STORMS ON THE PROMENADE

Overcoming a stormy sea of challenges to transform a declining mall into a dense mixed-use development mimicking native wetland conditions

The new Promenade of Wayzata 14-acre mixed use redevelopment on the east edge of downtown Wayzata, Minnesota in mid Phase 2 construction (Phase 1 complete). Lake Minnetonka visible at top of photo. Photo courtesy of Brenda Chamberland, Aerial Solutions.

Storms on the Promenade

Wayzata – City of Rich Lake History

Settled in 1852, the City of Wayzata resides on the north shore of beautiful Lake Minnetonka about twelve miles west of downtown Minneapolis. The over 14,000-acre irregularly-shaped lake with numerous bays, peninsulas, and islands is wildly popular in the region, and has always been celebrated in Wayzata. As far back as 1882, boating, fishing, and picnicking brought upwards of twenty thousand vacationers who would stay at seventeen hotels scattered along the lakeshore.[1] One of the largest hotels boasted 800 rooms built by famous Canadian-American railroad executive James J. Hill.[1] In fact, his railroad extended to Wayzata, making it the transportation hub of the area as vacationers would be transported from Wayzata's railroad landing to the hotels by "large paddlewheel boats, some able to accommodate as many as 3,300 passengers![1]"

Through the decades, hotels were replaced by summer cottages on the lake and up the hill. In the 1920's motor boating was the rage, and made the city home to two nationally famous speedboat makers on the shoreline.[1] Thousands of spectators came to the lake to watch boat races. After World War Two, many farms around the city became single family housing sites and the city annexed more surrounding land. Downtown shops continued to focus on fashion and service businesses.[1] In the 1970's many were replaced by condominiums and office buildings after a major highway to Minneapolis was widened decreasing business to Wayzata stores. Through it all, boating, fishing, and strolls along the lakeshore continued their timeless popularity.

Known today as a highly desirable executive office and retail center due to the lake, the city features dozens of high-quality specialty shops and many other fine businesses located along the lakefront. A beach, parks, and regional walking/biking trails are interspersed with mansions that spread from the lakeshore estates to the blocks going up the hill from downtown. Wayzata is one of the most picturesque and alluring towns of any in the Midwest.

Wayzata townscape from Lake Minnetonka.

Leaky Vessel on the Edge

Originally a 14-acre wetland by Lake Street at the edge of the city's downtown district, in 1964 it was filled to make way for a mall development called the Wayzata Bay Shopping Center consisting of roughly 12 acres of impervious roofs and parking lot, leaving just 2-acres of remaining wetlands. Gleason Creek which ran through the former wetland was contained within two large pipes so streets and a parking lot could be constructed over it.

Predeveloped condition – native wetland (1947).
Aerial photos from Historical Information Gatherers.

Existing condition through 2011 – shopping center (2003).

The new mall began showing signs of trouble from the beginning. Though the buildings were supported by driven timber and steel piles to maintain their grade and integrity, the parking lot and exterior utilities relied on soils for support. However, the site is subject to constant settlement due to the deep underlying wetland soils which range up to 35 feet thick below 25 feet of urban fill.

Utility breaks and repaving were regular occurrences at the mall due to the constant settlement. Parking lot settlement was exacerbated in a vicious cycle of repaving which added weight, thereby, setting off subsequent short-term settlement. In addition, the site continually experienced long-term settlement irrespective of new loads.

Remarkable as it may sound, roof drainage for most of the 90,000 square feet of flat roofs drained directly into extensive void space below the mall where significant settlement eventually allowed a person to walk upright. Periodic flooding in this unintentional "crawl space" reportedly required a small boat to navigate it for inspections and repairs. Two pipes on the north and west sides of the mall were open to the space, likely to overflow roof water to the city sewer, however, left evidence that they back flowed into the space instead. A roof pipe collection system was finally installed to route roof flows to new exterior storm sewer at the south side of the space. The roof drain was connected to the sewer with a flexible connection. However, because the site and sewer continued to settle, the connection periodically ruptured unnoticed, thereby allowing the space to flood again during the next storm. Sanitary sewer breaks periodically leaked into the space unnoticed for long periods of time, as well. Settlement eventually dropped the grade in the space to below the water table. A primitive lighting system, a makeshift sump pump, and a large automatic air transfer system were installed in the void space so corrections could be safely accomplished to address the constant crashing waves of maladies.

To add to the troubles, another repellent liquid – petroleum contamination – was present in various areas of the site. These and other conditions pushed the obsolete declining retail complex to near blight. This ship was truly a “leaky vessel.”

Inspector in “crawl space” below existing mall. Grade level Is estimated to have settled about 5-feet since original mall construction in 1964. AET, Inc.

Roof pipe (white) connected to exterior storm sewer (black) – a flexible coupling between the two pipes is under stress from exterior settlement at the existing mall.

Excavation to fix exterior watermain break at existing mall. At least eight distinct repaving layers apparent extending about 6-feet below grade.

Makeshift sump pump to manage constant water in “crawl space” below existing mall.

New Ship with Promenade Deck

Over the years, numerous developers proposed various plans for redeveloping the site, however, none advanced very far. Seeing this redevelopment opportunity as providential, Presbyterian Homes & Services (PHS) began investigating the property in early 2007. In February 2007, the design team met first with the Minnehaha Creek Watershed District (MCWD) to begin project collaboration, and the City and other regulatory bodies shortly thereafter. In June of 2008, the city approved a General Plan put forward by now project sponsor PHS for a mixed use development, and the detailed planning began in earnest. Called "The Promenade of Wayzata," the project is a 3-phase mixed-use redevelopment on 14-acres which replaces the old mall with 6 distinctive blocks focused on the pedestrian.

Plan for The Promenade of Wayzata (fka, Wayzata Bay Center Redevelopment).

Phase 1 construction was substantially complete in July 2014 and consists of a building block dedicated to the senior living community with independent living, assisted living, memory care, and skilled nursing called the Folkestone Terrace North (fka, North Block) with a second building block for independent living called Folkestone Terrace West (fka, Superior Block). Phase 2 began in late 2013 and consists of a building block for independent living called Folkestone Terrace South (fka, West Block), another building block for market rate condominiums and apartments called Regatta Wayzata Bay Residence (fka, Plaza Block), and, a last block for a park called The Great Lawn (fka, Plaza Park). Phase 2 is anticipated for completion in mid-2015. A future phase will complete the park and add a sixth and final building block (East Block) anticipated for a hotel and office. All buildings are programmed for retail components at street level, and have underground parking.

Thunderstorm of Goals & Constraints

The project is essentially a "land bridge" since all buildings, boulevards, and utilities require unconventional foundation systems (e.g., heavy concrete grade beams supported by driven steel pipe piling). When all phases are complete, the project will have driven upwards of 3400 steel pipe piles averaging 115 feet deep – that's over 70 miles of piling, over 6000 tons of steel, and over 3000 cubic yards of concrete/grout to fill the pipe piles. Thus, the basic premise to build a project on this site was foreboding. To add to this, and to help secure project approval from city officials, the plan laid additional ambitious goals to energize this forlorn part of the downtown and make it a vibrant place by providing a plethora of exceptional benefits to the community and environment. Goals included such things as realignment of problematic downtown street intersections, extensive walk and street snow melt systems, and geothermal heating and cooling from thousands of driven piles supporting the redevelopment, to name just a few.

While many of the goals were daunting, a signature goal of the project regarded stormwater. A dizzying array of investigations, preliminary designs, and collaborative meetings with regulatory authorities finally resulted in the goal for the project to mimic historic predevelopment stormwater conditions when the site was a wetland, thereby, far exceeding regulations which required matching existing conditions. This would demand a significant infiltration component to reduce volume and be formidable for most sites; however, for this site it was ominous, considering several facts:

1. **Voluminous volumes** – the proposed site is essentially not reducing impervious surface and therefore requires large expansive volumes of airspace integral to stormwater systems for attenuating storms.
2. **Impermeable mush** – site soils have literally no integrity for support of storm systems and are subject to significant long-term consolidation. Soils are also subject to significant short-term consolidation, even for minor raises in grade, and, soils could bounce if cut. Except for deep native sands, soils have virtually no infiltration potential.
3. **Cramped quarters** – from a vertical perspective, stormwater systems have to be located below streets in the narrow space between the bottom of substantive street structural systems (e.g., post-tension slabs, deep precast double tees) and above a shallow water table. In addition, any pipe discharges have to be elevated since adjacent city storm sewers were perpetually full of water from the adjacent lake level which was only 5 feet below grade. This level bounced higher during storms due to flows from extensive off-site regional areas of upland neighborhoods.
4. **Laterally limited labyrinth** – from a lateral perspective, stormwater systems must fit between dense arrays of driven piles, and far enough from buildings to limit seepage risks.

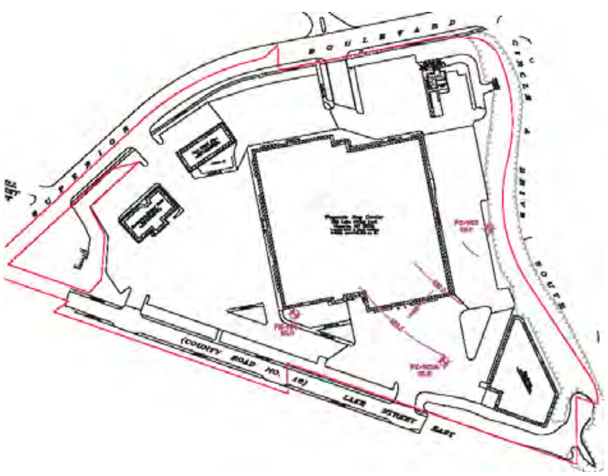
In short, big spaces with good soils are needed, and small spaces with bad soils are provided. Let's set sail!

