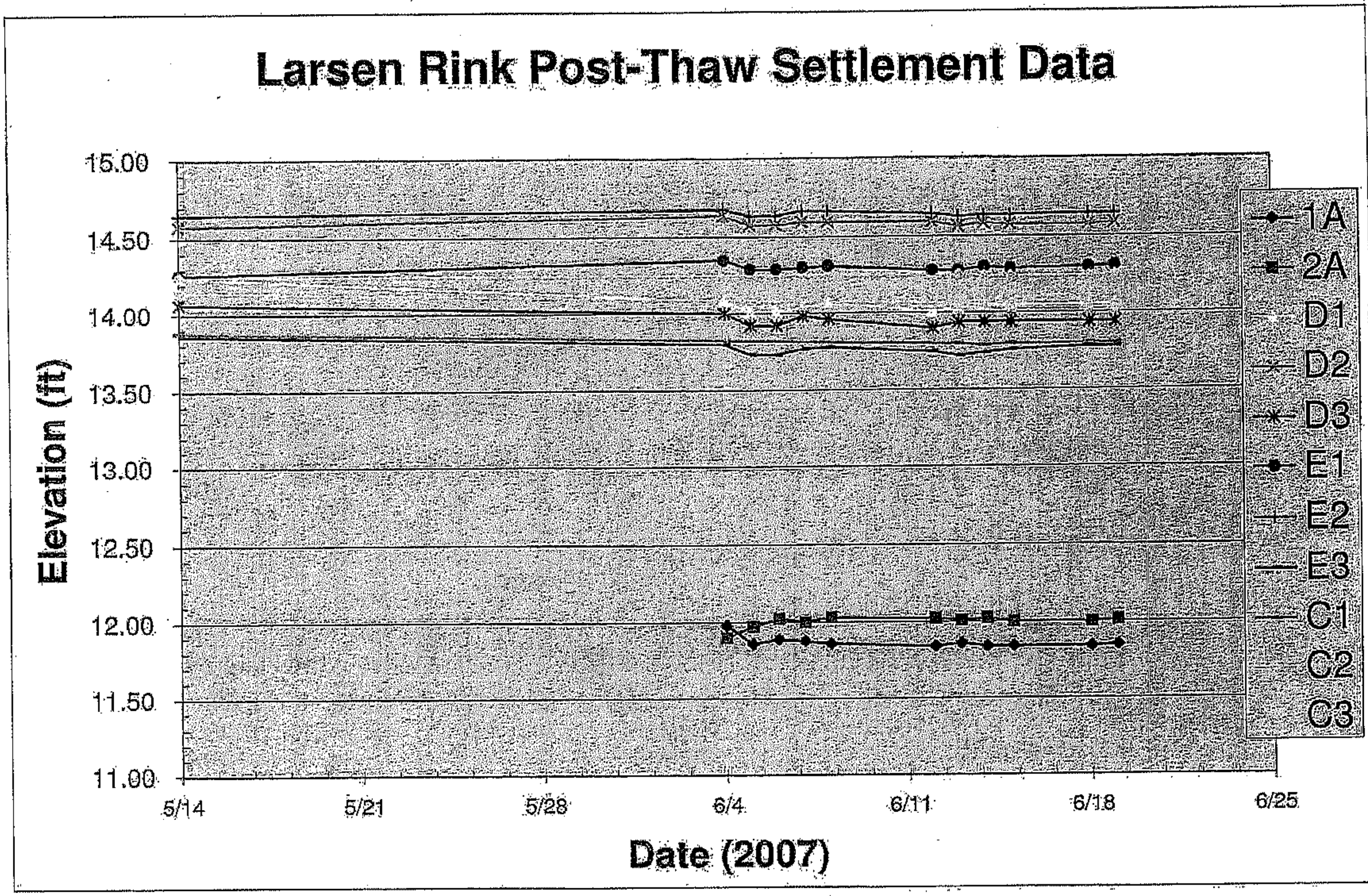
5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

6. This report has been prepared for the exclusive use of The Town of Winthrop and MacLaughlin Management and Design for specific application to the proposed slab repairs and building expansion of the existing Larsen Rink building at 45 Pauline Street in Winthrop, Massachusetts, in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

7. This soil and foundation engineering report has been prepared for this project by GZA. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

8. This report contains approximate cost estimates for purposes of evaluating alternative geotechnical design schemes. These estimates involve approximate quantity evaluations. A preliminary estimate of this nature is likely to vary substantially from Contractors' Bid Prices and is not to be considered the equivalent of nor as reliable as Contractors' Bid Prices. Prices for similar work undertaken in the future will be subject to general and sometimes erratic price increases.



Notes: 1. Plots are based on settlement data provided by Prism Builders on 6/19/07 and 6/21/07.
2. Points 1A and 2A are settlement platforms, other points are on the top of concrete-encased tie beams.

GEOTECHNICAL ENGINEERING REPORT
LARSEN RINK - SLAB REPAIRS AND EXPANSION
45 PAULINE STREET
WINTHROP, MASSACHUSETTS

PREPARED FOR:
Town of Winthrop
c/o MacLaughlin Management and Design
Kensington, New Hampshire

PREPARED BY:
GZA GeoEnvironmental, Inc.
Norwood, Massachusetts

December 2006
File No. 19260.0

feet along its short sides.

Figure 2 shows the relationship of the Larsen Rink building to the adjacent gymnasium building and the surrounding streets and property lines.

Based on our review of the above referenced drawings from the original building design, the building's structural loads are supported by driven 12-inch-diameter steel Monotube pile foundations with concrete pile caps. The piles are shown supporting the exterior walls in groups of two to four piles per column, with a design capacity of 35 tons each, with 25 tons supporting the structure and 10 tons allowed for negative skin friction. The existing ice area and thin bituminous slab within the surrounding building area is not pile-supported. In the ice rink area, the drawings show a thin bituminous paving (which, according to Mr. Wallace, does not currently exist below the ice), underlain by 6 inches of sand with embedded refrigeration lines, over 2 inches of urethane insulation. The drawings indicate 4 feet of "non frost-susceptible granular fill" below the insulation. The drawings also show steel tie rods running between pile caps at each column across the width of the building. The tie rods are encased in concrete and are immediately below the urethane insulation below the ice.

The drawings also indicate that, prior to raising the site grades over the building area, a program of placing a construction surcharge and allowing for settlement (measured with settlement platforms) over a 6 to 9 month period was to be performed, followed by removal of the surcharge and placement of free-draining structural fill soils to raise the grade by about 2.5 feet above pre-existing conditions. Actual construction records are not available documenting the implementation of the surcharge program.

Based on GZA's observations while on site, and information provided by Mr. Wallace, differential settlement and/or heave of the ice surface and surrounding bituminous pavement/slab has occurred. This differential settlement has been observed at any one time to be as much as 4 inches over short distances (less than 10 feet) below and adjacent to the ice surface. The surface of the ice currently contains a relative high "humped" zone that is at least 2 to 3 inches higher than the remainder of the ice, and runs approximately diagonally across the ice from the northeast faceoff circle to the southwest faceoff circle.

Based on our observations while on site, the structural walls and columns of the existing building appeared to be in relatively good condition, with some minor infrequent step-cracking observed in the mortar of the exterior brick façade.

Proposed Construction

It is our understanding that the Town of Winthrop intends to remove the existing ice surface, refrigeration piping, and surrounding bituminous slab and supporting materials (as necessary) and replace them with new concrete slabs, refrigeration piping, and supporting materials (as necessary). The refrigeration lines would be contained within the concrete slab. The proposed ice elevation is the same as the existing ice elevation (i.e. no raise-in-grade).

Test Pits

Four interior test pits were performed (TP-1 through TP-4) within the existing building on November 9, 2006. The test pits were performed to depths of 4.5 to 5 feet by Ronald Marini Corp. of Newton, Massachusetts using a mini-excavator. The existing bituminous surface layer was saw cut prior to excavating the test pits. GZA observed and logged the test pits and obtained samples of existing fill soils for laboratory gradation analyses. At TP-1 and TP-2, the size and depth of adjacent subsurface concrete structures were measured. The test pits were backfilled with the excavated materials, compacted by tamping in lifts with the excavator bucket upon completion. Patching of the bituminous surface course was to be performed by Town of Winthrop personnel.

Refer to Figure 2 for approximate test pit locations. Test pit logs are attached as Appendix C.

GEOTECHNICAL LABORATORY TESTING

GZA performed laboratory gradation analyses on six soil samples from the explorations (TP-1, S-1; TP-2, S-2; TP-3, S-2; TP-4, S-1; GZ-1, S-1A; and GZ-1, S-2A) to confirm visual classifications and assess soil reuse potential. Results are included in Appendix E.

SUBSURFACE CONDITIONS

Soils

Subsurface soil conditions varied greatly from the south side of the rink (near Pauline Street) to the north side of the rink. South of the rink, subsurface conditions generally consisted of granular soils. However, north of the rink, thick fill and thick fill and organic deposits are present. Based on discussions with Mr. Driscoll, we understand that the area north of the rink was previously filled. This is consistent with our review of historical USGS topographical maps that show the area north of the rink as water in 1903, and as land in 1943. The current USGS topographic map (Figure 1) shows the rink as being on filled land.

The following two concrete structures were encountered in the interior test pits: In TP-1, the top edge of a foundation element (likely a pile cap or grade beam) was observed at an approximate depth of 3.8 feet; and, in TP-2, the side of what appeared to be a concrete-encased tie rod was observed over a depth range of 0.8 to 2.1 feet.

Soil stratum descriptions in order of increasing depth are given below:

Fill: In GZ-1 (south of the rink), fill was encountered to a depth of 4 feet. In this boring and in the interior test pits, the fill was generally observed as brown, loose to medium dense, fine to coarse sand with up to about 35 percent gravel, and up to about 15 percent silt. In TP-1 through TP-3, the silt content in the fill was less than 6 led to significant differential settlement of the bituminous pavement and ice support layer across the building. Furthermore, the secondary compression will continue and thus impacts design considerations for the ice rink slab reconstruction. The amount of secondary compression will vary across the building due to the varying thickness of organic soils.

Due to the relatively shallow groundwater encountered, a permanent sub-slab drainage system is required to maintain the groundwater level below the slab base course during times of high groundwater. Temporary dewatering may be required during construction. The high groundwater table likely contributes to the heave observed in the ice surface and interior bituminous pavement.

Proposed Building Expansion

The primary geotechnical issues for the design of new foundations and slabs at the proposed building expansion area are: the significant variability of the soil conditions observed at the site, as observed in GZ-1 versus GZ-2; the possible presence of organic soils (as observed in GZ-2); the presence of loose granular soils (as observed in GZ-1); and the relatively high groundwater table observed in the explorations.

Due to the considerable variability in the soil conditions encountered in borings GZ-1 and GZ-2, including high variability in the depth of fill and presence of organic soils encountered, the geotechnical recommendations provided herein pertaining to the proposed building addition are considered preliminary. We recommend that an additional boring be performed to a depth of approximately 50 feet at the eastern extent of the proposed building addition prior to preparation of final geotechnical recommendations for the addition.

The loose density of several SPT samples below the water table in the natural granular soils in boring GZ-1 increases the potential for liquefaction and settlement due to seismic loading in these soils and may require further analyses if the building addition is not supported on piles bearing below the loose granular soils. Such analyses were not performed as part of this geotechnical evaluation, but should be performed prior to issuing final foundation and slab engineering recommendations for the proposed addition.

GEOTECHNICAL RECOMMENDATIONS

The geotechnical design and construction recommendations presented below are based on our understanding of the existing site conditions and proposed development, and our evaluation of the available subsurface data. These recommendations are subject to the limitations contained in Appendix A.

cost for a structural slab above a slab on grade. Should this option be selected, additional borings would need to be performed within the area of proposed slab reconstruction to evaluate the depth to the bearing stratum so that pile lengths could be estimated.

Geogrid-Soil Mat

If the risk of differential slab settlement is acceptable to the Town, and the option of a slab on grade is being considered, the differential settlement may be mitigated to some degree (but not completely) with the use of a layer of biaxial geogrid above and below a sub-slab drainage layer. Figure 3 presents a schematic sketch of this concept. The geogrid-soil-geogrid "sandwich" would produce a relatively stiff geocomposite mat that would distribute stresses better than soil alone, and may help mitigate potential slab cracking due to differential soil settlements below. During the design and construction of this option, consideration would have to be made for the existing concrete-encased tie rods running across the building width, which may physically prevent installation of portions of the geogrid.

The slab designer should consider the potential impact of the vertical load of the slab-on-grade on the tie rods when evaluating if this is a viable option.

The designer may also want to consider embedding the refrigeration pipes in a thin sand layer below the ice, underlain by insulation, similar to the current design and typically used for seasonal rinks. Although the differential settlement would still occur, long-term maintenance of the pipes and leveling of the sand layer may be easier than repairing or replacing a concrete slab.

Sub-Slab Drainage

With either slab-on-grade or structural slab support, a sub-slab drainage system is recommended to maintain the groundwater level about 3 feet below the ice level

The sub-slab drainage layer would contain a network of perforated PVC collection pipes connected to solid header pipes, which would be graded to drain to a sump which would be pumped, or drain by gravity into on-site drainage lines. The pipes would be set above the recently measured groundwater levels to avoid continuous, year-long dewatering. However, appropriate permits would be required for discharge of the water.

Figure 3 shows the drainage pipes below the slab-on-grade option. The collection pipes should be spaced at approximately 25 feet on-center.

additional boring should be performed to confirm conditions prior to adopting a site coefficient (S) factor used to evaluate the total lateral seismic force on the proposed building addition. However, based on GZ-1, our preliminary recommended S-Factor is 1.5 (Soil Profile Type S_3).

6. Frost Protection for Proposed Building Addition

Exterior footings and interior footings or underside of pile/PIF caps in unheated areas of the proposed addition should bear at least 4 feet below the final exterior grades for frost protection. Interior footings and underside of pile/PIF caps in heated areas should bear at least 18 inches below top of slab. Protect all subgrades for footings or PIF/pile caps from frost during construction.

7. Lateral Loads for Proposed Building Addition

For spread footings, we recommend that lateral loads for the proposed addition be resisted by sliding friction between the base of spread footings and subgrade soils. We recommend a friction factor against base shear of 0.4. The factor of safety against sliding should be at least 1.5.

Alternatively, should pile or PIF foundations be used, we recommend that lateral loads be resisted by passive soil resistance of the pile caps and grade beams against adjacent compacted Structural Fill. We recommend an allowable passive resistance be calculated using an equivalent unit weight of 180 pounds per square foot, discounting the contribution of the top 1 foot of soil.

Construction Recommendations

1. Slab Subgrade Preparation

For slab-on-grade construction (if selected), remove existing fill to bottom of proposed sub-slab drainage layer and proof-roll the exposed subgrade with a minimum of 6 passes of a large vibratory drum roller (minimum static weight of 10,000 pounds) and overexcavate any weak or soft spots identified during proof compaction. In confined areas, proof-rolling may be performed with a walk-behind double-drum roller with a minimum static weight of 1,000 pounds. Care should be taken to protect existing tie rods and existing concrete pile caps and grade beams. Do not proof-roll with large roller over the existing tie rods.

Replace excavated material with compacted Sand-Gravel Fill or Crushed Stone. Refer to Figure 3 for conceptual sketch of sub-slab drainage layer for the slab-on-grade option. Gradation requirements are provided in Table 2.

the Massachusetts Contingency Plan (MCP) if contamination exceeds Reportable Concentrations.

4. Protection of Adjacent Structures

Care should be taken when excavating or performing below grade construction to avoid damage to existing pile caps, grade beams, and tie rods for the existing building and the adjacent school gymnasium building.

5. Construction Dewatering

Excavations for the proposed ice rink slab reconstruction and new foundations for the proposed addition are anticipated to be close to or below the groundwater table. Thus, especially immediately after precipitation events, construction dewatering may be required to conduct all work "in the dry". Based on review of existing soil conditions, we anticipate this can be achieved with sump pumps with discharge on-site into excavated pits. Otherwise, discharge of pumped water to existing sanitary/storm sewers would require a federal, state and/or local discharge permit and chemical testing of the water.

FINAL DESIGN AND CONSTRUCTION

As stated above, we recommend the following additional subsurface explorations be performed prior to final design:

- An additional deep boring should be performed in the proposed building addition area prior to developing final foundation and slab recommendations for this construction;
- Should a pile-supported slab be selected, additional borings should be performed in the proposed area of slab reconstruction to verify required pile depths.

We trust the information presented herein is sufficient for your use in preparing final development plans for the proposed slab replacement work, and to advance building expansion design development. GZA recommends that we be retained to prepare the earthwork specifications and to review and comment on near-final construction plans to assist with implementation of our recommendations.

During construction, GZA should observe site earthwork and foundation construction for compliance with our recommendations, project foundation plans, and earthwork specifications.