Turbulent Sea of Hydrogeology

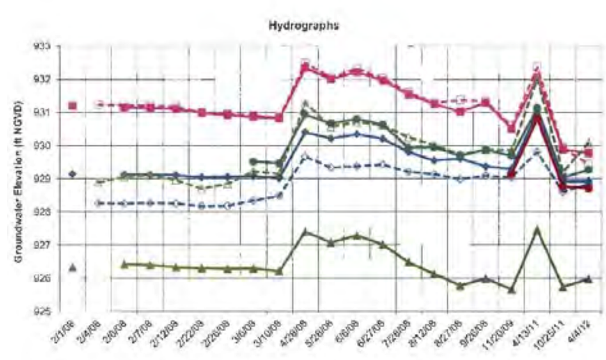
The geology underlying the Promenade of Wayzata is like a turbulent sea. A designer for the project stated, "I've never seen anything like it in over two decades working in the Midwest – one boring is clean sand 14 feet below grade and another boring 50 feet away is 17 feet deeper for the same sand stratum." In fact, sketches and graphs of site hydrogeology resemble a roiling ocean all tossed about.

"Turbulent sea of hydrogeology" – wildly varying depth to sand contours (5' intervals). AET, Inc.

Borings were utilized exclusively instead of test pits to gather geotechnical information due to the deep depth of the sand stratum, shallow water table, and need to maintain uninterrupted traffic in the existing mall parking lot. Borings in promising areas for locating the infiltration system were continuously sampled well into the sand stratum to help identify veins of impermeable soils, if present. Piezometers were also installed across the site to gather groundwater information, including depths, flow directions, and hydraulic conductivity testing.



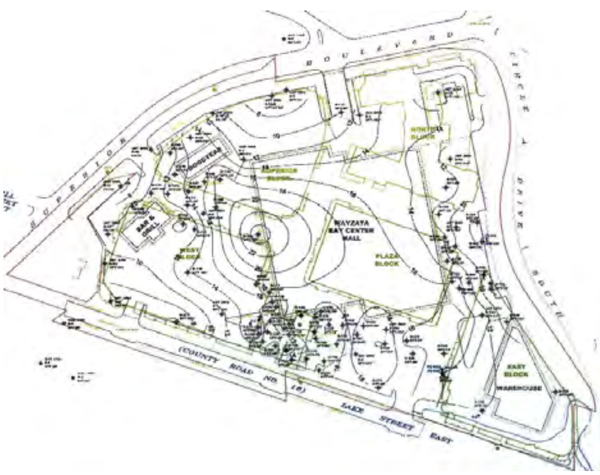
"Turbulent sea of hydrogeology" – steep groundwater flow contours 1/2' intervals) indicating flow in the deep sand stratum towards Lake Minnetonka. AET, inc.



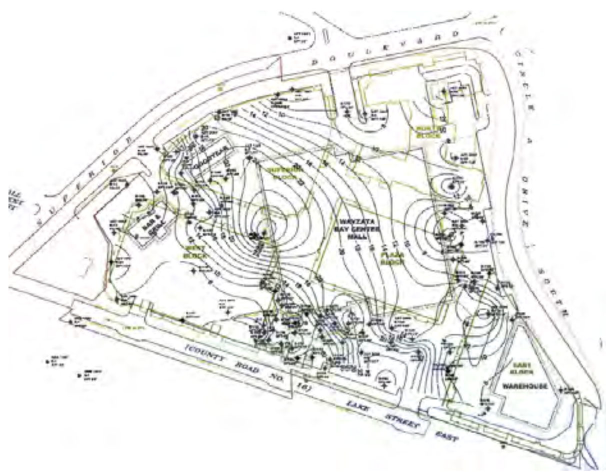
"Turbulent sea of hydrogeology" – piezometer water level measurements varying over 2-feet (2008 – 2012). AET, Inc.

The site consists of an unconfined surficial groundwater table averaging about 5 feet below grade within 8 to 24 feet of urban fill over 8 to 30 feet of clayey swamp deposits ("mush"). All this is in the way of reaching an underlying thick sand stratum critical for meeting stormwater infiltration goals. To complicate things further, piezometric data indicated semi-confined groundwater in the sand stratum having a separate water table slightly elevated above the unconfined water table, both bouncing over 2 feet between the lowest and highest readings as recorded within a period of several years.

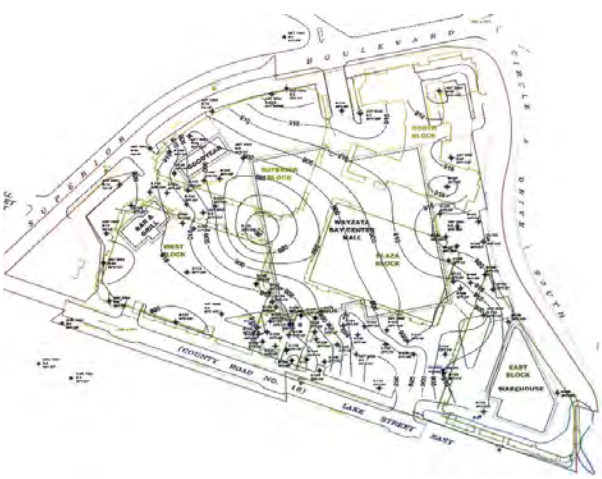
Historic borings were reviewed and new borings advanced. Initial investigations mostly rained on the design team's hopes, however, typically left some encouraging geologic data upon which to base the next targeted investigation. The wildly varying geology matched the emotions of the designers – up one day, down the next. A typhoon of other interdependent project design components and investigations (e.g., building, geothermal, piling, hydronic system, environmental, wetlands, etc…) proceeded concurrently and in constant flux as the design team searched the site for feasible areas to infiltrate stormwater and increase their understanding of site soils.



URBAN FILL THICKNESS (2' CONTOURS)



SWAMP DEPOSIT "MUSH" THICKNESS (2' CONTOURS)



SWAMP DEPOSIT "MUSH" BOTTOM (5' CONTOURS)

TOP OF GLACIAL TILL (5' CONTOURS)

"Turbulent sea of hydrogeology" – widely variable geology underlying The Promenade of Wayzata (fka, Wayzata Bay Center Redevelopment). AET, Inc.

Though borings indicated a deep sand stratum across much of the site, the stratum pinched out at some locations, especially away from the historic creek. This raised a concern amongst designers that the deep sand stratum could be laterally bound by impermeable soils thereby limiting its ability to receive site runoff – like a bathtub full to the brim with water overtops when the faucet is turned on.

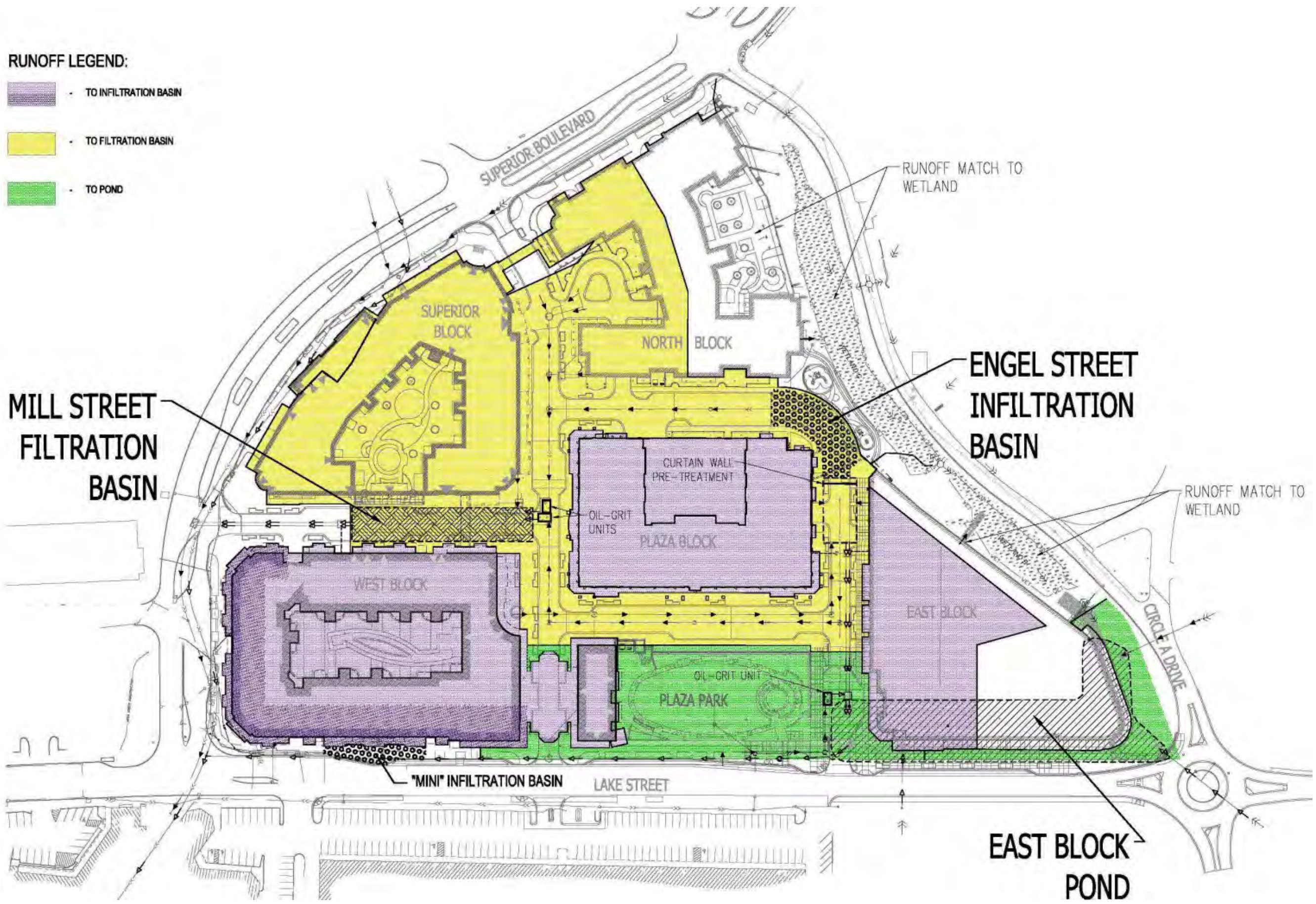
During the investigations, investigators executed a direct test on the deep sand stratum using a 30-inch steel casing advanced about 20-feet into the clean sands.   The initial test indicated virtually no infiltration – more bad news that threatened to kill the stormwater goals. The geotechnical agency suggested that significant sediment may have settled to the bottom of the water column during casing installation. Therefore, the next day, the casing was vacuumed and the test rerun indicating 24 inches per hour of infiltration for just under 5-feet of pressure head above the water table. This news kept the stormwater goals alive and was a great moment for the design team.

These and other hydrogeological analyses helped alleviate "bathtub" concerns and establish the competency of the deep native sand stratum for positive dissipation of runoff to groundwater.

Soil sampling at the old mall on a frigid day in the dead of winter.

Taming the Storms

Continuing the analogy of the project to a ship, three primary systems help it overcome the stormy sea of goals and constraints, each roughly the size of a football field: an infiltration basin, a filtration basin, and a pond, as indicated below.



Primary stormwater systems at The Promenade of Wayzata: Engel Street Infiltration Basin, Mill Street Filtration Basin, East Block Pond. Runoff areas to each system are indicated in color according to the legend.

Though these stormwater systems sound simple enough and are not out of the ordinary for traditional engineering, for this project they could not be considered ordinary. These and other significant design components combined in unique ways to create a robust vessel, as described in the following sections.

Taming the Storms – Engel Street Infiltration Basin (“The Big Hole”)

After numerous boring investigations, a nauseating array of preliminary designs, and an equally nauseating collection of rejected locations (including locating the basin inside several building footprints), the team finally concluded on an infiltration basin below the street where it turns 90 degrees between three buildings. Here the excavation to the sand stratum is relatively shallow in order to limit dewatering costs and risks, and the location is just adequate for feasible pipe routing below thick post-tension street sections on their route to the basin.

Termed the “Engel Street Infiltration Basin,” the system is the most significant of the three primary stormwater systems and consists of a large infiltration area and attached detention vault. Excavated through the urban fill and swamp deposits to native clean sands, the infiltration area measures roughly 200 feet wide by 300 feet long with a depth ranging between 14 to 31 feet deep – a big hole. While this depth is at, and arguably beyond, the limits of feasibility due to the shallow water table, it is relatively shallow compared to other areas of the site.

“The big hole” – soil correction plan for Engel Street infiltration basin (1’ contours). Shaded areas at bottom of excavation indicate areas for infrastructure support only due to difficulty in establishing a clean bottom for infiltration. Unshaded areas at bottom indicate relatively shallower and cleaner soil correction area for infrastructure support and infiltration where dry conditions from dewatering wells resulted in good inspection of subgrade.

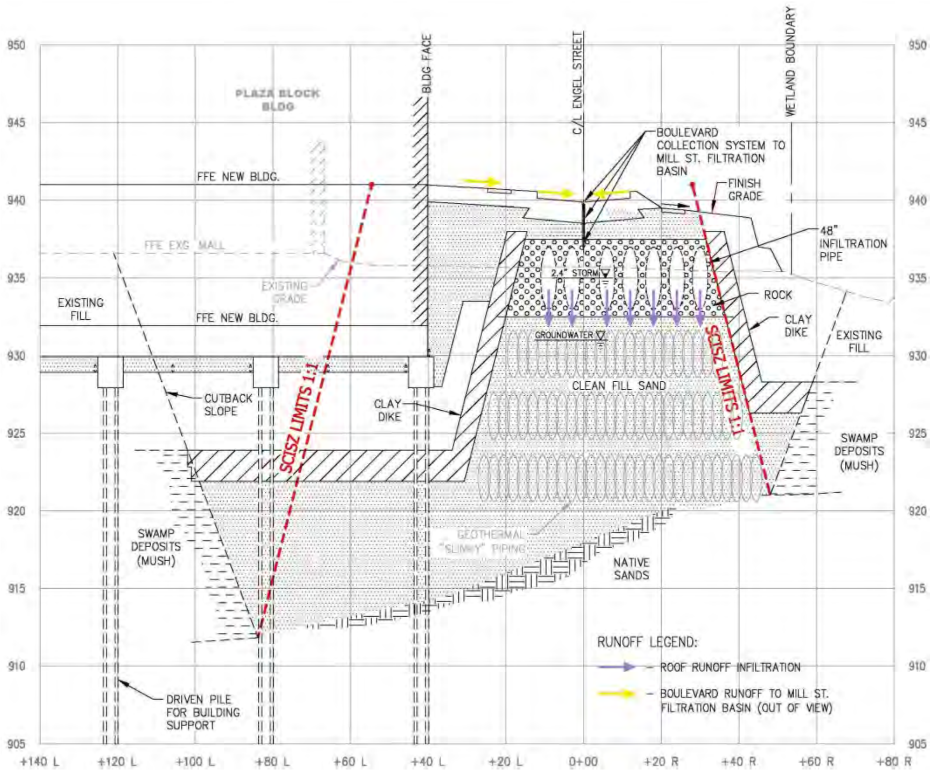
Dewatering wells dropped the shallow water table several feet below much of the excavation bottom for a good visual inspection of the subgrade. Excavation several feet below murky water allowed deeper fringe areas at the bottom of the basin to serve soil correction purposes only.

The majority of the excavation bottom being intended for soil correction and infiltration purposes, required a good examination of the subgrade since the team learned a valuable lesson from the infiltration test well – even a small amount of sediment on the sand can compromise the ability of the system to infiltrate. As expected based on careful review of the numerous borings, the majority of the native sand was clean having less than 5% fines (percent passing a USCS number 200 sieve).

Clean native gravelly sand below swamp deposits at Engel Street infiltration basin (foreground). Leading edge of imported fill sands (background).

Imported clean sand fill in excavation for Engel Street infiltration basin (foreground). Steel pipe pile driving for Phase 1 building (background).

Specifications required imported fill sand to connect the infiltration pipes to the native sands to have less than 3% fines. A pleasant surprise came when the earthwork contractor found a fill source consisting of less than 1% fines, resulting in greater overall system performance.

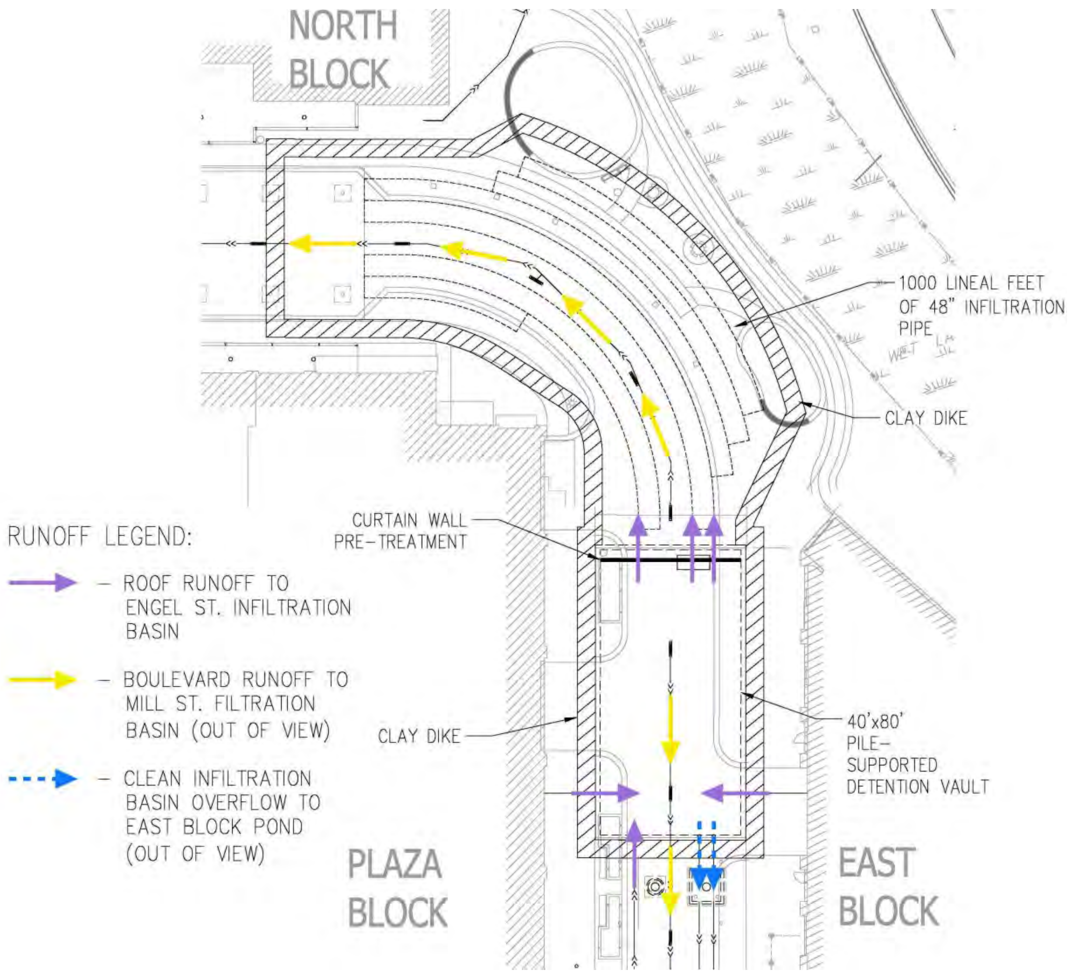


Section view indicating major components and flow routes for Engel Street infiltration basin. Soil correction infrastructure support zone (SCISZ) in red color. Infrastructure within the SCISZ Is constructed using conventional methods (e.g., no pile support).