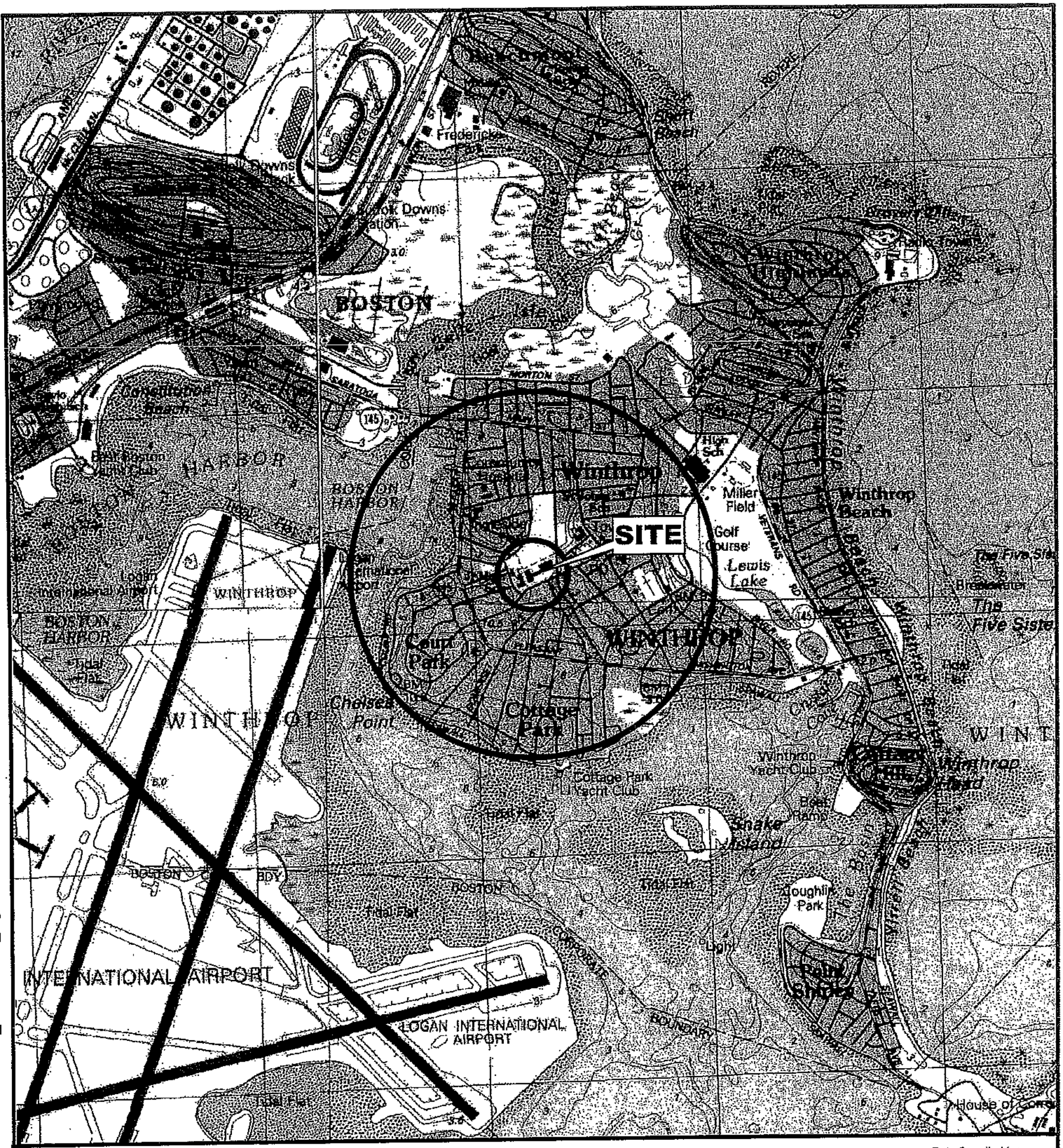
TABLES

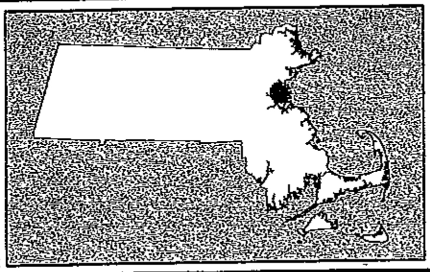
TABLE 2

COMPACTION METHODS

Compaction Method	Maximum Stone Size*	Maximum Loose Lift Thickness		Minimum Number of Passes	
		Below Structures and Pavement	Less Critical Area	Below Structures and Pavement	Less Critical Area
GRANULAR FILL; SAND-GRAVEL; CRUSHED STONE					
Hand-operated vibratory plate or light roller in confined areas	4"	6"	8"	4	4
Hand-operated vibratory drum rollers weighing at least 1,000# in confined areas	6"	10"	12"	4	4
Loaded 10-wheel truck or D-8 Crawler	6"	10"	12"	4	2
Light vibratory drum roller minimum weight at drum 3,000# minimum dynamic force 10,000#	8"	12"	18"	4	4
Medium vibratory drum roller minimum weight at drum 10,000# minimum dynamic force 20,000#	8"	18"	24"	6	6

* And no more than two-thirds (2/3) loose lift thickness.





SOURCE : SCANNED USGS TOPOGRAPHIC QUADRANGLES SCANNED BY THE MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS, MASSGIS. DISTRIBUTED JUNE, 2001.

Data Supplied by :

MASS GIS

0 1,000 2,000 4,000 6,000 Feet

N W E S

GZA

PROJ. MGR.: MAR
DESIGNED BY: MAR
REVIEWED BY: MAR
OPERATOR: OCO

DATE: 11-27-2006

SITE LOCATION MAP
SHOWING 500 FOOT & 1/2 MILE RADII

LARSEN RINK RENOVATIONS
45 PAULINE STREET
WINTHROP, MASSACHUSETTS

JOB NO.
01.0019260.00

FIGURE NO.
1

G:\19260\19260-00.MR\Figures\GIS\MXD Documents\192600-00_SiteLocation_Fig1.mxd

GZA
GeoEnvironmental, Inc.
One Edgewater Drive
Norwood, MA 02062
781-278-3700
Fax 781-278-5701
http://www.gza.com

Engineers and Scientists

JOB: LARSEN RINK 19260.0
SHEET NO. 1 OF 1
CALCULATED BY MAJC DATE 11-30-06
CHECKED BY MBH DATE 12-1-06
SCALE

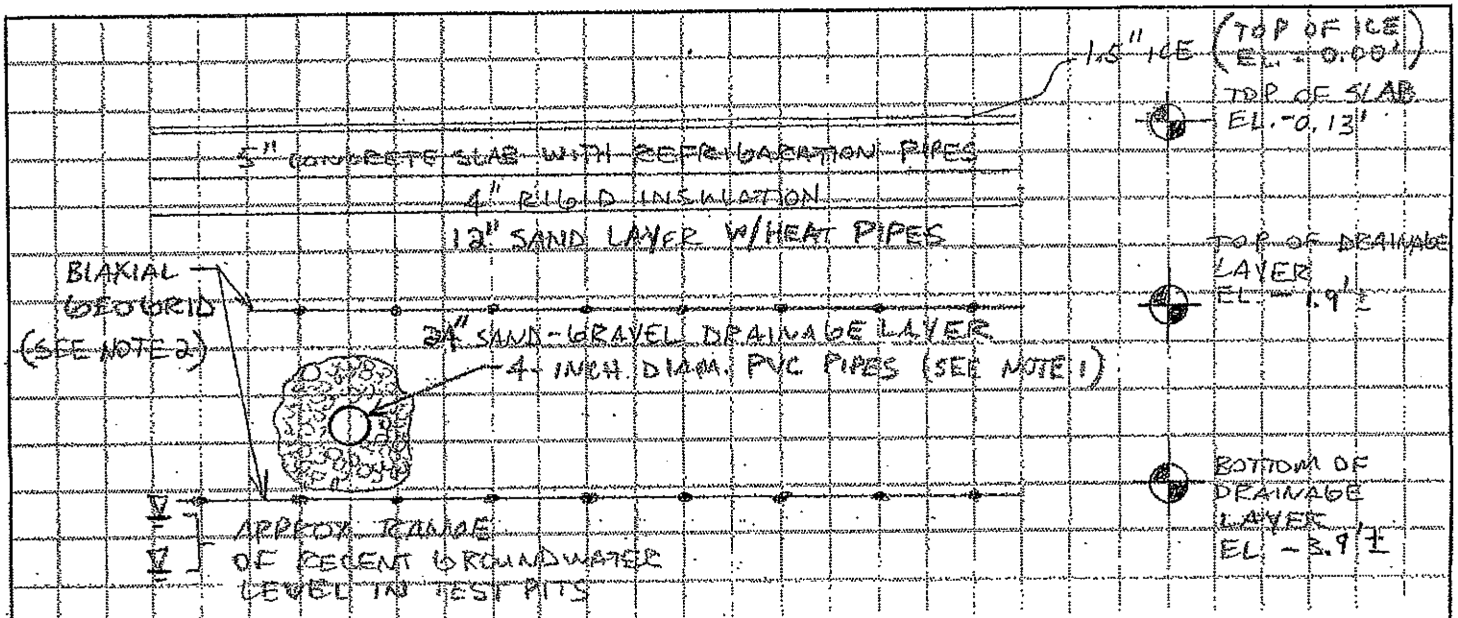


FIGURE 3 – SCHEMATIC SKETCH OF GEOGRID-SOIL MAT AND SUB-SLAB DRAINAGE LAYER

APPROXIMATE SCALE: 1/2-INCH = 1'-0"

NOTES:

1. DRAINAGE LAYER MAY ALSO CONSIST OF ¾-INCH CRUSHED STONE, ENVELOPED IN NON-WOVEN FILTER FABRIC (MIRAFI 140N OR EQUIV.). IF LAYER CONSISTS OF SAND-GRAVEL, COLLECTION PIPES SHALL BE SUROUNDED BY MIN. 6-INCHES OF CRUSHED STONE, WRAPPED IN NON-WOVEN FILTER FABRIC (MIRAFI 140N OR EQUIV.).

2. GEOGRID-SOIL MAT IS INTENDED TO MITIGATE DIFFERENTIAL SETTLEMENT BUT WILL NOT ELIMINATE DIFFERENTIAL SETTLEMENT. BIAXIAL GEOGRID REINFORCEMENT DESIGN TO BE DETERMINED.

3. EXISTING CONCRETE-ENCASED TIE RODS (NOT SHOWN FOR CLARITY) WILL IMPACT DESIGN AND CONSTRUCTION OF GEOGRID REINFORCEMENT.

GZA GeoEnvironmental, Inc.
133 Federal Street
Boston, MA 02110
Phone: (617) 482-1000 / Fax: (617) 482-6868

ADDENDUM TO CONTRACT-ENGINEERING CONSULTING SERVICES

CLIENT NAME/ADDRESS: MacLaughlin Management and Design, 12 Kady Lane, Kensington, NH 03833	**PROJECT:** Larsen Rink Settlement **LOCATION:** 45 Pauline St, Winthrop, MA 02152	**Date:** 9/5/08 **Project No.:** 19260.3 153.09
Contact: Terry MacLaughlin **Phone:** 603-686-0423 **Fax:**	**GZA PM:** Martin Rodick, P.E. **GZA PIC:** Bruce Fairless, P.E. **GZA C/R:** William Hover, P.E.	

SCOPE OF SERVICES:

Based on our understanding of the project, we proposed the following additional scope of work:

- Attend meeting on September 10, 2008

BASIS OF CHARGES:

Billings for the above described scope of services will be in accordance with our original agreement dated August 12, 2008. Estimated charges for the scope of work described herein are:

- Attend meeting on September 10, 2008 - $800

This increases our contract amount as follows:

Original contract amount:	$2,500
Net change due to previous Addendums:	$800
Revised Contract Amount including this Change Order:	$3,300

This estimate is based on the anticipated scope of work outlined above which represents our best judgment at this time as to the efforts required. Recognize, however, that unforeseen conditions which become evident during the course of the studies may alter or increase the scope of work required.

SCHEDULE:

CONDITIONS:

Terms of Engagement are as for our existing agreement dated August 12, 2008. Issuance of a Purchase Order implicitly implies acceptance of the attached Terms and Conditions.

ACCEPTANCE:

This Addendum for Services and the attached Terms and Conditions are hereby accepted and executed by a duly authorized signatory, who by execution hereof, warrants that he/she has full authority to act for, in the name, and on behalf of Client.

CLIENT NAME	GZA GEOENVIRONMENTAL, INC.
By: _______________ Date: __________	By: Bruce C. Fairless Date: 9/5/08
(Signature)	(Signature)

Please return one signed copy to GZA.

APPENDIX A

LIMITATIONS

APPENDIX B

FOUNDATION PLANS FROM ORIGINAL ICE RINK CONSTRUCTION

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, Massachusetts 02062

Larsen Rink-Slab Repairs and Expansion

Winthrop, Massachusetts

Boring No. GZ-1
Page: 1 of 2
File No. 19260.00
Checked By: MAR

			Casing	Sampler
Drilling Co.	New Hampshire Boring, Inc.			
Foreman	Steve Bolduc	Type	HW	Split Spoon
GZA Rep.	Ron Kubiak	I.D./O.D.	4"/4.5"	1-3/8"/2"
Date Start	11/8/06 End 11/8/06	Hammer Wt.	300#	140#
Location	See Exploration Location Plan	Hammer Fall	24"	30"
GS. Elev.	Datum	Other	4-1/4" HSA	

Groundwater Readings

Date	Time	Depth	Casing	Stab.
11/8/06	0845	NE	4.5' HSA	10 min
11/8/06	0910	5.3'	8' HSA	10 min

Depth	Casing Blows	No.	Pen/Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description and Classification	Stratum Description	Notes	
		S-1	24/12	0.5-2.5	4-5		Top 4": Medium dense, olive-brown, fine to medium SAND, some (+) Gravel, some (-) Silt. Bottom 8" (S-1A): Medium dense, brown, fine to coarse SAND, little (+) Gravel, trace Silt.	0.3' ASPHALT; FILL; 4'±	1, 2	No Equipment Installed
					6-6					
		S-2	24/11	2.5-4.5	4-5		S-2: Top 6": Loose, brown, fine to medium SAND, little (+) Gravel, trace Silt. Bottom 5" (S-2A): Olive-brown, fine to coarse SAND, some Gravel, little Silt. Wet near bottom.			
					3-16					
5		S-3	24/12	4.5-6.5	4-10		S-3: Wet, medium dense, dark brown, fine to coarse SAND and GRAVEL, trace (+) Silt.	SAND and GRAVEL; 9.5'±		
					14-24					
10		S-4	24/16	9-11	13-6		Top 4": Wet, medium dense, brown, angular GRAVEL, some fine to coarse Sand, little (+) Silt. Middle 6" (S-4A): Wet, medium dense, olive-brown, fine to medium SAND, trace Silt. 2" layer of SILT, some fine Sand. Bottom 6" (S-4B): Wet, stiff, gray, olive SILT and CLAY, trace Gravel, trace fine Sand.	10.5'± SAND; SILT and CLAY; 15'±		
					6-8					
15		S-5	24/12	14-16	4-3		Top 6": Wet, medium stiff, olive SILT and CLAY grading to Clayey SILT. Bottom 6" (S-5A): Wet, loose, olive, Clayey SILT grading to SILT.	SILT; 17.5'±		
					4-7					
20		S-6	24/2	19-21	4-9		Wet, medium dense, olive, Angular GRAVEL, some fine to coarse Sand, trace (+) Silt.	SANDY GRAVEL	3	
					11-7					
25		S-7	24/2	24-26	6-7		Wet, medium dense, olive, Angular GRAVEL, little fine to coarse Sand, trace Silt.		4	
					10-9					
		S-8	24/3	26-28	9-10		Wet, medium dense, olive, Angular GRAVEL, little fine to coarse Sand, trace (+) Silt.		4	
					7-6					
		S-9	24/7	29-31	6-4		Wet, loose, gray-brown, GRAVEL, some (+) fine to coarse Sand, trace Silt.		5	
30										

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. Advanced borehole with augers from 0 to 9 feet. Used 4-inch ID casing from 9 feet to bottom of boring.
3. Significant water loss while drilling from 19 to 24 feet.
4. Coarse piece of gravel stuck in tip of split spoon sampler for samples S-7 and S-8.
5. 12-inches of wash in casing during recovery of sample S-9. 6-inches of gravel wash above sample S-9.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, Massachusetts 02062

Larsen Rink-Slab Repairs and Expansion

Winthrop, Massachusetts

			Casing	Sampler
Drilling Co.	New Hampshire Boring, Inc.			
Foreman	Jason Stokes	Type	NW	Split Spoon
GZA Rep.	Adam Michonski	I.D./O.D.	3"/3.5"	1-3/8"/2"
Date Start	11/8/06 End 11/8/06	Hammer Wt.		140#
Location	See Exploration Location Plan	Hammer Fall		30"
GS. Elev.	Datum	Other	2-1/4" HSA	

Groundwater Readings

Date	Time	Depth	Casing	Stab.
11/8/06	0815	3'	4' HSA	15 min

Depth	Casing Blows	No.	Pen/Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description and Classification	Stratum Description	Notes	
		S-1	24/16	0-2	8-11		Top 2": TOPSOIL. Bottom 14": Medium dense, brown, fine to medium SAND, little (+) Silt, trace Organics.	0.16' TOPSOIL	1 2	
					14-12			FILL		
		S-2	24/6	2-4	13-21		S-2: Moist, dense, gray-brown, fine SAND, trace (+) Silt, slight organic odor.			
					28-36					
5		S-3	24/20	4-6	12-8		Top 12": Moist, dense, gray-brown, fine SAND, trace (+) Silt, slight organic odor. Bottom 8": Wet, dark gray, fine to medium SAND, trace Silt, organic odor.		3	No Equipment Installed
					17-24					
		S-4	24/18	6-8	11-13		S-4: Medium dense, light gray, fine SAND, trace Silt, slight organic odor.			
					11-13					
10		S-5	24/18	9-11	12-9		Top 3": Dark brown-black, fine to medium SAND, some Silt, little Gravel. Middle 13": Gray-brown, fine to coarse SAND, little Gravel, little Silt, trace Sea Shell fragments, Glass, possible Cinders, Ceramics. Bottom 2": Olive, fine SAND, little Silt, little Gravel, slight organic odor.			
					7-7					
15		S-6	24/14	14-16	8-6		Medium dense, black-dark brown, fine to coarse SAND, some Silt, some Cinders/Ash/Glass/Sea Shell fragments, little Gravel.			
					6-5					
		S-7	24/0	16-18	6-4		No Recovery.			
					7-6					
		S-8	24/16	18-20	9-5		Loose, black-dark brown, fine to coarse SAND, some Silt, some Cinders/Ash/Glass/Sea Shell fragments, little Gravel, trace pieces of Leather.			
					4-4					
20		S-9	24/20	20-22	4-3		S-9: Top 16": light gray-black, fine to coarse SAND, some Silt, some Cinders/Ash/Glass/Sea Shell fragments, little Gravel, trace pieces of Leather. Bottom4": Brown-olive, fine SAND, little Silt, trace Gravel, organic odor.	21.7'±		
					3-4			SAND with OCCASIONAL ORGANICS		
		S-10	24/12	22-24	6-8		S-10: Medium dense, brown-olive, fine SAND, little Silt, trace Gravel.			
					8-9					
25										
		S-11	24/10	26-28	7-9		S-11: Top 8": Olive-brown, fine to medium SAND, trace Silt, trace Gravel. Bottom 2": Black, fine grained PEAT, little fine Sand, (chunk of decaying wood fibers at tip of spoon).			
					12-16					
		S-12	24/3	28-30	20-28					
30					15-12					

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. Driller advanced borehole with HSA to 4 foot depth. Switched to cased drilling at 4 feet.
3. Samples below S-3 were wet.

APPENDIX D

TEST PIT LOGS

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, Massachusetts 02062

Larsen Rink - Slab Repairs and Expansion
Winthrop, MA

Test Pit No.	TP-2
Page No.	1 of 1
File No.	19260.00
Checked By:	MAR

Excavation Equipment

GZA Rep.	Ron Kubiak	Contractor	Ron Marini Corp.			Date	11/9/06
		Operator	Jerry Dearaujo			Ground Elev.	
Weather	Indoor Work	Make	JCB	Model	Micro	Time Started	0910
		Capacity	3/4 C.F.	Reach	6 ft.	Time Completed	1045

Depth	Soil Description (East Side – West Side)	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0	0.2' ASPHALT PAVEMENT					
	Orange-Brown, fine to coarse SAND, some Gravel, little Cobbles/small Class A Boulders trace Silt. (FILL)			E		1
1'		S-1 (0.5-3.5)		E		
2'	SEE NOTE 1			E		
3'	3.5'			E		
4'	Brown, fine to coarse SAND some fine to coarse GRAVEL, trace Silt. Isolated thin layers of dark brown gravelly sand, little Silt. (FILL)	S-2 (3.5-5.0)		E		2
5'	Bottom of Test Pit at 5'					
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

1. A 1.3' thick concrete structure (running north-south with a smooth face) was encountered at a depth of 0.8' along the east side of the test pit.
2. Test pit backfilled upon completion

Test Pit Plan

4' × 2' ↓ NORTH

Volume = 1.5 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E----Easy
M----Moderate
D----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YBL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
5 min	4.7

GZA GeoEnvironmental, Inc.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, Massachusetts 02062

Larsen Rink - Slab Repairs and Expansion
Winthrop, MA

Test Pit No. TP-4
Page No. 1 of 1
File No. 19260.00
Checked By: MAR

GZA Rep. Ron Kubiak
Weather Indoor Work

Excavation Equipment
Contractor Ron Marini Corp.
Operator Jerry Dearaujo
Make JCB Model Micro
Capacity 3/4 C.F. Reach 6 ft.

Date 11/9/06
Ground Elev.
Time Started 1200
Time Completed 1250

Depth	Soil Description (North Side / South Side)	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0	0.15' ASPHALT PAVEMENT			E		
	Light Brown, fine to medium SAND, trace (+) Silt, trace Gravel. (FILL) 1.5'	S-1				
1'		(0.5-1.5)		E		
2'	2'			E		
	Brown, fine to coarse SAND, some fine to coarse Gravel, trace (+) Cobbles, trace Silt. (FILL)					
3'		S-2		E		
4'	4.3'	(2.0-5.0)		M		1
	Dark gray-brown, fine to medium SAND, some Gravel, little Silt. (FILL)					
5'	Bottom of Test Pit at 5'					
6'						
7'						
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:
1. Test pit backfilled upon completion

Test Pit Plan
3.5'
2.5'
NORTH
Volume = 1.6 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E----Easy
M----Moderate
D----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

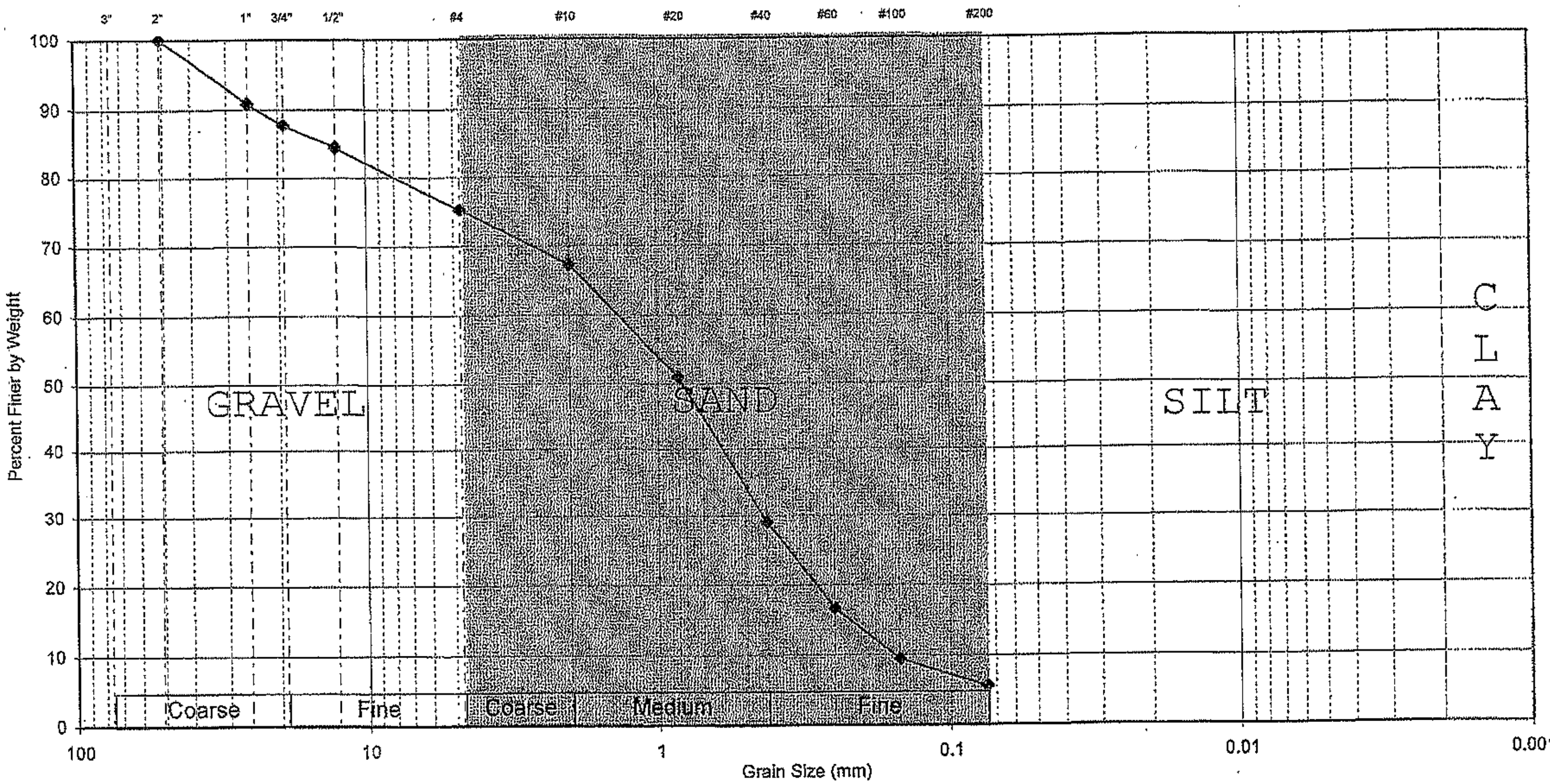
Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
(X) Encountered
( ) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
5 min	4.7

GZA GeoEnvironmental, Inc.

U.S. STANDARD SIEVE AND HYDROMETER



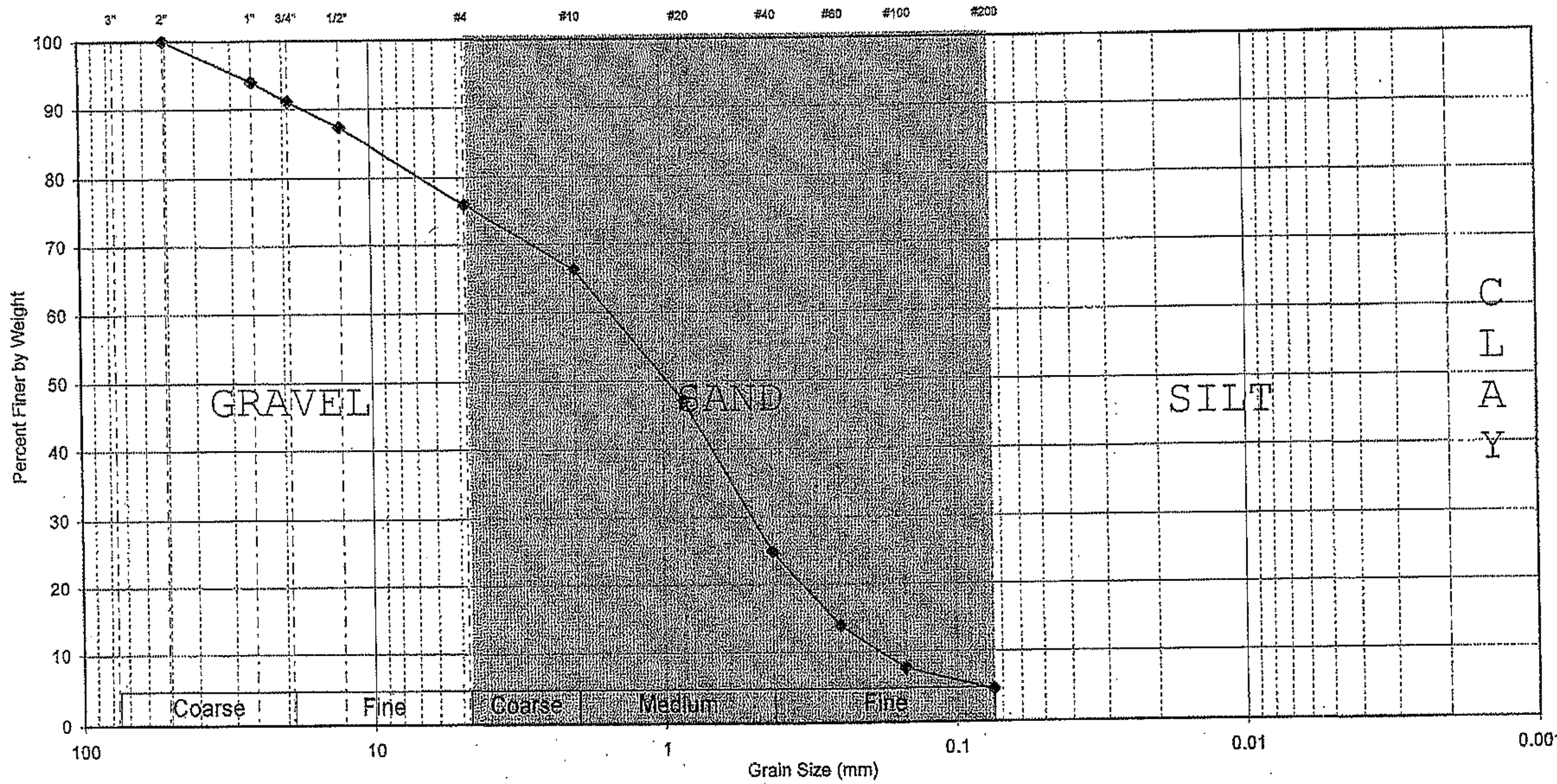
Gravel	Sand	Fines
24.8%	69.7%	5.5%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
1	TP-1	S-1	0.5-3.5'	Brown f-m SAND, some f-c Gravel, trace Silt				

Larsen Rink Slab Repairs
Winthrop, MA
GZA File # 19260

Tested by:	PEC	Date:	11/11/06
Reviewed by:	MBP	Date:	11/13/06

U.S. STANDARD SIEVE AND HYDROMETER



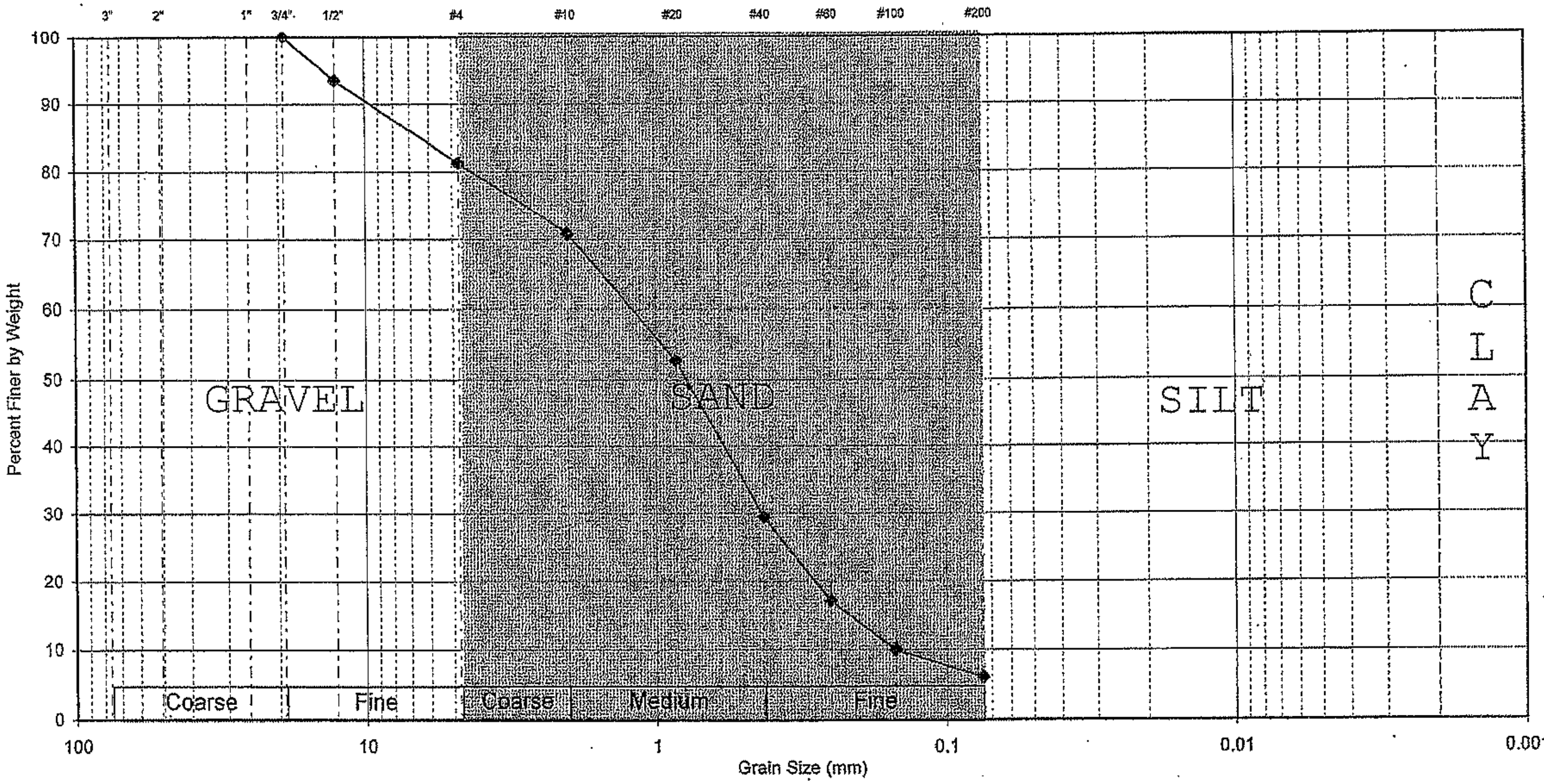
Gravel	Sand	Fines
24.2%	71.4%	4.5%

Lab #	Exploration	Sample	Depth	Description	WC	LL	PL	PI
3	TP-3	S-2	2-5'	Brown f-m SAND, some f-c Gravel, trace Silt				

Larsen Rink Slab Repairs
Winthrop, MA
GZA File # 19260

Tested by: PEC Date: 11/11/06
Reviewed by: MBP Date: 11/13/06

U.S. STANDARD SIEVE AND HYDROMETER



Gravel	Sand	Fines
18.8%	75.1%	6.0%

Lab #	Exploration	Sample	Depth (ft)	Description	WC	LL	PL	PI
5	GZ-1	S-1A	1.5 - 2.5'	Brown f-c SAND, little fine Gravel, trace Silt				

Larsen Rink Slab Repairs
Winthrop, MA
GZA File # 19260

Tested by: JMN Date: 11/14/06
Reviewed by: MBP Date: 11/15/06

MMD MacLAUGHLIN MANAGEMENT & DESIGN
Ice Skating & Sports Facility Consultants

5/18/07

Bruce -

What we need definitely is
components #1 #2 & #6. Anything
else will be on as need basis

Terry

PO Box 45 ■ Exeter, New Hampshire 03833 ■ Phone 603-772-8535 ■ Fax 603-778-0618 ■ Email ice@rcn.com

GZA
GeoEnvironmental, Inc.
Engineers and Scientists

May 17, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

133 Federal Street
10th Floor
Boston, MA 02110
617-482-1000
Fax: 617-482-6868
www.gza.com

Re: REVISED Proposal for Geotechnical Construction Phase Services
Larsen Rink – Proposed Slab Reconstruction
Winthrop, Massachusetts

Dear Mr. MacLaughlin:

In accordance with your request, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this revised proposal for construction phase services for the above-referenced project to MacLaughlin Management and Design (Client). The objective of our work is to address frozen ground issues that have recently been identified and provide geotechnical guidance and assistance during below-ground construction activities.

BACKGROUND

Based on our work on the project to date, and telephone conversations with you and with Mr. Sean Driscoll of the Town of Winthrop, we understand that the proposed slab reconstruction project will include demolishing and rebuilding the ice rink (excluding the building but including the existing ice surface and supporting sand layer, refrigerant piping, insulation, and dasher boards) as well as the unreinforced bituminous concrete pavement surrounding the ice rink. The proposed reconstruction will include new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink, consistent with one of the alternatives presented in our geotechnical report dated December 4, 2006, and shown on Contract Drawing No. G-1 prepared by GZA.

As stated in our report, this option of slab support should mitigate, but will not eliminate the differential settlement of the proposed slab due to ongoing secondary compression of the compressible organic soils believed to be present below the building and observed drilling techniques. The borings will be backfilled with the excavated material. Excess drill cuttings will be left on a site at a location designated by the Owner. We assume that the Owner will provide us access to water for drilling.