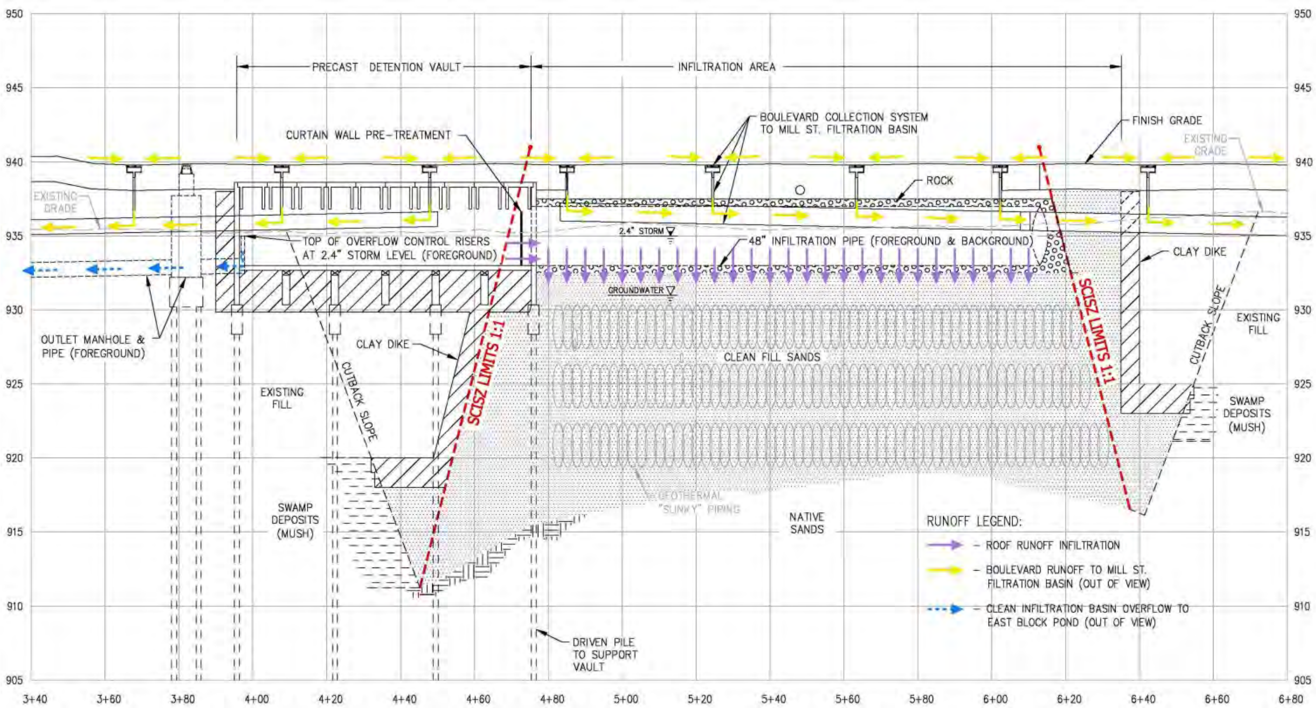
Designers referred to the zone of infrastructure support as the "SCISZ" – an acronym coined by the team which stands for "soil correction infrastructure support zone." The SCISZ is the three-dimensional zone of the new sand fill from competent approved subgrade at its base then extending up and laterally inward at a 1:1 slope to street level. Streets, walks, and utilities within the SCISZ did not require alternative foundation support (e.g., driven piles).

Perforated 48"corrugated metal pipe infiltration pipe installation at Engel Street infiltration basin. No alternative support for pipes is required since the soils on which the pipes bear are corrected inside the SCISZ. {SEE DRONE FLY-OVER OF THIS SYSTEM IN MID CONSTRUCTION @ www.youtube.com/watch?v=_1iz_thP_1c&feature=youtu.be) Photo courtesy of Contech.

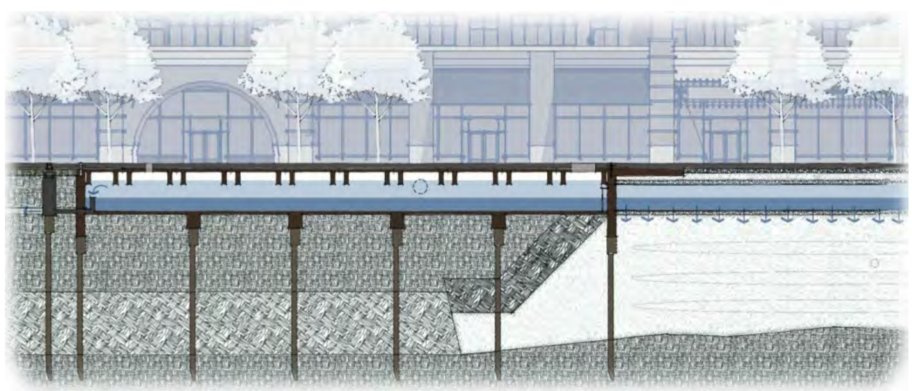
To help address heating and cooling needs for the adjacent building, three layers of geothermal "slinky" piping are placed at different elevations in the excavation in order to take advantage of the shallow water table and periodic circulation of runoff through the new fill soils of the basin. This piping combines with that installed in piles to total over 80 miles of geothermal piping for the first two phases of the project.



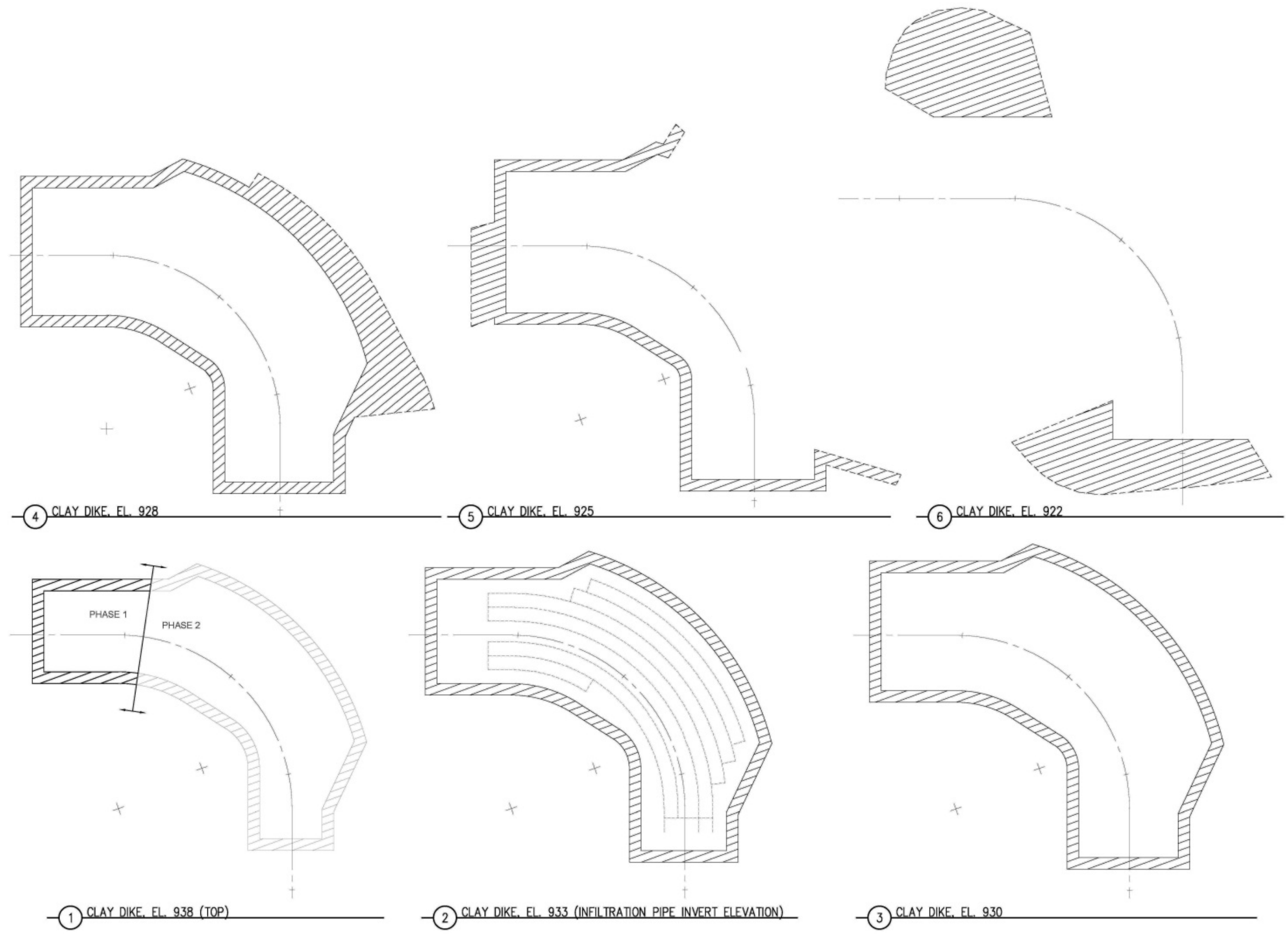
Plan view indicating major components and runoff flow routes for Engel Street infiltration basin (clay dike extending around infiltration area and vault). {SEE DRONE FLY-OVER OF THIS SYSTEM IN MID CONSTRUCTION @ www.youtube.com/watch?v=_1iz_thP_1c&feature=youtu.be).



Centerline profile indicating major components and runoff flow routes of Engel Street infiltration basin (clay dike extending around infiltration area and detention vault).


Early illustrated profile image indicating function of Engel Street infiltration basin.

Around the clean sand fill, a 5-foot wide clay dike limits seepage from the basin towards adjacent building envelopes. The clay dike is keyed into native clayey swamp deposits to contain the infiltration system and essentially eliminate seepage towards adjacent buildings when the basin bounces during storms.



Horizontal "slices" through the clay dike at various elevations for the Engel Street infiltration basin (dike around detention vault not indicated).

The maximum feasible infiltration area came up short for storage capacity to reach project goals. Therefore, a 40-foot by 80-foot precast vault is connected to the infiltration pipe network to provide additional storage capacity. Since the vault bears mostly outside of the SCISZ, it is supported by driven piling under grade beams (tie beams) with precast double tee top members. Little long-term settlement is expected below the vault since the grade is a cut of over several feet, therefore, the floor is a concrete slab on grade.

Looking south at Engel Street detention vault during construction. Three large openings are for connecting 48-inch perforated pipe network of adjacent infiltration basin.

Looking north inside Engel Street detention vault during construction. Large sun-filled openings are for eventual connection with 48-inch perforated pipe network of adjacent infiltration basin.

Looking south inside Engel Street detention vault during construction. Two large sun-filled round openings on right are for pending inlet pipes from project roof collection networks. Smaller higher opening on left is opening for eventual overlying street runoff collection pipe to route this dirtier runoff to the Mill Street filtration system.

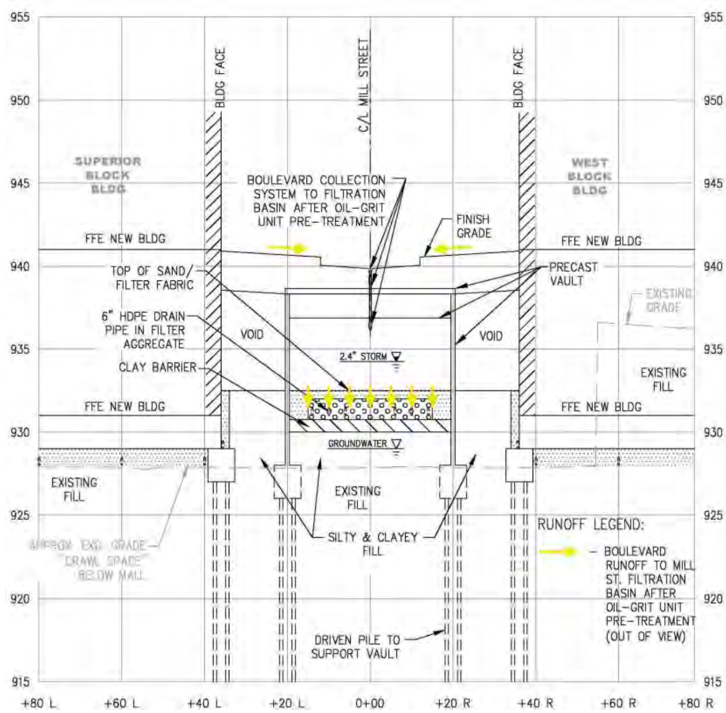
Two riser pipes for overflow of surficial portion of very infrequent storms rigidly connected to detention vault wall at south end of precast stormwater detention vault of Engel Street infiltration system (foreground). Riser rims set at 2.4-inch storm level, resulting in infiltration for 99% of annual rainfall for 5-acres of mostly impervious surfaces.

Runoff from about 5 acres of exclusively building roofs is directed to the detention vault before it passes through a filter fabric pretreatment curtain wall (see “Pretreatment” section) to one thousand lineal feet of perforated 48-inch diameter corrugated metal pipe gallery which distribute the runoff to the clean sands of the infiltration basin, thereby recharging the groundwater. A full 2.4-inch runoff event is fully infiltrated by the system which translates to no runoff to Lake Minnetonka for 99% of all annual rainfall for 5 acres of mostly impervious surfaces. The bulk of larger very infrequent storms are also infiltrated while the surficial portion of these storms (cleanest portion) overflows to risers in the vault. The risers drain to discharge lines routed to the East Block underbuilding pond (see “East Block Pond” section) where this clean portion is further cleaned and managed before discharging to Lake Minnetonka.

Taming the Storms – Mill Street Filtration Basin

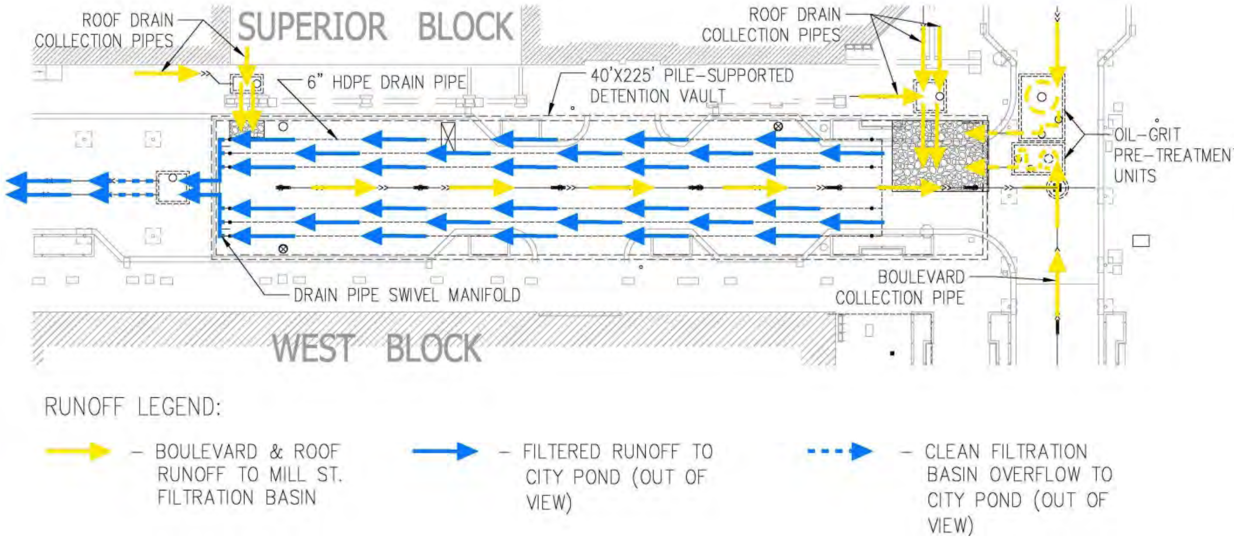
The second of the primary stormwater systems is an understreet filtration system which detains and filters runoff from about 5 acres of building roofs and boulevards (streets and walks). Termed the "Mill Street Filtration Basin," the far western portion was considered as one of many potential infiltration basin locations, however, finally rejected in favor of a filtration basin due to the excessive depth to the sand stratum, dewatering, and other complications. Its location is based on demand for large space, continuous linear orientation compatibility with street structural systems, outfall proximity, and collection pipe system feasibility.

The basin measures 40-feet x 220-feet of similar construction as the smaller detention vault connected to the Engel Street infiltration basin, however, the floor consists of fabric and engineered fill to do the filtering. The surface of the floor is a geotextile filter fabric that can be replaced. Below this sacrificial fabric is clean sand above butt-fusion welded high density polyethylene drain tile wrapped in another filter fabric and filter aggregate, on top of a clay barrier layer.

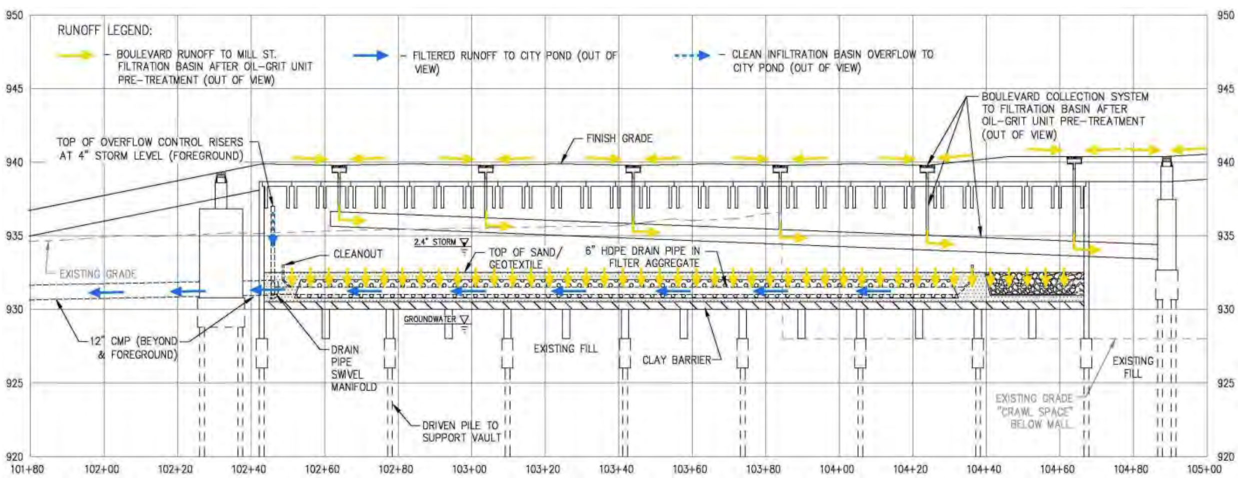


Section indicating major components and runoff flow routes of Mill Street filtration basin.