A GZA representative will coordinate and observe the exploration program, identify frozen soil, classify soil samples using the modified Burmister soil classification system, and prepare logs. Exploration locations will be based on tape measurements from existing site features. Exploration elevations will be estimated based on survey provided by the contractor (paid for by others).

Selected samples will be analyzed in our geotechnical laboratory for water content and organic content.

2. Frozen Ground Summary Letter

GZA will evaluate subsurface conditions beneath the rink based on the borings and the proposed construction. We will outline construction options to mitigate additional settlement due to thawing of the frozen ground. We will also provide monitoring recommendations. An exploration location plan and typed boring logs will be appended to the letter.

3. Review of Contractor Submittals

GZA will review and provide written comments on submittals required to be provided by the Contractor per project specification Section 02300 Earthwork, including excavation and backfilling methods, temporary support of concrete-encased structural ties, and proposed soils and geogrid materials. Our budget includes review of two submittals of proposed construction means and methods, and one geogrid materials submittal.

4. Construction Observation

GZA will visit the site to observe and document the following for conformance with the project documents:

a) Excavation below the rink to the grades required for installation of geogrid and sub-slab drainage layer and piping system;

b) Excavation subgrade and temporary support of existing concrete-encased structural steel ties;

c) Placement of geogrid, placement and compaction of soils, and construction of sub-slab drainage layer and piping systems.

TASKS	Cost
1. Frozen Ground Borings (1 to 2 days)	$3,800-6,300
2. Frozen Ground Summary Letter	$ 3,600
3. Review of Contractor Submittals ($800 each, assume 3)	$ 2,400
4. Construction Observation o On site up to 8 hours per day @ $1000/day* (assume 20 days) o Weekly Reports @ $400 each (assume 4) * part-time observation (up to 4 hours on-site/day) will be billed at $650/day	$ 20,000 $ 1,600
5. Geotechnical Laboratory Testing (Gradation/Proctor Tests @ $400 Each (assume 3)	$ 1,200
6. Evaluation of Settlement Monitoring Data	$ 4,000
7. Meetings; Assume 4 meetings @ $600 each	$ 2,400
Total	$39,000-$41,500

Our daily field engineering cost includes time on site, rental of a density gauge, travel time and mileage and project manager coordination. Extraordinary issues that may arise during construction will incur additional cost for analysis, phone consultation and/or preparation of correspondence. Billings for such additional costs will be based on actual accrued time and expenses billed at 2.8 times each individual's payroll cost (salary plus fringe benefits). Direct expenses will be marked up 15 percent. A communications fee equal to 3 percent of additional labor charges will be added to each invoice.

This cost estimate is based on the anticipated scope of work outlined above, which represents our present judgment as to the level of effort requested. It must be noted however, that our costs are totally dependent on the time the contractor takes to complete the work, and should construction take longer than anticipated, our costs will increase accordingly. It is therefore recommended that a contingency be added to the above projected cost for budgeting purposes.

CONDITIONS OF ENGAGEMENT

This proposal forms the basis of engagement of this firm. Conditions of engagement are described in the attached standard Terms and Conditions (02/07 Edition 05-9010).

Neither the professional activities of GZA, nor the presence of GZA's employees and/or subcontractors shall be construed by any party to imply that GZA has any responsibility for any contractors' methods of work performance, procedures, superintendence, sequencing of

This Proposal for Services and the referenced Terms and Conditions are hereby accepted and executed by a duly authorized signatory, who by execution hereof, warrants that he/she has full authority to act for, in the name, and on behalf of Client.

MACLAUGHLIN MANAGEMENT AND DESIGN

By: Terry MacLaughlin   Title: President

Typed Name: TERRY MacLaughlin   Date: 5/18/07

J:\19,000-20,999\19260\19260-00.MR\Construction\Larsen Rink CPS Prop revised.DOC

Components # 1, 2, & 6 –
Remainder on as need basis

Terry MacLaughlin

GZA
GeoEnvironmental, Inc.
One Edgewater Drive
Norwood, MA 02062
781-278-3700
Fax 781-278-5701
http://www.gza.com

Engineers and Scientists

JOB 19260 LARSEN RINK
SHEET NO. ______ OF ______
CALCULATED BY ______ DATE ______
CHECKED BY ______ DATE ______
SCALE ______

3 Phases 1) - Geotech Report - slab + expansion to bldg.
2) Design of slab with geogrid
3) Frozen Soil evaluation + Report
- Review of data.

- Client: Town of Winthrop; 1st contract

1. Report Dec 6, 2006

- 1-3 inches differential settlement over next 10-20 yrs.

2. Design of Slab base course including geogrid

3. "We understand Town has accepted risk of slab settlement in choosing this option."
- chose to not engage GZA to observe construction

May 25, 2007 Frozen Soil Report

P.4 - "6' thick layer of frozen compressible organic soil beneath Rink area". "The frozen soil under the rink area will lead to additional settlement"

P.5. - "settlement due to thawing expected to be greater than heave observed 14""
- "concerned thawing not complete in available time"
- "all frozen ground should be thawed before construction continues"

P.6. - "If construction is completed before the frozen ground has fully thawed and before post-thaw consolidation complete new concrete will likely settle and crack due to differential settlement"

p 6 - Incomplete thawing/surcharge → "we cannot estimate magnitude of the potential post-construction settlement under this scenario, but expect it to be at least several inches and maybe greater than one foot"
- "recommend delaying construction to allow complete thawing" etc

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Engineers and Scientists

JOB ______
SHEET NO. ______ OF ______
CALCULATED BY ______ DATE ______
CHECKED BY ______ DATE ______
SCALE ______

P.6. – suggested contr. sequence ... may mitigate impact from thawing

P 8 – "recommend GZA provide construction services."

Review of Data 7/6/07

– monitoring not performed as recommended.
– according to Prism; thawed to elevation +2. (13' depth)

P3 – "We anticipated settlement equal to heave"
"The lack of appreciable settlement may indicate not thawed"
"voids after thawing could later collapse and cause settlement"
P4 "recommend TP to confirm thawed"

GEOTECHNICAL ENGINEERING REPORT
LARSEN RINK - SLAB REPAIRS AND EXPANSION
45 PAULINE STREET
WINTHROP, MASSACHUSETTS

PREPARED FOR:
Town of Winthrop
c/o MacLaughlin Management and Design
Kensington, New Hampshire

PREPARED BY:
GZA GeoEnvironmental, Inc.
Norwood, Massachusetts

December 2006
File No. 19260.0

feet along its short sides.

Figure 2 shows the relationship of the Larsen Rink building to the adjacent gymnasium building and the surrounding streets and property lines.

Based on our review of the above referenced drawings from the original building design, the building's structural loads are supported by driven 12-inch-diameter steel Monotube pile foundations with concrete pile caps. The piles are shown supporting the exterior walls in groups of two to four piles per column, with a design capacity of 35 tons each, with 25 tons supporting the structure and 10 tons allowed for negative skin friction. The existing ice area and thin bituminous slab within the surrounding building area is not pile-supported. In the ice rink area, the drawings show a thin bituminous paving (which, according to Mr. Wallace, does not currently exist below the ice), underlain by 6 inches of sand with embedded refrigeration lines, over 2 inches of urethane insulation. The drawings indicate 4 feet of "non frost-susceptible granular fill" below the insulation. The drawings also show steel tie rods running between pile caps at each column across the width of the building. The tie rods are encased in concrete and are immediately below the urethane insulation below the ice.

The drawings also indicate that, prior to raising the site grades over the building area, a program of placing a construction surcharge and allowing for settlement (measured with settlement platforms) over a 6 to 9 month period was to be performed, followed by removal of the surcharge and placement of free-draining structural fill soils to raise the grade by about 2.5 feet above pre-existing conditions. Actual construction records are not available documenting the implementation of the surcharge program.

Based on GZA's observations while on site, and information provided by Mr. Wallace, differential settlement and/or heave of the ice surface and surrounding bituminous pavement/slab has occurred. This differential settlement has been observed at any one time to be as much as 4 inches over short distances (less than 10 feet) below and adjacent to the ice surface. The surface of the ice currently contains a relative high "humped" zone that is at least 2 to 3 inches higher than the remainder of the ice, and runs approximately diagonally across the ice from the northeast faceoff circle to the southwest faceoff circle.

Based on our observations while on site, the structural walls and columns of the existing building appeared to be in relatively good condition, with some minor infrequent step-cracking observed in the mortar of the exterior brick façade.

Proposed Construction

It is our understanding that the Town of Winthrop intends to remove the existing ice surface, refrigeration piping, and surrounding bituminous slab and supporting materials (as necessary) and replace them with new concrete slabs, refrigeration piping, and supporting materials (as necessary). The refrigeration lines would be contained within the concrete slab. The proposed ice elevation is the same as the existing ice elevation (i.e. no raise-in-grade).

Test Pits

Four interior test pits were performed (TP-1 through TP-4) within the existing building on November 9, 2006. The test pits were performed to depths of 4.5 to 5 feet by Ronald Marini Corp. of Newton, Massachusetts using a mini-excavator. The existing bituminous surface layer was saw cut prior to excavating the test pits. GZA observed and logged the test pits and obtained samples of existing fill soils for laboratory gradation analyses. At TP-1 and TP-2, the size and depth of adjacent subsurface concrete structures were measured. The test pits were backfilled with the excavated materials, compacted by tamping in lifts with the excavator bucket upon completion. Patching of the bituminous surface course was to be performed by Town of Winthrop personnel.

Refer to Figure 2 for approximate test pit locations. Test pit logs are attached as Appendix C.

GEOTECHNICAL LABORATORY TESTING

GZA performed laboratory gradation analyses on six soil samples from the explorations (TP-1, S-1; TP-2, S-2; TP-3, S-2; TP-4, S-1; GZ-1, S-1A; and GZ-1, S-2A) to confirm visual classifications and assess soil reuse potential. Results are included in Appendix E.

SUBSURFACE CONDITIONS

Soils

Subsurface soil conditions varied greatly from the south side of the rink (near Pauline Street) to the north side of the rink. South of the rink, subsurface conditions generally consisted of granular soils. However, north of the rink, thick fill and thick fill and organic deposits are present. Based on discussions with Mr. Driscoll, we understand that the area north of the rink was previously filled. This is consistent with our review of historical USGS topographical maps that show the area north of the rink as water in 1903, and as land in 1943. The current USGS topographic map (Figure 1) shows the rink as being on filled land.

The following two concrete structures were encountered in the interior test pits: In TP-1, the top edge of a foundation element (likely a pile cap or grade beam) was observed at an approximate depth of 3.8 feet; and, in TP-2, the side of what appeared to be a concrete-encased tie rod was observed over a depth range of 0.8 to 2.1 feet.

Soil stratum descriptions in order of increasing depth are given below:

Fill: In GZ-1 (south of the rink), fill was encountered to a depth of 4 feet. In this boring and in the interior test pits, the fill was generally observed as brown, loose to medium dense, fine to coarse sand with up to about 35 percent gravel, and up to about 15 percent silt. In TP-1 through TP-3, the silt content in the fill was less than 6 led to significant differential settlement of the bituminous pavement and ice support layer across the building. Furthermore, the secondary compression will continue and thus impacts design considerations for the ice rink slab reconstruction. The amount of secondary compression will vary across the building due to the varying thickness of organic soils.

Due to the relatively shallow groundwater encountered, a permanent sub-slab drainage system is required to maintain the groundwater level below the slab base course during times of high groundwater. Temporary dewatering may be required during construction. The high groundwater table likely contributes to the heave observed in the ice surface and interior bituminous pavement.

Proposed Building Expansion

The primary geotechnical issues for the design of new foundations and slabs at the proposed building expansion area are: the significant variability of the soil conditions observed at the site, as observed in GZ-1 versus GZ-2; the possible presence of organic soils (as observed in GZ-2); the presence of loose granular soils (as observed in GZ-1); and the relatively high groundwater table observed in the explorations.

Due to the considerable variability in the soil conditions encountered in borings GZ-1 and GZ-2, including high variability in the depth of fill and presence of organic soils encountered, the geotechnical recommendations provided herein pertaining to the proposed building addition are considered preliminary. We recommend that an additional boring be performed to a depth of approximately 50 feet at the eastern extent of the proposed building addition prior to preparation of final geotechnical recommendations for the addition.

The loose density of several SPT samples below the water table in the natural granular soils in boring GZ-1 increases the potential for liquefaction and settlement due to seismic loading in these soils and may require further analyses if the building addition is not supported on piles bearing below the loose granular soils. Such analyses were not performed as part of this geotechnical evaluation, but should be performed prior to issuing final foundation and slab engineering recommendations for the proposed addition.

GEOTECHNICAL RECOMMENDATIONS

The geotechnical design and construction recommendations presented below are based on our understanding of the existing site conditions and proposed development, and our evaluation of the available subsurface data. These recommendations are subject to the limitations contained in Appendix A.

cost for a structural slab above a slab on grade. Should this option be selected, additional borings would need to be performed within the area of proposed slab reconstruction to evaluate the depth to the bearing stratum so that pile lengths could be estimated.

Geogrid-Soil Mat

If the risk of differential slab settlement is acceptable to the Town, and the option of a slab on grade is being considered, the differential settlement may be mitigated to some degree (but not completely) with the use of a layer of biaxial geogrid above and below a sub-slab drainage layer. Figure 3 presents a schematic sketch of this concept. The geogrid-soil-geogrid "sandwich" would produce a relatively stiff geocomposite mat that would distribute stresses better than soil alone, and may help mitigate potential slab cracking due to differential soil settlements below. During the design and construction of this option, consideration would have to be made for the existing concrete-encased tie rods running across the building width, which may physically prevent installation of portions of the geogrid.

The slab designer should consider the potential impact of the vertical load of the slab-on-grade on the tie rods when evaluating if this is a viable option.

The designer may also want to consider embedding the refrigeration pipes in a thin sand layer below the ice, underlain by insulation, similar to the current design and typically used for seasonal rinks. Although the differential settlement would still occur, long-term maintenance of the pipes and leveling of the sand layer may be easier than repairing or replacing a concrete slab.

Sub-Slab Drainage

With either slab-on-grade or structural slab support, a sub-slab drainage system is recommended to maintain the groundwater level about 3 feet below the ice level

The sub-slab drainage layer would contain a network of perforated PVC collection pipes connected to solid header pipes, which would be graded to drain to a sump which would be pumped, or drain by gravity into on-site drainage lines. The pipes would be set above the recently measured groundwater levels to avoid continuous, year-long dewatering. However, appropriate permits would be required for discharge of the water.

Figure 3 shows the drainage pipes below the slab-on-grade option. The collection pipes should be spaced at approximately 25 feet on-center.

additional boring should be performed to confirm conditions prior to adopting a site coefficient (S) factor used to evaluate the total lateral seismic force on the proposed building addition. However, based on GZ-1, our preliminary recommended S-Factor is 1.5 (Soil Profile Type S_3).

6. Frost Protection for Proposed Building Addition

Exterior footings and interior footings or underside of pile/PIF caps in unheated areas of the proposed addition should bear at least 4 feet below the final exterior grades for frost protection. Interior footings and underside of pile/PIF caps in heated areas should bear at least 18 inches below top of slab. Protect all subgrades for footings or PIF/pile caps from frost during construction.

7. Lateral Loads for Proposed Building Addition

For spread footings, we recommend that lateral loads for the proposed addition be resisted by sliding friction between the base of spread footings and subgrade soils. We recommend a friction factor against base shear of 0.4. The factor of safety against sliding should be at least 1.5.

Alternatively, should pile or PIF foundations be used, we recommend that lateral loads be resisted by passive soil resistance of the pile caps and grade beams against adjacent compacted Structural Fill. We recommend an allowable passive resistance be calculated using an equivalent unit weight of 180 pounds per square foot, discounting the contribution of the top 1 foot of soil.

Construction Recommendations

1. Slab Subgrade Preparation

For slab-on-grade construction (if selected), remove existing fill to bottom of proposed sub-slab drainage layer and proof-roll the exposed subgrade with a minimum of 6 passes of a large vibratory drum roller (minimum static weight of 10,000 pounds) and overexcavate any weak or soft spots identified during proof compaction. In confined areas, proof-rolling may be performed with a walk-behind double-drum roller with a minimum static weight of 1,000 pounds. Care should be taken to protect existing tie rods and existing concrete pile caps and grade beams. Do not proof-roll with large roller over the existing tie rods.

Replace excavated material with compacted Sand-Gravel Fill or Crushed Stone. Refer to Figure 3 for conceptual sketch of sub-slab drainage layer for the slab-on-grade option. Gradation requirements are provided in Table 2.

the Massachusetts Contingency Plan (MCP) if contamination exceeds Reportable Concentrations.

4. Protection of Adjacent Structures

Care should be taken when excavating or performing below grade construction to avoid damage to existing pile caps, grade beams, and tie rods for the existing building and the adjacent school gymnasium building.

5. Construction Dewatering

Excavations for the proposed ice rink slab reconstruction and new foundations for the proposed addition are anticipated to be close to or below the groundwater table. Thus, especially immediately after precipitation events, construction dewatering may be required to conduct all work "in the dry". Based on review of existing soil conditions, we anticipate this can be achieved with sump pumps with discharge on-site into excavated pits. Otherwise, discharge of pumped water to existing sanitary/storm sewers would require a federal, state and/or local discharge permit and chemical testing of the water.

FINAL DESIGN AND CONSTRUCTION

As stated above, we recommend the following additional subsurface explorations be performed prior to final design:

- An additional deep boring should be performed in the proposed building addition area prior to developing final foundation and slab recommendations for this construction;
- Should a pile-supported slab be selected, additional borings should be performed in the proposed area of slab reconstruction to verify required pile depths.

We trust the information presented herein is sufficient for your use in preparing final development plans for the proposed slab replacement work, and to advance building expansion design development. GZA recommends that we be retained to prepare the earthwork specifications and to review and comment on near-final construction plans to assist with implementation of our recommendations.

During construction, GZA should observe site earthwork and foundation construction for compliance with our recommendations, project foundation plans, and earthwork specifications.

GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

January 18, 2007
File No. RFP 989.06

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

Re: REVISED Proposal for Final Design Geotechnical Engineering Services
Larsen Rink – Slab Repairs
45 Pauline Street
Winthrop, Massachusetts

One Edgewater Drive
Norwood
Massachusetts
02062
781-278-3700
FAX 781-278-5701
www.gza.com

Dear Mr. MacLaughlin:

In response to your request, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this revised proposal for final design phase geotechnical engineering services for the proposed renovation to the existing ice skating rink in Winthrop, Massachusetts.

This proposal has been revised from our previous proposal dated January 8, 2007 to change the Client from the Town of Winthrop to MacLaughlin Management and Design, as requested.

BACKGROUND

Based on telephone conversations with you, we understand that the Town of Winthrop has decided to demolish and rebuild the ice rink (excluding the building but including the existing ice surface and supporting sand layer, refrigerant piping, insulation, and dasher boards) as well as the unreinforced bituminous concrete pavement surrounding the ice rink. We understand the proposed reconstruction will include new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink, consistent with one of the alternatives presented in our geotechnical report dated December 4, 2006. As stated in our report, this option of slab support should mitigate, but will not eliminate the differential settlement of the proposed slab due to ongoing secondary compression of the compressible organic soils believed to be present below the building and observed adjacent to the building in boring GZ-2.

The objectives of our work will be to provide geotechnical engineering input to the contract documents pertaining to design of the sub-slab base course (outside of rink area), the sub-slab drainage layer, drainage piping and geogrid reinforcement (below ice rink slab).

We understand design and specification of the concrete slabs, refrigerant piping, and

BASIS OF BILLINGS

Billings for GZA's professional services for Tasks 1 through 3 will be based on the following unit costs:

Task	Unit Cost
1. Specifications and Review of Plans (Lump Sum)	$ 1,900
2. Sub-Slab Drainage System and Geogrid Design (Lump Sum)	$ 3,000
3. Meetings (per each Meeting)	$ 600

We anticipate attending one meeting, for an estimated total of $5,500 for this scope of work. This estimate is based on the scope of work outlined above, which represents our present judgment as to the level of effort requested.

SCHEDULE

Preliminary structural drawings showing slab design and interaction with existing tie-rods are required to prepare the sub-slab drainage system and geogrid design, prepare the technical specification section, and the review of plans. Thus, we expect to complete preparation of the technical specification section, comments on plans, and preparation of sub-slab drainage system and geogrid reinforcement within about 3 weeks of receiving all of this information.

CONDITIONS OF ENGAGEMENT

This proposal forms the basis of engagement of this firm. The conditions of our engagement are described on the attached Terms and Conditions (02/06-Edition/05-9010). This proposal and the attached Terms and Conditions of engagement shall constitute the entire agreement between the parties.

ACCEPTANCE

This proposal may be accepted by signing in the appropriate spaces and returning one copy to us, along with a retainer of $1,000. Issuance of a purchase order implicitly acknowledges acceptance of the referenced Terms and Conditions. This Proposal for Services and the Terms and Conditions shall constitute the entire agreement between the parties.

This Proposal for Services and the referenced Terms and Conditions are hereby accepted and executed by a duly authorized signatory, who by execution hereof, warrants that he/she has full authority to act for, in the name, and on behalf of Client.

MACLAUGHLIN MANAGEMENT AND DESIGN

By: Terry MacLaughlin Title: President

Typed Name: Terry MacLaughlin Date: 5/18/07

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Components # 1, 2, & 6 –
Remainder on as need basis

Terry MacLaughlin

Client: MacLaughlin Management and Design
Project No: 01.0019260.10

TERMS AND CONDITIONS FOR ENGINEERING AND CONSULTING

These Terms and Conditions, together with GZA's Proposal, make up the Agreement between GZA and you, the Client named above. *Before countersigning the Proposal, be sure you read and understand the paragraphs entitled, "Indemnification," "Release and Covenant Not To Sue Individuals" and "Limitation of Liability," which deal with the allocation of risk between you and GZA.*

1. Services. GZA will perform the services set forth in its Proposal and any amendments or change orders signed by both parties. Any request or direction from you that would require extra work or additional time for performance or would result in an increase in GZA's costs, including expert witness services and unanticipated meetings, will be the subject of a negotiated amendment or change order.

2. Standard of Care. GZA will perform the services with the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services at the same time under similar conditions in the same or similar locality. The foregoing standard of care is in lieu of all other standards and warranties, express or implied, including warranties of marketability or fitness for a particular purpose. You will notify GZA with reasonable specificity of any deficiencies in the services within 30 days of discovery but in no event later than 120 days after substantial completion of the services, and you will give GZA a reasonable opportunity to correct the deficiencies. You acknowledge that the services entail risk of personal injury and property damage (including cross-contamination) that cannot be avoided, even with the exercise of due care. You also acknowledge that environmental and geotechnical conditions can vary from those encountered at the times and locations of explorations and data collection, and that the limitation on available data may result in some level of uncertainty with respect to the interpretation of these conditions, despite due professional care. GZA therefore cannot guaranty specific results such as the identification of all contamination or other geotechnical or environmental conditions or problems nor their resolution.

3. Payment. Except as otherwise stated in the Proposal, you will compensate GZA for the services at its standard rates, reimburse its expenses, which will include a communication fee calculated as a percentage of labor invoiced, and pay any sales or similar taxes thereon. GZA will submit invoices periodically, and payment will be due within 30 days from invoice date. If you dispute any portion of an invoice, you will notify GZA in writing with specificity within 10 days and pay the undisputed portion within 30 days from invoice date. Overdue payments will bear interest at 1½ percent per month or, if lower, the maximum lawful rate. GZA may terminate its services upon 10 days' written notice anytime your payment is overdue on this or any other project, and you will pay for all services through termination, plus termination costs. You will reimburse GZA's costs of collecting overdue invoices, including reasonable attorneys' fees.

4. Client's Responsibilities. You will designate to GZA in writing a person to act as your representative. Except as otherwise agreed, you will secure the approvals, permits, licenses and consents necessary for performance of the services. You will provide GZA with all documents and other information that are pertinent to the services and are reasonably available to you, including information related to hazardous materials or other environmental or geotechnical conditions at the site. Before GZA performs any subsurface activities, you will provide it with all plans and other information available to you concerning underground services, conduits, pipes, tanks and other facilities and obstructions at the site. Unless otherwise indicated in writing, GZA will be entitled to rely on documents and information you provide.

5. Right of Entry. You grant GZA and its subcontractors permission to enter the site to perform the services. If you do not own the site, you represent and warrant that the owner has granted permission for GZA to enter the site and perform the services, and you will provide reasonable verification on request.

6. Site Restoration. Although GZA will act to limit damage to landscaping, paving, systems and structures at the site, you acknowledge that some damage may occur even with the exercise of due care, and you agree to compensate GZA for any restoration it is asked to perform unless otherwise indicated in the Proposal.

7. Underground Facilities. GZA will make arrangements to contact local governmental authorities and private firms who or technical information learned or developed by GZA will remain its property.

14. Confidentiality; Subpoenas. Information about this Agreement and GZA's services, and information you provide to GZA regarding your business and the site, will be maintained in confidence and will not be disclosed to others without your consent, except as GZA reasonably believes is necessary: (a) to perform its services; (b) to comply with professional standards to protect public health, safety and the environment; and (c) to comply with laws and court orders. GZA will make reasonable efforts to give you prior notice of any disclosure under (b) or (c) above. Information available to the public and information acquired from third parties without a breach of duty will not be considered confidential. You will reimburse GZA for responding to any subpoena or governmental inquiry or audit related to the services, at GZA's standard rates then in effect.

15. Insurance. During performance of the services, GZA will maintain workers compensation, commercial general liability, automobile liability, professional liability, and contractor's environmental liability insurance in the following minimum amounts:

a) Workers Compensation — Statutory
b) General Liability — $2,000,000 per occurrence and aggregate
c) Automobile Liability — $1,000,000 per occurrence and aggregate
d) Professional Errors and Omissions — $1,000,000 per occurrence and aggregate.
e) Contractor's Pollution Liability — $1,000,000 per occurrence and aggregate.

GZA will furnish you certificates of such insurance on request. GZA will purchase project-specific insurance at your request provided it is commercially available and you pay the premium.

16. Indemnification. You agree to hold harmless, indemnify, and defend GZA and its affiliates and subcontractors and their employees, officers, directors and agents against all claims, suits, fines and penalties, including mandated cleanup costs and attorneys' fees and other costs of settlement and defense, which claims, suits, fines, penalties or costs arise out of or are related to this Agreement or the services, except to the extent they are caused by the indemnified party's negligence or willful misconduct.

17. Limitation of Liability. To the fullest extent permitted by law and notwithstanding anything else in this Agreement to the contrary, the aggregate liability of GZA and its affiliates and subcontractors and their employees, officers, directors and agents (collectively referred to in this paragraph as "GZA") for all claims arising out of this Agreement or the services is limited to $50,000 or, if greater, 10% of the compensation received by GZA under this Agreement.

You may elect to increase the limit of liability for damages up to $100,000 if you do the following: indicate below that you elect to increase the limit to one of the levels designated below and pay the additional fee shown opposite the increased level, payment to be made simultaneously with the execution of this Agreement.

The additional charge serves as consideration for our undertaking the greater risk involved in performing the services for you under an increased limit of liability for damages above $50,000.

Limit of liability for damages	Additional fee	Client must initial
$75,000	$500	______
$100,000	$1,000	______

You agree that your payment of the additional fee does not constitute a charge for placement of additional insurance.

This limitation of liability applies to all injuries, damages, claims, losses, expenses and defense costs, whether based in contract, negligence, strict liability, statutory, warranty, trespass, indemnity, misrepresentation or any other theory of liability, except intentional misconduct, collectively hereinafter "Claim." If the Claim is covered and the Insurer acknowledges and provides coverage under GZA's commercial general liability or automobile liability insurance policy that exceeds this limitation of liability, GZA's liability will be increased to the extent of coverage afforded by the insurance outlined in Article 15 above; provided, however, GZA's liability shall not be increased if the applicable insurance carrier is placed in receivership, becomes insolvent or is otherwise unable to fulfill its obligations under the applicable policy. Any claim will be deemed waived unless received by GZA within three years of substantial completion of the services or, if shorter, the applicable statute of limitations period. In any event, GZA will not be liable for lost profits, loss of use of property, delays, or other special, indirect, incidental, consequential, punitive, exemplary or multiple damages. GZA will not be liable to you or the site owner for injuries or deaths suffered by GZA's or its subcontractors' employees.

18. Release and Covenant Not To Sue Individuals. You agree to hold personally harmless and to release any and all claims against any director, officer, employee, or agent of GZA arising from any negligent act, error, or omission now existing or hereinafter arising. You agree that any and all claims for damages arising from any negligent act, error, or

GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

May 17, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

133 Federal Street
10th Floor
Boston, MA 02110
617-482-1000
Fax: 617-482-6868
www.gza.com

Re: REVISED Proposal for Geotechnical Construction Phase Services
Larsen Rink – Proposed Slab Reconstruction
Winthrop, Massachusetts

Dear Mr. MacLaughlin:

In accordance with your request, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this revised proposal for construction phase services for the above-referenced project to MacLaughlin Management and Design (Client). The objective of our work is to address frozen ground issues that have recently been identified and provide geotechnical guidance and assistance during below-ground construction activities.

BACKGROUND

Based on our work on the project to date, and telephone conversations with you and with Mr. Sean Driscoll of the Town of Winthrop, we understand that the proposed slab reconstruction project will include demolishing and rebuilding the ice rink (excluding the building but including the existing ice surface and supporting sand layer, refrigerant piping, insulation, and dasher boards) as well as the unreinforced bituminous concrete pavement surrounding the ice rink. The proposed reconstruction will include new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink, consistent with one of the alternatives presented in our geotechnical report dated December 4, 2006, and shown on Contract Drawing No. G-1 prepared by GZA.

As stated in our report, this option of slab support should mitigate, but will not eliminate the differential settlement of the proposed slab due to ongoing secondary compression of the compressible organic soils believed to be present below the building and observed drilling techniques. The borings will be backfilled with the excavated material. Excess drill cuttings will be left on a site at a location designated by the Owner. We assume that the Owner will provide us access to water for drilling.

A GZA representative will coordinate and observe the exploration program, identify frozen soil, classify soil samples using the modified Burmister soil classification system, and prepare logs. Exploration locations will be based on tape measurements from existing site features. Exploration elevations will be estimated based on survey provided by the contractor (paid for by others).

Selected samples will be analyzed in our geotechnical laboratory for water content and organic content.

2. Frozen Ground Summary Letter

GZA will evaluate subsurface conditions beneath the rink based on the borings and the proposed construction. We will outline construction options to mitigate additional settlement due to thawing of the frozen ground. We will also provide monitoring recommendations. An exploration location plan and typed boring logs will be appended to the letter.

3. Review of Contractor Submittals

GZA will review and provide written comments on submittals required to be provided by the Contractor per project specification Section 02300 Earthwork, including excavation and backfilling methods, temporary support of concrete-encased structural ties, and proposed soils and geogrid materials. Our budget includes review of two submittals of proposed construction means and methods, and one geogrid materials submittal.

4. Construction Observation

GZA will visit the site to observe and document the following for conformance with the project documents:

a) Excavation below the rink to the grades required for installation of geogrid and sub-slab drainage layer and piping system;

b) Excavation subgrade and temporary support of existing concrete-encased structural steel ties;

c) Placement of geogrid, placement and compaction of soils, and construction of sub-slab drainage layer and piping systems.

TASKS	Cost
1. Frozen Ground Borings (1 to 2 days)	$3,800-6,300
2. Frozen Ground Summary Letter	$ 3,600
3. Review of Contractor Submittals ($800 each, assume 3)	$ 2,400
4. Construction Observation o On site up to 8 hours per day @ $1000/day* (assume 20 days) o Weekly Reports @ $400 each (assume 4) * part-time observation (up to 4 hours on-site/day) will be billed at $650/day	$ 20,000 $ 1,600
5. Geotechnical Laboratory Testing (Gradation/Proctor Tests @ $400 Each (assume 3)	$ 1,200
6. Evaluation of Settlement Monitoring Data	$ 4,000
7. Meetings; Assume 4 meetings @ $600 each	$ 2,400
Total	$39,000-$41,500

Our daily field engineering cost includes time on site, rental of a density gauge, travel time and mileage and project manager coordination. Extraordinary issues that may arise during construction will incur additional cost for analysis, phone consultation and/or preparation of correspondence. Billings for such additional costs will be based on actual accrued time and expenses billed at 2.8 times each individual's payroll cost (salary plus fringe benefits). Direct expenses will be marked up 15 percent. A communications fee equal to 3 percent of additional labor charges will be added to each invoice.

This cost estimate is based on the anticipated scope of work outlined above, which represents our present judgment as to the level of effort requested. It must be noted however, that our costs are totally dependent on the time the contractor takes to complete the work, and should construction take longer than anticipated, our costs will increase accordingly. It is therefore recommended that a contingency be added to the above projected cost for budgeting purposes.

CONDITIONS OF ENGAGEMENT

This proposal forms the basis of engagement of this firm. Conditions of engagement are described in the attached standard Terms and Conditions (02/07 Edition 05-9010).

Neither the professional activities of GZA, nor the presence of GZA's employees and/or subcontractors shall be construed by any party to imply that GZA has any responsibility for any contractors' methods of work performance, procedures, superintendence, sequencing of

This Proposal for Services and the referenced Terms and Conditions are hereby accepted and executed by a duly authorized signatory, who by execution hereof, warrants that he/she has full authority to act for, in the name, and on behalf of Client.

MACLAUGHLIN MANAGEMENT AND DESIGN

By: Terry MacLaughlin Title: President

Typed Name: TERRY MACLAUGHLIN Date: 5/18/07

J:\19,000-20,999\19260\19260-00.MR\Construction\Larsen Rink CPS Prop revised.DOC

Compounds # 1, 2, & 6 —
Remaining on as need basis
Terry MacLaughlin

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

May 25, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

133 Federal Street
10th Floor
Boston, MA 02110
617-482-1000
Fax: 617-482-6868
www.gza.com

Re: Frozen Ground Summary Report
Larsen Rink - Proposed Slab Reconstruction
Winthrop, Massachusetts

Dear Mr. MacLaughlin:

In accordance with our agreement dated May 17, 2007, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this report to MacLaughlin Management and Design (MMD, Client) summarizing the results of our frozen ground evaluation for the proposed slab reconstruction at the existing Larsen Rink building at 45 Pauline Street in Winthrop, Massachusetts. Previous explorations inside the rink building were shallow test pits outside of the rink area. The test pits did not identify frozen ground.

The objectives of this current study were to: 1) evaluate subsurface conditions in the frozen ground area beneath the rink; 2) evaluate the potential impacts of the frozen ground on the proposed reconstructed ice rink; 3) outline below-grade construction options to mitigate these impacts; and 4) provide monitoring recommendations.

BACKGROUND

The reconstruction project includes new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink, consistent with one of the alternatives presented in our geotechnical report dated December 4, 2006, and shown on Contract Drawing No. G-1 prepared by GZA.

As stated in our previous report, this option of slab support should mitigate, but will not eliminate the differential settlement of the proposed slab due to ongoing secondary compression of compressible organic soils present below the building and observed

- Performed a program of geotechnical laboratory testing including water content and organics content tests performed on 3 samples of organic soils from boring GZ-102.

- Performed geotechnical engineering analyses to evaluate the effects of the frozen ground on the project and methods to mitigate settlement.

- Prepared this geotechnical engineering report summarizing our findings and recommendations.

SUBSURFACE EXPLORATIONS

Borings

Three borings (GZ-101 through GZ-103) were performed within the former ice rink area by New Hampshire Boring, Inc. of Brockton, Massachusetts, on May 21, 2007. Borings GZ-101 and GZ-102 were performed in areas where the greatest heave was observed, and GZ-103 was performed in a less-heaved area, approximately 6 feet from the edge of the former rink. The borings were advanced via cased drilling methods with continuous split spoon sampling through unfrozen ground in GZ-101 and through frozen and unfrozen ground in GZ-102 and GZ-103. Rock coring techniques were used to advance through the frozen ground in GZ-101. Borings GZ-101 and GZ-102 were advanced to depths of about 13 to 16 feet, and each was terminated within likely natural granular soils below an organic soil layer. Boring GZ-103 was advanced to a depth of 9 feet, and did not encounter organic soils.