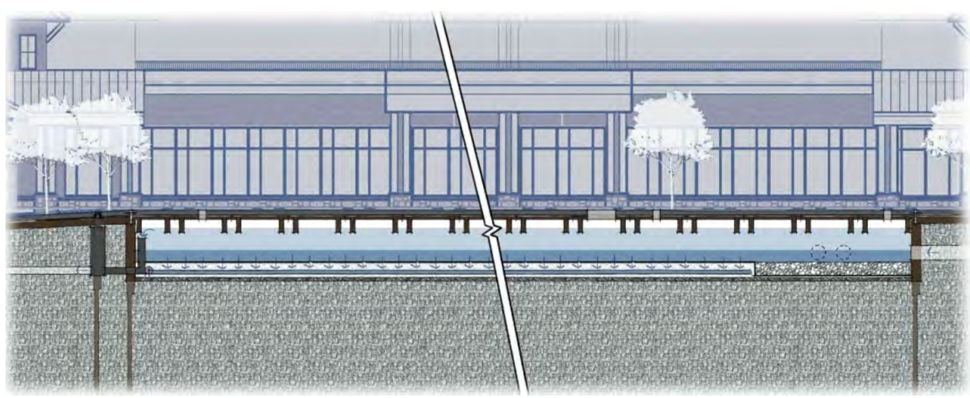
The eastern third of the basin occurs over some of the worst soils on the site and results in a raise of grade of about 5-feet since this area is the old mall "crawl space." Therefore, the soils were surcharged to remove the primary consolidation associated with the grade increase. The western two-thirds of the basin resulted in a cut of about 3-feet and relatively smaller long-term settlement. On the west side of the basin, drain pipes connect to a pipe manifold rigidly connected to the pile supported precast wall using a swiveling slip joint that allows the connection to maintain its integrity as the drain pipes settle with the settling soils over many years.



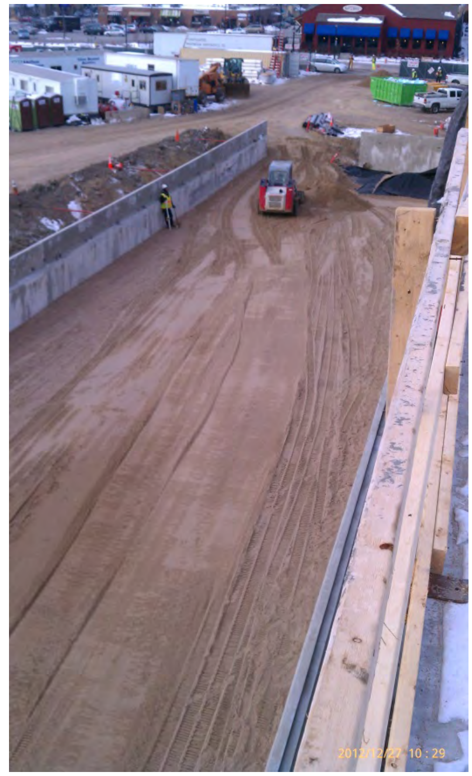
Plan view indicating major components and runoff flow routes of Mill Street filtration basin.



Centerline profile indicating major components and runoff flow routes of Mill Street filtration basin.



Early illustrated profile image indicating function of Mill Street filtration basin.



Recently placed clean sand in the Mill Street filtration basin prior to covering with sacrificial filter fabric and capping the basin with precast double tee structural members (left – looking easterly, right – looking westerly).

6-inch butt-fusion welded perforated drain tile in filter aggregate prior to slip-joint swivel connection to pending manifold pipe in Mill Street filtration basin.

Runoff discharges into this basin onto rip rap energy dissipation after being pre-treated by large oil-grit units (see "Pretreatment" section) and prior to being filtered through the filter fabrics and engineered soil media into the drain tile system. Almost a full 4-inch runoff event is fully filtered by the system – that's clean runoff to Lake Minnetonka for over 99% of all rain events including large very infrequent storms from 5 acres of mostly impervious surfaces. The bulk of rare extreme storms are also filtered while the surface portion of these storms (cleanest portion) overflows to risers in the vault. The risers drain to discharge lines routed to the city sewer where this clean portion is further cleaned and managed by the city's Lakeside Pond before discharging to Lake Minnetonka.

Taming the Storms – East Block Pond ("The Blue Grotto")

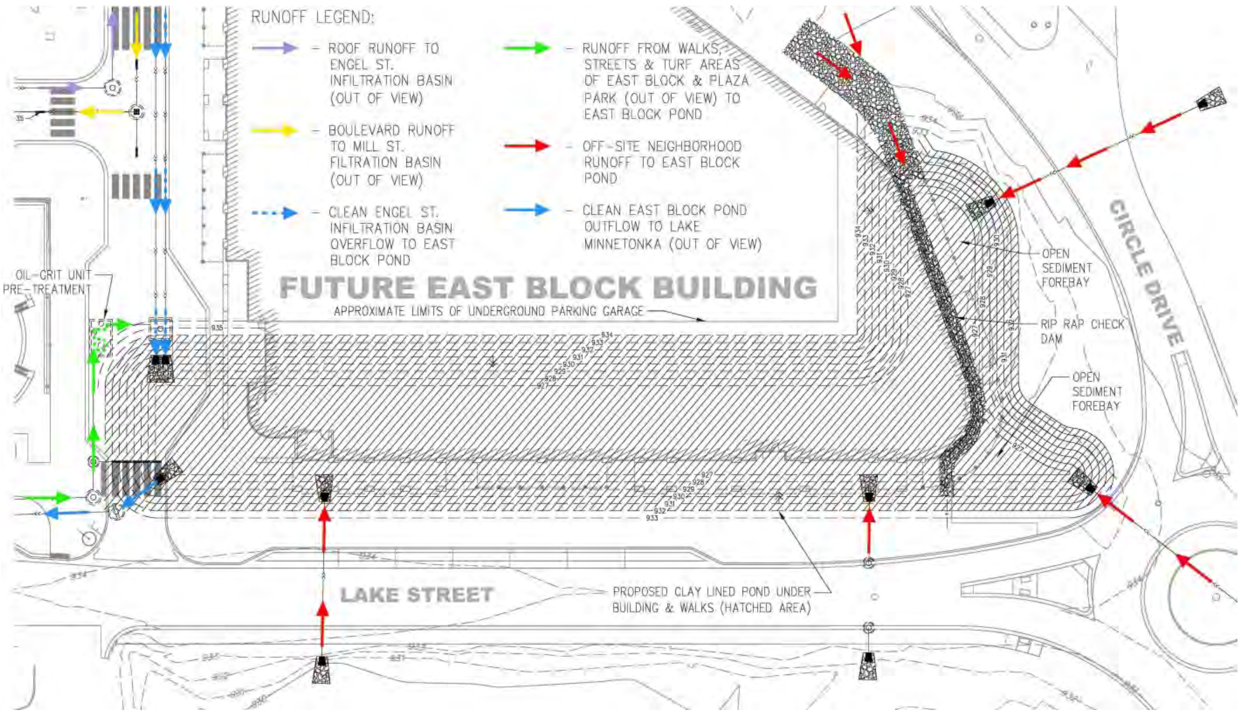
Occasionally referred to as "the blue grotto" by designers due to its likeness to the Grotta Azzurra sea cave in Italy, a new pond will be constructed completely below a building with low access into it from its far end where natural light shines in. Officially termed "The East Block Pond," the new pond is the third primary stormwater system constructed with the last and future phase of the project (Phase 3). The new pond manages and treats project stormwater runoff from 2-acres of walks, streets and vegetated areas of the East Block and The Great Lawn (fka, Plaza Park) after oil-grit unit pretreatment. It also manages and treats the overflow portion of larger very infrequent storms from the Engel Street infiltration basin. Finally, the pond manages and treats residential neighborhood runoff from about 10-acres which flow directly to the pond, and another 10-acres that flow to the pond after passing through separate upslope ponds.

In its existing condition, the pond is an irregularly-shaped shallow muddy wetland pond overgrown with a quagmire of invasive species that has long been used by the city to manage regional stormwater.

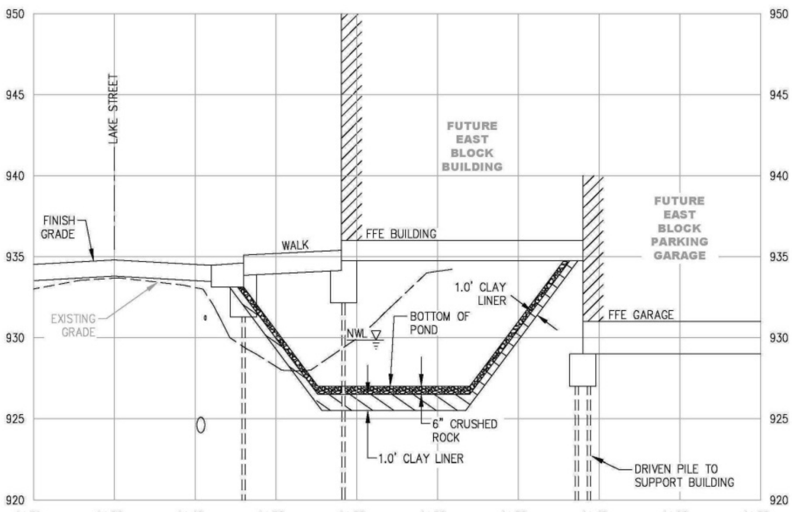
Looking north at nearly dry existing city pond during summer.