Boring locations are shown on Figure 1. Boring logs are attached as Appendix B.

SUBSURFACE CONDITIONS

Soil and Frozen Ground

Based on the recent explorations, subsurface conditions consisted of about 1 to 3 feet of unfrozen sand and gravel fill over 2 to 5 feet of frozen sand and gravel fill, over 3 to 4 feet of frozen organic soils in borings GZ-101 and GZ-102. The total thickness of organic soils in borings GZ-101 and GZ-102 was approximately 5 to 6 feet. In boring GZ-103, no organic soils were encountered and the frozen zone did not extend beneath the fill into the natural soils, which consisted of clay and silt at this location.

The total thickness of the frozen soils encountered in the borings ranged from 4 to 8 feet, and the frozen zone extended to a depth of approximately 6.5 to 10 feet below existing grade, which corresponds to approximate elevations +3 to +7 feet. Refer to the boring logs in Appendix B for additional details.

Our previous report anticipated organic soil beneath the rink based on adjacent borings outside the rink building, but did not anticipate frozen soils. Previous explorations inside the rink building consisted of shallow test pits outside of the rink area and did not encounter frozen ground. During our previous evaluation, we discussed the possibility of frozen ground beneath the rink with industry experts (Ice Builders) who indicated that because the rink operation was seasonal (versus operational all year), frozen ground below the rink was unlikely to be a major concern during construction.

There are three potential sources of soil settlement beneath the ice rink. These are:

1. Thawing of the frozen soil;
2. Consolidation of the thawed soil under self-weight and new surcharge loads; and
3. Time-related secondary compression of the organic soil.

The amount of the settlement due to thawing of frozen ground and soil consolidation is difficult to estimate, but is expected to be greater than the amount of heave experienced by the concrete-encased tie beams, which was measured to be up to approximately 14 inches.

If this high amount of settlement occurred after ice rink reconstruction, the settlement effects would be intolerable as the concrete would crack and settle, and associated refrigerant and heat piping systems would likely fail.

Thawing of the frozen soil and soil consolidation will require time. We understand there is a need to have the rink back in operation for the coming ice sports season. Thus, the settlement will need to be accelerated so that the majority of the settlement due to thawing, consolidation, and a portion of the secondary compression is complete prior to constructing the permanent slabs and systems.

Alternatives to accelerating the settlement are not considered economically feasible. These include excavating and replacing the compressible and/or frozen soil with off site fill or supporting rink loads on piles bearing below the compressible and/or frozen soil.

Accelerated thawing is currently underway over half of the rink area. Although thawing penetration can reportedly reach up to 1 foot per day, we are concerned that thawing of the frozen soil will not be complete in the available time to allow construction to proceed in time for the rink to be open for the next ice sports season. Ideally, all frozen ground should be thawed before construction continues.

Consolidation of the thawed ground can be accelerated and post-construction settlement mitigated by placing a temporary surcharge load for a period of time, forcing the primary consolidation settlement and some of the secondary compression to occur. Typically surcharge loads are at least 3 to 5 feet of soil placed above the finished grade. This only 2

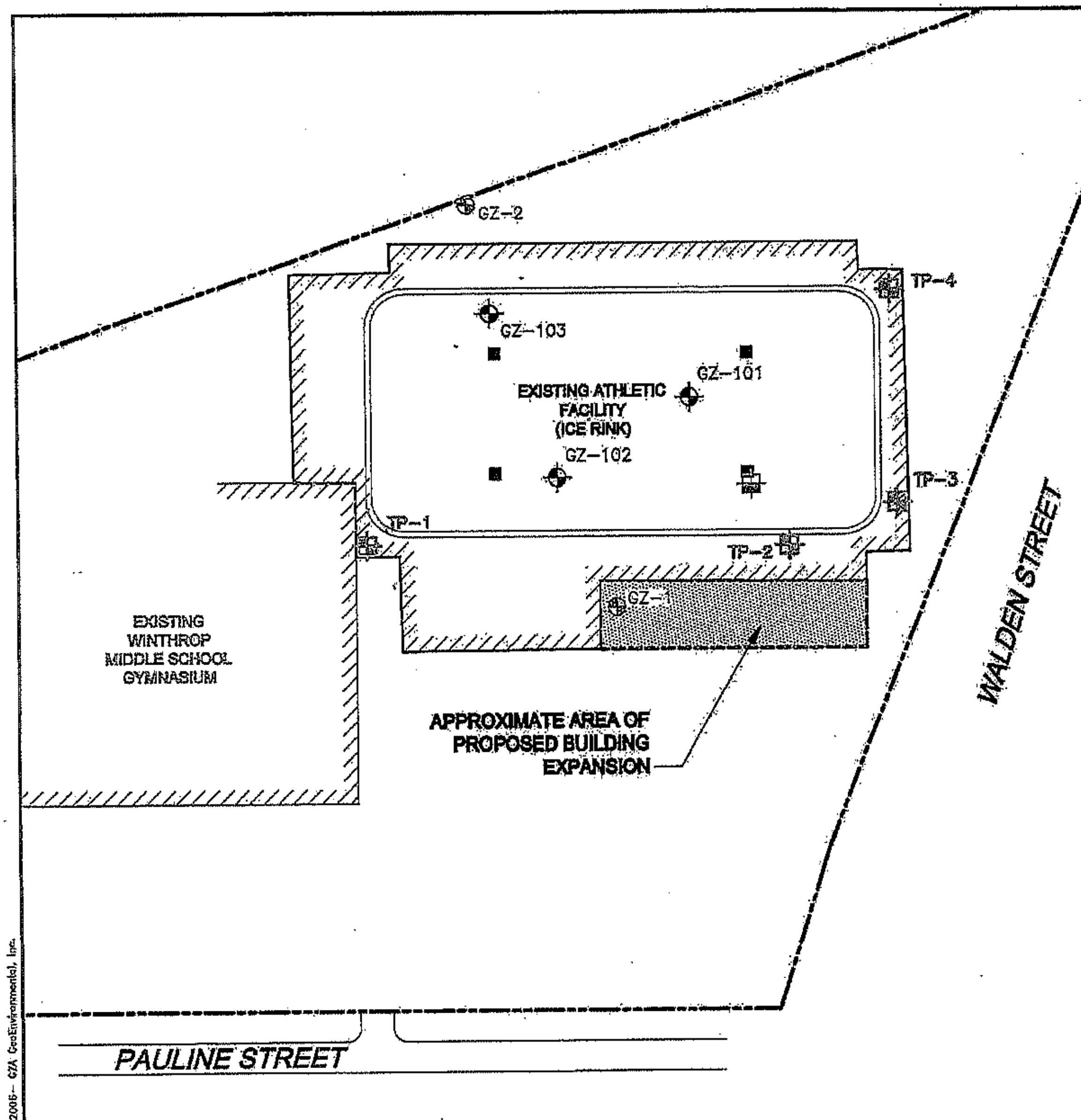
4. As soon as possible install a minimum of four settlement platforms to monitor ground settlement over time. Install at the lowest excavated grade. Suggested locations of settlement platforms are shown on the attached Figure 1. Settlement platforms should be placed approximately midway between tie beams.
5. Potentially thaw depth may be gauged by driving a smooth rod into the ground until the tip encounters the frozen ground and further driving is more difficult.
6. At the Contractor's option, following full thawing in an area and prior to placing surcharge, the proposed geogrid layers and sub-slab drainage pipes may be constructed in that area, provided perforated PVC collection pipes are replaced by suitable flexible perforated pipe, such as corrugated black ADS pipe (with subgrade sloped to drain towards manifold pipes).
7. Place surcharge consisting of 4 feet of sand-gravel fill or equivalent above finished grade. Monitor ties and settlement platforms and provide data to GZA for review.
8. Once settlement appears to have tapered off or as directed by the Town due to schedule, remove the surcharge. We anticipate that at least 4 to 6 weeks of surcharge will be required following thawing of the ground. This surcharge duration may be reduced by providing a greater surcharge.
9. Build ice rink slab and piping systems per existing contract drawings and specifications.

Monitoring Program

We recommend the following construction monitoring be performed via optical or laser survey methods:

Structure/medium	Locations	Frequency
Top of concrete encased ties	Every 50 feet along every tie, every 25 feet along ties with greater than 6 inches of initial heave.	Daily, decreasing to weekly after rate of settlement slows sufficiently.
Settlement platforms on soil	Minimum of one per each quarter of ice area (minimum of 4 total), placed approximately midway between ties.	Monday, Wednesday and Friday each week, decreasing to weekly after rate of settlement slows sufficiently.

Settlement platforms consist of a 3 foot by 3 foot piece of ¾-inch pressure-treated plywood with a 1-inch cast iron pipe flange bolted to the center of the plywood. Insert and attach 1-inch cast iron pipe into the flange and extend above grade as necessary. Once placed, the settlement platform should not be disturbed or knocked during construction. It may be cut off 6 inches below finished grade and left in place after construction. Survey to



LEGEND

GZ-101 — BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON MAY 21, 2007.

GZ-1 — BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON NOVEMBER 8, 2006.

TP-1 — TEST PIT PERFORMED BY RONALD MARINI CORP. OF NEWTON, MA AND OBSERVED BY GZA ON NOVEMBER 9, 2006.

APPROXIMATE LOCATION OF TEST PIT EXCAVATION PERFORMED BY CONTRACTOR ON MAY 11, 2007.

PROPOSED SETTLEMENT PLATFORM

PROPERTY LINE

NOTE

1. THE BASE MAP WAS DEVELOPED FROM A PLAN PROVIDED BY THE TOWN OF WINTHROP ENTITLED "ATHLETIC FACILITY - SITE PLAN", DRAWING NO. AF-1, BY JOSEPH E. STANUNAS ASSOCIATES ARCHITECTS OF HUDSON, MA, DATED 1/4/71, SCALE 1/16"=1'-0".

2. THE LOCATIONS OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS MADE IN THE FIELD FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USE.

SCALE 1" = 40 FEET
0 20' 40' 80'

PROJ MGR: MAR
DESIGNED BY: MAR
REVIEWED BY: MBH
OPERATOR: OCO
DATE: 12-01-2006

GZA GeoEnvironmental, Inc.
ONE EDGEWATER DRIVE
NORWOOD, MA 02062
PH.: (781) 278-3700
Fax: (781) 278-5701

LARSEN RINK RENOVATIONS
45 PAULINE STREET
WINTHROP, MASSACHUSETTS

EXPLORATION LOCATION AND PROPOSED INSTRUMENTATION PLAN

PROJECT NO. 19260.20

FIGURE NO. 1

GZA-J:\19,000-20,999\19260\19260-20.XRD\Figures\CADD\19260-20_Exploration Location and Proposed Instrumentation Plan.DWG [11x17] May 29, 2007 - 12:15pm oliver.olivenza

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, MA 02064

Larson Rink - Proposed Slab Reconstruction

Winthrop, MA

Boring No. GZ-101
Page No. 1 of 1
File No. 19260.2
Checked By: MAR

Drilling Co. New Hampshire Boring, Co.
Foreman Todd Penticost
GZA Rep. Ron Kubiak
Date Start 5/21/2007 End 5/21/2007
Location See Exploration Location Plan
GS. Elev. 11.25 Datum Note 5

	Casing	Sampler
Type	NW	Split Spoon
I.D./O.D.	3"/3.5"	1-3/8"/2"
Hammer Wt.	300#	140 lbs.
Hammer Fall	24"	30"
Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
5/21/07	10:45	1.8'	13.5'	2 min.

Depth	Casing	Blows	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	Notes
			S-1	17/12	0-1.4	6-57		Very dense, brown, fine to coarse SAND, some Gravel, trace SILT. Bottom 1": dark brown fine to medium SAND, little (+) SILT (FILL) (bottom 6" is frozen.)	FILL	1
			S-2	6/6	1.4 - 1.9	100/5" - 100		S-2: Frozen, dark gray-brown clayey SILT, fine(+) to medium SAND, some (-) SILT (FILL)		2
			C-1	60/15	3.2 - 8.2	1.3*		C-1: Top 15": unfrozen, dark gray-brown clayey SILT, some (+) fine to coarse SAND, some (-) Gravel. (FILL)	4.5' ±	
5				/38		6.5*		Bottom 38": Frozen, dark brown, fine grained PEAT, little woody fibers.	PEAT	
						for 2'				
						0.8*				
						0.3*				
			C-2	60/23	8.2 - 13.2	2.3*		C-2: Top 21": Dark brown, fine grained PEAT little woody fibers; 1" piece was frozen.		
10						for 3'		Bottom 2": Brown, fine to coarse SAND and GRAVEL, trace SILT (unfrozen)	10' ±	
						0.3*			SAND and GRAVEL	
			S-3	24/6	13.5 - 15.5	12-10		Wet, medium dense, brown, fine to coarse SAND and Gravel, trace SILT (unfrozen)		3
15						13-16				4
								Bottom of Boring at 15.5'		
20										
25										

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. * denotes approximate coring rate (minutes/foot, unless noted otherwise). Coring down pressure was approximately 150 psi from 3.2' to 6.2', and 100 psi from 8.2' to 13.2'
3. Coarse piece of Gravel lodged in tip of core barrel (Core Sample No. C-2)
4. Frozen soil was encountered between depths of approximately 0.5' and 8.5'.
5. Elevations per laser level survey by Prism Builders, Inc. Referenced to El. 15.00 at top of lobby floor

GZA GeoEnvironmental, Inc.
Engineers/Scientists

One Edgewater Drive
Norwood, MA 02064

Larson Rink - Proposed Slab Reconstruction

Winthrop, MA

Boring No. GZ-102
Page No. 1 of 1
File No. 19260.2
Checked By: MAR

Drilling Co: New Hampshire Boring, Co.
Foreman: Todd Penticost
GZA Rep.: Ron Kubiak
Date Start: 5/21/2007 End: 5/21/2007
Location: See Exploration Location Plan
GS. Elev.: 14.8 Datum: Note 4

	Casing	Sampler
Type	NW	Split Spoon
I.D./O.D.	3"/3.5"	1-3/8"/2"
Hammer Wt.	300#	140 lbs.
Hammer Fall	24"	30"
Other		

Groundwater Readings

Date	Time	Depth	Casing	Stab. Time
NOT RECORDED				

Depth	Casing Blows	No.	Pen./Rec.	Depth (Ft.)	Blows/6"	Field Test Data	Sample Description & Classification	Stratum Description	Notes
		S-1	24/13	0-2	5-8		Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt. (FILL)	FILL	1, 2
					18-12				
		S-2	21/16	2-4	11-13		Very dense, brown, fine to coarse SAND, some Gravel, trace Silt (FILL). Bottom 6" is frozen.		
					50-70/3"				
5									
		S-3	10/4				Frozen, brown, fine to medium SAND, some (+) Silt. (FILL)		
		S-3A	15	6.2-7	15/3"-30		S-3A: Frozen, dark brown, fine grained PEAT.	6.5'±	
		S-4	24/24	7-9	35-40		Frozen, dark brown, fine-grained PEAT, little Woody Fibers; 3" Layer of Fibrous PEAT, Numerous 1/16"± and few 1/8"± ice lenses. One 1/4" ice lens in Fibrous Peat.	PEAT	
					36-36				
10		S-5	24/20	9-11	18-4		S-5: Dark brown, fine-grained PEAT. Bottom 3" is PEAT and fine to medium SAND. Top 9" is frozen and has ice lenses similar to sample S-4.		3
					7-16			11'±	
		S-6	24/12	11-13	14-25		S-6: Wet, very dense, brown, fine to coarse (unfrozen) SAND and Gravel, little (-) Silt changing to fine to medium SAND, trace (+) Silt.	SAND & GRAVEL	
					29-35				
							Bottom of Boring at 13 feet.		
15									
20									
25									

Notes:
1. Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.
2. Advanced boring with casing to 3.5 feet, open-hole advancement from 3.5 to 7 feet, used casing from 7 feet to bottom of boring.
3. Frozen soil was encountered between depths of approximately 3 and 10 feet.
4. Elevations per laser level survey by Prism Builders, Inc. Referenced to El. 15.00 at top of lobby floor

LABORATORY TESTING DATA SHEET

Project Name Larsen Rink
Project No. 19260.20
Project Engineer M. Rodick

Location Winthrop, MA
Assigned By R. Kubiak
Report Date 5/25/2007

Reviewed By [signature]
Date Reviewed 5/25/07

				Identification Tests						Density	Strength Tests								
Boring No.	Sample No.	Depth ft.	Lab No.	Natural Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	Org. %	γ_d MAX (pcf) W_{opt} (%)	CBR Water Content %	CBR Dry unit wt. pcf	CBR @ 0.1" @ 0.2"	$\bar{\sigma}_c$ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	Laboratory Log and Soil Description
GZ-102	S-3A	6.2-7	1	229					74.0									
GZ-102	S-4	7-9	2	633					86.3									
GZ-102	S-5	9-11	3	633					85.4									

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

July 6, 2007
File No. 19260.20

Mr. Terry MacLaughlin
MacLaughlin Management and Design
12 Kady Lane
Kensington, NH 03833

Re: Preliminary Monitoring Data Review
Larsen Rink - Slab Reconstruction
Winthrop, Massachusetts

One Edgewater Drive
Norwood
Massachusetts
02062
781-278-3700
FAX 781-278-5701
www.gza.com

Dear Mr. MacLaughlin:

In accordance with our agreement dated May 17, 2007, GZA GeoEnvironmental, Inc. (GZA) has reviewed monitoring data supplied by Prism Builders of Wakefield, Massachusetts (Prism), the project general contractor. Monitoring recommendations were contained in our Frozen Ground Summary Letter dated May 25, 2007. Since issuance of our letter, we attended a meeting at the site on June 6, 2007, where monitoring and construction progress were discussed. We received the attached monitoring data and related information from Prism between June 14 and 25, 2007. GZA prepared the attached settlement-time plots based on the data.