Looking north at dry existing city pond during summer.

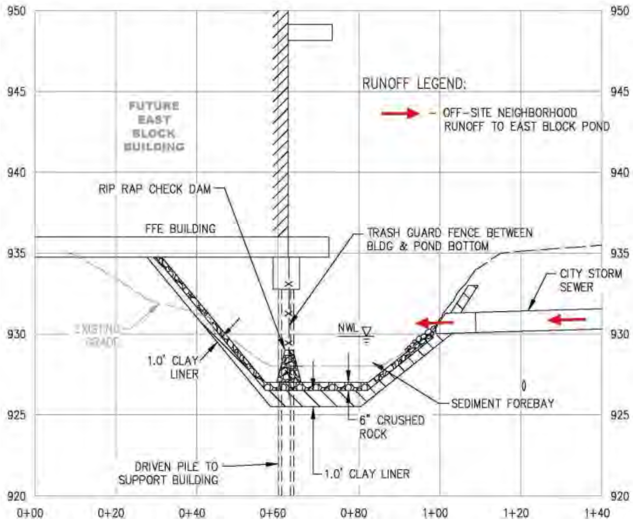
The reconstructed pond will be in generally the same location as the existing pond over some of the worst soils of the site adjacent to the underground parking garage of the East Block building with garage finish floor elevation just over a foot above the normal water level of the pond. Therefore, part of the criteria on which the pond shape is based includes virtually no filling of existing pond embankments so that consolidation is limited in the underlying soils. This helps maintain pond liner integrity thereby limiting risks of leakage towards the immediately adjacent below grade parking garage, especially during storms when the pond bounces several feet. Thus, the existing pond shape being irregular is now slightly expanded to follow a uniform and constructible footprint resulting in essentially no filling in the proposed condition. This slight expansion serves a secondary objective of providing necessary freeboard between the high water level bounce and the adjacent city street.



Plan view indicating major components and runoff flow routes of East Block pond.



East Block pond section at building indicating major components of East Block pond.



East Block pond section at open forebay indicating major components and runoff flow routes.

Compare critical pond performance criteria for the existing pond and the proposed pond:

Criteria	**Existing Condition**	**Proposed Condition**
Permanent pool	0.82 ac-ft required 0.49 ac-ft exists	0.61 ac-ft required 0.82 ac-ft provided
Permanent pool	3' minimum depth required 2' maximum depth exists	3' minimum depth required 3' minimum depth provided
Discharge	1.9 cfs /pond ac	0.16 cfs / pond ac
Prevent short-circuiting	No – narrow basin with virtually no bottom width; nearest inlet to outlet distance of 100'.	Yes – 40' bottom width; nearest inlet to outlet distance of 390'.
Pretreatment	No	Yes – two sediment forebays & oil-grit unit pre-treatment

The new pond will reduce contaminants discharging to the lake by over 10 pounds of phosphorus and over 1000 pounds of total suspended solids annually.

Though the new pond will present a challenge for future construction constitutes a truly unique condition below the new building, this "Blue Grotto" also has a unique beauty in significantly improving water quality discharge to Lake Minnetonka.

Taming the Storms – "Mini" Course Correction

In the summer of 2013 during Phase 2 final design, an unforeseen condition caused a course correction – the Plaza Block needed to replace virtually all programmed green roof draining to the Engel Street infiltration basin with conventional roof (about 13,000 sf). This excess runoff volume exceeded the capacity of the maxed out basin. As providence would have it, another unforeseen condition surfaced shortly thereafter – the West Block could not pipe about 28,000 sf of conventional roof to the Engel Street infiltration basin and also needed to reduce their green roof by about 7,800 sf (the building would still have about 14,000 sf of green roof). The West Block problem vaporized the Plaza Block problem since the Engel Street infiltration basin suddenly had excess capacity, even with the increased runoff from the Plaza Block roofs. However, the situation created need for additional runoff management for the orphaned West Block runoff, in order to maintain project stormwater goals.

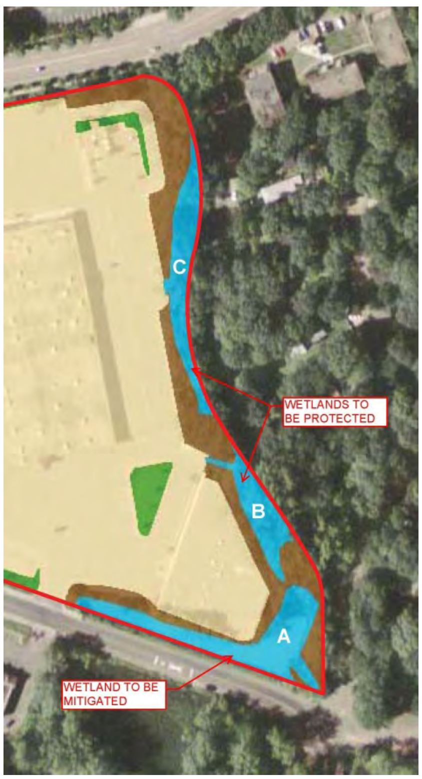
A few early borings identified the possibility for locating an infiltration basin under the sidewalk on the south side of the West Block where the deep sand stratum is relatively shallow. However, the idea was not pursued due in part to capacity and routing limitations. Presently, based on PHS direction to maintain stormwater goals and several confirmatory borings, installation of a new miniature infiltration basin ensued. About 20-feet wide by 150-feet long by 13-feet deep the "mini" infiltration basin is located immediately below the walks between Lake Street and the West Block building. The basin consists of 300-feet of 36-inch perforated pipe that drain through clean fil sands to the deep native sand stratum with a clay barrier dike separating it from the soils below the building. The system operates the same as the larger Engel Street infiltration basin by fully infiltrating a 2.4" storm equating to no runoff to Lake Minnetonka for 99% of all annual rainfall. The bulk of larger very infrequent storms are also infiltrated while the surficial portion of these storms (cleanest portion) overflows to Lake Minnetonka.

Back on course!

Taming the Storms – Wetland Care

Three wetlands of just under an acre of combined area exist on the far eastern edge of the site in a long slender natural area called the "east buffer" for its attribute of shrouding the project from adjacent off-site residences. The wetlands flow into Lake Minnetonka. One is an existing city management pond to be replaced with the above described underbuilding detention pond of the future East Block (Phase 3). In addition to being replaced in the same location with a bigger and better storm pond (see "East Block Pond" section), this wetland has been mitigated in another area of the city at 2.25 times its original size to stay ahead of future East Block construction.

The two remaining upland wetlands are preserved with new protective buffer established all around their perimeter. About 2 acres of the proposed project is dedicated to flowing into the wetlands to match hydraulic conditions to these wetlands for the 1-, 10-, and 100-year storms. The project mimicked the native quality of water discharging to them and in turn to Lake Minnetonka by exchanging parking lot runoff from the existing condition, with conventional and green roof runoff in the proposed condition – a substantial improvement in runoff quality to these wetlands and Lake Minnetonka to which they flow.



Existing wetlands in natural area on east side of site ("east buffer"). Wetland A is a city stormwater management pond to be replaced with a new pond located under the East Block building after local wetland mitigation.

The project identified and protected valuable species based on a comprehensive tree survey for the entire east buffer in and around these wetlands, requiring relocation of various proposed infrastructure during design of the buildings. Finally, prolific invasive species (e.g., buckthorn) are eliminated to further improve the long-term health and beauty of the wetlands and immediate upland areas towards native conditions.

Taming the Storms – Green Roofs

To help manage runoff and add charm for the residents of the buildings to enjoy, green roofs are an integral part of the project. Mostly "extensive" having a thin section of growing media 4- to 8-inches thick) for sedums, turf, and ground cover, the green roofs are located immediately above parking garages on most buildings. Smatterings of intensive planters with thick growing media up to 3-feet thick for trees extend across the roofs, also. At project completion, the total green roof area is estimated to be about 50,000 square feet (1.1 acres).

Under the charm – construction of waterproofing and drainage systems prior to adding soil media and plants on the green roof of the Folkestone Terrace West (fka, Superior Block). Photo courtesy of Adolfson & Peterson Construction.

Recently completed green roof of the Folkestone Terrace West (fka, Superior Block). Photo courtesy of Adolfson & Peterson Construction.

Recently completed green roof with putting green on the Folkestone Terrace West (fka, Superior Block). Photo courtesy of Adolfson & Peterson Construction.

Looking out over the Terrace green roof from the Parlour inside the Folkestone Terrace North (fka, North Block).

The Terrace green roof of the Folkestone Terrace North (fka, North Block).

The Terrace green roof of the Folkestone Terrace North (fka, North Block).

Lawn and planted area on The Terrace green roof of the Folkestone Terrace North (fka, North Block).

Taming the Storms – Pretreatment

The path for runoff to enter the Engel Street infiltration pipes is through the large detention vault where they connect via three of the 48-inch pipes. The runoff directed here is roof water which is relatively clean. Even so, regulators suggested adding a fabric filtration system to further reduce the long-term risk of prematurely clogging the infiltration system from fine particles. Therefore, designers added a filter fabric curtain wall system to the north end of the vault extending the full 40-foot width of the vault and from the concrete floor to above the projected level of the 100-year storm. The curtain wall is designed for removal and replacement of the fabric without removing the backer screen. In addition, the screen is removable for inspection and access of the expansive 48-inch infiltration pipes beyond.

Structural framing and steel backer screen construction for curtain wall pre-treatment system. When complete, a sacrificial filter fabric will be mounted against the backer screen to filter fine particles from entering the three 48-inchopenings to the infiltration system. A large vault opening indicated in upper right (background) of photo allows maintenance access for periodic removal and replacement of fabric.