BACKGROUND

The reconstruction project includes new concrete slabs within and surrounding the ice rink, as well as refrigerant piping and insulation systems, and a sub-slab drainage layer (with drainage piping and geogrid reinforcement) below the ice rink.

A test pit performed in May, 2007 in the rink area showed approximately 7 to 8 feet of frozen ground, beginning at a depth of approximately 2 feet below grade and extending to approximately 9 to 10 feet, when the reach of the machine was exceeded. GZA subsequently performed test borings in the rink area and observed frozen soil thickness ranged from 4 to 8 feet, and the frozen zone extended to a depth of approximately 6.5 to 10 feet below existing grade, which corresponds to approximate elevations +3 to +7 feet[1] (project datum).

Based on the borings, subsurface conditions consisted of about 1 to 3 feet of unfrozen sand and gravel fill over 2 to 5 feet of frozen sand and gravel fill, over 3 to 4 feet of frozen organic soils in

[1] Elevations presented in this report are approximate and are based on ground elevations provided by Prism Builders. We understand the elevations are based on an assumed project datum of +15.0 feet at the existing lobby floor (reference datum unknown).

MONITORING DATA

We received two pages of monitoring data from Prism. The first page was a hand-drawn sketch plan showing survey elevations of the top of the tie-beams surveyed on or about May 14, 2007, prior to starting the thawing. Also shown on the plan is the location of two settlement monitoring platforms (1A and 2A) installed on the excavated grade after thawing equipment was removed and before the surcharge was placed.

The second page was a spread sheet of survey data referenced to the plan by column location. Comparing the first reading (May 14) to the latest (June 19) indicates settlement of up to 2¼- inches. Three of the 9 tie-beam locations settled greater than 1 inch, 2 locations settled just under 1 inch, 2 location heaved up to about ½-inch and 2 locations did not move.

Since surcharge placement, Settlement Platform 1A has settled 1.6 inches and Settlement Platform 2A has heaved 1.3 inches. Tie-beam monitoring points have settled up to ¾-inch. Over about the last week (June 12 through 19) minor heave up to about ¼-inch was reported at each tie-beam locations except at C3 which settled between ¼ and ½ inch.

GZA has not visited the site since our meeting of June 6, 2007.

DISCUSSION

The settlement/heave trends of the data provided to GZA for interpretation is difficult to understand. It was anticipated that the amount of settlement during thawing would be at least equal to the observed heave. Up to about one foot of heave has previously occurred (based on survey of the top of concrete tie beams on May 14, 2007), but total settlement reported have been on the order of 1 to 2 inches. In addition, we anticipated settlement of several inches during the surcharge phase due to consolidation of the organic soils. Instead, the data indicates that a small amount of settlement has occurred during the surcharge phase. The heave trend over the last week is outside the normal range of measurement error and is unexpected. It appears the majority of the settlement occurred during the thawing phase.

The lack of appreciable settlement may indicate that the ground may not be completely thawed as indicated by Prism. It may also be due to survey error.

The data indicates that the tie-beams remain heaved from their originally-constructed position, similar to their positions prior to thawing and surcharging. We are concerned that the tie beams remaining heaved (and assumed to be in contact with the soil immediately below the beams) may indicate that bridging around voids may have occurred in the previously frozen soils. That is, if the soil within the previous frozen zone has settled due to melting of ice lenses and the tie beams and upper soils have not settled, small voids may be present in the previously frozen soils. If this is the case, these voids could later collapse and cause settlement of the beams and rink floor.

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the exploration logs.

3. Water level readings have been made in the explorations at the times and under the conditions stated on the logs. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed building are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc (GZA). It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

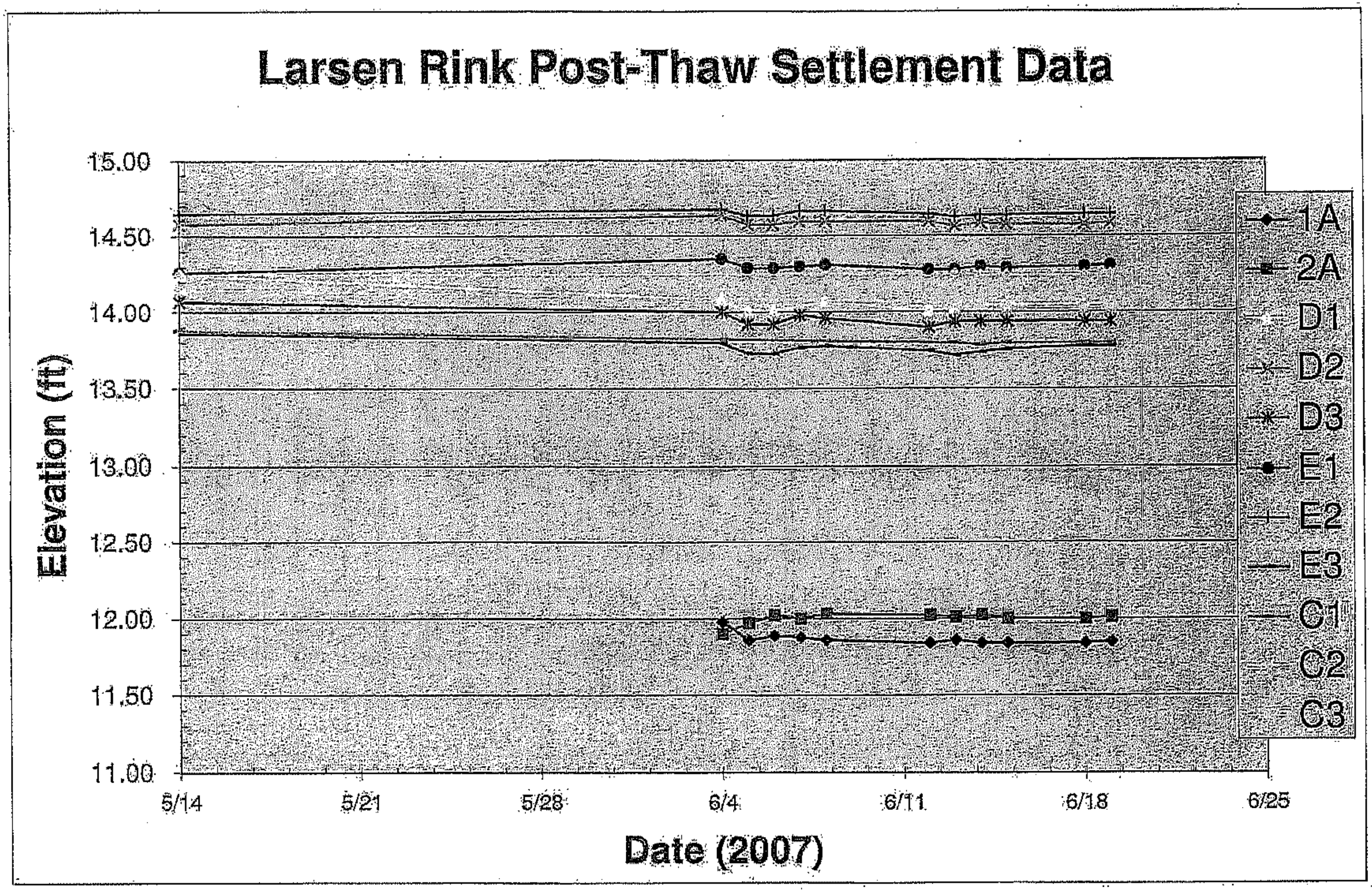
5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

6. This report has been prepared for the exclusive use of The Town of Winthrop and MacLaughlin Management and Design for specific application to the proposed slab repairs and building expansion of the existing Larsen Rink building at 45 Pauline Street in Winthrop, Massachusetts, in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

7. This soil and foundation engineering report has been prepared for this project by GZA. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

8. This report contains approximate cost estimates for purposes of evaluating alternative geotechnical design schemes. These estimates involve approximate quantity evaluations. A preliminary estimate of this nature is likely to vary substantially from Contractors' Bid Prices and is not to be considered the equivalent of nor as reliable as Contractors' Bid Prices. Prices for similar work undertaken in the future will be subject to general and sometimes erratic price increases.



Notes: 1. Plots are based on settlement data provided by Prism Builders on 6/19/07 and 6/21/07.
2. Points 1A and 2A are settlement platforms, other points are on the top of concrete-encased tie beams.

GZA
GeoEnvironmental, Inc.
One Edgewater Drive
Norwood, MA 02062
781-278-3700
Fax 781-278-5701
http://www.gza.com

Engineers and Scientists

JOB ____
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____

- Do. borings in settlement area to see frozen - unfrozen
- Geopiers in depressed area
- Lab testing in organics - compare to frozen
- proposal now to do additional borings
- cull files - take out drafts.
- print out emails from them
- remove BWF / MAR emails.
- consol. tests. - tubes
- borings outside building - unaffected by freezing

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May 16, 2008

Manager, Pollution Insurance Products Unit
AIG Technical Services, Inc.
Environmental Claims Department
101 Hudson Street, 31st Floor
Jersey City, NJ 07302

Re: Geotechnical Engineering Services
Larsen Rink-Proposed Slab Repairs, Expansion and Reconstruction
45 Pauline Street
Winthrop, Massachusetts
Insured: GZA GeoEnvironmental, Inc.
COPS policy # 3778297 (02/28/08 to 02/28/09)

Dear Sirs:

This letter will serve to notify you of circumstances that may in the future give rise to a claim relative to the subject project under the insurance policy identified above.

On October 31, 2006 GZA signed a contract with the Town of Winthrop to perform geotechnical engineering consulting services for the proposed renovations to the existing skating rink in Winthrop, Massachusetts. The specific geotechnical services were to evaluate the subsurface conditions and provide recommendations for slab and foundation design and construction. This work was, in part, necessitated due to settlement and/or heave of the existing ice surface and heaving and cracking of the existing ground floor slab surrounding the ice area.

GZA's scope of services were revised in January 2007 due to the subsequent decisions of the Town to demolish and rebuild the ice rink (excluding the building but including the existing ice surface and supporting sand layer, refrigerant piping, insulation, and dasher boards) as well as the unreinforced bituminous concrete pavement surrounding the ice rink. GZA then contracted directly with the Town's consultant, MacLaughlin Management and Design to provide geotechnical engineering input into the contract documents pertaining to the design of the sub-slab base course (outside the rink area) the sub-slab drainage area, drainage piping and goegrid reinforcement (below ice rink slab). GZA was not involved during the construction process.

It was not until May, 2007 that GZA was informed that the rink slab had a large mass of frozen ground to a depth of 8-10 feet beneath the slab that likely attributed to the past ice rink distress and needed to be addressed prior to the proposed ice rink slab reconstruction. GZA again contracted with MacLaughlin Management and Design to perform a study to (1) evaluate subsurface conditions in the frozen ground beneath the rink (2) evaluate the impact of frozen ground on the proposed reconstructed ice rink (3) outline below grade construction options to mitigate these impacts and (4) provide monitoring recommendations.

GZA was recently informed that after one season of operation, the new ice rink slab has settled over 8 inches and is likely not usable for the upcoming ice skating season.

No allegations, wrong doings or claims have been made against GZA as of this writing. We ask that you open a file on these circumstances. If GZA receives any indications in the future of any claims due to its involvement in the project we will notify AIG.

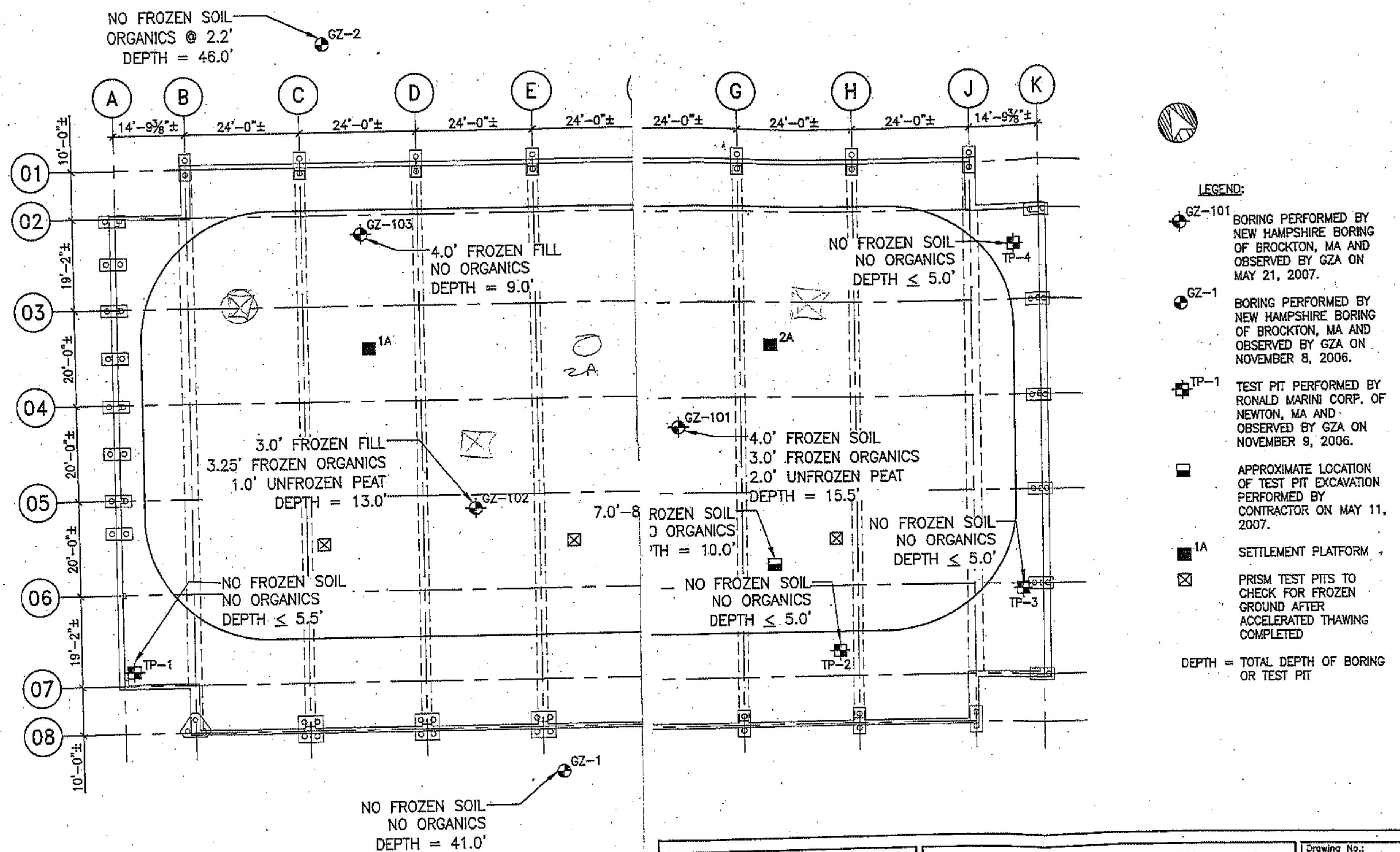
Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Lewis Litwack

Lewis Litwack
Director of Risk Management and Contracts

Cc: William Hover
Bruce Fairless/Martin Rodick
Ken Johnston/Sue Domko
Paul Sanfilippo, Risk Strategies



NOTE:

1. THE ORIGINAL LOCATIONS OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY OTHERS USING TAPE MEASUREMENTS MADE IN THE FIELD FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THE LOCATIONS SHOWN WERE SCALED FROM DOCUMENTS PREPARED BY OTHERS. THE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

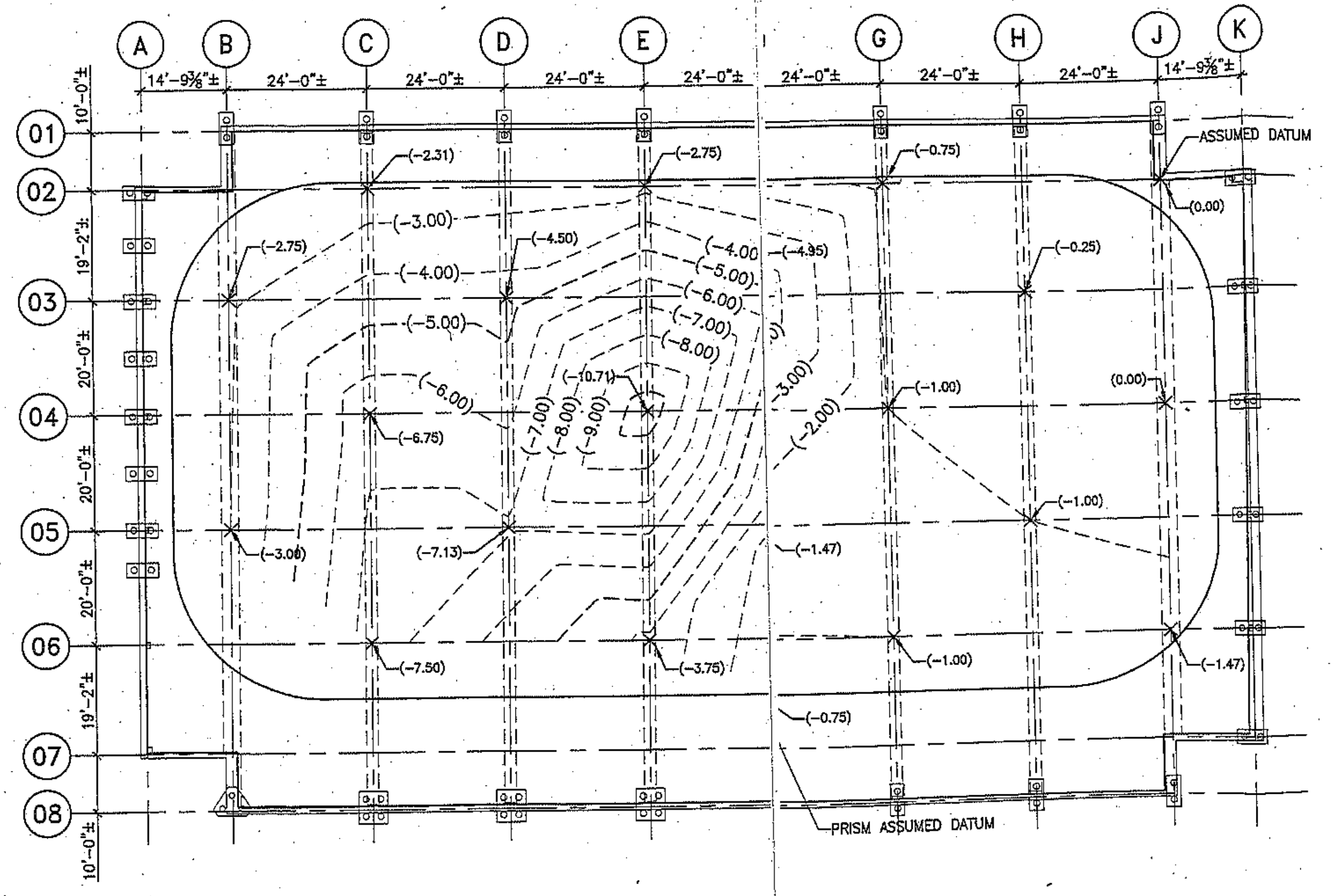
SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures
Simpson Gumpertz & Heger Inc.
41 Seyon Street, Building 1, Suite 500
Waltham, Massachusetts 02453
781.907.9000
fax 781.907.9009
www.sgh.com

Project: Post Construction Settlement
Larsen Skating Rink
Winthrop, MA

Drawing Title: Subsurface Exploration Summary and Location Plan

Proj.	Drawn:	Checked:	Date:	Scale:
080485.00	MFH	WPK	09/16/08	1" = 20'-0"

Drawing No.: Fig. 1



NOTES:
1. SURVEY BY PRISM BUILDERS DATED 6 AUGUST, 2008.
2. ALL SETTLEMENTS SHOWN ARE IN INCHES.
3. SURVEY DATUM IS TOP OF SLAB (ELEV. 0.00') LOCATION IS NOTED ON PLAN.
4. ALL ELEVATIONS ARE AT TOP OF SLAB. NEGATIVE VALUES REPRESENT SETTLEMENT RELATIVE TO THE DATUM.

LEGEND:

– –(–4.90)– – / ——(–5.00)—— CONTOUR LINES

CONTOUR INTERVAL = 1.00"

× (–0.02) SPOT ELEVATION (INCHES)

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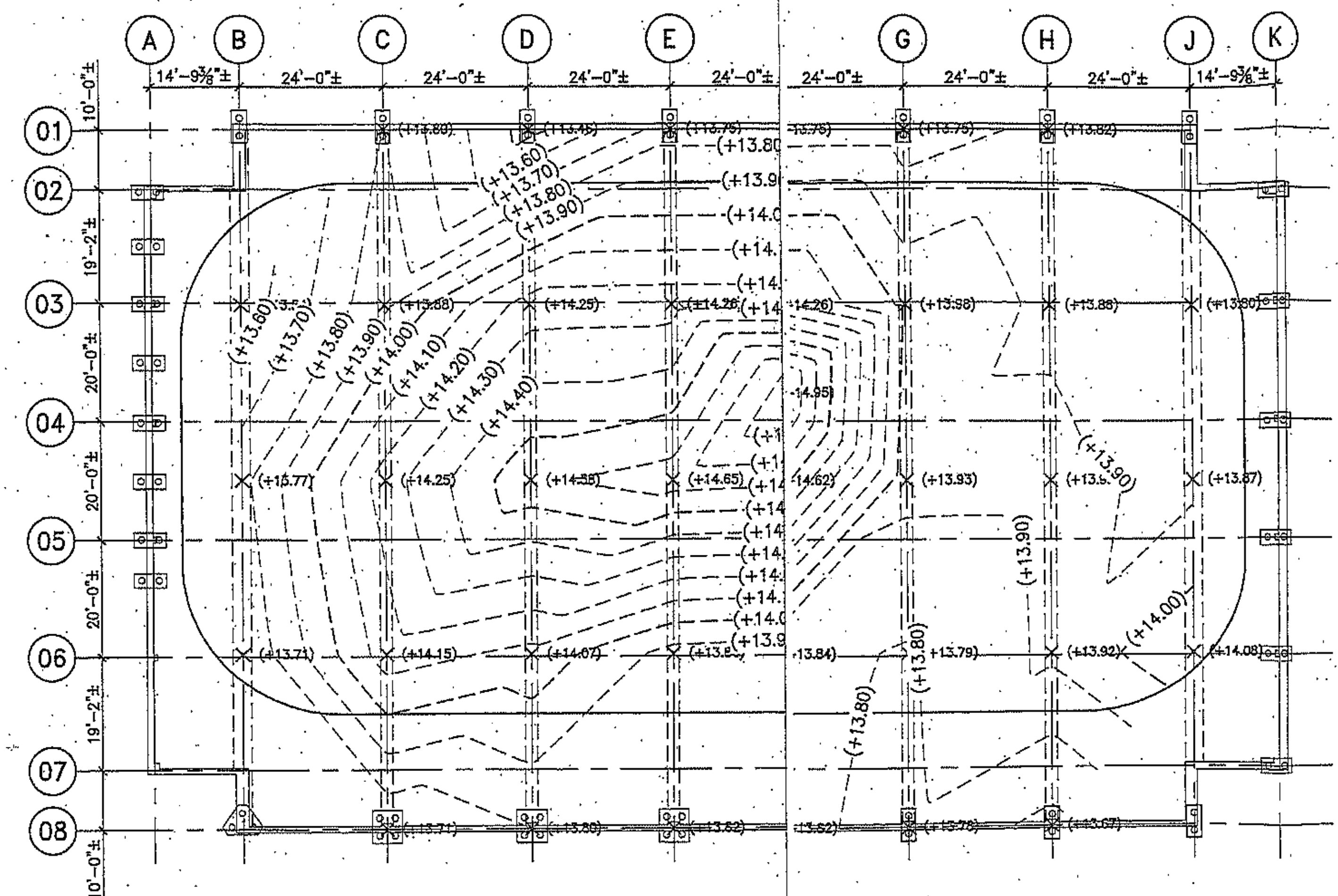
fax: 781.907.9009
www.sgh.com

Project: Post Construction Settlement
Larsen Skating Rink
Winthrop, MA

Drawing Title: Plan of Slab Settlement

Proj.	Drawn:	Checked:	Date:	Scale:
080485.00	MFH	WPK	09/16/08	1" = 20'-0"

Drawing No.: Fig. 2



NOTES:
1. SURVEY BY PRISM BUILDERS DATED 14 MAY, 2007. AS REFERENCED IN GZA REPORT DATED 26 JULY, 2007.
2. ALL ELEVATIONS ARE IN INCHES.
3. SURVEY DATUM IS FINISH FLOOR AT LOBBY (EL. 15.00')
4. ALL ELEVATIONS ARE AT TOP OF GRADE BEAM.

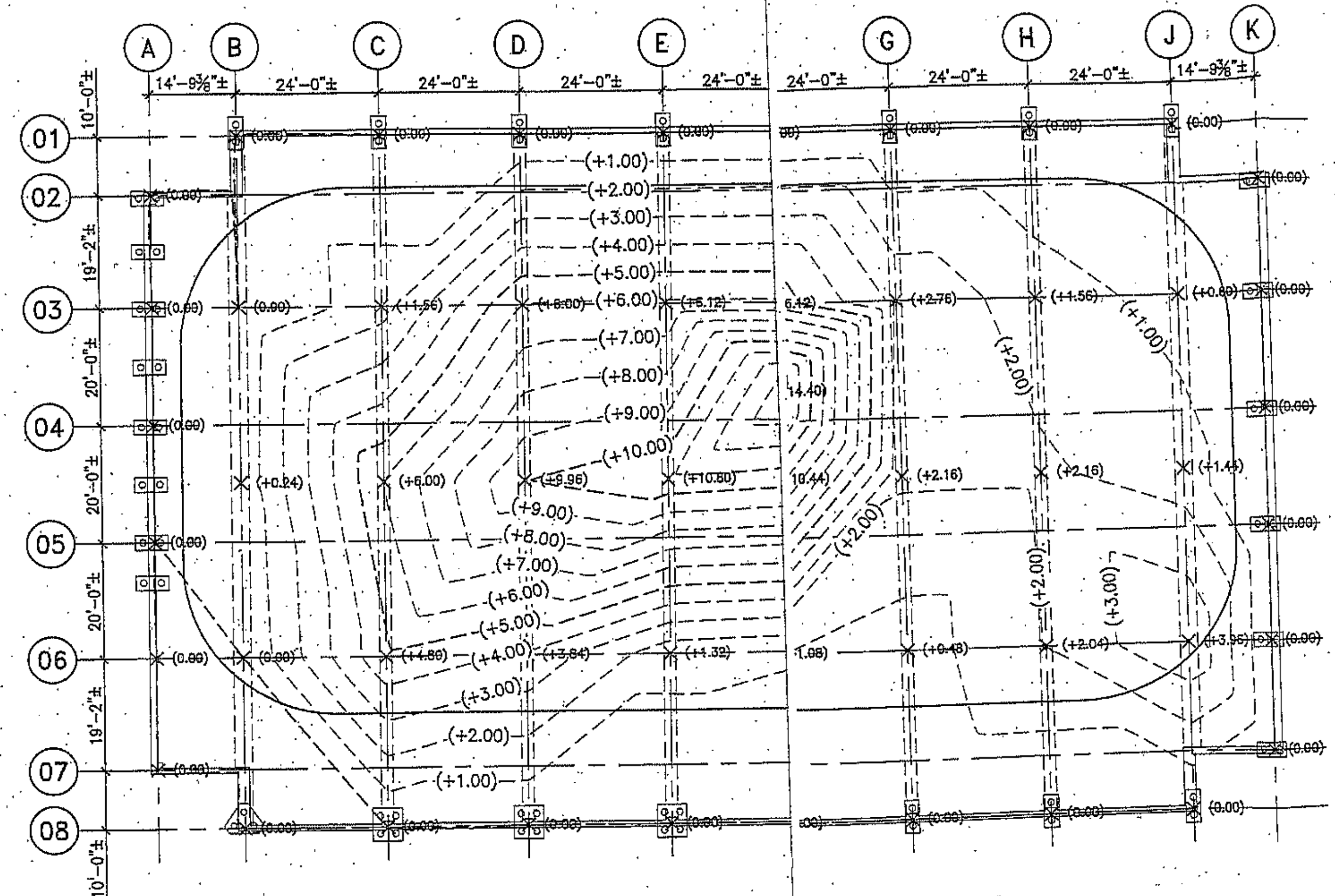
LEGEND:

— — (+13.90) — — / —— (+14.00) —— CONTOUR LINES

CONTOUR INTERVAL = 0.10'

X (−13.93) SPOT ELEVATION (FEET)

SIMPSON GUMPERTZ & HEGER Engineering of Structures and Building Enclosures Simpson Gumpertz & Heger Inc. 41 Seyon Street, Building 1, Suite 500 Waltham, Massachusetts 02453 781.907.9000 fax 781.907.9009 www.sgh.com	Project: Post Construction Settlement Larsen Skating Rink Winthrop, MA Drawing Title: Plan of Heaved Tie Beam Elevations Proj.: 080485.00 Drawn: MFH Checked: WPK Date: 09/16/08	Drawing No.: Fig. 3 Scale: 1" = 20'-0"



NOTES:
1. BASED ON TIE BEAM SURVEY BY PRISM BUILDERS DATED 14 MAY, 2007. AS REFERENCED IN GZA REPORT DATED 26 JULY, 2007. ASSUMES NO HEAVE OF TIE BEAMS OCCURRED AT THE EXTERIOR WALL. AVERAGE ELEVATION AT ENDS OF TIE BEAMS AT EXTERIOR WALL IS ASSUMED TO BE EL. 13.75".
2. ALL HEAVE VALUES ARE IN INCHES.
3. ALL HEAVE MEASURED AT TOP OF TIE BEAMS.

LEGEND:
(+4.90) (+5.00) TOTAL HEAVE CONTOUR LINES

CONTOUR INTERVAL = 1.00"

X (+6.12) HEAVE (INCHES)

SIMPSON GUMPERTZ & HEGER
Engineering of Structures and Building Enclosures
Simpson Gumpertz & Heger Inc.
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Waltham, Massachusetts 02453
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fax 781.907.9009
www.sgh.com

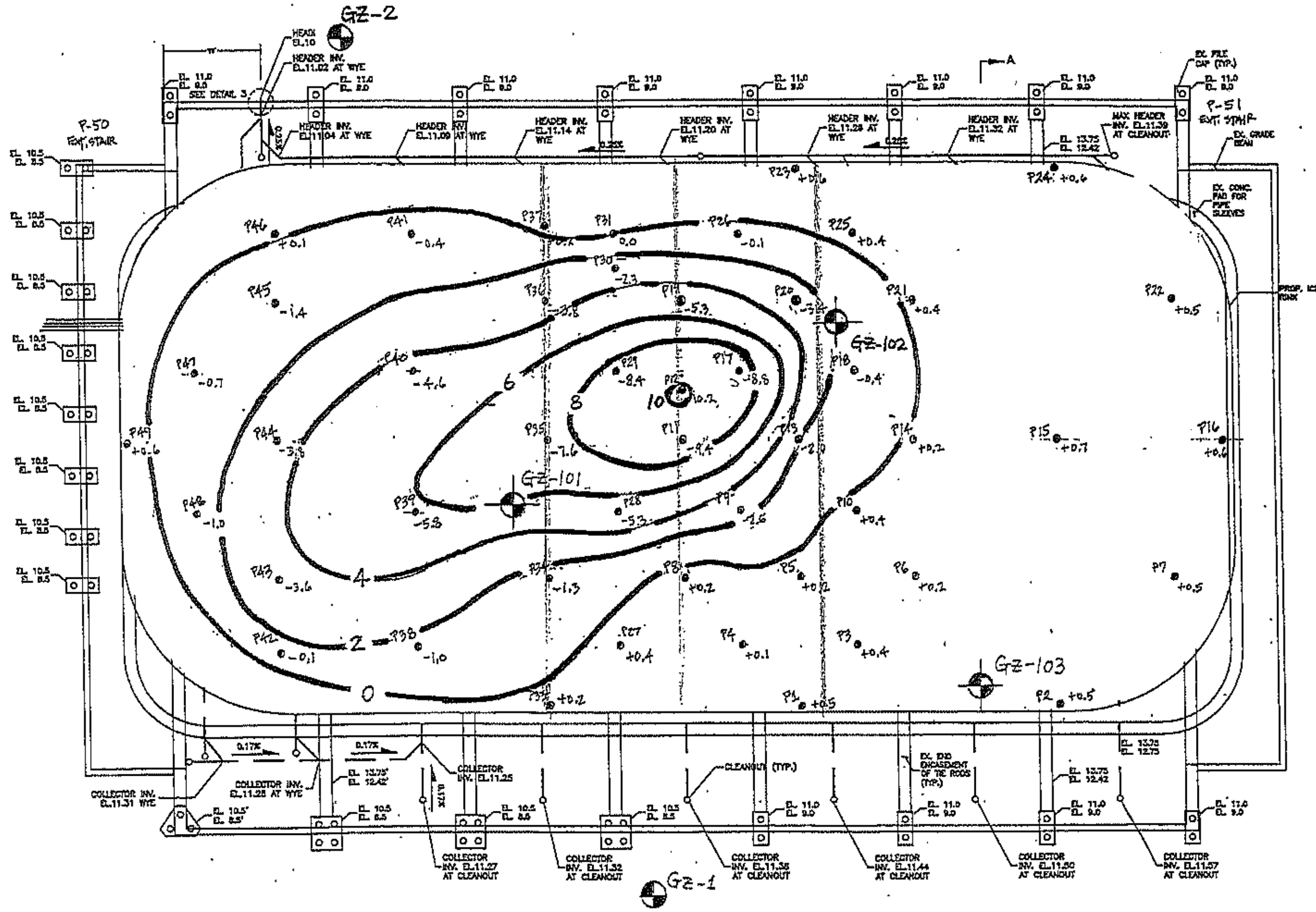
Project: Post Construction Settlement
Larsen Skating Rink
Winthrop, MA

Drawing Title: Plan of Estimated Tie Beam Heave

Proj.	Drawn:	Checked:	Date:
080485.00	MFH	WPK	09/16/08

Drawing No.: Fig. 4

Scale: 1" = 20'-0"



CALLED NORTH

0 10' 20' 40'

SCALE : 1" = 20 FEET

LEGEND:

- P45 SURFACE SETTLEMENT POINT LOCATION
- -1.4 SLAB SURFACE (INCHES) WITH RESPECT TO BENCHMARK IN LOBBY FLOOR SLAB
  - \+ INDICATES HIGHER
  - \- INDICATES LOWER
- —6— DEFLECTION CONTOUR (INCHES)
- GZ-101 BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON MAY 21, 2007.
- GZ-1 BORING PERFORMED BY NEW HAMPSHIRE BORING OF BROCKTON, MA AND OBSERVED BY GZA ON NOVEMBER 8, 2006.

NOTES:

1. THE BASEMAP WAS DEVELOPED FROM DRAWING TITLED "UNDERSLAB DRAINAGE AND GEOGRID SYSTEM" (DWG NO. G-1), DATED 2-16-2007, PREPARED BY GZA GEOINVIRONMENTAL, INC. OF NORWOOD, MASSACHUSETTS.
2. LOCATIONS OF THE SURVEY POINTS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS FROM EXISTING SITE FEATURES. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LARSEN RINK SLAB SURFACE DEFLECTIONS RELATIVE TO BENCHMARK AT LOBBY FLOOR SLAB (INCHES), GZA AUGUST 13, 2008 SURVEY
WINTHROP, MASSACHUSETTS

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists, ONE EDGEWATER DRIVE, NORWOOD, MASSACHUSETTS 02062

PREPARED FOR: MACLAUGHLIN MANAGEMENT & DESIGN, KENSINGTON, NH

SLAB SURFACE DEFLECTION CONTOUR PLAN

PROJ MGR: MAR	REVIEWED BY: WHH	CHECKED BY: MAR	FIGURE
DESIGNED BY: WHH/BW	DRAWN BY: BW	SCALE: 1" = 20 FEET	1
DATE: 8-14-2008	PROJECT NO. 19280.30	REVISION NO.	