Runoff from streets, walks, and vegetated areas is pretreated by large oil-grit swirl chambers prior to being discharged into the Mill Street filtration basin and East Block underbuilding pond. Similar to other manholes on the project, swirl chambers rest on pile caps of driven steel piling. The cost to extend and support large storm by-pass lines and appurtenant manholes around the chambers is equivalent to upsizing the chambers. Therefore, the chambers were upsized to allow large storms to pass through them, thereby, greatly improving their treatment performance and keeping even more sediment in the chambers where maintenance is relatively easy, versus the larger less accessible filtration basin and pond.

Large oil-grit swirl chambers over-pretreat boulevard runoff before discharging into the Mill Street filtration basin.

Taming the Storms – Slippery Pipes

The soils of the site are anticipated to settle up to several feet over many years thereby risking significant damage to the storm sewer. Conversely, possible upward pushing perched water conditions (buoyant forces) could also compromise storm sewer integrity. This quandry represented another “sea squall” for the project.

To solve the problem, designers intermittently anchored pipe to overlying post tension street slabs with hangers and put lightweight insulation board “backfill” above the pipes with poly sheeting and pea rock on the sides and bottom. Virtually no weight bears down on pipes and settling soils slip past.

To address buoyant uplift forces and facilitate constructability, hangers are rigid round reinforced concrete matching the pipe diameter and poured monolithically with the post tension slab over the top of the pipe.

Unconventional storm pipe installation at The Promenade of Wayzata.

Trench drain risers and hanger connectors for storm sewer at The Promenade of Wayzata.

Hanger connector for storm sewer at The Promenade of Wayzata.

Storm sewer extending from Mill Street filtration basin. Lightweight insulation "backfilled" over pipes with poly sheeting "slip sheets" on sidewalls. Sonotubes centered over hanger connectors to be filled with reinforced concrete during subsequent post-tension slab pour at The Promenade of Wayzata.

Storm sewer at The Promenade of Wayzata uses lightweight insulation "backfilled over pipes with poly sheeting "slip sheets" on sidewalls. Sonotubes centered over hanger connectors to be filled with reinforced concrete during subsequent post-tension slab pour.

Taming the Storms – Hydronic Snowmelt Systems

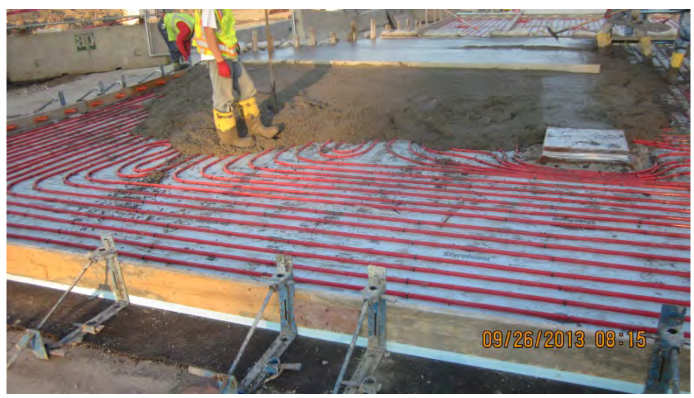
Only 2.5 percent of all of earth's water is freshwater[2]. Of this, less than 1 percent is available to us [2]. Our cold region lakes are becoming more saline due to salt use for winter maintenance which eventually causes chemical stratification and loss of lake turn over [2]. A Minnesota Pollution Control Agency (MPCA) study of 74 metro-area lakes in its third year found that 28 of the lakes have excessive levels of chloride, most of it from road salt [3]. Lake Minnetonka discharges to the Minnehaha Creek which is listed on the proposed 2014 Impaired Waters List for chloride [4].

Average salt use for winter pavement maintenance in the Twin Cities Metropolitan area is 350,000 tons per year [3]. In Minnesota, the average chloride concentration in surface waters is rapidly increasing from about 32 mg/L in 1960 to about 85 mg/L in 2005, closely correlating to an increase in rock salt usage from about 85,000 tons to 850,000 tons over the same period [2]. The only process that removes salt is reverse osmosis which is typically prohibitively expensive [2]. Therefore, source reduction is the only effective management tool for chloride at this time [5].

The old Wayzata Bay Shopping Center had about 8 acres of pedestrian and vehicular pavements when fully developed in about 1975. Based on 10 events requiring salt application, the old site applied about 32 tons of rock salt each winter season. Since 1975, this equates to roughly 1216 tons of salt discharged from the site to Lake Minnetonka and potentially to Minnehaha Creek.

When fully developed, The Promenade of Wayzata will have upwards of 80 miles of hydronic snowmelt tubing in all of the roughly 5 acres of streets and walks, thereby, equating to virtually no rock salt or similar use each winter season.

Hydronic snow-melt tubing placed in street during Phase 1 of the project.



Concrete pour over hydronic snow-melt tubing around stormwater inlet grate at street intersection of The Promenade of Wayzata.

Photos courtesy of Adolfson & Peterson Construction.

Hydronic snow-melt piping in walk by loading dock exit along Superior Boulevard at The Promenade of Wayzata.

Most developed sites in cold weather regions do not have continuous snow-melt systems, therefore, other contaminants inherent with streets and walks accumulate in snow piles and ice packs in and adjacent to these pavements all winter. Thus, during typical spring thaws, highly concentrated contaminants from these source areas are transported to stormwater systems at relatively high flow rates, especially during concurrent rain. These large spikes in contaminant transfer result in poor stormwater treatment system performance since typical systems aren't designed for such spikes.

The reverse is true at The Promenade of Wayzata where virtually all walks and streets have snowmelt systems. Contaminants are essentially only those which drop off tires from off-site vehicles coming onto The Promenade of Wayzata. Snowmelt systems deliver such contaminants at very slow low flows to underground stormwater systems since they melt snow and ice continually all winter. This results in much higher stormwater system efficiencies than the already high warm-weather efficiencies for which they are designed. This results in better fine and soluble contaminant removals and eliminates overflow to high flow by-passes, thereby, discharging extremely clean runoff to Lake Minnetonka from winter precipitation.

The hydronic snowmelt systems of the project are a significant environmental benefit to Lake Minnetonka and Minnehaha Creek in perpetuity.

Sailing Beyond Stormwater Regulations

Relatively speaking, most developers operate in "duck ponds," meeting bare bones regulatory stormwater requirements. To be fair, typical regulations require aggressive controls and go a long way in helping protect our precious natural water bodies. Consequently, costs to address typical regulations, especially in urban areas, can be substantial. While the extra capital for some building project components can have a return on investment (e.g., solar panels, wind turbines, energy efficient windows, etc…), stormwater systems typically have none. On the Promenade of Wayzata, conditions do not remotely lend themselves to conventional methods to implement stormwater systems, thereby raising the costs much higher.

Keeping these facts in mind, it is remarkable that the project sailed beyond the minimum requirements into "the deep," resulting in extraordinarily beneficial discharge to Lake Minnetonka and the Minnehaha Creek by mimicking historic predevelopment stormwater conditions when the site was a wetland, thereby, far exceeding regulations which required matching existing conditions. Consider the following:

- The regulations required that existing flow rates for the 1, 10, and 100 year storm events not be exceeded. The project decreased them by 60%, 40%, and 31%, respectively.

- The regulations had no volume reduction requirements for the 1, 10, and 100 year storm events. The project reduced the volumes discharging from the site by 32%, 20%, and 15%, respectively.

- The regulations had no infiltration requirements. The project infiltrated nearly 99% of all runoff for about 5 acres of the site. That's essentially all of the 30 inches of annual rain for any typical year, or nearly 4 million gallons annually.

- The regulations required that there be no net increase in total suspended solids (TSS) or total phosphorus (TP) discharged from the site and that new systems be 85% and 60% efficient, respectively. The project reduced these contaminants by 5500 pounds and 19 pounds annually and new systems are 89% and 72% efficient, respectively.

- The regulations required matching hydraulic conditions to existing wetlands. In addition to meeting this requirement, the project mimicked the native quality of water discharging to them and in turn to Lake Minnetonka by exchanging parking lot runoff from the existing condition, with conventional and green roof runoff in the proposed condition.

- The regulations had no salt (chlorides) reduction requirements. The project virtually eliminated chlorides by providing hydronic snow-melt systems in virtually all streets and walks.

Though the project suffered a delay during the economic downturn which started in 2008, PHS continued to direct the design team to stay on course to meet the stormwater goal of mimicking native wetland conditions. Now, in the second phase, this goal remains steady despite a torrent of stormy seas.

Looking out over a serene Lake Minnetonka on a beautiful day from atop a tower crane at The Promenade of Wayzata. Photo courtesy of Adolfson & Peterson Construction.

About the author

James W. Tiggelaar, PE, CCS, LEED AP is a professional engineer at LHB, Inc. with 23 years' experience in land development, especially focused on building and campus projects. He has a Bachelor of Science in Engineering from Calvin College in Grand Rapids, Michigan and lives just outside the Minneapolis metropolitan area. He is husband to a delightful woman and father to two vivacious girls. He enjoys working "outside the box" in close collaboration with owners, regulators, architects, other designers, and contractors to help ensure successful project outcomes. James has written numerous land development articles and spoken at a variety of land development forums.

Sources:

1 – Wayzata Historical Society website; http://www.wayzatahistoricalsociety.org/AboutWayzata.htm .
2 – Winter Parking Lot and Sidewalk Maintenance Manual, Minnesota Pollution Control Agency (MPCA) et al, 2008.
3 – "A Call for Less Salt in Our Roadways' Diet," Star Tribune, February 7, 2013.
4 – MPCA, 2014 Proposed Impaired Waters List.
5 – Minnesota Stormwater Manual, MPCA et al, "road salt" section.